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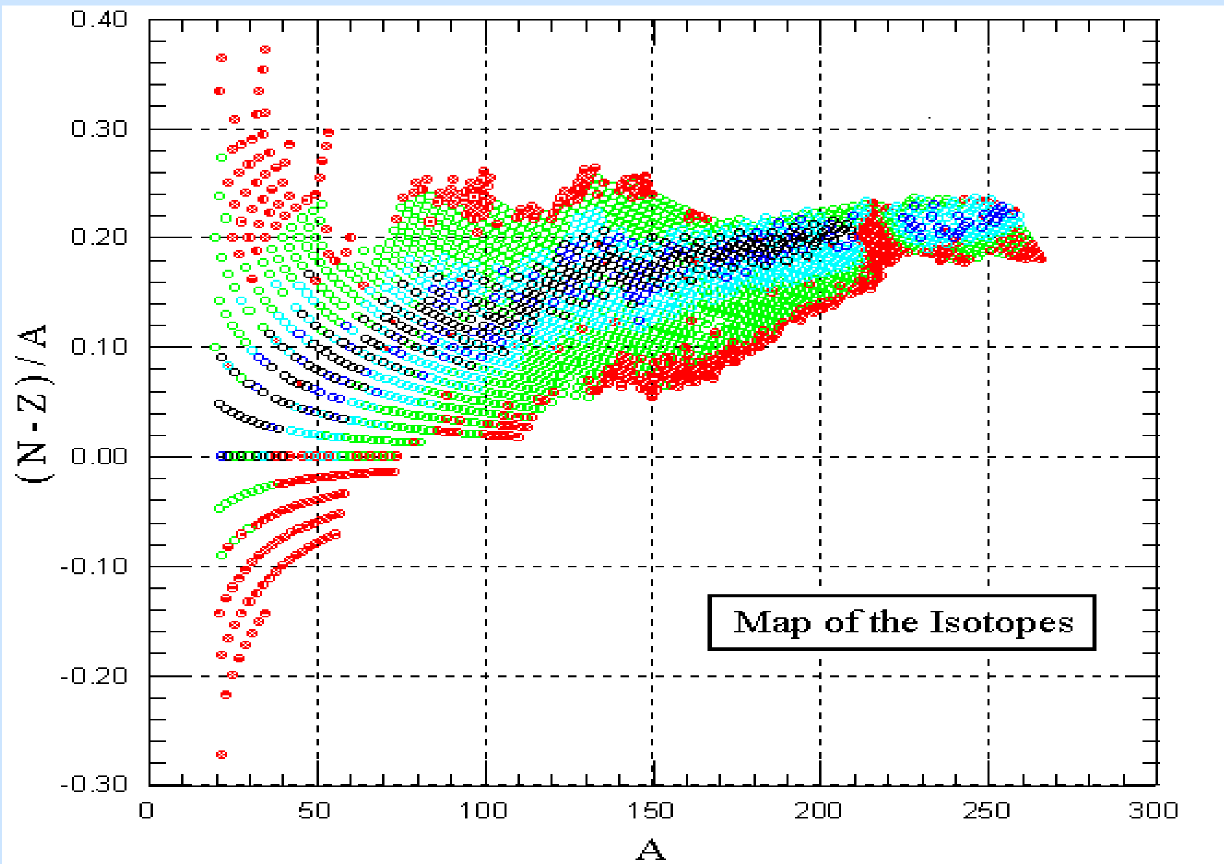
ANL/NDM-140

A Compilation of Information on the $^{31}P(p,\gamma)^{32}S$ Reaction and Properties of Excited Levels in ^{32}S

Donald L. Smith and Jason T. Daly

May 2000



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ANL/NDM-140

A Compilation of Information on the $^{31}P(p,\gamma)^{32}S$ Reaction and Properties of Excited Levels in ^{32}S [a]

by

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May 2000

Keywords

DATA COMPILATION. Nuclear reaction $^{31}P(p,\gamma)^{32}S$. Compound nucleus ^{32}S. Level spins/parities. Resonance interactions p + ^{31}P. Cross sections. Branching factors. Particle-decay widths. Astrophysics. Reaction rates.

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Table of Contents

Information About Other Issues of the ANL/NDM Series 5

Abstract 7

1. Introduction 9

2. Summaries of Work Reported in the Literature 13

3. Resonance Properties and Concluding Remarks 107

Acknowledgments 119

References 121

Appendix A: Unlocated NSR References 127

Appendix B: Compiled Information in EXFOR Format 131

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If any questions arise concerning the present report, the above-mentioned Internet site, or other reports in the Series, please direct them to:

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A Compilation of Information on the $^{31}P(p,\gamma)^{32}S$ Reaction and Properties of Excited Levels in ^{32}S [a]

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Abstract

This report documents a survey of the literature, and provides a compilation of data contained therein, for the $^{31}P(p,\gamma)^{32}S$ reaction. Attention here is paid mainly to resonance states in the compound-nuclear system ^{32}S formed by ^{31}P + p, with emphasis on radiative capture, *i.e.*, gamma-ray decay channels ($^{32}Si + \gamma$) which populate specific levels in ^{32}S. The energy region near the proton separation energy for ^{32}S is especially important in this context for applications in nuclear astrophysics. Properties of the excited states in ^{32}S are also considered. Summaries of all the located references with significant content are provided and numerical data contained in them are compiled in EXFOR format where applicable.

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1. Introduction

The (p,γ) and (p,α) hydrogen-burning reactions for nuclei in the mass range A = 30 - 50 are important for understanding energy generation and nucleo-synthesis in hot and explosive stellar environments such as those found in novas and supernovas [A96, C83, RR88]. Reactions of the type (p,γ) contribute to the production of progressively heavier nuclei while (p,α) reactions are responsible in part for their destruction. Detailed knowledge of the competition between these reaction processes is of considerable importance in gaining an understanding of the relative abundances of various nuclear species that are generated in hot stellar environments and ultimately ejected into the interstellar medium as a consequence of violent nova and supernova processes.

Due to Coulomb barrier effects, the cross sections for these reactions tend to be quite small and difficult if not impossible to measure directly for energies of astrophysical interest. Furthermore, they tend to vary rapidly with interaction energy. The corresponding reaction rates for a Maxwellian distribution of reactant energies are also very sensitive to the temperature of the stellar environment in question. Consequently, it is often necessary to calculate the reaction cross sections using nuclear models and then derive reaction rates from these results. In the mass range A = 30-50, the cross sections can be influenced by prominent discrete resonances in the compound-nuclear systems as well as by continuum-compound and direct interaction processes. The relative importance of these mechanisms depends on structural details for the target nuclei involved. Extensive information on nuclear potentials, nuclear level densities, spins and parities of specific nuclear levels, and properties of discrete resonances and their decay modes by particle emission and electromagnetic transitions must be considered in performing these calculations.

A long-term program of compiling and evaluating some of the important information needed for determining (p,γ) and (p,α) reaction rates involving targets in the mass range A = 30 - 50 has been undertaken at Argonne National Laboratory. The scope of the compilation activity is as follows: i) collect pertinent references from the literature; ii) prepare summaries of these references; iii) extract numerical values from these works and assemble them in computerized data files for convenient access. Nuclear Science References (NSR) is used as the principal reference source for this activity [NSR99]. The NSR list upon which the present work is based was downloaded from the Internet on 12 November 1999. The emphasis, with some exceptions, is on work reported during the last 30 years.

The present report focuses on the $^{31}P(p,\gamma)^{32}S$ reaction. The proton separation energy for ^{32}S is 8.864 MeV [T95], *i.e.*, Q = +8.864 MeV, so the compound nucleus ^{32}S is formed at a relatively high excitation energy (> 8.8 MeV) even for the relatively low incident proton energies encountered in a stellar environment. Using non-relativistic kinematics, and neglecting the small difference in mass between the ^{32}S compound nucleus in its ground state and at 8.864-MeV excitation for purposes of momentum conservation, it can be shown that the relationship between the incident proton energy E_p and the corresponding compound-nucleus excitation energy E_x for a resonance in ^{32}S formed by p + ^{31}P is given adequately by the expression

$$E_x \approx 0.96848E_p + Q, \qquad (1)$$

where Q = +8.864 MeV, as indicated above. Thus, the pertinent level density in the compound nucleus, ^{32}S, is substantial under these conditions [FS96]. Furthermore, these levels into which the proton is captured to form a compound nucleus can decay by proton emission (compound elastic scattering), by α-particle emission, and by gamma-ray emission (radiative decay) to lower levels in ^{32}S, potentially through many different branches. Consequently, the decay of ^{32}S* (excited ^{32}S) by photon emission is a very complicated issue which has to be handled carefully in order to deduce the total strength of compound nucleus radiative decay in comparison to decay by α-particle emission. This report focuses mainly on the compilation of data for radiative decay of highly excited states the compound nucleus ^{32}S.

A total of 64 reference citations pertaining to the ^{31}P(p,γ)^{32}S reaction were extracted from NSR. It was possible to locate 43 of these contributions through the available resources of the Argonne National Laboratory Information and Publishing Division (IPD). Of these, 40 references provided significant information. Some other references were located through citations in the reviewed references from NSR. Appendix B lists 21 references appearing in NSR which we were unable to locate in the present compilation effort. These references are presented in the exact form in which they appear in the NSR citation. The list is included in this report for the convenience of those readers who might wish to try and locate some of these references and examine their content. Primary references on the subject of this report appear in the References list. However, a number of secondary references are also provided in conjunction with the individual summaries. These secondary references were mentioned within the papers being summarized here, and they are included within the text of the summaries as entries with the format [...] whenever it was deemed that they might be potentially useful to the reader. These secondary references are not repeated in the References list.

Table 1 provides an index for the collected information. Summaries of the useful contributions appear in Section 2. Data files in a format akin to that of EXFOR [CINDA99], corresponding to references containing numerical as well as descriptive information, appear in Appendix B. The references to works included here are identified by codes for convenience in accessing the compiled information, *e.g.*, the contribution of Brenneisen *et al.* (1997) is identified by the code B+97. Absolute values of resonance strength, $S_{p\gamma} = (2J+1)\Gamma_p\Gamma_\gamma/\Gamma$ (J = resonance spin, Γ_p = proton partial width, Γ_γ = gamma partial width and Γ = total width), for the reaction ^{31}P(p,γ)^{32}S which were reported in some of these references are collected into a single table (Table 2) in Section 3 of the present report to facilitate their comparison. Note that some authors denote the expression $(\omega\gamma)_\gamma = S_\gamma/[(2J_p+1)(J_t+1)]$ as the resonance strength, where J_p is the incident projectile spin (J_p = ½ for a proton) and J_t is the target spin (J_t = ½ for ^{31}P). Thus, in the present situation, $(\omega\gamma)_\gamma = S_\gamma/4$. For consistency, all resonance strengths listed in Table 2 are expressed as values of S_γ, not $(\omega\gamma)_\gamma$. These resonance strengths can be used directly in calculating reaction rates either by numerical integration or by the formalism given in Rolfs and Rodney [RR88].

Table 1: Index of Physics Data References, Abstracts, Summaries, and EXFOR Data Files Included in this Compilation [a]

Ref. Code	NSR Code	Author(s)	Abstract	Summary	EXFOR File
AHR81		Anttila *et al.*	●	●	●
B+97	1997Br07	Brenneisen *et al.*	●	●	●
BS75	1975Bo42	Boydell and Sargood	●	●	●
C+74a	1974Ch09	Cheng *et al.*	●	●	●
C+74b	1974CaZU	Calarco *et al.*	●		

Ref. Code	NSR Code	Author(s)	Abstract	Summary	EXFOR File
CMR72	1972Co13	Coetzee *et al.*	●	●	●
D+65	1965De12	Dearnaley *et al.*	●	●	
D68	1968Do14	Dorum	●	●	
E90		Endt	●		●
EE66	1966En04	Engelbertink and Endt	●	●	●
F+88		Fang *et al.*	●	●	
G+70a	1970Ga26	Gales *et al.*	●	●	●
G+70b	1970GaZP	Gales *et al.*	●		
G+73	1973GlZU	Glavish *et al.*	●		
G+74	1974VeZQ	Grawe *et al.*	●	●	●
H81	1981He09	Hentela	●	●	●
HV70	1970Ho25	Homberg and Viitasalo	●	●	●
I+71	1971In02	Ingebretsen *et al.*	●	●	●
I+90	1990IlZY	Iliadis *et al.*	●		
I+91	1991Il01	Iliadis *et al.*	●	●	●
I+93	1993Il01	Iliadis *et al.*	●	●	●
K+70	1970Ka35	Karadzhev *et al.*	●		●
K+74	1973Ko28	Kostin *et al.*	●		●
K+77	1977Ko07	Kostin *et al.*	●		●
K+85	1985Ki07	Kiss *et al.*	●	●	●
K+98	1998Ka31	Kangasmaki *et al.*	●	●	●
KH73		Kildir and Huizenga	●	●	
L+72	1972Le29	Leccia *et al.*	●	●	●
MTK69	1969Ma34	Mason *et al.*	●	●	●
O+75	1975Ob02	O'Brien *et al.*	●	●	●
P+55		Paul *et al.*	●	●	●
PKS78	1978Pa03	Paine *et al.*	●	●	●
PS79		Paine and Sargood	●	●	●

Ref. Code	NSR Code	Author(s)	Abstract	Summary	EXFOR File
PSM69	1969Pi10	Piluso *et al.*	●	●	●
R+95		Ross *et al.*	●	●	●
RDS77	1977Ro07	Rogers *et al.*	●	●	●
RK71	1971Re15	Renan and Keddy	●	●	●
RWK87	1987Ra23	Raisanen *et al.*	●	●	●
S+99	1999Sa16	Savidou *et al.*	●	●	●
S83	1983Sa30	Sargood	●	●	
SAN73		Sharma *et al.*	●	●	
SE71	1971Si29	Singh and Evans	●	●	
T+69	1969Th03	Thibaud *et al.*	●	●	●
T70	1970ThZX	Thibaud	●	●	
V+73a	1973Ve08	Vernotte *et al.*	●	●	●
V+73b	1973Ve06	Vernotte *et al.*	●	●	●
V+74	1974VeZU	Vernotte *et al.*	●		●
V+76	1976Ve03	Vernotte *et al.*	●	●	●
VF74a	1974ViZW	Viitasalo and Forblom	●	●	
VF74b	1974Vi02	Viitasalo and Forblom	●		●
ZL86	1986Zi08	Zijderhand and Van der Leun	●	●	●

[a] When a specific item is provided in the present compilation, this is indicated by the symbol (●). When there is no pertinent entry, this fact is indicated by a blank space.

Finally, the reader is advised that this report was prepared using word processing software and a computer keyboard that were configured mainly for use of English (U.S.) language fonts. Consequently, for expediency in preparing the manuscript, titles and abstracts of papers published in foreign languages (mainly French) were typed without resorting to the use of those special fonts needed for the proper representation of these written foreign languages. Although the authors believe that the product is readable and comprehensible in its present form, they are aware that the corresponding text that appears herein is often not literally correct. Therefore, the authors wish to apologize to native speakers of these languages and ask for their forgiveness for resorting to this expediency.

2. Summaries of Work Reported in the Literature

Written summaries were generated for those collected references where the content merited such an effort. Some of these references contain rather extensive information that is potentially useful for nuclear astrophysics applications while others are either abstracts or short communications that are basically extended abstracts. Repetition is avoided when identical material appears in more than one location. The lengths of the summaries presented here tend to reflect the relative content of pertinent information in the corresponding references. Those summaries with considerable information are organized according to a more or less standard format for the convenience of the reader. All the numerical information that was compiled in EXFOR format is printed in Appendix B, but it is not duplicated in the summaries.

AHR81

TITLE

Proton-induced Thick-target Gamma-ray Yields for the Elemental Analysis of the Z = 3 - 9, 11 - 21 Elements

REFERENCE

A. Anttila, R. Hanninen, and J. Raisanen, *Journal of Radioanalytical Chemistry* **62**, 293 - 306 (1981).

ABSTRACT

A systematic study of the relative thick-target yields of prompt γ-rays following proton bombardment has been carried out at E_p = 1, 1.7, and 2.4 MeV for the elements Z = 3 - 9, 11 - 21. The relevant spectra for each element are depicted and a table of the most suitable γ-rays for elemental analysis are given. Depending on the strength of the reaction cross section, the sensitivity limits of the detection vary from ppm to a few percent under practical measuring arrangements. Particular aspects of the measuring techniques are discussed.

FACILITY

2.5-MV Van de Graaff accelerator, Helsinki University, Helsinki, Finland.

EXPERIMENT

The technique of proton-induced gamma-ray emission (PIGE) provides a very useful complement to the well-known proton-induced X-ray emission (PIXE). In particular, PIGE can be very sensitive to the elements having very light masses (A < 15) and low abundances in nature (*e.g.*, Li, B, and F), while at the same time it tends to be insensitive to dominating elements such as O, Si, and C. PIXE generally cannot be used for the detection of light elements because the corresponding photons are too low in energy to penetrate beyond a few atomic layers in the surface of the investigated materials. In spite of its clear advantages, PIGE was not considered to be a commonly used method of analysis. One evident reason is that no systematic investigation of the PIGE signals generated by various materials had been carried out prior to the present study. Consequently, the objective of the present experiment was to perform such a systematic study of gamma-ray yields from proton bombardment - at a few distinct energies - of all possible light elements and to present the results in a practical form.

MEASUREMENT PROCEDURES

Proton beams with E_p = 1, 1.7, and 2.4 MeV were generated by the 2.5-MV Helsinki Van de Graaff accelerator. The proton beam passed through adjustable slits and a 40-cm-long liquid nitrogen cold trap before striking the target, which could be cooled with water or liquid nitrogen. The proton beam spot on target was effectively collimated to about 2 mm. The angle between the proton beam and the target normal was 45°. The emitted γ-radiation was detected with a 110 cm^3 Princeton (NOTE: Presumably this means Princeton Gamma Tech.) Ge(Li) detector with an energy resolution of 1.9 keV at E_γ = 1.33 MeV and 3.0 keV at E_γ = 2.61 MeV. The detector efficiency was 21.8% (relative to a standard 7.6-cm dia. x 7.6-cm thick NaI scintillation detector). Gamma-ray spectra were stored in 4096 channels of a Nuclear Data multi-channel analyzer. These spectra were then analyzed using PDP-9 and Burroughs 6700 computers. In all of these measurements the γ-rays were measured by the Ge(Li) detector at an angle of 55° relative to the incident proton beam direction and a position 4 cm from the target. The beam intensity on target was adjusted according to the observed count rate and was kept in the range 1 nA to 1 μA, presumably to avoid excessive dead time while still ensuring adequate statistics. The Be, C, Mg, Al, and Si targets were 1 x 1 cm^2 plates with thickness of approximately 1 mm. In other cases the samples were prepared from powdered compounds by pressing them into pellets 1 mm thick and 6 mm in diameter.

The measurements were performed on all Z $\leq$ 21 elements except for hydrogen, helium, and neon. In the case of helium the Q-value of -5 MeV is too low. For hydrogen, the $^2H(p,\gamma)^3He$ reaction is possible but it is weak and no separate resonant γ-rays occur, only a non-resonant background. Neon has strong resonances but it is of little importance in the context of elemental analysis for non-gaseous materials. Instead, an illustrative spectrum was taken for argon gas using a separate (external) beam arrangement because in that setup argon produces a background radiation. Gamma-ray spectra were taken at E_p = 1, 1.7, and 2.4 MeV using gains of 0 - 3 MeV per 4096 channels and 0 - 13 MeV per 4096 channels. When the elements studied appeared in compound samples, *e.g.*, S in PbS, the relevant spectra were recorded for the other element as well.

DATA ACQUIRED

Gamma-ray spectral data and integrated proton beam current were recorded for each measurement. Spectrum recording dead time was also measured in each case.

DATA ANALYSIS

Each spectrum was normalized to the incident proton charge and was corrected for data recording dead time. The thick-target yields of the full-energy peaks of prominent characteristic gamma rays were determined and absolute yields were deduced from the known Ge(Li) detector efficiency at each relevant γ-ray energy. For clarity, background or impurity contributions to these spectra were subtracted when they occurred. However, features in the γ-ray spectra produced by neutron irradiation remain in these spectra. Corrections were also applied for the proton stopping powers of the irradiated materials. The stopping power errors can be as large as 20% in cases involving compounds. However, this was not considered to be significant by the authors since elemental assay studies usually involve measurements relative to reference materials (standards). In that way, factors related to stopping power, detector efficiency, and geometric effects tend to cancel with a concurrent reduction in the assay uncertainty.

RESULTS AND DISCUSSION

The results from this experiment are presented in the form of figures of normalized γ-ray spectra for each of the major elements studied. In all, 18 figures (Figs. 1 - 18) are given in the paper. The absolute thick-target gamma-ray yields for the prominent, "signature" γ-ray(s) in every spectrum are shown for each incident proton energy in a small table included with the figure. The same numerical results are summarized in Table 1 of this paper. No errors are given for these tabulated values. The main source of error comes from the stopping power. To aid in interpretation of the measured spectra, small level diagrams are also included on each figure to indicate the origin of the signature γ-ray transitions.

On the basis of the γ-ray spectra obtained from this experiment it is evident that the neutron yield occurring in connection with some of the isotopes is significant. It leads to an increase in the number of γ-ray peaks in the region $E_\gamma \leq 1$ MeV. Another concern is the broadening of some lines due to the Doppler effect when the lifetime of the excited state involved is short ($\leq$ 100 ps). The effect is strongest at an observation angle of 90°.

In using PIGE for the quantitative analysis of materials, the conventional technique is to compare the stopping power values and γ-ray yields of the unknown sample and the pure reference material. However, it usually happens that the composition of the unknown material is not so well known so determination of its stopping power is problematic. Techniques have been developed to compensate for this problem but they must be applied with care. The sensitivity of PIGE depends ultimately on the reaction cross sections but there are other important factors such as the resolving power and effectiveness of the detector, the proton beam intensity, and the composition of the sample. It is most convenient to employ the PIGE technique when the irradiated sample is mounted in a vacuum chamber. However, if the material to be studied is volatile, external-beam techniques have been developed which are useful in some circumstances.

B+97

TITLE

The Structure of ^{32}S: I - Spectroscopy of Highly-excited States

REFERENCE

J. Brenneisen, B. Erhardt, F. Glatz, Th. Kern, R. Ott, H. Roepke, J. Schmaelzlin, P. Siedle, and B.H. Wildenthal, *Zeitschrift fuer Physik* **A357**, 157 - 173 (1997).

ABSTRACT

Assignments of *I*, π, *T* are made to 30 levels in ^{32}S between 7.35 and 11.76 MeV excitation energy, making the spectroscopy of the $T = 0$ states rather complete up to 10 MeV and that of the $T = 1$ states up to 12 MeV. A reassessment of existing data in the light of the

new results clarifies the spectrum of $I^{\pi} = 1^{+}$, $T = 1$ states up to 15 MeV excitation energy. High-spin states ($I = 5 - 7$) below 10 MeV excitation energy have been investigated by n - γ angular-correlation measurements with the ^{29}Si(α,nγ) reaction at $E_{\alpha} = 14.4$ MeV. Five *g*-wave resonances of the ^{31}P(p,γ) reaction, leading to the formation of $I^{\pi} = 4^{+}, 5^{+}$ states in ^{32}S, have been identified between 10 and 12 MeV excitation energy. The spectrum of $T = 1$ states between 10.7 and 12 MeV, has been investigated by measurements of γ-ray angular distributions on resonances of the ^{31}P(p,γ) reaction and by measurements of resonance strengths. Several ^{32}S levels between 7.35 and 8.75 MeV excitation energy were studied as final states in resonance decays. Finally a search was performed for $I^{\pi} = 0^{+}$ resonances of the ^{28}Si(α,γ) reaction.

FACILITY

7-MV Van de Graaff accelerator, University of Freiburg, Freiburg, Germany.

EXPERIMENT

This work reports on part of a series of experimental-theoretical investigations of selected nuclei across the whole *s-d* shell. The motive is testing of shell model calculations which have been performed for all $8 < N, Z < 20$ nuclei, using the complete *s-d* basis space and the universal *s-d* shell Hamiltonian. Previous work in this project was concerned with nuclei in the lower half of the shell where valence nucleons are preferentially found in the $d_{5/2}$ and $s_{1/2}$ orbits. With the case of ^{32}S the investigation enters the realm where the $d_{3/2}$ orbit comes into play. The present paper aims at generating complete spectroscopic information for ^{32}S by filling numerous gaps in contemporary knowledge of the levels above 7 MeV excitation energy. A reassessment in the light of the new data is subsequently given of the $T = 0$ spectrum of ^{32}S and the $T = 1$ spectra of the isospin triad ^{32}P, ^{32}S, ^{32}Cl. It serves as the basis for a detailed comparison with theoretical results in a subsequent paper. Although this paper examines data for more than one isotope from several sources, the emphasis in the present summary concerns ^{32}S and the ^{31}P(p,γ)^{32}S reaction.

The present work aims to obtain as comprehensive as possible an overview of the ^{32}S level scheme by γ-ray spectroscopy with the ^{29}Si(α,nγ) and ^{31}P(p,γ). As indicated in the preceding paragraph, the latter reaction is the focus of the present compilation effort. In this context, the present study searches for and investigates the resonances of the ^{31}P(p,γ) reaction between 2 and 3.3 MeV bombarding energy ($E_x = 10.8 - 12.1$ MeV) with emphasis on the location of $T = 1$ analog states. These resonances are not only of interest in themselves, because they are amenable to a shell model description, but also because they can serve to populate $T = 0$ states in the badly investigated region between 7 and 9 MeV excitation energy. Furthermore a search is performed for predicted $I^{\pi} = 4^{+}, 5^{+}$ states which could show up as the *g*-wave resonances below $E_p = 2$ MeV. Such states are usually weak in the ^{31}P(p,γ) reaction because of a high centrifugal barrier and they escape observation in resonances of elastic proton scattering as well.

MEASUREMENT PROCEDURES

The yield curve of the ^{31}P(p,γ) reaction was measured using a 5" x 5" thick NaI (Tl) crystal as the γ-ray detector, placed at 55° with respect to the beam at a distance of 4 cm from the target. The target, which was water cooled, consisted of 20 μg/cm^2 Cd_2P_3 evaporated onto a polished tantalum sheet. The 7-MV Van de Graaff accelerator at University of Freiburg provided 5 - 10 μA proton beams. On several resonances of the ^{31}P(p,γ) reaction the γ-decay modes and angular distributions of γ-rays were measured. Two 120 cm^3 Ge detectors with a resolution of 2 keV at the ^{60}Co energies were employed. One of them, which served as the monitor, was kept in a fixed position at 55° with respect to the proton beam. The other was placed successively at angles of 0, 30, 45, 60, and 75 degrees with respect to the beam. The targets for these measurements were prepared by evaporating 20 - 40 μg/cm^2 P_3N_5 onto polished tantalum sheets. These targets withstood bombardment by 25 μA proton beams at incident energies of 2 MeV. The thick target yield of several observed ^{31}P(p,γ) resonances between E_p = 2 MeV and 3.3 MeV was measured by using targets of 50 - 100 μg/cm^2 P_3N_5. The Ge detectors were placed at 55° with respect to the beam and γ-ray spectra were accumulated over periods of typically 15 min. These measurements yielded the intensities of the prolific γ-decay modes of resonances. The intensities of the remaining decay modes were calculated from the high-statistics spectra accumulated in the course of angular distribution measurements. Secondary electron emission from the target was found to be negligible.

DATA ACQUIRED

The data acquired consisted of gamma-ray spectra from the ^{31}P(p,γ) reaction generated from proton bombardment of both thick and thin targets of phosphorus-bearing compounds. These spectra were recorded at various angles as indicated in the preceding section.

DATA ANALYSIS

Few details are mentioned in the paper. Presumably the γ-ray full-energy peak yields for the observed transitions were determined for all the recorded spectra. These were normalized using recorded integrated proton currents and data from the monitor detector. Corrections for detector efficiency would have been applied as well.

RESULTS AND DISCUSSION

The results section of this paper is very extensive so no attempt will be made in the present summary to include all the details from the original paper. The reader is referred to the text and tables contained in the paper for further information. The discussions in the paper are grouped into two categories. One deals with a search for high-spin states below E_p = 2 MeV and the second with the search for and interpretation of ^{31}P(p,γ) resonances from E_p = 2 to above 3 MeV.

Concerning the low-energy region, the ^{31}P(p,γ) reaction had been well investigated earlier with Ge(Li) detectors up to 2.03 MeV bombarding energy (E_x = 10.83 MeV). The only states with assigned spins $I > 3$ are *f*-wave resonances with $I^\pi = 4^-$ at E_p = 1150, 1438, and 1582 keV. Further candidates of high-spin are known resonances at E_p = 1274 and 1768 keV. The γ-decay of these two states were reinvestigated in the present work by measuring γ-ray angular distributions in order to obtain spin assignments. Both of these resonances were found to have *g*-wave character and I^π values of 4^+ and 5^+, respectively. A reinvestigation of the ^{31}P(p,γ) yield curve between 1.6 and 2 MeV proton bombarding energy reveled the existence of two hitherto unknown resonances at E_p = 1830 and 1900 keV (E_x = 10366 and 10705 keV). Their γ-decays lead preferentially to $I^\pi = 4^-$ and 5^- states and thus suggest negative-parity assignments to these resonances. The formation would proceed by *f*-wave capture leading to levels with $I^\pi = 3^-$ or, more likely, $I^\pi = 4^-$. Since the present investigation was mainly interested in positive-parity states, this topic was not explored further.

It is noted in the paper that the potential of the ^{31}P(p,γ) reaction had not been fully exploited above the E_p = 2027 keV resonance, although sporadic studies have been reported. A comprehensive R-matrix analysis of the resonances in elastic scattering above 2 MeV has been reported in the literature. (NOTE: See original paper for references.) In the present work the yield curve of the ^{31}P(p,γ) reaction between 2 and 3.3 MeV proton bombarding energy has been measured in detail. Three resonances at E_p = 2214, 2895, and 2923 keV were found that were not known from proton elastic scattering. Further study revealed that these are *g*-wave resonances, thus explaining their absence in proton elastic scattering (spin too high). The E_p = 2214 keV (E_x = 11010 keV) resonance can be identified by the fact that its quantum numbers and γ-decay modes agree with an E_x = 10998 keV state previously observed in the $^{28}Si(\alpha,\gamma)$ reaction. [See actual paper for reference.] Apart from these three resonances and an un-investigated broad structure at E_p = 2769 keV, all resonances previously observed in proton elastic scattering were seen in the present $^{31}P(p,\gamma)$ investigation. The energies correspond to within a few keV except for resonances above the E_p = 2988 keV resonance. At the higher energies, the resonance energies reported from proton scattering appear to be systematically low by 6 keV. It is speculated that these earlier energies are in error, perhaps due to an undetected problem associated with calibration of the magnetic spectrometer. Exploratory measurements of γ-decay modes were made on the majority of observed (p,γ) resonances. The main interest of this work was in identifying resonance candidates for high-spin or $T = 1$ assignments. Because it was suspected that some of the resonances for $E_p < 2$ MeV might be $T = 1$ in character, they were also included in this investigation. Some resonances which are known to have low spin and which are not candidates for $T = 1$ states were omitted from the present investigation. Resonance strength and angular distributions were then measured for the selected resonances.

The thick target yield of (p,γ) resonances is proportional to the quantity $S = (2I+1)\Gamma_p\Gamma_\gamma/\Gamma$, where I is the resonance spin, and Γ_p, Γ_γ, and Γ are the proton and γ-ray partial widths, and total width, respectively. The *S*-factor of the stronger resonances and the prospective high-spin states mentioned above were measured relative to the E_p = 2349 keV resonance for which S = 27 eV is assumed from an accurate measurement reported in the literature. (NOTE: See original paper for references.) A conservative error of 30% is assigned to the strength measurements of the present investigation.

The measurement of γ-ray angular distributions is a promising tool for assigning spin(-parity) quantum numbers to resonances with $I \geq 3$. This comes about because $I^\pi = ½^+$ for the target ^{31}P in its ground state. Consequently, the reaction process populates only the $m = 0, \pm 1$ sub-states leading to reasonably good alignment for high-spin resonances. In the present work, the γ-ray angular distributions were investigated for primary and secondary transitions on promising resonances. An analysis of these experimental angular distributions using conventional techniques led to predictions of spin and parity for the studied transitions. Quite remarkably, the results of this work resulted in unique spin assignments for the investigated levels without exception. Only in a few cases was it necessary to include additional information from the literature to eliminate ambiguities. This detailed analysis also led to the assignment of parities.

Finally, $T = 1$ assignments to levels in ^{32}S were based on comparing measured transition rates to the acknowledged upper limits of isoscalar E1, M1, and M2 transition rates found in the literature. (NOTE: See the original paper for references.) The majority of the levels to which such an assignment was made were in the 2 to 3.3 MeV range of incident proton energy which has been investigated in the present work. (NOTE: The authors state "... 2 to 3.3 MeV *excitation* energy ..." but this would appear to be a misprint.)

In the last sections of this paper, the authors merge the information from their measurements and analysis with existing information from the literature to form a contemporary picture of the highly excited levels above 7 MeV in ^{32}S.

BS75

TITLE

Accurate Branching Ratio Measurements in $^{31}P(p,\gamma)^{32}S$

REFERENCE

S.G. Boydell and D.G. Sargood, *Australian Journal of Physics* **28**, 383 - 393 (1975).

ABSTRACT

The reaction $^{31}P(p,\gamma)^{32}S$ has been investigated in the proton energy range 0.4 - 1.75 MeV. Gamma ray spectra were measured for 25 resonances with Ge(Li) detectors which were carefully calibrated for relative peak efficiencies. Allowance was then made for the effect of anisotropies in all the emitted γ-rays. These spectra have been analyzed to give branching ratios for bound and unbound levels. Comparisons made with previous work revealed some differences.

FACILITIES

800-kV electrostatic accelerator, University of Melbourne, Melbourne, Australia; 3-MV Van de Graaff accelerator, AAEC Research Establishment, Lucas Heights, N.S.W., Australia.

EXPERIMENT

This paper describes the measurement of γ-ray branching ratios of levels in ^{32}S up to 10.6 MeV, excited via the reaction $^{31}P(p,\gamma)^{32}S$.

MEASUREMENT PROCEDURES

The techniques and calibration procedures used in the present work are described in detail in an earlier paper [S.G. Boydell and D.G. Sargood, *Australian Journal of Physics* **28**, 369 (1975)] .Basically, it involves the use of Ge(Li) detectors to perform detailed spectral measurements of on-resonance γ-ray transitions. The authors provide a brief description of the experimental procedures used for the present investigation in their paper. Targets of Zn_2P_3 and elemental phosphorus were prepared by evaporation onto 0.025-cm-thick gold backings. The elemental phosphorus targets were deposited as the (stable) red allotrope, using a technique similar to that reported in the literature by Hooton [B.W. Hooton, *Nuclear Instruments and Methods* **27**, 338 (1964)]. The elemental targets were used for most measurements; only where very thin targets were required were the Zn_2P_3 ones used, as very thin elemental targets were difficult to prepare. Target thicknesses were chosen to be larger than the natural resonance widths, but much smaller than the resonance separation.

DATA ACQUIRED

The data acquired consist of on-resonance γ-ray spectra recorded with a Ge(Li) detector.

DATA ANALYSIS

The on-resonance γ-ray transitions were identified in the recorded Ge(Li) detector spectra. Peak areas were measured and γ-ray yields were determined from the known geometric factors and detector efficiency calibration.

RESULTS AND DISCUSSION

Branching ratios for observed transitions from resonance levels in $^{31}P(p,\gamma)^{32}S$ at energies $E_p < 1750$ keV were determined from the experimental data. The results are recorded in tabular form in the journal article. Errors in these derived quantities were estimated from the peak count errors and detector efficiency calibration uncertainty. Transitions from bound levels in ^{32}S were also deduced from the measured γ-ray spectra.

The remainder of the paper is devoted to discussing details associated with various resonance and bound levels in ^{32}S and to comparing results from the present work with those reported previously in the literature.

C+74a

TITLE

Status of Nuclear Coexistence for ^{32}S

REFERENCE

Y.T. Cheng, A. Goswami, M.J. Throop, and D.K. McDaniels, *Physical Review* **C9**, 1192 - 1195 (1974).

ABSTRACT

The mean lifetime of the 0^+ state at 3.778 MeV in ^{32}S has been carefully re-measured by the Doppler-shift-attenuation method using the reaction $^{31}P(p,\gamma)^{32}S$. This lifetime has been combined with other information to obtain a good experimental value for the admixture of the deformed and spherical states in ^{32}S, thereby confirming the validity of the coexistence picture for this nucleus.

FACILITY

4-MV Van de Graaff accelerator, Department of Physics, University of Oregon, Eugene, Oregon.

EXPERIMENT

The 4-MV Van de Graaff accelerator, beam handling equipment, detector, and electronics are described in earlier communications [E.F. Gibson *et al.*, *Physical Review* **172**, 1004 (1968); K.W. Dolan and D.K. McDaniels, *Physical Review* **175**, 1446 (1968)]. The primary intention of this work was to make a very careful measurement of the lifetime of the 0^+ level in ^{32}S at 3.778 MeV. To accomplish this, the resonance at 1117 keV in the reaction $^{31}P(p,\gamma)^{32}S$ was chosen since it has a 6% branch to the desired 0^+ state. Lifetime measurements of the first 2^+ and 4^+ levels in ^{32}S were also made, respectively, at the 811- and 1583-keV resonances in this reaction.

MEASUREMENT PROCEDURES

The Doppler-shift attenuation method (DSAM) was used in this experiment. Measurements were performed at 0 and 120° to the incident-proton beam direction. About 20 hours were required at each angle for the 3.778-MeV lifetime determination. At the 811- and 1583-keV resonances about 8 - 10 hours were required at each angle in order to acquire adequate statistics. Electronic stability of the data recording apparatus in terms of gain and zero shifts was monitored by simultaneously recording γ-rays from several known radioactive sources. The chosen γ-ray energies for monitoring bracketed the 3.778 - 2.230 MeV transition peak located at 1547 keV. The required corrections for these effects were always less than 0.2 channels. The uncertainty in the correction was less than ± 0.03 channels.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra obtained on the various resonances in $^{31}P(p,\gamma)^{32}S$ mentioned above and at the indicated γ-ray detection angles.

DATA ANALYSIS

The linear background in the spectra was subtracted and centroid shifts were calculated for the γ-ray transitions from the states at 2.230, 3.778, 4.458, 4.697, 5.006, and 6.622 MeV in ^{32}S. The measured fractional Doppler shift $F(\tau)$ was then compared with the theoretical value deduced, in the fashion described in the literature [A.E. Blaugrund, *Nuclear Physics* **88**, 501 (1966)].

RESULTS AND DISCUSSION

Determination of the lifetime for the 3.778-MeV 0^+ level in ^{32}S required careful monitoring of the electronic stability and good statistics since the observed Doppler shift of the 1547 keV γ-ray peak between 0 and 120° was less than 1 keV. The electronic shifts were limited to the range of 0.1 - 0.2 keV in the vicinity of this peak during the experiment, as monitored by the radioactive source measurements mentioned above. Better than 1% statistical accuracy was obtained for these peaks. Actually, two separate DSAM measurements were made of the lifetime for this state. The only difference between them was a factor of 1.4 in the target-to-detector distance. The centroids of the 1.548-MeV γ-ray peak were determined from the measured spectra by a first-moment calculation with careful attention given to background subtraction. Both of these measurements yielded τ = 1000 fsec with slightly different errors. The results are summarized in Table I of the original paper (not shown here).

The errors given include a 15% uncertainty in the stopping-power calculation. It was concluded from this investigation that the stopping power is dominated by nuclear rather than electronic effects in the present work. In fact, the stopping power calculation appears to be the major potential source of systematic error in the lifetime determination in the DSAM method of determining lifetimes; this issue is discussed extensively in the present paper. The present determination of the lifetime of the 3.778-MeV state appears to be more accurate than provided by five previous experiments; however, it is nevertheless in good agreement with the values obtained from previous experiments.

The lifetimes of the states at 2.230- and 4.458-MeV excitation in ^{32}S are also relevant to any check of the co-existence model for S. However, the lifetime determination for these states from the $^{31}P(p,\gamma)^{32}S$ reaction is complicated by two experimental problems. For the 2^+, 2.230 level, there is multiple feeding of the state, while for the 4^+, 4.458 level, the de-excitation energy for the γ-ray transition to the 2.230-MeV level cannot be resolved from the 2.230-MeV to ground-state transition. In spite of these difficulties, determinations of the lifetime were made in the present work. Furthermore, lifetimes were measured for the 4.697-, 5.006-, and 6.622-MeV states in this experiment. These results compare poorly with other values reported in the literature, especially for the 5.006-MeV level.

The remainder of the paper is devoted to a discussion of the nuclear co-existence model and the possibility that a vibrational model might apply for ^{32}S. The nuclear co-existence model assumes that the two low-lying 0^+ levels are linear combinations of ideal deformed and spherical states. This issue was investigated in the context of the present experiment by comparing calculated mixing ratios with values deduced from the measured lifetimes. Reasonable consistency was obtain from this analysis providing support for the assumed model. On the other hand, no evidence could be found in the present investigation to support the need for resorting to a vibrational model for ^{32}S. Furthermore, there is no theoretical basis for such an assumption.

C+74b

TITLE

Electric Quadrupole Strength in ^{32}S Observed in Polarized Proton Capture on ^{31}P

REFERENCE

J.R. Calarco, E.F. Glavish, E. Kuhlmann, S.S. Hanna, and P.M. Kurjan, *Bulletin of the American Physical Society* **A19**, 496 (1974).

ABSTRACT

Earlier measurements of the polarized and unpolarized angular distributions of photons from the reaction $^{31}P(\mathbf{p},\gamma_0)^{32}S$ (**p** signifies polarized protons) [H.F. Glavish *et al.*, *Bulletin of the American Physical Society* **A18**, 1601 (1973)] have been extended to search for E2 strength in the ground state proton channel. From a measurement of the coefficients up to order 4 of a Legendre polynomial expansion of these distributions, the model-independent E2 cross section may be uniquely determined. The results indicate that the $^{32}S(\gamma,p_0)$ reaction exhausts about 10% of the isovector E2 sum rule at excitation energies in the region of the giant E1 resonance.

COMMENT

A detailed summary was not prepared for this work. The only information available from the literature is a short abstract in *Bulletin of the American Physical Society*. No data were provided in this communication.

CMR72

TITLE

A Study of $^{31}P(p,\gamma)^{32}S$ Reaction and the Excited States of ^{32}S

REFERENCE

W.F. Coetzee, M.A. Meyer, and D.Reitmann, *Nuclear Physics* **A185**, 644 - 668 (1972).

ABSTRACT

Proton energies and strengths of resonances of the $^{32}P(p,\gamma)^{32}S$ reaction were determined for $E_p < 2$ MeV. The γ-decay of 35 resonances was studied by means of the 40 cm^3 Ge(Li) detector. The Q-value of this reaction and the energies, branching ratios, and mean lifetimes of bound levels were determined. The spins of the $E_x = 6.62$, 10.26, and 10.40 MeV levels were found to be $J = 4$ from angular distribution measurements. The present results are compared with previous measurements. Some γ-ray transition strengths have been calculated and compared with various models.

FACILITIES

1.1-MV Cockcroft-Walton accelerator described in the literature [M.A. Meyer and N.S. Wolmarans, *Nuclear Physics* **A136**, 663 (1969)]; 3-MV Van de Graaff accelerator also described in the literature [M.A. Meyer *et al.*, *Nuclear Physics* **A144**, 261 (1970)].

EXPERIMENT

The present experiment involved investigation of 35 resonances of the $^{32}P(p,\gamma)^{32}S$ reaction in the energy range below 2.1 MeV using a Ge(Li) detector to measure γ-ray spectra. The strengths and branching ratios of these resonances as well as the energies, branching ratios, mean lifetimes and spins of a number of bound levels were measured. The results obtained were then compared with theoretical predictions of various models.

MEASUREMENT PROCEDURES

Below $E_p = 1.1$ MeV, the experiment was performed with a proton beam from the 1.1-MV Cockcroft-Walton accelerator. Targets were prepared by evaporation of zinc phosphide onto 1-mm-thick copper backings. These backings were cleaned by heating in a vacuum. These targets were directly water cooled permitting beam currents up to 130 μA to be used. The total accumulated charge during the runs ranged between 0.5 - 3 Coulomb, depending on the strength of the particular resonance being examined. A 40-cm^3 Princeton Gamma-Tech Ge(Li) detector was used to detect the γ-rays from the resonances. The electronics consisted of a Tennelec TC-135 preamplifier, Tennelec 203 BLR main amplifier, and an Intertechnique 4000-channel analyzer with spectrum stabilizer.

For $E_p = 1$ - 2 MeV, the experiment was performed with a proton beam of 20 - 40 μA from the 3-MV Van de Graaff accelerator. The targets were prepared by evaporation of zinc phosphide onto 0.3-mm-thick tantalum backings which were cleaned in vacuum by electron bombardment. These backings were also water cooled. Ortec Ge(Li) detectors of 30 and 40 cm^3 were employed to detect γ-rays. The electronics consisted of an Ortec model 120-2B pre-amplifier, a Tennelec 203 BLR amplifier, and a Nuclear Data Series 2200 or Hewlett Packard 4096-channel analyzer.

Relative efficiency curves for the Ge(Li) detectors that were required to determine relative intensities of the γ-rays were determined using radioactive sources and spectral data from the $^{23}Na(p,\gamma)^{24}Mg$, $^{27}Al(p,\gamma)^{28}Si$ and $^{32}P(p,\gamma)^{32}S$ reactions.

Measurement of the γ-ray yield excitation curves involved use of a thin target in the energy range $E_p = 0.3$ - 2.03 MeV. Only γ-rays with energies > 2 MeV were recorded at an angle of 55° with respect to the incident protons. High-purity zinc phosphide material obtained from Johnson Matthey Chemicals, was used for the targets. This material was placed on Ta backings. Several measurements were made of this excitation curve and the results were found to be reproducible. The quoted resonance energies and their errors as derived from this experiment are averages from several measurements. Since P appeared with Zn in compound form, measurements on pure zinc and pure Ta backings were performed as well. This enabled the $^{32}P(p,\gamma)^{32}S$ resonances to be distinguished from Zn(p,γ) or gamma rays from the construction material of the target chamber.

Determination of resonance strengths for the $^{32}P(p,\gamma)^{32}S$ reaction, defined as $S = (2J+1)\Gamma_p\Gamma_\gamma/\Gamma$, where J is the resonance spin, Γ_p and Γ_γ are partial widths for proton and γ-ray emission, respectively, and Γ is the total width of the resonance, were determined for most of the resonances identified from the excitation-function measurements. Thin targets were also used for these measurements. A 10 cm x 10 cm NaI detector, placed at a distance of 1 cm from the target and an angle of 55° relative to the proton beam, was used in this experiment.

The details of γ-decay for all 35 observed $^{32}P(p,\gamma)^{32}S$ resonances were measured in the energy range $E_p < 2.1$ MeV. The intensities of individual γ-ray transitions were deducted from spectra recorded with the detector placed at 55° to the incident proton beam.

Mean lifetimes for certain bound levels in ^{32}S were deduced from measurements based on the Doppler-shift attenuation method (DSAM). For this purpose, targets approximately 10 keV thick were used to insure that the ^{32}S recoils stopped completely in the target. One problem encountered in these measurements was pronounced deterioration of the targets (reduced thickness) when proton beam currents of 100 μA were employed. To prevent this, a thin layer of gold was evaporated onto the target. Various techniques were then employed to insure that the measurements conformed to the requirements of the DSAM. Contemporary techniques based on published work [A.E. Blaugrund, *Nuclear Physics* **88**, 501 (1969); J.A. Ormrod *et al.*, *Canadian Journal of Physics* **43**, 275 (1965)] were employed to determine the stopping cross sections needed to determine level lifetimes. It was estimated that the uncertainty in the deduced lifetimes due to this effect was about 15%.

Measurements of selected γ-ray angular distributions were performed at the E_p = 888-, 1438-, and 1583-keV resonances in order to see if the γ-decay data could demonstrate Erne's $J \rightarrow J'$ rule. A Ge(Li) detector was placed at 0, 30, 60, and 90° relative to the incident proton beam during this experiment. The sequence 0° → 90° → 0° was repeated several times for each resonance, and checks were made to determine the eccentricity and γ-ray absorption as well as finite detector size effects.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra and angular distributions recorded as a function of incident proton energy using the above-mentioned Ge(Li) detectors. These measurements were performed not only at discrete resonance energies but also in contiguous small energy increments to enable γ-ray yield excitation functions to be determined. In addition to these spectra, incident proton charge, spectrum measurement dead times, and other information pertinent to the experiment were recorded as required.

DATA ANALYSIS

Relatively few details are provided explicitly in this paper concerning the actual analysis of the raw experimental data acquired in this investigation. Basically, the resonance energies were extracted from measured γ-ray excitation functions while relative resonance strengths were deduced from areas under the resonance peaks. Gamma-ray decay branching ratios for these resonances were deduced from relative yields of the observed γ-decay transitions. This branching information was essential for the determination of resonance strengths since the different resonances decay quite distinctly and the total γ-ray yield is needed to determine Γ_γ for each resonance. Relative resonance strengths were converted to absolute strengths by assuming $S = 0.52 \pm 0.08$ eV for the $E_p = 642$ resonance based on results from the literature [G.A.P. Engelbertink and P.M. Endt, *Nuclear Physics* **88**, 12 (1966)]. The energies of the resonance decay γ-rays were determined by means of a computer program which corrected for recoil losses and Doppler shifts. The input data for this analysis program consisted of known γ-ray energies and corresponding peak positions. Angular distribution data for the selected γ-ray transitions were fitted by least-squares to Legendre polynomial expansions. These results were compared with theoretical distributions in order to deduce level spins and parities as well as transition multipolarities

RESULTS AND DISCUSSION

The γ-ray yield excitation curve measured with a thin target was used to identify the discrete resonances and determine their energies. The calibration standards for determining the resonance energies were the $E_p = 991.88 \pm 0.04$ keV resonance of the $^{27}Al(p,\gamma)^{28}Si$ reaction and the $^{7}Li(p,n)$ threshold at $E_p = 1880.59 \pm 0.08$ keV [M.L. Roush *et al.*, *Nuclear Physics* **A147**, 235 (1970)]. As a consequence of the relatively high resolution obtained for this excitation function, two resonances which were earlier thought to be single (previous energies $E_p = 1148$ and 1400 keV) were found to be a doublet and triplet, respectively.

The $^{31}P(p,\gamma)^{32}S$ resonance strengths obtained in this experiment are given in Table 1. The errors in the strengths are of the order of 30%. These results are also compared with corresponding values from the literature. Values of proton strengths for (p,p_1) were determined by indirect means for several of the resonances. These results are given in Table 2 of the paper.

Branching ratios for the resonance and bound-state decay γ-rays are given in Tables 3 and 5 of the paper. Based on this information, energies of certain bound levels in ^{32}S could also be determined. These are given in Table 4 of the paper. Some corrections for recoil losses had to be applied to the data to obtain the quoted values for these level energies.

Extensive comparisons of these resonance and bound-state results with corresponding values reported in the literature appear within the text of this paper.

Values of ^{32}S bound-level Doppler-shift attenuation factors, F, and lifetimes τ deduced from the DSAM are given in Tables 6 and 7 of the paper. Comparisons with values from the literature are also presented.

Finally, the results of the angular distribution measurements are reported in Tables 8 and 9 of the paper. The remainder of the paper is devoted to examining the issues of spin, parity, and transition multipolarity for several levels. Comparisons with corresponding results from the literature are presented in the text.

In conclusion, this experiment showed that a study of (p,γ) resonances with a Ge(Li) detector yields useful information on the energy levels of nuclei, especially when lifetime measurements are included. Unambiguous interpretation of spectra requires that proton energies of resonances, the Q-value of the reaction, and the excitation energies of bound levels be known to an accuracy of the order of 1 keV. Doppler-shift measurements can sometimes determine whether a particular γ-ray is a primary or a secondary transition. The vibrational model gives a simple account of the energies and spins of the first four excited states and may also explain the E_x = 5.01 MeV ($J^{\pi} = 3^-$) level in ^{32}S. The computed transition strengths are then in good agreement with experimental values. However, the present results on transition strengths were found to not be in good agreement with particle-hole calculations based on an undeformed potential well. The many-particle shell-model calculations are in much better agreement with experiment.

D+65

TITLE

Fine Structure of the Giant Resonance in the Reaction ^{31}P(p,γ_0)^{32}S

REFERENCE

G. Dearnaley, D.S. Gemmell, B.W. Hooton, and G.A. Jones, *Nuclear Physics* **64**, 177 - 196 (1965).

ABSTRACT

The excitation function of the reaction ^{31}P(p,γ_0)^{32}S has been measured at 90° over the range E_p = 2 to 11.5 MeV. The yield curve exhibits many peaks, in the form of sharp resonances at low energies, but broader and overlapping more at the higher energies. Angular distributions have been taken on and near the peaks. The peaks are interpreted as resonances rather than fluctuations. Interpretation of the angular distributions, which are all dominated by a large $\sin^2\theta$ term indicative of electric dipole capture, requires a breakdown of the statistical theory of level widths. It is shown that external channel contributions to the capture process, though not negligible, are insufficient to account for the results observed.

FACILITY

UKAEA Harwell Laboratory tandem generator, Harwell, United Kingdom.

EXPERIMENT

The objective of this experiment was to explore the major part of the ^{32}S giant resonance by means of proton bombardment of ^{31}P over the range of proton energies available at the Harwell tandem generator. The energy resolution of the tandem generator coupled with the use of thin targets of phosphorus enabled an energy resolution of about 10 keV to be achieved thereby revealing considerable structure in the ^{31}P(p,γ_0)^{32}S reaction excitation function.

MEASUREMENT PROCEDURES

The Harwell tandem generator was calibrated on the neutron thresholds in ^{27}Al and ^{58}Ni at 5.803 and 9.513 MeV, respectively [Freeman *et al.*, *Proceedings of the Second*

International Conference on Nuclide Masses, Vienna, Austria (1963)]. The analyzed proton beam was focused through a uranium stop onto the target. Targets of red phosphorus on thick gold backings were used in the measurements. They were prepared by evaporating phosphorus in the presence of a hot tungsten filament. The γ-rays were detected with a 12.7-cm diameter x 10.2-cm long sodium iodide crystal coupled to an EMI photo-multiplier tube. The (p,n) threshold in phosphorus is at 6.23 MeV so above this energy a wax cone was used in front of the γ-ray detector to reduce the flux of neutrons on the crystal. A lead cone reduced the γ-ray interactions at the edges of the crystal thereby leading to a sharper full-energy peak in the spectrum. A biased amplifier was used to reduce dead time due to the pile up of unwanted low-amplitude pulses from this detector. Spectra were acquired using a multichannel analyzer. Background was estimated by measurements involving bombardment of a blank gold target.

The angular distributions were measured by rotating the counter about the axis of the target and measuring the yield of γ-rays for a determined amount of integrated proton beam current.

DATA ACQUIRED

The data acquired consisted of sodium iodide detector γ-ray spectra recorded at various proton energies and γ-ray detector observation angles. Typical spectra are shown in figures included in the paper.

DATA ANALYSIS

An absolute cross section calibration was established by using a special target prepared on a thin carbon backing. The thickness of phosphorus on this target was determined from 1.4 MeV elastic proton scattering at 90° using a semi-conductor counter and documented techniques [Cohen-Ganouna *et al.*, *Nuclear Physics* **40**, 67 (1963)]. By this method the target thickness was determined with an uncertainty of about 5%. The largest error in the absolute cross section arises from the uncertainty in the line shape of the high-energy γ-ray and the error involved in determining the efficiency of the γ-ray detector. Recall that these measurements were performed with a sodium iodide scintillation detector. To this end, the $T(p,\gamma_0)^4He$ reaction was used to determine the line shape, and the detector efficiency was deduced from calculations. It was estimated that the total error in the absolute cross section was about 20% under the most favorable conditions. Above 9.5 MeV proton energy, where background corrections are considerable, the error was assumed to be even larger.

The relative yields of γ_0 at various angles were determined from the pulse-height spectra in the following manner. Background was subtracted from the spectrum and an estimate of the peak height was obtained directly from a plot. The γ-ray intensity was taken to be proportional to the number of counts in a fixed number of channels (usually twenty) in the spectra at the vicinity of the full-energy peak. Solid angle and Doppler shift corrections were taken into account in a manner described in the literature [Gemmell and Jones, *Nuclear Physics* **33**, 102 (1962)].

RESULTS AND DISCUSSION

The final reported excitation function at 90° reported in the paper for the $^{31}P(p,\gamma_0)^{32}S$ reaction was the result of many normalized runs using targets of various thickness. It agrees well with previous work but shows more structure due to improved resolution. This excitation function is strongly suggestive of a region in which the level spacing is not very much greater than the level width; the structure seems to indicate partial resolution of closely spaced levels. The ensuing discussion of this excitation function amounts largely to speculation based on the fact that individual resonances are not clearly resolved, even at the lower excitation functions.

This work has been largely superseded by later measurements performed with germanium γ-ray detectors and even finer proton energy resolution. Therefore, the conclusions drawn in this early paper should not be taken too seriously, in our opinion.

The measured angular distributions near the peaks of resonances show very different qualitative features above and below E_p = 4 MeV. Basically, at the lower energies, the yield at 0° is comparable with that at other angles. At higher energies the yield at 0° is generally much smaller than the yields at 90°. The authors devote a considerable portion of the text of this paper to a qualitative discussion of various physical issues. From this they conclude that the observed angular distributions could be due to either E1 radiation from a 1^- state or M1 radiation from a 1^+ state. Again, because of the questionable quality of data recorded with a sodium iodide detector at this early date, one should perhaps not accord too much weight to their various qualitative physical arguments.

D68

TITLE

Polarization Measurements on Gamma Rays from Transitions in ^{32}S

REFERENCE

O. Dorum, *Physica Norvegica* **3**, No. 1, 31 - 41 (1968).

ABSTRACT

The linar polarization of the 1.61-, 2.24-, 2.77-, and 3.61-MeV transitions in the $^{31}P(p,\gamma)^{32}S$ reaction at 1436 keV proton energy is measured with a Compton polarimeter. From this measurement the spin and parity of the following levels in ^{32}S are deduced: 10.23 MeV, $J^\pi = 4^-$ (or 2^-); 6.62 MeV, $J^\pi = 4^-$; 5.01 MeV, $J^\pi = 3^-$. The 6.62 and 5.01 MeV states are the lowest lying odd parity states so far found in ^{32}S.

FACILITY

Oslo Van de Graaff Laboratory, Institute of Physics, University of Oslo, Oslo, Norway.

EXPERIMENT

Measurements of γ-ray linear polarization were carried out in order to provide data to compare with theoretical calculations which are described extensively in this paper.

MEASUREMENT PROCEDURES

The measurements were performed at the Oslo University Van de Graaff laboratory. For the $^{31}P(p,\gamma)^{32}S$ γ-ray transitions the proton energy was set at a value well up on the flat portion of the resonance yield from the E_p = 1436-keV resonance. Targets were produced by evaporating Zn_3P_2 onto Ta backings.

The Compton polarimeter used in the present work consisted of one 1.5 inch x 1.5 inch NaI(Tl) scintillation counter as the scatterer and two 5 inch x 5 inch NaI(Tl) scintillation crystals as detectors for the scattered photons. These latter two detectors were designated as A and B for convenience. The scatterer, denoted as C, was placed with its center 11.5 cm from the target and vertically above it. The cylindrical axis of this detector coincided with the axis of a goniometer. The two detectors A and B could be rotated on the goniometer about the scatterer. The distance of A and B from the goniometer axis was 10.3 cm. The height of the cylindrical axis of the two detectors was 16 cm. The geometry is shown schematically in Fig. 3 of the original paper. The detectors A and B measured in two directions $\gamma = 0°$ and $\gamma = \pm 90°$. The positions of these detectors were fully correlated as shown in Fig. 4 of the original paper. The gain of detectors A and B were equalized so that a particular γ-ray would give equal pulse-height spectra. This was normally accomplished by adjusting the HV to the photo-multiplier tubes. A fast-slow circuitry was established in order to register only pulses which represent Compton events in detector C. The fast signal resolving time had a resolution of 0.1 μs. The electronic details, including gating and pulse-height discrimination levels used in the experimental setup, are discussed in the original paper. An estimate was made of the geometrical eccentricity of this setup using the isotropic 2.36-MeV γ-rays from the $^{12}C(p,\gamma)^{13}N$ resonance at $E_p = 456$ keV. By this method, it was determined that the eccentricity was 1.044 ± 0.012 following several measurements. This bias was later used as a correction factor in analyzing the data. The performance of the entire setup was validated by observing the linear polarization of the 1.37 MeV γ-ray from the $^{24}Mg(p,p'-\gamma)$ reaction at $E_p = 2.01$ MeV. This is a pure E2 transition whose properties are well known from an earlier study [G.J. McCallum, *Physical Review* **123**, 568 (1961)]. Good agreement was obtained in this measurement with what was anticipated from the earlier investigation.

DATA ACQUIRED

Three measurements were made on the ratio $N_{exp} = (N_{A0} \times N_{B0})^{½}(N_{A90} \times N_{B90})^{-1/2}$ for the 3.61-, 2.77-, 2.24- and 1.61- MeV γ-ray transitions in the cascade between the states at 10.23, 6.62, 5.01, 2.24 and 0 MeV in ^{32}S.

DATA ANALYSIS

Very few details are provided of the actual data analysis procedure used to determine the various NaI detector counts. However, some indication as to how the peak yields were deduced from measured spectra is given in Fig. 6.

RESULTS AND DISCUSSION

Measured values of N_{exp} for the γ-ray transitions in ^{32}S, corrected for eccentricity, were averaged to provide the results shown in Table 3 of the original paper. Comparisons between these results and other measured and theoretical values are discussed in the text of the paper. From this analysis it was shown that the 5.01-MeV state in ^{32}S has odd parity in agreement with earlier measurements. This appeared to be the lowest odd-parity state in ^{32}S discovered up to that time. It's character appeared to the authors to be vibrational. It was suggested that this might be a 3^- state previously postulated to appear at 5 MeV excitation. The 6.62 MeV state also has odd parity with $J^\pi = 4^-$ and it is connected to the 5.01-MeV odd-parity state through a strong 1.61-MeV transition. The authors could not draw any significant conclusions from their work other than to suggest that there might be a band of odd-parity excited states in ^{32}S.

E90

TITLE

Energy Levels of A = 21 - 44 Nuclei (VII)

REFERENCE

P.M. Endt, *Nuclear Physics* **A521**, 1 - 830 (1990)

ABSTRACT

The experimentally determined properties of A = 21 - 44 nuclides are compiled and evaluated with special emphasis on nuclear spectroscopy.

Separate tables for each of the nuclides reviewed present the available information about the following properties (in this order):

- excitation energies E_x,
- γ-ray branching ratios b(γ),
- γ-ray mixing ratios δ,
- lifetimes τ_m or widths Γ,
- neutron, proton, or α-particle resonances,
- partial widths,
- single-nucleon transfer reactions,
- beta-decay,
- arguments for spin and parity (J^π) and isospin (T) assignments,

For each nuclide a master table summarizing the "best" or adopted values for E_x, J^π, T , and τ_m or Γ precedes the auxiliary tables listed above. The review of each A-chain concludes with a discussion of isospin multiplets. Figures are presented of the level schemes of all nuclei and, for each A-chain, an overview of the relative energies of the ground states and lowest analogue states of all nuclei in the chain.

COMMENTS

This is one of the best known and most comprehensive compilations available on nuclear data for light nuclei; it occupies an entire volume of the journal *Nuclear Physics*. Data for the $^{31}P(p,\gamma)^{32}S$ reaction that appear to be pertinent to determining reaction rates for astrophysical applications are included in the EXFOR file prepared from this source. The origins of these data are documented in the original compilation [E90] so they are not repeated in the EXFOR file entry and they are not summarized here.

EE66

TITLE

Measurements of the (p,γ) Resonance Strengths in the *s-d* Shell

REFERENCE

G.A.P. Engelbertink and P.M. Endt, *Nuclear Physics* **88**, 12-20 (1966).

ABSTRACT

Resonance strengths of selected resonances in the E_p = 0.3 - 2.1 MeV region in the (p,γ) reactions on ^{23}Na, $^{24-26}$Mg, ^{27}Al, $^{28-30}$Si, ^{31}P, ^{32,34}S, ^{35,37}Cl, ^{39,41}K, and ^{40}Ca are compared through relative yield measurements, using targets of many different chemical compounds, each containing at least two of the investigated isotopes. If in a (N,Z) diagram lines are drawn between isotopes connected in this way, one obtains several closed cycles, providing internal checks on the measure strength ratios. The final best values of the relative strengths are obtained by least-squares analysis. The E_p = 621 keV ^{30}Si(p,γ)^{31}P resonance of which the strength is known from a γ-ray resonant absorption experiment, was used to convert the relative into absolute strengths.

FACILITIES

850-kV Cockcroft-Walton generator and 3-MeV Van de Graaff generator, Fysisch Laboratorium, Rijksuniversiteit, Utrecht, The Netherlands.

EXPERIMENT

The objective of the present investigation was to measure relative resonance strengths in the energy range 0.3 - 2.1 MeV using targets of many different chemical compound, thereby covering the elements Na, Mg, Al, Si, P, S, Cl, K and Ca, all of natural isotopic constitution. Basically, this experiment covers all elements in the Z = 10 - 20 region. The selected resonances were strong, sufficiently isolated in energy from other resonances, and possessed known γ-decay properties. These relative measurements were then normalized to an independent absolute measurement of the E_p = 621-keV ^{30}Si(p,γ)^{31}P resonance through a complex, over-determined network of resonance-strength ratio measurements, thereby avoiding many experimental difficulties associated with measurements of absolute resonance strength. The experimental errors in the final results were found to be of the order of 15%.

MEASUREMENT PROCEDURES

The γ-radiation was detected with a cylindrical 10 cm x 10 cm NaI scintillation crystal at a front-face-to-target distance of 40 mm. The counter was placed at an angle of 55° to the proton beam to eliminate the $P_2(\cos\theta)$ angular distribution effects. For all selected resonances it was known that $P_4(\cos\theta)$ terms in the angular distribution are small or absent, except in the case of ^{40}Ca.

Most of the targets were prepared by evaporation *in vacuo* onto 0.3-mm (thick) tantalum backings. The chemical compounds used are listed in the original paper. The main criterion for selection of these materials was that they not decompose during evaporation onto the substrate. Targets of various thicknesses were prepared but they could all be categorized as either “thin” or “thick”. Strength ratios measured with targets of different thickness and varying evaporation conditions did not exhibit differences in the derived experimental results beyond the estimated errors. This served as a valuable check against possible decomposition of the targets during the measurements. To avoid target deterioration during proton bombardment, they were water cooled and the beam power was maintained at levels < 3 W. The measurements cycles stepped through various resonances but always ended by repeating the first resonance of the sequence to check on reproducibility.

Integrated proton charge was measured with a calibrated current integrator. Secondary emission effects were prevented by the use of a charge suppressor ring at a negative potential between the target and diaphragm which defined the proton beam.

DATA ACQUIRED

The data acquired consisted of numerous γ-ray spectra as measured with the NaI detector. In addition, integrated beam currents were recorded and additional parameters related to detector dead time and related issues were noted.

DATA ANALYSIS

Gamma-ray yields were derived from the measured spectra after subtraction of background events. These results were used to calculate relative resonance strengths in accordance with a formula given in the original paper. One of the major sources of error was in determining the stopping power as a function of proton energy for the various materials used. Various smaller corrections were applied to the data, including γ-ray absorption, coincident and random summing effects, *etc.*

RESULTS AND DISCUSSION

The results from this experiment consist of measured strength ratios as indicated in Table 1 of the original paper. The values in this table are always averages of several measurements which were performed with various target thickness and for checks on reproducibility under conditions which were presumed to be stable. Ultimately, absolute strengths were derived for 16 (p,γ) resonances after normalizing the measured relative values to the above-mentioned standard. These values are given in Table 2 of the paper; comparisons with other results from the literature are also presented in that table.

It was noted in the original paper that the results from this experiment often agreed quite well within the errors with previously reported results. However, another group of results exhibit discrepancies which amount to a factor of 2 or 3, or even as high as 50! Strong arguments were presented for accepting the results from the present experiment as being the more reliable ones in cases where significant discrepancies were observed. It is suggested that the present set of resonance strengths might serve as secondary standards for other measurements of this general type.

F+88

TITLE

Proton Resonances in ^{32}S from E_x = 9.83 to 12.74 MeV

REFERENCE

D.F. Fang, E.G. Bilpuch, C.R. Westerfeldt, and G.E. Mitchell, *Physical Review* **C37**, 28 - 40 (1988).

ABSTRACT

Differential cross sections for the $^{31}P(p,p_0)$, (p,p_1), (p,α_0), and (p,α_1) reactions were measured in the range E_p = 1.00 - 4.01 MeV with an overall resolution of about 400 eV. The resonance parameters were extracted for 143 levels with a multilevel, multichannel R-matrix code. These parameters include resonance energy, total angular momentum, parity, partial widths, channel spin or orbital angular momentum mixing ratios, and, for some resonances, the relative signs of width amplitudes. Eight isobaric analog resonances were identified in ^{32}S. Proton resonance strengths were compared with shell model predictions. The $^{32}P(p,\alpha_0)$ data were used to obtain the reaction rates for the inverse reaction $^{28}Si(\alpha,p_0)$.

FACILITY

KN Van de Graaff accelerator, Triangle Universities Nuclear Laboratory (TUNL), Duke Station, Durham, North Carolina.

EXPERIMENT

Although this work does not deal directly with the $^{31}P(p,\gamma)^{32}S$ reaction, it is of interest in the present context because it provides extensive information about the resonances in the compound nucleus ^{32}S and the proton widths for these resonances. In the present experiment ^{32}S was studied by proton scattering, namely, (p,p_0) and (p,p_1), and α-particle emission, namely, (p,α_0) and (p,α_1) reactions, for the target isotope ^{31}P. For present purposes, emphasis is placed on the proton scattering aspect since the (p,α) data were compiled and discussed in an earlier Argonne report of this series [R.E. Miller and D.L. Smith, Report ANL/NDM-144, Argonne National Laboratory (1997)]. These TUNL measurements were performed with very high energy resolution and good definition of the absolute incident proton energy over the range E_p = 1.00 - 4.01 MeV. This measurement activity was part of a program of investigating odd-mass target nuclei in the 2*s*-1*d* shell.

MEASUREMENT PROCEDURES

This experiment was performed using the KN Van de Graaff accelerator and associated high resolution system at TUNL. Details of this experiment are presented in a Ph.D. thesis by Dufei Fang [D. Fang, *Proton Resonance Spectroscopy in ^{32}S*, Thesis, TUNL, Duke Station, Durham, NC (1987)]. It was suggested in the present paper that a description of the facility would soon be published in the journal *Nuclear Instruments and Methods*, but no reference has been identified since the present paper's publication in 1988.

The measurement system provided an overall energy resolution of 300 - 400 eV for thin solid targets in the range of proton beam energy $E_p \approx$ 1 - 4 MeV. Proton-induced reactions were measured from 1.00 - 4.01 MeV at laboratory angles 90, 127, 145, and 165°. Scattered protons and emitted α-particles were detected simultaneously using surface barrier detectors. In order to measure the $^{31}P(p,\alpha_1)$ reaction above E_p = 2.98 MeV, transmission detectors were employed at 108, 135, and 165° to detect α_1 particles; particle identification was required because the α_1 particles generate the same pulse height in the surface barrier detectors as protons elastically scattered from ^{16}O. In practice, the (p,p_1) reactions were observed above E_p = 2.18 MeV and the (p,α_1) reaction above E_p = 2.98 MeV. The solid angles for the detectors were adjusted such that the counting rates for Rutherford scattering at these detectors were approximately equal.

Targets were prepared by evaporating Zn_3P_2 onto ultra-pure Ni coated (~ 0.5 $\mu g/cm^2$) carbon foils (4 - 5 $\mu g/cm^2$). The targets contained 1 - 3 $\mu g/cm^2$ of ^{31}P. Ni was added to the backing because it enhanced both target stability and uniformity. Targets prepared in this manner were found to be reasonably stable at 2 - 3 μA incident proton beam currents. Data were acquired on-line using a VAX 11/750 computer and a general data processing software system called XSSystem [C.R. Gould *et al.*, *IEEE Transactions on Nuclear Science*, **NS-28**, 3709 (1981)]. Data were measured in energy steps of 100 - 400 eV, depending on the resonance structure. The counting statistics was better than 2%. Most of the measurements reported in this paper were performed twice to insure reproducibility.

DATA ACQUIRED

The data acquired consisted of high-resolution scattered proton spectra over the energy range E_p = 1.00 - 4.01 MeV. These collected data provide excitation functions for (p,p_0) and (p,p_1) scattering.

DATA ANALYSIS

Experimental excitation functions for (p,p_0) and (p,p_1) scattering were fitted with the multi-level, multi-channel R-matrix program MULTI6 which is based on the differential cross section expression of R-matrix theory given by Lane and Thomas [A.M. Lane and R.G. Thomas, *Reviews of Modern Physics* **30**, 257 (1958)]. The code MULTI6 generates the theoretical excitation functions with a given set of resonance parameters that includes resonance energy, spin/parity (J^π) values and partial widths. These calculated excitation functions are compared with the experimental excitation functions. The fitting process was performed by trial and error until sets of parameters that yield good fits to the data were achieved. The details of the R-matrix model and its implications in the context of the observed excitation functions is discussed extensively in the original paper. They will not be considered here.

RESULTS AND DISCUSSION

In total,143 resonances were observed from E_p = 1.00 - 4.01 MeV in the present investigation. This paper presents the measured and calculated excitation functions in the form of plots and also gives the extracted resonance parameters and spectroscopic factors in tabular form. There is an extensive discussion of the physical consequences of these results. Level interference effects are discussed and eight isobaric analog resonances in ^{32}S were identified. The spectroscopic factors derived from this experiment were found to be in excellent agreement with the (d,p) measurements for the parent states. Comparisons were made with shell model predictions and reasonably good agreement was observed provided that the strengths for the two iso-spin values are summed. Finally, astrophysical reaction rates were calculated using the resonance parameter information. They were found to be in good agreement with theoretical predictions for the stellar temperature range T_9 = 2 - 5. (NOTE: T_9 = 1 implies 1 x 10^9 ° K).

G+70a

TITLE

Recherche du Premier Etat *T* = 2 du Noyau Soufre-32 au Moyen de la Reaction $^{31}P(p,\gamma)^{32}S$

REFERENCE

S. Gales, M. Langevin, J.-M. Maison, and J. Vernotte, *Comptes Rendues Academie Scientifique (Paris)* **B271**, 970 - 973 (1970). [In French].

ABSTRACT

Un Niveau a 12050 ± 4 keV a ete observe dans la reaction $^{31}P(p,\gamma)^{32}S$ a une energie E_p = 3289 ± 3 keV. Des arguments sont presentes en faveur de l'attribution des caracteristiques 0^+, $T = 2$ a ce niveau, qui serait ainsi le premier etat $T = 2$ du noyau ^{32}S.

FACILITY

4-MV Van de Graaff accelerator, Institut de Physique Nucleaire d'Orsay, Orsay, France.

EXPERIMENT

The objective of this experiment was to obtain an improved understanding of the characteristics of the excited levels in ^{32}S found in the energy region that could correspond to the first $T = 2$ isobaric analog level of this nucleus. This was undertaken by studying the reactions (p,γ), $(p,p_1\gamma)$, $(p,p_2\gamma)$, and $(p,\alpha_1\gamma)$ for the target nucleus ^{31}P. The present summary focuses on the proton capture and scattering reactions since the α-particle emission data were compiled in an earlier report [R.E. Miller and D.L. Smith, Report ANL/NDM-144, Argonne National Laboratory (1997)].

MEASUREMENT PROCEDURES

Proton beams were obtained from the 4-MV Orsay Van de Graaff accelerator. In particular, the energy region considered was E_p = 3.10 - 3.35 MeV. The target consisted of red phosphorus vacuum-evaporated onto a tungsten backing. A 1.27 cm x 12.7 cm NaI(Tl) scintillation crystal was used to measure the γ-ray excitation function. It was placed 10 cm from the target at an angle of 55°. A Ge(Li) detector with 37 cm^3 volume was used to measure γ-ray spectra and angular distributions with high resolution for certain conditions. The energy scale for the accelerator was calibrated by observing the well-known $^{13}C(p,n)^{13}N$ threshold at 3235.7 ± 0.7 keV [J.B. Marion and F.C. Young, *Nuclear Reaction Analysis*, North-Holland Publishing Company, Amsterdam (1968)]. No other experimental details are provided in this short communication.

DATA ACQUIRED

The data acquired in this experiment consisted of γ-ray spectra measured with a NaI(Tl) scintillation detector and a Ge(Li) detector at several energies in the range E_p = 3.10 - 3.35 MeV.

DATA ANALYSIS

No details are provided concerning the analysis of the experimental data.

RESULTS AND DISCUSSION

Seven resonances were observed in the proton energy range examined in this experiment. Only those resonances which could be candidates for the $T = 2$ isobaric analog state are discussed in the paper. These include the resonances found at E_p = 3189 ± 3, 3223 ± 3, and 3289 ± 3 keV that correspond to levels in ^{32}S at E_x = 11953 ± 4, 11986 ± 4, and 12050 ± 4 keV, respectively. The original paper discusses the properties of these various levels based on existing information and results from the present experiment. These arguments are not included in this summary. Finally, it was concluded by the authors that the level at E_x = 12050 keV was the best candidate for the T = 2 state that they sought in this particular investigation.

G+70b

TITLE

Etude du Noyau ^{32}S dans la Voie ^{31}P + p

REFERENCE

S. Gales, M. Langevin, J.-M. Maison, and J. Vernotte, Report NP-18872, *Annuaire (Annual Report) 1970*, Institut de Physique Nucleaire, Universite de Paris Sud, Paris, France, 14 (1970). [In French].

ABSTRACT

Brief Abstract:

1) Evidence is presented for the 12.050 MeV level being the first T = 2 state in ^{32}S.

2) The $^{31}P(p,\gamma)^{32}S$ reaction has been studied in the energy range E_p = 1.4 - 1.6 MeV. Some of the resonance levels exhibit gamma decay which is similar to the de-excitation of analogue toward anti-analogue levels.

Extended Abstract:

Nous avons poursuivi l'etude entreprise l'annee derniere (voir precedent Annuaire).

1) Dans la zone d'energie ou l'on prevoit le premier etat T = 2, trois candidats possibles on ete retenus dans l'etude de la reaction $^{31}P(p,\gamma)^{32}S$. Sur la base de leur schema de desexcitation gamma, deux d'entre eux on ete elimines. Le troisieme niveau (dont l'energie d'excitation E_{ex} = 12050 ± 4 keV est en accord avec la prevision theoretique et la valeur experimentale 12034 ± 40 keV obtenue a Berkeley dans la reaction $^{34}S(p,t)^{32}S$ et forme par des ondes l = 0; des mesures de correlation angulaire gamma-gamma ont montre que le moment angulaire de ce niveau est J = 0. Les deus mesures precedentes fournissent donc la valeur $J^{\pi} = 0^+$ pour ce niveau (comme pour le niveau fondamental de ^{32}Si dont il doit etre l'analogue). La desexcitation gamma se fait exclusivament, a la precision experimentale pres, vers de niveaux de spin isobarique T = 1 (en accord ave la regle de slection pour le rayonnement electromagnetique: ΔT = 0 ou 1). Ceci nous a conduit a considerer le niveau a 12050 ± 4 keV comme un bon candidat pour etre le premier niveau T = 2 de ^{32}S. Actuellement nous sommes en train d'analyser le resultats de la reaction de diffusion elastique resonnante $^{31}P(p,p)^{31}P$ pour obtenir des informations sur la quantite Γ_p/Γ; nous analysons egalement les donnees de la fonction d'excitation pour obtenir une valeur de la largeur radiative Γ_γ.

2) Nous avons aussi continue l'etude de la reaction $^{31}P(p,\gamma)^{32}S$ dans la zone E_p = 1.4 - 1.6 MeV. Des niveaux ont ete observes dont certains n'ont pu etre mis en evidence que par l'etude complementaire des reactions $^{31}P(p,p)^{31}P$ et $^{31}P(p,\alpha_0)^{28}Si$. L'analyse en cours de ces diverses reactions dovrait nous fournir des renseignements sur les largeurs partielles de ces niveaux. Des spectres de desexcitation gamma ont ete mesures systematiquement pour toutes

les resonances. Certaines d'entre elles presentent des desexcitations qui semblent caracteristiques de transitions d'etats analogues vers des etats antianalogues. Enfin, des distributions angulaires des rayonnements gamma mesures pour 4 resonances fournissent les resultats suivants:

E_{ex} = 10219 keV (forme a E_p = 1399 keV): $J = 3$;
E_{ex} = 10229 keV (forme a E_p = 1410 keV): $J = 1$;
E_{ex} = 10256 keV (forme a E_p = 1437 keV): $J = 4$.

De plus, le moment angulaire du niveau at 6623 keV est $J = 4$.

3) En plus de l'achievement des travaux precites, nos projets pour l'annee 1971 comportent des experiences avec S. Fortier, H. Laurent et J.P. Shapira. Ces experiences portent sur la localisation et l'identification des etats $T = 2$ dans des noyaux $T_z = +1$ (^{28}Al, ^{32}P, ^{36}Cl, ^{40}K at ^{44}Sc) au moyen de reactions (^{3}He,p) ou (^{3}He,α) induites par le faisceau de ^{3}He de 3 MeV. De plus, nous avons l'intention de mesurer la desexcitation gamma de es etats, et si possible d'acceder a des grandeurs telles que leur temps de vie.

COMMENT

This contribution appears in an annual progress report of Institut de Physique Nucleaire, Universite de Paris Sud, Paris, France. The entire report is reproduced above in the "Extended Abstract" which is written in French. No formal summary is provided for this reference.

G+73

TITLE

The Giant Dipole Resonance of ^{32}S Observed with the Polarized Proton Capture Reaction

REFERENCE

H.F. Glavish, J.R. Calarco, R. Avida, S.S. Hanna, and P.M. Kurjan, *Bulletin of the American Physical Society* **18**, 1601 (1973).

ABSTRACT

By measuring the polarized as well as the unpolarized angular distributions for the reaction ^{31}P(p,γ_0)^{32}S it has been possible to determine the E1 capture amplitudes. Unlike other capture reactions that have been investigated the polarization effects in this reaction are small which is attributed to a small phase difference between the E1 capture amplitudes. Measurements have been made with the aim of studying the constancy or otherwise of the configuration of the giant dipole states in ^{32}S.

COMMENT

A detailed summary was not prepared for this work. The only information available from the literature is a short abstract in *Bulletin of the American Physical Society*. No data were provided in this communication.

G+74

TITLE

An Investigation of Odd Parity States in ^{32}S

REFERENCE

H. Grawe, J.E. Cairns, M.W. Greene, and J.A. Kuehner, *Canadian Journal of Physics* **52**, 950 - 958 (1974).

ABSTRACT

States in ^{32}S have been populated using the $^{31}P(p,\gamma)$ reaction at the E_p = 895, 1438, and 1583 keV resonances. Angular distributions, a linear polarization measurement, and the results from the $^{32}S(\alpha,\alpha')$ reaction at 180° yielded the following spin and/or parity assignments for found levels: J^{π} (6.62) = 4^-; J^{π} (6.76) = 3^-, 4^+, 5^-; J^{π} (6.85) = 3^-, 4^+;J^{π} (7.95) = 3, 4, 5^-; and for resonance states: J (10.26) = 4 ; J (10.40) = 4. The γ decay of selected excited states has been studied and mixing ratios were obtained for the strongest branches. Doppler shift measurements yielded lifetimes of 810 (-250, +350) fs, > 300 fs, and 110 (-40, +60) fs for the states at 6.62, 6.76 ,and 7.95 MeV, respectively. The results are discussed and compared with shell model predictions.

FACILITY

3-MV KN Van de Graaff accelerator and FN tandem accelerator, McMaster University, Hamilton, Ontario, Canada.

EXPERIMENT

The present experiment includes the measurement of γ-ray yield curves from E_p = 0.8 - 2.0 MeV and angular distribution, linear polarization, and Doppler shift attenuation method (DSAM) measurements for states fed from the $^{31}P(p,\gamma)$ resonances at E_p = 895, 1438, and 1583 keV. There was also an investigation of the $^{32}S(\alpha,\alpha')$ reaction at 180° where only states with natural parity $(-)^J$ are populated. These latter results are not of direct interest in the present context; however, they do give information on specific levels in ^{32}S which may be indirectly relevant.

MEASUREMENT PROCEDURES

Targets of Zn_3P_2 evaporated on Ta backings that could be directly water cooled were bombarded with a 20 μA proton beam from the McMaster University 3-MV KN Van de Graaff accelerator. The typical target thickness was 6 keV for 1.5-MeV protons.

The γ-rays were detected in a 45 cm^3 Ge(Li) detector with a resolution of 2.5 keV at 1.33 MeV γ-ray energy. Resonance yield curves were measured between 0.8 and 2.0 MeV proton bombarding energy. The γ-decay of resonances at 895, 1054, 1089, 1118, 1438, and 1583 keV were observed at 55 and 90° relative to the incident proton beam. Angular distributions were measured at the 1438- and 1583-keV resonances. This involved the recording of γ-ray spectra at 0, 30, 45, 60 and 90° with the Ge(Li) detector placed at a distance of 7.5 cm from the target. An additional small Ge(Li) detector with a volume of 12 cm^3 was used as a fixed relative monitor. The DSAM measurements were performed with the larger Ge(Li) detector situated at angles of 0, 45, and 120° relative to the proton beam and 10 cm from the target. A radioactive source was placed in a fixed position relative to the detector in order to monitor for electronic gain-shift effects and thereby provide information as required for corrections. The efficiency of the Ge(Li) used for the primary measurements was determined using a ^{56}Co source. This source was also used to check for instrumental anisotropy that would effect the angular distribution measurements. For γ-ray energies above 3.5 MeV, the known γ-ray spectrum from the ^{26}Mg(p,γ)^{27}Al reaction at the E_p = 1408 keV resonance was employed to calibrate the detector.

The linear polarization of the 6.62 → 5.01 MeV transition was measured at the E_p = 1438 keV resonance using a single Ge(Li) polarimeter that had been described in an earlier publication [Ewan *et al.*, *Physics Letters* **B29**, 352 (1969)].

Finally, measurements on the ^{32,34}S(α,α') reactions were performed using the McMaster University FN tandem accelerator. Natural and ^{34}S-enriched targets of CdS were evaporated on 10 μg/cm^2 carbon foils and these were bombarded with a 200 nA $^4He^{++}$ beam. The target thickness was 20 μg/cm^2. (NOTE: the original paper states that it was a $^5He^{++}$ beam but this seems likely to be a misprint). Scattered α-particles were detected with a Si surface barrier detector (annulus) situated near 180°. The subtended angle was limited to 176.8° ≤ θ_α ≤ 178.7°. Spectra of scattered α-particles were taken at 5 energies between 16 and 18 MeV in 0.5-MeV steps.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra recorded with Ge(Li) detectors and α-particle spectra recorded with a Si surface barrier detector (annulus).

DATA ANALYSIS

No details are given concerning analysis of the measured data.

RESULTS AND DISCUSSION

In the present paper, only results obtained at the E_p = 895, 1438, and 1583 keV resonances are presented. Results for other resonances were found to be in good agreement with data published earlier by Coetzee *et al.* [CMR72] which are also included in the present compilation. As evidenced by their γ-day, these selected states are strongly linked to the odd parity bound states of ^{32}S. The results presented in the original paper include the plot of a typical spectrum as well as a level and γ-decay diagram (Fig. 2 of the original paper) which includes branching factors. These results are discussed - level by level - in the text of the original paper. These details are omitted here.

Concerning the (α,α') measurements, it is apparent that for a ½$^+$ target (^{31}P), only natural parity states $(-)^J$ can be populated via this process if the scattered particle is detected near 0 or 180°. Measurements were performed with targets of S compounds that involved both natural abundance and ^{34}S enriched materials. In Fig. 2 of the original paper it is indicated whether the ^{32}S state was observed in α-particle scattering (+), and hence was natural parity, or whether it was not observed (-). The results observed for ^{34}S appear to be consistent with J^π values assigned from previous work [J.G. Van der Baan and B.R. Sikora, *Nuclear Physics* **A173**, 456 (1971); M.W. Greene *et al.*, *Nuclear Physics* **A188**, 83 (1972)], namely, 2^-, 5^-, and 4^- for the states at 5.32-, 5.69-, and 6.64-MeV excitation.

The DSAM lifetime measurements yielded results for the 6.62-, 6.76-, and 7.95-MeV states in ^{32}S. Corrections for electronic gain shifts were obtain by monitoring the positions of the 0.899- and 1.836-keV lines from a ^{88}Y radioactive source and the fully shifted primary γ-rays from the resonance. As usual, the reliability of lifetime results from DSAM measurements depends strongly on the accuracy of the stopping power calculations. The authors discuss this issue and compare their results with earlier work from the literature. The derived lifetimes of the indicated states are included in Table 1 of the original paper.

The measured γ-ray angular distributions were fitted with Legendre polynomials by least-squares. Corrections for solid angle were applied to these data. Spin/parity values and multipole mixing ratios were deduced by comparisons with theoretical calculations using well-established methods. The details of this analysis and interpretation of the results are discussed extensively in the original paper but are omitted here. Extensive discussions of comparisons of these data with predictions from shell-model calculations also appear in the paper. These too are omitted here.

H81

TITLE

Analog of the 3.00-MeV State of ^{32}P in ^{32}S

REFERENCE

R. Hentela, *Physical Review* **C23**, 1900 - 1905 (1981).

ABSTRACT

The analog of the E_x = 3005-keV, $J^{\pi} = 3^+$ state of ^{32}P in ^{32}S has been studied using the $^{31}P(p,\gamma)^{32}S$ reaction. The analog candidate at E_p = 1151 keV, E_x = 9979 keV, previously regarded as a singlet, has been established to be a doublet with 0.5 keV spacing. The gamma decay schemes, the branching ratios, and the resonance strengths of the members of the doublet have been determined. The results of the angular distribution measurements together with earlier data lead to unique spin and parity assignments of 4^- and 3^+, respectively, for the lower and upper members of the doublet. In addition, for the bound states of ^{32}S at E_x = 6852 and 7485 keV, unique assignments of $J^{\pi} = 4^+$ and 2^+, respectively, have been deduced.

FACILITY

2.5-MV Van de Graaff accelerator, Department of Physics, Helsinki University, Helsinki, Finland.

EXPERIMENT

The objective of this work was to determine whether the E_x = 9979-keV, J = 3 level in ^{32}S populated at E_p = 1151 keV by the $^{31}P(p,\gamma)^{32}S$ reaction is indeed the analog of the E_x = 3005-keV, $J^{\pi} = 3^+$ level in ^{32}P. This issue had been addressed earlier but it was re-visited in the present investigation because of clear inconsistencies in the earlier data. The approach was to explore this resonance with the $^{31}P(p,\gamma)^{32}S$ reaction using a high-performance Ge(Li) detector. Furthermore, this investigation included more precise measurements on this reaction, *e.g.*, resonance γ-ray decay angular distribution determinations using a Ge(Li) detector, than were performed earlier in this same laboratory [HV70].

MEASUREMENT PROCEDURES

The measurements were performed at the Helsinki University 2.5-MV Van de Graaff accelerator. The targets were prepared by evaporating GaP in a high vacuum system onto 0.4-mm-thick tantalum backings. The targets were water cooled during use. Proton beam currents were in the range 15 - 40 μA. The beam-energy spread was determined from the thick target yield of the E_p = 992-keV $^{27}Al(n\gamma)^{28}Si$ resonance; it was found to be less than 0.5 keV.

The emitted γ-rays were detected with a Princeton Gamma-Tech 110 cm^3 Ge(Li) detector; it exhibited a full-width at half maximum (FWHM) of 3.1 keV at 2.6 MeV photon energy. Pulse-height information was acquired in 4096 channels using a Nuclear Data ND-160M analyzer. Well-known γ-rays from ^{56}Co decay and the $^{27}Al(n\gamma)^{28}Si$ reaction were used to generate an efficiency calibration for this detector. A second Ge(Li) detector with 38 cm^3 volume was used as a monitor during angular distribution measurements. It was located in a fixed position at 90° with respect to the incident proton beam and 8 cm from the target. Data from the monitor detector were acquired on-line using a PDP-9 computer.

The yield of γ-rays in the vicinity of the E_p = 1151-keV resonance of the $^{31}P(p,\gamma)^{32}S$ reaction was measured using a thin (0.7 keV at E_p = 1151 keV) target. The detector was positioned at 55° relative to the proton beam and 4 cm from the target.

Resonance strength measurements were made relative to the E_p = 642-keV resonance using a 10-keV thick target. Selected γ-ray transitions from resonance decay were used for this purpose.

Finally, angular distribution measurements were performed at 0, 30, 45, 60, and 90° relative to the incident protons. A total proton charge of 0.1 C was collected at each angle. For these measurements a 1.5-keV thick target was used and the distance of the detector from this target was 4 cm. Eccentricity and absorption corrections of the measurement system were checked by observing the angular distribution of the E_p = 620-keV, $J^\pi = ½^+$ resonance in the $^{30}Si(p,\gamma)^{31}P$ reaction.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra from Ge(Li) detectors recorded with a multi-channel analyzer and on-line computer system. Integrated proton beam current was also recorded.

DATA ANALYSIS

Very few details are provided in this paper concerning analysis of the experimental data. Spin/parity and multipole-mixing ratios for the measured γ-ray transitions were obtained, where possible, by comparison of the experimental angular distributions with theoretically calculated distributions. The least-squares method was employed in these comparisons.

RESULTS AND DISCUSSION

The thin-target γ-ray yield data near the "resonance" provided strong evidence that it was, in fact, a doublet with an energy separation of about 0.5 keV, thereby confirming the results from earlier work at Helsinki University [HV70]. The measured proton energies of these resonances were found to be 1150.0 ± 0.7 and 1150.5 ± 0.7 keV, respectively. The γ-ray branching ratios for these two resonances are distinct. It was possible to determine these branching factors experimentally; they are presented in tabular form in the original paper.

The resonance strengths were determined for the individual resonances in this doublet by comparison of their γ-ray yields relative to that for the E_p = 642-keV resonance. The γ-ray transition to the 6224-keV state in ^{32}S was used in determining the strength for the lower-energy resonance while the γ-ray transition to the 4459-keV state in ^{32}S was used in determining the strength for the upper-energy resonance. The ground-state γ-transition for the E_p = 642 keV resonance was used as the reference standard for this resonance strength determination.

The experimental γ-ray angular distributions were fitted by least-squares with even-order Legendre polynomial expansions. Geometry corrections were then applied and these coefficients were compared with corresponding values from theoretical calculations to provide estimates of spin/parity and multipole-mixing ratios as mentioned above. The results from this analysis are provided in Table II of the original paper; they are also discussed extensively in the text.

The remainder of the paper is devoted to discussing the nature of the observed resonances at E_p = 1150.0 and 1150.5 keV and of the various γ-ray transitions observed in the decay of these resonances. It was determined that J = 4 was the most likely choice for the 1150.0-keV resonance while J = 2 is the most likely for the 1150.5-keV resonance.

HV70

TITLE

The E_p = 1146 keV and 1151 keV Resonances in the $^{31}P(p,\gamma)^{32}S$ Reaction

REFERENCE

P. Holmberg and M. Viitasalo, *Physica Scripta* **1**, 159 - 160 (1970).

ABSTRACT

More evidence on the existence of resonances at E_p = 1146 keV and 1151 keV in the $^{31}P(p,\gamma)^{32}S$ reaction has been obtained. The decays of these resonances are investigated and decay schemes presented. Angular distributions of the strong transitions to the first excited state in ^{32}S are measured. Spin and parity 2^+ is suggested for both resonance states.

FACILITY

Van de Graaff accelerator, Department of Physics, University of Helsinki, Helsinki, Finland. (NOTE: The maximum voltage of this accelerator is not specified in the paper but it is presumed to be 2.5-MV based on another reference included in the present compilation [H81]).

EXPERIMENT

The region of $E_p \approx 1150$ keV for the $^{31}P(p,\gamma)^{32}S$ reaction had been studied previously but there were discrepancies in the results. Several authors reported a single resonance while another indicated that there should be two, namely, at $E_p = 1146$ and 1151 keV. The measurements prior to 1970 had been performed with NaI(Tl) scintillation detectors. The purpose of the present investigation was to repeat these earlier studies using a Ge(Li) detector. The particular objective was to ascertain whether there is, in fact, a doublet of levels in ^{32}S that can be identified from two distinct resonances for incident protons around 1150 keV. The present short communication reports on this work.

MEASUREMENT PROCEDURES

Protons were accelerated by the Van de Graaff accelerator and were then deflected through 90° by an energy analyzing magnet. The proton energy calibration relied on use of the nuclear magnetic resonance (NMR) method to measure the magnetic field accurately. The proton beam current was kept at ≈ 3 μA. Targets were prepared by vacuum evaporation onto tantalum backings.

The γ-radiation was detected using a 38 cm^3 Ge(Li) detector with a resolution of 3.5 keV FWHM at 1332 keV γ-ray energy. (NOTE: This reported efficiency and resolution seem rather primitive by today's standards but they were quite typical of the state-of-the-art values that could be obtained at this early stage in the development of Ge γ-ray detectors). The γ-ray spectra were recorded by a 4096-channel Nuclear Data ND-60 pulse-height analyzer. ^{56}Co and IAEA standard sources were used for the energy and efficiency calibration of this spectrometer.

Gamma-ray angular distributions were also measured at five angles between 0 and 90° using a 5 inch x 5 inch NaI(Tl) detector positioned at a distance of 13 cm from the target. Measurements of the isotropic angular distribution from the $^{30}Si(p,\gamma)^{31}P$ reaction at $E_p = 620$ keV was used to check the centering of the proton beam spot on target and, hence, the geometry symmetry of the apparatus.

DATA ACQUIRED

The data acquired consist of γ-ray spectra measured with both a Ge(Li) detector and a NaI(Tl) scintillation detector. No further details were provided.

DATA ANALYSIS

The data analysis procedure is not discussed in this paper.

RESULTS AND DISCUSSION

The only information provided in this paper are two spectra - corresponding to the γ-decay of each resonance - and a γ-ray de-excitation diagram showing transition energies and branching ratios for each of these resonances. These results are discussed to some extent in the final section of the paper. It was concluded that there are indeed two closely spaced resonances. Spin/parity $J = 2^+$ are suggested for both of them.

I+71

TITLE

Evidence for Vibrational Excited States in ^{32}S

REFERENCE

F. Ingebretsen, B.W. Sargent, A.J. Ferguson, J.R. Leslie, A. Henrikson, and J.H. Montague, *Nuclear Physics* **A161**, 433 - 448 (1971).

ABSTRACT

The 0_2^+, 2_2^+, and 4_1^+ states at 3781, 4283, and 4461 keV respectively in ^{32}S were studied, with emphasis on the latter two. The spin and parity of 4^+ was confirmed for the 4461 keV state. The γ-ray energies of the $4_1^+ \rightarrow 2_1^+$ and $2_1^+ \rightarrow 0_1^+$ transitions were determined as 2229.4 ± 1.2 and 2231.7 ± 1.0 keV, respectively. The lifetimes of the 4_1^+ and 2_1^+ states were measured by the Doppler-shift attenuation method as 0.21 ± 0.06 and 0.35 ± 0.06 ps respectively. The $2_2^+ \rightarrow 0_1^+$ and $2_2^+ \rightarrow 2_1^+$ transitions have a branching ratio of 5.9 ± 0.3, and the latter is pure E2 within the experimental error. The strengths of the $2_1^+ \rightarrow 0_1^+$, $0_2^+ \rightarrow 2_1^+$, $2_2^+ \rightarrow 2_1^+$, and $4_1^+ \rightarrow 2_1^+$ transitions are respectively 7 ± 1, 15 ± 4, 7.3 ± 0.7, and 12 ± 3 W.u. these values suggest that the 2_1^+ level is a one-phonon vibrational state and that the 0_2^+, 2_2^+, and 4_1^+ levels make up a predominately two-phonon vibrational triplet.

FACILITIES

MP Tandem Van de Graaff accelerator, Chalk River Nuclear Laboratories, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada; 3-MV Van de Graaff accelerator, Queen's University, Kingston, Ontario, Canada.

EXPERIMENT

The work consisted of two experiments, one of which was a study of the reaction ^{32}S(p,p')^{32}S on the Chalk River MP Tandem accelerator to obtain the energy, spin, and lifetime of the 4461-keV level. The other was a study of the ^{31}P(p,γ)^{32}S reaction carried out on the 3-MV Van de Graaff accelerator at Queen's University to obtain the branching of the 2_2^+ state to the 2_1^+ and 0_1^+ states and the E2/M1 amplitude ratio of the $2_2^+ \rightarrow 2_1^+$ transition.

The authors point out that study of the 4461-keV level is severely complicated by the fact that it decays solely by a cascade through the 2_1^+ state to the 0_1^+ ground state and the fact that the primary and secondary transitions of this cascade differ in energy by less than 3 keV. These two components in the γ-ray spectrum are indistinguishable even with a Ge(Li) detector. The problem has been resolved in the present work by a careful comparison of the spectrum from the 2_1^+ state that contains the secondary component only with the spectrum from the 4_1^+ state that contains both components. The γ-ray spectra associated with individual levels were selected by coincidence with the corresponding proton groups detected in an annular silicon surface barrier particle detector near 180°.

MEASUREMENT PROCEDURES

The proton beam from the MP Tandem accelerator passed through two tantalum collimators - the smaller being 2.2 mm in diameter - and the 4.0-mm-diameter hole in the particle detector before impinging on the target 31.3 mm beyond the counter. The beam was finally stopped in a shielded beam trap several meters further along the beam line. The target was natural sulphur with a thickness of 383 μg/cm^2 supported by a 100 μg/cm^2 gold backing.

The target was mounted on a copper cold finger that was cooled to liquid nitrogen temperature to prevent sublimation of the sulfur during irradiations; this arrangement proved to be completely stable during the entire course of the experiment. The 4461-keV state was identified as that corresponding to a proton energy of 9.275 in favor of other states seen in this vicinity during the excitation function measurements.

Gamma rays from $^{32}S(p,p'\gamma)^{32}S$ were detected with a 44-cm^3 Ge(Li) detector at mean angles of 45, 60, 75, 90, 105, 120, and 133.5° relative to the incident proton beam. Proton-gamma coincidences were encoded and stored event by event using a PDP-1 computer. A NaI(Tl) scintillation detector 12.7 cm diameter by 15.2 cm long was installed at 90° relative to the proton beam to enable γ-γ coincidences to be measured between this detector and the Ge(Li) detector, similar to the p-γ coincidences. A weak ^{88}Y source was attached to the target chamber to provide a continuous γ-ray energy calibration. Sources of ^{24}Na γ-ray activity mounted on gold foil were also used to determine geometrical and absorption corrections for the coincidence experiment and to check for non-linear effects in the Ge(Li) spectrometer after completion of the $(p,p'\gamma)$ measurements. This source was mounted in the target position.

The study of the 4383-keV state in ^{32}S was carried out at Queen's University using the $^{31}P(p,\gamma)^{32}S$ reaction. This was done at the 1.555-MeV resonance corresponding to an excitation of 10.371 MeV in ^{32}S. The 4383-keV had been found earlier to be strongly populated through this resonance [S.L. Anderson, *Physica Norvegica* **1**, 247 (1965)]. The target was zinc phosphide on a 0.51-mm- thick gold sheet. The plane of the target was set at 114° relative to the incident proton beam. The γ-ray yield curve was measured with a resolution of 6 keV FWHM. Two Ge(Li) detectors were used; one had a volume of 23 cm^3 and the other was 38 cm^3. The smaller detector could be rotated and was set in turn at 8 angles in the range 0 - 90°. The larger detector was used as a monitor and was situated at a fixed angle of 90°. Gamma-ray spectra were accumulated in a PDP-9 computer.

DATA ACQUIRED

The data acquired consisted of proton spectra, γ-ray spectra, p-γ coincidence spectra, and γ-γ coincidence spectra. These were recorded with a silicon surface barrier detector (annulus), NaI(Tl) scintillation detector, and a Ge(Li) detector.

DATA ANALYSIS

Various details on the analysis of these data are presented in the original paper. It was indicated that corrections were applied for instrumental uncertainties and geometric factors that could affect the angular distribution and coincidence measurements. Angular distribution data were fitted with even-order Legendre polynomial expansions in the usual way, and the geometry-corrected expansion coefficients were compared to values computed from theory in order to make predictions about spin, parity, and γ-ray multipolarity. Stopping power calculations were carried out as needed for determination of the lifetimes of several states in ^{32}S. This were accomplished using an available computer code [C. Broude, *Canadian Journal of Physics* **45**, 3415 (1967)] and related information from the literature [J. Lindhard *et al.*, *Mat. Fys. Medd. Dan. Vid. Selsk.* **33**, No. 14 (1963); A. E. Blaugrund, *Nuclear Physics* **88**, 501 (1966)].

RESULTS AND DISCUSSION

The energies of 11 strong γ-ray transitions in ^{32}S were determined in the experiment at Chalk River. In general these were Doppler shifted, but accurate values for the un-shifted energies were deduced from lifetime analyses for the states involved in the transitions. These energies appear in Table 1 of the original paper where comparisons are also made to results from other work. Details on these lifetime determinations and the results are also given in the paper in Table 2.

The spin of the 4461-keV state was deduced from the angular correlation measurements at Chalk River. From this investigation, it was deduced that the spin must be 4 and the parity positive (*i.e.*, a 4^+ state). This result confirms the conclusion of earlier investigators [J. Vernotte *et al.*, *Nuclear Physics* **A124**, 350 (1969); G.T. Garvey *et al.*, *Physics Letters* **29B**, 108 (1969)].

The lifetime of several states in ^{32}S were measured by examining the centroid shifts of the γ-ray transition photo peaks. The lifetime values were derived by comparing the calculated and measured Doppler-shift attenuation factors for the transition studied. The results from this analysis appear in Table 2 of the original paper. These results generally compare well with other values reported in the literature.

As indicated above, there are two decay modes for the ^{32}S 4283-keV 2_2^+ state, namely, to the 2_1^+ state or to the 0_1^+ ground state. In this experiment the branching ratio α for $(2_2^+ \rightarrow 0_1^+)/(2_2^+ \rightarrow 2_1^+)$ and E2/M1 mixing ratio δ were found by measuring the angular distributions of the 2051-keV and 4283-keV γ-rays. The results are $\alpha = 5.9 \pm 0.3$ and $\delta = \mathrm{tg}(-88 \pm 3°)$.

Finally, transition strengths B(E2) and B(M1) in W.u. were deduced for the four lowest excited states of ^{32}S. These values are given in Table 3 of the original paper. The remainder of the paper is devoted to discussing the physical implication of these results.

I+90

TITLE

The Influence of Low-energy Resonances in $^{31}P(p,\gamma)^{32}S$

REFERENCE

C. Iliadis, U. Giesen, J. Goerres, L. Van Wormer, M. Wiescher, R.E. Azuma, J. King, M. Buckby, C.A. Barnes, and T.R. Wang, *Bulletin of the American Physical Society* **35**, No. 8, 1673 (1990).

ABSTRACT

The understanding of the rp-process nucleo-synthesis in the Si-P-S region is of particular interest for the interpretation of the recently observed high Si and S abundances in nova ejecta. The reaction branch between $^{31}P(p,\gamma)$ and $^{31}P(p,\alpha)$ determines whether the material is processed further toward the Fe-Ni region, or whether it is stored in a SiPS-cycle which would lead to an enrichment in the abundances of these isotopes. We therefore measured the $^{31}P(p,\gamma)^{32}S$ and $^{31}P(p,\alpha)^{28}Si$ reactions in the proton energy range of $280 \leq E \leq 830$ keV in search for resonances in the two reaction channels. The experiments were performed at the JN Van de Graaff at the University of Toronto and at the 3-MV Pelletron at Cal Tech. Six resonances were observed in the (p,γ)-channel. Resonance strengths were obtained for all observed levels. The influence of these resonances on the $^{31}P(p,\gamma)$ and $^{31}P(p,\alpha)$ reaction rates as well as the possibility of a SiPS-cycle at nova conditions will be discussed.

COMMENT

A detailed summary was not prepared for this work. The only information available from the literature is a short abstract in *Bulletin of the American Physical Society*. No data were provided in this communication.

I+91

TITLE

The Reaction Branching $^{31}P(p,\gamma)$/ $^{31}P(p,\alpha)$ in the rp-Process

REFERENCE

C. Iliadis, U. Giesen, J. Goerres, S. Graff, M. Wiescher, R.E. Azuma, J. King, M. Buckby, C.A. Barnes, and T.R. Wang, *Nuclear Physics* **A533**, 153 - 169 (1991).

ABSTRACT

The reactions $^{31}P(p,\gamma)^{32}S$ and $^{31}P(p,\alpha)^{28}Si$ have been studied in the energy range 280 - 620 keV to investigate the influence of low-energy resonances on the stellar reaction rates. Several new resonances have been observed and the resonance strengths for both reaction channels have been determined. The reaction rates have been calculated from the present results and are compared with the results of Hauser-Feshbach calculations.

FACILITIES

3-MV Pelletron tandem accelerator, Kellogg Radiation Laboratory, California Institute of Technology, Pasedena, California; 1-MV Van de Graaff accelerator, University of Toronto, Toronto, Ontario, Canada; 350-keV Cockcroft Walton accelerator, University of Toledo, Toledo, Ohio.

EXPERIMENT

Proton capture reactions in the mass A = 28 - 32 range were studied in order to better understand the mechanisms whereby CNO material is processed into the Fe-Ni mass range by the rp-process. In particular, competition between the (p,γ) and (p,α) is important in determining the efficiency with which material is processed to higher masses in various stellar environments. Although the emphasis here concerns the (p,γ) reaction, both of these processes will be considered because they are intimately related in the discussions of the present paper.

The present experiment involves measurements on the $^{31}P(p,\gamma)^{32}S$ and $^{31}P(p,\alpha)^{28}Si$ reactions over the incident-proton energy range 280 to 620 keV.

MEASUREMENT PROCEDURES

The $^{31}P(p,\gamma)^{32}S$ experiments were carried out in the range E_p = 0.35 - 0.62 MeV at the 3-MV Pelletron tandem accelerator at Cal Tech. This facility provided proton beams of up to

100 μA with an energy resolution of about 1 keV, as determined by observing the known, narrow resonance at E_r = 991.88 ± 0.04 keV in the reaction $^{27}Al(p,\gamma)^{28}Si$ [P.B. Lyons *et al.*, *Nuclear Physics* **A130**, 1 (1969)]. The proton-beam energy was calibrated using this resonance as well as the known $^{31}P(p,\gamma)^{32}S$ resonance at 811 keV to ±1 keV. For further investigation of the low-energy $^{31}P(p,\gamma)^{32}S$ resonances and for measurements on $^{31}P(p,\alpha)^{28}Si$, use was made of the 1-MV Van de Graaff accelerator at the University of Toronto. This accelerator provided proton beams of 50 μA with an energy resolution of about 1 keV and energy calibration of better than ±2 keV.

Targets for both of these experiments were produced by implanting ^{31}P ions into a 0.5-mm- thick Ta backing with an incident dose of 133 μA-h using the 350-keV Cockcroft Walton accelerator at University of Toledo. The implantation energy was 200 keV which leads to a well-defined target thickness of ~ 15 keV at 355 keV bombarding energy. The ^{31}P beam was scanned over an area of 1.5 cm^2 to insure homogeneous implantation over the target surface. The target thickness and stoichiometry, Ta_2P_3, were determined by measuring the thick- target yield curve of the well-known resonance in $^{31}P(p,\gamma)^{32}S$ at E_p = 811 keV. These targets were water cooled during proton bombardment and were found to be very stable.

The experimental setups at Cal Tech and Toronto were very similar for the $^{31}P(p,\gamma)^{32}S$ measurements. The proton beam passed through a Ta collimator and was directed onto the target; the target was oriented at 45° with respect to the beam direction. A liquid nitrogen cooled copper tube was placed between the collimator and target to inhibit carbon deposition on the target. The target and chamber formed a Faraday cage for charge integration and a negative voltage (-300 V) was applied to the cooling tube to suppress secondary electron emission from the target. The γ-rays from $^{31}P(p,\gamma)^{32}S$ were observed with a 35% efficient Ge detector placed close to the target at 55°. This detector was shielded with 5 cm of lead to reduce background from the room. The γ-efficiency was determined from the known branching ratios and resonance strengths of the 632- and 992-keV resonances in $^{27}Al(p,\gamma)^{28}Si$ [P.B. Lyons *et al.*, *Nuclear Physics* **A130**, 1 (1969); B.M. Paine and D.G. Sargood, *Nuclear Physics* **A331**, 389 (1979)].

The $^{31}P(p,\alpha)^{28}Si$ measurements were performed using two surface-barrier detectors, each with an active area of 450 mm^2; they were mounted at 90 and 135° with respect to the beam direction. The solid angles of these detectors were defined to be 0.14 sr by means of collimators with a diameter of 2.3 cm mounted 3 mm in front of the detectors. These solid angles were measured using a ^{241}Am α-particle source; the values obtained agreed well with results from geometric calculations. The target-detector distance was 5.5 cm. 2.2 μm-thick Havar foils were placed between the detector collimators and the detectors themselves in order to absorb the intense yield of elastically scattered protons from the target. The presence of these absorption foils reduced the original 20-keV resolution of these detectors due to severe straggling effects for the low-energy α-particles. The actual resolution was determined by observing α-particles from the $^{19}F(p,\alpha_2)^{16}O$ reaction (Q = 1.983 MeV) at the 340-keV resonance in this reaction. These α-particles are in the same energy range as those from the $^{31}P(p,\alpha_0)^{28}Si$ (Q = 1.983 MeV). The α_2-group from the fluorine reaction was well resolved from the elastically scattered protons (after losing about 1.5 MeV passing through the Havar foil) and exhibited a resolution of about 100 keV. Protons with energies E_p > 450 keV penetrated the foils and produced substantial background in the region of the spectrum where α-particles from $^{31}P(p,\alpha_0)^{28}Si$ appeared. Measurements on the well-known $^{19}F(p,\alpha_2)^{16}O$ resonance at 340-keV were also used to estimate the possible losses of reaction yield due to multiple scattering of low-energy α-particles in the case of the $^{31}P(p,\alpha)^{28}Si$ reaction. The energy calibration of the surface-barrier detector system was determined by measuring α-particles from $^6Li(p,\alpha)^3He$ (E_p = 400 keV), and known resonances in $^{15}Ni(p,\alpha)^{12}C$ (E_p = 338 keV), $^{18}O(p,\alpha)^{15}N$ (E_p = 334 keV), and $^{19}F(p,\alpha)^{16}O$ (E_p = 340 keV).

DATA ACQUIRED

The data acquired were γ-ray spectra recorded with a Ge detector and charged-particle spectra measured with surface-barrier detectors.

DATA ANALYSIS

Few details are given concerning the analysis of the obtained experimental data.

RESULTS AND DISCUSSION

The excitation function for $^{31}P(p,\gamma)^{32}S$ was measured in the energy range E_p = 280 - 620 keV in energy steps smaller than the target thickness at (15 keV at E_p = 355 keV). Six resonances were observed. Four were known from previous work: E_r = 355 (1^+), 439 (1^+), 541 (2^-), and 619 keV (2^+). Two resonances, at 383 and 403 keV, had not been observed for the γ-decay channel in previous experiments on excited levels of ^{32}S. Since the 383-keV resonance was very weak it could barely be seen as a small shoulder on the high-energy tail of the thick-target yield of the 355-keV resonance. To insure that this was not just an anomaly attributable to resolution effects, a careful measurement was also made of the shape of the well-resolved 541-keV resonance. No resonances in $^{31}P(p,\gamma)^{32}S$ were observed in the energy range below E_p = 350 keV. However, transfer reaction data indicate the existence of several levels in the corresponding excitation energy range of ^{32}S [P.M. Endt and C. van der Leun, *Nuclear Physics* **A310**, 1 (1978); J. Kalifa *et al.*, *Physical Review* **C17**, 1961 (1978)].

The excitation curve for the $^{31}P(p,\alpha)^{28}Si$ reaction was measured at 90 and 135° in the energy range 280 - 450 keV in proton-energy steps of less than 5 keV. A continuous background due to the $^{11}B(p,\alpha)2^{4}He$ three-particle breakup reaction from protons on ^{11}B contamination in the Ta backings was observed in the charged-particle spectra. Additional peaks from $^{15}N(p,\alpha)$ and $^{18}O(p,\alpha)$ reactions were also observed. These sources of background were identified by using blank Ta targets and targets implanted with ^{11}B, ^{15}N and ^{18}O. Background at very low pulse-height was due to protons elastically scattered from Ta that penetrated the detector foils. The yields in this latter case were consistent with the predictions of Rutherford scattering. This proton-beam-scattered background was measured by bombarding a pure Ta target with protons over the range E_p = 280 - 450 keV in steps of 2.5 keV. Repeated background measurements demonstrated reproducibility to within ± 5%. Although it was difficult to separate the proton and α-particle events in the recorded charged-particle spectra, an excitation curve for $^{31}P(p,\alpha_0)^{28}Si$ was nevertheless obtained at both angles and these curves clearly indicate a resonance at E_r = 383 keV. This resonance corresponds to the newly observed weak resonance in $^{31}P(p,\gamma)^{32}S$ at the same energy. The width of the α-particle yield curve for this resonance was 15 keV which agrees well with the target thickness deduced from $^{31}P(p,\gamma)^{32}S$ measurements on this same resonance.

The excitation energies of the compound levels in ^{32}S observed in this experiment were deduced in two ways, namely, from the energies of the γ-decay transitions to known levels in ^{32}S and from the midpoints of the resonance peaks in the $^{31}P(p,\gamma)^{32}S$ and $^{31}P(p,\alpha)^{28}Si$ excitation functions. These values are given in Table 1 of the original paper where comparison is also made with previous values from the literature [P.M. Endt and C. van der Leun, *Nuclear Physics* **A310**, 1 (1978)]. The agreement is good. The authors state that only those compound levels in ^{32}S with natural parity can decay to ^{28}Si by α-particle emission. On this basis, they assign spin/parity $J^\pi = 1^-$ for the state at 9.236 keV. Information on γ-ray decay branching from the observed resonances is given in Table 2 of the original paper. Possibilities for spin/parity assignment based on this evidence and other pertinent information from the literature are discussed in the text.

Resonance strengths for both the (p,γ) and (p,α) reactions on ^{31}P were deduced in the present experiment from thick-target yield determinations. The procedure is outlined briefly in the original paper; it depends on knowledge of the stopping power which was deduced from information in the literature [H.H. Anderson and J.F. Ziegler, *Stopping Powers and Ranges in all Elements*, Pergamon, New York (1977)]. These results were normalized relative to the well-known strength $(\omega\gamma)_\gamma = 0.25 \pm 0.02$ eV for the 811-keV resonance in the ^{31}P(p,γ)^{32}S reaction. The main source of error in these determinations was the stopping power. Small corrections for the presence of $P_4(\cos\theta)$ Legendre-polynomial terms in γ-ray angular distributions were anticipated to be no larger than 5% in the worst case so angular distributions were not measured in this experiment. However, in the case of the ^{31}P(p,α)^{28}Si resonance at 383 keV, strong anisotropy was observed in the α-particle emission. Consequently, pains were taken to apply a correction - based on measurements at 90 and 135° - in the determination of the (p,α) resonance strength. The (p,γ) and (p,α) strengths for reactions on ^{31}P in the energy range where measurements were performed are given in Table 3 of the original paper. Estimates of corresponding resonance strengths for resonances at lower proton energy were calculated based on assumptions concerning spectroscopic factors and other pertinent information from the literature. These results are given in Table 4 of the original paper.

Finally, the paper provides information on astrophysical reaction rates for the ^{31}P(p,γ)^{32}S and ^{31}P(p,α)^{28}Si reactions based on the assumption that they are dominated by discrete narrow (presumably non-interfering) resonances. The results for stellar temperatures T_9 = 0.05 - 2 GK are provided in Table 5 of the paper.

I+93

TITLE

Explosive Hydrogen Burning of ^{31}P

REFERENCE

C. Iliadis, J. Goerres, J.G. Ross, K.W. Scheller, M. Wiescher, C. Grama, Th. Schange, H.P. Trautvetter, and H.C. Evans, *Nuclear Physics* **A559**, 83 - 99 (1993).

ABSTRACT

Proton threshold states in ^{32}S have been studied via the reactions ^{31}P(p,γ)^{32}S, ^{31}P(p,α)^{28}Si, and ^{28}Si(α,γ)^{32}S to investigate their influence on a possible SiP cycle in explosive hydrogen burning. One new resonance at $E_p = 200 \pm 2$ keV has been found in the (p,γ) reaction channel, but only upper limits could be deduced for the corresponding (p,α) and (α,γ) resonance strengths. The stellar reaction rates for ^{31}P(p,γ)^{32}S are now experimentally determined for stellar temperatures $T_9 \geq 0.05$, whereas the stellar rates for ^{31}P(p,α)^{28}Si still carry large uncertainties for $T_9 < 0.4$. the results of the present work suggest only weak cycling in the SiP mass range at all stellar temperatures of interest.

FACILITIES

400-kV accelerator, Ruhr-Universitaet Bochum, Bochum, West Germany; 4-MV Van de Graaff accelerator, Queen's University, Kingston, Ontario, Canada; 1-MV JN Van de Graaff accelerator, University of Toronto, Toronto, Ontario, Canada.

EXPERIMENT

This experiment was carried out to supplement earlier work on the $^{31}P(p,\gamma)/^{31}P(p,\alpha)$ reaction-rate branching in stellar nucleosynthesis. The earlier work identified several new resonances in the range $E_p = 280 - 620$ keV. The results from that study dominate the reaction rates for stellar temperatures $T_9 \geq 0.4$ GK. However, for lower stellar temperatures the reaction rates were deemed to be uncertain by orders of magnitude. This uncertainty appeared to be dominated by the possible influence of a state at $E_x = 9060$ keV in ^{32}S - corresponding to a proton resonance at $E_R = 200$ keV - which had been observed earlier in transfer reaction studies [Kalifa *et al.*, *Physical Review* **C17**, 1961 (1978); E90]. Therefore, the objective of the present investigation was to study the $^{31}P(p,\gamma)^{32}S$, $^{31}P(p,\alpha)^{28}Si$, and $^{28}Si(\alpha,\gamma)^{32}S$ reactions in order to determine the $^{31}P(p,\gamma)/\,^{31}P(p,\alpha)$ reaction branching pertinent to the important $T_9 = 0.1 - 0.5$ GK range of stellar temperatures. Although the main emphasis here is with the (p,γ) reaction, all three processes will be considered because they are intimately related in the discussions of this paper.

MEASUREMENT PROCEDURES

The (p,γ) and (p,α) reactions were performed at the Ruhr-Universitaet Bochum 400-kV accelerator; proton beams of 80 - 180 μA in the energy range $E_p = 160 - 370$ keV were provided by this facility. The proton energy was calibrated using proton resonances of the well-known $^{14}N(p,\gamma)^{15}O$ and $^{27}Al(p,\gamma)^{28}Si$ reactions [E90] with an uncertainty of $\pm$ 1 keV and energy spread of 1 keV. The (α,γ) experiment was performed at the 4-MV Queen's University Van de Graaff accelerator; α-particle beams of 30 μA in the energy range $E_\alpha = 2.4 - 2.6$ MeV were provided by this facility. The energy spread and calibration for the α-particles was less than 2 keV. Finally, the 1-MV JN Van de Graaff at Toronto University was used for all the target stoichiometry determinations. For this purpose, proton beams up to 60 μA at energies $E_p = 300 - 800$ keV were used. The proton energy spread was about 1 keV and the calibration uncertainty was 2 keV.

A ^{31}P-implanted target was used for the (p,γ) and (p,α) experiments at Bochum. These were produced by bombarding 0.25-mm-thick Ta backing with ^{31}P ions using the SNICS source at University of Notre Dame. This was accomplished using an implantation dose of 200 μA-h at an ion energy of 80 keV. This produced a target that was 13-keV thick at $E_p =$ 355 keV. The target stoichiometry was determined from the well-known strength of the resonance at $E_R = 811$ keV in $^{31}P(p,\gamma)^{32}S$ [B.M. Paine and D.G. Sargood, *Nuclear Physics* **A331**, 389 (1979)]. A ratio of Ta-to-P of 0.8 ± 0.2 was obtained using stopping power values from the literature [H.H. Anderson and J.F. Ziegler, *Stopping Powers and Ranges in all Elements, Vol. 3*, Pergamon Press, New York (1977)]. For the (α,γ) measurements at Kingston, two Si targets were used. The first was produced by implanting ^{28}Si ions into a 0.5-mm-thick Ta backing with an implantation dose of 211 μA-h at an ion energy of 80 keV. The second target was produced by evaporation of natural Si onto a 0.5-mm-thick Ta backing. The thicknesses of these targets were 54 keV and 11 keV, respectively, as determined by the yield curves of the resonance at $E_\alpha = 2614$ keV in $^{28}Si(\alpha,\gamma)^{32}S$. The stoichiometries ($SiTa_{0.3\pm0.2}$ and $SiO_{2.1\pm0.4}$) were obtained for the implanted and evaporated targets, respectively. These values were deduced by measuring the $E_R = 370$-keV resonance in $^{28}Si(p,\gamma)^{29}P$ [S. Graff *et al.*, *Nuclear Physics* **A510**, 346 (1990)].

The γ-rays were detected at Bochum with a 100% Ge detector that exhibited a resolution of 2.0 keV at 1.33 MeV. The detector was placed at 55° with respect to the proton beam direction at a distance of 1.5 cm from the target. The detector relative efficiency was measured using a calibrated ^{152}Eu source as well as γ-rays from the resonance reactions ^{14}N(p,γ)^{15}O (E_R = 278 keV) and ^{11}B(p,γ)^{12}C (E_R = 163 keV). The energy calibration of this detector was determined using a ^{60}Co source and known γ-ray energies from ^{31}P(p,γ)^{32}S at the E_R = 355-keV resonance, after correcting for Doppler shifts.

The α-particles from the (p,α) reaction on ^{31}P were measured using two Si surface barrier detectors, each with an active area of 600 mm^2, mounted in a target chamber at 90 and 135° with respect to the proton beam. The solid angles of these detectors were defined by collimators. Each detector was placed 6.1 cm from the target. The target and chamber formed a Faraday cup and the copper cold finger was held at a bias of -300 V to suppress secondary emission. 1.5 μm-thick Ni foils were placed between the target and surface-barrier detectors to stop the intense flux of scattered protons. The effective solid angles of these surface-barrier detectors were calculated from geometric information and measured as well using a ^{241}Am α-particle source. The results obtained from these two methods agreed well. The energy scales of these detectors were established by observing α-particles emitted at a resonance of the ^{19}F(p,α_2)^{16}O reaction (E_R = 227 keV) and ^{6}Li(p,α)^{3}He at E_p = 240 keV.

The γ-rays at Kingston were measured with Ge detectors (20 - 30%) placed at 6 angles, 28, 60, 90 (top), 90 (bottom), 120, and 143° with respect to the α-particle beam direction and 3.8 - 8.0 cm from the target. Gamma-ray efficiencies and energy calibrations were obtain using a ^{60}Co source and well-known transitions of the E_R = 2614-keV resonance in ^{28}Si(α,γ)^{32}S reaction [W.O. Rogers *et al.*, *Nuclear Physics* **A281**, 345 (1977)].

For the (p,γ) and (p,α) experiments at Bochum the proton beam passed through a collimator and focused to a profile of 1.5 cm diameter on target. The target was directly water cooled and was mounted at 45° with respect to the proton beam. A liquid-nitrogen-cooled copper tube was placed between the collimator and target. It served as a cold-finger trap to reduce carbon buildup on target. In spite of this, some carbon did build up on target and it was necessary to correct for proton energy loss in this layer by monitoring the intensity and width of the primary γ-ray peak from ^{12}C(p,γ)^{13}N. A very similar setup was used for the α-particle reaction studies at Kingston. However, there the (α,γ) measurements were hampered by high neutron background from the ^{13}C(α,n)^{16}O reaction so any potential carbon buildup in the target chamber had to be minimized.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra recorded with Ge detectors or charged-particle spectra recorded with Si surface-barrier detectors (to detect α-particles).

DATA ANALYSIS

Few details concerning analysis of the data are given in the original paper.

RESULTS AND DISCUSSION

Gamma-ray spectra were measured in the range E_p = 195 - 370 keV with a charge accumulation of 1 - 2 Coulomb for each spectrum. Two resonances were observed, one at E_p = 355 keV and the other (a very weak one) at E_p = 200 keV. The 355-keV resonance was known from earlier work [I+91,E90]. The 200-keV resonance had not been observed previously. The corresponding state in ^{32}S was determined to be 9059 ± 2 keV, as determined from measurements on the observed resonance-decay γ-rays. The resonance strength of this state was determined relative to the 355-keV resonance by the usual method which takes into account the relative γ-ray intensities as well as stopping powers. Several corrections were applied including one for coincidence summing since the Ge detector was placed very close to the target. Based on the available evidence, the spin/parity for this new state was deduced to be $(1,2)^-$.

Simultaneous α-particle measurements were performed to in order to try and identify a (p,α) resonance corresponding to the above-mentioned new (p,γ) resonance. The reaction examined was $^{31}P(p,\alpha_0)^{28}Si$. This attempt ended in failure since no α-particles that could be attributed to this reaction were observed in the spectrum. Nevertheless, an upper limit could be placed on the yield from this reaction based on examination of the background and statistical considerations. This in turn led to assignment of an upper limit for the (p,α) strength of a resonance at this excitation in ^{32}S; this value is given in the original paper.

Measurements on the $^{28}Si(\alpha,\gamma)^{32}S$ reaction provide a useful tool for detecting possible states of natural parity and predominant T = 0 character in ^{32}S that would be useful for examination of the $^{31}P(p,\alpha_0)^{28}Si$ reaction if the incoming and outgoing reaction-channel partial widths are not too small. The state at E_x = 9059 keV would correspond to a resonance at E_R = 2412 keV in the (α,γ) channel. The present experiment was performed using a thin, evaporated target of Si. Once again, no γ-rays which could be attributed to α_0-decay of a resonance were found at the appropriate α-particle bombarding energy to excite such a resonance. Evidence for the known nearby resonance at E_R = 2418 keV was observed in the measurement. This offered the possibility of calculating an upper limit for the (α,γ) strength of a resonance at E_x = 9059 keV in ^{32}S; this value is given in the original paper. Another state of natural parity in ^{32}S at E_x = 9196 ± 8 keV ($J^\pi = 2^+$) had been reported. Once again, no γ-rays were observed from (α,γ) that could be attributed to a resonance at this energy. Upper limits on the (p,γ) and (p,α) resonance-decay strengths were determined for this case as well. These values are reported in the paper.

So, it is concluded that this experiment provided some solid evidence for a resonance at E_R = 200 keV in the $^{31}P(p,\gamma)^{32}S$ reaction and the corresponding resonance strength was computed. However, no evidence could be found for an α-decay channel for this resonance, either through direct $^{31}P(p,\alpha_0)^{28}Si$ measurements or through location of a natural parity state from $^{28}Si(\alpha,\gamma)^{32}S$ measurements that might help in identifying a corresponding resonance in this channel for forming the E_x = 9059-keV state in ^{32}S. Only upper-bound estimates could be provided of (p,γ) and (p,α) resonance strengths in the present study.

The remainder of the paper is devoted to discussing the relative contributions of various components to the reaction rate analyses for $^{31}P(p,\gamma)^{32}S$ and $^{31}P(p,\alpha)^{28}Si$ in stellar environments. This includes specific discrete, narrow resonances, low-energy wings of resonances, high-energy wings of resonances, sub-threshold resonances, and direct capture into final states of ^{32}S. It is found that discrete, narrow resonances dominate the $^{31}P(p,\gamma)^{32}S$ reaction rate for $T_9 \geq 0.05$ GK while the direct capture process dominates for lower temperatures. In the case of $^{31}P(p,\alpha)^{28}Si$, the narrow resonances dominate the stellar rate for $T_9 \geq 0.1$ GK. In the opinion of the authors, SiP-cycling is probably weak to non-existent for T_9 = 0.1 - 0.5 GK, but large uncertainties in the (p,α) channel still remained as of 1993 when this work was published.

K+70

TITLE

Investigation of a Possible Violation of the Independence of the Decay of a Compound Nucleus of the Spin of the Input Channel

REFERENCE

K.V. Karadzhev, V.I. Man'ko, A.N. Nersesyan, and F.E. Chukreev, *Journal of Experimental and Theoretical Physics (JETP) Letters* **12**, 104 - 105 (1970).

ABSTRACT

Brief Abstract:

None given.

Extended Abstract:

In verifying Bohr's hypothesis that the decay of a compound nucleus is independent of the method of its production, it is customary to compare the cross sections of the different reactions leading to the production of one and the same compound nucleus [M.J. Fluss *et al.*, *Physical Review* **187**, 1449 (1969)]. In an earlier publication [K.V. Karadzhev *et al.*, *JETP Letters* **11**, 53 (1970)] we proposed a different method, based on measurements of the angular distributions of the products of the nuclear reactions.

We have noted a strong disparity between the angular distributions of the α particles and γ rays from the reactions $^{31}P(p,\alpha)^{28}Si$ [K.V. Karadzhev *et al.*, *Soviet Journal of Nuclear Physics* **7**, 190 (1968); P.P. Riley *et al.*, *Nuclear Physics* **A96**, 641 (1967)] and $^{31}P(p,\gamma_0)^{32}S$ [F.D. Paul *et al.*, *Physical Review* **99**, 1339 (1955)] (the transition to the ground level of the ^{32}S nucleus), measured for the same resonance with spin and parity 1^- at a proton energy of 2114 keV. Since the spin of the ^{31}P target is $\frac{1}{2}^+$, it is obvious that in both aforementioned reactions there can be two input channels, with channel spins 0 and 1. The contributions of each of the two input channels to the cross section are characterized by a spin-mixing coefficient t, which shows what fraction of the reaction cross section goes through the input channel with spin $s = 0$. From measurements of the angular distribution of the α particles for the resonance with E = 2114 keV, carried out by us [K.V. Karadzhev *et al.*, *Soviet Journal of Nuclear Physics* **7**, 190 (1968)] and independently by an American group [R.P. Riley *et al., Nuclear* Physics **A96**, 641 (1967)], it follows that $t = 0.95 \pm 0.01$. More details on the connection between the spin-mixing coefficient and the form of the angular distributions of the products of the reaction are given in our earlier paper [K.V. Karadzhev *et al.*, *JETP Letters* **11**, 53 (1970)]. On the other hand, measurements of the angular distribution of the γ rays, performed by a Canadian group [F.D. Paul *et al.*, *Physical Review* **99**, 1339 (1955)], yielded for the same resonance $t = 0.72 \pm 0.04$, although these coefficients should be strictly identical if Bohr's hypothesis is valid.

To explain the causes of these discrepancies, we have decided to repeat the measurements performed by the Canadian group. We obtained first the excitation function of the reaction $^{31}P(p,\gamma_0)^{32}S$ in the region of the resonance with E = 2114 keV, shown in the figure (NOTE: Figure is not included here). The target was a thin layer of zinc phosphide P_3Zn_2, sputtered on a tantalum substrate. The γ rays were registered with a scintillation spectrometer with NaI(Tl) crystal having a height of 10 cm and a diameter of 9 cm, since the use of a semiconductor germanium detector is difficult in this case, in view of the small reaction cross section.

The latter circumstances, even when scintillation counters are used, makes it necessary to place the crystals as close as possible to the target, *i.e.*, to work under conditions of poor geometry.

Since the spin and parity of the investigated resonance are known, we did not investigate the total angular distribution, but measured only the ratio of the yields of the γ rays at angles 90° and 0° to the beam of incident protons. This ratio turned out to be N(90°)/N(0°) = 5.54 ± 0.5. Hence, introducing corrections for the geometry, we obtained a spin mixing coefficient of t = 0.98 (+ 0.02, -0.10). It should be noted here that if the figure obtained by the Canadian group (t = 0.72) were correct, we should obtain N(90°)/N(0°) = 2.

Thus, it follows from our measurements that the coefficient of spin mixing turns out to be the same, within the limits of experimental error, for the reactions $^{31}P(p,\alpha)^{28}Si$, $^{31}P(p,p)^{31}P$, and $^{31}P(p,\gamma_0)^{32}S$

COMMENT

The entire communication is included in the abstract given above. No formal summary is provided for this reference.

K+74

TITLE

Isospin Structure of ^{32}S Levels from the Radiative Proton Capture Reaction

REFERENCE

V. Ya. Kostin, E.G. Kopanets, A.A. Koval, A.N. L'vov, V. Ya. Migalenya, and S.P. Tsytko, *Bulletin of the Academy of Sciences of the USSR - Physics Series* **37**, No. 9, 84 - 86 (1974).

ABSTRACT

Brief Abstract:

None given.

Extended Abstract:

The existence of isospin selection rules for dipole transitions in self-conjugate nuclei makes it possible to determine the isospins and the degrees of isospin mixing of the excited states from measurements of the γ transitions [D.H. Wilkinson, *Nuclear Spectroscopy - Part B*, Ed. F. Ajzenberg-Selove, Academic Press, NY (1960)]. We have investigated the self-conjugate nucleus ^{32}S via the $^{31}P(p,\gamma)^{32}S$ reaction at incident proton energies E_p from 1.8 to 2.8 MeV, using the electrostatic accelerator at the Physical Technical Institute of the Ukrainian SSR Academy of Sciences, thin deposited Zn_3P_2 targets, a Ge(Li) detector giving a resolution of 3.8 keV for 1333 keV γ rays, and a multichannel pulse height analyzer. We measured the spectra for ten resonances: those at E_p = 1891, 1952, 1975, 1981, 1989, 2023, 2118, 2323, and 2682 keV.

As an example, we show in Fig. 1 (NOTE: figure is not included here) the γ-ray spectrum from the decay of the resonance with excitation energy E_{ex} = 10.785 MeV (E_p = 1981 keV). Figure 2 (NOTE: Figure is not included here) shows the decay schemes for all ten resonances. The spins and parities given for the resonance levels were taken from the literature [K.V. Karadzhev *et al.*, *Yadernaya Fizika* **9**, 742 (1969); P.M. Endt and C. Van der Leun, *Nuclear Physics* **A105**, 1 (1967)]; they indicate that there are many strong dipole transitions (transitions of the type $I = 1 \rightarrow I = 0$).

The isospin selection rules for self-conjugate nuclei account for the fact that the dipole transitions between levels having the same isospin are considerably weaker than those between levels with different isospins. Quantitative estimates for nuclei with $20 < A \leq 40$ have been given in the literature [S.J. Skorka *et al.*, *Nuclear Data* **A2**, 347 (1966); E.G. Kopanets *et al.*, *KhFTI, Kar'kov*, 21-72 (1972)]. In the literature [S.J. Skorka *et al.*, *Nuclear Data* **A2**, 347 (1966)] the probabilities for allowed ($\Delta T = 1$) and forbidden ($\Delta T = 0$) dipole transitions are given as averages over all the nuclei in the above mass-number interval. In the literature [E.G. Kopanets *et al.*, *KhFTI, Kar'kov*, 21-72 (1972)] the corresponding estimates were given without averaging over A, *i.e.*, separately for each of the nuclei included; in particular, such estimates were given for ^{32}S.

The squares of the reduced matrix elements for forbidden ($\Delta T = 0$) and allowed ($\Delta T = 1$) dipole transitions taken from the literature [S.J. Skorka *et al.*, *Nuclear Data* **A2**, 347 (1966); E.G. Kopanets *et al.*, *KhFTI, Kar'kov*, 21-72 (1972)] are given in Table 1 (NOTE: Table is not included here) in Weisskopf units. The isospins of the resonance levels can be determined by comparing the strengths of the observed dipole transitions with the strengths of the allowed and forbidden transitions as given in Table 1. Table 2 (NOTE: Table is not included here) gives the values that we found for the squares of the reduced matrix elements for dipole transitions from the resonances in the investigated excitation-energy interval.

The transitions from the resonance at E_p = 1891 keV to the ground state ($I^\pi = 0^+$, $T = 0$) and to the 3.775 MeV level ($I^\pi = 0^+$, $T = 0$) are of type E1 and their matrix elements correspond to allowed transitions. Hence the 10.698 MeV (E_p = 1891 keV) level must have isosopin $T = 1$. The matrix element for the E1 transition from the 10.778 MeV level (E_p = 1975 keV) corresponds to a forbidden transition, so this level must have $T = 0$.

The square of the reduced matrix element for the E1 transition from the 10.826 MeV level (E_p = 2023 keV) corresponds to an allowed transition, while that for the observed E1 transition from the 10.918 MeV level (E_p = 2118 keV) is several times larger than would be expected for a forbidden transition. We may supposed that these two levels constitute an isospin-mixed doublet. According to Marion's results [J.B. Marion, *Nuclear Research with Low Energy Accelerators*, Eds. J.B. Marion and D.M. Van Patter, Academic Press, NY, 497 (1967)], two levels with the same spin and parity that lie no more than a few hundred keV apart may be the terms of an isospin-mixed doublet provided one has $T = 1$, and the other, $T = 0$. Then their wave functions ... can be written in the form (NOTE: Wave function equations are omitted here). The coefficients α and β are determined from the relation ... (NOTE: Equation is omitted here), where the E1 transitions go between some $T = 0$ level and the two doublet levels. Assuming that the 10.826 and 10.918 MeV levels form an isospin-mixed doublet, we write ... (NOTE: Equation is omitted here). From the squares of the reduced matrix elements for the E1 transitions, we find $\alpha = 0.452$ and $\beta = 0.892$. Thus we have ... (NOTE: Equations are omitted here), *i.e.*, the 10.826 MeV level has $T = 1$, and the 10.918 MeV level, $T = 0$. One can use the experimental value 0.51 of the ratio α/β to evaluate the matrix element for the Coulomb interaction responsible for the isospin mixing by means of the formula ... (NOTE: Formula is omitted here). For the doublet at 10.826 and 10.9018 MeV we find a value of 47 keV for the matrix element for the Coulomb interaction; this is in good agreement with the estimate of 50 keV given in the literature [E.G. Kopanets *et al.*, *KhFTI,* *Kar'kov*, 21-72 (1972)] for the average value of the matrix element for the Coulomb interaction in ^{32}S.

The resonances at E_p = 2323 and 2341 keV are both spin-one states, but their parities are not known; hence, the transitions from these states to the ground state could be of type E1 or M1. If the transition from the 11.117 MeV level (E_p = 2323 keV) is of the type M1, the square of its reduced matrix element is 2 x 10^{-2} Weisskopf units, and that means that the transition is hindered by a factor of ten as compared with the allowed transition, but if the transition is of type E1, the square of its reduced matrix element is 6 x 10^{-1} Weisskopf units, and that corresponds to an allowed transition. Hence, to determine the isospin of the 11.117 MeV level we must first know its parity. The square of the reduced matrix element of the transition from the 11.135 MeV level (E_p = 2341 keV) is 7 x 10^{-1} Weisskopf units if the transition is of type M1, and 2 x 10^{-2} Weisskopf units if it is of type E1; both these values correspond to allowed transitions, so the 11.135 MeV (E_p = 2341 KeV) level has $T = 1$.

COMMENT

The entire communication is included in the extended abstract given above. No formal summary is provided for this reference.

K+77

TITLE

Angular Distributions of γ-Rays from the $^{31}P(p,\gamma)^{32}S$ Reaction

REFERENCE

V. Ya. Kostin, E.G. Kopanets, A.A. Koval, A.N. L'vov, V. Ya. Migalenya, and S.P. Tsytko, *Bulletin of the Academy of Sciences of the USSR- Physics Series* **41**, No. 1, 124 - 125 (1977).

ABSTRACT

Brief Abstract:

None given.

Extended Abstract:

The angular distributions of γ-rays from the decay of the resonance states of ^{32}S (9950, 9979, 10372, and 10756 keV) in the $^{31}P(p,\gamma)^{32}S$ reaction have been determined. The probable spin values of these states are: 1, 1, 2, and (2), respectively.

The reaction $^{31}P(p,\gamma)^{32}S$ has been extensively investigated. Proton energies of 0.3 - 2.0 MeV and 1.8-3.0 MeV were used in earlier experiments described in the literature [W.F. Coetzee *et al.*, *Nuclear Physics* **A185**, 644 (1972); V. Ya. Kostin *et al.*, *Fiz. Zh.* **20**, 1787 (1975)] to determine the excitation function, the γ-ray spectra, and the decay schemes for 43 resonance states, *i.e.*, approximately 70% of all resonances excited at proton energies up to 3 MeV. At the same time, the angular distributions of the γ-rays were determined for 14 states as discussed in the literature [W.F. Coetzee *et al.*, *Nuclear Physics* **A185**, 644 (1972); C.J.

Piluso *et al.*, *Physical Review* **181**, 1555 (1969); P. Holmberg and M. Viitasalo, *Physica Scripta* **1**, 159 (1970].

In this paper, we report measurements of the angular distributions of γ-rays from resonance decay at proton energies of 1121, 1151, 1557, and 1953 keV. The measurements were carried out on the electrostatic accelerator of the Kharkov Physicotechnical Institute of the Academy of Sciences of the Ukrainian SSR, using a Ge(Li) detector (DGDK-60B). The sensitive volume of the detector was 60 cm^3 and the resolution at E_γ = 1333 keV was 3.5 keV. Thin Zn_3P_2 targets evaporated onto tantalum supports were used. The angular distributions of the γ-rays corresponding to aligned nuclear states were analyzed as described in the literature [V. Ya. Kostin *et al.*, "Problems in Atomic Science and Technology", *Series on High Energy Physics of the Nucleus*, Kharkov Physico-Technical Institute 75-15, Kharkov, No. 3 (15) 21 (1975)].

The figure (NOTE: Figure is not included here) shows the decay scheme for the resonances that we have investigated. The branching ratios are given in accordance with the literature [W.F. Coetzee *et al.*, *Nuclear Physics* **A185**, 644 (1972); V. Ya. Kostin *et al.*, *Fiz. Zh.* **20**, 1787 (1975)], whereas the spins of the resonance levels were deduced from our data. The angular distributions were determined for the strongest transitions. Table 1 (NOTE: Table is not included here) gives the coefficients α_2 and α_4 in the expansion of the measured angular distributions in terms of the Legendre polynomials, together with the spins, population parameters, and multipole mixing coefficients. For the 9950- and 10372- keV resonances, the spins are in agreement with the data in (the literature). The 9979-keV state was assigned $I^\pi = 3^-$ in the literature [W.F. Coetzee *et al.*, *Nuclear Physics* **A185**, 644 (1972)] whereas the analysis of the angular distribution of γ-rays due to the transition to the 2230-keV state was used in the literature [P. Holmberg and M. Viitasalo, *Physica Scripta* **1**, 159 (1970] to show that $I^\pi = 2^+$.

Table 2 (NOTE: Table is not included here) gives the results of an analysis of the angular distributions associated with the cascade 9979 → 5549 → 0 keV for different assumptions regarding the spin of the resonance state at 9979 keV. It is clear from the table that the most probably spin is $I = 1$ (χ^2 minimum).

In the case of the 10756-keV resonance, the minimum χ^2 corresponds to $I = 2$, but exceeds the 0.1% limit by an order of magnitude. This means that the spin of this state cannot be regarded as unambiguously established.

Since the parity of the 10372-keV resonance state is known from the literature [W.F. Coetzee *et al.*, *Nuclear Physics* **A185**, 644 (1972)], we can use the above values of the multipole mixing coefficients and the level width (1.8 eV from the literature [W.F. Coetzee *et al.*, *Nuclear Physics* **A185**, 644 (1972)]) to determine the probabilities of electromagnetic transitions from the resonance state. Table 3 (NOTE: Table is not included here) gives the squares of the reduced matrix elements of the γ-transitions for the 10372-keV resonance.

COMMENT

The entire communication is included in the extended abstract given above. No formal summary is provided for this reference.

K+85

TITLE

Measurements of Relative Thick Target Yields for PIGE Analysis on Light Elements in the Proton Energy Interval 2.4-4.2 MeV

REFERENCE

A.Z. Kiss, E. Koltay, B. Nyako, E. Somorjai, A. Anttila, and J. Raisanen, *Journal of Radioanalytical and Nuclear Chemistry (Articles)* **89**, No. 1, 123 - 141 (1985).

ABSTRACT

In order to extend the energy range of the systematic investigation on relative thick target yields performed by Antilla *et al.* [AHR81] for $1 \le E_p \le 2.4$ MeV bombarding energies, gamma spectra and yield data are presented for elements Z = 3 - 9, 11-17, and 19 - 21 in the energy range $2.4 \le E_p \le 4.2$ MeV and the results are discussed from the point of view of PIGE analysis.

FACILITY

5-MV Van de Graaff accelerator, Institute of Nuclear Research, Hungarian Academy of Sciences, Debrecen, Hungary.

EXPERIMENT

Particle-induced prompt γ-ray emission (PIGE) is normally considered as a method complementary to proton induced X-ray emission (PIXE), capable of detecting the low atomic number elements not seen in PIXE measurements. However, a recent paper demonstrated that the PIGE method can compete with PIXE for the analysis of heavier elements [J. Raisanen and R. Hanninen, *Nuclear Instruments and Methods* **205**, 259 (1983)]. Contrary to the PIXE method, PIGE also offers the possibility of distinguishing among different isotopes of a given element because γ-ray emission tends to provide distinct isotopic signatures. To avoid difficulties associated with calibration, measurements on unknown samples are generally made relative to standards with similar geometry and radiation absorption characteristics.

The present investigation was performed to provide a consistent set of thick-target (p,γ) and (p,X-γ) data for nearly all elements in the range Z = 3 - 21 and for energies E_p = 1 - 4.2 MeV. Here, "X" signifies emission of a secondary particle, *e.g.*, a proton (p) or neutron (n). Earlier work by this group provided similar information for energies E_p = 1 - 2.4 MeV [A. Anttila *et al.*, *Journal of Radioanalytical Chemistry* **62**, 441 (1981)], consequently, the focus of the present investigation is the energy range E_p = 2.4 - 4.2 MeV. In fact, the results reported for the first time in the present paper were normalized to the data from the earlier investigation at E_p = 2.4 MeV.

MEASUREMENT PROCEDURES

The proton beam was obtained from the 5-MV Debrecen Van de Graaff accelerator. The well-collimated beam passed through two 50-cm-long liquid nitrogen traps before hitting the target. The beam/target angle was 45°.

Elemental Be, Mg, C, Al, and Si targets were used in the form of thick plates. Other targets were made from chemical compounds that were pressed into pellets. In order to relate the data for pure elemental targets to compound targets, use was made of a documented procedure to take into account issues of stoichiometry and stopping power [M.J. Kenny *et al.*, *Nuclear Instruments and Methods* **168**, 115 (1980); H.H. Andersen and J.F. Ziegler, *Hydrogen Stopping Powers and Ranges in All Elements, Vol. 3*, Pergamon Press, New York (1977)].

Gamma radiation was detected with a 25-cm^3 Ge(Li) detector with energy resolution of 2.6 keV at E_γ = 1.33 MeV. This detector was placed at 55° relative to the incident protons and 10 cm away from the target. The proton beam current was adjusted in the range 1 nA - 1 μA in order to maintain the data recording system dead time nearly constant for the different samples. These data were recorded with a Nuclear Data 50/50 on-line acquisition system; the spectra were analyzed with a PDP 11/40 computer.

All elements in the range Z = 3 - 21 were examined except for neon and argon (both gases). The proton energies of the present investigation were E_p = 2.4, 3.1, 3.8, and 4.2 MeV.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra measured with a Ge(Li) detector. Each spectrum consisted of 4096 channels (4K). In the special case of fluorine and calcium, where high-energy γs are produced, repeated spectra where taken with x 2 and x 4 gain reductions as well as with the standard gain of the recording system.

DATA ANALYSIS

Gamma-ray spectra were corrected for detection dead time. Normalization of the present measured results for E_p = 2.4 - 4.2 MeV was based on earlier data from this group for the energy range E_p = 1 - 2.4 MeV. The relative sensitivities of the present Ge(Li) detector (25 cm^3) and the one used in the earlier study (110 cm^3) were determined for γ-ray energies in the range E_γ = 0.11 - 3.56 MeV. There was no normalization determination for γ-rays of higher energy since the photo-peak yields in the smaller detector decreased rapidly with photon energy. This leads to some difficulty in cases where high-energy γs are present such as is the case for fluorine and calcium targets.

RESULTS AND DISCUSSION

The results in this paper are presented in the form of representative γ-ray spectra for several elements as well as γ-yields expressed in the form of full-energy peak counts per micro-Coulomb per steradian. The specific γ-rays involved are identified by their energy, and the reactions that produce them are also specified in Table 1 of the original paper.

As the proton energy increased from 2.4 to 4.2 MeV, the number of isotopes with open neutron-emission channels increased from 7 to 15 for materials in the range of Z studied in this work. One consequence of this fact is that a number of γ-peaks begin to appear in the Ge(Li) detector spectra due to neutron-induced reactions on Ge. Most of these had been identified earlier [J.L. Rodda *et al.*, *Nuclear Instruments and Methods* **74**, 224 (1969)]. This is not a serious problem in principle as long as these lines are of modest size and do not interfere with any important lines from (p,γ) reactions on the isotope under investigation. In fact, the latter situation does occur in some cases, *e.g.*, the 670-keV line in the case of Cl. A more serious practical problem at the higher energies is that gradual neutron-induced radiation damage occurs in the exposed Ge(Li) detector; this leads to reduced full-energy-peak resolutions and distorted peak shapes (tailing). It was also found that the destructive effect of (p,n) neutrons increases with volume of the Ge(Li) detector. It was for that reason that a relatively small detector was used in the present study.

The remainder of the paper is devoted to discussing various aspects of the PIGE method of analysis, including the opening of additional reaction channels at higher energies, leading to new opportunities for analysis, versus the generally negative impact of (p,n) reactions as discussed above. These details are not mentioned here but can be learned by reading the original paper.

K+98

TITLE

Lifetimes of ^{32}S Levels

REFERENCE

A. Kangasmaki, P. Tikkanen, J. Keinonen, W.E. Ormand, S. Raman, Zs. Fulop, A.Z. Kiss, and E. Somorjai, *Physical Review* **C58**, 699 - 720 (1998).

ABSTRACT

Mean lifetimes of 20 out of 31 bound levels in ^{32}S below an excitation energy of 8.0 MeV are deduced from the Doppler-broadened γ-ray line shapes produced in the reactions $^{2}H(^{31}P,n\gamma)^{32}S$, $^{28}Si(^{6}Li,pn\gamma)^{32}S$, and $^{31}P(p,\gamma)^{32}S$. Of the 20 levels, lifetimes for 4 are reported here for the first time. For the remaining 16 levels, the lifetime values obtained in this work are considered to be more reliable and accurate than those reported in the literature. Compared to lifetime measurements reported in the literature, significant procedural improvements have been made by (i) using the entire line shape in the data analysis, (ii) making measurements with targets implanted in high-stopping-power media, and (iii) simulating with the Monte-Carlo method the slowing-down process, experimental conditions, and the delayed feeding from higher levels to the level being analyzed. The low-lying portion of the level scheme, level lifetimes, γ-ray branchings, E2/M1 mixing ratios, and reduced transition probabilities are compared with shell-model calculations. The reduced B(E2) values for 16 out of 18 transitions and B(M1) values for 5 out of 10 transitions are reproduced to within a factor of 5. A one-to-one correspondence between 33 experimental and predicted states is established up to 8.2 MeV for both positive- and negative-parity states.

FACILITIES

5-MV tandem accelerator EGP-10-II, Accelerator Laboratory, University of Helsinki, Helsinki, Finland; 5-MV Van de Graaff, Institute of Nuclear Research, Debrecen, Hungary.

EXPERIMENT

Despite the fact that ^{32}S is one of the most extensively studied nuclei in the *sd*-shell, essential experimental data are still lacking. An important ingredient for testing model calculations - reliable lifetime data for most of the excited states of ^{32}S - is still missing (as of 1998). Although the lifetime of the 2.230-MeV first-excited level is fairly well known through various independent studies which tend to agree reasonably well, the remaining levels appear to be known only with large uncertainties. The reason for these uncertainties and discrepancies between various measurements can be traced to difficulties encountered in applying the Doppler-shift attenuation method (DSAM) for determining lifetimes. This has been the predominate method used previously for lifetime measurements. Looking at the problem in more detail, it appears that the DSAM method often leads to questionable results for the lifetimes because of the difficulties encountered in producing good-quality, uniform targets, poor knowledge of stopping cross sections - and small stopping powers in general - for many materials which have been used, the limitations of approximations employed in data analysis, and the small recoil energies which many reactions produce.

The objective of the present experiment was to provide more accurate measurements of lifetimes of excited states in ^{32}S by eliminating - or reducing - many of the sources of experimental error which had afflicted the earlier measurements. Among the steps taken were use of stable targets with well-known stoichiometry that were produced by ion implantation, slowing-down materials with high stopping powers or at least stopping powers that are well known or can be deduced reasonably accurately from available information, performance of realistic Monte Carlo simulations of the slowing down process, and selection of reactions that produce large recoil velocities. Three reactions were used to excite levels in ^{32}S: ^{2}H(^{31}P,nγ)^{32}S, ^{28}Si(^{6}Li,pnγ)^{32}S, and ^{31}P(p,γ)^{32}S. Although we are primarily concerned with the latter reaction in the present compilation, data from the other reactions are also admitted because these results are significant for the understanding of excited-state lifetimes in ^{32}S.

MEASUREMENT PROCEDURES

Deuterium targets for a study of the ^{2}H(^{31}P,nγ)^{32}S reaction were prepared by implanting ^{2}H into thick gold (high stopping power) and silicon (low stopping power) targets. This was accomplished using a 100-kV isotope separator at Helsinki. The low stopping power target was used to determine the initial recoil velocity distribution while the high stopping power target provided an effective way to measure short lifetimes. In the case of the ^{28}Si(^{6}Li,pnγ)^{32}S studies, 0.4-mm thick, single-crystal silicon sheets were used as targets. However, for the actual DSAM lifetime measurements the ^{28}Si target with high stopping power was prepared by implanting 100-keV ^{28}Si^{+} ions into 0.4-mm-thick Ta sheets. A ^{31}P target with high stopping power was prepared for the ^{31}P(p,γ)^{32}S studies by implanting 60-keV ^{31}P^{+} ions into 0.4-mm-thick Ta sheets. The energy losses encountered by the incident charged particles in these various targets were as follows: 800 keV for 29-MeV ^{31}P ions in gold; 80 keV for 8.0-MeV ^{6}Li ions in Ta; 5 keV for 1.5-MeV protons in Ta. The stability of these targets was checked by monitoring the γ-yields. Further tests were performed by means of elastic-recoil proton detection analysis (ERDA) and nuclear-resonance-broadening methods for deducing the depth profiles of implanted target materials both before and after the DSAM measurements. In general, these targets were quite stable. An exception was some loss of deuterium from the gold-backed target in the beginning of its bombardment with a ^{31}P beam. Furthermore, it was observed that the implantation depth distributions were stable. Apparently, the implanted layer had no significant effect on the slowing down of ^{32}S recoils in gold, silicon, and tantalum and, hence, on the extracted lifetimes.

Lifetime measurements were performed at Helsinki, Finland. No mention is made of the detector(s) and related measurement system(s) used in this work. However, it was indicated that these were identical to the setup(s) described in an earlier communication [A. Kangasmaki *et al.*, *Physical Review* **C55**, 1697 (1997)]. In the case of ^{2}H(^{31}P,nγ)^{32}S, intense competition occurred from the much stronger ^{2}H(^{31}P,pγ)^{32}P reaction. Lifetimes for levels in ^{32}P were deduced from analysis of these transitions and these results had been reported in the earlier paper mentioned just two sentences earlier in this summary. The ^{31}P$^{4,5+}$ and ^{6}Li^{2+} ion beams were supplied by the 5-MV Helsinki tandem accelerator. Bombarding energies of ~24 and ~29 MeV for the ^{31}P ions and 8.0 and 12.0 MeV for the ^{6}Li ions were chosen to optimize yield and monitor the effect of possible feeding transitions on γ-ray line shapes. The beams were focused and collimated to a 2 x 2 mm^{2} spot on the target that was set with its surface perpendicular to the incident beam direction. Care was taken to avoid carbon buildup - and consequent background problems - on the bombarded targets. This was accomplished by maintaining a high vacuum and allowing the target to heat up from the deposited beam power.

The $^{31}P(p,\gamma)^{32}S$ reaction measurements were performed at the 5-MV Van de Graaff at Debrecen, Hungary. The proton beams were in the range 1.0 - 1.6 MeV and the typical intensity was 7 μA. The beam spot on target was 5 mm in diameter. The target was mounted perpendicular to the beam. Integrated beam charges ranged from 200 mC in the DSAM lifetime measurements to 300 - 600 mC in the branching ratio measurements. The choice depended on the resonance strength. In this case, a 25% efficient Ortec HPGe detector was used. The resolution was 2.20 keV at E_γ = 1.46 MeV and 3.01 keV at E_γ = 2.61 MeV. Lead shielding was used to reduce background. The γ-decay of the 1557- and 1583-keV proton resonances were studied using an escape suppression arrangement wherein a BGO veto detector was used. This device was borrowed from the Groningen Cyclotron Laboratory and it provided a factor of six suppression. The γ-ray intensities were measured at 55° with respect to the proton beam axis. The γ-ray detector was set at 0 and 90° relative to the proton beam for the lifetime measurements at the 1057-, 1557-, and 1583-keV resonances.

DATA ACQUIRED

The data acquired consisted of recorded γ-ray spectra as a function of incident ion energy. Although not mentioned in this paper, it is presumed that these were Ge-detector measurements.

DATA ANALYSIS

Lifetimes were deduced from the analysis of Doppler-broadened γ-ray line shapes. This analysis utilized Monto-Carlo simulation that allowed for realistic representation of the various factors affecting line shape. This approach provided much more detailed information than simple line-centroid shift determinations normally used in the DSAM method. Of particular importance in determining short lifetimes was consideration of realistic descriptions of distributions of initial recoil velocities. This required application of an iterative procedure in the case of the $^{2}H(^{31}P,n\gamma)^{32}S$ reaction.

The stopping powers of the slowing-down media (silicon, gold, or tantalum) for ^{32}S ions were described in the line shape analysis according to a set of equations given in the original paper. Stopping powers in gold for recoil velocities exceeding 0.018c (where c = velocity of light) were obtained from the literature [J.S. Forster *et al.*, *Nuclear Instruments and Methods* **136**, 349 (1976)]. For lower velocities the stopping power was obtained as a linear extrapolation to zero at $v = 0$. In the case of tantalum, the stopping power for ^{32}S in this material was obtained from another source [J.F. Ziegler *et al.*, *The Stopping and Range of Ions in Solids - Vol. 1*, Pergamon, NY (1985)]. Considerable attention is devoted in the original paper to the issue of ion stopping power, including the question of the relative importance of electronic and nuclear effects on stopping power. The reader can refer to this source to find out the details.

RESULTS AND DISCUSSION

The lifetimes measured in this experiment are summarized in Table III of the original paper. Lifetimes obtained by different reactions used in the present study are in good mutual agreement in all cases. This tends to support the virtue of the careful analysis involved in this experiment (*e.g.*, the use of Monte-Carlo simulation and careful determination of stopping powers). There are, however, wide variations between the present results and others reported in the literature. The authors suggest that these discrepancies are probably due to inconsistent target structures, stopping power data, and analytic methods. Concerning ^{32}S γ-decay branching factors, the only results presented in this paper are those for the E_p = 1557- and 1583-keV resonances. The original paper discusses these results in detail so they are not repeated here.

The remainder of the paper is devoted to a discussion of shell-model calculations of lifetimes and transition strengths and comparison of these results to measured values. It was concluded that the results from calculation and experiment are reasonably consistent. One of the main draw backs is lack of definitive knowledge of J^{π} and T assignments for some of the levels as well as data on E2/M1 mixing ratios for the transitions.

KH73

TITLE

Isospin Dependence of the Nuclear Level Width

REFERENCE

M. Kildir and J.R. Huizenga, *Physical Review* **C8**, 1965 - 1967 (1973).

ABSTRACT

Statistical fluctuation analyses of ^{31}P(p,α) and ^{31}P(p,p') excitation functions are used to deduce level widths for the $T_<$ and $T_>$ isospin states in ^{32}S at 17.8 MeV of 38.7 ± 2.7 and 26.2 ± 3.5 keV, respectively. These two widths in ^{55}Mn at 17.6 MeV are reported also. Relative level densities of the two isospins are calculated for each nucleus.

FACILITY

Not mentioned in this paper.

EXPERIMENT

The method of statistical fluctuation analysis was applied to two independent sets of compound levels $T_<$ and $T_>$ isospin states. Widths for levels of each of the two isospins in the composite nucleus ^{32}S have been determined by fluctuation analysis of the excitation functions for ^{31}P(p,p_0), ^{31}P(p,p_2), ^{31}P(p,α_0), and ^{31}P(p,α_1) reactions. The isospin-dependent level widths have been used to calculate relative level densities of the T = 0 and T = 1 states in ^{32}S at an excitation energy of 17.8 MeV.

MEASUREMENT PROCEDURES

The excitation functions for ^{31}P(p,p') and ^{31}P(p,α) were measured simultaneously in the proton-energy interval 8.51 to 10.01 MeV in 10-keV steps. A phosphorus target of approximately 40-μg/cm^2 thickness was prepared by vacuum evaporation onto a 20-μg/cm^2 carbon foil. The target was placed at 30° relative to the incident proton beam. Protons and α-particles were detected with surface-barrier solid state detectors. The proton detectors, other than one at 90°, were covered with aluminum absorber sufficiently thick to just stop the α-particles. Samples of the recorded spectra are presented as figures in the original paper.

DATA ACQUIRED

Proton and α-particle spectra recorded with surface-barrier solid state detectors.

DATA ANALYSIS

A small decrease in cross section with increasing proton energy was observed in the spectra. This energy dependence was removed before performing fluctuation analyses. Two methods were used to estimate the energy dependence for the excitation functions: One was based on Hauser-Feshbach calculations while the second involved a straight line fit to the data. Level widths were determined from an auto-correlation function of the experimental data after correction for energy dependence of the cross sections.

RESULTS AND DISCUSSION

Calculations of level widths were performed using the statistical model of nuclear reactions according to a method described in the literature [H. Vonach *et al.*, *Nuclear Physics* **A122**, 465 (1967)]. The remainder of this short paper is devoted to comparing these results from the experimentally measured information. The paper concludes that the results obtained are consistent with two classes of isospin states in the composite nucleus ^{32}S. Hence, Ericson fluctuation measurements for different reaction channels can be used as probes to determine experimentally the individual densities of levels of two isospins.

L+72

TITLE

Etude des Resonances de la Reaction $^{31}P(p,\gamma)^{32}S$ dans le Domaine d'Energie E_p = 1100 - 1600 keV

REFERENCE

F. Leccia, M.M. Aleonard, D. Castera, Ph. Hubert, and P. Mennrath, *Le Journal de Physique (Paris)* **33**, Nos. 5-6, 451 - 455 (1972). [In French].

ABSTRACT

In the energy range E_p = 1100 - 1600 keV of the $^{31}P(p,\gamma)^{32}S$ reaction, twelve resonances were studied, five of which were new. The strengths of these resonances and the gamma decay of the resonance levels were determined, as well as the energies and branching ratios of the bound levels of ^{32}S.

FACILITY

4-MV Van de Graaff accelerator, Centre d'Etudes Nucleaires de Bordeaux-Gradignan, Le Haut-Vigneau, France.

EXPERIMENT

The purpose of this investigation was to complement earlier work by studying the $^{31}P(p,\gamma)^{32}S$ reaction in the energy range E_p = 1100 - 1600 keV. It was sought to determine resonance strengths and γ-decay of 12 resonances in ^{32}S as well as the decay and branching factors for certain bound-state levels in ^{32}S.

MEASUREMENT PROCEDURES

Proton beams were obtained from the 4-MV Van de Graaff accelerator at Centre d'Etudes Nucleaires de Bordeaux-Gradignan. The reactions $^{27}Al(p,\gamma)^{28}Si$ at E_p = 991.90 ± 0.04 keV and $^{13}C(p,\gamma)^{14}N$ at E_p = 1747.6 ± 0.9 keV served to calibrate the energy scale of the accelerator. Proton beams up to 60 μA were employed with energy dispersion of the order of 1 keV.

Targets of 10 and 50 $\mu g/cm^2$ were obtained by evaporating zinc phosphide onto 0.2-mm-thick gold supports. Circulating water was needed to cool these targets at the beam intensities employed for the experiment. Gamma-ray emission excitation functions were measured using a NaI scintillation detector 12.7-cm dia. x 12.7-cm thick that was placed 4 cm from the target at 55° relative to the incident beam direction. An energy bias assured that only γ-rays with energies greater than 2.5 MeV were included in this determination. Gamma-rays de-exciting the observed resonances were measured with a 40 cm^3 Ge(Li) detector. This detector had a resolution (FWHM) of 3.5 keV for the 1.332-MeV ^{60}Co line. This detector was placed at 90° relative to the incident proton beam to eliminate Doppler broadening.

The excitation function was measured twice in succession. For the range E_p = 1100 - 1300 keV use was made of the 50 $\mu g/cm^2$ target while the 10 $\mu g/cm^2$ target was used for the experiment in the range E_p = 1300 - 1600 keV.

DATA ACQUIRED

The data acquired consisted of a γ-ray yield excitation function measured with a NaI detector and spectra of decay γ-rays at the resonance positions measured with a Ge(Li) detector.

DATA ANALYSIS

Relative resonance strengths were deduced from γ-ray peak areas after adjustment for branching factors. These relative strengths were normalized using the resonance at E_p = 1248 keV for the range E_p = 1100 - 1300 keV and the resonance at E_p = 1555 keV for the range E_p = 1300 - 1600 keV. Normalization values are based on compiled information from the literature [P.M. Endt and C. Van der Leun, *Nuclear Physics* **A105**, 1 (1967)].

RESULTS AND DISCUSSION

Twelve resonances were observed in the range of proton energy examined in this experiment. Five of these were new. Evidence was also obtained for a doublet at E_p = 1146 - 1151 keV. Two tables are provided in the original paper with values of resonance energy and strength given in Table I and decay branching factors in Table II. The remainder of the paper is devoted to discussing these results and to comparisons with other results from the literature.

MTK69

TITLE

Mechanism of the $^{31}P(p,\gamma)^{32}S$ Reaction in the Giant Dipole Resonance Region

REFERENCE

W.M. Mason, N.W. Tanner, and G. Kernel, *Nuclear Physics* **A138**, 253 - 272 (1969).

ABSTRACT

The radiative capture of protons by ^{31}P has been studied in the energy range E_p = 9.5 - 11.5 MeV and the gamma rays to the ground and first excited states of ^{32}S were analyzed. Excitation functions and angular distributions were measured in energy steps of 20 keV. It was found that the angular distributions are almost invariant with energy and are slightly forward peaked indicating an E2 intensity of the order one per cent. From the Legendre polynomial coefficient A_2/A_0 the channel spin $s = 0$ and $s = 1$ fractions of the cross section were separated for ground state gamma rays; it is observed that $s = 0$ accounts for ≈ 75% of the γ_0 integrated strength. There are large variations in gamma-ray yield as a function of energy and an analysis in terms of statistical fluctuation theory shows that ≈ 90% of the cross section is due to a "direct interaction" mechanism. A large correlation between the γ_0 and γ_1 yields is observed.

FACILITY

Tandem Van de Graaff accelerator, Nuclear Physics Laboratory, Oxford University, Oxford, England, United Kingdom.

EXPERIMENT

The present work investigates in detail the angular distributions and excitation function for the $^{31}P(p,\gamma_0)^{32}S$ reaction over the energy region E_p = 9.5 - 11.5 MeV. In this region there existed some controversy as to whether the excitation functions could be explained in terms of some dominant resonances - even though the levels probably overlap strongly - or whether the interpretation ought to be in terms of Ericson fluctuations and hence the direct interaction mechanism. This work sought to explore this issue by collecting data that could be used to examine the reaction mechanism(s).

MEASUREMENT PROCEDURES

The proton beam was supplied by the Oxford tandem Van de Graaff accelerator. Details of the experimental arrangement had been published earlier [G. Kernel and W.M. Mason, *Nuclear Physics* **A123**, 205 (1969)]. The beam was focused through a 3-mm diameter uranium collimator, passed through the foil target, and was stopped on a uranium disk which was shielded by a concrete wall from the γ-ray counters. NaI(Tl) crystals of 12.5 x 15 cm were used for this purpose. Each was stabilized for gain and included pulse pile-up rejection circuitry. Data were obtained in three distinct runs labeled I, II, and III, respectively. In I, the crystals were placed at 45, 75, and 105° with respect to the proton beam. In II, at 30, 64, 98, and 132°. In III, at 90° only. In each instance the distance from the target was 38 cm. In addition, a large 24 cm x 30 cm NaI(Tl) crystal was employed in various positions for monitoring during the indicated three sets of runs.

Initially a target of phosphorus evaporated on a thick tantalum backing was used. The beam was stopped in the target so it was possible to measure γ-ray yields at small forward angles; however, the background proved excessive in this arrangement. This led to use of targets of phosphorus evaporated onto thin carbon backings (about 20 $\mu g/cm^2$). Target thicknesses were determined by measuring excitation functions over the sharp E_p = 4.665 MeV resonance in the reaction $^{31}P(p,\gamma_0)^{32}S$. The choice of target thicknesses and energy steps for the main excitation function measurements in this work were consistent with the observed fact that the structure in the excitation function had widths of not less than ≈ 50 keV in the energy region covered by this experiment.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra measured with NaI(Tl) scintillation detectors as a function of incident proton energy.

DATA ANALYSIS

Since the energy range covered was E_p = 0.5 - 11.5 MeV, the proton binding energy for ^{32}S is 8.86 MeV, and the first- and second-excited states occur at 2.24 and 3.78 MeV, the γ-ray transitions to the first-excited state (γ_1) and to the ground state (γ_0) were sufficiently resolved and prominent in the scintillation detector spectra, in comparison with the background, to enable information on both of their yields to be extracted. The underlying cosmic-ray background was determined from the clear high-energy region; this enabled it to be subtracted from the spectra. A procedure to determine the γ_0 and γ_1 line shapes is described in the original paper.

The excitation functions for (p,γ_0) and (p,γ_1) were normalized to one another based on detailed angular distribution information. The angular distributions were fitted with Legendre-polynomial expansions up to order $P_4(\cos\theta)$.

Absolute cross section measurements were made with the 24 cm x 30 cm NaI(Tl) crystal during runs I, II, and III. The response and efficiency of this detector were deduced from measurements on the $^3H(p,\gamma_0)^4He$ reaction. The measured angular distributions were interpreted in terms of the channel-spin formalism. The details of this analysis appear in the original paper.

A statistical analysis was carried out on the yield curve based on the assumption that the structure was due to strongly overlapping levels ($\Gamma/D \gg 1$). In order to be sure that this condition was satisfied, an estimate was made of the level density of $J^\pi = 1^-$ and $T = 1$ states in ^{32}S which are mainly responsible for the $^{31}P(p,\gamma_0)^{32}S$ reaction. Earlier suggestions appeared to be widely discrepant (ranging from Γ/D = 2 to 25) so an independent assessment was carried out in the present work. One approach was based on arguments involving both the $^{31}P(p,\alpha_0)^{28}Si$ and $^{31}P(p,\gamma_0)^{32}S$ reactions; it yielded the result $\Gamma/D \approx 8$. Another estimate of Γ/D was made from a knowledge of transmission coefficients appropriate to the various decay channels of excited 1^- states in ^{32}S. This approach yielded $\Gamma/D \approx 5.5$. Both of these values adequately satisfy the necessary condition $\Gamma/D \geq 2$ for a valid fluctuation analysis, based on an unpublished suggestion from Dallimore and Hall (Oxford University). Additional support for the fluctuation interpretation of these data comes from the observed constant density of peaks in the measured excitation functions over the proton-energy region investigated in this experiment. The auto-correlation and group-correlation functions were computed for the total (p,γ_0) and (p,γ_1) yield curves and were found to have Lorentzian shapes.

RESULTS AND DISCUSSION

The main features from the analysis of the $^{31}P(p,\gamma)^{32}S$ experimental data that were mentioned in the original paper can be summarized as follows: i) The mean cross section for the $^{31}P(p,\gamma_0)^{32}S$ reaction suggests that the ^{31}P ground state is predominantly a $(2s_{1/2})^{-1}$ hole state with some admixture of $(1d_{3/2})$. ii) The present data suggest a ratio of (p,γ_0) to (p,γ_1) yield for ^{31}P of about 5. iii) The (p,γ_0) cross section is dominated by the channel spin $s = 0$ component (75% of the strength) over the region investigated. iv) There appear to be a sufficient number of overlapping 1^- levels to satisfy the condition $\Gamma/D \geq 2$ for a valid fluctuation analysis. The results for $^{31}P(p,\gamma_0)^{32}S$ suggest that some 90% of the cross section is due to the direct interaction mechanism. Roughly the same can be said for the $^{31}P(p,\gamma_1)^{32}S$ reaction. v) There is a large correlation between the (p,γ_0) and (p,γ_1) cross sections. Such a correlation could be due to the similarity in the intrinsic configuration of the 0^+ and 2^+ ground and first-excited states of ^{32}S, since both are members of the same rotational band. vi) The measured γ-ray angular distributions are slightly forward peaked with the responsible odd Legendre polynomial coefficients observed to be fairly constant with energy for both (p,γ_0) and (p,γ_1). vii) In a very broad sense, at the examined energies the (p,γ) reaction appears to be dominated by direct interaction while (p,α) can be explained without any direct component.

O+75

TITLE

Total Yield Measurements in $^{31}P(p,\gamma)^{32}S$

REFERENCE

R. O'Brien, Z.E. Switkowski, A.K. Smith, and D.G. Sargood, *Australian Journal of Physics* **28**, 155 - 162 (1975).

ABSTRACT

The reaction $^{31}P(p,\gamma)^{32}S$ has been investigated in the proton energy range 0.33 - 1.75 MeV. Total γ-ray strengths were determined for 28 resonances. Yield curves were measured over limited portions of the energy range, which between them covered the whole range. An estimate of the nonresonant cross section was obtained, and total resonance widths were deduced.

FACILITY

Not mentioned in the paper. The reader is referred by the authors to a second paper in the same volume of the journal (Paper I) for details [Z.E. Switkowski *et al.*, *Australian Journal of Physics* **28**, 141 (1975)].

EXPERIMENT

The present investigation focuses on absolute measurements of the resonance strengths and non-resonant yield from the $^{31}P(p,\gamma)^{32}S$ reaction in the proton-energy range 330 - 1750 keV.

MEASUREMENT PROCEDURES

The detection system, experimental arrangement and measurement procedures were the same as described in a companion paper (to be referred to here henceforth as Paper I) in the same issue of the journal [Z.E. Switkowski *et al.*, *Australian Journal of Physics* **28**, 141 (1975)]. The only exception is that the excitation functions were measured for two different γ-ray energy ranges (3.0 - 12.0 and 7.5 - 12.0 MeV, respectively) necessitating an additional data recording channel. Generally, the data for the broader γ-ray energy window were used. The exception was when the contamination reaction $^{19}F(p,\alpha\gamma)^{16}O$ rendered the spectrum below 7.5 MeV doubtful.

Targets were prepared from 99.999% pure elemental red phosphorus using a previously described deposition process [B.W. Hooton, *Nuclear Instruments and Methods* **27**, 338 (1964)] in which red phosphorus is deposited from a strongly heated phosphorus atmosphere produced initially by evaporation. Direct evaporation was avoided since that tended to produce unstable yellow phosphorus targets. The deposits were prepared on cleaned and baked tantalum or gold substrates. They were found to be durable under extended proton bombardment.

Resonance strengths were measured using both semi-thick and thin targets. Semi-thick targets were used at 17 of the 28 resonances observed in the examined proton-energy range. Excitation functions were measured using 1 - 2 keV steps and γ-ray spectra were collected at each point. Proton beam currents were in the range 0.4 - 4 μA and the collected charge at each point was in the range 50 - 300 μC, depending on the observed yield. The determination of relative resonance strengths for cases not amenable to semi-thick target measurements was performed using thin targets. Then, excitation functions were measured over limited energy intervals which, collectively, spanned the range 0.33 - 1.75 MeV. Again, elemental phosphorus targets were used but the target thicknesses and proton-energy steps were tailored to the energy ranges in question. These energy steps ranged from 1 - 2 keV. The standard resonance for this portion of the experiment was the 642-keV resonance. All resonance strengths deduced from the thin-target yield measurements were referred to this particular resonance. Fifteen resonances were investigated using both methods.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra recorded from a NaI scintillation detector.

DATA ANALYSIS

The techniques described in Paper I (*e.g.*, the photo-fraction method) were generally employed here for analysis of the thick-target data, except for the procedure used in extrapolating the spectrum to zero energy. For most of the resonances, the lower γ-ray energy was 2.23 MeV. Then, enough of the spectrum could be recorded to enable direct extrapolation of the spectrum based on a collection of mono-energetic line shapes rather than relying on the photo-fraction method described in Paper I. Errors incurred via the extrapolation procedure were generally found to be less than 5%; more typically they amounted to about 2%. Stopping power values required for resonance strength calculations were obtained from the literature [J.B. Marion and F.C. Young, *Nuclear Reaction Analysis*, North-Holland Publishing Company, Amsterdam (1968)].

An important aspect of this work was determining detector efficiencies. A set of partial detection efficiency curves (described in Paper I) was determined using data from resonance spectra where the branching factors were known. The process is described in more detail in the original paper. In the case of overlapping resonances a fitting procedure described in Paper I enabled the individual contributions to be estimated.

For those fifteen resonances studied by both the semi-thick and thin target methods, the relative strengths among them were found to agree within the errors.

The γ-ray yield remaining after extraction of the narrow resonances was interpreted as the contribution of very broad resonances and of non-resonant proton capture. It had been suggested earlier by S.G. Boydell (University of Melbourne, Australia) in a private communication that most of the off-resonance yield in the energy region examined corresponds to ground-state γ-ray transitions. Consequently, partial detection efficiencies derived in the course of this work were used to estimate the total γ-ray yield. This yield was converted to a cross section using the target thickness value determined by the excitation function fitting procedure employed for the narrow-resonance studies.

RESULTS AND DISCUSSION

The discrete resonance strengths deduced from the present investigation are given in Table 1 of the original paper along with error estimates and, in some cases, estimated values for total width Γ of the resonance. No attempt was made to independently determine the resonance energies accurately. In most cases the energies were obtain from the literature [CMR72]. The yield remaining after subtracting the narrow resonance contribution appeared to consist of five broad resonances plus a non-resonant component. The broad resonance contribution was estimated by fitting resonance shapes. The corresponding resonance strengths are given in Table 2 of the original paper. What remained after subtracting these components was treated as the non-resonant component. The corresponding non-resonant cross-section curve is plotted in Fig. 2 of the original paper.

The remainder of the paper is devoted to comparing the results from the present experiment with corresponding values from the literature.

P+55

TITLE

Proton Capture Gamma Rays from the Reaction $^{31}P(p,\gamma)^{32}S$ Leading to the Ground and First Excited States of ^{32}S

REFERENCE

E.B. Paul, H.E. Gove, A.E. Litherland, and G.A. Bartholomew, *Physical Review* **99**, 1339 - 1344 (1955).

ABSTRACT

Resonances in the reaction $^{31}P(p,\gamma)^{32}S$ which show transitions to the ground or first excited state of ^{32}S have been studied for proton energies between 0.68 and 2.35 MeV. Angular distributions have been measured for resonances at 0.816, 0.825, 1.117, 1.146, 1.248, 1.892, 1.985, 2.027, 2.120, 2.320, and 2.340 MeV. These distributions along with the $^{31}P(p,\alpha_0)^{28}Si$ results enabled assignments of 1^- to be made for the resonances at 1.892, 2.027, and 2.120 MeV, of $1^{\pm}$ for those at 0.825, 1.117, 1.985, 2.320, and 2.340 MeV, and of $2^{\pm}$ to that at 1.248 MeV. Partial widths for γ_0 and γ_1 were also measured and are compared with theory. Analysis of the angular distributions at one resonance suggests that the spin of the first excited state of ^{32}S at 2.25 MeV is 2^+. The reduced proton widths for the three resonances with $J = 1^-$ together amount to 60 percent of the single-particle width.

FACILITY

Chalk River electrostatic generator, Chalk River Laboratory, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada.

EXPERIMENT

The present investigation involves measurements of yield, angular distributions, and partial widths of proton-capture γ-rays leading to the ground and first-excited states of ^{32}S at observed proton-energy resonances in the range 0.68 - 2.35 MeV (NOTE: It is mentioned in the paper that some of the results had been reported earlier [H.E. Gove and E.B. Paul, *Physical Review* **92**, 852 (1953); H.E. Gove *et al.*, *Physical Review* **97**, 104 (1955)]). From these measurements it is possible to make definite spin assignments to several of the capturing states, to draw some conclusions about the first-excited state of ^{32}S, and to relate some of the measured widths to theoretical E1 widths. In some case the opportunity existed to measure resonance total widths and to compare these with theoretical single-particle widths. Furthermore, a comparison between measured angular distributions and those predicted by *j-j* and *l-s* coupling is considered.

MEASUREMENT PROCEDURES

The Chalk River electrostatic generator provided beams of bombarding protons. They were analyzed in energy with a 90° magnet whose field was monitored and stabilized using a proton resonance fluxmeter. A pair of tantalum plates formed a set of slits that enabled formation of a feedback signal that controlled the proton energy to within about 0.1%. The beam spot on target was confined by a tantalum aperture to a spot of 0.25-inch diameter. The beam currents were in the range 5 to 20 μA.

Targets were prepared by evaporating Zn_3P_2 on 20-mil tantalum backings. The thickness was about 700 eV at 1.25 MeV proton energy for the γ-ray yield measurements and 10 keV for the angular distribution determinations.

The γ-rays were measured with NaI(Tl) scintillation detectors; some were 2 inch x 2 inch and others were 5 inch diameter x 4 inch thick. They could be mounted in a goniometer such that measurements could be made in the range 0 to 150° with respect to the proton beam.

A γ-ray detector was set at 90° and three inches from the target for the yield measurements. Only those γ-rays corresponding to transitions to the ground state or first-excited state were recorded. On resonances where the ground-state γ-ray was present, measurements were also taken with a high bias to exclude pulses from other transitions in order to confirm the resonance condition. The target thickness was measured on the well-isolated resonance at 1.248 MeV by comparing the step in the thick-target yield curve with the area under the thin-target yield following a documented procedure [W. Fowler *et al.*, *Reviews of Modern Physics* **20**, 236 (1948)]. This measurement yielded the indicated value 700 eV for the thin target.

For the angular distribution measurements, one γ-ray detector was placed 5 inches from the target center in a manner that allowed for rotation over the range 0 to 150° with respect to the proton beam while a second γ-ray detector was placed on the other side of the beam line at a fixed angle of 90° where it served as a relative monitor. Where necessary, corrections were applied for γ-ray absorption in the target backing. These angular distribution results were fitted to Legendre-polynomial expansions by the method of least squares, including terms up to P_4.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra measured with NaI(Tl) scintillation detectors. Spectra were obtained at various incident proton energies and detector angles.

DATA ANALYSIS

The number of γ-rays leading to the ground or first-excited state in ^{32}S per incident proton was computed by extrapolating the pulse-height spectrum to zero pulse height. The procedure was tested using the known $^{19}F(p,\alpha\gamma)$ reaction and was found to give agreement to within 10%.

RESULTS AND DISCUSSION

The yield curve measurements provided evidence for 12 resonances in the energy range examined. Eight of these resonate predominantly for the ground-state transition (γ_0) while the remaining four resonate predominantly for transitions to the first-excited state (γ_1). There was an observed tendency for those levels which resonate with γ_0 not to resonate for γ_1. The converse is also true, except possibly for the resonance at E_p = 1.248 MeV which was weakly resonant for γ_0. Comparisons are made in the original paper between these results and those reported in earlier communications.

Theoretical expressions for the angular distributions of proton-capture γ-rays which proceed directly to the ground state of ^{32}S are particularly simple because the ground state of ^{31}P is $½^+$ while that for ^{32}S is 0^+. There is no multipole mixing because the final state has zero spin. The rest of the paper is devoted to discussing the measured and theoretical angular distributions and their significance in the context of the level properties of ^{32}S.

PKS78

TITLE

(p,γ) Resonance Strengths in the s-d Shell

REFERENCE

B.M. Paine, S.R. Kennett, and D.G. Sargood, *Physical Review* **C17**, 1550 - 1554 (1978).

ABSTRACT

Resonance strengths of selected resonances in the range E_p = 0.5 - 0.9 MeV in the (p,γ) reactions on ^{23}Na, ^{27}Al, ^{31}P, and ^{35}Cl have been compared through relative yield measurements with targets consisting of mixtures of chemical compounds, each containing at least two of the isotopes of interest. Chemical composition of the targets was determined by Rutherford scattering of α particles. Absolute strengths were deduced by normalizing to a strength of $S = 3.26 \pm 0.4$ eV for the E_p = 633 keV resonance in $^{27}Al(p,\gamma)^{28}Si$.

FACILITY

5-MV Pelletron accelerator, University of Melbourne, Parkville, Victoria, Australia.

EXPERIMENT

This experiment was carried out as an attempt to resolve some of the discrepancies existing in the literature at the time concerning the strengths of resonances in (p,γ) reactions for various target materials. In this summary, we are concerned only with that aspect of the work which is concerned with the $^{31}P(p,\gamma)^{32}S$ reaction.

MEASUREMENT PROCEDURES

Targets containing at least two of the nuclides whose resonance strengths were to be compared (including phosphorus) were bombarded with protons from the University of Melbourne 5-MV Pelletron accelerator. The currents were ~ 0.5 μA and the proton beam energy resolution was ~ 300 eV. The energy was increased in steps of 0.25 keV in tracing out excitation functions across the resonances of interest.

The target backings consisted of carbon foils of thickness 10 and 40 $\mu g/cm^2$ mounted on tantalum target frames. The various target materials were evaporated under vacuum onto these backings. The proton beam was collimated to 2 mm diameter before impinging on the targets. Secondary electron emission from the target was suppressed by applying a positive bias voltage. The transmitted proton beam was collected in a Faraday cup. Several different targets were mounted on an assembly which allowed for easy interchange of the targets *in situ* without breaking the vacuum.

The targets were analyzed by Rutherford scattering of α-particle beams. The conditions chosen to insure adherence to the Rutherford law were scattering angles in the range 120 - 145° and α-particle energies in the range 3 - 4 MeV. A 200 μm-thick Si surface barrier detector was placed behind a 1-mm-dia. aperture at a position 4.7 cm from the target spot to measure the scattered α-particles.

The γ-ray yield was measured by observing the strongest one or two full-energy peaks in spectra measured with a 70- cm^3 Ge(Li) detector placed 1 cm from the target at 90° relative to the incident proton beam. The absolute detection efficiency was measured relative to that for a 12.7 cm x 12.7 cm NaI(Tl) scintillation detector placed at 125° (a zero node of the Legendre polynomial expansion P_2 term) by performing measurements with both systems for an isolated resonance. The efficiency of the scintillation detector was calculated using tabulated photon cross sections [E. Storm and H.I. Israel, *Nuclear Data Tables* **A7**, 565 (1970)] and branching ratios obtained from several literature sources listed in the original paper. The efficiency determined in this way was checked against that determined using calibrated radioactive γ-ray sources and excellent agreement was obtained.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra measured with a Ge(Li) detector and a NaI(Tl) scintillation detector at various incident proton energies.

DATA ANALYSIS

Few details are provided on the analysis of these data. However, there is considerable discussion in the paper concerning the stoichiometry and stability of the various target materials. Absolute resonance strengths were deduced from the measured relative strengths by normalizing them to the strength of 3.26 ± 0.4 eV for the E_p = 633 keV resonance in the

$^{27}Al(p,\gamma)^{28}Si$ reaction as confirmed by the agreement of results obtained from various literature sources mentioned in the original paper.

RESULTS AND DISCUSSION

The results from this investigation are summarized in Table I of the original paper. This table includes information on stoichiometric analysis of the various target materials as well as measured ratios of resonance strengths. Absolute resonance strengths obtained by normalization of relative values to the known value for the E_p = 633 keV resonance in the $^{27}Al(p,\gamma)^{28}$ Si reaction are presented in Table II of the original paper.

PS79

TITLE

(p,γ) Resonance Strengths in the s-d Shell

REFERENCE

B.M. Paine and D.G. Sargood, *Nuclear Physics* **A331**, 389 - 400 (1979).

ABSTRACT

The strengths of selected resonances in the range E_p = 0.5 - 2.0 MeV in the (p,γ) reactions on ^{26}Mg, ^{30}Si, ^{34}S, ^{37}Cl, ^{39}K and ^{40}Ca have been found relative to the E_p = 632 and 992 keV resonances in $^{27}Al(p,\gamma)^{28}Si$ by relative yield measurements. Targets were made from mixtures or chemical compounds such that each contained at least two of the isotopes of interest and their chemical composition was determined by Rutherford back-scattering of α-particles. Absolute measurements were conducted on the selected resonances in $^{27}Al(p,\gamma)^{28}Si$ and $^{30}Si(p,\gamma)^{31}P$ by semi-thick-target and thin-target techniques with the target thickness, needed for the latter technique, found by Rutherford back-scattering of protons. Absolute strengths for all of the resonances treated, together with one from each of ^{23}Na, ^{31}P and ^{35}Cl, reported in a previous paper, were deduced by normalizing to the absolute measurements on the $^{27}Al(p,\gamma)^{28}Si$ resonances.

FACILITY

5-MV Pelletron accelerator, University of Melbourne, Parkville, Victoria, Australia.

EXPERIMENT

This experiment was conducted to help resolve existing discrepancies in (p,γ) resonance strengths found in the literature. In an earlier study referred to in the present work as Paper I [PKS78] results from a study of (p,γ) resonance strengths for ^{23}Na, ^{27}Al, ^{31}P, and ^{35}Cl were reported. The present investigation extends this study to include each element in the range Z = 11 - 20 except for argon. Although most of the measurements involved materials other than phosphorus, measurements on ^{31}P were included in the present set in order to establish the desired links to other isotopes. The objective of the program, which includes not just the present experiment but the one described in Paper I, was to generate a network of relative strengths - not only between individual resonances but between different materials.

Furthermore, absolute resonance strength measurements were performed for the E_p = 632 and 992 keV resonances in $^{27}Al(p,\gamma)^{28}Si$ and the 620-keV resonance in $^{30}Si(p,\gamma)^{31}P$.

The experimental determination of resonance strength was based on an equation which relates the strength to a collection of measurable and calculable quantities [C. Broude *et al.*, *Proceedings of the Physical Society* **72**, 1115 (1958)]. This methodology was applied for both semi-thick targets and thin targets. To be applicable for semi-thick targets it was required that the target thickness in energy units be considerably greater than the resonance width, a condition which was fulfilled for all the targets used in this work. A slight modification to the formalism was applied for measurements involving thin targets.

MEASUREMENT PROCEDURES

Targets were prepared by evaporation onto transmission carbon backings. Natural materials were used where the measurement involved the most common isotope of the element. For other targets, the isotopic enrichments were > 99% (*i.e.*, for ^{26}Mg, ^{30}Si, ^{34}S, and ^{37}Cl). The various materials used to fabricate targets are indicated in the diagram of Fig. 1 of the original paper. These targets were mounted in a 15.2-cm diameter scattering chamber. A variable-angle particle detector was mounted inside the chamber. Outside the chamber a shielded NaI(Tl) scintillation detector was placed at 125° to the incident proton beam. A re-entrant port at 90° was used to enable a Ge(Li) detector to be placed close to the target. Charged-particle beams were obtained from the University of Melbourne 5-MV Pelletron accelerator. Further details of the experimental arrangement and measurement procedures are given in Paper I [PKS78].

The absolute measurements on $^{27}Al(p,\gamma)^{28}Si$ and $^{30}Si(p,\gamma)^{31}P$ were carried out using 99.999% pure elemental aluminum of thickness 47 $\mu g/cm^2$ and 99.7% pure SiO_2 of thickness 23 $\mu g/cm^2$ on 40 $\mu m/cm^2$ carbon foils. Rutherford back scattering of protons with energy ~ 1 MeV and α-particles with energy ~ 2 MeV was used as a technique to measure target thickness. Since these details do not relate directly to the present concern (^{31}P) they are omitted here but can be found in the original paper.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra measured with the NaI(Tl) scintillation detector and the Ge(Li) detector as well as proton and α-particle spectra measured with the charged-particle detector situated in the scattering chamber.

DATA ANALYSIS

Refer to the present original paper and Paper I [PKS78] for details.

RESULTS AND DISCUSSION

Table 1 of the original paper summarizes the measured resonance strength ratios from this experiment. Included in this table are the isotopes and materials involved, the resonance proton energies, and the strength ratios and corresponding errors. Table 2 of the original paper gives the absolute strengths measured for $^{27}Al(p,\gamma)^{28}Si$ and $^{30}Si(p,\gamma)^{31}P$ using both the semi-thick and thin-target methods as well as adopted values. The two techniques yielded results which were in excellent agreement. Finally, Table 3 of the original paper provides the absolute strengths obtained for all the other (p,γ) resonance reactions as obtained by normalizing relative values to the standards given in Table 2.

The remainder of the paper is devoted to comparing these results with other values from the literature.

PSM69

TITLE

Lifetime and Angular Distribution Measurements from the $^{31}P(p,\gamma)^{32}S$ Reaction

REFERENCE

C.J. Piluso, G.C. Salzman, and D.K. McDaniels, *Physical Review* **181**, 1555 - 1564 (1969).

ABSTRACT

The $^{31}P(p,\gamma)^{32}S$ reaction has been studied at several resonances with a 20-cm^3 Ge(Li) detector. A level at 6.664 MeV has been populated which may be the same as one found at 6.671 MeV from (^{3}He,d) experiments. This state is found to branch almost equally to the states at 3.775 and 2.230 MeV. Measured branching ratios for the first six excited states are in agreement with earlier work except for a ground-state transition for the 5.006-MeV level which supports an odd-parity assignment for this state. New branching ratios are assigned for the levels at 5.544 and 6.673 MeV. Doppler-shift lifetime measurements for the states at 3.775, 4.280, 4.694, 5.006, 5.410, 5.544, 6.226, and 6.623 MeV are consistent with other measurements. The lifetime of the level at 6.664 MeV is found to be 0.054 (+0.013, -0.009) psec. An upper limit of 0.01 psec is set for the mean life of the 7.952-MeV level. Angular distributions have been measured with the Ge(Li) detector for the 1.248- and 1.438-MeV resonances. Spins deduced from combining these results with the lifetime measurements confirm previous assignments for levels at 6.623, 6.226, and 5.410 MeV. The spin of the 4.459-MeV level is limited to 3 or 4, consistent with other recent work and with the hypothesis of Goswami *et al.* that this is the 4^+ level of a rotational band based on the 0^+ ground state. Mixing ratios are given for a number of transitions.

FACILITY

4-MeV Van de Graaff accelerator, Department of Physics, University of Oregon, Eugene, Oregon.

EXPERIMENT

The objective of this work was to perform a detailed study of four resonances in the $^{31}P(p,\gamma)^{32}S$ reaction. Included were measurements of accurate level energies, a study of branching ratios, a determination of lifetimes by the Doppler-shift attenuation method (DSAM), and an investigation of γ-ray angular distributions.

MEASUREMENT PROCEDURES

The proton beam from the University of Oregon 4-MeV Van de Graaff accelerator was focused onto the target through two 3/16-inch apertures. Gamma rays were measured using a 20-cm^3 Ge(Li) detector. This detector had been described in an earlier communication [E.F. Gibson *et al.*, *Physical Review* **172**, 1004 (1968)]. It was mounted on a movable arm of a scattering table. A 3 inch x 3 inch NaI counter was mounted on another movable arm. The Ge(Li) detector was placed 1.6 inches from the target at 55 or 90° relative to the incident proton beam.

Phosphorus targets were prepared by evaporating 99.999% pure Zn_3P_2 onto 0.010-inch gold backings. A fluorine target was also prepared by evaporating BaF_2 onto a 0.010-inch tantalum backing. It was used for determining the system asymmetry for angular distribution measurements.

Thick targets (8 - 10 keV) were used for the resonance spectra measurements with the Ge(Li) detector. Spectra with adequate statistics for studying resonance decay branching were accumulated after about 12 h running time at beam currents of 10 - 12 μA. These spectra were accumulated for the following resonances: E_p = 1.248, 1.438, 1.556, and 1.583 MeV. The DSAM was used to accumulate data for the determination of level lifetimes.

Angular distributions were obtained by recording γ-ray spectra at 90, 75, 60, 52, 41, 30, and 0°. During the angular distribution measurements, the Ge(Li) detector was located 2.7 inches from the target. Exposures of about 12 h at 10 μA were required at each angle for each resonance, obviously adding up to a lot of beam time! In these measurements, the NaI detector was used as a monitor. It was placed 6 inches from the target at an angle of 130° relative to the incident protons. Several sources of systematic error arose in the measurement of angular distributions; the most serious was the possibility of deviation of the target spot from the center of rotation. It was for this reason that yield measurements were made of the 6.129-MeV γ-ray from the $^{19}F(p,\alpha\gamma)^{16}O$ reaction on the 0.936-MeV resonance. Another potential source of error was gain drifts in the NaI detector channel. To avoid this problem, or at least minimize its effect, the angular distributions were measured in the order 90, 60, 30, 0, 41, 75, and 52°. Finally, a significant uncertainty could be attributed to determination of the peak areas at different angles.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra recorded with a Ge(Li) detector and a NaI scintillation detector.

DATA ANALYSIS

The location of γ-ray peak centroids and determination of the Ge(Li) detector calibration was carried out using computer programs described in an earlier communication [E.F. Gibson *et al.*, *Physical Review* **172**, 1004 (1968)]. The procedure for deriving lifetimes from measured Doppler shift data (DSAM) was quite standard. It is described in reasonable detail in the original paper and will not be repeated here. It is mentioned in the paper that the 1.556-MeV resonance level populates several levels of lower excitation in ^{32}S; consequently, it provided a good opportunity to measure lifetimes for several of these states.

The angular distributions were fitted with even-order Legendre-polynomial expansions. The highest term was determined by angular momentum selection rules. Also, theoretical expressions for the coefficients have been derived and reported in the literature. References are given in the original paper.

RESULTS AND DISCUSSION

The proton energies for the four investigated resonances were found to be 1.248, 1.438, 1.556, and 1.583 MeV, respectively. The γ-ray energy uncertainties were about 1 keV for peaks < 3 MeV and 3 keV for those of higher energy. Errors in the derived branching ratios were estimated to be less than 10% for stronger branches and as high as 50% for weak branches. Table I of the original paper provides the branching factors measured in this experiment. Lifetimes were determined for 10 states in ^{32}S. These are given - along with their errors - in Table II of the original paper. Angular distribution coefficients based on least-squares fits to data for observed γ-rays from the 1.248 and 1.438 resonances are given in Table III along with their errors. These data were then employed - along with conventional techniques of analysis - to estimate level spins and parities as well as multipole mixing ratios. The results are given in Tables IV and V of the original paper.

The remainder of the paper is devoted to comparing results from this experiment with other data reported in the literature.

R+95

TITLE

Indirect Study of Low-Energy Resonances in $^{31}P(p,\alpha)^{28}Si$ and $^{35}Cl(p,\alpha)^{32}S$

REFERENCE

J.G. Ross, J. Goerres, C. Iliadis, S. Vouzoukas, M. Wiescher, R.B. Vogelaar, S. Utku, N.P.T. Bateman, and P.D. Parker, *Physical Review* **C52**, 1681 - 1690 (1995).

ABSTRACT

The reaction sequences governing the reaction flow in the rp-process are important for the understanding of the energy generation and nucleosynthesis of heavy elements in hot and explosive stellar hydrogen burning. Of considerable interest are (p,α) reactions along the process path which lead to the formation of reaction cycles rather than to chains of proton capture processes and β decays. Previous direct attempts to measure the low-energy reaction cross sections for $^{31}P(p,\alpha)^{28}Si$ and $^{35}Cl(p,\alpha)^{32}S$ resulted only in upper limits for the strengths of possible low-energy resonances which may dominate the reaction rates. In this paper an indirect experimental approach is presented to study the structure of the low-energy unbound states in the compound nuclei ^{32}S and ^{36}Ar. The results allow a more accurate determination of the contributions of these low-energy levels in the (p,α) reaction channel.

FACILITY

AVF cyclotron facility, Department of Physics, Princeton University, Princeton, New Jersey.

EXPERIMENT

Direct techniques to locate and measure the strengths of resonances in the $^{31}P(p,\gamma)^{32}S$, and $^{31}P(p,\alpha)^{28}Si$ reactions at very low proton energy are very difficult to perform because the yields are extremely low as a result of Coulomb barrier effects [C. Iliadis *et al.*, *Nuclear Physics* **A533**, 153 (1991); C. Iliadis *et al.*, *Nuclear Physics* **A559**, 83 (1993)]. The relative rates of these two reactions at various stellar temperatures are important for gaining an understanding the SiP cycle. These reaction rates are very sensitive to the existence and strength of low-lying resonances - say those with $E_p < 0.5$ MeV - when the explosive stellar temperatures are moderate (*i.e.*, $\leq$ 0.4 GK) as is generally the case in novae events. The present paper provides an interesting review of the status of possible low-lying unbound states in ^{32}S prior to the reported work. The purpose of this investigation was to search for low-lying states just above the proton binding energy in ^{32}S - by using a proton transfer reaction, namely, $^{31}P(^3He,d)^{32}S$, to populate them - and then provide estimates of their resonance strengths. Previous investigations of these reactions demonstrated that many levels in the excitation energy range of interest are strongly populated by this method, thereby suggesting that most of these levels have pronounced single-particle configurations. Therefore, they should also be strongly prone to population by resonant proton capture. The particle and γ-ray decays of these states were measured by indirect means in order to determine relative partial widths Γ_γ/Γ, Γ_α/Γ, and Γ_p/Γ. Although the $^{35}Cl(^3He,d)^{36}Ar$ reaction was also studied in this experiment, the present summary focuses on the more relevant $^{31}P(^3He,d)^{32}S$ process.

MEASUREMENT PROCEDURES

A ^3He beam of 25 MeV with an average beam intensity of 50 nA was provided by the Princeton AVF cyclotron.

Targets of ^{31}P were prepared by vacuum evaporation of a Co_2P layer of 30 - 50 $\mu g/cm^2$ on a 40 $\mu g/cm^2$ carbon foil. An elemental cobalt target was prepared in the same way for background measurements.

The emitted deuterons were detected at 0° in the laboratory using the Princeton QDDD magnetic spectrometer as described in the literature [A. Champagne *et al.*, *Nuclear Physics* **A487**, 433 (1988)]. The typical energy resolution was about 20 keV which was sufficient to resolve most of the levels of interest. The energy calibration of the spectrometer was established by observing the population of well-known levels in ^{32}S. Protons and α-particles emitted from the decay of the populated states were measured in coincidence with the deuterons using three 450-mm^2 silicon surface barrier detectors positioned at 90, 110, and 145° relative to the incident ^3He-particle beam. These detectors were situated 9.5 cm from the target. Their energy calibration was provided by performing measurements with a ^{241}Am α-particle source. The charged-particle detector solid angles were determined from the geometry of the setup and they were confirmed experimentally by resorting to measurements of the strong $^{19}F(^3He,d\text{-}\alpha)$ reaction to the 0^+ state at 6.725 MeV in ^{20}Ne which decays 100% to the isotropic $^{16}O_{g.s.} + \alpha$ channel. The use of three detectors allowed a direct determination of the angular distributions of emitted protons and α-particles. These distributions were fitted with even-order Legendre-polynomial expansions of order up to P_4.

The γ-ray decay of the populated states was measured using a 12.7 cm x 10.2 cm NaI detector placed at about 90° relative to the incident beam direction and 5.4 cm away from the target. The efficiency of this detector was calculated using knowledge of the geometry and tabulated nuclear data [J.B. Marion and F.C. Young, *Nuclear Reaction Analysis Graphs and Tables*, North-Holland Publishing Company, Amsterdam, 1968]. The calculated efficiency was checked by measurements using a calibrated ^{137}Cs source and the γ-ray decay of the well known state at 9.059 MeV excitation in ^{32}S [C. Iliadis *et al.*, *Nuclear Physics* **A533**, 153 (1991)]. Gamma-ray spectra were measured in coincidence with various deuteron groups. To reduce the influence of low-energy γ-rays a 3-mm-thick lead plate was positioned between the NaI detector and the target.

DATA ACQUIRED

Spectra of emitted deuterons were measured with a magnetic spectrometer. Spectra of emitted protons and α-particles were measured using silicon surface-barrier detectors.

Gamma-ray spectra were measured with a NaI detector. These spectra constituted the raw data from this experiment.

DATA ANALYSIS

Spectral data were corrected for detector efficiencies, solid angles, and absorption (in the case of γ-rays). Peak yields for emitted deuterons, protons, and α-particles were extracted from the measured direct and/or coincidence spectra. Thus, the relative widths Γ_p/Γ and Γ_α/Γ could be deduced from the measured direct deuteron and d-p or d-α coincidence yields after correcting for solid-angle and angular-distribution effects. Due to limited resolution of the NaI detector and the small number of γ-ray events distributed over the whole spectrum, it was not possible to determine new branching ratios for the de-populated states of ^{32}S. Because of the existing uncertainties in γ-ray branching and poor statistics, the relative γ-partial width Γ_γ/Γ was derived from the total number of coincident events in the spectrum normalized to the average number of emitted γ-rays per decay. Since the NaI detector subtended a large solid angle, angular distribution effects associated with the γ-ray emission were neglected.

RESULTS AND DISCUSSION

Table I of the original paper gives the relative α-particle and γ-ray widths measured for the proton unbound states in ^{32}S, along with their respective errors.

The remainder of the paper is devoted to a detailed discussion of the implications of the present experiment on calculated stellar reaction rates. It is concluded that the $^{31}P(p,\alpha)^{28}Si$ process is considerably weaker than the $^{31}P(p,\gamma)^{32}S$ process. The consequence is a weakening of the SiP cycling process and enhanced efficiency for mass transfer toward heavier elements in hot stellar environments.

RDS77

TITLE

A Study of $^{28}Si(\alpha,\gamma)^{32}S$ Resonances Below E_α = 3.83 MeV

REFERENCE

D.W.O. Rogers, W.R. Dixon, and R.S. Storey, *Nuclear Physics* **A281**, 345 - 353 (1977).

ABSTRACT

The γ-decays of eleven resonances in the $^{28}Si(\alpha,\gamma)^{32}S$ reaction below E_α = 3.83 MeV have been studied using a large Ge(Li) detector. Results for branching ratios differ considerably from previous NaI work. The previous discrepancy in radiative strengths for the 2.61 MeV resonance is explained by this data. The strengths of the first five resonances at E_α = 1.77, 1.99, 2.19, 2.37, and 2.42 MeV appear to be (39 ± 13)% lower than previously reported. Spin-parities of 1^-, 2^+, and 2^+ have been assigned to the levels at 8.50, 8.69, and 8.86 MeV respectively. The radiative width of the E_p = 1.467 MeV, $J^\pi = 3^-$ resonance in the $^{31}P(p,\gamma)^{32}S$ reaction has also been measured.

FACILITY

4-MV Van de Graaff accelerator, National Research Council of Canada, Ottawa, Canada.

EXPERIMENT

The main objective of this experiment was to measure the radiative strengths and branching ratios for resonances in the $^{28}Si(\alpha,\gamma)^{32}S$ reaction below $E_\alpha = 3.83$ MeV. However, the radiative width of the $E_p = 1.467$ MeV, $J^\pi = 3^-$ resonance in $^{31}P(p,\gamma)^{32}S$ has also been measured. The present summary will emphasize those aspects of the experiment pertaining to the (p,γ) measurement.

MEASUREMENT PROCEDURES

An 85 μg/cm^2 target of red phosphorus was used in this experiment to re-measure the radiative strength of the $E_p = 1467$ keV resonance in $^{31}P(p,\gamma)^{32}S$ in order to extract absolute widths for the 3^- level at 10.29 MeV excitation in ^{32}S. This target was too thick to separate the closely spaced resonances at $E_p = 1467$ and 1470 keV, however it was possible to ensure that there was no feeding of the 5.01 MeV level in ^{32}S from the strong resonance at 1470 keV by noting that there was no feeding to the 6.22-MeV level. The target was surrounded by a shroud kept at liquid nitrogen temperature to reduce carbon build up. This shroud was also biased at -300 V to ensure proper current measurement from the target.

A 12.7 cm x 12.7 cm NaI γ-ray detector was used to measure the thick-target yield excitation functions. A 14% efficient Ge(Li) detector was used to measure all the radiative strengths on the resonances. No other details on this experiment are provided in the original paper.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra as a function of proton energy recorded with a NaI detector. These were used to generate an excitation function; γ-ray spectra recorded at resonance energies with a Ge(Li) detector provided branching information.

DATA ANALYSIS

Very few details are provided in the original paper, especially for the (p,γ) experiment.

RESULTS AND DISCUSSION

The paper provides γ-decay branching information for the resonances in ^{32}S that were excited by the $^{28}Si(\alpha,\gamma)^{32}S$ reaction (see Fig. 3 of the original paper). The results of the $^{31}P(p,\gamma)^{32}S$ resonance strength measurement are given in the text of the original paper (in Section 4). The value obtained agreed well with information given in the literature [J. Vernotte *et al.*, *Nuclear Physics* **A212**, 493 (1973)], so a weighted average was calculated. This led to a recommended value of $(\omega\gamma)_{1467} = 0.21 \pm 0.06$ eV for the strength of the $E_p =$ 1467 keV resonance.

RK71

TITLE

Lifetimes of Low-Lying Excited States in ^{32}S

REFERENCE

M.J. Renan and R.J. Keddy, *Il Nuovo Cimento* **3A**, No. 2, 347 - 354 (1971).

ABSTRACT

The lifetimes of the excited states at 2.23, 5.01, 6.23, and 9.389 MeV in ^{32}S have been determined with the Doppler-shift attenuation method. The results are compared with predictions based on the collective and shell models.

FACILITY

1-MeV Cockcroft-Walton acclerator, University of the Witwatersrand, Johannesburg, South Africa.

EXPERIMENT

The Doppler-shift attenuation method (DSAM) has been used to measure the lifetimes of some of the lower-lying levels in ^{32}S. These levels were populated by means of the $^{31}P(p,\gamma)^{32}S$ reaction at incident proton energies from 500 - 800 keV. This work was motivated by the observation that earlier attempts to measure these lifetimes resulted in values that are in poor agreement.

MEASUREMENT PROCEDURES

The 1-MeV Cockcroft-Walton accelerator at University of the Witwatersrand was used to provide proton beams. These beams were momentum analyzed by a 90° magnet and were stabilized to 1 keV.

Targets were prepared from natural red phosphorus powder compressed to a density of 2.2 g/cm^3. It was found that evaporated zinc phosphide targets produced - with the energy limitations of this accelerator - attenuated shifts which were too small to be measured accurately.

Gamma-ray spectra were recorded with a 40-cm^3 Ge(Li) detector having a resolution of 2.8 keV FWHM at 1.33 MeV. Three resonances were investigated. They were located at E_p = 459, 541, and 642 keV. The decay γ-ray energies and branching factors were taken from the literature [P.M. Endt and C. van der Leun, *Nuclear Physics* **A105**, 1 (1967)]. These spectra were recorded at both 0 and 135° relative to the incident proton beam. Digital stabilizers were used to preserve the gain and zero-point stability of the spectrometer system. The runs were repeated several times to assure reproducibility of the results.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra measured with a Ge(Li) detector at two different angles and for proton energies in the vicinity of three different resonances.

DATA ANALYSIS

The attenuated Doppler shift was determined by comparing the energies of the gamma rays measured at the two different angles indicated above. A least-squares procedure was used to determine the γ-ray peak centroids. Then, the standard DSAM was applied. This required knowledge of stopping powers. They were determined according to a prescription from the literature [J. Lindhard *et al.*, *Mat. Fys. Medd. Dan. Selsk.* **33**, 1 (1963)]. Beyond this, few details on the method of data analysis are provided in the original paper.

RESULTS AND DISCUSSION

The measured lifetimes are given in Table I of the original paper; they are also compared there with other results from the literature. The electromagnetic transition strengths deduced from the present lifetime measurements are presented in Table II of the original paper. These various experimental values are then compared with results from theoretical calculations as discussed in the remainder of the paper.

RWK87

TITLE

Absolute Thick-Target γ-Ray Yields for Elemental Analysis by 7 and 9 MeV Protons

REFERENCE

J. Raisanen, T. Witting, and J. Keinonen, *Nuclear Instruments and Methods in Physics Research* **B28**, 199 - 204 (1987).

ABSTRACT

A systematic study of absolute thick-target γ-ray yields, produced in the bombardment of elements with Z = 3 - 9, 11 - 17, 19, 20, 22 - 30, 32, 39 - 42, 44, 46 - 51, 53, 62, 64, 70, 72 - 74, 78, 79, and 82 by 7 and 9 MeV protons, has been carried out. The most suitable γ-ray energies and absolute yields for elemental analysis are listed. Relative neutron yields are also given.

FACILITY

5-MV tandem accelerator EGP-10-11, Accelerator Laboratory, University of Helsinki, Helsinki, Finland.

EXPERIMENT

The aims of the present work were to use higher bombarding energies than utilized previously to study γ-ray yields from particle channels, to extend γ-ray yield data for the analysis of elements with Z > 20, to provide consistent data for a broad range of elements, and to determine the most suitable γ-ray energies for elemental analysis. Absolute, thick-target γ-ray yields were measured for the elements Z = 3 - 9, 11 - 17, 19, 20, 22 - 30, 32, 39 - 42, 44, 46 - 51, 53, 62, 64, 70, 72 - 74, 78, 79, and 82 at incident proton energies of 7 and 9 MeV. In considering the use of high bombarding energies for PIGE analysis, the neutron yield is the most crucial drawback and had to be taken into account. Consequently, neutron yields were also measured.

MEASUREMENT PROCEDURES

The proton beam was obtained from the Helsinki EGP-10-11 tandem accelerator. Gamma-radiation was detected with a shielded 80-cm^3 Canberra Ge(Li) detector that had an energy resolution of 1.9 keV at E_γ = 1.33 MeV and an efficiency of 18%. This detector was placed at 55° relative to the incident proton beam to minimize angular distribution effects (a node of the Legendre polynomial term P_2). A target-to-detector distance of 27 cm was used to minimize the effects of small changes in solid angle due to different target geometries. Sources of ^{60}Co, ^{56}Co, and ^{152}Eu were used to obtain energy and absolute efficiency calibrations for this detector. Neutrons were detected using a BF_3 counter located 30 cm from the target.

The proton beam was adjusted to keep the γ-count rate constant and the dead time below 1%. This was accomplished with beams in the range 0.1 to 20 nA, depending on the target. The collected proton charge was measured accurately by employing a calibrated current integrator and suppression of secondary-electron emission. The total collected charge per recorded spectrum was in the range of 0.07 to 31 μC.

Most of the targets were 1 cm x 1 cm slabs, 1 mm thick. Powdered chemical compounds were also used for targets as required. These were in the form of pressed pellets 1 mm thick and 6 mm in diameter.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra recorded with a Ge(Li) detector.

DATA ANALYSIS

Relatively few details are given concerning analysis of the data. The measured γ-ray yields were corrected for the effect of detector efficiency and material stopping powers so that the observed thick-target yields could be interpreted in terms of equivalent pure elements. The stopping powers used for 7 and 9 MeV protons were obtained from the literature [H.H. Anderson and J.F. Ziegler, *Hydrogen Stopping Powers and Ranges in All Elements*, Pergamon, New York (1977)].

RESULTS AND DISCUSSION

The measured thick-target absolute γ-ray yields per micro-Coulomb acquired in this experiment are listed in Table 1 of the original paper. Only the individual γ-ray transitions which were considered to be relevant to elemental analysis are listed. Furthermore, all peaks below 511 keV were excluded except for cases where no other suitable transition could be found or where such a low-energy γ-ray was truly dominant. The reasons for selecting this threshold were: i) The absorption of radiation in the target and detector shield was sizeable making it difficult to obtain accurate yield values. ii) The γ-peak density was high in that region making it difficult to avoid overlapping problems. iii) The Compton tail of 511-keV annihilation radiation introduced a high background so that small peaks could not be easily located or identified. Wherever possible, more than one characteristic γ-ray was identified for each element. This aided in identification of the elements and allowed for the possibility of checking for background or interference through the calculation of ratios.

The experimental uncertainties in the corrected absolute γ-ray yield values were estimated by the authors to be below 10%, consisting of the following main components: stopping power (2%), γ-ray intensities (2 - 5%), and detector efficiency (5%). In spite of this optimistic assessment, comparisons of corrected elemental γ-ray yields based on targets with various compositions involving those elements yielded variations up to 20%. The authors believed that these deviations could be explained mainly by uncertainties with target stoichiometry leading to calculation of erroneous stopping powers.

Neutrons from (p,n) reactions on various target materials were a concern, as mentioned above. In particular, strong peaks due to various Ge(n,n') reactions in the Ge(Li) detector produced troublesome peaks in the measured spectra. To reduce the effect of neutrons on the detector, a paraffin absorber containing boron was placed between the target and the Ge(Li) detector. This had the negative effect of absorbing the low-energy γ-rays as mentioned above. Although this shielding reduced the Ge(n,n') γ-rays, it also led to generation of a 478-keV peak in the recorded spectra due to the $^{10}B(n,\alpha\gamma)^{7}Li$ reaction.

The remainder of the paper is devoted to discussing the advantages and limitations of using the PIGE method of analysis at these higher proton energies. One general trend noted by the authors is the increasing dominance of (p,p') and (p,n) reactions relative to (pγ) reactions as the proton energy is increased. The reader is referred to the original paper for these details.

S+99

TITLE

Proton Induced Thick Target γ-Ray Yields of Light Nuclei at the Energy Region E_p = 1.0 - 4.1 MeV

REFERENCE

A. Savidou, X. Aslanoglou, T. Paradellis, and M. Pilakouta, *Nuclear Instruments and Methods in Physics Research* **B152**, 12 - 18 (1999).

ABSTRACT

Excitation function measurements of thick target γ-ray yields were taken for the elements Li, B, F, Na, Mg, Al, Si, and P after bombardment with protons at the energy interval E_p = 1.0 - 4.1 MeV. The yields of all γ-rays emitted at E_p = 1.77 and 4.0 MeV are tabulated and discussed.

FACILITY

5.5-MV Tandem accelerator TN11, Institute of Nuclear Physics, MCSR "Demokritos", Athens, Greece.

EXPERIMENT

Nuclear reactions of the type (p,γ), (p,p'γ), (p,nγ), and (p,$\alpha\gamma$) can be very useful as probes to determine elemental content, especially for light nuclei where X-ray fluorescence, or proton-induced X-ray emission (PIXE) produces radiations that are so low in energy that they cannot effectively penetrate more than a few atomic layers of material. On the other hand, the more energetic γ-rays produced by proton-induced γ-emission (PIGE) processes can easily penetrate through considerable distances, relatively speaking. While the PIGE method had been reported earlier in articles referenced in the present paper, the objective of the present investigation was to examine the thick-target proton-induced γ-ray yield specifically due to the elements Li, B, F, Na, Mg, Al, Si, and P at bombarding energies E_p = 1.77 and 4.0 MeV at an emission angle of 90° relative to the incident proton beam. This angle was selected to minimize the effects of Doppler broadening of the γ-ray lines. The energy E_p = 4.0 MeV was selected as the working energy while E_p = 1.77 MeV was studied because this lower energy is accessible to many small accelerators while, at the same time, measurable γ-ray yields can still be achieved there. The plan of this program was to select certain specific γ-rays from each element to use for the purpose of quantitative analysis. In order to apply the PIGE method for accurate determinations of sample composition, corrections have to be made based on knowledge of stopping powers and cross sections. Consequently, detailed excitation functions were measured over the energy range E_p = 1.0 - 4.1 MeV.

MEASUREMENT PROCEDURES

The Institute of Nuclear Physics 5.5-MV tandem accelerator was used in this investigation. Proton beams were directed to the targets via two sets of collimators of diameter 4 mm. The targets were placed at 45° relative to the proton beam and were cooled to 10° C using an ethyl alcohol refrigeration system to enable them to withstand the incident beam power. An electric potential of 300 V was applied to the target to suppress secondary emission electrons that would distort the integrated beam charge readings.

Gamma-rays were measured using an intrinsic Ge detector with resolution of 1.9 keV at E_γ = 1333 keV. As indicated above, this detector was located at 90° relative to the proton beam. A ^{152}Eu source was used to calibrate this detector. The targets were all composed of powder graphite and cellulose, mixed with less than 10% of the compound containing the element under investigation. All materials were of natural abundance. Four pellets were prepared for each element considered.

Detailed spectra were recorded at E_p = 1.77 and 4.0 MeV for Li, B, F, Na, Mg, Al, Si, and P. Various beam currents were used depending on the γ-ray yields from the targets. The objective was good statistics and spectra in which the small peaks were well shaped. The excitation functions were measured in steps of 10 keV over the range E_p = 1.0 - 1.82 MeV and 50 keV for the range E_p = 2.2 - 4.1 MeV.

Although not directly related to the individual objective, thick-target γ-ray spectra were also taken, but only at E_p = 1.77 and 4.0 MeV, for a number of heavy elements in order to investigate the problem of accidental overlap of γ-rays between light and heavy elements. Natural metallic targets were used for the elements Fe, Mn, Co, Cu, Pb, Sn, Ti, and Sn. Compounds mixed with cellulose were used for targets containing Br, Cl, Zn, Mo, V, K, Ca, Cr, Ni, and N. For these heavier element compounds, the concentration was 30 - 40% by weight.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra recorded with the Ge detector, as indicated above.

DATA ANALYSIS

Few details are given, but it is mentioned in the original paper that the measured yields were corrected for detector efficiency and then reduced to equivalent mono-atomic values using known stopping power and weight concentration information.

RESULTS AND DISCUSSION

The characteristic corrected γ-ray yields at E_p = 1.77 and 4.0 MeV for the light elements are given in Table 1 of the original paper. They are normalized to collected proton charge. Out of all the γ-rays emitted by the elements as a result of various nuclear reactions, the authors proposed a single favored one to be followed for each element at the two proton energies considered. These gamma rays are listed in Table 2 of the original paper. A large portion of the remainder of the paper is devoted to discussing these choices and the reasons for their selection.

The final section of the paper discusses an application of the method to the analysis of a clay sample. Measurements were performed at both energies. The targets were prepared by drying the clay material at 300° C for 4 hours to expel all water molecules except those chemically bonded to the material, and hence to insure stable stoichiometry. The elemental abundances by weight percent determined by the PIGE method were then compared to the certified composition. The agreement was reasonably good, although it is apparent from Table 4 of the original paper that it was not always within the expected errors.

S83

TITLE

Effect of Excited States on Thermonuclear Reaction Rates

REFERENCE

D.G. Sargood, *Australian Journal of Physics* **36**, 583 - 589 (1983).

ABSTRACT

Values of the ratio of the thermonuclear reaction rate of a reaction, with target nuclei in a thermal distribution of energy states, to the reaction rate with all target nuclei in their ground states are tabulated for neutron, proton, and α-particle induced reactions on the naturally occurring nuclei from ^{20}Ne to ^{70}Zn, at temperatures of 1, 2, 3.5, and 5 x 10^9 °K. The ratios are determined from reaction rates based on statistical model cross sections.

FACILITY

Not applicable.

EXPERIMENT

Not applicable.

MEASUREMENT PROCEDURES

Not applicable.

DATA ACQUIRED

Not applicable.

DATA ANALYSIS

Not applicable.

RESULTS AND DISCUSSION

This is a theoretical investigation which employs statistical model calculations and assumptions about the thermal equilibrium distributions of states of all naturally occurring targets elements from ^{20}Ne to ^{70}Zn in various stellar environments.

The thesis of this work is that in elevated-temperature stellar environments, it cannot be assumed that all the target nuclei will reside in their ground states. In reality, the target nuclei will exist in a thermal distribution of states, including the ground state and various excited states, depending on the equilibrium temperature of the stellar environment under consideration. For practical purposes the possibility of long-lived isomeric states and departures from equilibrium conditions were not considered in this work although the possibility is mentioned and references to other work which consider this possibility are provided in the original paper.

The results of the present analysis are summarized in Tables 1 - 4 of the paper. There, ratios are provided of the "true" estimated reaction rate to the reaction rate calculated under the assumption that the target nuclei reside in the ground state. Our main concern in this context is for the ^{31}P(p,γ)^{32}S reaction. Let "R" stand for the ratio in question. Then, from Table 1 of the original paper we extract the results: R = 1.00 (T_9 = 1 GK); R = 0.996 (T_9 = 2 GK); R = 0.972 (T_9 = 3.5 GK); R = 0.901 (T_9 = 5 GK). Clearly, the effect is significant for the very highest stellar environments, of the sort likely to be encountered in supernova explosions. However, this needs to be viewed in the context of the uncertainties involved in calculations of stellar reaction rates. In particular, calculations involving nuclei in excited states can be carried out only using nuclear models, *e.g.*, the Hauser-Feshbach statistical model, where the assumptions involved lead to results whose uncertainties are at least as large as the effect in question.

SAN73

TITLE

Application of the Blocking Technique to Measure Lifetimes of Nuclear Levels Excited in (p,α) Resonance Reactions in P and Al

REFERENCE

R.P. Sharma, J.U. Andersen, and K.O. Nielsen, *Nuclear Physics* **A204**, 371 - 384 (1973).

ABSTRACT

The mean lifetimes of the 9.486 and 12.19 MeV levels in ^{32}S and ^{28}Si excited in the ^{31}P(p,α)^{28}Si and ^{27}Al(p,α)^{24}Mg reactions, respectively, have been measured by observing the

axial blocking dips (shadows) of emitted α-particles with single crystals of GaP and Al as targets. The respective lifetimes are 80 and 100 as. These results are in good agreement with the values deduced from the yields of (p,α), (p,γ), and (α,γ) reactions and thus provide a test of the blocking technique.

FACILITY

2-MV Van de Graaff accelerator, Institute of Physics, University of Aarhus, Aarhus, Denmark.

EXPERIMENT

The blocking method has been applied to measure the lifetimes of the compound nuclei ^{32}S and ^{28}Al formed by the ^{31}P(p,α)^{28}Si and ^{27}Al(p,α)^{24}Mg, respectively. While this work relates to properties of ^{32}S, it has nothing to do with the ^{31}P(p,γ)^{32}S reaction.

In particular, we are concerned here with a measurement on the 642-keV resonance for ^{31}P(p,α)^{28}Si, corresponding to a level at 9.486-MeV excitation in ^{32}Si. The blocking technique is basically a time-of-flight approach, and it works only if the compound nucleus formed decays by the emission of a charged particle. It is also a solid-state phenomenon which relies on the regular atomic structure found in single crystals. When the decay occurs within a distance of 10^{-9} cm from a lattice site in a crystal, the emitted particles are blocked in axial and planar directions. With increasing displacement from the lattice site, the blocking effect becomes less effective. The velocity of the compound nucleus depends on the momentum of the captured particle and will normally be in the range of 10^7 - 10^9 cm/sec. Consequently, the blocking approach offers the possibility to measure lifetimes in the range 1 - 100 as. (NOTE: 1 as = 1 attosecond = 10^{-18} second.) Shorter and longer lifetimes are not amenable to this technique. In the case of ^{31}P(p,α)^{28}Si, at the 642-keV resonance, the level has spin/parity of 1^- and it decays by emission of a 2.1-MeV α-particle. This case of an isolated resonance with convenient particle energies offered a good example to test the method.

MEASUREMENT PROCEDURES

The original paper discusses the procedures in considerable detail. Much of the discussion centers around the manner in which the crystal structure of GaP was exploited in the experiment. A thick crystal was used. In this case, the beam energy was set slightly above the resonance energy so that the reaction would be mainly confined to a shallow depth in the crystal. A well-collimated beam of protons (0.5 mm x 0.5 mm) was provided by a 2-MV Van de Graaff accelerator. Since a relatively large proton dose was required to perform the measurement ($\approx$ 2.5 α-particles are produced for 10^{10} incident protons), and the experiment was moderately sensitive to radiation damage effects in the GaP, pains were taken to distribute the dose over the total crystal area (6 mm x 8 mm). The crystal was mounted on a goniometer so that its orientation could be changed in small increments. The two <111> axes (A and B) were oriented at 10° and 81°, respectively relative to the incident proton beam. The precise orientation of the crystal was determined in the usual way by the channeling technique, using back-scattered protons. By observing a difference in the minimum yield along the A and B directions, it was possible to estimate the lifetime of the resonance in ^{32}S. The α-particle yields were measured with plastic films (cellulose nitrate) located 15 cm from the target. They were developed in such a way as to discriminate against the overwhelming background of scattered protons (approximately 10^6 protons for each α-particle). A position-sensitive detector was used to monitor for radiation damage of the GaP crystal during this experiment. Since the path lengths along directions A and B are significantly different, any de-channeling effects that might be present could affect interpretation of the data. To check for this effect, measurements were performed at an incident proton energy of 1.53 MeV, just above the 1.51-MeV resonance. This resonance is much stronger than the 642-keV resonance and it has a much shorter lifetime (≈ 0.1 as), *i.e.*, one that is too short to influence the blocking pattern.

DATA ACQUIRED

The data acquired were α-particle yields as measured with the plastic-film detectors. The difference in the blocking dips were measured and plotted. The original article discusses the procedure in considerable detail.

DATA ANALYSIS

The formalism for analyzing the data is discussed in the original article. The main source of error was a determination of the constant "C" which appears in Eq. (1) of the paper. The authors believe that the uncertainty is no more than 30% for the lifetime measured by this method.

RESULTS AND DISCUSSION

The present experiment yielded the result $\tau = 80 \pm 24$ as for the mean lifetime of the 9.486-MeV excited state in ^{32}S. This corresponds to a total width $\Gamma = 8.2 \pm 2.5$ eV. This result agrees quite well with the value 8 eV obtained elsewhere by a measurement of the resonance strength.

SE71

TITLE

Relative Efficiency of Ge(Li) Gamma Ray Detectors from 0.5 to 12 MeV

REFERENCE

B.P. Singh and H.C. Evans, *Nuclear Instruments and Methods* **97**, 475 - 482 (1971).

ABSTRACT

The double-escape peak efficiency for several Ge(Li) detectors has been measured between 1.6 and 11.6 MeV using radioactive sources and gamma-ray cascades following proton capture reactions. These measurements were made relative to the full-energy peak efficiency which was obtained between 0.5 and 3.25 MeV. The data were fitted by empirical functions and the overall accuracy of the relative efficiency was between 3% and 5% for the full-energy peak and 6% for the double escape peak. Several examples of branching ratio measurements are presented and the relative intensity of weak gamma-ray transitions following ^{56}Co beta decay has been determined.

FACILITY

Not applicable.

EXPERIMENT

A method is described for obtaining the double escape peak (DEP) efficiencies of Ge(Li) detectors between 1.6 and 11.6 MeV using radioactive sources and γ-ray cascades following the decay of unbound levels formed by proton capture. This topic would be of no direct interest for present purposes except for the fact that a study of the decay scheme of the 10.073 MeV $J = 2$ level in ^{32}S formed via the $^{31}P(p,\gamma)^{32}S$ reaction is used as an example to illustrate the method. The details of the calibration procedure will not be discussed here. The reader who is interested can refer to the original paper.

MEASUREMENT PROCEDURES

No details are provided.

DATA ACQUIRED

Gamma-ray spectra were recorded with a Ge(Li) detector.

DATA ANALYSIS

No specific details are provided other than to indicate that the calibration methods described in the present paper were employed to determine the energies and relative intensities of the γ-ray transitions associated with the decay of the particular resonance in ^{32}S.

RESULTS AND DISCUSSION

Figure 4 from the original paper shows the γ-ray spectrum recorded with a Ge(Li) detector at 60° relative to an incident proton beam of 1248 keV. Full-energy, single- and double-escape peaks are indicated on the plot. Figure 5 shows the decay scheme for the resonance as deduced by the method discussed in the original paper. Both energies and relative intensities are given in the diagram. No other information of interest for present purposes is provided in this paper.

T+69

TITLE

Mesures des Vies Moyennes des Premiers Etats Excites du Noyau ^{32}S

REFERENCE

J.P. Thibaud, M.M. Aleonard, D. Castera, P. Hubert, F. Leccia, et P. Mennrath, *Nuclear Physics* **A135**, 281 - 288 (1969). [In French].

ABSTRACT

Doppler-shift measurements of γ-rays from the $^{31}P(p,\gamma)^{32}S$ reaction lead to the mean lifetimes $\tau_m = 260 \pm 80$, 50 ± 13, 170 ± 100, 250 ± 50, 68 ± 12, 61 ± 15, and > 1000 fs for the levels $^{32}S^* = 2.237$, 4.287, 4.698, 5.012, 5.553, 6.226, and 6.621 MeV, respectively. The experimental electromagnetic transition rates are compared with those calculated with the

asymmetric model of Davydov and Filippov. The level schemes of ^{16}O, ^{24}Mg, and ^{32}S have analogous characteristics.

FACILITY

4-MV Van de Graaff accelerator, Centre d'Etudes Nucleaires de Bordeaux, Bordeaux, France.

EXPERIMENT

Lifetimes for the 2.237-, 4.287-, 4.698-, 5.012-, 6.226- and 6.621-MeV levels in ^{32}S have been measured by the Doppler-shift attenuation method (DSAM) using proton beams in the energy range 0.811 - 1.555 MeV. Measured γ-ray transition rates have been compared with theoretical calculations based on the Davydov and Filippov asymmetric model.

MEASUREMENT PROCEDURES

Using adjustable slits it was possible to obtain proton beam currents on targets of several micro-amperes with energy definition and stability of less than 1 keV. Targets of phosphorus were prepared by evaporation of Zn_3P_2 on gold backings. These targets were sufficiently pure so that no contamination due to $^{19}F(p,\alpha\gamma)^{16}O$ was visible for protons in the energy range examined. Gamma-rays were measured with a Ge(Li) detector. The combination of detector and electronics used was sufficiently stable so that no corrections were needed to compensate for drifts in the recording system gain. The resolution was measured to be about 5 keV for the 2.614-MeV gamma-ray line from ^{228}Th. Measurements were performed at the 0.811-, 1.148- and 1.248-MeV resonances.

DATA ACQUIRED

Gamma-ray spectra were measured with the Ge(Li) detector at each of the resonances mentioned above.

DATA ANALYSIS

Locations of γ-ray full-energy peak centroids were established. The greatest uncertainty in this process was that of determining these peak centroids. The standard DSAM was applied in the analysis of these data. Electromagnetic transition rates were also deduced from the measured γ-ray spectra.

RESULTS AND DISCUSSION

Lifetime values (or in some cases upper limits) were determined for eleven levels populated in the decays from these resonances. Electromagnetic transition rates determined from the data were compared with the results of model calculations. While this work provides useful information about the nuclear structure of levels in ^{32}S, it provides very little information of direct interest to the calculation of reaction rates for the $^{31}P(p,\gamma)^{32}S$ reaction at astrophysical energies.

T70

TITLE

Contribution a l'Etude des Probabilities de Transition Electromagnetique dans les Noyaux ^{28}Si, ^{32}S et ^{36}Ar

REFERENCE

J.P. Thibaud, Thesis, Centre d'Etudes Nucleaires de la Faculte des Sciences, University of Bordeaux, Bordeaux, France, Report FRNC -TH-106 (1970). [In French].

ABSTRACT

Depuis quelques annees, la couche *s-d* est devenue une des regions privilegiees dans l'etude de la structure nucleaire. De nombreux resultats experimentaux on en effect montre que, si le nuclides du debut de la couche presentent les proprietes des noyaux de cette region. La premiere consiste a diagonaliser un hamiltonien modele dans un espace plus ou moins restreint de fonctions d'onde du modele en couches. Cette methode a donne des accords souvent spectaculaires avec les resultats experimentaux, mais au prix d'une comprehension moins simple de la structure des etats que celle fournie par d'autres approches theoriques, telle que la methode HARTREE-FOCK; celle-ci conserve en effet leur signification a des notions importantes comme, par exemple, celle de deformation des etats nucleaires. Cette deuxieme voie de description des proprietes nucleaires a ete tres employee dans la couche s-d, et principalement pour les noyaux de type A = 4n. La methode HARTREE-FOCK, que permet de determiner les caracteristiques du champ deforme a partir de l'interaction nucleon-nucleon, a donne de bons resultats dans le debut de la couche *s-d*; mais, pour des noyaux de masse plus elevee, le nombre moins grand des resultats experimentaux rend la confrontation entre les calculs de HARTREE-FOCK et l'experience plus incertaine. Nous avons donc ete amenes a etudier les noyaux ^{28}Si, ^{32}Si et ^{36}Ar du point de vue des transitions electromagnetiques puisque ces dermieres constituent un des tests majeurs de la validite d'un modele.

La connaissance des probabilites de transition necessite la mesure des vies moyennes des etats excites des differents noyaux. La methode la plus employee pour effectuer de telles mesures est, sans conteste, celle de l'attenuation du deplacement Doppler, don't le domaine d'application s'etend approximativement a des temps de vie de 5 fs a plus de 1000 fs. Depuis l'avenement des detecteurs Ge(Li) de gros volume et de tres bonne resolution, la mesure precise de deplacements faibles, de l'ordre du keV, est devenue possible et, dans ces conditions, nous avons choisi d'utiliser les reactions de capture radiative pour peupler les etats excites des noyaux ^{28}Si, ^{32}Si et ^{36}Ar; ces reactions presentent en effet l'avantage d'une plus grande simplicite experimentale.

Dans la methode d'attenuation du deplacement Doppler, la principale limitation de la precision des mesures provient d'une connaissance trop grossiere des phenomenes de ralentissement des ions de recul dans la matiere. Nous nou sommes attaches a l'examen de ce probleme et nous tenterons de montrer que, de ce point de vue, les reactions de capture radiative sont plutot favorables par rapport a des reactions mettant en jeu des energies de recul des ions plus importantes.

Dans un premier chapitre, nous exposons les resultats obtenus dans differents calculs de type HARTREE-FOCK pour les noyaux ^{28}Si, ^{32}Si et ^{36}Ar. Puis nous decrivons la methode d'attenuation du deplacement Doppler ainsi que les problemes poses par les phenomenes de ralentissement des ions de recul dans la materiere; ce deuxieme chapitre comprend egalement une description des conditions experimentales. Le troisieme chapitre est consacre a l'expose des resultats obtenus. Enfin, dans la dermiere partie, nous comparons nos resultats avec les

differentes predictions des calculs HARTREE-FOCK concernant les deformations d'equilibre des etats intrinseques des trois noyaux ^{28}Si, ^{32}Si et ^{36}Ar.

FACILITY

Not determined. Only a few pages were reproduced from a microfiche copy of the original thesis. Those pages dealing with experimental details were omitted.

EXPERIMENT

Measurements of branching factors for the γ-ray decay of resonances in the $^{31}P(p,\gamma)^{32}S$ reaction at E_p = 811, 1148, 1248, 1438, and 1556 keV were carried out. Lifetimes were also measured for several excited states in ^{32}S. Comparison was made between these experimental results and those obtained from Hartree-Fock calculations.

MEASUREMENT PROCEDURES

Details are not available since only a few pages reproduced from a microfiche copy of the original thesis were available. Those pages dealing with experimental details were left out.

DATA ACQUIRED

Gamma-ray spectra were measured. Details are not available since only a few pages were reproduced from a microfiche copy of the original thesis. Those pages dealing with experimental details were omitted.

DATA ANALYSIS

Details are not available since only a few pages were reproduced from a microfiche copy of the original thesis. Those pages dealing with experimental details were omitted.

RESULTS AND DISCUSSION

The measured branching factors and lifetimes are given in tables in the thesis. There is also a discussion of these results provided in the text. Based on further analysis, assumptions about spins and parities of the levels, and comparisons with theory, values are given for gamma-ray decay widths Γ_γ and transition matrix elements (the latter in W.u.).

V+73a

TITLE

Recherche de Resonances Isobariques Analogues dans ^{32}S au Moyen des Reactions $^{31}P(p,\gamma)^{32}S$, $^{31}P(p,p)^{31}P$, et $^{31}P(p,\alpha_0)^{28}Si$

REFERENCE

J. Vernotte, S. Gales, M. Langevin, et J.M. Maison, *Nuclear Physics* **A212**, 493 - 530 (1973). [In French].

ABSTRACT

Fourteen resonance levels have been observed in a study of the $^{31}P(p,\gamma)^{32}S$, $^{31}P(p,p)^{31}P$ and $^{31}P(p,\alpha_0)^{28}Si$ Reactions in the proton energy range E_p = 1240-1600 keV. Resonance strengths have been determined for thirteen resonances of the $^{31}P(p,\gamma)^{32}S$ reaction. The γ-ray decay schemes of ten resonances have been studied by means of a Ge(Li) detector. Spin values of resonance levels and of some bound levels have been obtained or confirmed by γ-ray angular distribution measurements done at seven resonances. For the thirteen resonances of the $^{31}P(p,p)^{31}P$ reaction, the proton orbital momenta have been determined. By combining the information from the three reactions, spins, parities, total and partial widths have been obtained for twelve resonance levels. Strong M1 transitions have been observed at the E_p = 1247, 1402, 1437, 1555, and 1581 keV resonances. Two *T*-mixed doublets are identified at E_p = 1247 and 1472 keV, $J^\pi = 2^-$, and at E_p = 1402 and 1469 keV, $J^\pi = 3^-$. The resonance levels at E_p = 1437 and 1581 keV may be components of a third almost completely mixed doublet. The E_p = 1555 keV resonance level has been assigned $T = 1$. The E_p = 1411 keV, $J^\pi = 1^+$, resonance level has been identified with a level previously observed in the β^+ decay of ^{32}Cl. Strong E2 transitions similar to those observed in some other doubly even *s-d* shell nuclei have been observed between odd-parity levels of ^{32}S.

FACILITIES

4-MV Van de Graaff accelerator, Institut de Physique Nucleaire d'Orsay, Orsay, France; 2-MV Van de Graaff accelerator, Centre de Recherches Nucleaires de Strasbourg-Cronenbourg, Strasbourg, France.

EXPERIMENT

The objective of this work was to investigate resonances in the proton reactions $^{31}P(p,\gamma)^{32}S$, $^{31}P(p,p)^{31}P$, and $^{31}P(p,\alpha_0)^{28}Si$ over the energy domain E_p = 1.24 - 1.60 MeV, corresponding to the region of excitation E_x = 10.07 - 10.40 in ^{32}S. This investigation was intended to supplement earlier studies of this nature and resolve some of the uncertainties and discrepancies apparent in these results. The de-excitation scheme of ten of the thirteen resonances observed in the $^{31}P(p,\gamma)^{32}S$ have been studied using a Ge(Li) detector. Angular distribution measurements of de-excitation γ-rays have been performed for seven of these resonances to see if most intense transitions corresponded to pure M1, $J \rightarrow J$ transitions. The relative degree of purity or admixture of $T = 0$ and $T = 1$ isospin configurations for these resonance states was explored. Reduced widths θ_p^2 were obtained for six of the (p,p) resonances were compared with those deduced from spectroscopic factors S_n derived from a recent study of the $^{31}P(d,p)^{32}P$ reactions reported in the literature [J.J.M. van Gasteren *et al.*, *Nuclear Physics* **A210**, 29 (1973)]. Information on the α-particle decay width Γ_α of certain levels in ^{32}S was obtained from a study of the $^{31}P(p,\alpha_0)^{28}Si$ reaction. The present summary focuses on the (p,γ) reaction. The interested reader is referred to the original paper for details on other aspects of this experiment.

MEASUREMENT PROCEDURES

The investigation of the $^{31}P(p,\gamma)^{32}S$ reaction was carried out at both the 4-MV Orsay Van de Graaff and 2-MV Strasbourg-Cronenbourg Van de Graaff facilities. The reader is referred to an earlier paper which contains a description of the experimental setup at the 4-MV Orsay facility [J. Vernotte *et al.*, *Nuclear Physics* **A102**, 449 (1967)]. Targets of red phosphorus were prepared by vacuum evaporation *in situ* onto 0.2-mm thick supports of tungsten. These targets were placed at 45° relative to the incident proton beam. They were cooled using either an air jet (Orsay) or circulating water (Strasbourg-Cronenbourg). Before striking the target, the beam passed by a cold finger cooled by liquid nitrogen in order to reduce carbon buildup on the target. No evidence of contamination from the $^{19}F(p,\alpha\gamma)^{16}O$ was observed during the experiment. Proton beam currents were limited to 2 μA at Orsay and 10 μA at Strasbourg-Cronenbourg. Under these conditions, no deterioration of the targets was observed for runs of duration amounting to several days.

NaI(Tl) scintillation detectors 12.7 cm x 12.7 cm, protected from background radiation by 5 cm of lead, along with conventional electronics, were used at both facilities. A 37-cm^3 Ge(Li) detector was also employed in the measurements at Orsay. This detector had a resolution of 3.5 keV at 1.33 MeV (^{60}Co) and 15 keV at 10 MeV γ-energy. A 80-cm^3 Ge(Li) detector was employed at Strasbourg-Cronenbourg. This detector had a resolution of 2.5 keV at 1.33 MeV and 11 keV at 10 MeV. For angular distribution measurements either a NaI (Tl) detector or a Ge(Li) detector could be mounted on a movable angular distribution table. In either case, a NaI(Tl) detector was used as a monitor (presumably in a fixed position). The efficiencies of the Ge(Li) detectors were measured to an accuracy of about 10% for photon energies below 3.2 keV using a ^{56}Co source. For higher γ-ray energies, the known relative intensities of gamma rays from decay of the 1555-keV resonance, excited by the $^{31}P(p,\gamma)^{32}S$ reaction, were employed to calibrate the detectors [C.J. Piluso *et al.*, *Physical Review* **181**, 1555 (1969)].

The excitation function was measured over the range E_p = 1.24 - 1.60 MeV with a NaI(Tl) detector placed at 55° relative to the incident protons and 1.6 cm from the target. The target was 11 μg/cm^2 thick for measurements at E_p < 1.4 MeV and 23 μg/cm^2 for measurements at E_p > 1.4 MeV. The measurement procedure was calibrated relative to the E_p = 1747.6 ± 0.9 keV resonance of the $^{13}C(p,\gamma)^{14}N$ reaction using results from the literature [J.B. Marion and F.C. Young, *Nuclear Reaction Analysis*, North-Holland Publishing Company, Amsterdam (1968)].

Resonance strengths for the well-resolved resonances at E_p = 1247, 1437, 1515, 1555, and 1581 keV were determined from a single measurement with the 11 μg/cm^2 P target and one of the NaI(Tl) detectors located at 55° relative to the proton beam and 3 cm distant from the target. The strongest transition in the spectrum at each resonance was used for the measurements. Examination of the yield from the E_p = 1247 resonance performed at the beginning and end of the experiment provided a means for monitoring target stability. Resonance strengths for the resonances at E_p = 1399, 1402, 1405, 1411, 1469, 1472 and 1474 keV were determined using a Ge(Li) detector. The results were normalized to the E_p = 1437 keV resonance. Procedures required to resolve the contributions of the doublet components in 1402 - 1405 and 1472 -1474 keV are discussed in the text of the original paper. The uncertainties in the resonance strengths were estimated to be 20% except for the E_p = 1405 and 1474 keV resonances where the uncertainty was 40%.

There was little mention of details pertaining to the angular distribution measurements in this experiment.

DATA ACQUIRED

The acquired data consisted of γ-ray spectra recorded with NaI(Tl) and Ge(Li) detectors at various angles.

DATA ANALYSIS

Very few details are given in the original paper concerning analysis of either the excitation function data or the resonance decay γ-ray data for the $^{31}P(p,\gamma)^{32}S$ reaction. The angular distribution data were fitted with even-order Legendre polynomial expansions.

RESULTS AND DISCUSSION

Values of proton energy and resonance strength for the $^{31}P(p,\gamma)^{32}S$ reaction resonances observed in the present work appear in Table 1 of the original paper. Estimates of the uncertainty in the resonance energies are given in keV while errors for the resonance strengths are given in percent. It is mentioned in the text of the original paper that the measured resonance strengths are based on a comparison with the known strength of the E_p = 642 keV resonance in $^{31}P(p,\gamma)^{32}S$ of S = 0.52 ± 008 eV reported in the literature [G.A.P. Engelbertink and P.M. Endt, *Nuclear Physics* **88**, 12 (1966)]. Comparison is also made in Table 1 with comparable results from the literature. Results from the present investigation of the resonance decay branching factors are given in Table 2 of the original paper. There is an extensive discussion of these results in the text of the original paper. Table 3 summarizes the present results for resonance energies and compares them with other results from the literature. Legendre coefficients for the angular distributions associated with γ-rays observed in the decay of resonances at E_p = 1247, 1399, 1402, 1411, 1437, 1472, and 1581 keV are listed in Table 4 of the original text, along with estimated errors. Table 5 gives the spins, parities, and multipole mixing ratios associated with these transitions.

The remainder of this extensive paper is devoted to a discussion of the results from (p,p) and (p,α_0) measurements and the implications of these data in the context of the spins, parities, and isospins of various levels in ^{32}S as well as properties of the γ-ray transitions between these states.

V+73b

TITLE

Investigation of the Lowest T = 2 State of ^{32}S in the ^{31}P + p Reactions

REFERENCE

J. Vernotte, S. Gales, M. Langevin, and J.M. Maison, *Physical Review* **C8**, 178 - 187 (1973).

ABSTRACT

Two resonances have been observed at 3.283 ± 0.0003 and 3.289 ± 0.003 MeV in the $^{31}P(p,\gamma)^{32}S$ reaction. The corresponding excitation energies are 12.044 ± 0.004 and 12.050 ± 0.004 MeV. The γ-decay schemes and resonance strengths have been measured. On the basis of γ-ray angular-distribution and proton elastic scattering measurements the 12.044-MeV level has been assigned $J^\pi,T = 4^-,1$. The 12.050-MeV level has been assigned J = 0 from γ-ray angular-distribution and correlation measurements. A proton elastic scattering experiment has yielded an upper limit of 230 eV for the total width of the 12.050-MeV level. This state is shown to be the lowest $J^\pi,T = 0^+,2$ state in ^{32}S.

FACILITY

4-MV Van de Graaff accelerator, Institut de Physique Nucleaire, Orsay, France.

EXPERIMENT

Gamma-ray yields, angular distributions and branching factors were measured for the $^{31}P(p,\gamma)^{32}S$, $^{31}P(p,p'\gamma)^{31}P$ and $^{31}P(p,\alpha\gamma)^{28}Si$ reactions. Proton elastic and inelastic scattering distributions were measured for $^{31}P + p$. The objective was to determine the properties of two resonances in the range E_p = 3.28 - 3.29 MeV in ^{31}P. The present summary emphasizes the material in this paper dealing with the $^{31}P(p,\gamma)^{32}S$ reaction.

MEASUREMENT PROCEDURES

A target of red phosphorus was prepared for the γ-ray measurements by vacuum evaporation onto a 0.2-mm tungsten backing. This target was placed at 45° to the incident proton beam in an air-cooled target holder and wobbled to distribute the heat from the beam. The proton beam was stopped down to 2 mm diameter and the beam current on target was limited to 2 μA to insure its stability during the experiment. A liquid-nitrogen cold trap was placed before the target chamber to prevent buildup of contaminants. A target for the proton scattering measurements was prepared by using a thin, self-supporting carbon foil. In this instance the beam current was limited to 300 nA to insure that the target would sustain no damage. The target thickness was determined by low-energy Rutherford scattering of protons. The proton beam was stopped 150 cm beyond the target in a graphite-lined Faraday cup. The energy resolution of the proton beam was obtained by observing the sharp resonance in $^{13}C(p,\gamma)^{14}N$ at 1.7476 MeV. In this experiment the gamma rays were detected with a 3.8-cm-dia. x 3.8-cm-thick NaI(Tl) detector and a 37-cm^3 Ge(Li) detector. The detectors were calibrated using a ^{56}Co source and gamma rays from the 1.555-MeV resonance of the $^{31}P(p,\gamma)^{32}S$ reaction. The scattered protons were detected using four silicon surface-barrier detectors.

DATA ACQUIRED

Gamma-ray yield curves corresponding to each of the reactions indicated above were measured over the proton energy range 3.27 - 3.30 MeV. Gamma-ray decay branching factors and gamma-ray angular distributions were measured at the two indicated resonances. Proton elastic scattering data were also obtained in this energy range.

DATA ANALYSIS

The resonance energies were deduced from gamma-ray yield curves obtained using the NaI(Tl) detector. These data also yielded values for the resonance strengths based on a comparison with the known strength of the 0.642-MeV resonance in $^{31}P(p,\gamma)^{32}S$. The gamma-ray decay properties of these resonances were sorted out using spectra recorded with both the NaI(Tl) detector and Ge(Li) detector. In some cases coincidence measurements were performed. Gamma-ray angular distributions were also measured in this way and multipole mixing parameters were determined by comparison of the angular distributions with theory. The elastic proton scattering data were compared with theory after folding a resolution function with the theoretical results.

RESULTS AND DISCUSSION

The accumulated data enabled spin, parity and isospin values to be assigned to the 12.044- and 1.2050-MeV levels in ^{32}S. It also provided considerable insight into the structure of these levels. The information from this experiment is of very limited usefulness from the point of view of astrophysics because it addresses a relatively high energy region in the excitation of ^{32}S. However, it does provide some information on the nature of the $^{31}P(p,\gamma)^{32}S$ reaction to guide the calculations at lower energy.

V+74

TITLE

Electromagnetic Decay of the E_x = 6621 keV Level of ^{32}S

REFERENCE

J. Vernotte, J.M. Maison, C. Miehe, A. Chevallier, A. Huck, and G. Walter, “Nuclear Models in Theory and Experiment”, *Proceedings of the International Conference on Nuclear Structure and Spectroscopy*, Amsterdam, The Netherlands, September 9 - 13, 1974, Editors Harmen Blok and A.E.L. Dieperink, Gruner Press, Amsterdam, 79 (1974).

ABSTRACT

A new study of the electromagnetic decay of the E_x = 6221 keV (resonance) of ^{32}S, $J^\pi = 4^-$ has been undertaken for several reasons. First a new measurement of the mixing ratio δ(M2/E1) of the 6621 → 4459 keV transition, $4^- \rightarrow 4^+$, seemed necessary because a previous measurement [J. Vernotte *et al.*, *Nuclear Physics* **A212**, 493 (1973)] of this mixing ratio (δ = 0.23 ± 0.03) led to a surprisingly strong [P.M. Endt, University of Utrecht, The Netherlands, Private Communication] M2, $\Delta T = 0$, transition, 3.3 ± 1.2 W.u. (using the data of [P.M. Endt and C. Van der Leun, *Nuclear Physics* **A214**, 1 (1973)]): τ_m = 390 ± 80 fs; branching ratio of the 6621 → 4459 keV transition, 28 ± 5%). Second, it was interesting to measure the E2 and E3 strengths of the transitions decaying the E_x = 6621 keV level towards the E_x = 5006 and 2231 keV levels in order to test if the E_x = 6621 keV level could be a member of the quintuplet of odd-parity states which would result, in the framework of the vibrational model, from the coupling [P.R. Gardner *et al.*, *Australian Journal of Physics* **25**, 659 (1972)] of the one quadrupole phonon state (E_x = 2232 keV, $J^\pi = 2^+$) with the one octupole phonon state (E_x = 5006 keV, $J^\pi = 3^-$). The members of such a quintuplet must feed the E_x = 2231 and 5006 keV levels by E3 and E2 transitions the strengths of which would be comparable to the ones of the transitions decaying the E_x = 5006 and 2231 keV levels toward the ground state (23 ± 5 W.u. and 10 ± 1 W.u. respectively) [P.M. Endt and C. Van der Leun, *Atomic Data and Nuclear Data Tables* **13**, 67 (1974)].

The proton beam from the CRN Strasbourg-Cronenbourg 3-MV Van de Graaff accelerator has been used to populate the E_x = 6621 keV level through the two strong resonances of the $^{31}P(p,\gamma)^{32}S$ reaction at E_p = 1437 and 1581 keV, $J^\pi = 4^-$. The electromagnetic radiation was detected by a 69-cm^3 Ge(Li) diode located at 8 cm from the red phosphorus target evaporated onto a gold backing. A new value of the lifetime of the E_x = 6621 keV level, τ_m = 975 ± 200 fs, was deduced through the Doppler shift attenuation method from spectra taken at 0°, 90°, and 130°. Branching and mixing ratios deduced from γ-ray angular distribution measurements are presented in the table. The new values of the lifetime and of the branching and mixing ratios lead to a much weaker strength for the 6621 → 4459 keV M2 transition. The 6621 → 5006 keV E2 transition strength is quite comparable to the 2231 → 0 keV E2 transition one. However, the 6621 → 2231 keV E3 transition strength is weaker by an order of magnitude than the 5006 → 0 keV E3 transition one, in disagreement with the quadrupole-octupole coupling scheme predictions.

COMMENT

A summary was not prepared for this work. The available information is communicated in a short conference paper which is presented in its entirety above, except for a short table.

V+76

TITLE

Electromagnetic Properties of the 6621- and 7950-keV Levels in ^{32}S

REFERENCE

J. Vernotte, J.M. Maison, A. Chevallier, A. Huck, C. Miehe, and G. Walter, *Physical Review* **C13**, 984 - 993 (1976).

ABSTRACT

Lifetime and γ-ray angular distribution measurements have been carried out at the 1247-, 1399-, 1402-, 1437-, and 1581-keV resonances of the $^{31}P(p,\gamma)^{32}S$ reaction. Mean lifetime values have been measured for the 5006-, 5413-, 6224-, 6621-, and 7950-keV levels in ^{32}S and the spin and parity values for the 7950-keV level have been determined as $J^{\pi} = 4^{-}$. The strengths of some iso-scalar M2 transitions were measured. Electromagnetic features of the 6621-keV level are discussed in the framework of the vibrational model.

FACILITY

3-MV Van de Graaff accelerator, Centre de Recherches Nuclearires, Strasbourg-Cronenbourg, France.

EXPERIMENT

The objective of this experiment was to measure γ-ray branching ratios and angular distributions as well as lifetimes of the decaying levels in ^{32}S, using the Doppler-shift attenuation method (DSAM), for the 1247-, 1399-, 1402-, 1437- and 1581-keV resonances observed in the $^{31}P(p,\gamma)^{32}S$ reaction. The energy range of the measurements was E_p = 1.25 - 1.58 MeV.

MEASUREMENT PROCEDURES

Red phosphorus targets of 40, 60 and 90 μg/cm^2 were prepared by vacuum evaporation onto 0.2-mm thick gold backing. These targets were placed in an air-cooled chamber. The proton beam passed through a liquid-nitrogen-cooled trap to reduce carbon buildup on the targets. Gamma-ray spectra were measured using Ge(Li) detectors at various laboratory angles. A monitor detector was kept at 90° while other detectors were used for measurements at 0, 30, 45, and 90°. These detectors were calibrated using a ^{56}Co source, and the measurement system was checked for geometric anisotropy by observing the isotropic 844-keV gamma ray from the $^{27}Al(p,p_1\gamma)^{27}Al$ reaction at the 1683-keV resonance.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra from which relative full-energy peak intensities were determined for the various γ-transitions involved in the decay of the levels in ^{32}S corresponding to the above-mentioned resonances in the $^{31}P(p,\gamma)^{32}S$ reaction. The Doppler attenuation shift factors needed for lifetime determinations were deduced from data taken at 0, 30, 45, and 90° using targets that were thick enough to stop the recoiling ^{32}S atoms, namely, 60 and 90 $\mu g/cm^2$.

DATA ANALYSIS

Gamma-ray branching ratios were deduced directly from the measured full-energy peak intensities, as corrected for detector efficiency. The multipole mixing ratios, δ, were deduced by a least-squares comparison of measured angular distributions for individual γ-rays with those derived from theory.

RESULTS AND DISCUSSION

The authors discuss the properties of each of the excited levels of ^{32}S involved in this investigation in terms of the measured and predicted branching factors, angular distributions and excited-state lifetimes.

VF74a

TITLE

An Investigation of Excited States in ^{32}S by the $^{31}P(p,\gamma)^{32}S$ Reaction

REFERENCE

M. Viitassalo and I. Forsblom, *Report NP-20034*, Accelerator Laboratory, Department of Physics, University of Helsinki, Helsinki, Finland (1974).

ABSTRACT

The $^{31}P(p,\gamma)^{32}S$ reaction has been studied in the proton energy region 300 - 1420 keV using Ge(Li)-techniques. Gamma decay schemes of 16 resonances are proposed. The branching ratios of the resonance states and 23 bound states are presented. The spin of the E_x = 7116 keV level was found to be $J^\pi = 2^+$. In addition, the present results are compared with earlier ones.

FACILITY

3-MV Van de Graaff accelerator, Helsinki University, Helsinki, Finland.

EXPERIMENT

This investigation focused on the study of 16 resonances in the $^{31}P(p,\gamma)^{32}S$ reaction in the energy range E_p = 300 - 1420 keV. Three resonances, at E_p = 1146, 1151, and 1251 keV, were not re-investigated because they had been considered in earlier work [I. Forsblom *et al.*, *Soc. Fenn. Comm. Phys.-Math.* **40**, 1 (1970); V+73a]. As a consequence of the present work, the γ-decay of 23 bound states in ^{32}S is examined. Furthermore, new information is provided on level energies, branching ratios, and spins of bound states. These results are compared with other experiments reported in the literature.

MEASUREMENT PROCEDURES

Protons were accelerated with the Helsinki 3-MV Van de Graaff accelerator. Gamma-rays were detected with a 38-cm^3 co-axial Ge(Li) detector. The resolution of this detector was 4.2 keV FWHM at $E_\gamma = 2.61$ MeV. A second Ge(Li) detector of 58 cm^3 volume and resolution of 3.8 keV at $E_\gamma = 2.61$ MeV was also employed. These detectors possessed efficiencies of 5% and 10%, respectively, for 1.33-MeV ^{60}Co γ-ray full-energy-peak detection relative to a 3-inch-dia. x 3-inch-thick NaI(Tl) scintillation detector. Phosphorus targets were prepared by evaporating Zn_3P_2 onto 0.2 mm tantalum backings *in vacuo*.

The reaction Q value was determined by measurements on the E_p = 541, 811, and 888 keV resonances using the $E_p = 991.88 \pm 0.04$ keV resonance in $^{27}Al(p,\gamma)^{28}Si$ reaction as a standard [M.L. Roush *et al.*, *Nuclear Physics* **A147**, 235 (1970)]. This led to the following refined values of E_p for the resonance energies (with uncertainties): 541.4 ± 0.5, 811.4 ± 0.5, and 887.9 ± 0.5 keV. By summing the strong γ-ray cascades associated with these resonances, the value Q = +8865.1 ± 0.9 keV was deduced for the $^{31}P(p,\gamma)^{32}S$ reaction. Using this value, it was then possible to calculate the excitation energy of the resonance states in ^{32}S. The agreement with values reported in the literature [W.F. Coetzee *et al.*, *Nuclear Physics* **A185**, 644 (1972)] is good except for the E_p = 1053, 1087, and 1117 keV resonances where the present values are 2 - 3 keV lower.

Single spectra for the γ-ray intensity measurements were taken with the detector at 55° relative to the incident protons and a distances of 2 cm from the target to detector. Radioactive ^{56}Co and ^{208}Tl sources were used for Ge(Li) detector calibration. In order to check for the effects of Doppler-shift broadening, spectra were also recorded at 90°.

Gamma-ray angular distributions were measured for transitions that de-excite the E_p = 1400 keV resonance. No details are given about these measurements.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra recorded with Ge(Li) detectors.

DATA ANALYSIS

Few details are provided. The angular distribution data were fitted with an even-order Legendre polynomial expansion including terms up to P_4. A chi-square test was used to compare the measured distributions with those calculated from theory. This enabled selections to be made of spin , parity and multipole mixing ratios for several transitions.

RESULTS AND DISCUSSION

The relative intensities of the γ-rays that de-excite the resonance states in ^{32}S are summarized in Table 1 in the original report. Table 2 compares the resonance energies and branching ratios obtained in this work with other results from the literature. Comments on features of the decay of individual resonance are collected in the text.

The results of the angular-distribution measurements are summarized in Table 3 of the original report where values of coefficients (and their errors) for the Legendre-polynomial expansion fits to measured data are presented. This table also gives the accepted spin and parity values for several excited levels in ^{32}S as well as experimentally determined multipole mixing ratios. These results are discussed in further detail in the text of the original report.

VF74b

TITLE

An Investigation of Excited States in ^{32}S by the $^{31}P(p,\gamma)^{32}S$ Reaction

REFERENCE

M. Viitasalo and I. Forsblom, *Zeitschrift fuer Physik* **269**, 173 - 179 (1974).

ABSTRACT

The $^{31}P(p,\gamma)^{32}S$ reaction has been studied in the proton energy region 300 - 1420 keV using Ge(Li)-techniques. Gamma decay schemes of 16 resonances are proposed. The branching ratios of the resonance states and 23 bound states are presented. The spin of the E_x = 7116 keV level was found to be $J^\pi = 2^+$. In addition, the present results are compared with earlier ones.

COMMENT

The content of this journal paper is essentially identical to the earlier report discussed above [VF74a]. Consequently, the information is not repeated here.

ZL86

TITLE

Strong M2 Transitions

REFERENCE

F. Zijderhand and C. Van der Leun, *Nuclear Physics* **A460**, 181 - 200 (1986).

ABSTRACT

The recommended upper limit (RUL) for isospin-allowed M2 γ-ray transition strengths is largely determined by the strongest observed M2 transitions. In order to check this M2 RUL the strengths of the five strongest reported primary M2 transitions have been remeasured via (p,γ) reactions. The results are:

^{14}N,	$E_x = 8.91 \rightarrow 0$ MeV:	2.2 ± 0.3 W.u.
^{16}O,	$E_x = 12.97 \rightarrow 0$ MeV:	1.0 ± 0.3 W.u.
^{16}O,	$E_x = 12.53 \rightarrow 0$ MeV:	1.12 ± 0.17 W.u.

^{21}Na, $E_x = 2.80 \rightarrow 0.33$ MeV: < 0.4W.u.
^{32}S, $E_x = 10.08 \rightarrow 0$ MeV: 0.93 ± 0.13 W.u.

Although all but one of these new M2 strengths are lower than the previously reported values, the M2 RUL of 3 W.u. for nuclei with A = 6 - 44 cannot be reduced due to the strong transition in ^{14}N.

FACILITY

3-MV Van de Graaff accelerator, Fysisch Laboratorium, Rijksuniversiteit Utrecht, Utrecht, The Netherlands.

EXPERIMENT

The investigation described in this paper focused on the strength of five primary M2 transitions from proton-capture resonance levels, as indicated in Table 1 of the original paper. One of these pertained to ^{32}S, namely, the decay by a 10.08-MeV $2^- \rightarrow 0^+$ γ-ray transition from the 10.08-MeV unbound state. The present summary emphasizes those aspects of the experiment dealing with ^{32}S.

MEASUREMENT PROCEDURES

Proton beams were obtained from the Utrecht 3-MeV Van de Graaff accelerator. A 90° analyzing magnet with stabilizing slits generated a proton-energy resolution $\Delta E_p \approx 200$ eV at $E_p = 1$ MeV. The beam currents used ranged from 5 to 150 μA on target, selected on the basis of required stability and count-rate issues. A liquid-nitrogen cooling trap was positioned in front of the target to reduce contamination problems. The beam spot on target was normally less than 2 mm x 2 mm. To reduce local heating and thus deterioration, the targets were directly water cooled and, in most cases, the proton beam was wobbled up and down over a range of 10 mm. Targets were replaced whenever the sought-after γ-ray yield was observed to decrease by about 30%.

Targets for the $^{31}P(p,\gamma)^{32}S$ measurements were prepared by sputtering 10 to 20 $\mu g/cm^2$ of 99.99% pure phosphorus onto 0.5-mm-thick copper backings. These backings had better head conductivity than the tantalum backing which were generally used in this investigation. This tended to reduce the deterioration of the phosphorus targets under bombardment with high proton beam currents. The tradeoff was the need to accept a higher γ-ray background.

The γ-ray measurements were performed using one hyper-pure n-type Ge detector and four Ge(Li) detectors. The active volumes were about 100 cm^3 and the γ-ray energy resolutions were in the range 1.8 to 2.1 keV at $E_\gamma = 1.33$ MeV. The γ-ray efficiency curves of these detectors for the range $E_\gamma = 0.2$ - 13 MeV were measured using the radioactive sources ^{56}Co, ^{110m}Ag, ^{133}Ba, ^{152}Eu, and ^{226}Ra, as well as proton capture resonances at $E_p = 767$ and 1317 keV in $^{27}Al(p,\gamma)^{28}Si$, at $E_p = 1020$, 1317, and 1417 keV in $^{23}Na(p,\gamma)^{24}Mg$, and at $E_p = 675$ and 1388 keV in $^{11}B(p,\gamma)^{12}C$. Lead absorbers of 5-mm thickness were positioned in front of the detectors to reduce the number of low-energy γ-rays and hence the counting rate. Corrections for absorption by lead were calculated and used to provide corrected efficiency curves. The detectors was placed at 55° relative to the incident proton beam. There was 4 cm distance between detector and target.

The intensities of M2 transitions examined in this experiment were weak compared to those of the competing primary transitions of lower multi-polarity for the (p,γ) resonances. Therefore, special attention was given to the measurement of γ-ray branching ratios. The spins and parities of the levels involved in this investigation were assumed to be well known.

The general experimental procedure was as follows: A yield curve was measured over the resonance with steps of about 0.5 keV in the vicinity of E_p = 1251 keV, in the case of the ^{31}P studies. At each proton energy, a spectrum was recorded and analyzed off-line for each relevant peak in the spectrum. Possible differences in these yield curves provided a way to check for a possible multiplet of states at the observed resonance, as described in the literature [G.J.L. Nooren and C. Van der Leun, *Nuclear Physics* **A423**, 197 (1984)]. However, in the case of ^{31}P, no evidence for a doublet was found. Measurements were made both on-resonance and off-resonance with good statistics. For ^{31}P, this amounted to a measurement at E_p = 1251 keV (on-resonance) and E_p = 1234 keV (off-resonance). For all the observed $^{31}P(p,\gamma)^{32}S$ transitions it was found that the off-resonance yield was less than 1% of the on-resonance yield. The γ-ray width Γ_γ was deduced from the resonance strength $S = (2J+1)\Gamma_p\Gamma_\gamma/\Gamma$, where J is the resonance spin, Γ_p is the proton width and Γ is the total width. All widths are in the center-of-mass system.

DATA ACQUIRED

The data acquired consisted of γ-ray spectra recorded with an intrinsic Ge detector or various Ge(Li) detectors. The yields of individual transitions were derived from these spectra. Measurements were made both on and off the resonances studied, as indicated above.

DATA ANALYSIS

The on-resonance γ-ray yield was corrected for the off-resonance contribution before determining the branching ratio of the M2 transition studied. Corrections were made for dead time effects, random and coincidence summing, and target quality. Random summing effects were monitored by using a pulse generator. Most of these corrections were kept smaller than 10% by judicious choice of proton beam current and geometry factors. The effects of coincidence summing were estimated to be smaller than 5%.

RESULTS AND DISCUSSION

The γ-ray decay branching ratios for the resonance at E_p = 1251 keV in the reaction $^{31}P(p,\gamma)^{32}S$ are given in Table 7 of the original paper. The strength of this resonance was determined relative to that of the resonance at E_p = 811 keV using the value $S(811) = 1.00 \pm 0.08$ eV obtained from the literature [B.M. Paine and D.G. Sargood, *Nuclear Physics* **A331**, 389 (1979)]. This led to the result $S(1251) = 4.3 \pm 0.5$ eV. Since the total width given in the literature is $\Gamma = 1.6 \pm 0.2$ keV [P.M. Endt and C. van de Leun, *Nuclear Physics* **A310**, 1, (1978)], this implies that $\Gamma_p \gg \Gamma_\gamma$. The measured strength therefore leads to $\Gamma_\gamma = 0.86 \pm 0.11$ eV and thus $\Gamma_{\gamma 0} = 1.5 \pm 0.2$ meV, since the ground-state transition branching ratio is (1.7 ± 0.1)% from the present experiment. This ground-state transition width is equivalent to an M2 strength SM2(10.08 → 0) = 0.93 ± 0.13 W.u. This compares well with results published earlier.

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3. Resonance Properties and Concluding Remarks

Most of the relevant numerical information provided in the references assembled for the present compilation can be categorized as follows: i) resonance energies and strengths for the $^{31}P(p,\gamma)^{32}S$ reaction; ii) properties of levels in the compound nucleus ^{32}S; iii) features of γ-ray transitions associated with the decay of excited levels in ^{32}S (in some cases only those transitions involving γ-rays that populate the ^{32}S ground state, γ_0, are considered); iv) data of an engineering nature which can be used in applications of the $^{31}P(p,\gamma)^{32}S$ reaction for the assay of phosphorus in materials.

In astrophysics, the main concern is the determination of reaction rates for typical stellar environments in which there exist Maxwellian distributions of reactant energies. The present investigation deals mainly with statistical reaction processes that proceed through resonances in the compound nucleus ^{32}S. At lower excitation energies, these resonances are predominantly isolated ones, even though the density of levels is relatively large in this nucleus. Somewhat higher in excitation (above a few MeV incident proton energy) - where the ^{32}S levels are largely unresolved and their average width exceeds the average level spacing ($\Gamma/D \geq 1$) - it is necessary to abandon the consideration of discrete levels and resort to a level-density formalism and statistical-model (Hauser-Feshbach) analysis. Since the density of levels in ^{32}S is reasonably high in the energy domain of main interest for astrophysics, the contribution from direct processes to the total reaction rate is expected to be fairly small. This is the case since proton-reaction yields in most stellar environments, even the very hot ones encountered in novae and supernovae, tend to be affected by the cross sections for proton energies below a few MeV, corresponding to a region of excitation in ^{32}S dominated by the isolated resonances. Even in the case of the $^{32}S(p,\gamma)^{33}Cl$ reaction, where the level density for ^{33}Cl is smaller than for ^{32}S at excitation energies encountered in astrophysical environments, it has been found that direct processes are essentially negligible except in the narrow stellar temperature window $T_9 = 0.12$ to 0.16 [MS97]. However, at very high excitations (incident proton energies of 10 MeV or higher) the direct reaction mechanism plays a more important role and the reaction-yield excitation functions are found to exhibit prominent fluctuations, known as Ericson fluctuations, that must be dealt with using yet another approach. So, while the issue of direct-reaction contributions is not a critical one for astrophysics, it cannot be ignored entirely. It can be investigated according to procedures mentioned by Rolfs and Rodney [RR88].

Because knowledge of the discrete-resonance energies and strengths is so important for astrophysical applications, values of these parameters acquired from the present review of the literature are assembled in Table 2. The emphasis is on those resonances that correspond to formation of the compound nucleus ^{32}S by p + ^{31}P and that possess significant γ-decay strength. However, the tabulation of resonances in ^{32}S is not limited exclusively to those cases. Table 2 lists discrete resonance energies (E_p and E_x), widths (Γ, Γ_p, and Γ_γ) and strengths S_γ (see definition in Section 1), where available. Here, Γ_γ and $S_{p\gamma}$ correspond to total γ-ray emission associated with the $^{31}P(p,\gamma)^{32}S$ reaction, unless indicated otherwise. In the literature, widths and strengths for γ_0 are sometimes given separately and have to be related to the total γ-decay width and strength through complete knowledge of the decay branching factors. Uncertainties in the resonance energies and the resonance strengths are provided whenever possible because these uncertainties propagate directly to the computed reaction rates through a well-known formula that is frequently used for analyses of resonance phenomena in stellar environments (*e.g.*, see Rolfs and Rodney [RR88]).

The information compiled in Table 2 was extracted from specific references that were mentioned in Section 2 as well as from the Evaluated Nuclear Structure Data File [ENSDF].

The reference codes corresponding to these contributions (most of these were also mentioned in Table 1) are used to identify the information collected in this table.

Table 2: ^{32}S Discrete Resonant State Energies, Spin/Parity, Widths and γ-Decay Strength

Ref. Code	$E_p{}^a$ (keV)	$E_x{}^b$ (keV)	$J^{\pi\ c}$	Γ^d (eV)	$\Gamma_p{}^e$ (eV)	$\Gamma_\gamma{}^f$ (eV)	$S_{p\gamma}{}^g$ (eV)
B+97	1278.2	10102.4±1.0	$4^{(+)}$				
B+97	1696.9	10507.9±1.0	2^+				
B+97	1765.5	10574.4±1.0	5^+				
B+97	1829.5	10636.4±1.0	(3 - 5)				
B+97	1900.7	10705.3±1.0	(3 - 5)				
B+97	1953.7	10756.7±1.0	3^+				6.4(±30%)
B+97	1976.6	10778.8±1.0	2^+				6.7(±30%)
B+97	1981.7	10783.8±1.0	1^+				9.3(±30%)
B+97	1982.5	10784.5±1.0	0^+				0.64(±30%)
B+97	1989.5	10791.3±1.0	2^+				
B+97	2024.7	10825.4±1.0	2^+				11.2(±30%)
B+97	2136.5	10933.7±1.0	3^+				6.2(±30%)
B+97	2215.2	11009.9±1.0	4^+				5.4(±30%)
B+97	2300.2	11092.3±1.0	3^-				4.9(±30%)
B+97	2331	11123±1	1^+				10.9(±30%)
B+97	2349.3	11139.8±1.0	1^+				27(±30%)
B+97	2448.1	11235.5±1.0	3^+				3.8(±30%)
B+97	2467.1	11253.9±1.0	3^+				4.4(±30%)
B+97	2548.5	11332.8±1.0	2^+				
B+97	2695.0	11474.6±1.0	3^+				15.2(±30%)
B+97	2706.5	11485.8±1.0	2^+				
B+97	2813.8	11589.7±1.0	2^+				3.1(±30%)
B+97	2826.9	11602.4±1.0	2^+				
B+97	2862.8	11637.1±1.0	1^+				15.1(±30%)
B+97	2896.3	11669.6±1.0	5^+				6.1(±30%)
B+97	2924.3	11696.7±1.0	5^+				2.5(±30%)
B+97	2988.4	11758.8±1.0	4^-				5.5(±30%)
B+97	3175.6	11940.1±1.0	3^-				3.8(±30%)
B+97	3282.8	12043.9±1.0	4^-				
BS75	439	9289 [h]	1^+				
BS75	541	9388 [h]	2^-				
BS75	642	9486 [h]	1^-				
BS75	811	9649 [h]	2^+				
BS75	821	9659 [h]	1				
BS75	874	9710 [h]	2^+				
BS75	888	9724 [h]	$2^-,3,4^-$				
BS75	895	9731 [h]	$1^-,2^+$				
BS75	984	9817 [h]	$2^+,3^-$				
BS75	1016	9848 [h]	1^-				
BS75	1057	9888 [h]	1,2				
BS75	1090	9920 [h]	1,2,3,4				
BS75	1121	9950 [h]	1^-				
BS75	1151	9979 [h]	3^-				

Ref. Code	E_p [a] (keV)	E_x [b] (keV)	J^{π} [c]	Γ [d] (eV)	Γ_p [e] (eV)	Γ_γ [f] (eV)	$S_{p\gamma}$ [g] (eV)
BS75	1155	9983 [h]	2^+				
BS75	1251	10076 [h]	2^-				
BS75	1400	10220 [h]	2^+				
BS75	1403	10223 [h]	3^-				
BS75	1411	10231 [h]	2^+				
BS75	1438	10257 [h]	4^-				
BS75	1473	10291 [h]	2^+				
BS75	1515	10331 [h]	1^-				
BS75	1557	10372 [h]	2^+				
BS75	1583	10397 [h]	$4^{(-)}$				
BS75	1699	10509 [h]	$1^\pm,2^\pm,3^-$				
CMR72	354.8±0.4 [i]	9208 [h]					0.003(±30%)
CMR72	439.4±0.5 [i]	9290 [h]					0.25(±30%)
CMR72	541.4±0.6 [i]	9388 [h]					1.0(±30%)
CMR72	618.9±1.0 [i]	9463 [h]					0.06 (±30%)
CMR72	642.4±0.7 [i]	9486 [h]					0.52±0.08 [j]
CMR72	811.3±0.5 [i]	9650 [h]					2.2(±30%)
CMR72	821.0±1.0 [i]	9659 [h]					0.43(±30%)
CMR72	874.3±0.5 [i]	9711 [h]					0.29(±30%)
CMR72	887.8±0.5 [i]	9724 [h]					0.18(±30%)
CMR72	894.5±0.5 [i]	9730 [h]					0.7(±30%)
CMR72	983.8±1.0	9817 [h]					0.18(±30%)
CMR72	1056.5±0.6	9887 [h]					1.1(±30%)
CMR72	1089.6±0.6	9919 [h]					0.38(±30%)
CMR72	1120.7±0.6	9949 [h]					3.0(±30%)
CMR72	1150.5±0.6	9978 [h]					3.9(±30%)
CMR72	1155.1±0.6	9983 [h]					1.5(±30%)
CMR72	1251.4±0.6	10076 [h]					11(±30%)
CMR72	1400.1±0.6	10220 [h]					1.3(±30%)
CMR72	1402.9±0.8	10223 [h]					5.0(±30%)
CMR72	1411.4±0.6	10231 [h]					2.0(±30%)
CMR72	1438.3±0.7	10257 [h]					11(±30%)
CMR72	1473.1±0.6	10291 [h]					2.4(±30%)
CMR72	1556.6±0.6	10372 [h]					9(±30%)
CMR72	1582.9±0.6	10397 [h]					8(±30%)
CMR72	1698.9±1.0	10509 [h]					0.9(±30%)
CMR72	1746.9±1.0	10556 [h]					2.9(±30%)
CMR72	1764.2±1.0	10573 [h]					0.9(±30%)
CMR72	1796.1±1.0	10603 [h]					1.1(±30%)
CMR72	1891.5±1.0	10696 [h]					2.2(±30%)
CMR72	1896.0±1.0	10700 [h]					2.5(±30%)
CMR72	1954.0±1.0	10756 [h]					7(±30%)
CMR72	1977.1±1.0	10779 [h]					3.9(±30%)
CMR72	1983.6±1.0	10785 [h]					8(±30%)
CMR72	1990.0±1.0	10791 [h]					5.3(±30%)
CMR72	2026.6±1.0	10827 [h]					15(±30%)
E90	354.8±0.4	9208.1±0.7	$(1,2^+)$	0.36±0.11			0.01
E90	439.4±0.5	9290.1±0.8	$(1,2^+)$				0.11

Ref. Code	E_p [a] (keV)	E_x [b] (keV)	J^{π} [c]	Γ [d] (eV)	Γ_p [e] (eV)	Γ_γ [f] (eV)	$S_{p\gamma}$ [g] (eV)
E90	541.4±0.6	9388.9±0.8	2^-				0.45
E90	618.9±1.0	9463.9±1.2	2^+				0.03
E90	642.4±0.7	9486.7±0.9	1^-	8.2±2.5			0.24±0.04
E90	811.3±0.5	9650.3±0.8	$(1^+$-$3^+)$				1.00±0.15
E90	821.0±1.0	9659.6±1.2	$(1,2^+)$	2.4±0.7			0.20
E90	874.3±0.5	9711.3±0.8	$(1^-,2^+)$	3.6			0.13
E90	887.8±0.5	9724.3±0.8	$(3,4)^-$				0.08
E90	894.5±0.5	9730.8±0.8	$(1^-,2^+)$				0.32
E90	983.8±1.0	9817.3±1.2	$(2^+,3^-)$				0.08
E90	994±3	9827±3					
E90	1016±3	9849±3	1^-	100±10			0.03
E90	1056.5±0.6	9887.7±0.8	$(1,2)^+$	10±5			0.50
E90	1089.6±0.6	9919.8±0.8	$(2,3)^+$	10±5			0.17
E90	1120.7±0.6	9949.9±0.8	1^-	150±15			1.4
E90	1150.0±0.7	9978.3±0.9	4^-				0.11±0.03
E90	1150.5±0.7	9978.8±0.9	3^+				1.0±0.2
E90	1155.1±0.6	9983.2±0.8	0^+	100±10			0.68
E90	1251.4±0.6	10076.5±0.8	2^-	1500±150			4.3±0.5
E90	1279.9±0.8	10104.1±1.0	$(2^+$-$4^+)$				0.11
E90	1400.1±0.6	10220.5±0.8	3^+	10±5			0.59
E90	1402.9±0.8	10223.2±1.0	3^-	56±10			2.3
E90	1406.0±1.5	10226.2±1.6	1^-	180±20			
E90	1411.4±0.6	10231.5±0.8	1^+	25±3			0.91
E90	1438.3±0.7	10257.5±0.9	4^-	35±4			5.0
E90	1470.0±1.5	10288.2±1.6	3^-	160±20			0.07
E90	1473.1±0.6	10291.2±0.8	2^-	125±13			1.1
E90	1475.3±1.5	10293.3±1.6	2^+	70±10			0.17
E90	1515.8±1.5	10332.5±1.6	1^-	6100±700			
E90	1556.6±0.6	10372.1±0.8	2^+	25±3			4.1
E90	1582.9±0.6	10397.6±0.8	4^-	12±2			3.6
E90	1587.0±1.5	10401.6±1.6	0^-	7000±700			
E90	1643±3	10456±3	0^+	1700±200			
E90	1698.9±1.0	10509.9±1.2	2^+	10±5			0.41
E90	1717±3	10527±3	2^+	80±10			
E90	1740±4	10550±4		8000			
E90	1764.2±1.0	10573.1±1.2	$(2^+$-$4^+)$	15±2			0.41
E90	1796.1±1.0	10604.0±1.2	1^-	150±20			0.50
E90	1818±3	10626±3	3^-	660±70			
E90	1891.5±1.0	10696.4±1.2	2^+	180±20			1.0
E90	1896.0±1.0	10700.8±1.2	1^-	21000±4000			1.1
E90	1954.0±1.0	10757.0±1.2	2^+	50±10			3.2
E90	1967±3	10769±3	2^-	5100±500			
E90	1977.1±1.0	10779.3±1.2	2^+	620±70			1.8
E90	1983.6±1.0	10785.6±1.2	1^+	750±80			3.6
E90	1985.2±1.0	10787.2±1.2	0^+	600±60			
E90	1990.9±1.0	10792.7±1.2	2^+	170±20			2.4
E90	2025.3±1.0	10826.0±1.2	1^-	22000±4000			
E90	2026.6±1.0	10827.3±1.2	2^+	320±30			6.8
E90	2118±3	10916±3	1^-	1600±200			
E90	2136±3	10933±3	2^+	48±5			

Ref. Code	E_p [a] (keV)	E_x [b] (keV)	J^{π} [c]	Γ [d] (eV)	Γ_p [e] (eV)	Γ_γ [f] (eV)	$S_{p\gamma}$ [g] (eV)
E90	2181±3	10977±3	2^-	6700±700			
E90	2258±3	11051±3	2^+	4200±400			
E90	2291±3	11083±3	2^+	85±9			
E90	2300±3	11092±3	3^-	70±7			
E90	2332±3	11123±3	1^+	6400±700			
E90	2350±3	11140±3	1^+	2600±300			
E90	2408±3	11197±3	3^-	80±10			
E90	2437±3	11225±3	1^-	190±20			
E90	2443±3	11231±3	3^-	800±100			
E90	2447±3	11234±3	1^-	7900±800			
E90	2450±3	11237±3	2^+	50±10			
E90	2468±3	11255±3	2^+	210±20			
E90	2549±3	11333±3	2^+	150±20			
E90	2659±3	11440±3	2^-	350±40			
E90	2666±3	11447±3	1^-	5300±600			
E90	2696±3	11476±3	3^+	230±30			
E90	2707±3	11487±3	2^+	500±50			
E90	2729±3	11508±3	$2^-(1^-)$	33000±6000			
E90	2780±3	11557±3	3^-	50±10			
E90	2808±3	11584±3	0^+	3100±300			
E90	2811±3	11587±3	1^-	1600±1600			
E90	2812±3	11588±3	2^+	160±20			
E90	2829±3	11604±3	2^+	810±80			
E90	2830±3	11605±3	$(1,2)^-$	7000±700			
E90	2832±3	11607±3	0^+	310±30			
E90	2834±3	11609±3	1^-	19000±4000			
E90	2848±3	11623±3	1^+	5500±600			
E90	2850±3	11625±3	3^-	60±10			
E90	2855±3	11630±3	1^-	27000±5000			
E90	2862±3	11636±3	1^-	1900±200			
E90	2865±3	11639±3	1^+	800±80			
E90	2906±3	11679±3	2^+	2600±300			
E90	2950±3	11722±3	2^+	2800±300			
E90	2964±3	11735±3	1^-	24000±3000			
E90	2978±3	11749±3	1^+	900±90			
E90	2988±3	11758±3	3^-	140±20			
E90	3014±3	11784±3	3^-	30±10			
E90	3034±3	11803±3	3^+	120±10			
E90	3036±3	11805±3	3^-	2000±400			
E90	3038±3	11807±3	1^-	37000±7000			
E90	3050±3	11818±3	2^-	19000±4000			
E90	3064±3	11832±3	2^+	140±20			
E90	3098±3	11865±3	2^-	8200±900			
E90	3102±3	11869±3	0^+	1100±100			
E90	3133±3	11879±3	3^-	3600±700			
E90	3136±3	11902±3	3^-	2400±500			
E90	3145±3	11910±3	1^-	6300±700			
E90	3165±3	11930±3	0^+	100±20			
E90	3169±3	11934±3	$3^-(2^-)$	15±2			
E90	3171±3	11936±3	3^-	1450±150			

Ref. Code	E_p [a] (keV)	E_x [b] (keV)	J^{π} [c]	Γ [d] (eV)	Γ_p [e] (eV)	Γ_γ [f] (eV)	$S_{p\gamma}$ [g] (eV)
E90	3172±3	11937±3	$2^+(1^+)$	110±20			
E90	3184±3	11948±3	1^+	2500±300			
E90	3191±3	11955±3	3^-	80±20			
E90	3196±3	11960±3	2^-	8600±1700			
E90	3217±3	11980±3	$3^+(2^+)$	410±40			
E90	3228±3	11991±3	1^-	32000±6000			
E90	3238±3	12000±3	2^+	2000±200			
E90	3252±3	12014±3	2^+	9000±900			
E90	3260±3	12022±3	2^+	2600±300			
E90	3276±3	12037±3	4^-	400±40			
E90	3289±3	12050±3	0^+	< 230			2.4±5
E90	3365±3	12123±3	1^-	50000±10000			
E90	3385±3	12143±3	3^-	3200±300			
E90	3389±3	12147±3	2^+	13000±3000			
E90	3394±3	12152±3	3^+	330±30			
E90	3396±3	12154±3	3^-	4300±400			
E90	3426±3	12183±3	1^+	3500±400			
E90	3428±3	12185±3	1^-	10500±1100			
E90	3439±3	12195±3	1^-	5500±1100			
E90	3471±3	12226±3	3^+	200±20			
E90	3488±3	12243±3	1^-	340±30			
E90	3518±3	12272±3	3^-	300±60			
E90	3543±3	12296±3	1^-	15000±2000			
E90	3545±3	12298±3	2^+	320±30			
E90	3584±3	12336±3	1^-	2800±300			
E90	3588±3	12339±3	$1^-(2^-)$	23000±5000			
E90	3620±3	12370±3	3^-	180±20			
E90	3632±3	12382±3	2^+	1050±110			
E90	3639±3	12389±3	2^+	1800±400			
E90	3640±3	12390±3	1^-	4200±400			
E90	3649±3	12399±3	$2^+(0^+)$	350±40			
E90	3672±3	12421±3	3^-	2800±300			
E90	(3672±3)	(12421±3)	3^-	60±10			
E90	3680±3	12429±3		≈ 15000			
E90	3709±3	12457±3	3^-	3200±600			
E90	3716±3	12463±3	1^-	4800±500			
E90	3725±3	12472±3	1^+	26000±5000			
E90	3726±3	12473±3	2^+	1400±140			
E90	3735±3	12482±3	3^-	350±40			
E90	3741±3	12488±3	$1^-(2^+)$	≈ 400			
ENSDF	164 [k]	9023±2	3^-				
ENSDF	202 [k]	9060±3	$(0 - 2)^-$				
ENSDF	208 [k]	9065±2	4^+				
ENSDF	283 [k]	9138±5					
ENSDF	316 [k]	9170±4					
ENSDF	343 [k]	9196±8	2^+				
ENSDF	355 [k]	9208.1±0.7	1^+	0.36±0.11			
ENSDF	384 [k]	9236±2	1^-				
ENSDF	404 [k]	9255±10	$(1 - 3)^+$				

Ref. Code	E_p [a] (keV)	E_x [b] (keV)	J^π [c]	Γ [d] (eV)	Γ_p [e] (eV)	Γ_γ [f] (eV)	$S_{p\gamma}$ [g] (eV)
ENSDF	440 [k]	9290.1±0.8	1^+				
ENSDF	542 [k]	9388.9±0.8	2^-				
ENSDF	619 [k]	9463.8±1.5	$(3^- - 7^-)$				
ENSDF	619 [k]	9463.9±1.2	2^+				
ENSDF	643 [k]	9486.7±0.9	1^-	8.2±2.5			
ENSDF	716 [k]	9557±10					
ENSDF	798 [k]	9636.4±1.5	$(2^- - 6^-)$				
ENSDF	812 [k]	9650.3±0.8	2^+				
ENSDF	821 [k]	9659.6±1.2	1^+	2.4±0.7			
ENSDF	875 [k]	9711.5±0.7	2^+	3.6			
ENSDF	888 [k]	9724.3±0.8	$(3,4)^-$				
ENSDF	895 [k]	9730.8±0.8	1^-				
ENSDF	951 [k]	9785±5					
ENSDF	984 [k]	9817.3±1.2	3^-				
ENSDF	994 [k]	9827±3					
ENSDF	1017 [k]	9849±3	1^-	100±10			
ENSDF	1057 [k]	9887.7±0.8	1^+	10±5			
ENSDF	1090 [k]	9919.8±0.8	2^+	10±5			
ENSDF	1121 [k]	9949.9±0.8	1^-	150±15			
ENSDF	1151 [k]	9978.3±0.9	4^-				
ENSDF	1151 [k]	9978.8±0.9	3^+				
ENSDF	1156 [k]	9983.2±0.8	0^+	100±10			
ENSDF	1195 [k]	10021±10	$(2 - 4)^-$				
ENSDF	1252 [k]	10076.5±0.8	2^-	1500±150			
ENSDF	1280 [k]	10104.1±1.0	$(2^+,3^-,4^+)$				
ENSDF	1401 [k]	10220.5±0.8	3^+	10±5			
ENSDF	1403 [k]	10223.2±1.0	3^-	56±10			
ENSDF	1407 [k]	10226.2±1.6	1^-	180±20			
ENSDF	1412 [k]	10231.5±0.8	1^+	25±3			
ENSDF	1439 [k]	10257.5±0.9	4^-	35±4			
ENSDF	1458 [k]	10276±8	4^+				
ENSDF	1471 [k]	10288.2±1.6	3^-	160±20			
ENSDF	1474 [k]	10291.2±0.8	2^-	125±13			
ENSDF	1476 [k]	10293.3±1.6	2^+	70±10			
ENSDF	1516 [k]	10332.5±1.6	1^-	6100±700			
ENSDF	1557 [k]	10372.1±0.8	2^+	25±3			
ENSDF	1584 [k]	10397.6±0.8	4^-	12±2			
ENSDF	1588 [k]	10401.6±1.6	0^-	7000±700			
ENSDF	1615 [k]	10428±10					
ENSDF	1645 [k]	10457±3	0^+	1700±200			
ENSDF	1699 [k]	10509.9±1.2	2^+	10±5			
ENSDF	1718 [k]	10528±3	2^+	80±10			
ENSDF	1741 [k]	10550±4		8000			
ENSDF	1765 [k]	10573.1±1.2	$(2^+ - 4^+)$	15±2			
ENSDF	1797 [k]	10604.0±1.2	1^-	150±20			
ENSDF	1819 [k]	10626±3	3^-	660±70			
ENSDF	1892 [k]	10696.4±1.2	2^+	180±20			
ENSDF	1897 [k]	10700.8±1.2	1^-	21000±4000			
ENSDF	1955 [k]	10757.0±1.2	2^+	50±10			
ENSDF	1967 [k]	10769±3	2^-	5100±500			

Ref. Code	E_p [a] (keV)	E_x [b] (keV)	J^{π} [c]	Γ [d] (eV)	Γ_p [e] (eV)	Γ_γ [f] (eV)	$S_{p\gamma}$ [g] (eV)
ENSDF	1978 [k]	10779.3±1.2	2^+	620±70			
ENSDF	1984 [k]	10785.6±1.2	1^+	750±80			
ENSDF	1986 [k]	10787.2±1.2	0^+	600±60			
ENSDF	1991 [k]	10792.7±1.2	2^+	170±20			
ENSDF	2026 [k]	10826.0±1.2	1^-	22000±4000			
ENSDF	2027 [k]	10827.3±1.2	2^+	320±30			
ENSDF	2119 [k]	10916±3	1-	1600±200			
ENSDF	2272 [k]	11064±5	$(0,2)^+$				
ENSDF	2301 [k]	11092±3	3-	70±7			
ENSDF	2350 [k]	11140±3	1^+	2600±300			
ENSDF	2409 [k]	11197±3	3^-	80±8			
ENSDF	2849 [k]	11623±3	1^+	5500±600			
ENSDF	3172 [k]	11936±3	3^-	1450±150			
ENSDF	3276 [k]	12037±3	4^-	400±40			
ENSDF	3290 [k]	12050±3	0^+	< 230			
EE66	642	9486 [h]					0.52±0.08
F+88	1250	10075	2^-		1500		
F+88	1403	10223	3^-		16		
F+88	1438	10257	4^-		35		
F+88	1583	10398	4^-		12		
F+88	1557	10368	2^+		25		
F+88	1989	10791	2^+		80		
F+88	2023	10824	2^+		170		
F+88	2181	10977	2^-		6600 (l = 1)		
					100 (l = 3)		
F+88	2022	10823	1-		19000		
F+88	2300	11092	3-		30		
G+70b	1399	10219	3				
G+70b	1410	10229	1				
G+70b	1437	10256	4				
G+74	895	9731 [h]					
G+74	1438	10257 [h]	4				
G+74	1583	10397 [h]	4				
H81	1150.0	9978.7	4^-				
H81	1150.5	9979.2	3^+				
HV70	1146	9974	2^+				
HV70	1151	9979	2^+				
I+91	163	9022 [h]	3^-		5.5×10^{-11}	0.016	2.24×10^{-10}
I+91	201	9059 [h]	$(0 - 2)^-$				1.12×10^{-5}
I+91	206	9064 [h]	4^+		7.0×10^{-11}	0.005	4.0×10^{-10}
I+91	316	9170 [h]	3^+				$\le 1.48\times10^{-4}$
I+91	342	9195 [h]	2^+				$\le 2.44\times 0^{-4}$
I+91	355±1	9208 [h]	1^+				$(1.68\pm0.28)\times10^{-2}$

Ref. Code	E_p [a] (keV)	E_x [b] (keV)	J^{π} [c]	Γ [d] (eV)	Γ_p [e] (eV)	Γ_γ [f] (eV)	$S_{p\gamma}$ [g] (eV)
I+91	383±2	9235 [h]	1^-				$(2.40\pm0.48)\times10^{-4}$
I+91	403±2	9254 [h]	2^+				$(1.80\pm0.28)\times10^{-3}$
I+91	439±1	9289 [h]	1^+				0.100±0.016
I+91	541±1	9388 [h]	2^-				0.48±0.08
I+91	619±1	9463 [h]	2^+				$(4.4\pm0.8)\times10^{-3}$
I+93	164	9023	3^-				$\leq 4.0\times10^{-10}$
I+93	200±2	9059±2	$(1,2)^-$				$(1.92\pm0.64)\times10^{-6}$
I+93	207	9065	4^+				$\leq 1.32\times10^{-8}$
I+93	315	9170	3^+				$\leq 1.48\times10^{-4}$
I+93	342	9196	2^+				$\leq 2.44\times10^{-4}$
I+93	355	9208	1^+				$(1.68\pm0.28)\times10^{-2}$
I+93	383	9236	1^-				$(2.40\pm0.48)\times10^{-4}$
I+93	403	9255	2^+				$(1.80\pm0.28)\times10^{-3}$
I+93	439	9290	1^+				0.100±0.016
I+93	541	9389	2^-				0.48±0.08
I+93	619	9464	2^+				$(4.4\pm0.8)\times10^{-3}$
K+74	1891±3	10698					
K+74	1975±2	10778					
K+74	2023±2	10826					
K+74	2118±2	10918					
K+74	2323±2	11117					
K+74	2341±2	11135					
K+77	1121	9950	1				
K+77	1151	9979	1				
K+77	1557	10372	2^+				
K+77	1953	10756	(2)				
K+98	164 [k]	9023	3^-				
K+98	165 [k]	9024	$6^-(4^-)$				
K+98	202 [k]	9060	$(1,2)^-$				
K+98	208 [k]	9065	4^+				
K+98	383 [k]	9235	2 - 5				
K+98	949 [k]	9783	$6^+(4^+)$				
L+72	1117 ±1	9947 ±2	1				1.7
L+72	1146 ±1	9975 ±2	$2^+,3$				5.4
L+72	1151 ±1	9980 ±2	2^+				1.3
L+72	1248 ±1	10074±2	2^-				9.2
L+72	1398 ±1	10219±2	$1^+,2^{(\pm)}$				1.8
L+72	1401 ±1	10222±2	3^-				5.8
L+72	1409 ±1	10230±2	$1^+,2^+$				1.5
L+72	1437 ±1	10257±2	4^-				20.0
L+72	1468 ±1	10287±2	3^-				Weak
L+72	1471 ±1	10290±2	2^+				2.4
L+72	1555 ±1	10371±2	$2^{(+)}$				11.0
L+72	1583 ±1	10398±2	3,4				15.2

Ref. Code	E_p [a] (keV)	E_x [b] (keV)	J^{π} [c]	Γ [d] (eV)	Γ_p [e] (eV)	Γ_γ [f] (eV)	$S_{p\gamma}$ [g] (eV)
O+75	355	9208 [h]		< 1000			0.017±0.002
O+75	439	9289 [h]		< 1000			0.13±0.02
O+75	541	9388 [h]		< 1000			0.51±0.06
O+75	620	9464 [h]		< 1000			0.006±0.004
O+75	642	9486 [h]		< 1000			0.25±0.03
O+75	811	9649 [h]		< 1000			1.06±0.11
O+75	821	9659 [h]		< 1000			0.23±0.04
O+75	874	9710 [h]		~ 1000			0.06±0.02
O+75	875±10	9713 [h]		95000±9500			0.045
O+75	888	9724 [h]		< 1000			0.034±0.017
O+75	895	9731 [h]		< 1000			0.31±0.07
O+75	984	9817 [h]		< 1000			0.091±0.014
O+75	994±3	9827 [h]		4000±800			< 0.3
O+75	995±10	9829 [h]		140000±14000			0.140
O+75	1016±3	9848 [h]		< 1000			0.031±0.009
O+75	1057	9888 [h]		< 1000			0.55±0.06
O+75	1090	9920 [h]		< 1000			0.19±0.06
O+75	1121	9950 [h]		< 1000			1.04 ±0.13
O+75	1150±10	9978 [h]		60000±6000			0.098
O+75	1151	9979 [h]		< 1000			1.85±0.22
O+75	1155	9983 [h]		< 1000			0.66±0.08
O+75	1250±10	10076 [h]		80000±8000			0.095
O+75	1251	10076 [h]		1500±800			4.6±0.6
O+75	1360±10	10183 [h]		60000±6000			0.178
O+75	1400	10220 [h]		< 1000			0.7±0.2
O+75	1403	10223 [h]		< 1000			2.0±0.6
O+75	1411	10231 [h]		< 1000			0.5±0.1
O+75	1438	10257 [h]		< 1000			4.8±0.6
O+75	1473	10291 [h]		< 1000			1.2±0.2
O+75	1515±3	10331 [h]		5800±1200			0.8±0.2
O+75	1557	10372 [h]		< 1000			4.2±0.5
O+75	1583	10397 [h]		< 1000			4.6±0.6
O+75	1699	10509 [h]		< 1000			0.70±0.15
P+55	816	9654 [h]					1.76 [m]
P+55	825	9663 [h]	$1^{\pm}$	0.12 [l]			0.36 [l]
P+55	1117	9946 [h]	$1^{\pm}$	0.63 [l]			1.88 [l]
P+55	1146	9974 [h]					2.16 [m]
P+55	1248	10073 [h]	$2^{\pm}$	0.048 [l]			0.24 [l]
				0.74 [m]			3.68 [m]
P+55	1892	10696 [h]	1^{-}	24000	≈ 24000		36.8 [l]
P+55	1985	10786 [h]	$1^{\pm}$	10000	≈ 10000		13.2 [l]
P+55	2027	10827 [h]	1^{-}	24000	≈ 24000		26 [l]
P+55	2120	10917 [h]	1^{-}	5000	≈ 5000		4.0 [l]
P+55	2320	11111 [h]	$1^{\pm}$	8000	≈ 8000		20 [l]
P+55	2340	11130 [h]	$1^{\pm}$	8000	≈ 8000		64 [l]
PKS78	811	9649 [h]					0.95±0.29
PS79	642	9486 [h]					0.22±0.02

Ref. Code	E_p [a] (keV)	E_x [b] (keV)	J^π [c]	Γ [d] (eV)	Γ_p [e] (eV)	Γ_γ [f] (eV)	$S_{p\gamma}$ [g] (eV)
PS79	811	9649 [h]					0.93±0.12
R+95	159 [n]	9023	3^-		1.38×10^{-11}(±40%)		$(5.6\pm3.2)\times10^{-11}$
R+95	194 [n]	9059	$(1,2)^-$				$(1.92\pm0.64)\times10^{-6}$
R+95	201 [n]	9065	4^+				$\leq 1.32\times10^{-8}$
R+95	305 [n]	9170	3^+				$\leq 1.48\times10^{-4}$
R+95	331 [n]	9196	2^+				$\leq 2.44\times10^{-4}$
R+95	344 [n]	9208	1^+		8.0×10^{-3}(±40%)		$(1.68\pm0.28)\times10^{-2}$
R+95	371 [n]	9236	1^-		6.67×10^{-3}(±40%)		$(2.40\pm0.48)\times10^{-4}$
R+95	390 [n]	9255	2^+		5.2×10^{-4}(±40%)		$(1.80\pm0.28)\times10^{-3}$
R+95	425 [n]	9290	1^+		9.33×10^{-2}(±40%)		0.100±0.016
R+95	524 [n]	9389	2^-		1.55(±40%)		0.48±0.08
R+95	600 [n]	9464	2^+				$(4.4\pm0.8)\times10^{-3}$
RDS77	384 [k]	9236±2	1^-		< 0.010	≈ 0.180±0.036	
RDS77	622 [k]	9466.0±1.5	2^+		0.034±0.008	0.242±0.052	
RDS77	642 [k]	9486±2	1^-		3.1±0.7	0.480±0.060	
RDS77	876 [k]	9712±2	2^+		≥ 0.058	0.183	
RDS77	1400 [k]	10220±2	3^-		20±4	1.8±0.3	4.3±0.9
RDS77	1467 [k]	10290±2	3^-		7.6±1.4	0.360±0.070	0.210±0.060
V+73a	1247.4±1.5	10072 [h]					11.8(±20%)
V+73a	1279.1±1.5	10103 [h]					0.25(±20%)
V+73a	1399.3±0.8	10219 [h]					1.3(±20%)
V+73a	1401.9±1.5	10222 [h]					3.8(±20%)
V+73a	1405.1±1.5	10225 [h]					0.25(±40%)
V+73a	1410.6±0.8	10230 [h]					1.0(±20%)
V+73a	1437.3±1.5	10256 [h]					8.3(±20%)
V+73a	1469.0±1.5	10287 [h]					0.15(±20%)
V+73a	1472.1±1.5	10290 [h]					1.5(±20%)
V+73a	1474.3±1.5	10292 [h]					0.38(±40%)
V+73a	1514.7±1.5	10331 [h]					2.2(±20%)
V+73a	1555.4±1.5	10370 [h]					8.7(±20%)
V+73a	1581.1±1.5	10395 [h]					7.9(±20%)
V+73a	1585.2±1.5	10399 [h]					
V+73b	3283 [k]	12044±4	4^-				7.0±1.4
V+73b	3290 [k]	12050±4	0^+				2.4±0.5
V+76	1247	10072	2^-				
V+76	1402	10222	3^-				
V+76	1437	10256	4^-				
V+76	1581	10395	4^-				
VF74a	355	9209±2	1				
VF74a	439	9290±2	1^+				
VF74a	541	9389±2	2^-				
VF74a	642	9487±2	1^-				
VF74a	811	9651±2	2^+				
VF74a	821	9660±2	1				

Ref. Code	E_p [a] (keV)	E_x [b] (keV)	J^{π} [c]	Γ [d] (eV)	Γ_p [e] (eV)	Γ_γ [f] (eV)	$S_{p\gamma}$ [g] (eV)
VF74a	888	9725±2	$2^-,3,4^-$				
VF74a	895	9732±2	$1^-,2^+$				
VF74a	983	9817±2	$2^+,3^-$				
VF74a	1016	9849±2					
VF74a	1053	9886±2	1,2				
VF74a	1087	9918±2					
VF74a	1117	9947±2	1				
VF74a	1400	10221±2	3^+				
VF74a	1402	10223±2	3^-				
VF74a	1410	10231±2	2^+				
VF74b	355	9209±2	1				
VF74b	439	9290±2	1^+				
VF74b	541	9389±2	2^-				
VF74b	642	9487±2	1^-				
VF74b	811	9651±2	2^+				
VF74b	821	9660±2	1				
VF74b	888	9725±2	$2^-,3,4^-$				
VF74b	895	9732±2	$1^-,2^+$				
VF74b	983	9817±2	$2^+,3^-$				
VF74b	1016	9849±2	$1^{(-)},2^+$				
VF74b	1053	9886±2	1,2				
VF74b	1087	9918±2					
VF74b	1117	9947±2	1				
VF74b	1400	10221±2	3^+				
VF74b	1402	10223±2	3^-				
VF74b	1410	10231±2	2^+				

[a] Incident proton energy for the p + ^{31}P resonance (given in Laboratory coordinate system unless otherwise indicated).

[b] Excitation energy for the resonance state in the compound nucleus ^{32}S.

[c] Spin/parity of the resonance in ^{32}S. When more than one possibility is allowed by the available information, this is indicated.

[d] Total width of the compound-nuclear state in ^{32}S.

[e] Proton width of the compound-nuclear state in ^{32}S.

[f] Width for decay of the compound-nuclear state in ^{32}S by γ-ray emission. Unless indicated otherwise, this is assumed to be the total width for this process, inclusive of all γ-ray branches.

[g] Strength of decay of the compound-nuclear state in ^{32}S by γ-ray emission. Unless indicated otherwise, this is assumed to be the total γ-decay strength for this process. As indicated in Section 1 of the text, the strength is defined here as $S_{p\gamma} = (2J+1)\Gamma_p\Gamma_\gamma/\Gamma$.

[h] E_x is not given in reference so it is calculated to the nearest 1 keV from given E_p using Eq. (1) in the text of this report.

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[k] E_p is not given in reference so it is calculated to the nearest 1 keV from given E_x using Eq. (1) in the text of this report.

[l] Value corresponds only to the ground-state transition γ_0.

[m] Value corresponds only to the first-excited-state transition γ_1.

[n] Value given in Center of Mass coordinate system.

Acknowledgments

The authors are indebted to Prof. Michael C. Wiescher, Department of Physics, University of Notre Dame, for suggesting this research project and for his thoughtful guidance during the course of this work. Comments received from Laura Van Wormer, Physics Department, Hiram College, and Michael S. Smith, Physics Division, Oak Ridge National Laboratory, are also gratefully acknowledged. One of the authors (JTD) received financial support for his stay at Argonne National Laboratory during the Summer of 1996 through the Student Research Participation Program administered by the Division of Educational Programs. This work was supported by the U.S. Department of Energy, Office of Science Programs, under Contract W-31-109-Eng-38.

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The ^{31}P(p,gamma)^{32}S Reaction in the Proton Energy Range 2000-2400 keV
Nuclear Reactions:
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1970GaZZ
REPT 1970 Ann Rept IPN(Paris) P14
Nuclear Reactions:
^{31}P(p,gamma), (p,p), (p,alpha), E=1.4-1.6 MeV; measured sigma(E;Egamma,theta(gammagamma)). ^{32}S deduced resonances, level-width, J.

1970Vi04
Comment.Phys.-Math. 40, 149 (1970)
M.Viitasalo, I.Forsblom
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1971GaZL
JOUR JPQCA C5b-233, 2/14/72
Nuclear Reactions:
^{31}P(p,gamma), E approx 3.289 MeV; measured sigma(E;Egamma,theta(gammagamma)). ^{32}S deduced resonance, level-width, J, pi, t.

1971SiYH
REPT QNP-71-4, Queen'S Univ, Ontario, B P Singh, 4/27/72
Radioactivity:
^{147}Pm level deduced T½.

1972CaZO
JOUR PHCAA 28 27, No4, J E Cairns, 6/19/72
Nuclear Reactions:
^{31}P(p,gamma), E=0.8-2.0 MeV; measured gamma-linear polarization, sigma(E;Egamma). ^{32}S deduced levels, J, pi, gamma-branching.

1972KaYJ

REPT INDC(CCP)-31/U P3
Nuclear Reactions:
^{31}P(p,gamma), E=2.114 MeV; measured Igamma(theta). No data.

1972Vi12
Comment.Phys.-Math. 42, 263 (1972)
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Nuclear Reactions:
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1974BoYK
REPT CONF-740218, Paper 6
Nuclear Reactions:
^{23}Na, ^{31}P(p,gamma); measured sigma(E,Egamma, theta). ^{24}Mg, ^{32}S deduced levels, resonances, J, pi.

1974ChXM
REPT Univ Paris, IPN 1974 Annual, PN31
Nuclear Reactions:
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1974VeZQ
REPT Univ Louis Pasteur, Strasbourg, 1974 Annual, P50
Nuclear Reactions:
^{31}P(p,gamma); measured sigma(EEgamma), gamma(t). ^{32}S levels deduced $T_{1/2}$, lambda.

1974ViZZ
JOUR ZEPYA 268 No3 abstracts, Viitasalo
Nuclear Reactions:
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1975Ko24
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Proton Radiative Capture by ^{31}P Nuclei
Nuclear Reactions:
^{31}P(p,gamma), E=1800-3000 keV; measured sigma(E,Egamma, theta). ^{32}S deduced resonances, strengths, M(lambda).

1976ChYW
REPT Univ Paris, 1975 Ann, N31, Chevalier
Nuclear Reactions:
^{31}P(p,gamma), E=1437, 1581 keV; measured gamma-spectra. ^{32}S deduced levels, T½, gamma-branching, transition strengths.

1976KoZE
CONF Baku p156
Nuclear Reactions:

^{31}P(p,gamma), E=1-2 MeV; measured sigma(theta). ^{32}S resonances deduced J, delta.

1979HeZU

JOUR PHCAA 35 6, AE5, Henrikson

Nuclear Reactions:

^{31}P(p,gamma), ^{28}Si(alpha,gamma), E not given; measured Egamma, Igamma, gamma(theta). ^{32}S deduced level, J, pi.

1980AnZB

CONF Berkeley(Int Conf on Nucl Phys) Proc, P134, Antony

Nuclear Reactions:

^{31}P(p,gamma), E not given; measured sigma(Egamma,E); deduced d coefficient of isobaric multiplet mass equation. ^{32}Si, ^{32}S deduced mass differences.

1980PaZP

Diss.Abst.Int. 41B, 606 (1980)

B.M.Paine

(p,Gamma) Resonance Strengths in the s-d Shell

Nuclear Reactions:

^{23}Na, ^{26}Mg, ^{27}Al, ^{30}Si, ^{31}P, ^{34}S, $^{35,37}Cl$, ^{39}K, ^{40}Ca(p,gamma), E=0.5-2 MeV; measured Egamma, gamma-yield; deduced resonance strengths. Thin target.

1982VeZV

Univ.Paris, Inst.Phys.Nucl., Ann.Rept., pE.63 (1982)

J.Vernotte, J.Kalifa, J.M.Maison, A.Huck, G.Walter

Etude de la Desexcitation Electromagnetique du Niveau Ex=9389 keV de ^{32}S

Nuclear Reactions:

^{31}P(p,gamma), E AP = 3 MeV; measured gamma(theta). ^{32}S deduced levels, IAS, gamma transition strengths, multipolarity, J, pi, T assignment.

1996BrZZ

Priv.Comm. (1996)

J.Brenneisen, B.Erhardt, F.Glatz, Th.Kern, R.Ott, H.Ropke, J.Schmalzlin, P.Siedle, B.H.Wildenthal

The Structure of ^{32}S

Nuclear Reactions:

^{31}P(p,gamma), E not given; measured gamma(theta). ^{29}Si(alpha,ngamma), E=14.4 MeV; measured ngamma(theta). ^{32}S deduced levels, J, pi, T.

1997GyZZ

Proc.9th Intern.Symposium on Capture Gamma-Ray Spectroscopy and Related Topics, Budapest, Hungary, October 1996, G.L.Molnar, T.Belgya, Zs.Revay, Eds., Vol.1, p.256 (1997)

Gy.Gyurky, Zs.Fulop, A.Z.Kiss, E.Somorjai, A.Kangasmaki, P.Tikkanen, J.Keinonen

Study of sd-Shell Nuclei by In-Beam Gamma-Ray Spectroscopy

Nuclear Reactions:

^{2}H(^{31}P,n), E not given; ^{31}P(p,gamma), E=1.0-1.6 MeV; measured Egamma, Igamma, DSA. ^{32}S deduced levels T½.

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Appendix B: Compiled Information in EXFOR Format

The Exchange Format (EXFOR), which is widely used for compiling neutron cross section data, was adapted for the present purpose [CINDA99]. This format provides for an easily deciphered, platform-independent ASCII representation of both textual material and numerical data. Furthermore, it is a format which is generally familiar to investigators in the nuclear data community. Since EXFOR has been used in the past primarily for compiling cross section data on neutron reactions, some creativity had to be exercised in producing the present files of data relevant to charged-particle reactions and properties of reaction-product nuclei while still preserving most of the historical characteristics of the file structure. These files printed below have been sent to the National Nuclear Data Center, Brookhaven National Laboratory, Upton, New York, U.S.A., for inclusion in a library of data on charged-particle reactions which is being collected there.

AHR81

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ENTRY            AHR81          0                                   AHR81 0    1
SUBENT        AHR81  1          0                                   AHR81 1    1
BIB                 12         31                                   AHR81 1    2
INSTITUTE  (SFHLS)                                                  AHR81 1    3
REFERENCE  (J,JRC,62,293,1981)                                      AHR81 1    4
AUTHORS    (A.ANTTILA,R.HANNINEN,J.RAISANEN)                        AHR81 1    5
TITLE      PROTON-INDUCED THICK-TARGET GAMMA-RAY YIELDS FOR THE     AHR81 1    6
           ELEMENTAL ANALYSIS OF THE Z=3-9, 11-21 ELEMENTS          AHR81 1    7
FACILITY   (VDG) 2.5-MV VAN DE GRAAFF ACCELERATOR, HELSINKI         AHR81 1    8
           UNIVERSITY, HELSINKI, FINLAND.                           AHR81 1    9
INC-PART   (P) PROTONS.                                             AHR81 1   10
TARGETS    POWDERED COMPOUNDS PRESSED INTO PELLETS. CHEMICAL        AHR81 1   11
           COMPOSITION OF PHOSPHORUS TARGET NOT MENTIONED. TARGET   AHR81 1   12
           SIZE 1-MM THICK BY 6-MM DIAMETER.                        AHR81 1   13
METHOD     PROTON-INDUCED GAMMA-RAY EMISSION (PIGE) TECHNIQUE WAS   AHR81 1   14
           EMPLOYED. PROTON BEAMS OF 1, 1.7, AND 2.4 MEV ARE USED   AHR81 1   15
           IN THE EXPERIMENT. THE BEAM CURRENTS WERE IN THE RANGE   AHR81 1   16
           1-NANOAMP TO 1-MICROAMP. LIQUID NITROGEN COOLED TRAP     AHR81 1   17
           TO PREVENT CONTAMINANT BUILDUP ON THE TARGET. TARGET     AHR81 1   18
           WAS COOLED WITH WATER OR LIQUID NITROGEN. TARGET WAS     AHR81 1   19
           PLACED AT 45-DEG RELATIVE TO INCIDENT PROTON BEAM.       AHR81 1   20
           MEASURED EMITTED GAMMA RAYS. WHEN ELEMENT APPEARED IN    AHR81 1   21
           A COMPOUND, MEASUREMENTS ARE MADE FOR OTHER COMPONENTS   AHR81 1   22
           OF THE COMPOUND TO SIMPLIFY BACKGROUND IDENTIFICATION.   AHR81 1   23
           SPECTRA WERE NORMALIZED TO INCIDENT PROTON CHARGE.       AHR81 1   24
           YIELDS OF PROMINENT GAMMA-RAY FULL-ENERGY PEAKS WERE     AHR81 1   25
           DEDUCED FROM THE MEASURED SPECTRA.                       AHR81 1   26
DETECTOR   (GELI) 110 CM-3 GE(LI) DETECTOR AT 4-CM FROM TARGET      AHR81 1   27
           AT 55-DEG RELATIVE TO INCIDENT PROTON BEAM.              AHR81 1   28
MONITOR    (CI) CURRENT INTEGRATOR.                                 AHR81 1   29
CORRECTION DATA WERE CORRECTED FOR DETECTOR RECORDING DEAD TIME     AHR81 1   30
           AND STOPPING POWERS OF IRRADIATED MATERIALS.             AHR81 1   31
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ERR-ANALYS ERRORS NOT GIVEN. AUTHORS NOTE THAT STOPPING POWER      AHR81 1   32
           ERRORS ALONE COULD BE AS LARGE AS 20 PERCENT.           AHR81 1   33
ENDBIB              31                                             AHR81 1   34
ENDSUBENT            1                                             AHR81 199999
SUBENT        AHR81  2          0                                  AHR81 2    1
BIB                  2          5                                  AHR81 2    2
REACTION   31P(P,GAMMA)32S                                         AHR81 2    3
COMMENTS   THICK-TARGET GAMMA-RAY YIELD VALUES FOUND IN TABLE 1.   AHR81 2    4
           RESULTS CORRESPOND TO 1266 KEV GAMMA RAY. EP = PROTON   AHR81 2    5
           ENERGY. YLD = GAMMA-RAY YIELD IN UNITS DIM1. DIM1 =     AHR81 2    6
           COUNTS/MICRO-COULOMB/STERADIAN.                         AHR81 2    7
ENDBIB               5                                             AHR81 2    8
DATA                 2          2                                  AHR81 2    9
EP         YLD                                                     AHR81 2   10
MEV        DIM1                                                    AHR81 2   11
 1.7        7.2                                                    AHR81 2   12
 2.4        3.8000E+04                                             AHR81 2   13
ENDDATA              4                                             AHR81 2   14
ENDSUBENT            2                                             AHR81 299999
SUBENT        AHR81  3          0                                  AHR81 3    1
BIB                  2          5                                  AHR81 3    2
REACTION   31P(P,GAMMA)32S                                         AHR81 3    3
COMMENTS   THICK-TARGET GAMMA-RAY YIELD VALUES FOUND IN TABLE 1.   AHR81 3    4
           RESULTS CORRESPOND TO 1779 KEV GAMMA RAY. EP = PROTON   AHR81 3    5
           ENERGY. YLD = GAMMA-RAY YIELD IN UNITS DIM1. DIM1 =     AHR81 3    6
           COUNTS/MICRO-COULOMB/STERADIAN.                         AHR81 3    7
ENDBIB               5                                             AHR81 3    8
DATA                 2          1                                  AHR81 3    9
EP         YLD                                                     AHR81 3   10
MEV        DIM1                                                    AHR81 3   11
 2.4        20.                                                    AHR81 3   12
ENDDATA              3                                             AHR81 3   13
ENDSUBENT            3                                             AHR81 399999
SUBENT        AHR81  4          0                                  AHR81 4    1
BIB                  2          5                                  AHR81 4    2
REACTION   31P(P,GAMMA)32S                                         AHR81 4    3
COMMENTS   THICK-TARGET GAMMA-RAY YIELD VALUES FOUND IN TABLE 1.   AHR81 4    4
           RESULTS CORRESPOND TO 2230 KEV GAMMA RAY. EP = PROTON   AHR81 4    5
           ENERGY. YLD = GAMMA-RAY YIELD IN UNITS DIM1. DIM1 =     AHR81 4    6
           COUNTS/MICRO-COULOMB/STERADIAN.                         AHR81 4    7
ENDBIB               5                                             AHR81 4    8
DATA                 2          3                                  AHR81 4    9
EP         YLD                                                     AHR81 4   10
MEV        DIM1                                                    AHR81 4   11
 1.0        1.3                                                    AHR81 4   12
 1.7        17.                                                    AHR81 4   13
 2.4        35.                                                    AHR81 4   14
ENDDATA              5                                             AHR81 4   15
ENDSUBENT            4                                             AHR81 499999
ENDENTRY             4                                             AHR819999999
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ENTRY            B+97          0                                   B+97 0    1
SUBENT        B+97  1          0                                   B+97 1    1
BIB                12         33                                   B+97 1    2
INSTITUTE  (GER,UNIVERSITY OF FREIBURG,FREIBURG)                   B+97 1    3
REFERENCE  (J,ZP/A,357,157,1997)                                   B+97 1    4
AUTHORS    (J.BRENNEISEN,B.ERHARDT,F.GLATZ,TH.KERN,R.OTT,          B+97 1    5
           H.ROEPKE,J.SCHMAELZLIN,P.SIEDLE,B.H.WILDENTHAL)         B+97 1    6
TITLE      THE STRUCTURE OF 32S: I - SPECTROSCOPY OF HIGHLY-       B+97 1    7
           EXCITED STATES                                          B+97 1    8
FACILITY   (VDG) 7-MV VAN DE GRAAFF ACCELERATOR, UNIVERSITY OF     B+97 1    9
           FREIBURG, FREIBURG, GERMANY.                            B+97 1   10
INC-PART   (P) PROTONS.                                            B+97 1   11
TARGETS    20 MICROGRAM/CM-2 CD2P3 EVAPORATED ONTO POLISHED        B+97 1   12
           TANTALUM SHEET. 20-40 MICROGRAM/CM-2 P3N5 (THE TARGETS  B+97 1   13
           WITHSTOOD 25 MICROAMPS OF PROTONS AT 2 MEV) AND 50-100  B+97 1   14
           MICROGRAM/CM-2 P3N5. BACKING UNKNOWN FOR P3N5 TARGETS.  B+97 1   15
METHOD     EXPERIMENT INVOLVED A SEARCH FOR RESONANCES IN THE      B+97 1   16
           32P(P,GAMMA)32S REACTION IN THE INCIDENT PROTON ENERGY  B+97 1   17
           RANGE 2-3.3 MEV, CORRESPONDING TO LEVELS IN 32S AT      B+97 1   18
           EXCITATIONS IN THE RANGE 10.8-12.1 MEV. EMPHASIS ON     B+97 1   19
           OBSERVING T=1 ISOBARIC ANALOG STATES. 7-MV FREIBURG     B+97 1   20
           VAN DE GRAAFF ACCELERATOR PROVIDED 5-25 MICROAMP PROTON B+97 1   21
           BEAMS. MEASURED GAMMA-RAY YIELD EXCITATION FUNCTION     B+97 1   22
           WITH NAI DETECTOR AT 4 CM FROM TARGET AND AN ANGLE OF   B+97 1   23
           55-DEG RELATIVE TO PROTON BEAM. GAMMA-DECAY MODES AND   B+97 1   24
           GAMMA-RAY ANGULAR DISTRIBUTIONS ARE MEASURED AT SEVERAL B+97 1   25
           RESONANCES WITH A GE(LI) DETECTOR. DEDUCED RESONANCE    B+97 1   26
           AND TRANSITION STRENGTHS FROM GAMMA-RAY YIELD DATA.     B+97 1   27
DETECTOR   (SCINT) 5 INCH DIA BY 5 INCH THICK NAI SCINTILLATOR.    B+97 1   28
           (GELI) 120 CM-3 GE(LI) DETECTOR WITH 2-KEV RESOLUTION   B+97 1   29
           FOR 60CO GAMMA RAYS.                                    B+97 1   30
MONITOR    (CI) CURRENT INTEGRATOR.                                B+97 1   31
           (GELI) 120 CM-3 GE(LI) DETECTOR WITH 2-KEV RESOLUTION   B+97 1   32
           FOR 60CO GAMMA RAYS.                                    B+97 1   33
CORRECTION NOT DISCUSSED.                                          B+97 1   34
ERR-ANALYS NOT DISCUSSED.                                          B+97 1   35
ENDBIB             33                                              B+97 1   36
ENDSUBENT           1                                              B+97 199999
SUBENT        B+97  2          0                                   B+97 2    1
BIB                 2          7                                   B+97 2    2
REACTION   31P(P,GAMMA)32S                                         B+97 2    3
COMMENTS   GAMMA-RAY DECAY BRANCHING FACTORS FOR 32S LEVELS WITH   B+97 2    4
           EXCITATION LESS THAN 10 MEV. DATA TAKEN FROM TABLE 1.   B+97 2    5
           EX = EXCITATION ENERGY OF 32S LEVEL. EX-ERR = ERROR     B+97 2    6
           IN 32S LEVEL EXCITATION ENERGY. EI = INITIAL 32S LEVEL  B+97 2    7
           FOR GAMMA TRANSITION. EF = FINAL 32S LEVEL FOR GAMMA-   B+97 2    8
           RAY TRANSITION. B = GAMMA-RAY BRANCHING FACTOR. B-ERR = B+97 2    9
           ERROR IN GAMMA-RAY BRANCHING FACTOR. PCT = PERCENT.     B+97 2   10
ENDBIB              7                                              B+97 2   11
DATA                6         26                                   B+97 2   12
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EX          EX-ERR      EI          EF          B           B-ERR        B+97 2   13
KEV         KEV         KEV         KEV         PCT         PCT          B+97 2   14
 7350.2      0.6         7350.2      4695.       100.                    B+97 2   15
 7637.0      1.0         7637.0      4282.       100.                    B+97 2   16
 7701.8      0.5         7701.8      2230.       100.                    B+97 2   17
 7882.9      0.9         7882.9      2230.       75.         5.          B+97 2   18
 7882.9      0.9         7882.9      5549.       11.         5.          B+97 2   19
 7882.9      0.9         7882.9      5006.       14.         5.          B+97 2   20
 7921.0      1.0         7921.0      2230.       80.                     B+97 2   21
 7974.9      0.7         7974.9      2230.       50.         5.          B+97 2   22
 7974.9      0.7         7974.9      5006.       19.         5.          B+97 2   23
 8191.1      0.6         8191.1      4282.       18.         3.          B+97 2   24
 8191.1      0.6         8191.1      4459.       28.         6.          B+97 2   25
 8191.1      0.6         8191.1      5549.       30.         6.          B+97 2   26
 8191.1      0.6         8191.1      5413.       24.         5.          B+97 2   27
 8296.3      1.0         8296.3      2230.       54.         9.          B+97 2   28
 8296.3      1.0         8296.3      4282.       27.         9.          B+97 2   29
 8407.0      1.4         8407.0      3778.       51.         5.          B+97 2   30
 8407.0      1.4         8407.0      4282.       9.          2.          B+97 2   31
 8407.0      1.4         8407.0      4695.       10.         2.          B+97 2   32
 8729.3      0.6         8729.3      5413.       18.         3.          B+97 2   33
 8729.3      0.6         8729.3      6621.       16.         3.          B+97 2   34
 8729.3      0.6         8729.3      6852.       10.         2.          B+97 2   35
 8745.6      0.8         8745.6      5413.       7.          3.          B+97 2   36
 8745.6      0.8         8745.6      5549.       8.          4.          B+97 2   37
 8745.6      0.8         8745.6      6411.       40.         5.          B+97 2   38
 8745.6      0.8         8745.6      6621.       34.         5.          B+97 2   39
 8745.6      0.8         8745.6      6852.       12.         5.          B+97 2   40
ENDDATA               28                                                 B+97 2   41
ENDSUBENT              2                                                 B+97 299999
SUBENT           B+97  3          0                                      B+97 3    1
BIB                    2         10                                      B+97 3    2
REACTION    31P(P,GAMMA)32S                                              B+97 3    3
COMMENTS    GAMMA-DECAY BRANCHING FACTORS FOR UNBOUND RESONANCES IN      B+97 3    4
            32S. DATA TAKEN FROM TABLE 3. EX = EXCITATION ENERGY         B+97 3    5
            OF UNBOUND RESONANT STATE IN 32S. EI = INITIAL 32S           B+97 3    6
            LEVEL FOR GAMMA-RAY TRANSITION. EF = FINAL 32S LEVEL         B+97 3    7
            FOR GAMMA-RAY TRANSITION. B = GAMMA-RAY BRANCHING            B+97 3    8
            FACTOR. B-ERR = ERROR IN GAMMA-RAY BRANCHING FACTOR.         B+97 3    9
            PCT = PERCENT. NOTE: IN A FEW CASES WHERE INFORMATION        B+97 3   10
            IN TABLE 3 WAS NOT CLEAR OR APPEARED TO BE ERRONEOUS,        B+97 3   11
            THESE DATA WERE SIMPLY LEFT OUT OF THIS COMPILATION.         B+97 3   12
ENDBIB                10                                                 B+97 3   13
DATA                   5        240                                      B+97 3   14
EX          EI          EF          B           B-ERR                    B+97 3   15
KEV         KEV         KEV         PCT         PCT                      B+97 3   16
 10102.4     10102.4     2230.       42.4        0.9                     B+97 3   17
 10102.4     10102.4     4282.       9.7         0.5                     B+97 3   18
 10102.4     10102.4     4459.       19.8        0.6                     B+97 3   19
 10102.4     10102.4     5006.       21.1        0.6                     B+97 3   20
 10102.4     10102.4     5413.       7.0         0.6                     B+97 3   21
 10507.9     10507.9     0.          5.3         0.3                     B+97 3   22
 10507.9     10507.9     2230.       20.6        0.5                     B+97 3   23
 10507.9     10507.9     4282.       6.7         0.4                     B+97 3   24
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10507.9	10507.9	4695.	0.8	0.2	B+97 3	25
10507.9	10507.9	5006.	1.1	0.2	B+97 3	26
10507.9	10507.9	5413.	6.9	0.3	B+97 3	27
10507.9	10507.9	5798.	2.0	0.2	B+97 3	28
10507.9	10507.9	7115.	49.4	0.9	B+97 3	29
10507.9	10507.9	7190.	4.6	0.3	B+97 3	30
10507.9	10507.9	7350.	1.1	0.3	B+97 3	31
10574.4	10574.4	4459.	54.7	0.9	B+97 3	32
10574.4	10574.4	5413.	28.7	0.5	B+97 3	33
10574.4	10574.4	6411.	1.5	0.4	B+97 3	34
10574.4	10574.4	6621.	2.4	0.3	B+97 3	35
10574.4	10574.4	6762.	3.3	0.3	B+97 3	36
10574.4	10574.4	7350.	3.7	0.3	B+97 3	37
10574.4	10574.4	8270.	2.1	0.2	B+97 3	38
10636.4	10636.4	6621.	70.6	1.5	B+97 3	39
10636.4	10636.4	6762.	9.4	0.9	B+97 3	40
10636.4	10636.4	7702.	3.9	0.6	B+97 3	41
10636.4	10636.4	7950.	16.0	0.8	B+97 3	42
10705.3	10705.3	4459.	8.1	2.0	B+97 3	43
10705.3	10705.3	6621.	52.1	1.7	B+97 3	44
10705.3	10705.3	6762.	31.1	1.5	B+97 3	45
10705.3	10705.3	7702.	8.7	0.9	B+97 3	46
10756.7	10756.7	2230.	1.1	0.2	B+97 3	47
10756.7	10756.7	4282.	3.5	0.2	B+97 3	48
10756.7	10756.7	4459.	56.7	0.9	B+97 3	49
10756.7	10756.7	5413.	7.6	0.4	B+97 3	50
10756.7	10756.7	5549.	18.0	0.6	B+97 3	51
10756.7	10756.7	6621.	1.3	0.3	B+97 3	52
10756.7	10756.7	7115.	1.5	0.2	B+97 3	53
10756.7	10756.7	7350.	3.5	0.2	B+97 3	54
10756.7	10756.7	7702.	2.0	0.2	B+97 3	55
10756.7	10756.7	8729.	1.0	0.3	B+97 3	56
10756.7	10756.7	9065.	0.7	0.2	B+97 3	57
10778.8	10778.8	0.	8.3	0.2	B+97 3	58
10778.8	10778.8	2230.	42.9	0.9	B+97 3	59
10778.8	10778.8	4282.	16.7	0.3	B+97 3	60
10778.8	10778.8	4695.	4.5	0.2	B+97 3	61
10778.8	10778.8	5413.	7.1	0.2	B+97 3	62
10778.8	10778.8	5549.	0.6	0.1	B+97 3	63
10778.8	10778.8	5798.	0.6	0.1	B+97 3	64
10778.8	10778.8	5549.	1.6	0.2	B+97 3	65
10778.8	10778.8	7003.	12.9	0.3	B+97 3	66
10778.8	10778.8	7350.	0.3	0.1	B+97 3	67
10778.8	10778.8	7485.	0.8	0.1	B+97 3	68
10778.8	10778.8	7975.	2.1	0.2	B+97 3	69
10778.8	10778.8	8407.	0.2	0.1	B+97 3	70
10778.8	10778.8	9023.	1.2	0.1	B+97 3	71
10783.8	10783.8	0.	51.7	0.6	B+97 3	72
10783.8	10783.8	2230.	14.7	0.4	B+97 3	73
10783.8	10783.8	3778.	1.7	0.2	B+97 3	74
10783.8	10783.8	4282.	3.7	0.2	B+97 3	75
10783.8	10783.8	4695.	10.4	0.4	B+97 3	76
10783.8	10783.8	5549.	11.9	0.3	B+97 3	77
10783.8	10783.8	7003.	1.6	0.1	B+97 3	78

10783.8	10783.8	7115.	0.3	0.1	B+97 3	79
10783.8	10783.8	7637.	0.7	0.1	B+97 3	80
10783.8	10783.8	7921.	1.3	0.1	B+97 3	81
10784.5	10784.5	7003.	100.		B+97 3	82
10791.3	10791.3	0.	17.2	0.4	B+97 3	83
10791.3	10791.3	2230.	46.1	0.5	B+97 3	84
10791.3	10791.3	4282.	7.1	0.4	B+97 3	85
10791.3	10791.3	4695.	3.3	0.3	B+97 3	86
10791.3	10791.3	5006.	9.2	0.3	B+97 3	87
10791.3	10791.3	5413.	4.2	0.2	B+97 3	88
10791.3	10791.3	5549.	1.8	0.2	B+97 3	89
10791.3	10791.3	5798.	0.6	0.1	B+97 3	90
10791.3	10791.3	7003.	4.6	0.1	B+97 3	91
10791.3	10791.3	7115.	4.0	0.1	B+97 3	92
10791.3	10791.3	8127.	1.9	0.1	B+97 3	93
10825.4	10825.4	0.	18.6	2.7	B+97 3	94
10825.4	10825.4	2230.	32.1	2.8	B+97 3	95
10825.4	10825.4	4282.	25.3	2.2	B+97 3	96
10825.4	10825.4	5006.	9.4	1.7	B+97 3	97
10825.4	10825.4	5413.	4.9	1.2	B+97 3	98
10825.4	10825.4	5549.	5.5	1.2	B+97 3	99
10825.4	10825.4	7003.	4.3	0.3	B+97 3	100
10933.7	10933.7	2230.	6.0	0.2	B+97 3	101
10933.7	10933.7	4282.	31.2	0.3	B+97 3	102
10933.7	10933.7	4459.	7.3	0.3	B+97 3	103
10933.7	10933.7	5413.	4.2	0.2	B+97 3	104
10933.7	10933.7	5549.	4.7	0.2	B+97 3	105
10933.7	10933.7	6411.	7.1	0.2	B+97 3	106
10933.7	10933.7	7115.	1.9	0.2	B+97 3	107
10933.7	10933.7	7350.	9.5	0.2	B+97 3	108
10933.7	10933.7	7485.	2.4	0.2	B+97 3	109
10933.7	10933.7	8690.	2.4	0.1	B+97 3	110
10933.7	10933.7	9712.	2.3	0.1	B+97 3	111
11009.9	11009.9	2230.	4.3	0.1	B+97 3	112
11009.9	11009.9	4282.	11.3	0.2	B+97 3	113
11009.9	11009.9	4459.	48.0	0.5	B+97 3	114
11009.9	11009.9	5006.	18.2	0.3	B+97 3	115
11009.9	11009.9	5413.	1.5	0.1	B+97 3	116
11009.9	11009.9	6411.	7.9	0.1	B+97 3	117
11009.9	11009.9	6621.	0.3	0.1	B+97 3	118
11009.9	11009.9	6762.	0.5	0.1	B+97 3	119
11009.9	11009.9	7115.	0.5	0.1	B+97 3	120
11009.9	11009.9	7350.	1.2	0.1	B+97 3	121
11009.9	11009.9	7485.	0.4	0.1	B+97 3	122
11009.9	11009.9	7702.	1.1	0.1	B+97 3	123
11009.9	11009.9	7883.	2.1	0.1	B+97 3	124
11009.9	11009.9	7950.	0.3	0.1	B+97 3	125
11009.9	11009.9	8270.	0.7	0.1	B+97 3	126
11092.3	11092.3	4282.	2.4	0.4	B+97 3	127
11092.3	11092.3	4459.	14.8	0.6	B+97 3	128
11092.3	11092.3	5006.	20.0	0.6	B+97 3	129
11092.3	11092.3	6224.	12.9	0.4	B+97 3	130
11092.3	11092.3	6621.	23.4	0.4	B+97 3	131
11092.3	11092.3	6762.	0.7	0.4	B+97 3	132

11092.3	11092.3	7702.	12.1	0.3	B+97 3	133
11092.3	11092.3	7950.	4.3	0.2	B+97 3	134
11092.3	11092.3	7975.	3.1	0.1	B+97 3	135
11092.3	11092.3	8191.	0.7	0.2	B+97 3	136
11092.3	11092.3	8296.	5.4	0.2	B+97 3	137
11123.	11123.	0.	70.0	0.5	B+97 3	138
11123.	11123.	2230.	10.1	0.3	B+97 3	139
11123.	11123.	3778.	6.7	0.2	B+97 3	140
11123.	11123.	4695.	4.7	0.2	B+97 3	141
11123.	11123.	7003.	6.4	0.2	B+97 3	142
11123.	11123.	7536.	5.1	0.2	B+97 3	143
11139.8	11139.8	0.	84.8	0.7	B+97 3	144
11139.8	11139.8	2230.	9.2	0.6	B+97 3	145
11139.8	11139.8	3778.	1.8	0.2	B+97 3	146
11139.8	11139.8	4695.	2.3	0.2	B+97 3	147
11139.8	11139.8	6224.	0.4	0.1	B+97 3	148
11139.8	11139.8	7003.	0.6	0.1	B+97 3	149
11139.8	11139.8	7536.	0.4	0.1	B+97 3	150
11235.5	11235.5	2230.	47.5	0.6	B+97 3	151
11235.5	11235.5	4282.	36.8	0.6	B+97 3	152
11235.5	11235.5	4459.	3.1	0.2	B+97 3	153
11235.5	11235.5	5413.	3.4	0.2	B+97 3	154
11235.5	11235.5	5549.	1.3	0.2	B+97 3	155
11235.5	11235.5	6411.	2.0	0.2	B+97 3	156
11235.5	11235.5	7702.	1.5	0.1	B+97 3	157
11235.5	11235.5	8191.	3.1	0.1	B+97 3	158
11235.5	11235.5	8690.	1.4	0.1	B+97 3	159
11253.9	11253.9	2230.	65.7	0.5	B+97 3	160
11253.9	11253.9	4282.	5.6	0.2	B+97 3	161
11253.9	11253.9	4695.	1.1	0.1	B+97 3	162
11253.9	11253.9	5006.	4.7	0.2	B+97 3	163
11253.9	11253.9	5413.	1.2	0.1	B+97 3	164
11253.9	11253.9	5549.	1.1	0.1	B+97 3	165
11253.9	11253.9	6411.	1.6	0.1	B+97 3	166
11253.9	11253.9	7702.	0.8	0.1	B+97 3	167
11253.9	11253.9	7950.	1.8	0.1	B+97 3	168
11253.9	11253.9	8191.	4.8	0.1	B+97 3	169
11253.9	11253.9	8296.	0.4	0.1	B+97 3	170
11253.9	11253.9	8407.	2.7	0.1	B+97 3	171
11253.9	11253.9	8690.	2.4	0.1	B+97 3	172
11253.9	11253.9	8729.	0.8	0.1	B+97 3	173
11253.9	11253.9	8861.	0.9	0.1	B+97 3	174
11332.8	11332.8	0.	31.1	2.0	B+97 3	175
11332.8	11332.8	4282.	17.8	1.2	B+97 3	176
11332.8	11332.8	4695.	5.0	0.9	B+97 3	177
11332.8	11332.8	5006.	5.9	0.9	B+97 3	178
11332.8	11332.8	6411.	8.1	0.9	B+97 3	179
11332.8	11332.8	7003.	1.9	0.8	B+97 3	180
11332.8	11332.8	7115.	6.5	0.8	B+97 3	181
11332.8	11332.8	8127.	14.6	0.7	B+97 3	182
11332.8	11332.8	9660.	9.2	0.9	B+97 3	183
11474.6	11474.6	4282.	74.2	0.4	B+97 3	184
11474.6	11474.6	4459.	4.7	0.1	B+97 3	185
11474.6	11474.6	5413.	6.7	0.1	B+97 3	186

11474.6	11474.6	5549.	1.0	0.1	B+97 3 187
11474.6	11474.6	6224.	0.7	0.1	B+97 3 188
11474.6	11474.6	6411.	0.4	0.1	B+97 3 189
11474.6	11474.6	6621.	1.7	0.1	B+97 3 190
11474.6	11474.6	8729.	3.7	0.1	B+97 3 191
11474.6	11474.6	8746.	3.7	0.1	B+97 3 192
11485.8	11485.8	3778.	42.5	4.8	B+97 3 193
11485.8	11485.8	5006.	34.0	6.0	B+97 3 194
11485.8	11485.8	8127.	23.5	4.0	B+97 3 195
11589.7	11589.7	0.	38.0	0.7	B+97 3 196
11589.7	11589.7	2230.	14.5	0.5	B+97 3 197
11589.7	11589.7	3778.	3.2	0.3	B+97 3 198
11589.7	11589.7	4282.	21.5	0.4	B+97 3 199
11589.7	11589.7	4459.	6.9	0.4	B+97 3 200
11589.7	11589.7	4695.	0.7	0.2	B+97 3 201
11589.7	11589.7	5006.	2.9	0.3	B+97 3 202
11589.7	11589.7	6411.	0.3	0.2	B+97 3 203
11589.7	11589.7	7115.	9.8	0.3	B+97 3 204
11589.7	11589.7	8407.	1.7	0.1	B+97 3 205
11602.4	11602.4	4695.	45.0	1.4	B+97 3 206
11602.4	11602.4	5006.	20.3	1.0	B+97 3 207
11602.4	11602.4	5549.	17.0	0.9	B+97 3 208
11602.4	11602.4	7190.	14.3	0.7	B+97 3 209
11602.4	11602.4	7536.	5.4	0.7	B+97 3 210
11637.1	11637.1	0.	87.4	0.5	B+97 3 211
11637.1	11637.1	2230.	2.4	0.2	B+97 3 212
11637.1	11637.1	3778.	1.1	0.1	B+97 3 213
11637.1	11637.1	4695.	1.9	0.1	B+97 3 214
11637.1	11637.1	5549.	3.1	0.1	B+97 3 215
11637.1	11637.1	5798.	0.6	0.1	B+97 3 216
11637.1	11637.1	6224.	0.5	0.1	B+97 3 217
11637.1	11637.1	7003.	0.7	0.1	B+97 3 218
11637.1	11637.1	7190.	0.4	0.1	B+97 3 219
11637.1	11637.1	7434.	0.2	0.1	B+97 3 220
11637.1	11637.1	7485.	0.4	0.1	B+97 3 221
11637.1	11637.1	7921.	0.5	0.1	B+97 3 222
11637.1	11637.1	8344.	0.7	0.1	B+97 3 223
11669.6	11669.6	4459.	9.1	0.2	B+97 3 224
11669.6	11669.6	6411.	63.0	0.4	B+97 3 225
11669.6	11669.6	6762.	0.4	0.1	B+97 3 226
11669.6	11669.6	7567.	13.5	0.2	B+97 3 227
11669.6	11669.6	8191.	9.6	0.2	B+97 3 228
11669.6	11669.6	8346.	3.9	0.2	B+97 3 229
11669.6	11669.6	8729.	0.4	0.1	B+97 3 230
11696.7	11696.7	4459.	19.2	0.2	B+97 3 231
11696.7	11696.7	6411.	60.1	0.4	B+97 3 232
11696.7	11696.7	6621.	0.9	0.2	B+97 3 233
11696.7	11696.7	7350.	1.0	0.1	B+97 3 234
11696.7	11696.7	7567.	8.8	0.2	B+97 3 235
11696.7	11696.7	8191.	6.1	0.1	B+97 3 236
11696.7	11696.7	8346.	4.0	0.1	B+97 3 237
11758.8	11758.8	5006.	2.4	0.4	B+97 3 238
11758.8	11758.8	6621.	27.2	0.5	B+97 3 239
11758.8	11758.8	6762.	55.0	0.6	B+97 3 240

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 11758.8    11758.8    7950.      7.8        0.6                     B+97 3  241
 11758.8    11758.8    8296.      7.7        0.2                     B+97 3  242
 11940.1    11940.1    2230.      17.6       0.3                     B+97 3  243
 11940.1    11940.1    4282.      17.8       0.2                     B+97 3  244
 11940.1    11940.1    4459.      35.6       0.4                     B+97 3  245
 11940.1    11940.1    5413.      9.9        0.2                     B+97 3  246
 11940.1    11940.1    5549.      7.7        0.3                     B+97 3  247
 11940.1    11940.1    6224.      2.2        0.1                     B+97 3  248
 11940.1    11940.1    6621.      5.6        0.2                     B+97 3  249
 11940.1    11940.1    7950.      2.3        0.1                     B+97 3  250
 11940.1    11940.1    8407.      0.5        0.1                     B+97 3  251
 12043.9    12043.9    4459.      2.0        0.3                     B+97 3  252
 12043.9    12043.9    5006.      78.6       1.0                     B+97 3  253
 12043.9    12043.9    6621.      2.1        0.4                     B+97 3  254
 12043.9    12043.9    6762.      14.9       0.8                     B+97 3  255
 12043.9    12043.9    7950.      2.5        0.4                     B+97 3  256
ENDDATA            242                                               B+97 3  257
ENDSUBENT            3                                               B+97 399999
SUBENT         B+97  4          0                                    B+97 4    1
BIB                  2         10                                    B+97 4    2
REACTION   31P(P,GAMMA)32S                                           B+97 4    3
COMMENTS   RESONANCE STRENGTHS FROM TABLE 3. EX = EXCITATION         B+97 4    4
           ENERGY OF UNBOUND RESONANT STATE IN 32S. EP =             B+97 4    5
           PROTON ENERGY FOR EXCITING THE (P,GAMMA) RESONANCE.       B+97 4    6
           ALL GIVEN ENERGIES ARE ACCURATE TO WITHIN 1 KEV.          B+97 4    7
           J-PI = RESONANCE SPIN (NO SIGN = POSITIVE PARITY;         B+97 4    8
           NEGATIVE SIGN = NEGATIVE PARITY). VALUES OF J-PI ARE      B+97 4    9
           GIVEN ONLY WHEN THEY ARE CERTAIN. S = RESONANCE           B+97 4   10
           STRENGTH = (2J+1)*GAMMA(P)*GAMMA(GAMMA)/GAMMA(TOTAL),     B+97 4   11
           AS INDICATED IN SECTION 4.3.                              B+97 4   12
ENDBIB              10                                               B+97 4   13
DATA                 4         19                                    B+97 4   14
EX         EP         J-PI       S                                   B+97 4   15
KEV        KEV        NO-DIM     EV                                  B+97 4   16
 10756.7    1953.7     3.0        6.4                                B+97 4   17
 10778.8    1976.6     2.0        6.7                                B+97 4   18
 10783.8    1981.7     1.0        9.3                                B+97 4   19
 10784.5    1982.5     0.0        0.64                               B+97 4   20
 10825.4    2024.7     2.0        11.2                               B+97 4   21
 10933.7    2136.5     3.0        6.2                                B+97 4   22
 11009.9    2215.2     4.0        5.4                                B+97 4   23
 11092.3    2300.2    -3.0        4.9                                B+97 4   24
 11123.     2331.      1.0        10.9                               B+97 4   25
 11139.8    2349.3     1.0        27.                                B+97 4   26
 11235.5    2448.1     3.0        3.8                                B+97 4   27
 11253.9    2467.1     3.0        4.4                                B+97 4   28
 11474.6    2695.0     3.0        15.2                               B+97 4   29
 11589.7    2813.8     2.0        3.1                                B+97 4   30
 11637.1    2862.8     1.0        15.1                               B+97 4   31
 11669.6    2896.3     5.0        6.1                                B+97 4   32
 11696.7    2924.3     5.0        2.5                                B+97 4   33
 11758.8    2988.4    -4.0        5.5                                B+97 4   34
 11940.1    3175.6    -3.0        3.8                                B+97 4   35
ENDDATA             21                                               B+97 4   36
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ENDSUBENT            4                                                 B+97 499999
SUBENT         B+97  5          0                                      B+97 5    1
BIB                  2          8                                      B+97 5    2
REACTION   31P(P,GAMMA)32S                                             B+97 5    3
COMMENTS   GAMMA-RAY ANGULAR DISTRIBUTION INFORMATION FROM TABLE       B+97 5    4
           4. EX = EXCITATION ENERGY OF UNBOUND RESONANT STATE IN      B+97 5    5
           32S. EI = INITIAL 32S LEVEL FOR GAMMA TRANSITION. EF =      B+97 5    6
           FINAL 32S LEVEL FOR GAMMA-RAY TRANSITION. A2 = P2           B+97 5    7
           LEGENDRE COEFFICIENT. A2-ERR = ERROR IN P2 LEGENDRE         B+97 5    8
           COEFFICIENT. A4 = P4 LEGENDRE COEFFICIENT. A4-ERR =         B+97 5    9
           ERROR IN P4 LEGENDRE COEFFICIENT.                           B+97 5   10
ENDBIB               8                                                 B+97 5   11
DATA                 7        108                                      B+97 5   12
EX         EI         EF         A2         A2-ERR     A4              B+97 5   13
A4-ERR                                                                 B+97 5   14
KEV        KEV        KEV        NO-DIM     NO-DIM     NO-DIM          B+97 5   15
NO-DIM                                                                 B+97 5   16
 10102.     10102.     4282.      0.64       0.01      -0.45           B+97 5   17
 0.02                                                                  B+97 5   18
 10102.     4282.      0.         0.33       0.08      -0.12           B+97 5   19
 0.10                                                                  B+97 5   20
 10102.     10102.     4459.     -0.15       0.07      -0.29           B+97 5   21
 0.09                                                                  B+97 5   22
 10574.     10574.     5413.      0.43       0.03      -0.23           B+97 5   23
 0.05                                                                  B+97 5   24
 10574.     5413.      2230.      0.38       0.03       0.28           B+97 5   25
 0.04                                                                  B+97 5   26
 10757.     10757.     5549.     -0.02       0.05       0.08           B+97 5   27
 0.07                                                                  B+97 5   28
 10757.     5549.      2230.      0.06       0.05      -0.02           B+97 5   29
 0.03                                                                  B+97 5   30
 10757.     10757.     4459.      0.03       0.03      -0.02           B+97 5   31
 0.03                                                                  B+97 5   32
 10757.     4459.      2230.      0.34       0.01      -0.12           B+97 5   33
 0.01                                                                  B+97 5   34
 10934.     10934.     4282.     -0.45       0.05      -0.05           B+97 5   35
 0.06                                                                  B+97 5   36
 10934.     4282.      0.         0.37       0.03      -0.22           B+97 5   37
 0.04                                                                  B+97 5   38
 10934.     10934.     6852.     -0.10       0.04      -0.01           B+97 5   39
 0.05                                                                  B+97 5   40
 10934.     10934.     7350.      0.40       0.05       0.02           B+97 5   41
 0.07                                                                  B+97 5   42
 10934.     7350.      4695.      0.42       0.06      -0.13           B+97 5   43
 0.07                                                                  B+97 5   44
 11010.     11010.     4459.      0.57       0.01      -0.11           B+97 5   45
 0.02                                                                  B+97 5   46
 11010.     11010.     6411.      0.58       0.04      -0.11           B+97 5   47
 0.05                                                                  B+97 5   48
 11010.     6411.      2230.      0.32       0.03      -0.18           B+97 5   49
 0.04                                                                  B+97 5   50
 11010.     11010.     5006.     -0.53       0.04       0.05           B+97 5   51
 0.06                                                                  B+97 5   52
 11010.     5006.      2230.     -0.30       0.02      -0.00           B+97 5   53
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0.02						B+97 5	54
11010.	11010.	7883.	0.66	0.01	-0.17	B+97 5	55
0.08						B+97 5	56
11010.	7883.	2230.	0.41	0.02	-0.07	B+97 5	57
0.03						B+97 5	58
11092.	11092.	6621.	-0.07	0.03	0.00	B+97 5	59
0.05						B+97 5	60
11092.	6621.	5006.	0.53	0.03	0.26	B+97 5	61
0.05						B+97 5	62
11092.	11092.	7702.	0.53	0.04	-0.13	B+97 5	63
0.06						B+97 5	64
11092.	7702.	2230.	-0.37	0.07	-0.04	B+97 5	65
0.09						B+97 5	66
11092.	11092.	7975.	0.45	0.09	0.09	B+97 5	67
0.02						B+97 5	68
11092.	11092.	8296.	0.75	0.06	-0.08	B+97 5	69
0.09						B+97 5	70
11236.	11236.	4282.	-0.41	0.04	-0.05	B+97 5	71
0.08						B+97 5	72
11236.	4282.	0.	0.41	0.02	-0.30	B+97 5	73
0.03						B+97 5	74
11254.	11254.	4282.	-0.15	0.09	-0.06	B+97 5	75
0.01						B+97 5	76
11254.	4282.	0.	0.41	0.06	-0.32	B+97 5	77
0.06						B+97 5	78
11254.	11254.	8406.	-0.32	0.09	-0.06	B+97 5	79
0.09						B+97 5	80
11475.	11475.	5413.	0.42	0.07	-0.11	B+97 5	81
0.04						B+97 5	82
11475.	5413.	2230.	0.24	0.02	-0.02	B+97 5	83
0.02						B+97 5	84
11475.	11475.	6666.	-0.28	0.07	-0.02	B+97 5	85
0.08						B+97 5	86
11475.	6666.	3778.	0.42	0.07	-0.31	B+97 5	87
0.02						B+97 5	88
11475.	11475.	8729.	0.44	0.03	-0.10	B+97 5	89
0.03						B+97 5	90
11475.	11475.	8746.	0.45	0.03	-0.06	B+97 5	91
0.03						B+97 5	92
11670.	11670.	7567.	0.48	0.02	-0.03	B+97 5	93
0.02						B+97 5	94
11670.	7567.	5413.	0.45	0.05	-0.09	B+97 5	95
0.07						B+97 5	96
11670.	11670.	6411.	-0.09	0.01	-0.01	B+97 5	97
0.01						B+97 5	98
11670.	6411.	2230.	0.45	0.09	-0.26	B+97 5	99
0.02						B+97 5	100
11670.	11670.	4459.	-0.26	0.04	-0.04	B+97 5	101
0.04						B+97 5	102
11670.	11670.	8191.	-0.35	0.03	-0.06	B+97 5	103
0.04						B+97 5	104
11670.	8191.	4459.	0.51	0.09	-0.18	B+97 5	105
0.14						B+97 5	106
11670.	8191.	5413.	-0.47	0.09	0.20	B+97 5	107

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 0.13                                                                 B+97 5  108
 11670.     8191.      5549.       0.42       0.06      -0.20         B+97 5  109
 0.08                                                                 B+97 5  110
 11697.     11697.     6411.      -1.01       0.02       0.17         B+97 5  111
 0.02                                                                 B+97 5  112
 11697.     6411.      2230.      -0.31       0.05       0.09         B+97 5  113
 0.06                                                                 B+97 5  114
 11697.     11697.     8191.      -0.31       0.05       0.09         B+97 5  115
 0.06                                                                 B+97 5  116
 11940.     11940.     5413.       0.52       0.05       0.05         B+97 5  117
 0.07                                                                 B+97 5  118
 11940.     5413.      2230.       0.28       0.03       0.05         B+97 5  119
 0.04                                                                 B+97 5  120
 11940.     11940.     5549.      -0.23       0.08       0.11         B+97 5  121
 0.09                                                                 B+97 5  122
 11940.     11940.     4459.      -0.10       0.03      -0.06         B+97 5  123
 0.04                                                                 B+97 5  124
ENDDATA            112                                                B+97 5  127
ENDSUBENT            5                                                B+97 599999
SUBENT         B+97  6          0                                     B+97 6    1
BIB                  1          7                                     B+97 6    2
COMMENTS   PROPERTIES OF KNOWN ENERGY LEVELS IN 32S BELOW 10.76       B+97 6    3
           MEV ARE GIVEN. INFORMATION IS OBTAINED FROM TABLE 8.       B+97 6    4
           EX = LEVEL EXCITATION ENERGY. J-PI = SPIN AND PARITY.      B+97 6    5
           NEGATIVE SIGN IMPLIES NEGATIVE PARITY, OTHERWISE           B+97 6    6
           PARITY IS POSITIVE. T = ISOSPIN. QUANTUM NUMBERS ARE       B+97 6    7
           ONLY GIVEN WHEN THEY WERE ASSUMED AT THE TIME OF THIS      B+97 6    8
           WORK TO BE KNOWN WITH NO AMBUIGUITY.                       B+97 6    9
ENDBIB               7                                                B+97 6   10
DATA                 6        108                                     B+97 6   11
EX         J-PI       T                                               B+97 6   12
KEV        NO-DIM     NO-DIM                                          B+97 6   13
 0.         0.                                                        B+97 6   14
 2230.      2.                                                        B+97 6   15
 3778.      0.                                                        B+97 6   16
 4282.      2.                                                        B+97 6   17
 4459.      4.                                                        B+97 6   18
 4695.      1.                                                        B+97 6   19
 5006.     -3.                                                        B+97 6   20
 5413.      3.                                                        B+97 6   21
 5549.      2.                                                        B+97 6   22
 5798.     -1.                                                        B+97 6   23
 6224.     -2.                                                        B+97 6   24
 6411.      4.                                                        B+97 6   25
 6581.                                                                B+97 6   26
 6621.     -4.                                                        B+97 6   27
 6666.      2.                                                        B+97 6   28
 6762.     -5.                                                        B+97 6   29
 6852.      4.                                                        B+97 6   30
 7003.      1.         1.                                             B+97 6   31
 7115.      2.         1.                                             B+97 6   32
 7190.      1.                                                        B+97 6   33
 7350.      3.                                                        B+97 6   34
 7434.     -1.                                                        B+97 6   35
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7485.	2.		B+97 6	36
7536.	0.	1.	B+97 6	37
7567.	5.		B+97 6	38
7637.	0.		B+97 6	39
7702.	-3.		B+97 6	40
7883.	4.		B+97 6	41
7885.			B+97 6	42
7921.			B+97 6	43
7950.	-4.		B+97 6	44
7975.	-3.		B+97 6	45
8127.	1.	1.	B+97 6	46
8191.	4.		B+97 6	47
8270.			B+97 6	48
8281.			B+97 6	49
8296.	-3.		B+97 6	50
8344.	2.		B+97 6	51
8346.			B+97 6	52
8380.			B+97 6	53
8407.	2.		B+97 6	54
8492.	-1.		B+97 6	55
8507.	0.		B+97 6	56
8690.	2.		B+97 6	57
8729.	3.		B+97 6	58
8746.	3.		B+97 6	59
8861.	2.		B+97 6	60
9023.	-3.		B+97 6	61
9024.			B+97 6	62
9060.			B+97 6	63
9065.	4.		B+97 6	64
9138.			B+97 6	65
9170.	3.	1.	B+97 6	66
9208.	1.	1.	B+97 6	67
9235.			B+97 6	68
9236.	-1.		B+97 6	69
9255.	2.	1.	B+97 6	70
9290.	1.		B+97 6	71
9389.	-2.		B+97 6	72
9463.			B+97 6	73
9464.	2.		B+97 6	74
9487.	-1.		B+97 6	75
9557.			B+97 6	76
9635.			B+97 6	77
9650.	2.	1.	B+97 6	78
9660.	1.	1.	B+97 6	79
9712.	2.		B+97 6	80
9724.			B+97 6	81
9731.	-1.		B+97 6	82
9783.			B+97 6	83
9817.	3.		B+97 6	84
9827.			B+97 6	85
9849.	-1.		B+97 6	86
9888.			B+97 6	87
9920.	3.		B+97 6	88
9950.	1.		B+97 6	89

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 9978.     -4.                                                     B+97 6   90
 9979.      3.                                                     B+97 6   91
 9983.     -2.                                                     B+97 6   92
 9986.      0.                                                     B+97 6   93
 10021.                                                            B+97 6   94
 10077.    -2.                                                     B+97 6   95
 10102.                                                            B+97 6   96
 10221.     3.                                                     B+97 6   97
 10223.    -3.                                                     B+97 6   98
 10226.    -1.                                                     B+97 6   99
 10232.     1.                                                     B+97 6  100
 10258.    -4.                                                     B+97 6  101
 10276.     4.         1.                                          B+97 6  102
 10288.    -3.                                                     B+97 6  103
 10291.    -2.                                                     B+97 6  104
 10293.     2.                                                     B+97 6  105
 10333.    -1.                                                     B+97 6  106
 10372.     2.         1.                                          B+97 6  107
 10398.    -4.                                                     B+97 6  108
 10402.    -0.                                                     B+97 6  109
 10434.                                                            B+97 6  110
 10457.     0.                                                     B+97 6  111
 10508.     2.                                                     B+97 6  112
 10528.     2.                                                     B+97 6  113
 10574.     5.                                                     B+97 6  114
 10604.    -1.                                                     B+97 6  115
 10626.    -3.                                                     B+97 6  116
 10636.                                                            B+97 6  117
 10696.     2.                                                     B+97 6  118
 10701.    -1.                                                     B+97 6  119
 10705.                                                            B+97 6  120
 10757.     3.         1.                                          B+97 6  121
ENDDATA           110                                              B+97 6  122
ENDSUBENT           6                                              B+97 699999
ENDENTRY            6                                              B+979999999
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BS75

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ENTRY             BS75          0                                  BS75 0    1
SUBENT         BS75  1          0                                  BS75 1    1
BIB                12          26                                  BS75 1    2
INSTITUTE  (AULAML)                                                BS75 1    3
REFERENCE  (J,AUJ,28,383,1975)                                     BS75 1    4
AUTHORS    (S.G.BOYDELL,D.G.SARGOOD)                               BS75 1    5
TITLE      ACCURATE BRANCHING RATIO MEASUREMENTS IN                BS75 1    6
           31P(P,GAMMA)32S                                         BS75 1    7
FACILITIES (C-W) 800-KV ELECTROSTATIC ACCELERATOR, UNIV. OF        BS75 1    8
           MELBOURNE, MELBOURNE, AUSTRALIA.                        BS75 1    9
           (VDG) 3-MV VAN DE GRAAFF ACCELERATOR, AAEC RESEARCH     BS75 1   10
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           ESTABLISHMENT, LUCAS HEIGHTS, N.S.W., AUSTRALIA.        BS75 1   11
INC-PART   (P) PROTONS.                                            BS75 1   12
TARGETS    ELEMENTAL PHOSPHORUS TARGETS OF NORMAL THICKNESS WERE   BS75 1   13
           PREPARED BY DEPOSITION AS THE STABLE, RED ALLOTROPE     BS75 1   14
           ON GOLD BACKINGS. VERY THIN TARGETS WERE PREPARED BY    BS75 1   15
           EVAPORATION OF ZN2P3 ON GOLD BACKINGS. THICKNESS WAS    BS75 1   16
           CHOSEN TO BE LARGER THAN THE RESONANCE WIDTH BUT        BS75 1   17
           SMALLER THAN THE RESONANCE SEPARATION.                  BS75 1   18
METHOD     YIELDS OF GAMMA RAYS FOLLOWING THE DECAY OF 32S         BS75 1   19
           FORMED IN EXCITED STATES BY PROTON BOMBARDMENT OF       BS75 1   20
           PHOSPHORUS WERE MEASURED AT RESONANCE PROTON ENERGIES.  BS75 1   21
           DECAY BRANCHING RATIOS WERE DEDUCED FROM THE DATA.      BS75 1   22
DETECTORS  (GELI) GE(LI) DETECTORS OF UNSPECIFIED SIZE.            BS75 1   23
MONITOR    (CI) CURRENT INTEGRATOR.                                BS75 1   24
CORRECTION GAMMA-RAY YIELD DATA WERE CORRECTED FOR DETECTOR        BS75 1   25
           EFFICIENCY.                                             BS75 1   26
ERR-ANALYS ERRORS DUE TO GAMMA-RAY PEAK YIELD UNCERTAINTIES AND    BS75 1   27
           DETECTOR CALIBRATION UNCERTAINTIES ARE PROVIDED.        BS75 1   28
ENDBIB              26                                             BS75 1   29
ENDSUBENT            1                                             BS75 199999
SUBENT        BS75  2          0                                   BS75 2    1
BIB                  2          12                                 BS75 2    2
REACTION   31P(P,GAMMA)32S                                         BS75 2    3
COMMENTS   BRANCHING RATIOS FOR THE GAMMA-RAY DECAY OF RESONANCE   BS75 2    4
           LEVELS IN 32S ARE GIVEN. INFORMATION IS OBTAINED FROM   BS75 2    5
           TABLE 1. EP = RESONANCE PROTON ENERGY. J-PI-R = SPIN    BS75 2    6
           AND PARITY OF RESONANCE STATE. J-PI-F = SPIN AND        BS75 2    7
           PARITY OF FINAL STATE. NEGATIVE PARITY IS DENOTED BY    BS75 2    8
           A NEGATIVE SIGN. OTHERWISE PARITY IS POSITIVE. EF =     BS75 2    9
           ENERGY OF FINAL STATE IN 32S. B = BRANCHING RATIO.      BS75 2   10
           B-ERR = ERROR IN BRANCHING RATIO. WHENEVER A CERTAIN    BS75 2   11
           VALUE IS UNAVAILABLE OR AMBIGUOUS THE SPACE IS LEFT     BS75 2   12
           BLANK. PCT = PERCENT. ALL GIVEN VALUES OF B ARE         BS75 2   13
           UPPER LIMITS UNLESS ERRORS ARE INDICATED.               BS75 2   14
ENDBIB              12                                             BS75 2   15
DATA                 6         375                                 BS75 2   16
EP         J-PI-R     EF         J-PI-F     B          B-ERR       BS75 2   17
KEV        NO-DIM     MEV        NO-DIM     PCT        PCT         BS75 2   18
 439.        1.         0.         0.        40.         5.        BS75 2   19
 439.        1.         2.23       2.        19.         2.        BS75 2   20
 439.        1.         3.78       0.        0.8                   BS75 2   21
 439.        1.         4.28       2.        1.1                   BS75 2   22
 439.        1.         4.46       4.        0.7                   BS75 2   23
 439.        1.         4.70       1.        13.         1.        BS75 2   24
 439.        1.         5.01      -3.        1.1                   BS75 2   25
 439.        1.         5.41       3.        0.9                   BS75 2   26
 439.        1.         5.55       2.        1.4                   BS75 2   27
 439.        1.         5.80      -1.        0.9                   BS75 2   28
 439.        1.         6.22      -2.        1.8         0.3       BS75 2   29
 439.        1.         6.62      -4.        0.4                   BS75 2   30
 439.        1.         6.67                 0.4                   BS75 2   31
 439.        1.         7.12       2.        19.         4.        BS75 2   32
 439.        1.         7.54       0.        7.4         0.9       BS75 2   33
 541.       -2.         0.         0.        2.3         0.2       BS75 2   34
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541.	-2.	2.23	2.	62.	5.	BS75 2	35
541.	-2.	3.78	0.	0.5		BS75 2	36
541.	-2.	4.28	2.	1.9	0.5	BS75 2	37
541.	-2.	4.46	4.	0.6		BS75 2	38
541.	-2.	4.70	1.	1.6	0.6	BS75 2	39
541.	-2.	5.01	-3.	10.	1.	BS75 2	40
541.	-2.	5.41	3.	0.9		BS75 2	41
541.	-2.	5.55	2.	1.2	0.3	BS75 2	42
541.	-2.	5.80	-1.	1.1	0.3	BS75 2	43
541.	-2.	6.22	-2.	18.	3.	BS75 2	44
541.	-2.	6.62	-4.	1.3	0.3	BS75 2	45
541.	-2.	6.67		0.4		BS75 2	46
541.	-2.	6.76		0.4		BS75 2	47
541.	-2.	8.13	1.	1.9	0.3	BS75 2	48
642.	-1.	0.	0.	85.	7.	BS75 2	49
642.	-1.	2.23	2.	2.3		BS75 2	50
642.	-1.	3.78	0.	1.8		BS75 2	51
642.	-1.	4.28	2.	8.	1.	BS75 2	52
642.	-1.	4.46	4.	0.8		BS75 2	53
642.	-1.	4.70	1.	3.		BS75 2	54
642.	-1.	5.01	-3.	3.1	0.7	BS75 2	55
642.	-1.	5.41	3.	1.4		BS75 2	56
642.	-1.	5.55	2.	2.		BS75 2	57
642.	-1.	5.80	-1.	3.6	0.8	BS75 2	58
642.	-1.	6.22	-2.	2.4		BS75 2	59
642.	-1.	7.12	2.	8.3		BS75 2	60
811.	2.	0.	0.	0.4	0.2	BS75 2	61
811.	2.	2.23	2.	58.	5.	BS75 2	62
811.	2.	3.78	0.	0.4		BS75 2	63
811.	2.	4.28	2.	0.4		BS75 2	64
811.	2.	4.46	4.	1.2		BS75 2	65
811.	2.	4.70	1.	40.	3.	BS75 2	66
811.	2.	5.01	-3.	0.6		BS75 2	67
811.	2.	5.41	3.	1.7	0.4	BS75 2	68
811.	2.	5.55	2.	0.5		BS75 2	69
811.	2.	5.80	-1.	0.8		BS75 2	70
811.	2.	6.22	-2.	0.6		BS75 2	71
821.		0.	0.	81.	8.	BS75 2	72
821.		2.23	2.	10.	1.	BS75 2	73
821.		3.78	0.	1.8	0.3	BS75 2	74
821.		4.28	2.	0.2		BS75 2	75
821.		4.46	4.	0.4		BS75 2	76
821.		4.70	1.	2.3	1.	BS75 2	77
821.		5.01	-3.	0.3		BS75 2	78
821.		5.41	3.	0.2		BS75 2	79
821.		5.55	2.	2.2	0.3	BS75 2	80
821.		5.80	-1.	0.7		BS75 2	81
821.		6.22	-2.	0.3		BS75 2	82
821.		7.19	1.	2.1	0.9	BS75 2	83
821.		7.48		0.3	0.1	BS75 2	84
874.	2.	0.	0.	6.6	0.7	BS75 2	85
874.	2.	2.23	2.	43.	7.	BS75 2	86
874.	2.	3.78	0.	6.4	2.	BS75 2	87
874.	2.	4.28	2.	2.8	0.8	BS75 2	88

874.	2.	4.46	4.	1.2	0.5	BS75 2	89
874.	2.	4.70	1.	26.	2.	BS75 2	90
874.	2.	5.01	-3.	2.1	1.	BS75 2	91
874.	2.	5.41	3.	1.3		BS75 2	92
874.	2.	5.55	2.	1.8		BS75 2	93
874.	2.	5.80	-1.	3.6	0.9	BS75 2	94
874.	2.	6.22	-2.	1.7		BS75 2	95
874.	2.	7.00	1.	3.1	0.5	BS75 2	96
874.	2.	7.12	2.	3.1	0.5	BS75 2	97
874.	2.	8.13	1.	2.9	0.7	BS75 2	98
888.		0.	0.	0.4		BS75 2	99
888.		2.23	2.	0.8	0.2	BS75 2	100
888.		3.78	0.	1.2		BS75 2	101
888.		4.28	2.	0.9		BS75 2	102
888.		4.46	4.	0.7		BS75 2	103
888.		4.70	1.	0.9		BS75 2	104
888.		5.01	-3.	39.	3.	BS75 2	105
888.		5.41	3.	0.9		BS75 2	106
888.		5.55	2.	0.8		BS75 2	107
888.		5.80	-1.	0.4		BS75 2	108
888.		6.22	-2.	13.	1.4	BS75 2	109
888.		6.62	-4.	41.	3.	BS75 2	110
888.		6.76		5.1	2.	BS75 2	111
888.		7.12	2.	0.5		BS75 2	112
888.		7.54	0.	0.4		BS75 2	113
888.		7.70		1.0	0.5	BS75 2	114
888.		7.95		0.7		BS75 2	115
895.		0.	0.	4.0	0.5	BS75 2	116
895.		2.23	2.	19.	2.	BS75 2	117
895.		3.78	0.	0.8		BS75 2	118
895.		4.28	2.	22.	2.	BS75 2	119
895.		4.46	4.	0.5		BS75 2	120
895.		4.70	1.	5.2	0.9	BS75 2	121
895.		5.01	-3.	3.0	1.5	BS75 2	122
895.		5.41	3.	1.4		BS75 2	123
895.		5.55	2.	1.	0.5	BS75 2	124
895.		5.80	-1.	20.	2.	BS75 2	125
895.		6.22	-2.	20.	2.	BS75 2	126
895.		6.62	-4.	0.3		BS75 2	127
895.		7.70		0.6		BS75 2	128
895.		7.95		1.2	0.3	BS75 2	129
895.		8.13	1.	4.2	0.6	BS75 2	130
984.		0.	0.	0.7	0.2	BS75 2	131
984.		2.23	2.	20.	2.	BS75 2	132
984.		3.78	0.	0.8		BS75 2	133
984.		4.28	2.	10.	2.	BS75 2	134
984.		4.46	4.	1.7	0.4	BS75 2	135
984.		4.70	1.	0.9		BS75 2	136
984.		5.01	-3.	50.	3.	BS75 2	137
984.		5.41	3.	1.5		BS75 2	138
984.		5.55	2.	0.7		BS75 2	139
984.		5.80	-1.	2.7	0.3	BS75 2	140
984.		6.22	-2.	5.6	0.7	BS75 2	141
984.		6.62	-4.	0.6		BS75 2	142

984.		7.12	2.	8.6	0.6	BS75 2	143
1016.	-1.	0.	0.	10.	1.	BS75 2	144
1016.	-1.	2.23	2.	51.	4.	BS75 2	145
1016.	-1.	3.78	0.	0.5		BS75 2	146
1016.	-1.	4.28	2.	1.8	0.6	BS75 2	147
1016.	-1.	4.46	4.	1.3		BS75 2	148
1016.	-1.	4.70	1.	2.4	0.5	BS75 2	149
1016.	-1.	5.01	-3.	1.		BS75 2	150
1016.	-1.	5.41	3.	1.7		BS75 2	151
1016.	-1.	5.55	2.	0.9		BS75 2	152
1016.	-1.	5.80	-1.	5.7	1.	BS75 2	153
1016.	-1.	6.22	-2.	2.2		BS75 2	154
1016.	-1.	6.62	-4.	0.5		BS75 2	155
1016.	-1.	6.67		1.4	0.4	BS75 2	156
1016.	-1.	7.12	2.	27.	2.	BS75 2	157
1057.		0.	0.	1.7	0.2	BS75 2	158
1057.		2.23	2.	10.	1.	BS75 2	159
1057.		3.78	0.	0.6		BS75 2	160
1057.		4.28	2.	3.8	0.5	BS75 2	161
1057.		4.46	4.	0.2	0.1	BS75 2	162
1057.		4.70	1.	5.0	1.	BS75 2	163
1057.		5.01	-3.	7.		BS75 2	164
1057.		5.41	3.	1.2		BS75 2	165
1057.		5.55	2.	11.	1.	BS75 2	166
1057.		5.80	-1.	0.3		BS75 2	167
1057.		6.22	-2.	0.5		BS75 2	168
1057.		6.67		3.6	0.4	BS75 2	169
1057.		7.00	1.	24.	3.	BS75 2	170
1057.		7.12	2.	45.	6.	BS75 2	171
1090.		0.	0.	1.1		BS75 2	172
1090.		2.23	2.	41.	4.	BS75 2	173
1090.		3.78	0.	1.3		BS75 2	174
1090.		4.28	2.	1.2	0.7	BS75 2	175
1090.		4.46	4.	1.4		BS75 2	176
1090.		4.70	1.	11.		BS75 2	177
1090.		5.01	-3.	1.1		BS75 2	178
1090.		5.41	3.	2.7	1.	BS75 2	179
1090.		5.55	2.	35.	3.	BS75 2	180
1090.		5.80	-1.	1.3		BS75 2	181
1090.		6.22	-2.	2.3		BS75 2	182
1090.		6.62	-4.	1.1		BS75 2	183
1090.		6.67		5.		BS75 2	184
1090.		6.85		7.4	1.	BS75 2	185
1090.		7.12	2.	9.	1.	BS75 2	186
1090.		7.48		2.9	0.3	BS75 2	187
1090.		7.54	0.	0.8	0.4	BS75 2	188
1121.	-1.	0.	0.	76.	7.	BS75 2	189
1121.	-1.	2.23	2.	8.1	0.9	BS75 2	190
1121.	-1.	3.78	0.	2.8	0.6	BS75 2	191
1121.	-1.	4.28	2.	2.2	0.3	BS75 2	192
1121.	-1.	4.46	4.	1.		BS75 2	193
1121.	-1.	4.70	1.	1.5	0.3	BS75 2	194
1121.	-1.	5.01	-3.	0.3		BS75 2	195
1121.	-1.	5.41	3.	0.3		BS75 2	196

1121.	-1.	5.55	2.	0.8		BS75 2	197
1121.	-1.	5.80	-1.	0.3		BS75 2	198
1121.	-1.	6.22	-2.	0.4		BS75 2	199
1121.	-1.	6.62	-4.	0.5		BS75 2	200
1121.	-1.	7.00	1.	0.4	0.1	BS75 2	201
1121.	-1.	7.12	2.	1.5	0.2	BS75 2	202
1121.	-1.	8.13	1.	7.8	0.6	BS75 2	203
1151.	-3.	0.	0.	0.5		BS75 2	204
1151.	-3.	2.23	2.	31.	3.	BS75 2	205
1151.	-3.	3.78	0.	0.9		BS75 2	206
1151.	-3.	4.28	2.	1.		BS75 2	207
1151.	-3.	4.46	4.	7.6	0.7	BS75 2	208
1151.	-3.	4.70	1.	0.4		BS75 2	209
1151.	-3.	5.01	-3.	6.5	0.6	BS75 2	210
1151.	-3.	5.41	3.	6.6	0.6	BS75 2	211
1151.	-3.	5.55	2.	28.	2.	BS75 2	212
1151.	-3.	5.80	-1.	1.1	0.3	BS75 2	213
1151.	-3.	6.22	-2.	2.4	1.0	BS75 2	214
1151.	-3.	6.62	-4.	3.5	0.3	BS75 2	215
1151.	-3.	6.67		0.6		BS75 2	216
1151.	-3.	6.85		6.5	0.7	BS75 2	217
1151.	-3.	7.12	2.	4.0	0.7	BS75 2	218
1151.	-3.	7.48		3.9	0.3	BS75 2	219
1155.	2.	0.	0.	0.7	0.1	BS75 2	220
1155.	2.	2.23	2.	62.	6.	BS75 2	221
1155.	2.	3.78	0.	0.6		BS75 2	222
1155.	2.	4.28	2.	1.6	0.5	BS75 2	223
1155.	2.	4.46	4.	0.9		BS75 2	224
1155.	2.	4.70	1.	21.	2.	BS75 2	225
1155.	2.	5.01	-3.	0.9	0.2	BS75 2	226
1155.	2.	5.41	3.	1.		BS75 2	227
1155.	2.	5.55	2.	9.4	0.9	BS75 2	228
1155.	2.	5.80	-1.	0.9		BS75 2	229
1155.	2.	6.22	-2.	1.1		BS75 2	230
1155.	2.	6.62	-4.	1.2	0.4	BS75 2	231
1155.	2.	6.85		0.8	0.2	BS75 2	232
1155.	2.	7.00	1.	1.8	0.5	BS75 2	233
1155.	2.	7.12	2.	0.8	0.3	BS75 2	234
1251.	-2.	0.	0.	2.0	0.2	BS75 2	235
1251.	-2.	2.23	2.	32.	3.	BS75 2	236
1251.	-2.	3.78	0.	0.4		BS75 2	237
1251.	-2.	4.28	2.	1.5	0.2	BS75 2	238
1251.	-2.	4.46	4.	0.5		BS75 2	239
1251.	-2.	4.70	1.	0.9	0.2	BS75 2	240
1251.	-2.	5.01	-3.	13.	1.	BS75 2	241
1251.	-2.	5.41	3.	3.8	0.7	BS75 2	242
1251.	-2.	5.55	2.	0.7		BS75 2	243
1251.	-2.	5.80	-1.	1.5		BS75 2	244
1251.	-2.	6.22	-2.	46.	3.	BS75 2	245
1251.	-2.	6.62	-4.	0.7		BS75 2	246
1251.	-2.	6.67		0.7		BS75 2	247
1251.	-2.	7.70		0.3	0.1	BS75 2	248
1400.	2.	0.	0.	1.6	0.2	BS75 2	249
1400.	2.	2.23	2.	12.	1.	BS75 2	250

1400.	2.	3.78	0.	0.7		BS75 2	251
1400.	2.	4.28	2.	6.8	0.6	BS75 2	252
1400.	2.	4.46	4.	5.3	0.5	BS75 2	253
1400.	2.	4.70	1.	19.	2.	BS75 2	254
1400.	2.	5.01	-3.	4.9	0.7	BS75 2	255
1400.	2.	5.41	3.	2.9	0.3	BS75 2	256
1400.	2.	5.55	2.	6.8	0.7	BS75 2	257
1400.	2.	5.80	-1.	0.6		BS75 2	258
1400.	2.	6.22	-2.	0.7		BS75 2	259
1400.	2.	6.62	-4.	0.6		BS75 2	260
1400.	2.	6.67		0.7	O.2	BS75 2	261
1400.	2.	7.12	2.	41.	3.	BS75 2	262
1400.	2.	7.19	1.	0.5	0.1	BS75 2	263
1400.	2.	7.48		1.1	0.2	BS75 2	264
1403.	-3.	0.	0.	0.3	0.2	BS75 2	265
1403.	-3.	2.23	2.	14.	1.	BS75 2	266
1403.	-3.	3.78	0.	0.2		BS75 2	267
1403.	-3.	4.28	2.	1.		BS75 2	268
1403.	-3.	4.46	4.	21.	2.	BS75 2	269
1403.	-3.	4.70	1.	1.		BS75 2	270
1403.	-3.	5.01	-3.	62.	5.	BS75 2	271
1403.	-3.	5.41	3.	0.4	0.2	BS75 2	272
1403.	-3.	5.55	2.	1.		BS75 2	273
1403.	-3.	5.80	-1.	0.8		BS75 2	274
1403.	-3.	6.22	-2.	0.6		BS75 2	275
1403.	-3.	6.62	-4.	0.6		BS75 2	276
1403.	-3.	6.67		0.7	0.2	BS75 2	277
1403.	-3.	7.12	2.	2.0	1.5	BS75 2	278
1403.	-3.	7.48		0.4		BS75 2	279
1411.	2.	0.	0.	7.6	0.8	BS75 2	280
1411.	2.	2.23	2.	9.0	0.9	BS75 2	281
1411.	2.	3.78	0.	2.8	0.6	BS75 2	282
1411.	2.	4.28	2.	11.	1.	BS75 2	283
1411.	2.	4.46	4.	1.		BS75 2	284
1411.	2.	4.70	1.	4.3	0.6	BS75 2	285
1411.	2.	5.01	-3.	1.4		BS75 2	286
1411.	2.	5.41	3.	3.2	0.3	BS75 2	287
1411.	2.	5.55	2.	2.5	0.5	BS75 2	288
1411.	2.	5.80	-1.	1.		BS75 2	289
1411.	2.	6.22	-2.	4.2	0.9	BS75 2	290
1411.	2.	6.62	-4.	0.9		BS75 2	291
1411.	2.	6.67		1.		BS75 2	292
1411.	2.	6.76		1.1		BS75 2	293
1411.	2.	6.85		1.		BS75 2	294
1411.	2.	7.00	1.	47.	3.	BS75 2	295
1411.	2.	7.12	2.	3.2	1.0	BS75 2	296
1411.	2.	7.19	1.	0.9	0.2	BS75 2	297
1411.	2.	7.54	0.	5.4	0.7	BS75 2	298
1438.	-4.	0.	0.	0.3		BS75 2	299
1438.	-4.	2.23	2.	0.9	0.1	BS75 2	300
1438.	-4.	3.78	0.	0.1		BS75 2	301
1438.	-4.	4.28	2.	0.2		BS75 2	302
1438.	-4.	4.46	4.	9.7	0.7	BS75 2	303
1438.	-4.	4.70	1.	0.1		BS75 2	304

1438.	-4.	5.01	-3.	4.7	0.5	BS75 2 305
1438.	-4.	5.41	3.	0.2		BS75 2 306
1438.	-4.	5.55	2.	0.3		BS75 2 307
1438.	-4.	6.62	-4.	76.	5.	BS75 2 308
1438.	-4.	6.76		2.6	0.6	BS75 2 309
1438.	-4.	7.70		0.3		BS75 2 310
1438.	-4.	7.95		5.6	0.6	BS75 2 311
1473.	2.	0.	0.	4.0	0.4	BS75 2 312
1473.	2.	2.23	2.	35.	4.	BS75 2 313
1473.	2.	3.78	0.	1.5		BS75 2 314
1473.	2.	4.28	2.	2.8	0.4	BS75 2 315
1473.	2.	4.46	4.	3.		BS75 2 316
1473.	2.	4.70	1.	1.		BS75 2 317
1473.	2.	5.01	-3.	24.	1.	BS75 2 318
1473.	2.	5.41	3.	2.2	0.8	BS75 2 319
1473.	2.	5.55	2.	1.7		BS75 2 320
1473.	2.	5.80	-1.	2.4	0.8	BS75 2 321
1473.	2.	6.22	-2.	29.	2.	BS75 2 322
1473.	2.	6.62	-4.	1.4		BS75 2 323
1473.	2.	6.67		1.8	0.9	BS75 2 324
1473.	2.	7.48		2.3		BS75 2 325
1473.	2.	8.13	1.	3.4	1.0	BS75 2 326
1515.	-1.	0.	0.	15.	2.	BS75 2 327
1515.	-1.	2.23	2.	68.	6.	BS75 2 328
1515.	-1.	3.78	0.	2.3		BS75 2 329
1515.	-1.	4.28	2.	0.8		BS75 2 330
1515.	-1.	4.46	4.	1.3		BS75 2 331
1515.	-1.	4.70	1.	12.	1.	BS75 2 332
1515.	-1.	5.01	-3.	1.3		BS75 2 333
1515.	-1.	5.41	3.	2.6		BS75 2 334
1515.	-1.	5.55	2.	11.		BS75 2 335
1515.	-1.	5.80	-1.	3.4		BS75 2 336
1515.	-1.	6.22	-2.	2.5		BS75 2 337
1515.	-1.	6.62	-4.	2.6		BS75 2 338
1515.	-1.	6.67		2.2		BS75 2 339
1515.	-1.	6.76		2.9		BS75 2 340
1515.	-1.	7.00	1.	2.1		BS75 2 341
1515.	-1.	8.13	1.	5.	1.	BS75 2 342
1557.	2.	0.	0.	1.	0.2	BS75 2 343
1557.	2.	2.23	2.	12.	1.	BS75 2 344
1557.	2.	3.78	0.	0.6	0.2	BS75 2 345
1557.	2.	4.28	2.	40.	3.	BS75 2 346
1557.	2.	4.46	4.	0.3		BS75 2 347
1557.	2.	4.70	1.	9.2	0.7	BS75 2 348
1557.	2.	5.01	-3.	2.3	0.2	BS75 2 349
1557.	2.	5.41	3.	12.	1.	BS75 2 350
1557.	2.	5.55	2.	2.7	0.3	BS75 2 351
1557.	2.	5.80	-1.	0.6		BS75 2 352
1557.	2.	6.22	-2.	2.0	0.3	BS75 2 353
1557.	2.	6.62	-4.	0.6		BS75 2 354
1557.	2.	6.67		14.	1.	BS75 2 355
1557.	2.	6.85		0.6		BS75 2 356
1557.	2.	7.00	1.	0.6		BS75 2 357
1557.	2.	7.19	1.	1.2	0.9	BS75 2 358

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 1557.     2.         7.48                  2.6        0.9          BS75 2  359
 1583.                0.         0.         0.9                     BS75 2  360
 1583.                2.23       2.         0.8        0.3          BS75 2  361
 1583.                3.78       0.         0.3                     BS75 2  362
 1583.                4.28       2.         1.8        0.5          BS75 2  363
 1583.                4.46       4.         1.4        0.4          BS75 2  364
 1583.                4.70       1.         0.3                     BS75 2  365
 1583.                5.01      -3.         6.4        0.5          BS75 2  366
 1583.                5.41       3.         0.2                     BS75 2  367
 1583.                5.55       2.         0.5                     BS75 2  368
 1583.                5.80      -1.         1.                      BS75 2  369
 1583.                6.22      -2.         2.                      BS75 2  370
 1583.                6.62      -4.         82.        5.           BS75 2  371
 1583.                6.76                  2.2        1.7          BS75 2  372
 1583.                7.70                  0.3                     BS75 2  373
 1583.                7.95                  3.9        0.4          BS75 2  374
 1583.                8.13       1.         0.8        0.5          BS75 2  375
 1699.                0.         0.         8.8        0.9          BS75 2  376
 1699                 2.23       2.         21.        2.           BS75 2  377
 1699.                3.78       0.         2.5                     BS75 2  378
 1699.                4.28       2.         11.        1.           BS75 2  379
 1699.                4.46       4.         1.4                     BS75 2  380
 1699.                4.70       1.         2.5        0.8          BS75 2  381
 1699.                5.01      -3.         3.3        0.6          BS75 2  382
 1699.                5.41       3.         7.4        0.6          BS75 2  383
 1699.                5.55       2.         2.7        0.5          BS75 2  384
 1699.                5.80      -1.         2.1                     BS75 2  385
 1699.                6.22      -2.         7.3                     BS75 2  386
 1699.                6.62      -4.         1.5                     BS75 2  387
 1699.                6.67                  3.                      BS75 2  388
 1699.                6.76                  1.5                     BS75 2  389
 1699.                6.85                  1.5                     BS75 2  390
 1699.                7.00       1.         4.                      BS75 2  391
 1699.                7.12       2.         40.        4.           BS75 2  392
 1699.                7.19       1.         3.8        0.4          BS75 2  393
ENDDATA             377                                             BS75 2  394
ENDSUBENT             2                                             BS75 299999
SUBENT          BS75  3          0                                  BS75 3    1
BIB                   1         13                                  BS75 3    2
COMMENTS   BRANCHING RATIOS ARE GIVEN FOR THE GAMMA-RAY DECAY       BS75 3    3
           OF BOUND LEVELS IN 32S. INFORMATION IS OBTAINED FROM     BS75 3    4
           TABLE 2 OF THE PAPER. EI = INITIAL STATE EXCITATION      BS75 3    5
           ENERGY FOR GAMMA-RAY TRANSITION. J-PI-I = SPIN AND       BS75 3    6
           PARITY FOR INTIAL STATE. EF = FINAL STATE EXCITATION     BS75 3    7
           ENERGY FOR GAMMA-RAY TRANSITION. J-PI-F = SPIN AND       BS75 3    8
           PARITY FOR FINAL STATE. NEGATIVE PARITY IS INDICATED     BS75 3    9
           BY A NEGATIVE SIGN. OTHERWISE PARITY IS POSITIVE.        BS75 3   10
           B = BRANCHING RATIO. B-ERR = ERROR IN BRANCHING          BS75 3   11
           RATIO.  PCT = PERCENT. WHENEVER A CERTAIN VALUE IS       BS75 3   12
           UNAVAILABLE OR AMBIGUOUS THE SPACE IS LEFT BLANK.        BS75 3   13
           ALL GIVEN VALUES OF B ARE UPPER LIMITS UNLESS ERRORS     BS75 3   14
           ARE INDICATED.                                           BS75 3   15
ENDBIB               13                                             BS75 3   16
DATA                  6        140                                  BS75 3   17
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EI	J-PI-I	EF	J-PI-F	B	B-ERR	
MEV	NO-DIM	MEV	NO-DIM	PCT	PCT	BS75 3 19
2.23	2.	0.	0.	100.		BS75 3 20
3.78	0.	0.	0.	10.		BS75 3 21
3.78	0.	2.23	2.	100.		BS75 3 22
4.28	2.	0.	0.	87.	0.5	BS75 3 23
4.28	2.	2.23	2.	13.	0.5	BS75 3 24
4.28	2.	3.78	0.	0.4		BS75 3 25
4.46	4.	0.	0.	1.		BS75 3 26
4.46	4.	2.23	2.	100.		BS75 3 27
4.46	4.	3.78	0.	0.3		BS75 3 28
4.70	1.	0.	0.	39.	1.	BS75 3 29
4.70	1.	2.23	2.	61.	1.	BS75 3 30
4.70	1.	3.78	0.	0.4		BS75 3 31
4.70	1.	4.28	2.	0.6		BS75 3 32
5.01	-3.	0.	0.	4.	1.	BS75 3 33
5.01	-3.	2.23	2.	96.	1.	BS75 3 34
5.01	-3.	3.78	0.	0.04		BS75 3 35
5.01	-3.	4.28	2.	0.1		BS75 3 36
5.41	3.	0.	0.	5.		BS75 3 37
5.41	3.	2.23	2.	100.		BS75 3 38
5.41	3.	4.28	2.	6.		BS75 3 39
5.41	3.	4.46	4.	1.		BS75 3 40
5.41	3.	4.70	1.	1.		BS75 3 41
5.41	3.	5.01	-3.	2		BS75 3 42
5.55	2.	0.	0.	40.	1.5	BS75 3 43
5.55	2.	2.23	2.	60.	1.5	BS75 3 44
5.55	2.	3.78	0.	1.		BS75 3 45
5.55	2.	4.28	2.	1.		BS75 3 46
5.55	2.	4.46	4.	2.		BS75 3 47
5.55	2.	4.70	1.	1.		BS75 3 48
5.55	2.	5.01	-3.	0.4		BS75 3 49
5.80	-1.	0.	0.	100.		BS75 3 50
5.80	-1.	2.23	2.	5.		BS75 3 51
5.80	-1.	3.78	0.	1.5		BS75 3 52
5.80	-1.	4.28	2.	1.		BS75 3 53
5.80	-1.	4.46	4.	1.5		BS75 3 54
5.80	-1.	4.70	1.	1.		BS75 3 55
5.80	-1.	5.01	-3.	1.		BS75 3 56
6.22	-2.	0.	0.	1.5		BS75 3 57
6.22	-2.	2.23	2.	100.		BS75 3 58
6.22	-2.	3.78	0.	0.8		BS75 3 59
6.22	-2.	4.28	2.	1.5		BS75 3 60
6.22	-2.	4.46	4.	0.6		BS75 3 61
6.22	-2.	4.70	1.	0.5		BS75 3 62
6.22	-2.	5.01	-3.	2.		BS75 3 63
6.22	-2.	5.41	3.	0.2		BS75 3 64
6.62	-4.	0.	0.	0.3		BS75 3 65
6.62	-4.	2.23	2.	3.	0.3	BS75 3 66
6.62	-4.	3.78	0.	0.6		BS75 3 67
6.62	-4.	4.28	2.	0.2		BS75 3 68
6.62	-4.	4.46	4.	24.	0.7	BS75 3 69
6.62	-4.	4.70	1.	0.3		BS75 3 70
6.62	-4.	5.01	-3.	73.	1.	BS75 3 71

6.62	-4.	5.41	3.	0.9		BS75 3	72
6.67		0.	0.	3.		BS75 3	73
6.67		2.23	2.	37.	4.	BS75 3	74
6.67		3.78	0.	49.	5.	BS75 3	74
6.67		4.28	2.	7.		BS75 3	76
6.67		4.46	4.	3.		BS75 3	77
6.67		4.70	1.	14.	2.	BS75 3	78
6.67		5.01	-3.	4.		BS75 3	79
6.67		5.41	3.	1.		BS75 3	80
6.76		0.	0.	2.	1.	BS75 3	81
6.76		2.23	2.	7.		BS75 3	82
6.76		3.78	0.	4.		BS75 3	83
6.76		4.28	2.	3.		BS75 3	84
6.76		4.46	4.	24.	10.	BS75 3	85
6.76		4.70	1.	8.		BS75 3	86
6.76		5.01	-3.	74.	30.	BS75 3	87
6.76		5.41	3.	3.		BS75 3	88
6.85		0.	0.	8.		BS75 3	89
6.85		2.23	2.	7.		BS75 3	90
6.85		3.78	0.	8.		BS75 3	91
6.85		4.28	2.	80.	10.	BS75 3	92
6.85		4.46	4.	20.	10.	BS75 3	93
6.85		4.70	1.	5.		BS75 3	94
6.85		5.01	-3.	13.		BS75 3	95
6.85		5.41	3.	5.		BS75 3	96
7.00	1.	0.	0.	2.		BS75 3	97
7.00	1.	2.23	2.	100.		BS75 3	98
7.00	1.	3.78	0.	16.		BS75 3	99
7.00	1.	4.28	2.	2.		BS75 3	100
7.00	1.	4.46	4.	2.		BS75 3	101
7.00	1.	4.70	1.	1.		BS75 3	102
7.00	1.	5.01	-3.	2.		BS75 3	103
7.00	1.	5.41	3.	1.		BS75 3	104
7.12	2.	0.	0.	2.	0.5	BS75 3	105
7.12	2.	2.23	2.	86.	2.	BS75 3	106
7.12	2.	3.78	0.	1.4		BS75 3	107
7.12	2.	4.28	2.	3.	1.	BS75 3	108
7.12	2.	4.46	4.	1.		BS75 3	109
7.12	2.	4.70	1.	9.	1.	BS75 3	110
7.12	2.	5.01	-3.	1.		BS75 3	111
7.12	2.	5.41	3.	0.5		BS75 3	112
7.19	1.	0.	0.	41.	12.	BS75 3	113
7.19	1.	2.23	2.	59.	12.	BS75 3	114
7.19	1.	3.78	0.	55.		BS75 3	115
7.19	1.	4.28	2.	35.		BS75 3	116
7.19	1.	4.46	4.	54.		BS75 3	117
7.19	1.	4.70	1.	25.		BS75 3	118
7.19	1.	5.01	-3.	28.		BS75 3	119
7.48		0.	0.	100.		BS75 3	120
7.48		2.23	2.	7.		BS75 3	121
7.48		3.78	0.	15.		BS75 3	122
7.48		4.28	2.	13.		BS75 3	123
7.48		4.46	4.	14.		BS75 3	124
7.48		4.70	1.	6.		BS75 3	125

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 7.48                5.01      -3.        9.                      BS75 3  126
 7.48                5.41       3.        10.                     BS75 3  127
 7.54       0.       0.         0.        7.                      BS75 3  128
 7.54       0.       2.23       2.        14.                     BS75 3  129
 7.54       0.       3.78       0.        11.                     BS75 3  130
 7.54       0.       4.28       2.        8.                      BS75 3  131
 7.54       0.       4.46       4.        6.                      BS75 3  132
 7.54       0.       4.70       1.        100.                    BS75 3  133
 7.54       0.       5.01      -3.        5.                      BS75 3  134
 7.54       0.       5.41       3.        10.                     BS75 3  135
 7.70                0.         0.        60.                     BS75 3  136
 7.70                2.23       2.        100.                    BS75 3  137
 7.70                3.78       0.        45.                     BS75 3  138
 7.70                4.28       2.        70.                     BS75 3  139
 7.70                4.46       4.        50.                     BS75 3  140
 7.70                4.70       1.        50.                     BS75 3  141
 7.70                5.01      -3.        50.                     BS75 3  142
 7.70                5.41       3.        50.                     BS75 3  143
 7.95                0.         0.        0.5                     BS75 3  144
 7.95                2.23       2.        4.                      BS75 3  145
 7.95                3.78       0.        2.                      BS75 3  146
 7.95                4.28       2.        10.                     BS75 3  147
 7.95                4.46       4.        8.                      BS75 3  148
 7.95                4.70       1.        3.                      BS75 3  149
 7.95                5.01      -3.        60.         10          BS75 3  150
 7.95                5.41       3.        40.         10.         BS75 3  151
 8.13       1.       0.         0.        91.         6.          BS75 3  152
 8.13       1.       2.23       2.        9.          6.          BS75 3  153
 8.13       1.       3.78       0.        10.                     BS75 3  154
 8.13       1.       4.28       2.        3.                      BS75 3  155
 8.13       1.       4.46       4.        4.                      BS75 3  156
 8.13       1.       4.70       1.        4.                      BS75 3  157
 8.13       1.       5.01      -3.        2.                      BS75 3  158
 8.13       1.       5.41       3.        4.                      BS75 3  159
ENDDATA            142                                            BS75 3  160
ENDSUBENT            3                                            BS75 399999
SUBENT         BS75  4          0                                 BS75 4    1
BIB                  1          6                                 BS75 4    2
COMMENTS   UPPER LIMITS ARE GIVEN FOR THE UNOBSERVED GAMMA-RAY    BS75 4    3
           DECAY MODES OF BOUND LEVELS IN 32S. INFORMATION IS     BS75 4    4
           OBTAINED FROM TABLE 3 OF THE PAPER. EI = INITIAL       BS75 4    5
           STATE EXCITATION ENERGY FOR GAMMA-RAY TRANSITION.      BS75 4    6
           EF = FINAL STATE EXCITATION ENERGY FOR GAMMA-RAY       BS75 4    7
           TRANSITION. B = BRANCHING RATIO.                       BS75 4    8
ENDBIB               6                                            BS75 4    9
DATA                 3         70                                 BS75 4   10
EI         EF         B                                           BS75 4   11
MEV        MEV        PCT                                         BS75 4   12
 6.22       5.55       0.2                                        BS75 4   13
 6.62       5.55       0.2                                        BS75 4   14
 6.62       5.80       0.1                                        BS75 4   15
 6.67       5.55       2.                                         BS75 4   16
 6.67       5.80       1.                                         BS75 4   17
 6.76       5.55       1.                                         BS75 4   18
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6.76	5.80	2.	BS75	4	19
6.85	5.55	7.	BS75	4	20
6.85	5.80	3.	BS75	4	21
6.85	6.22	3.	BS75	4	22
7.00	5.55	1.	BS75	4	23
7.00	5.80	9.	BS75	4	24
7.00	6.22	0.5	BS75	4	25
7.12	5.55	1.	BS75	4	26
7.12	5.80	0.3	BS75	4	27
7.12	6.22	0.3	BS75	4	28
7.19	5.55	30.	BS75	4	29
7.19	5.80	11.	BS75	4	30
7.19	6.22	3.	BS75	4	31
7.19	6.62	7.	BS75	4	32
7.19	6.67	16.	BS75	4	33
7.48	5.55	10.	BS75	4	34
7.48	5.80	7.	BS75	4	35
7.48	6.22	7.	BS75	4	36
7.48	6.62	7.	BS75	4	37
7.48	6.67	3.	BS75	4	38
7.48	6.76	3.	BS75	4	39
7.48	6.85	3.	BS75	4	40
7.54	5.55	9.	BS75	4	41
7.54	5.80	5.	BS75	4	42
7.54	6.22	4.	BS75	4	43
7.54	6.62	3.	BS75	4	44
7.54	6.67	6.	BS75	4	45
7.54	6.76	3.	BS75	4	46
7.54	6.85	10.	BS75	4	47
7.54	7.00	2.	BS75	4	48
7.54	7.12	5.	BS75	4	49
7.54	7.19	2.	BS75	4	50
7.70	5.55	40.	BS75	4	51
7.70	5.80	40.	BS75	4	52
7.70	6.22	30.	BS75	4	53
7.70	6.62	25.	BS75	4	54
7.70	6.67	25.	BS75	4	55
7.70	6.76	50.	BS75	4	56
7.70	6.85	15.	BS75	4	57
7.70	7.00	15.	BS75	4	58
7.70	7.12	15.	BS75	4	59
7.70	7.19	15.	BS75	4	60
7.95	5.55	6.	BS75	4	61
7.95	5.80	6.	BS75	4	62
7.95	6.22	10.	BS75	4	63
7.95	6.62	2.	BS75	4	64
7.95	6.67	5.	BS75	4	65
7.95	6.76	2.	BS75	4	66
7.95	6.85	1.	BS75	4	67
7.95	7.00	1.	BS75	4	68
7.95	7.12	1.	BS75	4	69
7.95	7.48	1.	BS75	4	70
8.13	5.55	4.	BS75	4	71
8.13	5.80	1.	BS75	4	72

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 8.13       6.22       2.                                            BS75 4   73
 8.13       6.62       3.                                            BS75 4   74
 8.13       6.67       3.                                            BS75 4   75
 8.13       6.76       9.                                            BS75 4   76
 8.13       6.85       2.                                            BS75 4   77
 8.13       7.00       3.                                            BS75 4   78
 8.13       7.12       0.6                                           BS75 4   79
 8.13       7.19       0.7                                           BS75 4   80
 8.13       7.48       0.6                                           BS75 4   81
 8.13       7.54       0.6                                           BS75 4   82
ENDDATA            72                                                BS75 4   83
ENDSUBENT           4                                                BS75 499999
ENDENTRY            4                                                BS759999999
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C+74a

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ENTRY            C+74A          0                                   C+74A 0    1
SUBENT        C+74A  1          0                                   C+74A 1    1
BIB                12          22                                   C+74A 1    2
INSTITUTE  (USAORE)                                                 C+74A 1    3
REFERENCE  (J,PR/C,9,1192,1974)                                     C+74A 1    4
AUTHORS    (Y.T.CHENG,A.GOSWAMI,M.J.THROOP,D.K.MCDANIELS)           C+74A 1    5
TITLE      STATUS OF NUCLEAR COEXISTENCE FOR 32S                    C+74A 1    6
FACILITY   (VDG) 4-MEV VAN DE GRAAFF ACCELERATOR, DEPARTMENT        C+74A 1    7
           OF PHYSICS, UNIVERSITY OF OREGON, EUGENE, OREGON.        C+74A 1    8
INC-PART   (P) PROTONS.                                             C+74A 1    9
TARGETS    NO DETAILS ARE GIVEN IN PAPER. AN EARLIER PUBLICATION    C+74A 1   10
           IS REFERENCED.                                           C+74A 1   11
METHOD     UTILIZED THE DOPPLER SHIFT ATTENUATION METHOD TO         C+74A 1   12
           MEASURE LIFETIMES OF NUCLEAR STATES. THE GAMMA-RAY       C+74A 1   13
           MEASUREMENTS WERE PERFORMED AT 0 AND 120 DEGREES         C+74A 1   14
           RELATIVE TO THE INCIDENT PROTON BEAM. EXPERIMENTAL       C+74A 1   15
           PROCEDURES ARE GIVEN IN AN EARLIER REFERENCED            C+74A 1   16
           PUBLICATION.                                             C+74A 1   17
DETECTOR   (GELI) EXPERIMENT UTILIZED A GE(LI) DETECTOR.            C+74A 1   18
           DETAILS GIVEN IN AN EARLIER REFERENCED PUBLICATION.      C+74A 1   19
MONITOR    (CI) CURRENT INTEGRATOR.                                 C+74A 1   20
CORRECTION DATA CORRECTED FOR ELECTRONIC GAIN AND ZERO SHIFTS.      C+74A 1   21
           LINEAR BACKGROUND WAS SUBTRACTED.                        C+74A 1   22
ERR-ANALYS ERRORS IN MEASURED LIFETIMES ARE GIVEN BUT DETAILS       C+74A 1   23
           ARE NOT AVAILABLE.                                       C+74A 1   24
ENDBIB             22                                               C+74A 1   25
ENDSUBENT           1                                               C+74A 199999
SUBENT        C+74A  2          0                                   C+74A 2    1
BIB                 2           6                                   C+74A 2    2
REACTION   31P(P,GAMMA)32S                                          C+74A 2    3
COMMENTS   MEAN LIFETIMES ARE GIVEN FOR SEVERAL EXCITED STATES      C+74A 2    4
           OF 32S. INFORMATION IS OBTAINED FROM TABLE I OF THE      C+74A 2    5
           PAPER. EX = LEVEL EXCITATION ENERGY. EP = INCIDENT       C+74A 2    6
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          PROTON ENERGY. TAU = LIFETIME OF THE EXCITED LEVEL.     C+74A 2    7
          TAU-ERR = ERROR IN TAU. FSEC = 10**(-15) SEC.           C+74A 2    8
ENDBIB              6                                             C+74A 2    9
DATA                4          6                                  C+74A 2   10
EX         EP         TAU        TAU-ERR                          C+74A 2   11
MEV        KEV        FSEC       FSEC                             C+74A 2   12
 2.230      811.       195.       70.                             C+74A 2   13
 3.778      1117.      1000.      200.                            C+74A 2   14
 4.458      1583.      200.       90.                             C+74A 2   15
 4.697      811.       245.       50.                             C+74A 2   16
 5.006      1583.      1550.      380.                            C+74A 2   17
 6.622      1583.      560.       110.                            C+74A 2   18
ENDDATA             8                                             C+74A 2   19
ENDSUBENT           2                                             C+74A 299999
ENDENTRY            2                                             C+74A9999999
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CMR72

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ENTRY           CMR72          0                                  CMR72 0    1
SUBENT       CMR72  1          0                                  CMR72 1    1
BIB                12         40                                  CMR72 1    2
INSTITUTE  (SAFPOT)                                               CMR72 1    3
REFERENCE  (J,NP/A,185,644,1972)                                  CMR72 1    4
AUTHORS    (W.F.COETZEE,M.A.MEYER,D.REITMANN)                     CMR72 1    5
TITLE      A STUDY OF THE 31P(P,GAMMA)32S REACTION AND THE        CMR72 1    6
           EXCITED STATES OF 32S                                  CMR72 1    7
FACILITIES (C-W) 1.1-MV COCKCROFT-WALTON ACCELERATOR, PHYSICS     CMR72 1    8
           DEPARTMENT, POTCHEFSTROOM UNIVERSITY, SOUTH AFRICA.    CMR72 1    9
           (VDG) 3-MV VAN DE GRAAFF ACCELERATOR, PHYSICS          CMR72 1   10
           DEPARTMENT, POTCHEFSTROOM UNIVERSITY, SOUTH AFRICA.    CMR72 1   11
INC-PART   (P) PROTONS.                                           CMR72 1   12
TARGETS    TARGETS FOR USE WITH 1.1-MV C-W WERE MADE BY           CMR72 1   13
           EVAPORATING ZINC PHOSPHIDE ONTO 1-MM-THICK COPPER      CMR72 1   14
           BACKING. TARGETS FOR USE WITH 3-MV VDG WERE MADE BY    CMR72 1   15
           EVAPORATING ZIN PHOSPHIDE ONTO 0.3-MM-THICK TANTALUM   CMR72 1   16
           BACKING. THEY WERE CLEANED BY ELECTRON BOMBARDMENT.    CMR72 1   17
           ALL THE TARGETS WERE WATER-COOLED.                     CMR72 1   18
           ALL THE TARGETS WERE CLEANED BY HEATING IN A VACUUM.   CMR72 1   19
METHOD     PHOSPHORUS COMPOUND TARGETS WERE BOMBARDED WITH 0.35   CMR72 1   20
           TO 2.03 MEV PROTONS. GAMMA-RAY YIELD EXCITATION        CMR72 1   21
           FUNCTIONS WERE MEASURED TO DETERMINE RESONANCE         CMR72 1   22
           ENERGIES AND STRENGTHS. GAMMA-DECAY BRANCHING RATIOS   CMR72 1   23
           AND GAMMA-RAY ANGULAR DISTRIBUTIONS WERE MEASURED AT   CMR72 1   24
           THE RESONANCE ENERGIES FOR BOTH BOUND AND UNBOUND      CMR72 1   25
           STATES. LIFETIMES OF BOUND STATES WERE MEASURED BY     CMR72 1   26
           THE DOPPLER SHIFT ATTENUATION METHOD. DETAILS ARE      CMR72 1   27
           GIVEN IN THE PAPER.                                    CMR72 1   28
DETECTORS  (GELI) GE(LI) DETECTORS WITH 30 AND 40 CM**3 VOLUME    CMR72 1   29
           WERE USED TO DETECT GAMMA RAYS FOR THE BRANCHING       CMR72 1   30
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           RATIO AND ANGULAR DISTRIBUTION MEASUREMENTS.              CMR72 1   31
           (SCINT) A 10-CM X 10-CM NAI DETECTOR WAS USED FOR         CMR72 1   32
           THE EXCITATION FUNCTION MEASUREMENTS TO DETERMINE         CMR72 1   33
           RESONANCE ENERGIES AND RESONANCE STRENGTHS.               CMR72 1   34
MONITORS   (CI) CURRENT INTEGRATORS.                                 CMR72 1   35
CORRECTION GAMMA-RAY YIELDS WERE CORRECTED FOR DETECTOR              CMR72 1   36
           EFFICIENCY. CORRECTIONS FOR BACKGROUND EVENTS             CMR72 1   37
           WERE APPLIED TO GAMMA-RAY YIELD DATA.                     CMR72 1   38
ERR-ANALYS ERRORS ARE GIVEN FOR GAMMA-RAY ENERGIES, 32S LEVEL        CMR72 1   39
           EXCITATION ENERGIES, BRANCHING RATIOS, RESONANCE          CMR72 1   40
           STRENGTHS, AND ANGULAR DISTRIBUTION COEFFICIENTS.         CMR72 1   41
           DETAILS ARE GIVEN IN THE PAPER.                           CMR72 1   42
ENDBIB             40                                                CMR72 1   43
ENDSUBENT           1                                                CMR72 199999
SUBENT        CMR72  2          0                                    CMR72 2    1
BIB                 2          9                                     CMR72 2    2
REACTION   31P(P,GAMMA)32S                                           CMR72 2    3
COMMENTS   ENERGIES AND STRENGTHS OF RESONANCES FOR EP < 2.03        CMR72 2    4
           MEV ARE GIVEN. DATA TAKEN FROM TABLE 1 OF THE PAPER.      CMR72 2    5
           EP = RESONANCE PROTON ENERGY. EP-ERR = ERROR IN           CMR72 2    6
           PROTON ENERGY. S = RESONANCE GAMMA-RAY STRENGTH =         CMR72 2    7
           (2J+1)*GAMMA(P)*GAMMA(G)/GAMMA(TOTAL), AS                 CMR72 2    8
           INDICATED IN SECTION 3.2. ERRORS IN S ARE OF THE          CMR72 2    9
           ORDER OF 30 PERCENT BUT ARE NOT GIVEN EXPLICITLY IN       CMR72 2   10
           THE TABLE.                                                CMR72 2   11
ENDBIB              9                                                CMR72 2   12
DATA                3         35                                     CMR72 2   13
EP         EP-ERR     S                                              CMR72 2   14
KEV        KEV        EV                                             CMR72 2   15
 354.8      0.4        0.003                                         CMR72 2   16
 439.4      0.5        0.25                                          CMR72 2   17
 541.4      0.6        1.0                                           CMR72 2   18
 618.9      1.0        0.06                                          CMR72 2   19
 642.4      0.7        0.52                                          CMR72 2   20
 811.3      0.5        2.2                                           CMR72 2   21
 821.0      1.0        0.43                                          CMR72 2   22
 874.3      0.5        0.29                                          CMR72 2   23
 887.8      0.5        0.18                                          CMR72 2   24
 894.5      0.5        0.7                                           CMR72 2   25
 983.8      1.0        0.18                                          CMR72 2   26
 1056.5     0.6        1.1                                           CMR72 2   27
 1089.6     0.6        0.38                                          CMR72 2   28
 1120.7     0.6        3.0                                           CMR72 2   29
 1150.5     0.6        3.9                                           CMR72 2   30
 1155.1     0.6        1.5                                           CMR72 2   31
 1251.4     0.6        11.                                           CMR72 2   32
 1400.1     0.6        1.3                                           CMR72 2   33
 1402.9     0.8        5.0                                           CMR72 2   34
 1411.4     0.6        2.0                                           CMR72 2   35
 1438.3     0.7        11.                                           CMR72 2   36
 1473.1     0.6        2.4                                           CMR72 2   37
 1556.6     0.6        9.                                            CMR72 2   38
 1582.9     0.6        8.                                            CMR72 2   39
 1698.9     1.0        0.9                                           CMR72 2   40
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 1746.9     1.0        2.9                                              CMR72 2   41
 1764.2     1.0        0.9                                              CMR72 2   42
 1796.1     1.0        1.1                                              CMR72 2   43
 1891.5     1.0        2.2                                              CMR72 2   44
 1896.0     1.0        2.5                                              CMR72 2   45
 1954.0     1.0        7.                                               CMR72 2   46
 1977.1     1.0        3.9                                              CMR72 2   47
 1983.6     1.0        8.                                               CMR72 2   48
 1990.9     1.0        5.3                                              CMR72 2   49
 2026.6     1.0        15.                                              CMR72 2   50
ENDDATA             37                                                  CMR72 2   51
ENDSUBENT            2                                                  CMR72 299999
SUBENT        CMR72  3          0                                       CMR72 3    1
BIB                  2         12                                       CMR72 3    2
REACTION   31P(P,P1)31P                                                 CMR72 3    3
COMMENTS   STRENGTHS FOR (P,P1) RESONANCES IN THE RANGE EP =            CMR72 3    4
           1 TO 2 MEV WERE DERIVED FROM THE INTENSITY OF THE            CMR72 3    5
           1.27-MEV GAMMA RAY AND THE TOTAL INTENSITY OF THE            CMR72 3    6
           GAMMA-DECAY OF THE CORRESPONDING RESONANCE. THE              CMR72 3    7
           INFORMATION WAS OBTAINED FROM TABLE 2 OF THE PAPER.          CMR72 3    8
           EP = PROTON ENERGY. EP-ERR = ERROR IN PROTON                 CMR72 3    9
           ENERGY. S = RESONANCE INELASTIC PROTON STRENGTH =            CMR72 3   10
           (2J+1)*GAMMA(P)*GAMMA(P1)/GAMMA(TOTAL), AS                   CMR72 3   11
           INDICATED IN SECTION 3.2. ERRORS IN S ARE OF THE             CMR72 3   12
           ORDER OF 30 PERCENT BUT ARE NOT GIVEN EXPLICITLY IN          CMR72 3   13
           THE TABLE.                                                   CMR72 3   14
ENDBIB              12                                                  CMR72 3   15
DATA                 3         10                                       CMR72 3   16
EP         EP-ERR     S                                                 CMR72 3   17
KEV        KEV        EV                                                CMR72 3   18
 1400.1     0.6        0.061                                            CMR72 3   19
 1411.4     0.6        0.022                                            CMR72 3   20
 1796.1     1.0        2.0                                              CMR72 3   21
 1891.5     1.0        0.15                                             CMR72 3   22
 1896.0     1.0        0.25                                             CMR72 3   23
 1954.0     1.0        0.41                                             CMR72 3   24
 1977.1     1.0        0.55                                             CMR72 3   25
 1983.6     1.0        1.2                                              CMR72 3   26
 1990.9     1.0        6.0                                              CMR72 3   27
 2026.6     1.0        6.5                                              CMR72 3   28
ENDDATA             12                                                  CMR72 3   29
ENDSUBENT            3                                                  CMR72 399999
SUBENT        CMR72  4          0                                       CMR72 4    1
BIB                  2         12                                       CMR72 4    2
REACTION   31P(P,GAMMA)32S                                              CMR72 4    3
COMMENTS   GAMMA-RAY DECAY BRANCHING FOR THE RESONANCES IS              CMR72 4    4
           GIVEN. INFORMATION OBTAINED FROM TABLE 3. EP =               CMR72 4    5
           RESONANCE PROTON ENERGY. EX = EXCITATION OF RESONANT         CMR72 4    6
           STATE IN 32S. EF = ENERGY OF FINAL STATE FOR GAMMA-          CMR72 4    7
           RAY TRANSITION. J-PI-R = SPIN AND PARITY OF RESONANT         CMR72 4    8
           STATE. J-PI-F = SPIN AND PARITY OF FINAL STATE FOR           CMR72 4    9
           GAMMA-RAY TRANSITION. NEGATIVE PARITY IS INDICATED           CMR72 4   10
           BY A NEGATIVE NUMBER. OTHERWISE PARITY IS POSITIVE.          CMR72 4   11
           B = BRANCHING RATIO. WHEN INFORMATION IS NOT                 CMR72 4   12
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           AVAILABLE OR IS AMBIGUOUS, THE CORRESPONDING SPACE      CMR72 4   13
           IS LEFT BLANK. PCT = PERCENT.                           CMR72 4   14
ENDBIB              12                                             CMR72 4   15
DATA                 6         177                                 CMR72 4   16
EP          EX          J-PI-R     EF          J-PI-F     B        CMR72 4   17
KEV         KEV         NO-DIM     MEV         NO-DIM     PCT      CMR72 4   18
 355.        9209.                  0.          0.         38.     CMR72 4   19
 355.        9209.                  2.23        2.         35.     CMR72 4   20
 355.        9209.                  3.78        0.         6.      CMR72 4   21
 355.        9209.                  5.55        2.         5.      CMR72 4   22
 355.        9209.                  5.80       -1.         5.      CMR72 4   23
 355.        9209.        1.        6.22       -2.         11.     CMR72 4   24
 439.        9290.        1.        0.          0.         40.     CMR72 4   25
 439.        9290.        1.        2.23        2.         20.     CMR72 4   26
 439.        9290.        1.        4.70        1.         13.     CMR72 4   27
 439.        9290.        1.        6.22       -2.         2.      CMR72 4   28
 541.        9389.       -2.        0.          0.         2.      CMR72 4   29
 541.        9389.       -2.        2.23        2.         63.     CMR72 4   30
 541.        9389.       -2.        4.28        2.         2.      CMR72 4   31
 541.        9389.       -2.        4.70        1.         2.      CMR72 4   32
 541.        9389.       -2.        5.01       -3.         9.      CMR72 4   33
 541.        9389.       -2.        5.55        2.         1.      CMR72 4   34
 541.        9389.       -2.        5.80       -1.         2.      CMR72 4   35
 541.        9389.       -2.        6.22       -2.         17.     CMR72 4   36
 541.        9389.       -2.        6.62       -4.         1.      CMR72 4   37
 619.        9464.        2.        0.          0.         51.     CMR72 4   38
 619.        9464.        2.        2.23        2.         22.     CMR72 4   39
 619.        9464.        2.        4.70        1.         27.     CMR72 4   40
 642.        9487.       -1.        0.          0.         82.     CMR72 4   41
 642.        9487.       -1.        4.28        2.         9.5     CMR72 4   42
 642.        9487.       -1.        5.01       -3.         3.5     CMR72 4   43
 642.        9487.       -1.        5.80       -1.         0.5     CMR72 4   44
 811.        9651.        2.        0.          0.         0.1     CMR72 4   45
 811.        9651.        2.        2.23        2.         61.     CMR72 4   46
 811.        9651.        2.        4.70        1.         38.     CMR72 4   47
 811.        9651.        2.        5.41        3.         0.9     CMR72 4   48
 821.        9660.                  0.          0.         74.     CMR72 4   49
 821.        9660.                  2.23        2.         15.     CMR72 4   50
 821.        9660.                  3.78        0.         2.      CMR72 4   51
 821.        9660.                  4.70        1.         3.      CMR72 4   52
 821.        9660.                  5.55        2.         2.      CMR72 4   53
 874.        9712.        2.        0.          0.         7.      CMR72 4   54
 874.        9712.        2.        2.23        2.         59.     CMR72 4   55
 874.        9712.        2.        4.70        1.         34.     CMR72 4   56
 888.        9725.                  5.01       -3.         40.     CMR72 4   57
 888.        9725.                  6.22       -2.         14.     CMR72 4   58
 888.        9725.                  6.62       -4.         46.     CMR72 4   59
 895.        9731.                  0.          0.         3.      CMR72 4   60
 895.        9731.                  2.23        2.         18.     CMR72 4   61
 895.        9731.                  4.28        2.         24.     CMR72 4   62
 895.        9731.                  4.70        1.         5.      CMR72 4   63
 895.        9731.                  5.01       -3.         4.      CMR72 4   64
 895.        9731.                  5.55        2.         3.      CMR72 4   65
 895.        9731.                  5.80       -1.         19.     CMR72 4   66
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895.	9731.		6.22	-2.	18.	CMR72 4	67
984.	9818.		0.0	0.	0.4	CMR72 4	68
984.	9818.		2.23	2.	19.	CMR72 4	69
984.	9818.		4.28	2.	9.	CMR72 4	70
984.	9818.		4.46	4.	1.6	CMR72 4	71
984.	9818.		5.01	-3.	52.	CMR72 4	72
984.	9818.		5.80	-1.	3.	CMR72 4	73
984.	9818.		6.22	-2.	6.	CMR72 4	74
1057.	9888.		0.	0.	1.	CMR72 4	75
1057.	9888.		2.23	2.	10.	CMR72 4	76
1057.	9888.		4.28	2.	5.	CMR72 4	77
1057.	9888.		4.70	1.	5.	CMR72 4	78
1057.	9888.		5.55	2.	9.	CMR72 4	79
1090.	9920.		0.0	0.	0.5	CMR72 4	80
1090.	9920.		2.23	2.	46.	CMR72 4	81
1090.	9920.		4.28	2.	2.	CMR72 4	82
1090.	9920.		5.41	3.	3.	CMR72 4	83
1090.	9920.		5.55	2.	31.	CMR72 4	84
1121.	9950.		0.	0.	77.	CMR72 4	85
1121.	9950.		2.23	2.	9.	CMR72 4	86
1121.	9950.		3.78	0.	3.	CMR72 4	87
1121.	9950.		4.28	2.	2.	CMR72 4	88
1121.	9950.		4.70	1.	2.	CMR72 4	89
1151.	9979.	-3.	0.	0.	0.3	CMR72 4	90
1151.	9979.	-3.	2.23	2.	32.	CMR72 4	91
1151.	9979.	-3.	4.46	4.	6.	CMR72 4	92
1151.	9979.	-3.	5.01	-3.	8.	CMR72 4	93
1151.	9979.	-3.	5.41	3.	7.	CMR72 4	94
1151.	9979.	-3.	5.55	2.	26.	CMR72 4	95
1151.	9979.	-3.	6.22	-2.	4.	CMR72 4	96
1151.	9979.	-3.	6.62	-4.	5.	CMR72 4	97
1155.	9984.	2.	0.	0.	0.5	CMR72 4	98
1155.	9984.	2.	2.23	2.	64.	CMR72 4	99
1155.	9984.	2.	4.28	2.	2.	CMR72 4	100
1155.	9984.	2.	4.70	1.	19.	CMR72 4	101
1155.	9984.	2.	5.01	-3.	1.	CMR72 4	102
1155.	9984.	2.	5.41	3.	1.	CMR72 4	103
1155.	9984.	2.	5.55	2.	12.	CMR72 4	104
1155.	9984.	2.	6.22	-2.	0.4	CMR72 4	105
1155.	9984.	2.	6.62	-4.	0.6	CMR72 4	106
1251.	10077.	-2.	0.	0.	2.	CMR72 4	107
1251.	10077.	-2.	2.23	2.	34.	CMR72 4	108
1251.	10077.	-2.	4.28	2.	2.	CMR72 4	109
1251.	10077.	-2.	4.70	1.	1.	CMR72 4	110
1251.	10077.	-2.	5.01	-3.	12.	CMR72 4	111
1251.	10077.	-2.	5.41	3.	4.	CMR72 4	112
1251.	10077.	-2.	6.22	-2.	45.	CMR72 4	113
1438.	10258.	-4.	2.23	2.	1.	CMR72 4	114
1438.	10258.	-4.	4.46	4.	11.	CMR72 4	115
1438.	10258.	-4.	5.01	-3.	4.	CMR72 4	116
1438.	10258.	-4.	6.62	-4.	77.	CMR72 4	117
1473.	10292.	2.	0.	0.	2.	CMR72 4	118
1473.	10292.	2.	2.23	2.	36.	CMR72 4	119
1473.	10292.	2.	4.28	2.	2.	CMR72 4	120

1473.	10292.	2.	5.01	-3.	25.	CMR72	4	121
1473.	10292.	2.	5.41	3.	2.	CMR72	4	122
1473.	10292.	2.	6.22	-2.	31.	CMR72	4	123
1557.	10372.	2.	0.	0.	0.5	CMR72	4	124
1557.	10372.	2.	2.23	2.	12.	CMR72	4	125
1557.	10372.	2.	4.28	2.	43.	CMR72	4	126
1557.	10372.	2.	4.70	1.	8.	CMR72	4	127
1557.	10372.	2.	5.01	-3.	1.5	CMR72	4	128
1557.	10372.	2.	5.41	3.	13.	CMR72	4	129
1557.	10372.	2.	5.55	2.	2.	CMR72	4	130
1557.	10372.	2.	6.22	-2.	2.	CMR72	4	131
1583.	10398.		2.23	2.	1.	CMR72	4	132
1583.	10398.		4.28	2.	2.	CMR72	4	133
1583.	10398.		4.46	4.	1.8	CMR72	4	134
1583.	10398.		5.01	-3.	5.6	CMR72	4	135
1583.	10398.		6.62	-4.	84.	CMR72	4	136
1699.	10510.		0.	0.	5.	CMR72	4	137
1699.	10510.		2.23	2.	25.	CMR72	4	138
1699.	10510.		4.28	2.	15.	CMR72	4	139
1699.	10510.		4.70	1.	8.	CMR72	4	140
1699.	10510.		5.41	3.	8.	CMR72	4	141
1747.	10557.		0.	0.	40.	CMR72	4	142
1747.	10557.		2.23	2.	60.	CMR72	4	143
1764.	10574.		0.	0.	7.	CMR72	4	144
1764.	10574.		2.23	2.	44.	CMR72	4	145
1764.	10574.		4.46	4.	16.	CMR72	4	146
1764.	10574.		5.41	3.	33.	CMR72	4	147
1796.	10604.		0.	0.	19.	CMR72	4	148
1796.	10604.		2.23	2.	6.	CMR72	4	149
1796.	10604.		5.01	-3.	8.	CMR72	4	150
1796.	10604.		5.41	3.	10.	CMR72	4	151
1796.	10604.		5.55	2.	39.	CMR72	4	152
1796.	10604.		5.80	-1.	5.	CMR72	4	153
1892.	10697.	2.	0.	0.	70.	CMR72	4	154
1892.	10697.	2.	2.23	2.	5.	CMR72	4	155
1892.	10697.	2.	3.78	0.	3.	CMR72	4	156
1892.	10697.	2.	4.28	2.	10.	CMR72	4	157
1892.	10697.	2.	4.46	4.	1.	CMR72	4	158
1892.	10697.	2.	4.70	1.	2.	CMR72	4	159
1892.	10697.	2.	5.01	-3.	3.	CMR72	4	160
1892.	10697.	2.	5.55	2.	2.	CMR72	4	161
1892.	10697.	2.	5.80	-1.	3.	CMR72	4	162
1896.	10701.		0.	0.	84.	CMR72	4	163
1896.	10701.		2.23	2.	5.	CMR72	4	164
1896.	10701.		3.78	0.	4.	CMR72	4	165
1896.	10701.		4.70	1.	3.	CMR72	4	166
1896.	10701.		5.80	-1.	4.	CMR72	4	167
1954.	10757.		2.23	2.	2.	CMR72	4	168
1954.	10757.		4.46	4.	70.	CMR72	4	169
1954.	10757.		5.55	2.	19.	CMR72	4	170
1977.	10780.		0.	0.	9.	CMR72	4	171
1977.	10780.		2.23	2.	60.	CMR72	4	172
1977.	10780.		4.28	2.	21.	CMR72	4	173
1977.	10780.		4.70	1.	2.	CMR72	4	174

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 1977.      10780.                5.41      3.        4.        CMR72 4  175
 1984.      10786.                0.        0.        54.       CMR72 4  176
 1984.      10786.                2.23      2.        16.       CMR72 4  177
 1984.      10786.                3.78      0.        2.        CMR72 4  178
 1984.      10786.                4.28      2.        3.        CMR72 4  179
 1984.      10786.                4.46      4.        1.        CMR72 4  180
 1984.      10786.                4.70      1.        11.       CMR72 4  181
 1984.      10786.                5.55      2.        13.       CMR72 4  182
 1991.      10793                 0.        0.        23.       CMR72 4  183
 1991.      10793                 2.23      2.        49.       CMR72 4  184
 1991.      10793                 4.28      2.        9.        CMR72 4  185
 1991.      10793                 4.70      1.        5.        CMR72 4  186
 1991.      10793                 5.01     -3.        10.       CMR72 4  187
 2027.      10828.                0.        0.        24.       CMR72 4  188
 2027.      10828.                2.23      2.        37.       CMR72 4  189
 2027.      10828.                3.78      0.        2.        CMR72 4  190
 2027.      10828.                4.28      2.        22.       CMR72 4  191
 2027.      10828.                4.70      1.        2.        CMR72 4  192
 2027.      10828.                5.01     -3.        6.        CMR72 4  193
 2027.      10828.                5.41      3.        3.        CMR72 4  194
 2027.      10828.                5.80     -1.        3.        CMR72 4  195
ENDDATA           179                                           CMR72 4  196
ENDSUBENT           4                                           CMR72 499999
SUBENT        CMR72  5          0                               CMR72 5    1
BIB                 2           5                               CMR72 5    2
REACTION   31P(P,GAMMA)32S                                      CMR72 5    3
COMMENTS   EXCITATION ENERGIES OF LEVELS IN 32S OBSERVED IN THE CMR72 5    4
           PRESENT EXPERIMENT ARE GIVEN. EX = EXCITATION ENERGY CMR72 5    5
           OF THE LEVEL. EX-ERR = ERROR IN EXCITATION ENERGY.   CMR72 5    6
           INFORMATION OBTAINED FROM TABLE 4 OF THE PAPER.      CMR72 5    7
ENDBIB              5                                           CMR72 5    8
DATA                2          22                               CMR72 5    9
EX         EX-ERR                                               CMR72 5   10
KEV        KEV                                                  CMR72 5   11
 2230.5     0.3                                                 CMR72 5   12
 3778.2     1.8                                                 CMR72 5   13
 4282.2     1.0                                                 CMR72 5   14
 4458.9     1.0                                                 CMR72 5   15
 4695.3     0.4                                                 CMR72 5   16
 5006.5     1.0                                                 CMR72 5   17
 5412.6     1.0                                                 CMR72 5   18
 5548.8     1.4                                                 CMR72 5   19
 5797.6     1.0                                                 CMR72 5   20
 6224.2     1.0                                                 CMR72 5   21
 6621.0     1.0                                                 CMR72 5   22
 6666.1     1.0                                                 CMR72 5   23
 6761.6     1.0                                                 CMR72 5   24
 6853.5     1.6                                                 CMR72 5   25
 7003.7     1.0                                                 CMR72 5   26
 7116.5     1.0                                                 CMR72 5   27
 7189.0     1.5                                                 CMR72 5   28
 7484.8     1.0                                                 CMR72 5   29
 7535.5     1.0                                                 CMR72 5   30
 7702.4     2.0                                                 CMR72 5   31
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 7950.8     1.0                                                            CMR72 5   32
 8126.2     1.0                                                            CMR72 5   33
ENDDATA             24                                                     CMR72 5   34
ENDSUBENT            5                                                     CMR72 599999
SUBENT        CMR72  6          0                                          CMR72 6    1
BIB                  1         13                                          CMR72 6    2
COMMENTS   GAMMA-RAY DECAY BRANCHING FOR THE BOUND STATES IN               CMR72 6    3
           32S IS GIVEN. INFORMATION OBTAINED FROM TABLE 5.                CMR72 6    4
           EI = EXCITATION ENERGY OF THE INITIAL STATE IN 32S              CMR72 6    5
           FOR GAMMA-RAY TRANSITION. EF = ENERGY OF FINAL STATE.           CMR72 6    6
           J-PI-I = SPIN AND PARITY OF 32S INITIAL STATE FOR               CMR72 6    7
           GAMMA-RAY TRANSITION. J-PI-F = SPIN AND PARITY OF               CMR72 6    8
           FINAL STATE. NEGATIVE PARITY IS INDICATED BY A                  CMR72 6    9
           NEGATIVE NUMBER. OTHERWISE PARITY IS POSITIVE.                  CMR72 6   10
           B = BRANCHING RATIO. B-ERR IS ERROR IN BRANCHING                CMR72 6   11
           RATIO. WHEN INFORMATION IS NOT AVAILABLE OR IS                  CMR72 6   12
           AMBIGUOUS, THE CORRESPONDING SPACE IS LEFT BLANK.               CMR72 6   13
           WHEN NO ERROR IN B IS PROVIDED VALUE IS ASSUMED TO              CMR72 6   14
           BE AN UPPER BOUND. PCT = PERCENT.                               CMR72 6   15
ENDBIB              13                                                     CMR72 6   15
DATA                 6         62                                          CMR72 6   17
EI         J-PI-I     EF         J-PI-F     B          B-ERR               CMR72 6   18
MEV        NO-DIM     MEV        NO-DIM     PCT        PCT                 CMR72 6   19
 2.23       2.         0.         0.         100.                          CMR72 6   20
 3.78       0.         2.23       2.         100.                          CMR72 6   21
 4.28       2.         0.         0.         88.         4.                CMR72 6   22
 4.28       2.         2.23       2.         12.         4.                CMR72 6   23
 4.46       4.         0.         0.         2.                            CMR72 6   24
 4.46       4.         2.23       2.         100.                          CMR72 6   25
 4.70       1.         0.         0.         39.         3.                CMR72 6   26
 4.70       1.         2.23       2.         61.         3.                CMR72 6   27
 4.70       1.         3.78       0.         0.5                           CMR72 6   28
 5.01      -3.         0.         0.         8.          5.                CMR72 6   29
 5.01      -3.         2.23       2.         92.         5.                CMR72 6   30
 5.41       3.         0.         0.         10.                           CMR72 6   31
 5.41       3.         2.23       2.         90.         5.                CMR72 6   32
 5.41       3.         3.78       0.         20.                           CMR72 6   33
 5.41       3.         4.28       2.         10.                           CMR72 6   34
 5.55       2.         0.         0.         41.         5.                CMR72 6   35
 5.55       2.         2.23       2.         59.         5.                CMR72 6   36
 5.80      -1.         0.         0.         100.                          CMR72 6   37
 5.80      -1.         2.23       2.         5.                            CMR72 6   38
 6.22      -2.         0.         0.         2.                            CMR72 6   39
 6.22      -2.         2.23       2.         100.                          CMR72 6   40
 6.62      -4.         2.23       2.         3.          2.                CMR72 6   41
 6.62      -4.         4.46       4.         28.         5.                CMR72 6   42
 6.62      -4.         5.01      -3.         66.         5.                CMR72 6   43
 6.62      -4.         5.41       3.         3.          2.                CMR72 6   44
 6.67                  0.         0.         6.                            CMR72 6   45
 6.67                  2.23       2.         50.                           CMR72 6   46
 6.67                  3.78       0.         50.                           CMR72 6   47
 6.76                  0.         0.         3.          2.                CMR72 6   48
 6.76                  2.23       2.         25.                           CMR72 6   49
 6.76                  5.01      -3.         97.                           CMR72 6   50
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 6.85                0.          0.          10.                     CMR72 6   51
 6.85                2.23        2.          20.                     CMR72 6   52
 6.85                4.28        2.          100.                    CMR72 6   53
 7.00       1.       0.          0.          1.                      CMR72 6   54
 7.00       1.       2.23        2.          90.         5.          CMR72 6   55
 7.00       1.       3.78        0.          10.                     CMR72 6   56
 7.00       1.       4.28        2.          8.                      CMR72 6   57
 7.12       2.       0.          0.          4.          3.          CMR72 6   58
 7.12       2.       2.23        2.          92.         5.          CMR72 6   59
 7.12       2.       3.78        0.          5.                      CMR72 6   60
 7.12       2.       4.28        2.          4.          3.          CMR72 6   61
 7.19       1.       0.          0.          40.         10.         CMR72 6   62
 7.19       1.       2.23        2.          60.         10.         CMR72 6   63
 7.48                0.          0.          70.         20.         CMR72 6   64
 7.48                2.23        2.          25.                     CMR72 6   65
 7.48                3.78        0.          30.                     CMR72 6   66
 7.48                4.28        2.          5.                      CMR72 6   67
 7.54       0.       0.          0.          5.                      CMR72 6   68
 7.54       0.       2.23        2.          6.                      CMR72 6   69
 7.54       0.       4.70        1.          100.                    CMR72 6   70
 7.70                2.23        2.          100.                    CMR72 6   71
 7.95                0.          0.          2.                      CMR72 6   72
 7.95                2.23        2.          5.                      CMR72 6   73
 7.95                3.78        0.          15.                     CMR72 6   74
 7.95                4.28        2.          10.                     CMR72 6   75
 7.95                4.46        4.          6.                      CMR72 6   76
 7.95                4.70        1.          8.                      CMR72 6   77
 7.95                5.01       -3.          65.                     CMR72 6   78
 8.13       1.       0.          0.          84.         5.          CMR72 6   79
 8.13       1.       2.23        2.          16.         5.          CMR72 6   80
 8.13       1.       4.28        2.          12.                     CMR72 6   81
ENDDATA             64                                               CMR72 6   82
ENDSUBENT            6                                               CMR72 699999
SUBENT        CMR72  7          0                                    CMR72 7    1
BIB                  1          6                                    CMR72 7    2
COMMENTS   MEAN LIFETIMES OF BOUND LEVELS IN 32S MEASURED BY         CMR72 7    3
           DOPPLER SHIFT ATTENUATION METHOD ARE GIVEN. RESULTS       CMR72 7    4
           OBTAINED FROM TABLE 6 OF THE PAPER. EX = LEVEL            CMR72 7    5
           EXCITATION ENERGY. TAU = LEVEL MEAN LIFE. TAU-ERR =       CMR72 7    6
           ERROR IN LEVEL MEAN LIFE. IF NO ERROR IS GIVEN, VALUE     CMR72 7    7
           IS ASSUMED TO BE AN UPPER BOUND. FSEC = 10**(-15) SEC.    CMR72 7    8
ENDBIB               6                                               CMR72 7    9
DATA                 3         14                                    CMR72 7   10
EX         TAU        TAU-ERR                                        CMR72 7   11
MEV        FSEC       FSEC                                           CMR72 7   12
 2.23       185.       75.                                           CMR72 7   13
 3.78       1200.      550.                                          CMR72 7   14
 4.28       36.        8.                                            CMR72 7   15
 4.70       230.       55.                                           CMR72 7   16
 5.01       350.       80.                                           CMR72 7   17
 5.41       95.        25.                                           CMR72 7   18
 5.55       100.       30.                                           CMR72 7   19
 5.80       8.         5.                                            CMR72 7   20
 6.22       55.        10.                                           CMR72 7   21
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 6.62       420.       100.                                           CMR72 7   22
 6.67       22.        7.                                             CMR72 7   23
 6.85       95.        25.                                            CMR72 7   24
 7.00       5.                                                        CMR72 7   25
 7.12       5.                                                        CMR72 7   26
ENDDATA             16                                                CMR72 7   27
ENDSUBENT            7                                                CMR72 799999
SUBENT        CMR72  8          0                                     CMR72 8    1
BIB                  1         11                                     CMR72 8    2
COMMENTS   LEGENDRE POLYNOMIAL EXPANSION COEFFICIENTS USED TO         CMR72 8    3
           REPRESENT ANGULAR DISTRIBUTIONS ARE PROVIDED FOR           CMR72 8    4
           MEASURED GAMMA-RAY TRANSITIONS. MEASUREMENTS WERE          CMR72 8    5
           MADE A RESONANCES DEFINED BY INCIDENT PROTON ENERGY.       CMR72 8    6
           INFORMATION OBTAINED FROM TABLE 8 OF THE PAPER.            CMR72 8    7
           EP = PROTON ENERGY. EI = EXCITATION ENERGY OF INITIAL      CMR72 8    8
           STATE OF GAMMA-RAY TRANSITION. EF = EXCITATION ENERGY      CMR72 8    9
           OF FINAL STATE. A2 = LEGENDRE COEFFICIENT FOR P2 TERM      CMR72 8   10
           IN LEGENDRE EXPANSION. A2-ERR = ERROR IN A2. A4 =          CMR72 8   11
           LEGENDRE COEFFICIENT FOR P4 TERM IN LEGENDRE               CMR72 8   12
           EXPANSION. A4-ERR = ERROR IN A4.                           CMR72 8   13
ENDBIB              11                                                CMR72 8   14
DATA                 7         14                                     CMR72 8   15
EP         EI         EF         A2         A2-ERR     A4             CMR72 8   16
A4-ERR                                                                CMR72 8   17
KEV        MEV        MEV        NO-DIM     NO-DIM     NO-DIM         CMR72 8   18
NO-DIM                                                                CMR72 8   19
 888.       9.725      6.62       0.32       0.06      -0.11          CMR72 8   20
 0.08                                                                 CMR72 8   21
 888.       9.725      5.01       0.64       0.15       0.11          CMR72 8   22
 0.18                                                                 CMR72 8   23
 888.       6.62       5.01       0.31       0.14       0.08          CMR72 8   24
 0.17                                                                 CMR72 8   25
 888.       6.62       4.46       0.29       0.11      -0.07          CMR72 8   26
 0.13                                                                 CMR72 8   27
 1438.      10.258     6.62       0.42       0.02      -0.08          CMR72 8   28
 0.04                                                                 CMR72 8   29
 1438.      10.258     5.01      -0.51       0.11      -0.03          CMR72 8   30
 0.14                                                                 CMR72 8   31
 1438.      10.258     4.46      -0.07       0.03       0.39          CMR72 8   32
 0.10                                                                 CMR72 8   33
 1438.      6.62       5.01       0.27       0.02       0.13          CMR72 8   34
 0.02                                                                 CMR72 8   35
 1438.      6.62       4.46       0.30       0.03      -0.09          CMR72 8   36
 0.04                                                                 CMR72 8   37
 1583.      10.398     6.62       0.39       0.01      -0.09          CMR72 8   38
 0.02                                                                 CMR72 8   39
 1583.      10.398     5.01       0.04       0.03      -0.07          CMR72 8   40
 0.03                                                                 CMR72 8   41
 1583.      10.398     4.46       0.39       0.10      -0.16          CMR72 8   42
 0.12                                                                 CMR72 8   43
 1583.      6.62       5.01       0.32       0.02       0.19          CMR72 8   44
 0.03                                                                 CMR72 8   45
 1583.      6.62       4.46       0.40       0.08      -0.11          CMR72 8   46
 0.09                                                                 CMR72 8   47
```

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ENDDATA             32                                                CMR72 8   48
ENDSUBENT            8                                                CMR72 899999
SUBENT        CMR72  9          0                                     CMR72 9    1
BIB                  1         17                                     CMR72 9    2
COMMENTS   STRENGTHS OF GAMMA-RAY TRANSITIONS BETWEEN BOUND           CMR72 9    3
           LEVELS IN 32S ARE GIVEN. RESULTS ARE OBTAINED FROM         CMR72 9    4
           TABLE 11 OF THE PAPER. EI = EXCITATION ENERGY OF           CMR72 9    5
           INITIAL LEVEL OF THE TRANSITION. EF = EXCITATION           CMR72 9    6
           ENERGY OF THE FINAL LEVEL. GAM(G) = GAMMA-RAY              CMR72 9    7
           WIDTH. GAM(G)-ERR = ERROR IN GAMMA-RAY WIDTH.              CMR72 9    8
           S(E1) = E1 TRANSITION STRENGTH. S(E1)-ERR = ERROR          CMR72 9    9
           IN E1 TRANSITION STRENGTH. S(E2) = E2 TRANSITION           CMR72 9   10
           STRENGTH. S(E2)-ERR = ERROR IN E2 TRANSITION               CMR72 9   11
           STRENGTH. S(E3) = E3 TRANSITION STRENGTH. S(E3)-ERR        CMR72 9   12
           = ERROR IN E3 TRANSITION STRENGTH. S(M1) = M1              CMR72 9   13
           TRANSITION STRENGTH. S(M1)-ERR = ERROR IN M1               CMR72 9   14
           TRANSITION STRENGTH. S(M2)-ERR = ERROR IN M2               CMR72 9   15
           TRANSITION STRENGTH. BLANK ENTRIES APPEAR WHERE NO         CMR72 9   16
           INFORMATION IS GIVEN IN THE TABLE. W.U. = WEISSKOPF        CMR72 9   17
           UNITS OF TRANSITION STRENGTH. MILLI-EV = MILLI             CMR72 9   18
           ELECTRON VOLTS.                                            CMR72 9   19
ENDBIB              17                                                CMR72 9   20
DATA                14         15                                     CMR72 9   21
EI         EF         GAM(G)     GAM(G)-ERR S(E1)      S(E1)-ERR      CMR72 9   22
S(E2)      S(E2)-ERR  S(E3)      S(E3)-ERR  S(M1)      S(M1)-ERR      CMR72 9   23
S(M2)      S(M2)-ERR                                                  CMR72 9   24
MEV        MEV        MILLI-EV   MILLI-EV   W.U.       W.U.           CMR72 9   25
W.U.       W.U.       W.U.       W.U.       W.U.       W.U.           CMR72 9   26
W.U.       W.U.                                                       CMR72 9   27
 2.23       0.         3.6        1.4                                 CMR72 9   28
 13.        5.                                                        CMR72 9   29
                                                                      CMR72 9   30
 3.78       2.23       0.5        0.3                                 CMR72 9   31
 12.        6.                                                        CMR72 9   32
                                                                      CMR72 9   33
 4.28       0.         16.        4.                                  CMR72 9   34
 2.3        0.5                                                       CMR72 9   35
                                                                      CMR72 9   36
 4.28       2.23       2.2        0.9                                 CMR72 9   37
 12.        6.                               4000.      4000.         CMR72 9   38
                                                                      CMR72 9   39
 4.46       2.23       3.1        0.9                                 CMR72 9   40
 11.        3.                                                        CMR72 9   41
                                                                      CMR72 9   42
 4.70       0.         1.1        0.3                                 CMR72 9   43
                                             51000.     13000.        CMR72 9   44
                                                                      CMR72 9   45
 4.70       2.23       1.7        0.2                                 CMR72 9   46
 0.7        0.7                              400000.    150000.       CMR72 9   47
                                                                      CMR72 9   48
 5.01       0.         0.15       0.10                                CMR72 9   49
                       80.        50.                                 CMR72 9   50
                                                                      CMR72 9   51
 5.01       2.23       1.7        0.4        12000.     3000.         CMR72 9   52
```

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                                                                 CMR72 9   53
 0.7        0.7                                                  CMR72 9   54
 5.41       2.23       6.2        1.7                            CMR72 9   55
 3.8        1.0                              6000.      6000.    CMR72 9   56
                                                                 CMR72 9   57
 5.55       0.         2.7        0.9                            CMR72 9   58
 0.10       0.03                                                 CMR72 9   59
                                                                 CMR72 9   60
 5.55       2.23       3.9        1.2                            CMR72 9   61
 0.5        0.3                              400000.    150000.  CMR72 9   62
                                                                 CMR72 9   63
 5.80       0.         80.        50.        60000.     40000.   CMR72 9   64
                                                                 CMR72 9   65
                                                                 CMR72 9   66
 6.22       2.23       12.        2.         27000.     4000.    CMR72 9   67
                                                                 CMR72 9   68
 1.1        0.4                                                  CMR72 9   69
 6.62       2.3        0.05       0.03                           CMR72 9   70
                                             2000.      1000.    CMR72 9   71
                                                                 CMR72 9   72
ENDDATA             51                                           CMR72 9   73
ENDSUBENT            9                                           CMR72 999999
ENDENTRY             9                                           CMR729999999
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E90

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ENTRY              E90          0                                  E90 0    1
SUBENT          E90  1          0                                  E90 1    1
BIB                  6         11                                  E90 1    2
INSTITUTE  (NEDUTR)                                                E90 1    3
REFERENCE  (J,NP/A,521,1,1990)                                     E90 1    4
AUTHOR     (P.M.ENDT)                                              E90 1    5
TITLE      ENERGY LEVELS OF A = 21-44 NUCLEI (VII)                 E90 1    6
COMMENTS   AN EXTENSIVE COMPILATION OF DATA ON LIGHT NUCLEI IS     E90 1    7
           GIVEN. THIS SOURCE INCLUDES RELEVANT DATA FOR THE       E90 1    8
           31P(P,GAMMA)32S REACTION. ORIGINAL DATA REFERENCES      E90 1    9
           ARE GIVEN IN THE PAPER. EMPHASIS HERE IS ON DATA        E90 1   10
           WHICH PERTAIN TO THE DETERMINATION OF REACTION RATES    E90 1   11
           RATES FOR ASTROPHYSICS.                                 E90 1   12
STATUS     COMPILATION PUBLISHED IN THE JOURNAL NUCLEAR PHYSICS.   E90 1   13
ENDBIB              11                                             E90 1   14
ENDSUBENT            1                                             E90 199999
SUBENT          E90  2          0                                  E90 2    1
BIB                  1         11                                  E90 2    2
COMMENTS   PARAMETERS OF ENERGY LEVELS IN 32S ARE GIVEN. VALUES    E90 2    3
           ARE OBTAINED FROM TABLE 32.15 OF THE COMPILATION.       E90 2    4
           EX = EXCITATION ENERGY OF 32S LEVEL. EX-ERR = ERROR     E90 2    5
           IN EXCITATION ENERGY. J-PI = SPIN AND PARITY OF THE     E90 2    6
           LEVEL. NEGATIVE PARITY IS DENOTED BY A NEGATIVE         E90 2    7
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          NUMBER. OTHERWISE PARITY IS POSITIVE. T = LEVEL          E90 2    8
          ISOSPIN. TAU = LEVEL MEAN LIFETIME. TAU-ERR = ERROR      E90 2    9
          IN MEAN LIFETIME. GAMMA = LEVEL WIDTH. GAMMA-ERR =       E90 2   10
          ERROR IN WIDTH. EITHER WIDTH OR LIFETIME IS GIVEN,       E90 2   11
          NOT BOTH. WHEN NO VALUE IS GIVEN IT WAS NOT AVAILABLE    E90 2   12
          OR AMBIGUITY EXISTED. FSEC = 10**(-15) SEC.              E90 2   13
 ENDBIB             11                                             E90 2   14
DATA                 8        112                                  E90 2   15
EX         ERR-EX     J-PI       T          TAU        TAU-ERR     E90 2   16
GAMMA      GAMMA-ERR                                               E90 2   17
KEV        KEV        NO-DIM     NO-DIM     FSEC       FSEC        E90 2   18
EV         EV                                                      E90 2   19
 0.                    0.                                          E90 2   20
                                                                   E90 2   21
 2230.3     0.2        2.                    242.       7.         E90 2   22
                                                                   E90 2   23
 3778.3     0.7        0.                    1050.      200.       E90 2   24
                                                                   E90 2   25
 4281.5     0.4        2.                    42.        5.         E90 2   26
                                                                   E90 2   27
 4458.9     0.8        4.                    175.       25.        E90 2   28
                                                                   E90 2   29
 4695.4     0.4        1.                    350.       50.        E90 2   30
                                                                   E90 2   31
 5006.2     0.3       -3.                    670.       70.        E90 2   32
                                                                   E90 2   33
 5413.0     0.8        3.                    150.       30.        E90 2   34
                                                                   E90 2   35
 5548.9     0.7        2.                    80.        20.        E90 2   36
                                                                   E90 2   37
 5797.9     0.7       -1.                    10.        4.         E90 2   38
                                                                   E90 2   39
 6224.3     0.7       -2.                    85.        15.        E90 2   40
                                                                   E90 2   41
 6411.0     1.4        4.                    35.        8.         E90 2   42
                                                                   E90 2   43
 6581.      3.                                                     E90 2   44
                                                                   E90 2   45
 6621.1     0.3       -4.                    650.       100.       E90 2   46
                                                                   E90 2   47
 6665.7     0.8        2.                    45.        25.        E90 2   48
                                                                   E90 2   49
 6761.7     0.3       -5.                    300.                  E90 2   50
                                                                   E90 2   51
 6852.      2.         4.                    95.        25.        E90 2   52
                                                                   E90 2   53
 7002.5     1.0        1.         1.         5.                    E90 2   54
                                                                   E90 2   55
 7115.0     1.2        2.         1.         5.                    E90 2   56
                                                                   E90 2   57
 7189.7     1.2        1.                                          E90 2   58
                                                                   E90 2   59
 7348.      2.         3.                                          E90 2   60
                                                                   E90 2   61
```

7434.	2.	-1.				E90 2	62
						E90 2	63
7484.8	1.0	2.				E90 2	64
						E90 2	65
7535.7	0.8	0.	1.			E90 2	66
						E90 2	67
7567.3	1.4	5.				E90 2	68
						E90 2	69
7637.	5.	1.				E90 2	70
						E90 2	71
7701.7	1.4	-3.				E90 2	72
						E90 2	73
7885.	3.					E90 2	74
						E90 2	75
7914.	5.	1.				E90 2	76
						E90 2	77
7950.1	0.4	-4.		125.	20.	E90 2	78
						E90 2	79
7964.	3.	4.				E90 2	80
						E90 2	81
7974.	4.					E90 2	82
						E90 2	83
8126.5	0.6	1.	1.	230.	25.	E90 2	84
						E90 2	85
8194.	5.					E90 2	86
						E90 2	87
8276.	4.					E90 2	88
						E90 2	89
8294.	3.					E90 2	90
						E90 2	91
8344.	3.	2.				E90 2	92
						E90 2	93
8345.0	1.7					E90 2	94
						E90 2	95
8380.	4.					E90 2	96
						E90 2	97
8407.	4.					E90 2	98
						E90 2	99
8494.	2.	-1.	0.			E90 2	100
						E90 2	101
8507.	8.	0.				E90 2	102
						E90 2	103
8690.	2.	2.	0.			E90 2	104
						E90 2	105
8728.	3.					E90 2	106
						E90 2	107
8848.	8.					E90 2	108
						E90 2	109
8861.	2.	2.	0.			E90 2	110
						E90 2	111
9023.	2.	-3.	0.			E90 2	112
						E90 2	113
9060.	3.					E90 2	114
						E90 2	115

9065.	2.	4.	0.	20.	E90 2 116
					E90 2 117
9138.	5.				E90 2 118
					E90 2 119
9170.	4.				E90 2 120
					E90 2 121
9196.	8.	2.			E90 2 122
					E90 2 123
9208.1	0.7	1.	1.		E90 2 124
0.36	0.11				E90 2 125
9236.	2.	-1.	0.		E90 2 126
					E90 2 127
9255.	10.				E90 2 128
					E90 2 129
9290.1	0.8	1.			E90 2 130
					E90 2 131
9388.9	0.8	-2.			E90 2 132
					E90 2 133
9463.8	1.5				E90 2 134
					E90 2 135
9463.9	1.2	2.	0.		E90 2 136
					E90 2 137
9486.7	0.9	-1.	0.		E90 2 138
8.2	2.5				E90 2 139
9557.	10.				E90 2 140
					E90 2 141
9636.4	1.5				E90 2 142
					E90 2 143
9650.3	0.8	2.			E90 2 144
					E90 2 145
9659.6	1.2	1.	1.		E90 2 146
2.4	0.7				E90 2 147
9711.5	0.7	2.	0.		E90 2 148
3.6					E90 2 149
9724.3	0.8				E90 2 150
					E90 2 151
9730.8	0.8	-1.			E90 2 152
					E90 2 153
9785.	5.				E90 2 154
					E90 2 155
9817.3	1.2	-3.	0.		E90 2 156
					E90 2 157
9827.	3.				E90 2 158
					E90 2 159
9849.	3.	-1.	0.		E90 2 160
100.	10.				E90 2 161
9887.7	0.8	1.	0.		E90 2 162
10.	5.				E90 2 163
9919.8	0.8	2.	0.		E90 2 164
10.	5.				E90 2 165
9949.9	0.8	-1.	0.		E90 2 166
150.	15.				E90 2 167
9978.3	0.9	-4.			E90 2 168
					E90 2 169

9978.8	0.9	3.		E90 2 170
				E90 2 171
9983.2	0.8	0.	0.	E90 2 172
100.	10.			E90 2 173
10021.	10.			E90 2 174
				E90 2 175
10076.5	0.8	-2.	1.	E90 2 176
1500.	150.			E90 2 177
10104.1	1.0		0.	E90 2 178
				E90 2 179
10220.5	0.8	3.	0.	E90 2 180
10.	5.			E90 2 181
10223.2	1.0	-3.		E90 2 182
56.	10.			E90 2 183
10226.2	1.6	-1.		E90 2 184
180.	20.			E90 2 185
10231.5	0.8	1.	0.	E90 2 186
25.	3.			E90 2 187
10257.5	0.9	-4.	1.	E90 2 188
35.	4.			E90 2 189
10276.	8.	4.		E90 2 190
				E90 2 191
10288.2	1.6	-3.	0.	E90 2 192
160.	20.			E90 2 193
10291.2	0.8	-2.	0.	E90 2 194
125.	13.			E90 2 195
10293.3	1.6	2.	0.	E90 2 196
70.	10.			E90 2 197
10332.5	1.6	-1.	0.	E90 2 198
6100.	700.			E90 2 199
10372.1	0.8	2.	1.	E90 2 200
25.	3.			E90 2 201
10397.6	0.8	-4.	1.	E90 2 202
12.	2.			E90 2 203
10401.6	1.6	-0.		E90 2 204
7000.	700.			E90 2 205
10428.	10.			E90 2 206
				E90 2 207
10457.	3.	0.	0.	E90 2 208
1700.	200.			E90 2 209
10509.9	1.2	2.		E90 2 210
10.	5.			E90 2 211
10528.	3.	2.	0.	E90 2 212
80.	10.			E90 2 213
10550.	4.		0.	E90 2 214
8000.				E90 2 215
10573.1	1.2			E90 2 216
15.	2.			E90 2 217
10604.0	1.2	-1.	0.	E90 2 218
150.	20.			E90 2 219
10626.	3.	-3.	0.	E90 2 220
660.	70.			E90 2 221
10696.4	1.2	2.		E90 2 222
180.	20.			E90 2 223

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 10700.8    1.2       -1.         0.                                   E90 2  224
 21000.     4000.                                                      E90 2  225
 10757.0    1.2        2.                                              E90 2  226
 50.        10.                                                        E90 2  227
 10769.     3.        -2.                                              E90 2  228
 5100.      500.                                                       E90 2  229
 10779.3    1.2        2.         0.                                   E90 2  230
 620.       70.                                                        E90 2  231
 10785.6    1.2        1.                                              E90 2  232
 750.       80.                                                        E90 2  233
 10787.2    1.2        0.         0.                                   E90 2  234
 600.       60.                                                        E90 2  235
 10792.7    1.2        2.         0.                                   E90 2  236
 170.       20.                                                        E90 2  237
 10826.0    1.2       -1.         0.                                   E90 2  238
 22000.     4000.                                                      E90 2  239
 10827.3    1.2        2.         0.                                   E90 2  240
 320.       30.                                                        E90 2  241
 10916.     3.        -1.         0.                                   E90 2  242
 1600.      200.                                                       E90 2  243
ENDDATA            228                                                 E90 2  244
ENDSUBENT            2                                                 E90 299999
SUBENT          E90  3          0                                      E90 3    1
BIB                  2         11                                      E90 3    2
REACTION   31P(P,GAMMA)32S                                             E90 3    3
COMMENTS   RESONANCE PARAMETERS OF 31P(P,GAMMA)32S FOR EP              E90 3    4
           BELOW 2100 KEV ARE GIVEN. DATA ARE OBTAINED FROM            E90 3    5
           TABLE 32.20A. EP = RESONANCE PROTON ENERGY.                 E90 3    6
           EP-ERR = ERROR IN PROTON ENERGY. EX = RESONANCE              E90 3    7
           EXCITATION ENERGY. EX-ERR = ERROR IN EXCITATION             E90 3    8
           ENERGY. GAMMA = RESONANCE WIDTH. GAMMA-ERR = ERROR          E90 3    9
           IN RESONANCE WIDTH. S = RESONANCE GAMMA-RAY STRENGTH        E90 3   10
           = (2J+1)*GAMMA(P)*GAMMA(G)/GAMMA(TOTAL). S-ERR = ERROR      E90 3   11
           IN RESONANCE STRENGTH. A BLANK ENTRY INDICATES THAT         E90 3   12
           THE VALUE IS NOT AVAILABLE OR IS AMBIGUOUS.                 E90 3   13
ENDBIB              11                                                 E90 3   14
DATA                 8         50                                      E90 3   15
EP         EP-ERR     EX         EX-ERR     GAMMA      GAMMA-ERR       E90 3   16
S          S-ERR                                                       E90 3   17
KEV        KEV        KEV        KEV        KEV        KEV             E90 3   18
EV         EV                                                          E90 3   19
 354.8      0.4        9208.1     0.7        0.00036    0.00011        E90 3   20
 0.01                                                                  E90 3   21
 439.4      0.5        9290.1     0.8                                  E90 3   22
 0.11                                                                  E90 3   23
 541.4      0.6        9388.9     0.8                                  E90 3   24
 0.45                                                                  E90 3   25
 618.9      1.0        9463.9     1.2                                  E90 3   26
 0.03                                                                  E90 3   27
 642.4      0.7        9486.7     0.9        0.0082     0.0025         E90 3   28
 0.24       0.04                                                       E90 3   29
 811.3      0.5        9650.3     0.8                                  E90 3   30
 1.00       0.15                                                       E90 3   31
 821.0      1.0        9659.6     1.2        0.0024     0.0007         E90 3   32
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0.20						E90 3	33
874.3	0.5	9711.3	0.8	0.0036		E90 3	34
0.13						E90 3	35
887.8	0.5	9724.3	0.8			E90 3	36
0.08						E90 3	37
894.5	0.5	9730.8	0.8			E90 3	38
0.32						E90 3	39
983.8	1.0	9817.3	1.2			E90 3	40
0.08						E90 3	41
994.	3.	9827.	3.			E90 3	42
						E90 3	43
1016.	3.	9849.	3.	0.100	0.010	E90 3	44
0.03						E90 3	45
1056.5	0.6	9887.7	0.8	0.010	0.005	E90 3	46
0.50						E90 3	47
1089.6	0.6	9919.8	0.8	0.010	0.005	E90 3	48
0.17						E90 3	49
1120.7	0.6	9949.9	0.8	0.150	0.015	E90 3	50
1.4						E90 3	51
1150.0	0.7	9978.3	0.9			E90 3	52
0.11	0.03					E90 3	53
1150.5	0.7	9978.8	0.9			E90 3	54
1.0	0.2					E90 3	55
1155.1	0.6	9983.2	0.8	0.100	0.010	E90 3	56
0.68						E90 3	57
1251.4	0.6	10076.5	0.8	1.50	0.15	E90 3	58
4.3	0.5					E90 3	59
1279.9	0.8	10104.1	1.0			E90 3	60
0.11						E90 3	61
1400.1	0.6	10220.5	0.8	0.010	0.005	E90 3	62
0.59						E90 3	63
1402.9	0.8	10223.2	1.0	0.056	0.010	E90 3	64
2.3						E90 3	65
1406.0	1.5	10226.2	1.6	0.18	0.02	E90 3	66
						E90 3	67
1411.4	0.6	10231.5	0.8	0.025	0.003	E90 3	68
0.91						E90 3	69
1438.3	0.7	10257.5	0.9	0.035	0.004	E90 3	70
5.0						E90 3	71
1470.0	1.5	10288.2	1.6	0.16	0.02	E90 3	72
0.07						E90 3	73
1473.1	0.6	10291.2	0.8	0.125	0.013	E90 3	74
1.1						E90 3	75
1475.3	1.5	10293.3	1.6	0.07	0.01	E90 3	76
0.17						E90 3	77
1515.8	1.5	10332.5	1.6	6.1	0.7	E90 3	78
						E90 3	79
1556.6	0.6	10372.1	0.8	0.025	0.003	E90 3	80
4.1						E90 3	81
1582.9	0.6	10397.6	0.8	0.012	0.002	E90 3	82
3.6						E90 3	83
1587.0	1.5	10401.6	1.6	7.0	0.7	E90 3	84
						E90 3	85
1643.	3.	10456.	3.	1.7	0.2	E90 3	86

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                                                                      E90 3   87
 1698.9     1.0        10509.9    1.2        0.010      0.005         E90 3   88
 0.41                                                                 E90 3   89
 1717.      3.         10527.     3.         0.08       0.01          E90 3   90
                                                                      E90 3   91
 1740.      4.         10550.     4.         8.                       E90 3   92
                                                                      E90 3   93
 1764.2     1.0        10573.1    1.2        0.015      0.002         E90 3   94
 0.41                                                                 E90 3   95
 1796.1     1.0        10604.0    1.2        0.15       0.02          E90 3   96
 0.50                                                                 E90 3   97
 1818.      3.         10626.     3.         0.66       0.07          E90 3   98
                                                                      E90 3   99
 1891.5     1.0        10696.4    1.2        0.18       0.02          E90 3  100
 1.0                                                                  E90 3  101
 1896.0     1.0        10700.8    1.2        21.        4.            E90 3  102
 1.1                                                                  E90 3  103
 1954.0     1.0        10757.0    1.2        0.05       0.01          E90 3  104
 3.2                                                                  E90 3  105
 1967.      3.         10769.     3.         5.1        0.5           E90 3  106
                                                                      E90 3  107
 1977.1     1.0        10779.3    1.2        0.62       0.07          E90 3  108
 1.8                                                                  E90 3  109
 1983.6     1.0        10785.6    1.2        0.75       0.08          E90 3  110
 3.6                                                                  E90 3  111
 1985.2     1.0        10787.2    1.2        0.60       0.06          E90 3  112
                                                                      E90 3  113
 1990.9     1.0        10792.7    1.2        0.17       0.02          E90 3  114
 2.4                                                                  E90 3  115
 2025.3     1.0        10826.0    1.2        22.        4.            E90 3  116
                                                                      E90 3  117
 2026.6     1.0        10827.3    1.2        0.32       0.03          E90 3  118
 6.8                                                                  E90 3  119
ENDDATA            104                                                E90 3  120
ENDSUBENT            3                                                E90 399999
SUBENT          E90  4          0                                     E90 4    1
BIB                  2          8                                     E90 4    2
REACTION   31P(P,GAMMA)32S                                            E90 4    3
COMMENTS   RESONANCE PARAMETERS OF 31P(P,GAMMA)32S FOR EP             E90 4    4
           ABOVE 2100 KEV ARE GIVEN. DATA ARE OBTAINED FROM           E90 4    5
           TABLE 32.20B. EP = RESONANCE PROTON ENERGY.                E90 4    6
           EP-ERR = ERROR IN PROTON ENERGY. EX = RESONANCE             E90 4    7
           EXCITATION ENERGY. EX-ERR = ERROR IN EXCITATION            E90 4    8
           ENERGY. GAMMA = RESONANCE WIDTH. GAMMA-ERR = ERROR         E90 4    9
           IN RESONANCE WIDTH.                                        E90 4   10
ENDBIB               8                                                E90 4   11
DATA                 6         92                                     E90 4   12
EP         EP-ERR     EX         EX-ERR     GAMMA      GAMMA-ERR      E90 4   13
KEV        KEV        KEV        KEV        KEV        KEV            E90 4   14
 2118.      3.         10916.     3.         1.6        0.2           E90 4   15
 2136.      3.         10933.     3.         0.048      0.005         E90 4   16
 2181.      3.         10977.     3.         6.7        0.7           E90 4   17
 2258.      3.         11051.     3.         4.2        0.4           E90 4   18
 2291.      3.         11083.     3.         0.085      0.009         E90 4   19
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2300.	3.	11092.	3.	0.070	0.007	E90 4	20
2332.	3.	11123.	3.	6.4	0.7	E90 4	21
2350.	3.	11140.	3.	2.6	0.3	E90 4	22
2408.	3.	11197.	3.	0.08	0.01	E90 4	23
2437.	3.	11225.	3.	0.19	0.02	E90 4	24
2443.	3.	11231.	3.	0.8	0.1	E90 4	25
2447.	3.	11234.	3.	7.9	0.8	E90 4	26
2450.	3.	11237.	3.	0.05	0.01	E90 4	27
2468.	3.	11255.	3.	0.21	0.02	E90 4	28
2549.	3.	11333.	3.	0.15	0.02	E90 4	29
2659.	3.	11440.	3.	0.35	0.04	E90 4	30
2666.	3.	11447.	3.	5.3	0.6	E90 4	31
2696.	3.	11476.	3.	0.23	0.03	E90 4	32
2707.	3.	11487.	3.	0.50	0.05	E90 4	33
2729.	3.	11508.	3.	33.	6.	E90 4	34
2780.	3.	11557.	3.	0.05	0.01	E90 4	35
2808.	3.	11584.	3.	3.1	0.3	E90 4	36
2811.	3.	11587.	3.	1.6	1.6	E90 4	37
2812.	3.	11588.	3.	0.16	0.02	E90 4	38
2829.	3.	11604.	3.	0.81	0.08	E90 4	39
2830.	3.	11605.	3.	7.0	0.7	E90 4	40
2832.	3.	11607.	3.	0.31	0.03	E90 4	41
2834.	3.	11609.	3.	3.7	0.7	E90 4	42
2848.	3.	11623.	3.	5.5	0.6	E90 4	43
2850.	3.	11625.	3.	0.06	0.01	E90 4	44
2855.	3.	11630.	3.	27.	5.	E90 4	45
2862.	3.	11636.	3.	1.9	0.2	E90 4	46
2865.	3.	11639.	3.	0.80	0.08	E90 4	47
2906.	3.	11679.	3.	2.6	0.3	E90 4	48
2950.	3.	11722.	3.	2.8	0.3	E90 4	49
2964.	3.	11735.	3.	24.	3.	E90 4	50
2978.	3.	11749.	3.	0.90	0.09	E90 4	51
2988.	3.	11758.	3.	0.14	0.02	E90 4	52
3014.	3.	11784.	3.	0.03	0.01	E90 4	53
3034.	3.	11803.	3.	0.12	0.01	E90 4	54
3036.	3.	11805.	3.	2.0	0.4	E90 4	55
3038.	3.	11807.	3.	37.	7.	E90 4	56
3050.	3.	11818.	3.	19.	4.	E90 4	57
3064.	3.	11832.	3.	0.14	0.02	E90 4	58
3098.	3.	11865.	3.	8.2	0.9	E90 4	59
3102.	3.	11869.	3.	1.1	0.1	E90 4	60
3133.	3.	11879.	3.	3.6	0.7	E90 4	61
3136.	3.	11902.	3.	2.4	0.5	E90 4	62
3145.	3.	11910.	3.	6.3	0.7	E90 4	63
3165.	3.	11930.	3.	0.10	0.02	E90 4	64
3169.	3.	11934.	3.	0.015	0.002	E90 4	65
3171.	3.	11936.	3.	1.45	0.15	E90 4	66
3172.	3.	11937.	3.	0.11	0.02	E90 4	67
3184.	3.	11948.	3.	2.5	0.3	E90 4	68
3191.	3.	11955.	3.	0.08	0.02	E90 4	69
3196.	3.	11960.	3.	8.6	1.7	E90 4	70
3217.	3.	11980.	3.	0.41	0.04	E90 4	71
3228.	3.	11991.	3.	32.	6.	E90 4	72
3238.	3.	12000.	3.	2.0	0.2	E90 4	73

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 3252.      3.         12014.     3.         9.0         0.9           E90 4   74
 3260.      3.         12022.     3.         2.6         0.3           E90 4   75
 3276.      3.         12037.     3.         0.40        0.04          E90 4   76
 3289.      3.         12050.     3.         0.23                      E90 4   77
 3365.      3.         12123.     3.         50.         10.           E90 4   78
 3385.      3.         12143.     3.         3.2         0.3           E90 4   79
 3389.      3.         12147.     3.         13.         3.            E90 4   80
 3394.      3.         12152.     3.         0.33        0.03          E90 4   81
 3396.      3.         12154.     3.         4.3         0.4           E90 4   82
 3426.      3.         12183.     3.         3.5         0.4           E90 4   83
 3428.      3.         12185.     3.         10.5        1.1           E90 4   84
 3439.      3.         12195.     3.         5.5         1.1           E90 4   85
 3471.      3.         12226.     3.         0.20        0.02          E90 4   86
 3488.      3.         12243.     3.         0.34        0.03          E90 4   87
 3518.      3.         12272.     3.         0.30        0.06          E90 4   88
 3543.      3.         12296.     3.         15.         2.            E90 4   89
 3545.      3.         12298.     3.         0.32        0.03          E90 4   90
 3584.      3.         12336.     3.         2.8         0.3           E90 4   91
 3588.      3.         12339.     3.         23.         5.            E90 4   92
 3620.      3.         12370.     3.         0.18        0.02          E90 4   93
 3632.      3.         12382.     3.         1.05        0.11          E90 4   94
 3639.      3.         12389.     3.         1.8         0.4           E90 4   95
 3640.      3.         12390.     3.         4.2         0.4           E90 4   96
 3649.      3.         12399.     3.         0.35        0.04          E90 4   97
 3672.      3.         12421.     3.         2.8         0.3           E90 4   98
 3672.      3.         12421.     3.         0.06        0.01          E90 4   99
 3680.      3.         12429.     3.         15.                       E90 4  100
 3709.      3.         12457.     3.         3.2         0.06          E90 4  101
 3716.      3.         12463.     3.         4.8         0.5           E90 4  102
 3725.      3.         12472.     3.         26.         5.            E90 4  103
 3726.      3.         12473.     3.         1.40        0.14          E90 4  104
 3735.      3.         12482.     3.         0.35        0.04          E90 4  105
 3741.      3.         12488.     3.         0.40                      E90 4  106
ENDDATA              94                                                E90 4  107
ENDSUBENT             4                                                E90 499999
ENDENTRY              4                                                E909999999
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EE66

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ENTRY             EE66          0                                     EE66 0     1
SUBENT         EE66  1          0                                     EE66 1     1
BIB                  12        42                                     EE66 1     2
INSTITUTE  (NEDUTR)                                                   EE66 1     3
REFERENCE  (J,NP,88,12,1966)                                          EE66 1     4
AUTHORS    (G.A.P.ENGELBERTINK,P.M.ENDT)                              EE66 1     5
TITLE      MEASUREMENTS OF (P,GAMMA) RESONANCE STRENGTHS IN THE       EE66 1     6
           S-D SHELL                                                  EE66 1     7
FACILITIES (C-W) 850-KEV COCKCROFT-WALTON ACCELERATOR,                EE66 1     8
           RIJKSUNIVERSITEIT, UTRECHT, THE NETHERLANDS.               EE66 1     9
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           (VDG) 3-MEV VAN DE GRAAFF GENERATOR,                    EE66 1   10
           RIJKSUNIVERSITEIT, UTRECHT, THE NETHERLANDS.            EE66 1   11
INC-PART   (P) PROTONS.                                            EE66 1   12
TARGETS    VARIOUS COMPOUNDS INCLUDING ONES THAT CONTAIN THE       EE66 1   13
           ELEMENT PHOSPHORUS ARE USED. TARGETS WERE PREPARED      EE66 1   14
           BY VACUUM EVAPORATION OF MATERIALS ONTO 0.3-MM THICK    EE66 1   15
           TANTALUM BACKINGS. MATERIALS WERE SELECTED THAT         EE66 1   16
           WOULD NOT DECOMPOSE DURING EVAPORATION. SOME TARGETS    EE66 1   17
           WERE THICK AND OTHERS WERE THIN.                        EE66 1   18
METHOD     MEASUREMENTS WERE MADE IN THE PROTON ENERGY RANGE       EE66 1   19
           0.3 TO 2.1 MEV. RESONANCES WERE SELECTED WHICH WERE     EE66 1   20
           STRONG, SUFFICIENTLY ISOLATED FROM OTHER RESONANCES,    EE66 1   21
           AND HAD WELL-KNOWN GAMMA-RAY DECAY SCHEMES. THE         EE66 1   22
           STRENGTH OF THE EP = 621-KEV RESONANCE IN THE           EE66 1   23
           REACTION 30SI(P,GAMMA)31P WAS USED AS A STANDARD.       EE66 1   24
           THE GAMMA-RAY DETECTOR WAS PLACED 40 MM FROM THE        EE66 1   25
           TARGET AND AT AN ANGLE OF 55 DEGREES RELATIVE TO        EE66 1   26
           THE INCIDENT PROTONS TO ELIMINATE THE CONTRIBUTION      EE66 1   27
           FROM THE P2 LEGENDRE POLYNOMIAL TERM IN THE ANGULAR     EE66 1   28
           DISTRIBUTIONS OF EMITTED GAMMA RAYS. VARIOUS TARGET     EE66 1   29
           THICKNESSES WERE USED TO CHECK FOR SYSTEMATIC ERRORS    EE66 1   30
           IN THE MEASUREMENTS. THE TARGETS WERE WATER-COOLED      EE66 1   31
           AND THE BEAM CURRENT WAS KEPT LOW ENOUGH SO THAT        EE66 1   32
           THE BEAM POWER ON TARGET WAS LESS THAN 3 WATTS.         EE66 1   33
           EFFECTS DUE TO SECONDARY ELECTRON EMISSION FROM         EE66 1   34
           THE TARGET WERE MINIMIZED BY THE USE OF A SUPPRESOR     EE66 1   35
           RING AT NEGATIVE POTENTIAL RELATIVE TO THE TARGET.      EE66 1   36
           PROCEDURES FOR ANALYSIS OF THE EXPERIMENTAL DATA        EE66 1   37
           ARE DISCUSSED IN THE ORIGINAL PAPER.                    EE66 1   38
DETECTOR   (SCINT) 10 CM X 10 CM NAI SCINTILLATOR CRYSTAL.         EE66 1   39
MONITOR    (CI) CURRENT INTEGRATOR.                                EE66 1   40
CORRECTION DATA WERE CORRECTED FOR DETECTOR EFFICIENCY AND         EE66 1   41
           BACKGROUND EVENTS IN THE GAMMA-RAY SPECTRA.             EE66 1   42
ERR-ANALYS EXPERIMENTAL ERRORS IN THE FINAL RESULTS ARE OF THE     EE66 1   43
           ORDER OF 15 PERCENT.                                    EE66 1   44
ENDBIB              42                                             EE66 1   45
ENDSUBENT            1                                             EE66 199999
SUBENT         EE66  2          0                                  EE66 2    1
BIB                  2          6                                  EE66 2    2
REACTION   31P(P,GAMMA)32S                                         EE66 2    3
COMMENTS   ABSOLUTE RESONANCE STRENGTH IS GIVEN. DATA OBTAINED     EE66 2    4
           FROM TABLE 2 OF THE PAPER. EP = INCIDENT PROTON         EE66 2    5
           ENERGY OF THE RESONANCE. S = RESONANCE STRENGTH =       EE66 2    6
           (2J+1)*GAMMA(P)*GAMMA(G)/GAMMA(TOTAL). S-ERR =          EE66 2    7
           ERROR IN RESONANCE STRENGTH.                            EE66 2    8
ENDBIB               6                                             EE66 2    9
DATA                 3          1                                  EE66 2   10
EP         S          S-ERR                                        EE66 2   11
KEV        EV         EV                                           EE66 2   12
 642.       0.52       0.08                                        EE66 2   13
ENDDATA              3                                             EE66 2   14
ENDSUBENT            2                                             EE66 299999
ENDENTRY             2                                             EE669999999
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G+70a

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ENTRY            G+70A          0                                  G+70A 0    1
SUBENT        G+70A  1          0                                  G+70A 1    1
BIB                 13         28                                  G+70A 1    2
INSTITUTE  (FRPAR)                                                 G+70A 1    3
REFERENCE  (J,CR/B,271,970,1970)                                   G+70A 1    4
AUTHORS    (S.GALES,M.LANGEVIN,J.-M.MAISON,J.VERNOTTE)             G+70A 1    5
TITLE      RECHERCHE DU PREMIER ETAT T=2 DU NOYAU SOUFRE-32 AU     G+70A 1    6
           MOYEN DE LA REACTION 31P(P,GAMMA)32S                    G+70A 1    7
FACILITY   (VDG) 4-MV VAN DE GRAAFF ACCELERATOR, INSTITUT DE       G+70A 1    8
           PHYSIQUE NUCLEAIRE, ORSAY, FRANCE.                      G+70A 1    9
INC-PART   (P) PROTONS.                                            G+70A 1   10
TARGETS    NATURAL RED PHOSPHORUS EVAPORATED IN VACUUM ONTO A      G+70A 1   11
           TUNGSTEN BACKING.                                       G+70A 1   12
METHOD     PROTONS WERE OBTAINED FROM THE 4-MV ORSAY VAN DE        G+70A 1   13
           GRAAFF ACCELERATOR. MEASUREMENTS WERE MADE IN THE       G+70A 1   14
           PROTON ENERGY RANGE 3.10 TO 3.35 MEV. THE PROTON        G+70A 1   15
           ENERGY CALIBRATION WAS BASED ON THE KNOWN 3235.7-KEV    G+70A 1   16
           RESONANCE IN 13C(P,N)13N. A NAI SCINTILLATOR GAMMA-     G+70A 1   17
           RAY DETECTOR WAS PLACED 10 CM FROM THE TARGET AT AN     G+70A 1   18
           ANGLE OF 55 DEGREES RELATIVE TO THE INCIDENT            G+70A 1   19
           PROTON BEAM FOR THE GAMMA-RAY EXCITATION FUNCTION       G+70A 1   20
           MEASUREMENTS TO FIND THE 31P(P,GAMMA)32S RESONANCES.    G+70A 1   21
           DETAILED GAMMA-RAY SPECTRA AND GAMMA-RAY ANGULAR        G+70A 1   22
           DISTRIBUTIONS WERE MEASURED AT THE RESONANCES USING     G+70A 1   23
           A GE(LI) DETECTOR.                                      G+70A 1   24
DETECTORS  (SCINT) 12.7 CM X 12.7 CM NAI SCINTILLATOR CRYSTAL.     G+70A 1   25
           (GELI) 37-CM**3 GE(LI) DETECTOR.                        G+70A 1   26
MONITOR    (CI) CURRENT INTEGRATOR.                                G+70A 1   27
CORRECTION NONE MENTIONED.                                         G+70A 1   28
ERR-ANALYS NONE MENTIONED.                                         G+70A 1   29
COMMENTS   THE ORIGINAL PAPER IS WRITTEN IN FRENCH.                G+70A 1   30
ENDBIB              28                                             G+70A 1   31
ENDSUBENT            1                                             G+70A 199999
SUBENT        G+70A  2          0                                  G+70A 2    1
BIB                  2         10                                  G+70A 2    2
REACTION   31P(P,GAMMA)32S                                         G+70A 2    3
COMMENTS   DEDUCED ENERGIES, SPIN/PARITY AND ISOBARIC              G+70A 2    4
           SPIN OF LOWEST T=2 STATE IN 32S FROM GAMMA-RAY          G+70A 2    5
           MEASUREMENTS. EP = RESONANCE PROTON ENERGY.             G+70A 2    6
           EP-ERR = ERROR IN PROTON ENERGY. EX = EXCITATION        G+70A 2    7
           ENERGY OF 32S LEVEL. EX-ERR = ERROR IN EXCITATION       G+70A 2    8
           ENERGY. J-PI = SPIN AND PARITY OF RESONANCE STATE       G+70A 2    9
           IN 32S. NEGATIVE SIGN USED TO DENOTE NEGATIVE           G+70A 2   10
           PARITY. OTHERWISE PARITY IS POSITIVE. T = ISOBARIC      G+70A 2   11
           SPIN OF EXCITED STATE IN 32S.                           G+70A 2   12
ENDBIB              10                                             G+70A 2   13
DATA                 6          1                                  G+70A 2   14
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EP          EP-ERR     EX         EX-ERR     J-PI       T           G+70A 2   15
KEV         KEV        KEV        KEV        NO-DIM     NO-DIM      G+70A 2   16
 3289.       3.         12050.     4.         0.         2.         G+70A 2   17
ENDDATA               3                                             G+70A 2   18
ENDSUBENT             2                                             G+70A 299999
ENDENTRY              2                                             G+70A9999999
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G+74

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ENTRY            G+74          0                                     G+74 0    1
SUBENT        G+74  1          0                                     G+74 1    1
BIB                12         41                                     G+74 1    2
INSTITUTE  (CANMCM)                                                  G+74 1    3
REFERENCE  (J,CJP,52,950,1974)                                       G+74 1    4
AUTHORS    (H.GRAWE,J.E.CAIRNS,M.W.GREENE,J.A.KUEHNER)               G+74 1    5
TITLE      AN INVESTIGATION OF ODD PARITY STATES IN 32S              G+74 1    6
FACILITY   (VDG) 4-MV KN VAN DE GRAAFF ACCELERATOR, MCMASTER         G+74 1    7
           UNIVERSITY, HAMILTON, ONTARIO, CANADA.                    G+74 1    8
INC-PART   (P) PROTONS.                                              G+74 1    9
TARGETS    TARGETS WERE PREPARED BY EVAPORATING ZN3P2 ON             G+74 1   10
           TANTALUM BACKINGS THAT COULD BE DIRECTLY COOLED.          G+74 1   11
           THE TYPICAL TARGET THICKNESS WAS 6 KEV FOR 1.5-MEV        G+74 1   12
           PROTONS.                                                  G+74 1   13
METHOD     TARGETS OF ZN3P2 WERE BOMBARDED WITH 20 MICROAMP          G+74 1   14
           PROTON BEAMS FROM THE MCMASTER UNIVERSITY 4-MV            G+74 1   15
           KN VAN DE GRAAFF ACCELERATOR. RESONANT STATES IN          G+74 1   16
           32S AT EP = 895, 1054, 1089, 1118, 1438, AND 1583         G+74 1   17
           KEV WERE POPULATED BY THE 31P(P,GAMMA)32S REACTION.       G+74 1   18
           GAMMA-RAYS FROM THE DECAY OF THESE STATES WERE            G+74 1   19
           MEASURED WITH A 45-CM**3 GE(LI) DETECTOR AT 55 AND        G+74 1   20
           90 DEGREES. ANGULAR DISTRIBUTIONS WERE MEASURED AT        G+74 1   21
           0, 30, 45, 60, AND 90 DEGREES FOR THE EP = 1438           G+74 1   22
           AND 1583 KEV RESONANCES. THE TARGET TO DETECTOR           G+74 1   23
           DISTANCE WAS 7.5 CM. LIFETIME MEASUREMENTS WERE           G+74 1   24
           DETERMINED USING THE DOPPLER-SHIFT ATTENUATION            G+74 1   25
           METHOD. THE 45-CM**3 GE(LI) DETECTOR WAS PLACED           G+74 1   26
           AT 0, 45, AND 120 DEGREES. THE DETECTOR WAS AT            G+74 1   27
           10 CM FROM THE TARGET FOR THIS MEASUREMENT. A             G+74 1   28
           RADIOACTIVE SOURCE PLACED IN A FIXED POSITION WAS         G+74 1   29
           USED TO GENERATE UNSHIFTED GAMMA RAYS FOR THE             G+74 1   30
           PURPOSE OF CALIBRATION. THE EFFICIENCY OF THE             G+74 1   31
           45-CM**3 GE(LI) DETECTOR WAS DETERMINED WITH A            G+74 1   32
           CALIBRATED 56CO GAMMA-RAY SOURCE. A COMPUTER              G+74 1   33
           PROGRAM WAS USED TO ANALYZE THE DOPPLER-SHIFT             G+74 1   34
           ATTENUATION DATA. OTHER DETAILS ARE GIVEN IN              G+74 1   35
           THE ORIGINAL PAPER.                                       G+74 1   36
DETECTOR   (GELI) 45-CM**3 GE(LI) DETECTOR IN VARIOUS POSITIONS.     G+74 1   37
MONITORS   (GELI) 12-CM*3 GE(LI) DETECTOR IN A FIXED POSITION.       G+74 1   38
           (CI) CURRENT INTEGRATOR.                                  G+74 1   39
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CORRECTION CORRECTIONS WERE APPLIED FOR NON-RESONANT              G+74 1   40
           CONTRIBUTIONS AND FOR GAIN SHIFTS BETWEEN RUNS         G+74 1   41
           AT DIFFERENT ANGLES.                                   G+74 1   42
ERR ANALYS ERRORS GIVEN BUT DETAILS NOT DISCUSSED IN THE PAPER.   G+74 1   43
ENDBIB              41                                            G+74 1   44
ENDSUBENT            1                                            G+74 199999
SUBENT         G+74  2          0                                 G+74 2    1
BIB                  2          8                                 G+74 2    2
REACTION   31P(P,GAMMA)32S                                        G+74 2    3
COMMENTS   MEAN LIFETIMES FROM DOPPLER-SHIFT ATTENUATION          G+74 2    4
           MEASUREMENTS FROM TABLE 1 OF THE PAPER ARE GIVEN.      G+74 2    5
           EX = LEVEL EXCITATION ENERGY. TAU = MEAN LIFETIME.     G+74 2    6
           TAU-ERR(+) = POSITIVE LOBE OF ERROR IN MEAN LIFETIME.  G+74 2    7
           TAU-ERR(-) = NEGATIVE LOBE OF ERROR IN MEAN LIFETIME.  G+74 2    8
           FSEC = 10**(-15) SECONDS. A BLANK ENTRY INDICATES      G+74 2    9
           THAT NO VALUE IS AVAILABLE IN THE TABLE.               G+74 2   10
ENDBIB               8                                            G+74 2   11
DATA                 4          3                                 G+74 2   12
EX         TAU        TAU-ERR(+) TAU-ERR(-)                       G+74 2   13
MEV        FSEC       FSEC       FSEC                             G+74 2   14
 6.62       810.       350.       250.                            G+74 2   15
 6.76       300.                                                  G+74 2   16
 7.95       110.       60.        40.                             G+74 2   17
ENDDATA              5                                            G+74 2   18
ENDSUBENT            2                                            G+74 299999
SUBENT         G+74  3          0                                 G+74 3    1
BIB                  2         10                                 G+74 3    2
REACTION   31P(P,GAMMA)32S                                        G+74 3    3
COMMENTS   COEFFICIENTS OF LEGENDRE-POLYNOMIAL EXPANSION FITS     G+74 3    4
           TO MEASURED ANGULAR DISTRIBUTIONS OF GAMMA-RAYS        G+74 3    5
           DE-EXCITING SELECTED RESONANCES ARE GIVEN. DATA FROM   G+74 3    6
           TABLE 2. EP = RESONANCE PROTON ENERGY. EX = RESONANCE  G+74 3    7
           EXCITATION ENERGY IN 32S. EI = ENERGY OF INTIAL STATE  G+74 3    8
           OF GAMMA-RAY TRANSITION. EF = ENERGY OF FINAL STATE    G+74 3    9
           OF TRANSITION. A2 = COEFFICIENT OF P2 LEGENDRE TERM.   G+74 3   10
           A2-ERR = ERROR IN A2. A4 = COEFFICIENT OF P4           G+74 3   11
           LEGENDRE TERM. A4-ERR = ERROR IN A4.                   G+74 3   12
ENDBIB              10                                            G+74 3   13
DATA                 8         13                                 G+74 3   14
EP         EX         EI         EF         A2         A2-ERR     G+74 3   15
A4         A4-ERR                                                 G+74 3   16
KEV        MEV        MEV        MEV        NO-DIM     NO-DIM     G+74 3   17
NO-DIM     NO-DIM                                                 G+74 3   18
 1438.      10.256     10.256     7.95       0.040      0.07      G+74 3   19
 0.01       0.08                                                  G+74 3   20
 1438.      10.256     10.256     6.76      -0.20       0.07      G+74 3   21
-0.02       0.07                                                  G+74 3   22
 1438.      10.256     10.256     6.62       0.54       0.03      G+74 3   23
-0.01       0.04                                                  G+74 3   24
 1438.      10.256     10.256     5.01      -0.57       0.06      G+74 3   25
 0.02       0.07                                                  G+74 3   26
 1438.      10.256     10.258     4.46       0.53       0.05      G+74 3   27
 0.05       0.06                                                  G+74 3   28
 1438.      10.256     6.62       5.01       0.40       0.04      G+74 3   29
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 0.21       0.04                                                        G+74 3   30
 1438.      10.256     6.62       4.46        0.43       0.04           G+74 3   31
 0.01       0.05                                                        G+74 3   32
 1583.      10.395     10.395.    7.95        0.54       0.07           G+74 3   33
-0.07       0.07                                                        G+74 3   34
 1583.      10.395     10.395.    6.76       -0.07       0.09           G+74 3   35
 0.03       0.10                                                        G+74 3   36
 1583.      10.395     10.395.    6.62        0.48       0.02           G+74 3   37
-0.01       0.02                                                        G+74 3   38
 1583.      10.395     10.395.    5.01        0.11       0.04           G+74 3   39
 0.08       0.04                                                        G+74 3   40
 1583.      10.395     10.395.    4.46        0.52       0.10           G+74 3   41
-0.28       0.10                                                        G+74 3   42
 1583.      10.395     6.62       5.01        0.41       0.02           G+74 3   43
 0.23       0.02                                                        G+74 3   44
ENDDATA            30                                                   G+74 3   45
ENDSUBENT           3                                                   G+74 399999
ENDENTRY            3                                                   G+749999999
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H81

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ENTRY              H81         0                                         H81 0    1
SUBENT          H81  1         0                                         H81 1    1
BIB                 12        47                                         H81 1    2
INSTITUTE  (SFHLS)                                                       H81 1    3
REFERENCE  (J,PR/C,23,1900,1981)                                         H81 1    4
AUTHOR     (R.HENTELA)                                                   H81 1    5
TITLE      ANALOG OF THE 3.00-MEV STATE OF 32P IN 32S                    H81 1    6
FACILITY   (VDG) 2.5-MV VAN DE GRAAFF ACCELERATOR, HELSINKI              H81 1    7
           UNIVERSITY, HELSINKI, FINLAND.                                H81 1    8
INC-PART   (P) PROTONS.                                                  H81 1    9
TARGETS    TARGETS WERE PREPARED BY EVAPORATING GAP IN A HIGH            H81 1   10
           VACUUM SYSTEM ONTO 0.4 MM TANTALUM BACKINGS. THESE            H81 1   11
           TARGETS WERE DIRECTLY WATER COOLED THROUGHOUT THE             H81 1   12
           EXPERIMENT.                                                   H81 1   13
METHOD     BEAM CURRENTS OF 15 TO 40 MICROAMPS WERE USED. THE            H81 1   14
           BEAM ENERGY SPREAD WAS DETERMINED FROM MEASUREMENTS            H81 1   15
           AT THE EP = 992-KEV RESONANCE IN 27AL(P,GAMMA)28SI TO         H81 1   16
           BE LESS THAN 0.5 KEV. GE(LI) DETECTOR EFFICIENCY              H81 1   17
           WAS MEASURED USING GAMMA RAYS FROM A 56CO SOURCE AND          H81 1   18
           THE WELL-KNOWN 27AL(P,GAMMA)28SI REACTION. THE YIELD          H81 1   19
           OF GAMMA RAYS IN THE VICINITY OF THE 1151-KEV                 H81 1   20
           RESONANCE IN THE 31P(P,GAMMA)32 REACTION WAS                  H81 1   21
           MEASURED WITH THE LARGER OF TWO GE(LI) DETECTORS              H81 1   22
           AT 4 CM FROM THE TARGET AND 55 DEGREES RELATIVE TO            H81 1   23
           THE INCIDENT PROTON BEAM. 10 MILLICOULOMB OF CHARGE           H81 1   24
           WAS ACCUMULATED AT EACH ENERGY AND THE PROTON-ENERGY          H81 1   25
           STEPS WERE 0.22 KEV. PROTON ENERGY CALIBRATION WAS            H81 1   26
           BASED ON THE 991.88 AND 1317.15 KEV RESONANCES                H81 1   27
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           OF THE 27AL(P,GAMMA)28SI REACTION. IT WAS OBSERVED        H81 1   28
           THAT THE 1151-KEV RESONANCE IN 31P(P,GAMMA)32S IS         H81 1   29
           ACTUALLY A DOUBLET CONSISTING OF 1150.0 AND 1150.5        H81 1   30
           RESONANCE COMPONENTS. A SECOND SMALLER GE(LI)             H81 1   31
           DETECTOR WAS USED AS A FIXED-POSITION MONITOR FOR         H81 1   32
           ANGULAR DISTRIBUTION MEASUREMENTS. THE LARGER             H81 1   33
           GE(LI) DETECTOR WAS PLACED AT 0, 30, 45, 60, AND          H81 1   34
           90 DEGREES FOR THE ANGULAR DISTRIBUTION STUDIES.          H81 1   35
           0.1 COULOMB OF CHARGE WAS COLLECTED AT EACH ANGLE.        H81 1   36
           FURTHER DETAILS ARE GIVEN IN THE ORIGINAL PAPER.          H81 1   37
DETECTOR   (GELI) PRINCETON GAMMA-TECH 110-CM**3 GE(LI) DETECTOR     H81 1   38
           WITH A FWHM RESOLUTION OF 3.1 KEV AT 2.6 MEV.             H81 1   39
MONITORS   (GELI) 38-CM**3 GE(LI) DETECTOR LOCATED AT A FIXED        H81 1   40
           POSITION 8 CM FROM THE TARGET AND 90 DEGREES WITH         H81 1   41
           RESPECT TO THE INCIDENT PROTON BEAM.                      H81 1   42
           (CI) CURRENT INTEGRATOR.                                  H81 1   43
CORRECTION CORRECTED FOR DETECTOR EFFICIENCY, GEOMETRIC              H81 1   44
           EFFECTS, AND GAMMA-RAY ABSORPTION. THE ECCENTRICITY       H81 1   45
           AND ABSORPTION CORRECTIONS WERE FOUND TO BE LESS          H81 1   46
           THAN 2 PERCENT.                                           H81 1   47
ERR-ANALYS ERRORS ARE GIVEN BUT DETAILS ARE LIMITED IN THE           H81 1   48
           ORIGINAL PAPER.                                           H81 1   49
ENDBIB              47                                               H81 1   50
ENDSUBENT            1                                               H81 199999
SUBENT           H81  2          0                                   H81 2    1
BIB                  2          11                                   H81 2    2
REACTION   31P(P,GAMMA)32S                                           H81 2    3
COMMENTS   GAMMA-RAY DECAY BRANCHING RATIOS FOR RESONANCE            H81 2    4
           DOUBLET AT EP = 1151 MEV ARE GIVEN. DATA FROM             H81 2    5
           TABLE I OF ORIGINAL PAPER. EP = PROTON ENERGY OF          H81 2    6
           THE RESONANCE. EX = EXCITATION ENERGY FOR RESONANT        H81 2    7
           LEVEL IN 32S. EI = EXCITATION ENERGY FOR INITIAL          H81 2    8
           LEVEL IN GAMMA-RAY TRANSITION. EF = EXCITATION            H81 2    9
           ENERGY FOR FINAL LEVEL IN GAMMA-RAY TRANSITION.           H81 2   10
           B = BRANCHING RATIO. B-ERR = ERROR IN BRANCHING           H81 2   11
           RATIO. A BLANK ENTRY SIGNIFIES THAT NO VALUE IS           H81 2   12
           GIVEN IN THE TABLE. PCT = PERCENT.                        H81 2   13
ENDBIB              11                                               H81 2   14
DATA                 6          12                                   H81 2   15
EP         EX         EI         EF         B          B-ERR         H81 2   16
KEV        KEV        KEV        MEV        PCT        PCT           H81 2   17
 1150.0     9978.7     9978.7     5.01       49.        4.           H81 2   18
 1150.0     9978.7     9978.7     6.22       26.        3.           H81 2   19
 1150.0     9978.7     9978.7     6.62       25.        3.           H81 2   20
 1150.5     9979.2     9979.2     2.23       37.        3.           H81 2   21
 1150.5     9979.2     9979.2     4.46       7.7        0.8          H81 2   22
 1150.5     9979.2     9979.2     5.41       6.1        0.6          H81 2   23
 1150.5     9979.2     9979.2     5.55       31.        3.           H81 2   24
 1150.5     9979.2     9979.2     6.85       7.2        0.7          H81 2   25
 1150.5     9979.2     9979.2     7.00       1.3        0.2          H81 2   26
 1150.5     9979.2     9979.2     7.12       4.9        0.5          H81 2   27
 1150.5     9979.2     9979.2     7.48       4.0        0.4          H81 2   28
 1150.5     9979.2     9979.2     8.35       0.8        0.2          H81 2   29
ENDDATA             14                                               H81 2   30
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ENDSUBENT            2                                                H81 299999
SUBENT          H81  3          0                                     H81 3    1
BIB                  2         12                                     H81 3    2
REACTION   31P(P,GAMMA)32S                                            H81 3    3
COMMENTS   ANGULAR DISTRIBUTION COEFFICIENTS ARE GIVEN FOR            H81 3    4
           GAMMA-RAY TRANSITIONS DE-EXCITING THE 1150.0 AND           H81 3    5
           1150.5 KEV RESONANCES. DATA OBTAINED FROM TABLE II.        H81 3    6
           EP = PROTON ENERGY OF THE RESONANCE. EI = ENERGY           H81 3    7
           OF INITIAL 32S LEVEL FOR THE TRANSITION. EF = ENERGY       H81 3    8
           OF THE FINAL 32S LEVEL FOR THE TRANSITION. A2 =            H81 3    9
           COEFFICIENT OF THE P2 TERM IN A LEGENDRE POLYNOMIAL        H81 3   10
           FIT TO THE ANGULAR DISTRIBUTION. A2-ERR = ERROR            H81 3   11
           IN A2. A4 = COEFFICIENT OF THE P4 TERM IN A LEGENDRE       H81 2   12
           POLYNOMIAL FIT TO THE ANGULAR DISTRIBUTION. A4-ERR         H81 3   13
           = ERROR IN A4.                                             H81 3   14
ENDBIB              12                                                H81 3   15
DATA                 7         18                                     H81 3   16
EP         EI         EF         A2         A2-ERR     A4             H81 3   17
A4-ERR                                                                H81 3   18
KEV        KEV        KEV        NO-DIM     NO-DIM     NO-DIM         H81 3   19
NO-DIM                                                                H81 3   20
 1150.0     9978.7     5006.     -0.71       0.02       0.46          H81 3   21
 0.03                                                                 H81 3   22
 1150.0     9978.7     6224.      0.42       0.05      -0.43          H81 3   23
 0.05                                                                 H81 3   24
 1150.0     9978.7     6621.      0.61       0.04      -0.24          H81 3   25
 0.06                                                                 H81 3   26
 1150.5     9979.2     2230.      0.09       0.01       0.01          H81 3   27
 0.01                                                                 H81 3   28
 1150.5     9979.2     4459.      0.29       0.02      -0.08          H81 3   29
 0.03                                                                 H81 3   30
 1150.5     9979.2     5413.     -0.03       0.01      -0.13          H81 3   31
 0.02                                                                 H81 3   32
 1150.5     9979.2     5549.     -0.45       0.01       0.00          H81 3   33
 0.01                                                                 H81 3   34
 1150.5     9979.2     6852.     -0.22       0.02      -0.04          H81 3   35
 0.02                                                                 H81 3   36
 1150.5     9979.2     7003.      0.34       0.05      -0.11          H81 3   37
 0.07                                                                 H81 3   38
 1150.5     9979.2     7115.     -0.23       0.02       0.03          H81 3   39
 0.03                                                                 H81 3   40
 1150.5     9979.2     7485.     -0.33       0.02      -0.03          H81 3   41
 0.03                                                                 H81 3   42
 1150.5     9979.2     8345.     -0.42       0.07       0.57          H81 3   43
 0.10                                                                 H81 3   44
 1150.5     5549.      0.         0.50       0.01      -0.35          H81 3   45
 0.02                                                                 H81 3   46
 1150.5     6852.      4282.      0.37       0.02      -0.33          H81 3   47
 0.02                                                                 H81 3   48
 1150.5     6852.      4459.     -0.19       0.03      -0.31          H81 3   49
 0.04                                                                 H81 3   50
 1150.5     6852.      5413.      0.14       0.04      -0.24          H81 3   51
 0.05                                                                 H81 3   52
 1150.5     7115.      2230.      0.27       0.03      -0.10          H81 3   53
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 0.04                                                                   H81 3   54
 1150.5     7485.      0.         0.44       0.04      -0.44            H81 3   55
 0.05                                                                   H81 3   56
ENDDATA             40                                                  H81 3   57
ENDSUBENT            3                                                  H81 399999
SUBENT          H81  4          0                                       H81 4    1
BIB                  2         16                                       H81 4    2
REACTION   31P(P,GAMMA)32S                                              H81 4    3
COMMENTS   EXPERIMENTAL TRANSITION STRENGTHS OF GAMMA-RAY               H81 4    4
           TRANSITIONS FROM THE TWO RESONANCES NEAR EP = 1151           H81 4    5
           KEV ARE GIVEN. DATA OBTAINED FROM TABLE III OF THE           H81 4    6
           ORIGINAL PAPER. EP = RESONANCE PROTON ENERGY. EX =           H81 4    7
           EXCITATION ENERGY OF RESONANT STATE IN 32S. EI =             H81 4    8
           ENERGY OF INITIAL LEVEL IN 32S OF GAMMA-RAY                  H81 4    9
           TRANSITION. EF = ENERGY OF FINAL LEVEL IN 32S.               H81 4   10
           GAM(G) = GAMMA-RAY WIDTH OF RESONANT STATE.                  H81 4   11
           GAM(G)-ERR = ERROR IN GAMMA-RAY WIDTH. S(M1) =               H81 4   12
           M1 STRENGTH OF GAMMA-RAY TRANSITION. S(M1)-ERR =             H81 4   13
           ERROR IN M1 STRENGTH. S(E2) = E2 STRENGTH OF                 H81 4   14
           GAMMA-RAY TRANSITION. S(E2)-ERR = ERROR IN E2                H81 4   15
           STRENGTH. MILLIEV = 10**(-3) ELECTRON VOLTS.                 H81 4   16
           MILLIWU = 10**(-3) WEISSKOPF UNITS. A BLANK                  H81 4   17
           SPACE SIGNIFIES THAT VALUE WAS NOT AVAILABLE.                H81 4   18
ENDBIB              16                                                  H81 4   19
DATA                10         12                                       H81 4   20
EP         EX         EI         EF         GAM(G)     GAM(G)-ERR       H81 4   21
S(M1)      S(M1)-ERR  S(M2)      S(M2)-ERR                              H81 4   22
KEV        KEV        KEV        KEV        MILLIEV    MILLIEV          H81 4   23
MILLIWU    MILLIWU    MILLIWU    MILLIWU                                H81 4   24
 1150.0     9978.7     9978.7     5006.      6.         2.              H81 4   25
 0.34        0.10      330.       90.                                   H81 4   26
 1150.0     9978.7     9978.7     6224.      3.2        0.9             H81 4   27
                       800.       200.                                  H81 4   28
 1150.0     9978.7     9978.7     6621.      3.1        0.9             H81 4   29
 3.0        0.9        300.       200.                                  H81 4   30
 1150.5     9979.2     9979.2     2230.      54.        12.             H81 4   31
 5.3        1.2        18.        5.                                    H81 4   32
 1150.5     9979.2     9979.2     4459.      11.        3.              H81 4   33
 2.9        0.7        46.        15.                                   H81 4   34
 1150.5     9979.2     9979.2     5413.      9.         2.              H81 4   35
 3.6        0.8        170.       40.                                   H81 4   36
 1150.5     9979.2     9979.2     5549.      46.        10.             H81 4   37
 25.        6.         19.        15.                                   H81 4   38
 1150.5     9979.2     9979.2     6852.      10.        2.              H81 4   39
 16.        4.         17.        14.                                   H81 4   40
 1150.5     9979.2     9979.2     7003.      1.9        0.5             H81 4   41
                       1600.      400.                                  H81 4   42
 1150.5     9979.2     9979.2     7115.      7.         2.              H81 4   43
 14.        3.         18.        14.                                   H81 4   44
 1150.5     9979.2     9979.2     7485.      5.7        1.3             H81 4   45
 18.        4.                                                          H81 4   46
 1150.5     9979.2     9979.2     8345.      1.1        0.4             H81 4   47
 0.9        0.3        18000.     6000.                                 H81 4   48
ENDDATA             28                                                  H81 4   49
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ENDSUBENT           4                                                 H81 499999
SUBENT          H81  5          0                                     H81 5    1
BIB                  2         11                                     H81 5    2
REACTION   31P(P,GAMMA)32S                                            H81 5    3
COMMENTS   STRENGTHS OF TRANSITIONS BETWEEN T=1 STATES IN             H81 5    4
           32S. DATA OBTAINED FROM TABLE IV OF THE ORIGINAL           H81 5    5
           PAPER. EI = ENERGY OF INITIAL STATE IN 32S OF THE          H81 5    6
           GAMMA-RAY TRANSITION. EF = ENERGY OF FINAL STATE IN        H81 5    7
           32S. S(M1) = M1 TRANSITION STRENGTH. S(M1)-ERR =           H81 5    8
           ERROR IN M1 TRANSITION STRENGTH. S(E2) = E2                H81 5    9
           TRANSITION STRENGTH. S(E2)-ERR = ERROR IN E2               H81 5   10
           TRANSITION STRENGTH. A BLANK ENTRY SIGNIFIES THAT          H81 5   11
           NO VALUE WAS AVAILABLE IN THE TABLE. MILLIWU =             H81 5   12
           10**(-3) WEISSKOPF UNITS.                                  H81 5   13
ENDBIB              11                                                H81 5   14
DATA                 6          3                                     H81 5   15
EI         EF         S(M1)      S(M1)-ERR  S(E2)      S(E2)-ERR      H81 5   16
KEV        KEV        MILLIWU    MILLIWU    MILLIWU    MILLIWU        H81 5   17
 9979.      7003.                            1600.      400.          H81 5   18
 9979.      7115.      14.        3.         18.        14.           H81 5   19
 9979.      8345.      0.9        0.3        18000.     6000.         H81 5   20
ENDDATA              5                                                H81 5   21
ENDSUBENT            5                                                H81 599999
ENDENTRY             5                                                H819999999
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HV70

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ENTRY             HV70          0                                    HV70 0    1
SUBENT          HV70  1          0                                   HV70 1    1
BIB                  12         42                                   HV70 1    2
INSTITUTE  (SFHLS)                                                   HV70 1    3
REFERENCE  (J,PS,1,159,1970)                                         HV70 1    4
AUTHORS    (P.HOLMBERG,M.VIITASALO)                                  HV70 1    5
TITLE      THE EP = 1146 KEV AND 1151 KEV RESONANCES IN THE          HV70 1    6
           31P(P,GAMMA)32S REACTION                                  HV70 1    7
FACILITY   (VDG) 2.5-MV VAN DE GRAAFF ACCELERATOR, HELSINKI          HV70 1    8
           UNIVERSITY, HELSINKI, FINLAND.                            HV70 1    9
INC-PART   (P) PROTONS.                                              HV70 1   10
TARGETS    ZN3P2 TARGETS WERE PREPARED BY EVAPORATION IN VACUO       HV70 1   11
           ONTO TANTALUM BACKINGS.                                   HV70 1   12
METHOD     PROTONS WERE ACCELERATED WITH A VAN DE GRAAFF             HV70 1   13
           ACCELERATOR AND DEFLECTED WITH A 90-DEGREE ANALYZING      HV70 1   14
           MAGNET. THE PROTON ENERGY WAS CALIBRATED BY MEANS OF      HV70 1   15
           THE NUCLEAR MAGNETIC RESONANCE METHOD. THE PROTON         HV70 1   16
           BEAM STRENGTH WAS KEPT AT ABOUT 3 MICROAMPS. GAMMA        HV70 1   17
           RAYS DE-EXCITING THE EP = 1146 KEV AND 1151 KEV           HV70 1   18
           RESONANCES WERE DETECTED WITH A GE(LI) DETECTOR.          HV70 1   19
           THE DETECTOR ENERGY AND EFFICIENCY CALIBRATION            HV70 1   20
           WAS PERFORMED USING 56CO AND IAEA STANDARD GAMMA-         HV70 1   21
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           RAY SOURCES. GAMMA-RAY ANGULAR DISTRIBUTIONS WERE         HV70 1   22
           MEASURED AT THE RESONANCE PROTON ENERGIES WITH            HV70 1   23
           A NAI SCINTILLATION DETECTOR PLACED AT 0 DEGREE           HV70 1   24
           AND 90 DEGREES WITH RESPECT TO THE INCIDENT               HV70 1   25
           PROTON BEAM. THE CENTER OF THE BEAM SPOT WAS              HV70 1   26
           CHECKED BY MEASUREMENTS ON THE ISOTROPIC 7.89 MEV         HV70 1   27
           GAMMA RAY FROM THE 30SI(P,GAMMA)31P REACTION AT           HV70 1   28
           EP = 620 KEV. THE NAI DETECTOR WAS LOCATED AT A           HV70 1   29
           DISTANCE OF 13 CM FROM THE TARGET. THE MEASURED           HV70 1   30
           ANGULAR DISTRIBUTION DATA WERE FITTED WITH EVEN-          HV70 1   31
           ORDER LEGENDRE POLYNOMIAL EXPANSIONS THAT INCLUDED        HV70 1   32
           TERMS UP TO FOURTH ORDER.                                 HV70 1   33
DETECTORS  (GELI) 38-CM**3 GE(LI) DETECTOR WITH AN ENERGY            HV70 1   34
           RESOLUTION OF 3.5 KEV FWHM FOR THE 1.332-KEV GAMMA        HV70 1   35
           RAY IN THE 60NI SPECTRA FROM THE DECAY OF 60CO.           HV70 1   36
           (SCINT) 5-INCH X 4-INCH NAI(TL) SCINTILLATION             HV70 1   37
           DETECTOR.                                                 HV70 1   38
MONITOR    (CI) CURRENT INTEGRATOR.                                  HV70 1   39
CORRECTION THE ANGULAR DISTRIBUTION DATA WERE CORRECTED FOR          HV70 1   40
           GEOMETRIC ASYMMETRIES. GAMMA-RAY YIELD DATA WERE          HV70 1   41
           CORRECTED FOR DETECTOR EFFICIENCY.                        HV70 1   42
ERR-ANALYS ERRORS ARE GIVEN BUT NO DETAILS APPEAR IN THE             HV70 1   43
           ORIGINAL PAPER.                                           HV70 1   44
ENDBIB              42                                               HV70 1   45
ENDSUBENT            1                                               HV70 199999
SUBENT        HV70  2           0                                    HV70 2    1
BIB                  2          15                                   HV70 2    2
REACTION   31P(P,GAMMA)32S                                           HV70 2    3
COMMENTS   ANGULAR DISTRIBUTION INFORMATION FOR GAMMA-RAYS           HV70 2    4
           FROM THE DECAY OF RESONANCES IN 32S EXCITED BY THE        HV70 2    5
           31P(P,GAMMA)32S REACTION ARE GIVEN. DATA TAKEN FROM       HV70 2    6
           THE TEXT OF THE ORIGINAL PAPER. EP = RESONANCE            HV70 2    7
           PROTON ENERGY. EX = RESONANCE EXCITATION ENERGY.          HV70 2    8
           J-PI = SPIN AND PARITY OF THE RESONANCE. A NEGATIVE       HV70 2    9
           SIGN INDICATES NEGATIVE PARITY. OTHERWISE PARITY IS       HV70 2   10
           POSITIVE. EI = INTIAL STATE IN 32S FOR GAMMA-RAY          HV70 2   11
           TRANSITION. EF = FINAL STATE. EG = GAMMA-RAY ENERGY       HV70 2   12
           FOR THE OBSERVED TRANSITION. A2 = P2 TERM OF THE          HV70 2   13
           LEGENDRE-POLYNOMIAL EXPANSION USED TO FIT THE DATA.       HV70 2   14
           A2-ERR = ERROR IN A2.  A4 = P4 TERM OF THE                HV70 2   15
           LEGENDRE-POLYNOMIAL EXPANSION USED TO FIT THE DATA.       HV70 2   16
           A4-ERR = ERROR IN A4.                                     HV70 2   17
ENDBIB              15                                               HV70 2   18
DATA                10          2                                    HV70 2   19
EP         EX         JPI        EI         EF         EG            HV70 2   20
A2         A2-ERR     A4         A4-ERR                              HV70 2   21
KEV        KEV        NO-DIM     KEV        KEV        KEV           HV70 2   22
NO-DIM     NO-DIM     NO-DIM     NO-DIM                              HV70 2   23
 1146.      9974.      2.         9974.      2230.      7744.        HV70 2   24
 0.175      0.056     -0.097      0.076                              HV70 2   25
 1151.      9979.      2.         9979.      2230.      7749.        HV70 2   26
 0.284      0.066      0.137      0.087                              HV70 2   27
ENDDATA             10                                               HV70 2   28
ENDSUBENT            2                                               HV70 299999
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ENDENTRY            2                                               HV709999999
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I+71

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ENTRY            I+71          0                                    I+71 0    1
SUBENT        I+71  1          0                                    I+71 1    1
BIB                12         38                                    I+71 1    2
INSTITUTE  (CANCRC)                                                 I+71 1    3
           (CANKQU)                                                 I+71 1    4
REFERENCE  (J,NP/A,161,433,1971)                                    I+71 1    5
AUTHORS    (F.INGEBRETSEN,B.W.SARGENT,A.J.FERGUSON,                 I+71 1    6
           J.R.LESLIE,A.HENRIKSON,J.H.MONTAGUE)                     I+71 1    7
TITLE      EVIDENCE FOR VIBRATIONAL EXCITED STATES IN 32S           I+71 1    8
FACILITY   (VDG) 3-MV VAN DE GRAAFF, QUEEN'S UNIVERSITY,            I+71 1    9
           KINGSTON, ONTARIO.                                       I+71 1   10
           (VDG) MP TANDEM VAN DE GRAAFF, CHALK RIVER NUCLEAR       I+71 1   11
           LABORATORIES, CHALK RIVER, ONTARIO.                      I+71 1   12
INC-PART   (P) PROTONS.                                             I+71 1   13
TARGETS    383 MICROGRAM/CM**2 NATURAL SULFUR ON 100                I+71 1   14
           MICROGRAM/CM**2 GOLD BACKING. ZINC PHOSPHIDE ON          I+71 1   15
           0.51 MM GOLD SHEET.                                      I+71 1   16
METHOD     GAMMA-RAY DETECTION. GAMMA RAYS FROM 31P(P,GAMMA)32S     I+71 1   17
           AND 32S(P,P'GAMMA)32S REACTIONS. MEASURED                I+71 1   18
           GAMMA-RAY SINGLES SPECTRA, P-GAMMA AND GAMMA-GAMMA       I+71 1   19
           COINCIDENCES. MEASURED ANGULAR DISTRIBUTIONS.            I+71 1   20
           MEASURED LIFETIMES BY DOPPLER-SHIFT-ATTENUATION          I+71 1   21
           METHOD. EP = 9.275 MEV FAVORED POPULATION OF             I+71 1   22
           4461-KEV LEVEL IN 32S BY 32S(P,P'GAMMA)32S REACTION.     I+71 1   23
           MEASUREMENT AT EP = 1.555 MEV RESONANCE FOR              I+71 1   24
           31P(P,GAMMA)32S FAVORED POPULATION OF 4283-KEV LEVEL     I+71 1   25
           IN 32S. GAMMA-RAY MEASUREMENTS AT 45, 60, 75, 90,        I+71 1   26
           105, 120 AND 133.5 DEGREEs RELATIVE TO INCIDENT          I+71 1   27
           PROTON BEAM. 24NA SOURCE USED TO EXAMINE                 I+71 1   28
           INSTRUMENTAL ANISOTROPY AND ABSORPTION EFFECTS.          I+71 1   29
DETECTORS  (GELI)   23-, 38- AND 44- CM3 GE(LI) DETECTORS.          I+71 1   30
           (NAICR)  12.7-CM DIA BY 15.2-CM LONG NAI(TL) DETECTOR.   I+71 1   31
           (SOLST)  ANNULAR SILICON SURFACE BARRIER DETECTOR.       I+71 1   32
MONITORS   (CI)     CURRENT INTEGRATOR.                             I+71 1   33
           (NAICR)  NAI(TL) DETECTOR.                               I+71 1   34
           (GELI)   GE(LI) DETECTORS.                               I+71 1   35
CORRECTION CORRECTED DATA FOR RANDOM AND BACKGROUND COUNTS,          I+71 1   36
           INSTRUMENTAL ANISOTROPIES, AND GAMMA-RAY ABSORPTION.     I+71 1   37
ERR-ANALYS DATA UNCERTAINTIES GIVEN INCLUDE CONTRIBUTIONS FROM       I+71 1   38
           ENERGY CALIBRATION ERRORS, PEAK LOCATION ERRORS,         I+71 1   39
           STATISTICS, ESTIMATED UNIDENTIFIED SYSTEMATIC ERRORS.    I+71 1   40
ENDBIB             38                                               I+71 1   41
ENDSUBENT           1                                               I+71 199999
SUBENT        I+71  2          0                                    I+71 2    1
BIB                 2          8                                    I+71 2    2
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REACTION    32S(P,P'GAMMA)32S                                        I+71 2    3
COMMENTS    MEASURED THE ENERGIES FOR STRONG PROMPT GAMMA            I+71 2    4
            RAYS FROM PROTON INELASTIC SCATTERING AT EP =            I+71 2    5
            9.275 MEV. DATA ARE OBTAINED FROM TABLE 1 OF             I+71 2    6
            THE ORIGINAL PAPER. EG IS THE GAMMA-RAY ENERGY FOR       I+71 2    7
            32S(P,P'GAMMA)32S TRANSITION. EG-ERR = ERROR IN          I+71 2    8
            EG. EX IS EXCITATION ENERGY IN 32S ESTABLISHED           I+71 2    9
            FROM THE MEASUREMENT. EX-ERR = ERROR IN EX.              I+71 2   10
ENDBIB                8                                              I+71 2   11
DATA                  4          11                                  I+71 2   12
EG          ERR-EG     EX         ERR-EX                             I+71 2   13
KEV         KEV        KEV        KEV                                I+71 2   14
 2231.7      1.0        2231.7     1.0                               I+71 2   15
 2229.4      1.2        4461.1     1.2                               I+71 2   16
 1548.8      1.5        3781.0     2.0                               I+71 2   17
 4281.8      1.5        4283.0     2.0                               I+71 2   18
 2052.6      1.5        4283.0     2.0                               I+71 2   19
 4694.0      2.5        4697.0     2.0                               I+71 2   20
 2466.0      1.5        4697.0     2.0                               I+71 2   21
 2776.2      1.2        5008.0     2.0                               I+71 2   22
 3318.5      2.0        5550.0     3.0                               I+71 2   23
 3993.0      2.0        6225.0     3.0                               I+71 2   24
 2887.9      2.0        6668.0     3.0                               I+71 2   25
ENDDATA              13                                              I+71 2   26
ENDSUBENT             2                                              I+71 299999
SUBENT          I+71  3          0                                   I+71 3    1
BIB                   2          8                                   I+71 3    2
REACTION    32S(P,P'GAMMA)32S                                        I+71 3    3
COMMENT     MEASURED ANGULAR CORRELATION OF THE 2229.4-KEV GAMMA     I+71 3    4
            RAY IN COINCIDENCE WITH INELASTICALLY SCATTERED          I+71 3    5
            PROTONS POPULATING THE 4461.1 KEV STATE IN 32S.          I+71 3    6
            RESULTS ARE GIVEN IN THE TEXT OF THE ORIGINAL            I+71 3    7
            PAPER TERMS OF COEFFICIENT RATIOS A2/A0 AND A4/A0        I+71 3    8
            AND CORRESPONDING ERRORS A2/A0-ERR AND A4/A0-ERR         I+71 3    9
            AS DEFINED IN THE ORIGINAL PAPER.                        I+71 3   10
ENDBIB                8                                              I+71 3   11
DATA                  4          1                                   I+71 3   12
A2/A0       A2/A0-ERR  A4/A0      A4/A0-ERR                          I+71 3   13
 0.52        0.13       -0.39      0.12                              I+71 3   14
ENDDATA               2                                              I+71 3   15
ENDSUBENT             3                                              I+71 399999
SUBENT          I+71  4          0                                   I+71 4    1
BIB                   2          7                                   I+71 4    2
REACTION    32S(P,P'GAMMA)32S                                        I+71 4    3
COMMENTS    MEASURED LIFETIMES OF SEVERAL EXCITED STATES IN          I+71 4    4
            32S BY THE DOPPLER-SHIFT-ATTENUATION METHOD. EX =        I+71 4    5
            EXCITATION ENERGY OF 32S LEVEL. TAU = MEAN LIFETIME      I+71 4    6
            THE LEVEL. TAU-ERR = ERROR IN TAU DATA OBTAINED          I+71 4    7
            FROM TABLE 2 OF THE ORIGINAL PAPER. PICOSEC =            I+71 4    8
            10**(-12) SECOND.                                        I+71 4    9
ENDBIB                7                                              I+71 4   10
DATA                  3          8                                   I+71 4   11
EX          TAU        ERR-TAU                                       I+71 4   12
KEV         PICOSEC    PICOSEC                                       I+71 4   13
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 2232.0     0.35       0.06                                          I+71 4   14
 4461.0     0.21       0.06                                          I+71 4   15
 3781.0     0.75                                                     I+71 4   16
 4283.0     0.08       0.01                                          I+71 4   17
 4697.0     0.4        0.1                                           I+71 4   18
 5550.0     0.12       0.03                                          I+71 4   19
 6225.0     0.08       0.02                                          I+71 4   20
 6668.0     0.07       0.03                                          I+71 4   21
ENDDATA            10                                                I+71 4   22
ENDSUBENT           4                                                I+71 499999
ENDENTRY            4                                                I+719999999
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I+91

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ENTRY            I+91          0                                     I+91 0    1
SUBENT        I+91  1          0                                     I+91 1    1
BIB                12         66                                     I+91 1    2
INSTITUTES (USANOT)                                                  I+91 1    3
           (CANTOR)                                                  I+91 1    4
           (CAN) RYERSON POLYTECHNICAL INSTITUTE                     I+91 1    5
           (USACAL)                                                  I+91 1    6
REFERENCE  (J,NP/A,533,153,1991)                                     I+91 1    7
AUTHORS    (C.ILIADIS,U.GIESEN,J.GOERRES,S.GRAFF,M.WIESCHER,         I+91 1    8
           R.E.AZUMA,J.KING,M.BUCKBY,C.A.BARNES,T.R.WANG)            I+91 1    9
TITLE      THE REACTION BRANCHING 31P(P,GAMMA)/31P(P,ALPHA) IN       I+91 1   10
           THE RP-PROCESS                                            I+91 1   11
FACILITIES (VDG) 3-MV PELLETRON TANDEM ACCELERATOR, KELLOGG          I+91 1   12
           RADIATION LABORATORY, CALIFORNIA INSTITUTE OF             I+91 1   13
           TECHNOLOGY, PASADENA, CALIFORNIA.                         I+91 1   14
           (VDG) 1-MV VAN DE GRAAFF ACCELERATOR, UNIVERSITY OF       I+91 1   15
           TORONTO, TORONTO, ONTARIO, CANADA.                        I+91 1   16
           (C-W) 350-KV COCKROFT-WALTON ACCELERATOR, UNIVERSITY      I+91 1   17
           OF TOLEDO, TOLEDO, OHIO.                                  I+91 1   18
INC-PART   (P) PROTONS.                                              I+91 1   19
TARGETS    TARGETS WERE PRODUCED BY ION IMPLANTATION USING THE       I+91 1   20
           1-KV COCKROFT-WALTON ACCELERATOR. 31P IONS WERE           I+91 1   21
           IMPLANTED INTO A 0.5-MM THICK TANTALUM BACKING. THE       I+91 1   22
           IMPLANTATION ENERGY WAS 200 KEV AND THE INCIDENT          I+91 1   23
           DOSE WAS 133 MICROAMPERE-HOURS. THE 31P BEAM WAS          I+91 1   24
           SCANNED OVER AN AREA OF 1.5 CM**2 TO INSURE               I+91 1   25
           HOMOGENEOUS IMPLANTATION OVER THE ENTIRE AREA.            I+91 1   26
METHOD     THE 31P TARGETS PREPARED BY ION IMPLANTATION WERE         I+91 1   27
           FOUND TO HAVE WELL-DEFINED THICKNESS OF ABOUT 15          I+91 1   28
           KEV AT 355 KEV PROTON BOMBARDING ENERGY. THE TARGET       I+91 1   29
           THICKNESS AND STOICHIOMETRY, TA2P3, WERE DETERMINED       I+91 1   30
           BY MEASURING THE THICK-TARGET YIELD CURVE OF THE          I+91 1   31
           WELL KNOWN RESONANCE AT EP = 811 KEV IN THE REACTION      I+91 1   32
           31P(P,GAMMA)32S. THE TARGETS WERE DIRECTLY WATER          I+91 1   33
           COOLED AND PROVED TO BE VERY STABLE UNDER PROTON          I+91 1   34
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          BOMBARDMENT. MEASUREMENTS ON 31P(P,GAMMA)32S OVER          I+91 1   35
          THE RANGE EP = 0.35 TO 0.62 WERE CARRIED OUT AT            I+91 1   36
          THE CAL TECH PELLETRON FACILITY. BEAM CURRENTS UP          I+91 1   37
          TO 100 MICROAMPERES WERE USED. THE RESOLUTION WAS          I+91 1   38
          1 KEV AS MEASURED USING THE NARROW RESONANCE AT            I+91 1   39
          EP = 991.88 KEV IN 27AL(P,GAMMA)28SI. THE PROTON           I+91 1   40
          ENERGY WAS CALIBRATED USING THE EP = 811 KEV               I+91 1   41
          RESONANCE IN 31P(P,GAMMA)32S. MEASUREMENTS IN THE          I+91 1   42
          RANGE EP = 0.28 TO 0.45 MEV WERE CONDUCTED AT THE          I+91 1   43
          TORONTO VAN DE GRAAFF FACILITY. PROTON BEAM CURRENTS       I+91 1   44
          UP TO 50 MICROAMPERES WERE USED. THE RESOLUTION WAS        I+91 1   45
          1 KEV AND THE ENERGY CALIBRATION WAS KNOWN TO BETTER       I+91 1   46
          THAN 2 KEV. THE EXPERIMENTAL SETUPS WERE SIMILAR IN        I+91 1   47
          BOTH LABORATORIES. TARGETS WERE MOUNTED AT 45              I+91 1   48
          DEGREES RELATIVE TO THE INCIDENT PROTON BEAM. A            I+91 1   49
          TANTALUM COLLIMATOR WAS USED TO DEFINE THE PROTON          I+91 1   50
          BEAM. A LIQUID-NITROGEN COOLED COPPER TUBE WAS             I+91 1   51
          PLACED BETWEEN THIS COLLIMATOR AND THE TARGET TO           I+91 1   52
          INHIBIT CARBON DEPOSITION ON THE TARGET. THE               I+91 1   53
          COOLED COPPER TUBE WAS BIASED AT -200 VOLTS TO             I+91 1   54
          SUPPRESS SECONDARY ELECTRON EMISSION FROM THE TARGET.      I+91 1   55
          GAMMA-RAYS WERE MEASURED WITH A GE(LI) DETECTOR IN         I+91 1   56
          CLOSE GEOMETRY AT 55 DEGREES RELATIVE TO THE INCIDENT      I+91 1   57
          PROTON BEAM. THE DETECTOR WAS SHIELDED WITH LEAD TO        I+91 1   58
          MINIMIZE BACKGROUND. THE GAMMA-RAY EFFICIENCY OF THIS      I+91 1   59
          DETECTOR WAS MEASURED USING THE WELL-KNOWN BRANCHING       I+91 1   60
          RATIOS FOR THE GAMMA-RAYS FROM THE 632- AND 992-KEV        I+91 1   61
          RESONANCES IN 27AL(P,GAMMA)28SI.                           I+91 1   62
DETECTOR   (GELI) 35-CM**3 GE(LI) DETECTOR.                          I+91 1   63
MONITOR    (CI) CURRENT INTEGRATOR.                                  I+91 1   64
CORRECTION DATA WERE CORRECTED FOR DETECTOR EFFICIENCY AND           I+91 1   65
          GAMMA RAY ABSORPTION. SEE ORIGINAL PAPER FOR DETAILS.      I+91 1   66
ERR-ANALYS ERRORS ARE GIVEN BUT FEW DETAILS ON THE ERROR ANALYSIS    I+91 1   67
          PROCEDURES ARE PROVIDED.                                   I+91 1   68
ENDBIB             66                                                I+91 1   69
ENDSUBENT           1                                                I+91 199999
SUBENT        I+91  2          0                                     I+91 2    1
BIB                 2          6                                     I+91 2    2
REACTION   31P(P,GAMMA)32S                                           I+91 2    3
COMMENTS   RESONANCE ENERGIES FOR THE OBSERVED PROTON UNBOUND        I+91 2    4
          LEVELS IN 32S ARE GIVEN. DATA OBTAINED FROM TABLE 1        I+91 2    5
          OF THE ORIGINAL PAPER. EP = RESONANCE PROTON ENERGY.       I+91 2    6
          EP-ERR = ERROR IN PROTON ENERGY. EX = RESONANCE            I+91 2    7
          EXCITATION ENERGY IN 32S.                                  I+91 2    8
ENDBIB              6                                                I+91 2    9
DATA                3          6                                     I+91 2   10
EP         EP-ERR     EX                                             I+91 2   11
KEV        KEV        MEV                                            I+91 2   12
 355.       1.         9.208                                         I+91 2   13
 383.       2.         9.236                                         I+91 2   14
 403.       2.         9.255                                         I+91 2   15
 439.       1.         9.290                                         I+91 2   16
 541.       1.         9.389                                         I+91 2   17
 619.       1.         9.464                                         I+91 2   18
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ENDDATA              8                                                    I+91 2   19
ENDSUBENT            2                                                    I+91 299999
SUBENT        I+91  3          0                                          I+91 3    1
BIB                  2         13                                         I+91 3    2
REACTION    31P(P,GAMMA)32S                                               I+91 3    3
COMMENTS    GAMMA-RAY BRANCHING IN THE DECAY OF OBSERVED                  I+91 3    4
            RESONANCES IN 31P(P,GAMMA)32S. EP = RESONANCE                 I+91 3    5
            PROTON ENERGY. EX = RESONANCE EXCITATION ENERGY               I+91 3    6
            IN 32S. EI = INITIAL STATE OF GAMMA-RAY TRANSITION.           I+91 3    7
            EF = FINAL STATE OF TRANSITION. J-PI(R) = SPIN/PARITY         I+91 3    8
            OF RESONANCE STATE. J-PI(F) = SPIN/PARITY OF FINAL            I+91 3    9
            STATE OF GAMMA-RAY TRANSITION. A NEGATIVE VALUE MEANS         I+91 3   10
            NEGATIVE PARITY. OTHERWISE PARITY IS POSITIVE. B =            I+91 3   11
            GAMMA-RAY BRANCHING RATIO. B-ERR = ERROR IN B. PCT =          I+91 3   12
            PERCENT. A BLANK SPACE INDICATES THAT NO VALUE WAS            I+91 3   13
            PROVIDED IN THE ORIGINAL PAPER. DATA OBTAINED FROM            I+91 3   14
            TABLE 2 OF THE ORIGINAL PAPER.                                I+91 3   15
ENDBIB              13                                                    I+91 3   16
DATA                 8         43                                         I+91 3   17
EP          EX          EI          J-PI(R)     EF          J-PI(F)       I+91 3   18
B           B-ERR                                                         I+91 3   19
KEV         MEV         MEV         NO-DIM      MEV         NO-DIM        I+91 3   20
PCT         PCT                                                           I+91 3   21
 355.        9.208       9.208       1.          7.190       1.           I+91 3   22
 2.8         0.7                                                          I+91 3   23
 355.        9.208       9.208       1.          6.224      -2.           I+91 3   24
 9.1         0.8                                                          I+91 3   25
 355.        9.208       9.208       1.          5.798      -1.           I+91 3   26
 6.2         1.2                                                          I+91 3   27
 355.        9.208       9.208       1.          5.549       2.           I+91 3   28
 7.1         1.1                                                          I+91 3   29
 355.        9.208       9.208       1.          4.282       2.           I+91 3   30
 2.1         0.6                                                          I+91 3   31
 355.        9.208       9.208       1.          3.778       0.           I+91 3   32
 4.1         0.6                                                          I+91 3   33
 355.        9.208       9.208       1.          2.230       2.           I+91 3   34
 34.1        2.0                                                          I+91 3   35
 355.        9.208       9.208       1.          0.          0.           I+91 3   36
 34.5        2.0                                                          I+91 3   37
 383.        9.236       9.236      -1.          4.695       1.           I+91 3   38
 17.0        7.9                                                          I+91 3   39
 383.        9.236       9.236      -1.          3.778       0.           I+91 3   40
 46.6        11.9                                                         I+91 3   41
 383.        9.236       9.236      -1.          2.230       2.           I+91 3   42
 36.4        8.7                                                          I+91 3   43
 403.        9.255       9.255       2.          6.666                    I+91 3   44
 8.9         1.6                                                          I+91 3   45
 403.        9.255       9.255       2.          6.224      -2.           I+91 3   46
 6.0         1.1                                                          I+91 3   47
 403.        9.255       9.255       2.          5.549       2.           I+91 3   48
 4.3         1.3                                                          I+91 3   49
 403.        9.255       9.255       2.          5.413       3.           I+91 3   50
 5.2         1.4                                                          I+91 3   51
 403.        9.255       9.255       2.          5.006      -3.           I+91 3   52
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14.0	2.1					I+91 3	53
403.	9.255	9.255	2.	4.695	1.	I+91 3	54
24.5	2.3					I+91 3	55
403.	9.255	9.255	2.	4.282	2.	I+91 3	56
5.6	1.3					I+91 3	57
403.	9.255	9.255	2.	2.230	2.	I+91 3	58
31.5	3.0					I+91 3	59
439.	9.290	9.290	1.	7.536	0.	I+91 3	60
5.6	0.5					I+91 3	61
439.	9.290	9.290	1.	7.115	2.	I+91 3	62
15.6	0.9					I+91 3	63
439.	9.290	9.290	1.	7.003	1.	I+91 3	64
1.0	0.2					I+91 3	65
439.	9.290	9.290	1.	6.224	-2.	I+91 3	66
2.5	0.3					I+91 3	67
439.	9.290	9.290	1.	5.798	-1.	I+91 3	68
1.1	0.2					I+91 3	69
439.	9.290	9.290	1.	4.695	1.	I+91 3	70
15.6	0.9					I+91 3	71
439.	9.290	9.290	1.	2.230	2.	I+91 3	72
18.7	0.9					I+91 3	73
439.	9.290	9.290	1.	0.	0.	I+91 3	74
39.9	1.7					I+91 3	75
541.	9.389	9.389	-2.	8.126	1.	I+91 3	76
1.3	0.1					I+91 3	77
541.	9.389	9.389	-2.	6.621	-4.	I+91 3	78
1.5	0.9					I+91 3	79
541.	9.389	9.389	-2.	6.224	-2.	I+91 3	80
15.9	0.7					I+91 3	81
541.	9.389	9.389	-2.	5.798	-1.	I+91 3	82
1.9	0.3					I+91 3	83
541.	9.389	9.389	-2.	5.549	2.	I+91 3	84
1.7	0.3					I+91 3	85
541.	9.389	9.389	-2.	5.413	3.	I+91 3	86
0.9	0.1					I+91 3	87
541.	9.389	9.389	-2.	5.006	-3.	I+91 3	88
7.8	0.4					I+91 3	89
541.	9.389	9.389	-2.	4.695	1.	I+91 3	90
2.0	0.2					I+91 3	91
541.	9.389	9.389	-2.	4.282	2.	I+91 3	92
1.9	0.2					I+91 3	93
541.	9.389	9.389	-2.	2.230	2.	I+91 3	94
62.6	2.3					I+91 3	95
541.	9.389	9.389	-2.	0.	0.	I+91 3	96
2.5	0.1					I+91 3	97
619.	9.464	9.464	2.	7.115	2.	I+91 3	98
5.4	1.5					I+91 3	99
619.	9.464	9.464	2.	4.695	1.	I+91 3	100
21.2	3.1					I+91 3	101
619.	9.464	9.464	2.	3.778	0.	I+91 3	102
4.7	1.3					I+91 3	103
619.	9.464	9.464	2.	2.230	2.	I+91 3	104
26.5	3.3					I+91 3	105
619.	9.464	9.464	2.	0.	0.	I+91 3	106

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 42.2       3.4                                                  I+91 3  107
ENDDATA             90                                           I+91 3  108
ENDSUBENT            3                                           I+91 399999
SUBENT        I+91  4          0                                 I+91 4    1
BIB                  2         13                                I+91 4    2
REACTION   31P(P,GAMMA)32S                                       I+91 4    3
COMMENTS   EXPERIMENTALLY DETERMINED RESONANCE STRENGTHS FOR     I+91 4    4
           THE REACTION 31P(P,GAMMA)32S ARE GIVEN. DATA OBTAINED I+91 4    5
           FROM TABLE 3 OF THE ORIGINAL PAPER. EP = PROTON       I+91 4    6
           ENERGY OF THE RESONANCE. J-PI = SPIN/PARITY OF THE    I+91 4    7
           RESONANCE. A NEGATIVE SIGN INDICATES NEGATIVE PARITY. I+91 4    8
           OTHERWISE PARITY IS POSITIVE. S = RESONANCE STRENGTH = I+91 4    9
           [(2J+1)/(2JP+1)*(2JT+1)]*GAMMA(P)*GAMMA(G)/GAMMA(TOT), I+91 4   10
           WHERE J = RESONANCE SPIN, JP = PROTON SPIN = 0.5, JT = I+91 4   11
           TARGET (31P) SPIN = 0.5, GAMMA(P) = PROTON WIDTH,     I+91 4   12
           GAMMA(G) = GAMMA-RAY WIDTH, AND GAMMA(TOT) = TOTAL    I+91 4   13
           WIDTH OF THE RESONANCE. S-ERR = ERROR IN S. A BLANK   I+91 4   14
           SPACE INDICATES VALUE NOT GIVEN IN THE TABLE.         I+91 4   15
ENDBIB              13                                           I+91 4   16
DATA                 4          8                                I+91 4   17
EP         J-PI       S          S-ERR                           I+91 4   18
KEV        NO-DIM     EV         EV                              I+91 4   19
 316.        3.        3.7000E-05                                I+91 4   20
 342.        2.        6.1000E-05                                I+91 4   21
 355.        1.        0.0042     0.0007                         I+91 4   22
 383.       -1.        6.0000E-05 1.2000E-05                     I+91 4   23
 403.        2.        4.5000E-04 7.0000E-05                     I+91 4   24
 439.        1.        0.025      0.004                          I+91 4   25
 541.       -2.        0.12       0.02                           I+91 4   26
 619.        2.        0.0011     0.0002                         I+91 4   27
ENDDATA             10                                           I+91 4   28
ENDSUBENT            4                                           I+91 499999
SUBENT        I+91  5          0                                 I+91 5    1
BIB                  2         15                                I+91 5    2
REACTION   31P(P,GAMMA)32S                                       I+91 5    3
COMMENTS   CALCULATED RESONANCE STRENGTHS FOR POSSIBLE LOW-      I+91 5    4
           ENERGY UNOBSERVED RESONANCES IN 31P(P,GAMMA)32S.      I+91 5    5
           EP = RESONANCE PROTON ENERGY. EX = RESONANCE          I+91 5    6
           EXCITATION ENERGY IN 32S. J=PI = RESONANCE SPIN/      I+91 5    7
           PARITY. A NEGATIVE VALUE INDICATES NEGATIVE PARITY.   I+91 5    8
           OTHERWISE PARITY IS POSITIVE. GAMMA(P) = PROTON       I+91 5    9
           WIDTH. GAMMA(G) = GAMMA-RAY WIDTH. S IS THE RESONANCE I+91 5   10
           STRENGTH CALCULATED AS DISCUSSED IN THE PAPER. S =    I+91 5   11
           [(2J+1)/(2JP+1)*(2JT+1)]*GAMMA(P)*GAMMA(G)/GAMMA(TOT), I+91 5   12
           WHERE J = RESONANCE SPIN, JP = PROTON SPIN = 0.5, JT = I+91 5   13
           TARGET (31P) SPIN = 0.5, GAMMA(P) = PROTON WIDTH,     I+91 5   14
           GAMMA(G) = GAMMA-RAY WIDTH, AND GAMMA(TOT) = TOTAL    I+91 5   15
           WIDTH OF THE RESONANCE. A BLANK SPACE INDICATES       I+91 5   16
           VALUE NOT GIVEN IN THE TABLE OR IS UNCERTAIN.         I+91 5   17
ENDBIB              15                                           I+91 5   18
DATA                 6          3                                I+91 5   19
EP         EX         J-PI       GAMMA(P)   GAMMA(G)   S         I+91 5   20
KEV        MEV        NO-DIM     EV         EV         EV        I+91 5   21
 163.        9.023     -3.         5.5000E-11 0.016      5.6000E-11 I+91 5   22
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 201.       9.060                                           2.8000E-06  I+91 5   23
 206.       9.065     4.         7.0000E-11 0.005           1.0000E-10  I+91 5   24
ENDDATA              5                                                  I+91 5   25
ENDSUBENT            5                                                  I+91 599999
ENDENTRY             5                                                  I+919999999
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I+93

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ENTRY            I+93          0                                        I+93 0    1
SUBENT        I+93  1          0                                        I+93 1    1
BIB                12         59                                        I+93 1    2
INSTITUTE  (USANOT)                                                     I+93 1    3
           (GERBOC)                                                     I+93 1    4
           (CANKQU)                                                     I+93 1    5
REFERENCE  (J,NP/A,559,83,1993)                                         I+93 1    6
AUTHORS    (C.ILIADIS,J.GOERRES,J.G.ROSS,K.W.SCHELLER,M.WIESCHER,       I+93 1    7
           C.GRAMA,TH.SCHANGE,H.P.TRAUTVETTER,H.C.EVANS)                I+93 1    8
TITLE      EXPLOSIVE HYDROGEN BURNING OF 31P                            I+93 1    9
FACILITIES (C-W) 400-KV COCKCROFT-WALTON ACCELERATOR, RUHR              I+93 1   10
           UNIVERSITAET, BOCHUM, FEDERAL REPUBLIC OF GERMANY.           I+93 1   11
           SNICS ION SOURCE, UNIVERSITY OF NOTRE DAME, NOTRE            I+93 1   12
           DAME, INDIANA.                                               I+93 1   13
INC-PART   (P) PROTONS.                                                 I+93 1   14
TARGETS    AN IMPLANTED 31P TARGET WAS PRODUCED BY BOMBARDING A         I+93 1   15
           0.25-MM-THICK TANTALUM BACKING WITH 31P IONS USING           I+93 1   16
           THE SNICS SOURCE AT NOTRE DAME. TARGET THICKNESS WAS         I+93 1   17
           13 KEV AT EP = 355 KEV. TARGET STOICHIOMETRY WAS             I+93 1   18
           DETERMINED FROM THE WELL-KNOWN STRENGTH OF THE               I+93 1   19
           31P(P,GAMMA)32S RESONANCE AT EP = 811 KEV. USING             I+93 1   20
           STOPPING POWER TABLES FROM ANDERSON AND ZEIGLER,             I+93 1   21
           THE RATIO TA/P WAS FOUND TO BE 0.8 (WITH 25% ERROR).         I+93 1   22
           THE TARGET WAS FOUND TO BE STABLE BY TESTS DONE              I+93 1   23
           THROUGHOUT THE COURSE OF THE EXPERIMENT.                     I+93 1   24
METHOD     PROTON BEAMS OF 80 TO 180 MICROAMPERES IN THE ENERGY         I+93 1   25
           RANGE EP = 160 TO 370 KEV WERE PROVIDED BY THE BOCHUM        I+93 1   26
           ACCELERATOR. THE PARTICLE ENERGY WAS CALIBRATED USING        I+93 1   27
           WELL-KNOWN RESONANCES IN 14N(P,GAMMA)15O AND IN              I+93 1   28
           27AL(P,GAMMA)28SI. THE ENERGY SPREAD WAS 1 KEV AND           I+93 1   29
           THE UNCERTAINTY IN THE ENERGY CALIBRATION WAS ALSO           I+93 1   30
           1 KEV. THE PROTON BEAM WAS COLLIMATED TO FORM A              I+93 1   31
           PROFILE 1.5 CM IN DIAMETER ON THE TARGET. THE TARGET         I+93 1   32
           WAS DIRECTLY WATERCOOLED AND MOUNTED AT 45 DEGREES           I+93 1   33
           WITH RESPECT TO THE PROTON BEAM. THE GAMMA-RAYS              I+93 1   34
           EMITTED DURING DE-EXCITATION OF THE 32S STATES               I+93 1   35
           EXCITED BY THE 31P(P,GAMMA)32S REACTION WERE                 I+93 1   36
           MEASURED WITH A GE(LI) DETECTOR PLACED AT 55 DEGREES         I+93 1   37
           WITH RESPECT TO THE PROTON BEAM AT A DISTANCE OF             I+93 1   38
           1.5 CM. RELATIVE GAMMA-RAY EFFICIENCIES WERE                 I+93 1   39
           MEASURED FOR EGAMMA = 0.25 TO 11.6 MEV USING A               I+93 1   40
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          CALIBRATED 152EU SOURCE AS WELL AS KNOWN GAMMA          I+93 1   41
          RAYS FROM 14N(P,GAMMA)15O AT THE EP = 278 KEV           I+93 1   42
          RESONANCE AND 11B(P,GAMMA)12C AT THE EP = 163 KEV       I+93 1   43
          RESONANCE. GAMMA-RAY YIELDS WERE MEASURED OVER THE      I+93 1   44
          PROTON ENERGY RANGE 195 TO 370 KEV WITH CHARGE          I+93 1   45
          ACCUMULATIONS OF 1 TO 2 COULOMB. TWO RESONANCES         I+93 1   46
          IN 31P(P,GAMMA) WERE OBSERVED DURING THE COURSE         I+93 1   47
          OF THIS WORK AT EP = 200 AND 355 KEV, RESPECTIVELY.     I+93 1   48
          THE RESONANCE AT EP = 200 KEV HAD NOT BEEN SEEN         I+93 1   49
          PREVIOUSLY. THE STRENGTH OF THIS NEWLY DISCOVERED       I+93 1   50
          EP = 200 KEV RESONANCE WAS DETERMINED RELATIVE TO       I+93 1   51
          THAT OF THE BETTER-KNOWN EP = 355 KEV RESONANCE.        I+93 1   52
DETECTOR   (GELI) 100-CM**3 GE(LI) DETECTOR.                       I+93 1   53
MONITOR    (CI) CURRENT INTEGRATOR.                                I+93 1   54
CORRECTION DATA CORRECTED FOR ENERGY LOSS IN THE CARBON-BUILDUP    I+93 1   55
          LAYER ON THE TARGET BY MONITORING THE INTENSITY AND     I+93 1   56
          WIDTH OF THE PRIMARY GAMMA-RAY PEAK RESULTING FROM      I+93 1   57
          13C(P,GAMMA)13N. DATA WERE ALSO CORRECTED FOR           I+93 1   58
          COINCIDENT SUMMING AND STOPPING POWER EFFECTS.          I+93 1   59
ERR-ANALYS ERRORS ARE GIVEN. SOME DETAILS CAN BE FOUND IN THE      I+93 1   60
          ORIGINAL PAPER.                                         I+93 1   61
ENDBIB              59                                             I+93 1   62
ENDSUBENT            1                                             I+93 199999
SUBENT        I+93  2          0                                   I+93 2    1
BIB                  2         16                                  I+93 2    2
REACTION   31P(P,GAMMA)32S                                         I+93 2    3
COMMENTS   PROPERTIES OF RESONANCES NEAR THE PROTON THRESHOLD      I+93 2    4
          OF 32S ARE GIVEN. INFORMATION OBTAINED FROM TABLE 1     I+93 2    5
          OF THE PAPER. EP = PROTON ENERGY. NOTE: A NEGATIVE      I+93 2    6
          VALUE SIGNIFIES A BOUND STATE IN 32S. EP-ERR = ERROR    I+93 2    7
          IN EP. EX = EXCITATION ENERGY OF RESONANT STATE IN      I+93 2    8
          32S. EX-ERR = ERROR IN EX. J-PI = SPIN/PARITY OF THE    I+93 2    9
          RESONANT STATE IN 32S. A NEGATIVE VALUE INDICATES       I+93 2   10
          NEGATIVE PARITY. OTHERWISE PARITY IS POSITIVE. TAU =    I+93 2   11
          ISOBARIC SPIN  OF 32S LEVEL. S = RESONANCE STRENGTH =   I+93 2   12
          [(2J+1)/(2JP+1)*(2JT+1)]*GAMMA(P)*GAMMA(G)/GAMMA(TOT),  I+93 2   13
          WHERE J = RESONANCE SPIN, JP = PROTON SPIN = 0.5, JT =  I+93 2   14
          TARGET (31P) SPIN = 0.5, GAMMA(P) = PROTON WIDTH,       I+93 2   15
          GAMMA(G) = GAMMA-RAY WIDTH, AND GAMMA(TOT) = TOTAL      I+93 2   16
          WIDTH OF THE RESONANCE. S-ERR = ERROR IN S. A BLANK     I+93 2   17
          SPACE INDICATES VALUE NOT GIVEN IN THE TABLE.           I+93 2   18
ENDBIB              16                                             I+93 2   19
DATA                 8         12                                  I+93 2   20
EP         EP-ERR     EX         EX-ERR     J-PI       TAU         I+93 2   21
S          S-ERR                                                   I+93 2   22
KEV        KEV        KEV        KEV        NO-DIM     NO-DIM      I+93 2   23
EV         EV                                                      I+93 2   24
-3.5                   8861.                 2.         0.         I+93 2   25
                                                                   I+93 2   26
 164.                  9023.                -3.         0.         I+93 2   27
 1.0000E-10                                                        I+93 2   28
 200.       2.         9059.      2.                               I+93 2   29
 4.8000E-07 1.6000E-07                                             I+93 2   30
 207.                  9065.                 4.         0.         I+93 2   31
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 3.3000E-09                                                         I+93 2   32
 315.             9170.              3.         1.                  I+93 2   33
 3.7000E-05                                                         I+93 2   34
 342.             9196.              2.                             I+93 2   35
 6.1000E-05                                                         I+93 2   36
 355.             9208.              1.         1.                  I+93 2   37
 4.2000E-03 7.0000E-04                                              I+93 2   38
 383.             9236.             -1.         0.                  I+93 2   39
 6.0000E-05 1.2000E-05                                              I+93 2   40
 403.             9255.              2.         1.                  I+93 2   41
 4.5000E-04 7.0000E-05                                              I+93 2   42
 439.             9290.              1.                             I+93 2   43
 0.025      0.004                                                   I+93 2   44
 541.             9389.             -2.                             I+93 2   45
 0.12       0.02                                                    I+93 2   46
 619.             9464.              2.         0.                  I+93 2   47
 1.1000E-03 2.0000E-04                                              I+93 2   48
ENDDATA            28                                               I+93 2   49
ENDSUBENT           2                                               I+93 299999
ENDENTRY            2                                               I+939999999
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K+70

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ENTRY            K+70          0                                    K+70 0    1
SUBENT        K+70  1          0                                    K+70 1    1
BIB                13         27                                    K+70 1    2
INSTITUTE  (CCP) INSTITUTE NOT SPECIFIED IN THE ORIGINAL PAPER.     K+70 1    3
REFERENCE  (J,JET/L,12,3,149,1970)                                  K+70 1    4
AUTHORS    (K.V.KARADZHEV,V.I.MAN'KO,A.N.NERSESYAN,F.E.CHUKREEV)    K+70 1    5
TITLE      INVESTIGATION OF A POSSIBLE VIOLATION OF THE             K+70 1    6
           INDEPENDENCE OF THE DECAY OF A COMPOUND NUCLEUS          K+70 1    7
           OF THE SPIN OF THE INPUT CHANNEL                         K+70 1    8
FACILITY   FACILITY NOT SPECIFIED IN THE ORIGINAL PAPER.            K+70 1    9
INC-PART   (P) PROTONS.                                             K+70 1   10
TARGET     THIN LAYER OF P3ZN2 SPUTTERED ON TANTALUM SUBSTRATE.     K+70 1   11
METHOD     MEASURED EXCITATION FUNCTION FOR 31P(P,GAMMA)32          K+70 1   12
           REACTION IN THE VICINITY OF THE EP = 2114 KEV            K+70 1   13
           RESONANCE. USED A NAI SCINTILLATION DETECTOR TO          K+70 1   14
           MEASURE GAMMA RAYS SINCE CROSS SECTION WAS TOO LOW       K+70 1   15
           TO USE A GERMANIUM DETECTOR. IT WAS NECESSARY TO         K+70 1   16
           PLACE THIS DETECTOR VERY CLOSE TO THE TARGET IN POOR     K+70 1   17
           GEOMETRY. TOTAL ANGULAR DISTRIBUTION NOT MEASURED.       K+70 1   18
           ONLY THE RATIO OF GAMMA-RAY YIELD AT 0 AND 90            K+70 1   19
           DEGREES WAS DETERMINED. NO OTHER DETAILS ARE GIVEN       K+70 1   20
           IN THE ORIGINAL PAPER.                                   K+70 1   21
DETECTOR   (SCINT) 9-CM DIA, X 10-CM LONG NAI SCINTILLATION         K+70 1   22
           DETECTOR.                                                K+70 1   23
MONITOR    MONITOR NOT SPECIFIED IN THE ORIGINAL PAPER.             K+70 1   24
CORRECTION CORRECTIONS FOR GEOMETRIC EFFECTS WERE APPLIED.          K+70 1   25
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ERR-ANALYS ERROR IN RESULT IS GIVEN. ERROR ANALYSIS METHOD          K+70 1   26
           NOT DISCUSSED IN THE ORIGINAL PAPER.                     K+70 1   27
COMMENT    THIS IS A VERY BRIEF COMMUNICATION THAT PROVIDES FEW     K+70 1   28
           DETAILS CONCERNING THE WORK.                             K+70 1   29
ENDBIB             27                                               K+70 1   30
ENDSUBENT           1                                               K+70 199999
SUBENT         K+70  2          0                                   K+70 2    1
BIB                 2          8                                    K+70 2    2
REACTION   31P(P,GAMMA)32S                                          K+70 2    3
COMMENTS   RATIO OF GAMMA-RAY YIELD AT 0 AND 90 DEGREES RELATIVE    K+70 2    4
           TO INCIDENT PROTON BEAM WAS MEASURED WITH A NAI          K+70 2    5
           SCINTILLATION DETECTOR PLACED CLOSE TO THE TARGET IN     K+70 2    6
           POOR GEOMETRY. DATA OBTAINED FROM TEXT OF ORIGINAL       K+70 2    7
           PAPER. EP = INCIDENT PROTON ENERGY. RATIO = RATIO        K+70 2    8
           OF GAMMA-RAY YIELD AT 90 DEGREES TO THAT OBTAINED        K+70 2    9
           AT 0 DEGREE. RATIO-ERR = ERROR IN RATIO.                 K+70 2   10
ENDBIB              8                                               K+70 2   11
DATA                3          1                                    K+70 2   12
EP         RATIO      RATIO-ERR                                     K+70 2   13
KEV        NO-DIM     NO-DIM                                        K+70 2   14
 2114.      5.54       0.5                                          K+70 2   15
ENDDATA             3                                               K+70 2   16
ENDSUBENT           2                                               K+70 299999
ENDENTRY            2                                               K+709999999
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K+74

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ENTRY            K+74          0                                    K+74 0    1
SUBENT         K+74  1          0                                   K+74 1    1
BIB                13         28                                    K+74 1    2
INSTITUTE  (CCPUFT)                                                 K+74 1    3
REFERENCE  (J,BAS,37,9,84,1974)                                     K+74 1    4
AUTHORS    (V.YA.KOSTIN,E.G.KOPANETS,A.A.KOVAL,A.N.L'VOV,           K+74 1    5
           V.YA.MIGALENYA,S.P.TSYITKO)                              K+74 1    6
TITLE      ISOSPIN STRUCTURE OF 32S LEVELS FROM THE RADIATIVE       K+74 1    7
           PROTON CAPTURE REACTION                                  K+74 1    8
FACILITY   (VDG) ELECTROSTATIC ACCELERATOR, PHYSICAL TECHNICAL      K+74 1    9
           INSTITUTE, URKRAINIAN SSR ACADEMY OF SCIENCES,           K+74 1   10
           KHARKOV, UKRAINE SSR.                                    K+74 1   11
INC-PART   (P) PROTONS.                                             K+74 1   12
TARGET     THINLY DEPOSITED ZN3P2.                                  K+74 1   13
METHOD     MEASUREMENTS WERE MADE ON THE 31P(P,GAMMA)32S            K+74 1   14
           REACTION OVER THE ENERGY RANGE EP = 1.8 TO 2.8 MEV.      K+74 1   15
           GAMMA-RAY SPECTRA WERE MEASURED WITH A GE(LI)            K+74 1   16
           DETECTOR AT TEN RESONANCES (EP = 1981, 1952, 1975,       K+74 1   17
           1981, 1989, 2023, 2118, 2323, 2341, AND 2682 KEV).       K+74 1   18
           AN ELECTROSTATIC ACCELERATOR WAS USED TO GENERATE        K+74 1   19
           PROTON BEAMS USED IN THE EXPERIMENT. DATA WERE           K+74 1   20
           ACQUIRED USING A MULTI-CHANNEL ANALYZER. NO OTHER        K+74 1   21
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           EXPERIMENTAL DETAILS ARE PROVIDED.                      K+74 1   22
DETECTOR   (GELI) GE(LI) DETECTOR WITH A RESOLUTION OF 3.8 KEV     K+74 1   23
           FOR 1333-KEV GAMMA-RAYS.                                K+74 1   24
MONITOR    NOT SPECIFIED IN ORIGINAL PAPER.                        K+74 1   25
CORRECTION CORRECTION PROCEDURES ARE NOT DISCUSSED IN THE          K+74 1   26
           ORIGINAL PAPER.                                         K+74 1   27
ERR-ANALYS NO ERRORS ARE GIVEN                                     K+74 1   28
COMMENT    THIS IS A RELATIVELY SHORT COMMUNICATION WITH FEW       K+74 1   29
           DETAILS PROVIDED.                                       K+74 1   30
ENDBIB             28                                              K+74 1   31
ENDSUBENT           1                                              K+74 199999
SUBENT        K+74  2          0                                   K+74 2    1
BIB                 2         10                                   K+74 2    2
REACTION   31P(P,GAMMA)32S                                         K+74 2    3
COMMENTS   MATRIX ELEMENTS FOR L=1 (DIPOLE) GAMMA-RAY              K+74 2    4
           TRANSITIONS ARE GIVEN. VALUES OBTAINED FROM TABLE       K+74 2    5
           2 OF THE ORIGINAL ARTICLE. EP = RESONANCE PROTON        K+74 2    6
           ENERGY. EP-ERR = ERROR IN EP. EX = RESONANCE            K+74 2    7
           EXCITATION ENERGY IN 32S. EI = INITIAL 32S STATE        K+74 2    8
           FOR GAMMA-RAY TRANSITION. EF = FINAL 32S STATE.         K+74 2    9
           TRANSTYP = TRANSITION TYPE (E1 = ELECTRIC DIPOLE,       K+74 2   10
           M1 = MAGNETIC DIPOLE). ME = MATRIX ELEMENT. W.U. =      K+74 2   11
           WEISSKOPF UNITS.                                        K+74 2   12
ENDBIB             10                                              K+74 2   13
DATA                7          9                                   K+74 2   14
EP         EP-ERR     EX         EI         EF         TRANSTYP    K+74 2   15
ME                                                                 K+74 2   16
KEV        KEV        KEV        KEV        KEV        NO-DIM      K+74 2   17
W.U.                                                               K+74 2   18
 1891.      3.         10698.     10698.     0.         E1         K+74 2   19
 0.015                                                             K+74 2   20
 1891.      3.         10698.     10698.     3.775      E1         K+74 2   21
 0.0015                                                            K+74 2   22
 1975.      2.         10778.     10778.     0.         E1         K+74 2   23
 0.0002                                                            K+74 2   24
 2023.      2.         10826.     10826.     0.         E1         K+74 2   25
 0.0035                                                            K+74 2   26
 2118.      2.         10918.     10918.     0.         E1         K+74 2   27
 0.0009                                                            K+74 2   28
 2323.      2.         11117.     11117.     0.         M1         K+74 2   29
 0.02                                                              K+74 2   30
 2323.      2.         11117.     11117.     0.         E1         K+74 2   31
 0.006                                                             K+74 2   32
 2341.      2.         11135.     11135.     0.         M1         K+74 2   33
 0.7                                                               K+74 2   34
 2341.      2.         11135.     11135.     0.         E1         K+74 2   35
 0.02                                                              K+74 2   36
ENDDATA            22                                              K+74 2   37
ENDSUBENT           2                                              K+74 299999
ENDENTRY            2                                              K+749999999
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ENTRY            K+77          0                                        K+77 0    1
SUBENT        K+77  1          0                                        K+77 1    1
BIB                13         29                                        K+77 1    2
INSTITUTE  (CCPUFT)                                                     K+77 1    3
REFERENCE  (J,BAS,41,1,124,1977)                                        K+77 1    4
AUTHORS    (V.YA.KOSTIN,E.G.KOPANETS,A.A.KOVAL,A.N.L'VOV,               K+77 1    5
           V.YA.MIGALENYA,S.P.TSYITKO)                                  K+77 1    6
TITLE      ANGULAR DISTRIBUTIONS OF GAMMA-RAYS FROM THE                 K+77 1    7
           31P(P,GAMMA)32S REACTION                                     K+77 1    8
FACILITY   (VDG) ELECTROSTATIC ACCELERATOR, PHYSICAL TECHNICAL          K+77 1    9
           INSTITUTE, URKRAINIAN SSR ACADEMY OF SCIENCES,               K+77 1   10
           KHARKOV, UKRAINE SSR.                                        K+77 1   11
INC-PART   (P) PROTONS.                                                 K+77 1   12
TARGETS    THINLY DEPOSITED ZN3P2 ON TANTALUM SUPPORTS.                 K+77 1   13
METHOD     ANGULAR DISTRIBUTIONS WERE MEASURED AT THE EP =              K+77 1   14
           1121, 1151, 1557, AND 1953 KEV RESONANCES. GAMMA-            K+77 1   15
           RAY SPECTRA WERE MEASURED WITH A 60-CM**3 GE(LI)             K+77 1   16
           DETECTOR. THE STRONGEST TRANSITIONS WERE FITTED WITH         K+77 1   17
           LEGENDRE-POLYNOMIAL EXPANSIONS UP TO FOURTH ORDER.           K+77 1   18
           AN ELECTROSTATIC ACCELERATOR WAS USED TO GENERATE            K+77 1   19
           PROTON BEAMS USED IN THE EXPERIMENT. NO OTHER                K+77 1   20
           EXPERIMENTAL DETAILS ARE PROVIDED.                           K+77 1   21
DETECTOR   (GELI) 60-CM*3 GE(LI) DETECTOR WITH A RESOLUTION OF          K+77 1   22
           3.5 KEV FOR 1333-KEV GAMMA-RAYS.                             K+77 1   23
MONITOR    NOT SPECIFIED IN ORIGINAL PAPER.                             K+77 1   24
CORRECTION CORRECTION PROCEDURES ARE NOT DISCUSSED IN THE               K+77 1   25
           ORIGINAL PAPER.                                              K+77 1   26
ERR-ANALYS ERRORS ARE GIVEN FOR LEGENDRE-POLYNOMIAL                     K+77 1   27
           COEFFICIENTS BUT NO DETAILS ARE PROVIDED ON HOW               K+77 1   28
           ERRORS WERE DETERMINED.                                      K+77 1   29
COMMENT    THIS IS A RELATIVELY SHORT COMMUNICATION WITH FEW            K+77 1   30
           DETAILS PROVIDED.                                            K+77 1   31
ENDBIB             29                                                   K+77 1   32
ENDSUBENT           1                                                   K+77 199999
SUBENT        K+77  2          0                                        K+77 2    1
BIB                 2         15                                        K+77 2    2
REACTION   31P(P,GAMMA)32S                                              K+77 2    3
COMMENTS   ANGULAR DISTRIBUTIONS OF GAMMA RAYS FROM THE DECAY           K+77 2    4
           OF RESONANCE STATES IN 32S ARE GIVEN. DATA OBTAINED          K+77 2    5
           FROM TABLE 1 OF THE ORIGINAL PAPER. EP = RESONANCE           K+77 2    6
           PROTON ENERGY. EX = EXCITATION ENERGY OF RESONANT            K+77 2    7
           STATE IN 32S. EI = ENERGY OF INITIAL STATE OF GAMMA-         K+77 2    8
           RAY TRANSITION. J-PI(I) = SPIN/PARITY OF INITIAL             K+77 2    9
           STATE. EF = ENERGY OF FINAL STATE. J=PI(F) =                 K+77 2   10
           SPIN/PARITY OF FINAL STATE. NEGATIVE SIGN SIGNIFIES          K+77 2   11
           NEGATIVE PARITY. OTHERWISE PARITY IS POSITIVE. A2 =          K+77 2   12
           LEGENDRE-POLYNOMIAL COEFFICIENT FOR P2 TERM. A2-ERR          K+77 2   13
           = ERROR IN A2. A4 = LEGENDRE-POLYNOMIAL COEFFICIENT          K+77 2   14
           FOR P4 TERM. A4-ERR = ERROR IN A4. A BLANK ENTRY             K+77 2   15
           SIGNIFIES THAT INFORMATION IS NOT AVAILABLE OR IS            K+77 2   16
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           INCOMPLETE IN THE ORIGINAL PAPER.                          K+77 2   17
ENDBIB             15                                                 K+77 2   18
DATA               10         13                                      K+77 2   19
EP         EX         EI         J-PI(I)    EF         J-PI(F)        K+77 2   20
A2         A2-ERR     A4         A4-ERR                               K+77 2   21
KEV        KEV        KEV        NO-DIM     KEV        NO-DIM         K+77 2   22
NO-DIM     NO-DIM     NO-DIM     NO-DIM                               K+77 2   23
 1121.      9950.      9950.                 0.         0.            K+77 2   24
 0.032      0.166      0.211      0.171                               K+77 2   25
 1121.      9950.      9950.                 2230.      2.            K+77 2   26
 0.761      0.098     -0.161      0.102                               K+77 2   27
 1121.      9950.      9950.                 8126.      1.            K+77 2   28
 0.299      0.038      0.093      0.038                               K+77 2   29
 1151.      9979.      9979.                 2230.      2.            K+77 2   30
-0.003      0.041      0.102      0.043                               K+77 2   31
 1151.      9979.      9979.                 5549.      2.            K+77 2   32
-0.339      0.035      0.038      0.035                               K+77 2   33
 1557.      10372.     10372.    2.          2230.      2.            K+77 2   34
 0.479      0.041     -0.024      0.043                               K+77 2   35
 1557.      10372.     10372.    2.          4282.      2.            K+77 2   36
 0.544      0.033     -0.088      0.034                               K+77 2   37
 1557.      10372.     10372.    2.          4695.      1.            K+77 2   38
-0.276      0.035     -0.171      0.036                               K+77 2   39
 1557.      10372.     10372.    2.          5412.      3.            K+77 2   40
 0.140      0.09       0.009      0.010                               K+77 2   41
 1557.      10372.     10372.    2.          6666.                    K+77 2   42
 0.438      0.031     -0.057      0.032                               K+77 2   43
 1953.      10756.     10756.                4459.      4.            K+77 2   44
-0.19       0.04       0.04       0.04                                K+77 2   45
 1953.      10756.     10756.                5412.      2.            K+77 2   46
 0.23       0.07       0.00       0.10                                K+77 2   47
 1953.      10756.     10756.                5549.      2.            K+77 2   48
-0.20       0.09      -0.03       0.08                                K+77 2   49
ENDDATA            30                                                 K+77 2   50
ENDSUBENT           2                                                 K+77 299999
SUBENT        K+77  3          0                                      K+77 3    1
BIB                 2         12                                      K+77 3    2
REACTION   31P(P,GAMMA)32S                                            K+77 3    3
COMMENTS   MATRIX ELEMENTS FOR GAMMA-RAY TRANSITIONS ARE GIVEN.       K+77 3    4
           VALUES ARE OBTAINED FROM TABLE 3 OF THE ORIGINAL           K+77 3    5
           ARTICLE. EX = EXCITATION ENERGY OF RESONANT STATE          K+77 3    6
           IN 32S. EI = ENERGY OF INITIAL STATE OF GAMMA-RAY          K+77 3    7
           TRANSITION. EF = ENERGY OF FINAL STATE. J-PI(I) =          K+77 3    8
           SPIN/PARITY OF INITIAL STATE. J-PI(F) = SPIN/PARITY        K+77 3    9
           OF FINAL STATE. NEGATIVE SIGN INDICATES NEGATIVE           K+77 3   10
           PARITY. OTHERWISE PARITY IS POSITIVE. TRANSTYP =           K+77 3   11
           TRANSITION TYPE (M1 = MAGNETIC DIPOLE, E2 = ELECTRIC       K+77 3   12
           QUADRUPOLE). ME = MATRIX ELEMENT. ME-ERR = ERROR IN        K+77 3   13
           ME. W.U. = WEISSKOPF UNITS.                                K+77 3   14
ENDBIB             12                                                 K+77 3   15
DATA                8          5                                      K+77 3   16
EX         EI         J-PI(I)    EF         J-PI(F)    TRANSTYP       K+77 3   17
ME         ME-ERR                                                     K+77 3   18
KEV        KEV        NO-DIM     KEV        NO-DIM     NO-DIM         K+77 3   19
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W.U.       W.U.                                                    K+77 3   20
 10372.     10372.     2.         2230.      2.         M1         K+77 3   21
 0.019      0.006                                                  K+77 3   22
 10372.     10372.     2.         4282.      2.         M1         K+77 3   23
 0.16       0.05                                                   K+77 3   24
 10372.     10372.     2.         4695.      1.         M1         K+77 3   25
 0.038      0.013                                                  K+77 3   26
 10372.     10372.     2.         5412.      3.         M1         K+77 3   27
 0.011      0.004                                                  K+77 3   28
 10372.     10372.     2.         5412.      3.         E2         K+77 3   29
 10.        3.                                                     K+77 3   30
ENDDATA            14                                              K+77 3   31
ENDSUBENT           3                                              K+77 399999
ENDENTRY            3                                              K+779999999
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K+85

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ENTRY            K+85          0                                   K+85 0    1
SUBENT        K+85  1          0                                   K+85 1    1
BIB                12         37                                   K+85 1    2
INSTITUTES (HUNDEB)                                                K+85 1    3
           (SFHLS)                                                 K+85 1    4
REFERENCE  (J,JRN,89,1,123,1985)                                   K+85 1    5
AUTHORS    (A.Z.KISS,E.KOLTAY,B.NYAKO,E.SOMORJAI,A.ANTTILA,        K+85 1    6
           J.RAISANEN)                                             K+85 1    7
TITLE      MEASUREMENTS OF RELATIVE THICK TARGET YIELDS FOR        K+85 1    8
           PIGE ANALYSIS ON LIGHT ELEMENTS IN THE PROTON           K+85 1    9
           ENERGY INTERVAL 2.4 - 4.2 MEV                           K+85 1   10
FACILITY   (VDG) 5-MV VAN DE GRAAFF ACCELERATOR, INSTITUTE OF      K+85 1   11
           NUCLEAR RESEARCH, DEBRECEN, HUNGARY.                    K+85 1   12
INC-PART   (P) PROTONS.                                            K+85 1   13
TARGETS    PHOSPHORUS COMPOUND (UNSPECIFIED) PRESSED INTO          K+85 1   14
           PELLETS. TARGETS OF OTHER MATERIALS ALSO USED.          K+85 1   15
METHOD     PROTON BEAM WAS OBTAINED FROM THE 5-MV VAN DE GRAAFF    K+85 1   16
           ACCELERATOR AT DEBRECEN. PROTONS WERE COLLIMATED AND    K+85 1   17
           PASSED THROUGH A 50-CM-LONG LIQUID NITROGEN COLD        K+85 1   18
           TRAP BEFORE HITTING THE TARGET. THE ANGLE BETWEEN       K+85 1   19
           THE PROTON BEAM AND THE TARGET WAS 45 DEGREES. GAMMA    K+85 1   20
           RAYS WERE DETECTED WITH A 25-CM**3 GE(LI) DETECTOR      K+85 1   21
           PLACED AT 55 DEGREES AND 10 CM DISTANCE FROM THE        K+85 1   22
           TARGET. THE PROTON BEAM CURRENT WAS MAINTAINED AT       K+85 1   23
           A LEVEL BETWEEN 1 NANOAMP AND 1 MICROAMP IN ORDER TO    K+85 1   24
           MINIMIZE DEAD TIME OF THE DETECTION SYSTEM. THE         K+85 1   25
           PRESENT EXPERIMENT INVOLVED MEASUREMENTS OF GAMMA-      K+85 1   26
           RAY YIELDS FROM VARIOUS ELEMENTAL AND COMPOUND          K+85 1   27
           MATERIALS (INCLUDING PHOSPHORUS) FOR EP = 2.4 TO        K+85 1   28
           4.2 MEV. PRESENT DATA WERE NORMALIZED TO EARLIER        K+85 1   29
           RESULTS TAKEN AT LOWER PROTON ENERGIES WITH A           K+85 1   30
           DIFFERENT GE(LI) DETECTOR. THE RATIO OF THE TWO         K+85 1   31
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           DETECTOR SENSITIVITIES FOR GAMMA-RAY ENERGIES BELOW      K+85 1   32
           3.56 MEV WERE TAKEN INTO CONSIDERATION IN THE DATA       K+85 1   33
           ANALYSIS.                                                K+85 1   34
DETECTOR   (GELI) 25-CM**3 UJV (CZECHOSLOVAKIA) GE(LI) DETECTOR.    K+85 1   35
MONITOR    (CI) CURRENT INTEGRATOR.                                 K+85 1   36
CORRECTION YIELD DATA WERE CORRECTED FOR DETECTION SYSTEM DEAD      K+85 1   37
           TIME AND FOR TARGET STOICHIOMETRY AND STOPPING POWER.    K+85 1   38
ERR-ANALYS NO ERRORS ARE GIVEN.                                     K+85 1   39
ENDBIB              37                                              K+85 1   40
ENDSUBENT            1                                              K+85 199999
SUBENT          K+85  2          0                                  K+85 2    1
BIB                  2          15                                  K+85 2    2
REACTIONS  A: 31P(P,P1-GAMMA)31P                                    K+85 2    3
           B: 31P(P,ALPHA1-GAMMA)28SI                               K+85 2    4
           C: 31P(P,GAMMA1)32S + 31P(P,P2-GAMMA)31P                 K+85 2    5
COMMENTS   THICK-TARGET GAMMA-RAY YIELDS FOR TRANSITIONS FROM       K+85 2    7
           PROTON-INDUCED REACTIONS ON PHOSPHORUS ARE GIVEN.        K+85 2    8
           DATA OBTAINED FROM TABLE 1 OF THE ORIGINAL PAPER.        K+85 2    9
           CODE = REACTION IDENTIFICATION (A, B, OR C ABOVE).       K+85 2   10
           NOTE: CODE "C" CORRESPONDS TO TWO REACTIONS WITH         K+85 2   11
           UNRESOLVED GAMMA RAYS OF 2230 AND 2234 KEV LABELED       K+85 2   12
           BY 2232. EP = INCIDENT PROTON ENERGY. EG = ENERGY        K+85 2   13
           OF THE OBSERVED GAMMA-RAY TRANSITION. YIELD =            K+85 2   14
           THE NORMALIZED GAMMA-RAY YIELD. N/MICROC/SR = FULL-      K+85 2   15
           ENERGY-PEAK GAMMA-RAY COUNTS PER MICROCOULOMB PER        K+85 2   16
           STERADIAN. SEE TEXT FOR FURTHER DETAILS ON THE           K+85 2   17
           PROTON-INDUCED GAMMA-RAY EMISSION (PIGE) METHOD.         K+85 2   18
ENDBIB              15                                              K+85 2   19
DATA                 4          15                                  K+85 2   20
CODE       EG         EP         YIELD                              K+85 2   21
NO-DIM     KEV        MEV        N/MICROC/SR                        K+85 2   22
 A          1266.      1.7        720.                              K+85 2   23
 A          1266.      2.4        38000.                            K+85 2   24
 A          1266.      3.1        1.6000E+06                        K+85 2   25
 A          1266.      3.8        5.2000E+06                        K+85 2   26
 A          1266.      4.2        2.3000E+07                        K+85 2   27
 B          1779.      2.4        2000.                             K+85 2   28
 B          1779.      3.1        2.1000E+05                        K+85 2   29
 B          1779.      3.8        6.5000E+05                        K+85 2   30
 B          1779.      4.2        1.6000E+06                        K+85 2   31
 C          2232.      1.0        130.                              K+85 2   32
 C          2232.      1.7        1700.                             K+85 2   33
 C          2232.      2.4        3500.                             K+85 2   34
 C          2232.      3.1        12000.                            K+85 2   35
 C          2232.      3.8        4.0000E+05                        K+85 2   36
 C          2232.      4.2        9.5000E+05                        K+85 2   37
ENDDATA             17                                              K+85 2   38
ENDSUBENT            2                                              K+85 299999
ENDENTRY             2                                              K+859999999
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ENTRY            K+98          0                                   K+98 0    1
SUBENT        K+98  1          0                                   K+98 1    1
BIB                12         62                                   K+98 1    2
INSTITUTES (SFHLS)                                                 K+98 1    3
           (USALSU)                                                K+98 1    4
           (USAORL)                                                K+98 1    5
           (HUNDEB)                                                K+98 1    6
REFERENCE  (J,PR/C,58,2,699,1998)                                  K+98 1    7
AUTHORS    (A.KANGASMAKI,P.TIKKANEN,J.KEINONEN,W.E.ORMAND,         K+98 1    8
           S.RAMAN,ZS.FULOP,A.Z.KISS,E.SOMORJAI)                   K+98 1    9
TITLE      LIFETIMES OF 32S LEVELS                                 K+98 1   10
FACILITIES 100-KV ISOTOPE SEPARATOR, ACCELERATOR LABORATORY,       K+98 1   11
           UNIVERSITY OF HELSINKI, HELSINKI, FINLAND.              K+98 1   12
           (VDG) 5-MV TANDEM ACCELERATOR EGP-10-II,                K+98 1   13
           UNIVERSITY OF HELSINKI, HELSINKI, FINLAND.              K+98 1   14
           (VDG) 5-MV VAN DE GRAAFF ACCELERATOR, INSTITUTE         K+98 1   15
           OF NUCLEAR RESEARCH, DEBRECEN, HUNGARY.                 K+98 1   16
INC-PART   (P) PROTONS.                                            K+98 1   17
           (31P) PHOSPHORUS.                                       K+98 1   18
           (6LI) LITHIUM-6.                                        K+98 1   19
TARGETS    DEUTERIUM TARGETS USED FOR THE 2H(31P,N-GAMMA)32S       K+98 1   20
           MEASUREMENTS WERE PREPARED BY IMPLANTING 2H INTO        K+98 1   21
           THICK GOLD (HIGH STOPPING POWER) AND SILICON SHEETS     K+98 1   22
           (LOW STOPPING POWER). PRELIMINARY TEST MEASUREMENTS     K+98 1   23
           FOR THE 28SI(6LI,P-N-GAMMA)32S REACTION WERE MADE       K+98 1   24
           USING 0.4-MM-THICK SINGLE CRYSTAL SILICON SHEETS        K+98 1   25
           AS TARGETS. A 28SI TARGET WITH HIGH STOPPING POWER      K+98 1   26
           WAS PREPARED BY IMPLANTING 28SI INTO 0.4-MM-THICK       K+98 1   27
           TANTALUM SHEETS. A 31P TARGET WITH HIGH STOPPING        K+98 1   28
           POWER WAS PREPARED BY IMPLANTING 31P IN GOLD AT 60      K+98 1   29
           KEV. THE ION IMPLANTATIONS WERE ALL DONE USING THE      K+98 1   30
           100-KV ISOTOPE SEPARATOR AT HELSINKI. THE TARGET        K+98 1   31
           STABILITY IN EACH CASE WAS MONITORED BY OBSERVING       K+98 1   32
           THE GAMMA-RAY YIELDS. THE TARGETS WERE FOUND TO         K+98 1   33
           BE QUITE STABLE EXCEPT FOR THE DEUTERIUM TARGETS        K+98 1   34
           WHICH WERE FOUND INITIALLY TO LOSE SOME MATERIAL        K+98 1   35
           WHEN BOMBARDED WITH 31P BEAMS.                          K+98 1   36
METHOD     LEVELS IN 32S EXCITED IN THREE NUCLEAR REACTIONS:       K+98 1   37
           2H(31P,N-GAMMA)32S, 28SI(6LI,P-N-GAMMA)32S, AND         K+98 1   38
           31P(P,GAMMA)32S. LOW STOPPING POWER TARGETS WERE        K+98 1   39
           USED TO MEASURE THE INITIAL RECOIL VELOCITY             K+98 1   40
           DISTRIBUTIONS. HIGH STOPPING POWER TARGETS WERE         K+98 1   41
           USED FOR MEASURING SHORT LIFETIMES. IT WAS ASSUMED      K+98 1   42
           THAT THE IMPLANTED LAYERS HAD NO SIGNIFICANT EFFECT     K+98 1   43
           ON THE SLOWING DOWN OF 32S RECOILS IN THE VARIOUS       K+98 1   44
           SUBSTRATE MATERIALS (GOLD, SILICON, AND TANTALUM).      K+98 1   45
           THE TARGETS WERE SET PERPENDICULAR TO THE INCIDENT      K+98 1   46
           BEAMS. THE CARBON BUILDUP ON THE TARGETS WAS KEPT       K+98 1   47
           TO A MINIMUM BY GOOD VACUUM SYSTEMS AND ALLOWING        K+98 1   48
           THE TARGETS TO STAY RELATIVELY HOT FROM THE             K+98 1   49
           INCIDENT ION BEAMS. OTHER DETAILS PERTAINING TO         K+98 1   50
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           VARIOUS ASPECTS OF THE EXPERIMENT ARE AVAILABLE         K+98 1   51
           FROM THE ORIGINAL PAPER.                                K+98 1   52
DETECTORS  (HPGE) ORTEC HIGH PURITY GERMANIUM DETECTOR WITH        K+98 1   53
           AN EFFICIENCY OF 25 PERCENT. THE RESOLUTION WAS         K+98 1   54
           2.20 KEV AT EG = 1.46 MEV AND 3.01 KEV AT EG =          K+98 1   55
           2.61 MEV.                                               K+98 1   56
           (BGO) BISMUTH GERMANATE (BGO) DETECTOR USED FOR         K+98 1   57
           COMPTON SUPPRESSION.                                    K+98 1   58
MONITOR    (CI) CURRENT INTEGRATOR.                                K+98 1   59
CORRECTION DATA WERE CORRECTED FOR STOPPING POWER AND DELAYED      K+98 1   60
           FEEDING OF STATES.                                      K+98 1   61
ERR-ANALYS ERRORS ARE GIVEN IN THE PAPER. THE MAIN SOURCES OF      K+98 1   62
           ERROR WERE THE STOPPING POWERS OF IONS INCIDENT         K+98 1   63
           ON THE TARGETS.                                         K+98 1   64
ENDBIB              62                                             K+98 1   65
ENDSUBENT            1                                             K+98 199999
SUBENT        K+98  2          0                                   K+98 2    1
BIB                  2         15                                  K+98 2    2
REACTIONS  A: 2H(31P,N-GAMMA)32S                                   K+98 2    3
           B: 28SI(6LI,P-N-GAMMA)32S                               K+98 2    4
           C: 31P(P,GAMMA)32S                                      K+98 2    5
COMMENTS   LIFETIMES OF LEVELS IN 32S ARE GIVEN. EXPERIMENT        K+98 2    6
           EMPLOYED THREE DIFFERENT REACTIONS. DATA OBTAINED       K+98 2    7
           FROM TABLE III OF THE ORIGINAL PAPER. EX = ENERGY       K+98 2    8
           OF EXCITED LEVEL IN 32S. REAC = REACTION USED TO        K+98 2    9
           EXCITE THIS STATE (A, B, OR C AS DEFINED ABOVE).        K+98 2   10
           EINC = INCIDENT PARTICLE ENERGY (31P, 6LI, OR P).       K+98 2   11
           TAU = MEASURED MEAN LIFETIME. TAU-ERR = ERROR IN        K+98 2   12
           TAU. FSEC = 10**(-15) SECOND. BLANK SPACE INDICATES     K+98 2   13
           THAT THERE IS NO ENTRY IN THE TABLE OR EXACT VALUE      K+98 2   14
           IS UNCERTAIN. IN PARTICULAR, MEASUREMENTS MADE WITH     K+98 2   15
           REACTION "B" ARE STATED TO INVOLVE EITHER 8 OR 12       K+98 2   16
           MEV BUT IT IS NOT CLEAR IN THE TABLE WHICH WAS USED.    K+98 2   17
ENDBIB              15                                             K+98 2   18
DATA                 5         37                                  K+98 2   19
EX         REAC       EINC       TAU        TAU-ERR                K+98 2   20
KEV        NO-DIM     MEV        FSEC       FSEC                   K+98 2   21
 2230.      C           1.557      252.       40.                  K+98 2   22
 3778.      B                      1280.      130.                 K+98 2   23
 3778.      C           1.557      1300.      400.                 K+98 2   24
 4282.      A           24.        60.        9.                   K+98 2   25
 4282.      A           29.        60.        10.                  K+98 2   26
 4282.      B                      57.        7.                   K+98 2   27
 4282.      C           1.557      57.7       2.0                  K+98 2   28
 4695.      C           1.557      400.       40.                  K+98 2   29
 5006.      C           1.557      380.       70.                  K+98 2   30
 5413.      B                      241.       35.                  K+98 2   31
 5413.      C           1.557      237.       40.                  K+98 2   32
 5549.      A           24.        84.        15.                  K+98 2   33
 5549.      C           1.557      95.        12.                  K+98 2   34
 5798.      A           24.        6.9        3.0                  K+98 2   35
 5798.      A           29.        11.8       3.0                  K+98 2   36
 6224.      A           24.        99.        20.                  K+98 2   37
 6224.      A           29.        112.       13.                  K+98 2   38
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 6411.      B                    35.        5.                        K+98 2   39
 6621.      C          1.583     800.       120.                      K+98 2   40
 6666.      C          1.557     88.        8.                        K+98 2   41
 6762.      C          1.583     375.       50.                       K+98 2   42
 7002.      A          24.       2.3        1.2                       K+98 2   43
 7002.      A          29.       2.8        1.2                       K+98 2   44
 7002.      C          1.057     2.0        0.7                       K+98 2   45
 7115.      A          24.       7.         4.                        K+98 2   46
 7115.      A          29.       3.6        1.8                       K+98 2   47
 7115.      C          1.057     2.3        0.5                       K+98 2   48
 7190.      A          24.       11.        4.                        K+98 2   49
 7190.      A          29.       12.        3.                        K+98 2   50
 7434.      A          24.       10.0       1.8                       K+98 2   51
 7434.      A          29.       11.7       1.4                       K+98 2   52
 7485.      A          24.       6.8        2.0                       K+98 2   53
 7485.      A          29.       7.4        1.7                       K+98 2   54
 7485.      C          1.557     6.9        1.7                       K+98 2   55
 7536.      A          24.       6.3        1.1                       K+98 2   56
 7536.      A          29.       3.3        1.0                       K+98 2   57
 7950.      C          1.583     210.       50.                       K+98 2   58
ENDDATA             39                                                K+98 2   59
ENDSUBENT            2                                                K+98 299999
SUBENT         K+98  3          0                                     K+98 3    1
BIB                  2         15                                     K+98 3    2
REACTION   31P(P,GAMMA)32S                                            K+98 3    3
COMMENTS   GAMMA-RAY DECAY OF RESONANCES IN THE REACTION              K+98 3    4
           31P(P,GAMMA)32S. DATA OBTAINED FROM TABLE IV IN            K+98 3    5
           THE ORIGINAL PAPER. EP = RESONANCE PROTON ENERGY.          K+98 3    6
           EX = EXCITATION ENERGY OF RESONANCE IN 32S. EI =           K+98 3    7
           ENERGY OF INITIAL STATE IN 32S OF GAMMA-RAY                K+98 3    8
           TRANSITION. EF = ENERGY OF FINAL STATE. J-PI(I) =          K+98 3    9
           SPIN/PARITY OF INITIAL STATE. J-PI(F) = SPIN/PARITY        K+98 3   10
           OF FINAL STATE. A NEGATIVE VALUE OF SPIN/PARITY            K+98 3   11
           INDICATES NEGATIVE PARITY. OTHERWISE PARITY IS             K+98 3   12
           POSITIVE. TI = ISOBARIC SPIN OF INITIAL STATE.             K+98 3   13
           TF = ISOBARIC SPIN OF FINAL STATE. B = BRANCHING           K+98 3   14
           FACTOR. B-ERR = ERROR IN BRANCHING FACTOR. A BLANK         K+98 3   15
           SPACE INDICATES THAT VALUE IS NOT AVAILABLE IN             K+98 3   16
           TABLE IV OR THAT THERE IS AMBIGUITY. PCT = PERCENT.        K+98 3   17
ENDBIB              15                                                K+98 3   18
DATA                10         31                                     K+98 3   19
EP         EX         EI         J-PI(I)    TI         EF             K+98 3   20
J-PI(F)    TF         B          B-ERR                                K+98 3   21
KEV        MEV        KEV        NO-DIM     NO-DIM     KEV            K+98 3   22
NO-DIM     NO-DIM     PCT        PCT                                  K+98 3   23
 1557.      10.372     10372.     2.         1.         0.            K+98 3   24
 0.                    0.30       0.08                                K+98 3   25
 1557.      10.372     10372.     2.         1.         2230.         K+98 3   26
 2.                    7.6        0.8                                 K+98 3   27
 1557.      10.372     10372.     2.         1.         4282.         K+98 3   28
 2.                    37.4       2.6                                 K+98 3   29
 1557.      10.372     10372.     2.         1.         4695.         K+98 3   30
 1.                    10.7       1.0                                 K+98 3   31
 1557.      10.372     10372.     2.         1.         5006.         K+98 3   32
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-3.                    2.7        0.3                                  K+98 3   33
 1557.      10.372     10372.     2.        1.        5413.            K+98 3   34
 3.                    12.6       1.3                                  K+98 3   35
 1557.      10.372     10372.     2.        1.        5549.            K+98 3   36
 2.                    3.3        0.4                                  K+98 3   37
 1557.      10.372     10372.     2.        1.        6224.            K+98 3   38
-2.                    2.5        0.3                                  K+98 3   39
 1557.      10.372     10372.     2.        1.        6666.            K+98 3   40
 2.                    19.8       1.8                                  K+98 3   41
 1557.      10.372     10372.     2.        1.        7002.            K+98 3   42
 1.         1.         0.20       0.07                                 K+98 3   43
 1557.      10.372     10372.     2.        1.        7190.            K+98 3   44
 1.                    1.5        0.4                                  K+98 3   45
 1557.      10.372     10372.     2.        1.        7350.            K+98 3   46
 3.                    0.3                                             K+98 3   47
 1557.      10.372     10372.     2.        1.        7485.            K+98 3   48
 2.                    1.40       0.18                                 K+98 3   49
 1583.      10.398     10398.    -4.        1.        2230.            K+98 3   50
 2.                    0.20       0.03                                 K+98 3   51
 1583.      10.398     10398.    -4.        1.        4282.            K+98 3   52
 2.                    0.30       0.19                                 K+98 3   53
 1583.      10.398     10398.    -4.        1.        4459.            K+98 3   54
 4.                    1.00       0.14                                 K+98 3   55
 1583.      10.398     10398.    -4.        1.        5006.            K+98 3   56
-3.                    4.9        0.6                                  K+98 3   57
 1583.      10.398     10398.    -4.        1.        5413.            K+98 3   58
 3.                    0.10       0.03                                 K+98 3   59
 1583.      10.398     10398.    -4.        1.        5798.            K+98 3   60
-1.                    0.30       0.06                                 K+98 3   61
 1583.      10.398     10398.    -4.        1.        6224.            K+98 3   62
-2.                    0.4                                             K+98 3   63
 1583.      10.398     10398.    -4.        1.        6411.            K+98 3   64
 4.                    0.4                                             K+98 3   65
 1583.      10.398     10398.    -4.        1.        6621.            K+98 3   66
-4.                    82.0       1.6                                  K+98 3   67
 1583.      10.398     10398.    -4.        1.        6762.            K+98 3   68
-5.                    2.7        0.4                                  K+98 3   69
 1583.      10.398     10398.    -4.        1.        6852.            K+98 3   70
 4.                    1.60       0.22                                 K+98 3   71
 1583.      10.398     10398.    -4.        1.        7002.            K+98 3   72
 1.         1.         0.30       0.07                                 K+98 3   73
 1583.      10.398     10398.    -4.        1.        7350.            K+98 3   74
 3.                    0.70       0.11                                 K+98 3   75
 1583.      10.398     10398.    -4.        1.        7567.            K+98 3   76
 5.                    0.30       0.06                                 K+98 3   77
 1583.      10.398     10398.    -4.        1.        7702.            K+98 3   78
-3.                    0.70       0.09                                 K+98 3   79
 1583.      10.398     10398.    -4.        1.        7950.            K+98 3   80
-4.                    4.7        0.5                                  K+98 3   81
 1583.      10.398     10398.    -4.        1.        7975.            K+98 3   82
-3.                    0.4                                             K+98 3   83
 1583.      10.398     10398.    -4.        1.        8126.            K+98 3   84
 1.         1.         0.20       0.04                                 K+98 3   85
ENDDATA            66                                                  K+98 3   86
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ENDSUBENT           3                                           K+98 399999
SUBENT        K+98  4         0                                 K+98 4    1
BIB                 2        16                                 K+98 4    2
REACTIONS  NOT SPECIFIED.                                       K+98 4    3
COMMENTS   EXPERIMENTAL PROBABILITIES FOR GAMMA-RAY TRANSITIONS K+98 4    4
           BETWEEN POSITIVE PARITY STATES IN 32S ARE GIVEN.     K+98 4    5
           THESE DATA WERE OBTAINED FROM TABLE VIII OF THE      K+98 4    6
           ORIGINAL PAPER. EI = EXCITATION ENERGY OF THE        K+98 4    7
           INITIAL STATE IN 32S. EF = ENERGY OF FINAL STATE.    K+98 4    8
           J-PI(I) = SPIN/PARITY OF INITIAL STATE. J-PI(F) =    K+98 4    9
           SPIN/PARITY OF FINAL STATE. ALL PARITIES ARE         K+98 4   10
           POSITIVE IN THIS SET. TRANSTYP = TRANSITION TYPE     K+98 4   11
           (M1 = MAGNETIC DIPOLE, E2 = ELECTRIC QUADRUPOLE).    K+98 4   12
           TP = TRANSITION PROBABILITY. TP-ERR = ERROR IN TP.   K+98 4   13
           W.U. = WEISSKOPF UNITS. IN THOSE CASES WHERE ERRORS  K+98 4   14
           ARE ASYMMETRIC, THAT VALUE CORRESPONDING TO THE      K+98 4   15
           LARGEST ERROR COMPONENT IS GIVEN. SPECIFIC VALUES OF K+98 4   16
           ALL ASYMMETRIC ERROR COMPONENTS CAN BE FOUND IN THE  K+98 4   17
           ORIGINAL PAPER. A BLANK SPACE IMPLIES NO VALUE GIVEN. K+98 4  18
ENDBIB             16                                           K+98 4   19
DATA                7         34                                K+98 4   20
EI         J-PI(I)    EF         J-PI(F)    TRANSTYP   TP       K+98 4   21
TP-ERR                                                          K+98 4   22
KEV        NO-DIM     KEV        NO-DIM     NO-DIM     W.U.     K+98 4   23
W.U.                                                            K+98 4   24
 2230.      2.         0.         0.         E2         10.1    K+98 4   25
 0.5                                                            K+98 4   26
 3778.      0.         2230.      2.         E2         11.9    K+98 4   27
 1.2                                                            K+98 4   28
 4282.      2.         0.         0.         E2         1.38    K+98 4   29
 0.05                                                           K+98 4   30
 4282.      2.         2230.      2.         M1         3.5000E-05 K+98 4 31
 5.4000E-05                                                     K+98 4   32
 4282.      2.         2230.      2.         E2         8.9     K+98 4   33
 0.5                                                            K+98 4   34
 4459.      4.         2230.      2.         E2         11.9    K+98 4   35
 1.7                                                            K+98 4   36
 4695.      1.         0.         0.         M1         0.00031 K+98 4   37
 0.00003                                                        K+98 4   38
 4695.      1.         2230.      2.         M1         0.0025  K+98 4   39
 0.0005                                                         K+98 4   40
 4695.      1.         2230.      2.         E2         0.44    K+98 4   41
 0.29                                                           K+98 4   42
 5413.      3.         2230.      2.         M1         7.0000E-05 K+98 4 43
 4.0000E-05                                                     K+98 4   44
 5413.      3.         2230.      2.         E2         1.7     K+98 4   45
 0.3                                                            K+98 4   46
 5549.      2.         0.         0.         E2         0.113   K+98 4   47
 0.015                                                          K+98 4   48
 5549.      2.         2230.      2.         M1         0.0044  K+98 4   49
 0.0009                                                         K+98 4   50
 5549.      2.         2230.      2.         E2         0.5     K+98 4   51
 0.3                                                            K+98 4   52
 6411.      4.         2230.      2.         E2         3.0     K+98 4   53
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 0.4                                                                K+98 4   54
 6666.      2.         3778.      0.         E2         3.7         K+98 4   55
 0.5                                                                K+98 4   56
 6852.      4.         4282.      2.         E2         9.2         K+98 4   57
 2.6                                                                K+98 4   58
 6852.      4.         4459.      4.         M1         0.0020      K+98 4   59
 0.0012                                                             K+98 4   60
 6852.      4.         4459.      4.         E2         1.6         K+98 4   61
 0.9                                                                K+98 4   62
 7115.      2.         0.         0.         E2         0.09        K+98 4   63
 0.04                                                               K+98 4   64
 7115.      2.         2230.      2.         M1         0.081       K+98 4   65
 0.016                                                              K+98 4   66
 7115.      2.         2230.      2.         E2         2.1         K+98 4   67
 0.6                                                                K+98 4   68
 7190.      1.         0.         0.         M1         0.003       K+98 4   69
 0.001                                                              K+98 4   70
 7485.      2.         0.         0.         E2         0.81        K+98 4   71
 0.19                                                               K+98 4   72
 7536.      0.         4695.      1.         M1         0.300       K+98 4   73
 0.100                                                              K+98 4   74
 7567.      5.         4459.      4.         M1         5.0000E-05  K+98 4   75
                                                                    K+98 4   76
 7567.      5.         4459.      4.         E2         2.2         K+98 4   77
 0.6                                                                K+98 4   78
 7567.      5.         5413.      3.         E2         4.7         K+98 4   79
 1.8                                                                K+98 4   80
 8126.      1.         0.         0.         M1         0.220       K+98 4   81
 0.040                                                              K+98 4   82
 9065.      4.         4282.      2.         E2         0.074       K+98 4   83
 0.009                                                              K+98 4   84
 9065.      4.         4459.      4.         M1         8.0000E-06  K+98 4   85
 4.6000E-05                                                         K+98 4   86
 9065.      4.         4459.      4.         E2         0.22        K+98 4   87
 0.03                                                               K+98 4   88
 9065.      4.         5413.      3.         M1         0.00024     K+98 4   89
 0.00007                                                            K+98 4   90
 9065.      4.         5413.      3.         E2         1.29        K+98 4   91
 0.15                                                               K+98 4   92
ENDDATA              72                                             K+98 4   93
ENDSUBENT             4                                             K+98 499999
ENDENTRY              4                                             K+989999999
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L+72

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ENTRY            L+72          0                                    L+72 0     1
SUBENT        L+72  1          0                                    L+72 1     1
BIB                  13         45                                  L+72 1     2
INSTITUTE  (FRGRA)                                                  L+72 1     3
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REFERENCE  (J,JPR,33,5-6,451,1972)                               L+72 1    4
AUTHORS    (F.LECCIA,M.M.ALEONARD,D.CASTERA,PH.HUBERT,P.MENRATH) L+72 1    5
TITLE      ETUDE DES RESONANCES DE LA REACTION 31P(P,GAMMA)32S   L+72 1    6
           DANS LE DOMAINE D'ENERGIE EP = 1100 - 1600 KEV        L+72 1    7
FACILITY   (VDG) 4-MV VAN DE GRAAFF ACCELERATOR, CENTRE D'ETUDES L+72 1    8
           NUCLEAIRES DE BORDEAUX-GRADIGNAN, GRADIGNAN, FRANCE.  L+72 1    9
INC-PART   (P) PROTONS.                                          L+72 1   10
TARGETS    ZINC PHOSPHIDE EVAPORATED ON 0.2-MM THICK GOLD        L+72 1   11
           SUPPORT. TARGET THICKNESSES WERE 10 AND 50 MICROGRAM  L+72 1   12
           PER CM**2. THESE TARGETS WERE WATER COOLED IN ORDER   L+72 1   13
           TO DISSIPATE THE HEAT FROM THE BEAM AT THE ELEVATED   L+72 1   14
           CURRENTS USED IN THIS EXPERIMENT.                     L+72 1   15
METHOD     PROTON BEAMS WERE OBTAINED FROM THE 4-MV VAN DE       L+72 1   16
           GRAAFF ACCELERATOR AT CENTRE D'ETUDES DE BORDEAUX-    L+72 1   17
           GRADIGNAN. THE ACCELERATOR ENERGY WAS CALIBRATED      L+72 1   18
           USING THE EP = 991.90-KEV RESONANCE IN 27AL(P,GAMMA)  L+72 1   19
           AND EP = 1747.6-KEV RESONANCE IN 13C(P,GAMMA). PROTON L+72 1   20
           BEAM CURRENTS UP TO 60 MICROAMPS WERE EMPLOYED. THE   L+72 1   21
           BEAM ENERGY UNCERTAINTY WAS OF THE ORDER OF 1 KEV.    L+72 1   22
           THE GAMMA-RAY EXCITATION FUNCTION WAS MEASURED USING  L+72 1   23
           A NAI SCINTILLATION DETECTOR PLACED AT 55 DEGREES AND L+72 1   24
           4 CM DISTANCE FROM THE TARGET. A BIAS PLACED ON THIS  L+72 1   25
           DETECTOR ENABLED THE MEASUREMENT OF GAMMA-RAYS WITH   L+72 1   26
           ENERGIES ABOVE 2.5 MEV. GAMMA-RAYS DE-EXCITING THE    L+72 1   27
           RESONANCES WERE MEASURED USING A GE(LI) DETECTOR.     L+72 1   28
           THE RESOLUTION OF THIS DETECTOR WAS 3.5 KEV FOR       L+72 1   29
           1332-KEV GAMMA RAYS FROM 60CO DECAY. THE GE(LI)       L+72 1   30
           DETECTOR WAS PLACED AT 90 DEGREES RELATIVE TO THE     L+72 1   31
           INCIDENT PROTON BEAM IN ORDER TO ELIMINATE DOPPLER    L+72 1   32
           EFFECTS. DETECTOR CALIBRATED USING KNOWN GAMMA RAYS   L+72 1   33
           FROM SOURCES AND THE 27AL(P,GAMMA) REACTION. THE      L+72 1   34
           FULL-ENERGY-PEAK YIELDS FOR THE GAMMA RAYS THAT       L+72 1   35
           DE-EXCITE THE RESONANCES WERE USED TO DETERMINE       L+72 1   36
           RESONANCE STRENGTHS AND DECAY BRANCHING FACTORS.      L+72 1   37
DETECTORS  (SCINT) NAI SCINTILLATION DETECTOR 12.7-CM DIA. X     L+72 1   38
           12.7-CM LONG.                                         L+72 1   39
           (GELI) GE(LI) DETECTOR OF 40-CM**3 VOLUME.            L+72 1   40
MONITOR    (CI) CURRENT INTEGRATOR.                              L+72 1   41
CORRECTION DATA WERE CORRECTED FOR GE(LI) DETECTOR EFFICIENCY    L+72 1   42
           AND GAMMA-RAY BRANCHING FACTORS.                      L+72 1   43
ERR-ANALYS ERRORS ARE GIVEN FOR THE RESONANCE PROTON ENERGIES    L+72 1   44
           AND LEVEL EXCITATIONS ONLY. VERY FEW DETAILS ON THE   L+72 1   45
           ERROR ANALYSIS ARE FOUND IN THE ORIGINAL PAPER.       L+72 1   46
COMMENTS   ORIGINAL PAPER IS WRITTEN IN FRENCH.                  L+72 1   47
ENDBIB              45                                           L+72 1   48
ENDSUBENT            1                                           L+72 199999
SUBENT        L+72  2          0                                 L+72 2    1
BIB                  2         10                                L+72 2    2
REACTION   31P(P,GAMMA)32S                                       L+72 2    3
COMMENTS   RESONANCE STRENGTHS FOR THE 31P(P,GAMMA)32S REACTION  L+72 2    4
           ARE GIVEN. DATA ARE OBTAINED FROM TABLE I OF THE      L+72 2    5
           ORIGINAL PAPER. EP = RESONANCE PROTON ENERGY. EP-ERR  L+72 2    6
           = ERROR IN EP. EX = EXCITATION ENERGY OF LEVEL IN     L+72 2    7
           32S. EX-ERR = ERROR IN EX. S = RESONANCE STRENGTH =   L+72 2    8
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          (2J+1)*GAMMA(P)*GAMMA(GAMMA)/GAMMA(TOTAL), WHERE J =       L+72 2    9
          RESONANCE SPIN, GAMMA(P) = PROTON WIDTH, GAMMA(GAMMA)      L+72 2   10
          = GAMMA-RAY WIDTH, AND GAMMA(TOTAL) = TOTAL WIDTH OF       L+72 2   11
          THE RESONANCE.                                             L+72 2   12
ENDBIB             10                                                L+72 2   13
DATA                5          11                                    L+72 2   14
EP         EP-ERR     EX         EX-ERR     S                        L+72 2   15
KEV        KEV        KEV        KEV        EV                       L+72 2   16
 1117.      1.         9947.      1.         1.7                     L+72 2   17
 1146.      1.         9975.      1.         5.4                     L+72 2   18
 1151.      1.         9980.      1.         1.3                     L+72 2   19
 1248.      1.         10074.     1.         9.2                     L+72 2   20
 1398.      1.         10219.     1.         1.8                     L+72 2   21
 1401.      1.         10222.     1.         5.8                     L+72 2   22
 1409.      1.         10230.     1.         1.5                     L+72 2   23
 1437.      1.         10257.     1.         20.0                    L+72 2   24
 1471.      1.         10290.     1.         2.4                     L+72 2   25
 1555.      1.         10371.     1.         11.0                    L+72 2   26
 1583.      1.         10398.     1.         15.2                    L+72 2   27
ENDDATA            13                                                L+72 2   28
ENDSUBENT           2                                                L+72 299999
SUBENT        L+72  3           0                                    L+72 3    1
BIB                 2          14                                    L+72 3    2
REACTION   31P(P,GAMMA)32S                                           L+72 3    3
COMMENTS   BRANCHING FACTORS FOR THE GAMMA-RAY DECAY OF              L+72 3    4
           RESONANCES IN THE 31P(P,GAMMA)32S REACTION ARE            L+72 3    5
           GIVEN. THESE DATA WERE OBTAINED FROM TABLE II OF          L+72 3    6
           THE ORIGINAL PAPER. EP = RESONANCE PROTON ENERGY.         L+72 3    7
           EX = EXCITATION ENERGY IN 32S. EI = INITIAL ENERGY        L+72 3    8
           OF GAMMA-RAY TRANSITION. EF = FINAL ENERGY OF GAMMA-      L+72 3    9
           RAY TRANSITION. J-PI(I) = SPIN/PARITY OF INITIAL          L+72 3   10
           STATE. J-PI(F) = SPIN/PARITY OF FINAL STATE. A            L+72 3   11
           NEGATIVE SIGN SIGNIFIES NEGATIVE PARITY. OTHERWISE        L+72 3   12
           THE PARITY IS POSITIVE. B = BRANCHING FACTOR. A           L+72 3   13
           BLANK SPACE INDICATES THAT THE QUANTITY IS NOT            L+72 3   14
           GIVEN IN THE ORIGINAL PAPER OR ITS VALUE THERE IS         L+72 3   15
           AMBIGUOUS. PCT = PERCENT                                  L+72 3   16
ENDBIB             14                                                L+72 3   17
DATA                7          78                                    L+72 3   18
EP         EX         EI         J-PI(I)    EF         J-PI(F)       L+72 3   19
B                                                                    L+72 3   20
KEV        KEV        KEV        NO-DIM     MEV        NO-DIM        L+72 3   21
PCT                                                                  L+72 3   22
 1117.      9947.      9947.                 0.         0.           L+72 3   23
 76.                                                                 L+72 3   24
 1117.      9947.      9947.                 2.23       2.           L+72 3   25
 10.                                                                 L+72 3   26
 1117.      9947.      9947.                 3.78       0.           L+72 3   27
 2.                                                                  L+72 3   28
 1117.      9947.      9947.                 4.28       2.           L+72 3   29
 1.                                                                  L+72 3   30
 1117.      9947.      9947.                 4.69       1.           L+72 3   31
 2.                                                                  L+72 3   32
 1117.      9947.      9947.                 7.00       1.           L+72 3   33
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1.						L+72 3	34
1117.	9947.	9947.		7.11	2.	L+72 3	35
2.						L+72 3	36
1146.	9975.	9975.		2.23	2.	L+72 3	37
30.						L+72 3	38
1146.	9975.	9975.		4.46	4.	L+72 3	39
6.						L+72 3	40
1146.	9975.	9975.		5.01	-3.	L+72 3	41
3.						L+72 3	42
1146.	9975.	9975.		5.41	3.	L+72 3	43
6.						L+72 3	44
1146.	9975.	9975.		5.55	2.	L+72 3	45
31.						L+72 3	46
1146.	9975.	9975.		6.22	-2.	L+72 3	47
2.						L+72 3	48
1146.	9975.	9975.		6.62	-4.	L+72 3	49
3.						L+72 3	50
1146.	9975.	9975.		6.85		L+72 3	51
9.						L+72 3	52
1146.	9975.	9975.		7.11	2.	L+72 3	53
4.						L+72 3	54
1151.	9980.	9980.	2.	0.	0.	L+72 3	55
1.						L+72 3	56
1151.	9980.	9980.	2.	2.23	2.	L+72 3	57
60.						L+72 3	58
1151.	9980.	9980.	2.	4.28	2.	L+72 3	59
2.						L+72 3	60
1151.	9980.	9980.	2.	4.69	1.	L+72 3	61
23.						L+72 3	62
1151.	9980.	9980.	2.	5.01	-3.	L+72 3	63
2.						L+72 3	64
1151.	9980.	9980.	2.	5.55	2.	L+72 3	65
10.						L+72 3	66
1151.	9980.	9980.	2.	6.62	-4.	L+72 3	67
1.						L+72 3	68
1151.	9980.	9980.	2.	7.00	1.	L+72 3	69
2.						L+72 3	70
1248.	10074.	10074.	-2.	0.	0.	L+72 3	71
2.						L+72 3	72
1248.	10074.	10074.	-2.	2.23	2.	L+72 3	73
31.						L+72 3	74
1248.	10074.	10074.	-2.	4.28	2.	L+72 3	75
1.						L+72 3	76
1248.	10074.	10074.	-2.	4.69	1.	L+72 3	77
1.						L+72 3	78
1248.	10074.	10074.	-2.	5.01	-3.	L+72 3	79
12.						L+72 3	80
1248.	10074.	10074.	-2.	5.41	3.	L+72 3	81
4.						L+72 3	82
1248.	10074.	10074.	-2.	6.22	-2.	L+72 3	83
49.						L+72 3	84
1398.	10219.	10219.		0.	0.	L+72 3	85
2.						L+72 3	86
1398.	10219.	10219.		2.23	2.	L+72 3	87

11.						L+72 3	88
1398.	10219.	10219.		4.28	2.	L+72 3	89
7.						L+72 3	90
1398.	10219.	10219.		4.69	1.	L+72 3	91
25.						L+72 3	92
1398.	10219.	10219.		5.41	3.	L+72 3	93
3.						L+72 3	94
1398.	10219.	10219.		7.11	2.	L+72 3	95
52.						L+72 3	96
1401.	10222.	10222.	-3.	2.23	2.	L+72 3	97
11.						L+72 3	98
1401.	10222.	10222.	-3.	4.46	4.	L+72 3	99
22.						L+72 3	100
1401.	10222.	10222.	-3.	5.01	-3.	L+72 3	101
67.						L+72 3	102
1401.	10222.	10222.	-3.	5.55	2.	L+72 3	103
1.						L+72 3	104
1409.	10230.	10230.		0.	0.	L+72 3	105
4.						L+72 3	106
1409.	10230.	10230.		2.23	2.	L+72 3	107
9.						L+72 3	108
1409.	10230.	10230.		3.78	0.	L+72 3	109
6.						L+72 3	110
1409.	10230.	10230.		4.28	2.	L+72 3	111
11.						L+72 3	112
1409.	10230.	10230.		4.69	1.	L+72 3	113
6.						L+72 3	114
1409.	10230.	10230.		5.41	3.	L+72 3	115
3.						L+72 3	116
1409.	10230.	10230.		7.00	1.	L+72 3	117
50.						L+72 3	118
1409.	10230.	10230.		7.11	2.	L+72 3	119
5.						L+72 3	120
1437.	10257.	10257.	-4.	2.23	2.	L+72 3	121
1.						L+72 3	122
1437.	10257.	10257.	-4.	4.46	4.	L+72 3	123
10.						L+72 3	124
1437.	10257.	10257.	-4.	5.01	-3.	L+72 3	125
4.						L+72 3	126
1437.	10257.	10257.	-4.	6.41	-3.	L+72 3	127
1.						L+72 3	128
1437.	10257.	10257.	-4.	6.62	-4.	L+72 3	129
79.						L+72 3	130
1468.	10287.	10287.	-3.	0.	0.	L+72 3	131
7.						L+72 3	132
1468.	10287.	10287.	-3.	2.23	2.	L+72 3	133
14.						L+72 3	134
1468.	10287.	10287.	-3.	4.46	4.	L+72 3	135
11.						L+72 3	136
1468.	10287.	10287.	-3.	5.01	-3.	L+72 3	137
68.						L+72 3	138
1471.	10290.	10290.	2.	0.	0.	L+72 3	139
2.						L+72 3	140
1471.	10290.	10290.	2.	2.23	2.	L+72 3	141

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 33.                                                                   L+72 3  142
 1471.      10290.     10290.     2.         5.01      -3.             L+72 3  143
 24.                                                                   L+72 3  144
 1471.      10290.     10290.     2.         5.55       2.             L+72 3  145
 2.                                                                    L+72 3  146
 1471.      10290.     10290.     2.         6.22      -2.             L+72 3  147
 35.                                                                   L+72 3  148
 1471.      10290.     10290.     2.         6.66                      L+72 3  149
 4.                                                                    L+72 3  150
 1555.      10371.     10371.                0.         0.             L+72 3  151
 0.5                                                                   L+72 3  152
 1555.      10371.     10371.                2.23       2.             L+72 3  153
 12.                                                                   L+72 3  154
 1555.      10371.     10371.                4.28       2.             L+72 3  155
 35.                                                                   L+72 3  156
 1555.      10371.     10371.                4.46       4.             L+72 3  157
 1.                                                                    L+72 3  158
 1555.      10371.     10371.                4.69       1.             L+72 3  159
 11.                                                                   L+72 3  160
 1555.      10371.     10371.                5.01      -3.             L+72 3  161
 3.                                                                    L+72 3  162
 1555.      10371.     10371.                5.41       3.             L+72 3  163
 11.                                                                   L+72 3  164
 1555.      10371.     10371.                5.55       2.             L+72 3  165
 3.                                                                    L+72 3  166
 1555.      10371.     10371.                6.22      -2.             L+72 3  167
 3.                                                                    L+72 3  168
 1555.      10371.     10371.                6.66                      L+72 3  169
 18.                                                                   L+72 3  170
 1583.      10398.     10398.                2.23       2.             L+72 3  171
 0.5                                                                   L+72 3  172
 1583.      10398.     10398.                4.46       4.             L+72 3  173
 1.                                                                    L+72 3  174
 1583.      10398.     10398.                5.01      -3.             L+72 3  175
 6.                                                                    L+72 3  176
 1583.      10398.     10398.                6.62      -4.             L+72 3  177
 89.                                                                   L+72 3  178
ENDDATA           160                                                  L+72 3  179
ENDSUBENT           3                                                  L+72 399999
ENDENTRY            3                                                  L+729999999
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MTK69

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ENTRY            MTK69          0                                     MTK69 0    1
SUBENT        MTK69  1          0                                     MTK69 1    1
BIB                12          63                                     MTK69 1    2
INSTITUTES (UKOXF)                                                    MTK69 1    3
           (SLNIJS)                                                   MTK69 1    4
REFERENCE  (J,NP/A,138,253,1969)                                      MTK69 1    5
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AUTHORS    (W.M.MASON,N.W.TANNER,G.KERNEL)                      MTK69 1    6
TITLE      MECHANISM OF THE 31P(P,GAMMA)32S REACTION IN THE     MTK69 1    7
           GIANT DIPOLE RESONANCE REGION                        MTK69 1    8
FACILITY   (VDG) TANDEM VAN DE GRAAFF ACCELERATOR, OXFORD       MTK69 1    9
           UNIVERSITY, OXFORD, U.K. NO DETAILS GIVEN.           MTK69 1   10
INC-PART   (P) PROTONS.                                         MTK69 1   11
TARGETS    PHOSPHORUS EVAPORATED ONTO THIN CARBON BACKINGS OF   MTK69 1   12
           THICKNESS APPROXIMATELY EQUAL TO 20 MICROGRAMS/CM**2.  MTK69 1   13
           TARGET THICKNESS WAS DETERMINED BY PERFORMING AN     MTK69 1   14
           EXCITATION FUNCTION MEASUREMENT ON THE NARROW        MTK69 1   15
           RESONANCE AT EP = 4.665 MEV IN THE 31P(P,GAMMA-0)32S  MTK69 1   16
           REACTION. THE THICKNESSES RANGED FROM 10 - 25 KEV.   MTK69 1   17
METHOD     PROTON BEAMS IN THE ENERGY RANGE EP = 9.5 - 11.5     MTK69 1   18
           MEV WERE OBTAINED FROM THE OXFORD TANDEM VAN DE      MTK69 1   19
           GRAAFF ACCELERATOR. THE BEAM WAS FOCUSSED THROUGH A  MTK69 1   20
           3-MM DIAMETER URANIUM COLLIMATOR. IT PASSED THROUGH  MTK69 1   21
           THE TARGET FOIL AND ULTIMATELY WAS STOPPED ON A      MTK69 1   22
           URANIUM DISK FROM WHICH ALL THE RADIATION COUNTERS   MTK69 1   23
           USED IN THE EXPERIMENT WERE SHIELDED BY A CONCRETE   MTK69 1   24
           WALL. TYPICAL BEAM CURRENTS WERE 200 - 250 NANOAMPS  MTK69 1   25
           AND THE INTEGRATED PROTON CHARGE ON TARGET PER       MTK69 1   26
           RUN VARIED FROM 100 - 150 MICROCOULOMB. THE          MTK69 1   27
           COLLIMATOR CURRENT FRACTION WAS USUALLY LESS THAN    MTK69 1   28
           0.002 RELATIVE TO THE TRANSMITTED BEAM CURRENT. ONLY MTK69 1   29
           THE GROUND-STATE (GAMMA-0) AND FIRST-EXCITED-STATE   MTK69 1   30
           (GAMMA-1) TRANSITIONS WERE CONSIDERED IN THIS        MTK69 1   31
           EXPERIMENT. GAMMA-RAY YIELD EXCITATION FUNCTIONS     MTK69 1   32
           WERE MEASURED AT ALL THE INDICATED ANGLES IN ENERGY  MTK69 1   33
           STEPS OF 20 KEV. THE GAMMA-0 AND GAMMA-1 TRANSITIONS MTK69 1   34
           WERE REASONABLY WELL RESOLVED IN ALL THE NAI DETECTOR  MTK69 1   35
           SPECTRA. THE GAMMA-0 LINE SHAPE WAS DETERMINED FROM  MTK69 1   36
           MEASUREMENTS OF 3H(P,GAMMA)4HE. THIS ENABLED THE     MTK69 1   37
           YIELDS OF THE INDIVIDUAL TRANSITIONS TO BE READILY   MTK69 1   38
           UNFOLDED FROM THE SPECTRA. IN ORDER TO NORMALIZE     MTK69 1   39
           THE VARIOUS MEASURED EXCITATION FUNCTIONS, ANGULAR   MTK69 1   40
           DISTRIBUTION DATA AT EACH ENERGY WERE FITTED WITH    MTK69 1   41
           LEGENDRE-POLYNOMIAL EXPANSIONS UP TO FOURTH ORDER.   MTK69 1   42
DETECTORS  (SCINT) NAI(TL) SCINTILLATION CRYSTAL DETECTORS      MTK69 1   43
           WERE USED. SEVERAL NAI DETECTORS OF 12.5 CM X 15     MTK69 1   44
           CM WERE USED: AT 45, 75, AND 105 DEGREES (RUN I),    MTK69 1   45
           30, 64, 98, AND 132 DEGREES (RUN II), AND 90         MTK69 1   46
           DEGREES (RUN III). THE GIVEN ANGLES WERE MEASURED    MTK69 1   47
           RELATIVE TO THE INCIDENT PROTON BEAM. THESE          MTK69 1   48
           DETECTORS WERE ALL SITUATED 38 CM FROM THE TARGET.   MTK69 1   49
           A LARGER NAI DETECTOR OF 24 CM X 30 CM WAS USED IN   MTK69 1   50
           THE EXPERIMENT FOR NORMALIZATION PURPOSES AS IS      MTK69 1   51
           DISCUSSED IN GREATER DETAIL IN SECTION 2 OF THE      MTK69 1   52
           ORIGINAL PAPER.                                      MTK69 1   53
MONITORS   (CI) CURRENT INTEGRATOR.                             MTK69 1   54
           (SCINT) 24 CM X 30 CM NAI(TL) SCINTILLATION          MTK69 1   55
           DETECTOR.                                            MTK69 1   56
CORRECTION SPECTRAL DATA WERE CORRECTED FOR COSMIC-RAY          MTK69 1   57
           BACKGROUND, FINITE SOLID ANGLE, AND GAMMA-RAY        MTK69 1   58
           ANGULAR DISTRIBUTION EFFECTS. CORRECTIONS WERE       MTK69 1   59
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           ALSO APPLIED FOR DEAD-TIME AND PILE-UP REJECTION        MTK69 1   60
           LOSSES. THESE LATTER EFFECTS AMOUNTED TO NO MORE        MTK69 1   61
           THAN 5 PERCENT.                                         MTK69 1   62
ERR-ANALYS THE ERRORS WERE ESTIMATED TO EQUAL ABOUT 20 PERCENT.    MTK69 1   63
           FEW DETAILS ON THE ERROR ANALYSIS ARE GIVEN IN THE      MTK69 1   64
           ORIGINAL PAPER.                                         MTK69 1   65
ENDBIB              63                                             MTK69 1   66
ENDSUBENT            1                                             MTK69 199999
SUBENT        MTK69  2          0                                  MTK69 2    1
BIB                  2          9                                  MTK69 2    2
REACTION   31P(P,GAMMA-0)32S                                       MTK69 2    3
COMMENTS   RESULTS FROM THREE INDEPENDENT CROSS-SECTION            MTK69 2    4
           MEASUREMENTS ARE GIVEN. DATA ARE OBTAINED FROM          MTK69 2    5
           TABLE 1 OF THE ORIGINAL PAPER. RUN = RUN NUMBER         MTK69 2    6
           AS DISCUSSED ABOVE. TARGET = TARGET THICKNESS.          MTK69 2    7
           EP = PROTON ENERGY. SIG = ABSOLUTE CROSS SECTION        MTK69 2    8
           FOR 31P(P,GAMMA-0)32S REACTION. SIG-ERR = ERROR IN      MTK69 2    9
           SIG. MCRG/CM2 = MICROGRAM/CM**2. MICROB = MICROBARN     MTK69 2   10
           = 10**(-24) BARN.                                       MTK69 2   11
ENDBIB               9                                             MTK69 2   12
DATA                 5          3                                  MTK69 2   13
RUN        TARGET     EP         SIG        SIG-ERR                MTK69 2   14
NO-DIM     MCRG/CM2   MEV        MICROB     MICROB                 MTK69 2   15
 I          444.       9.72       36.1       7.2                   MTK69 2   16
 II         178.       11.24      56.5       11.3                  MTK69 2   17
 III        249.       10.38      54.4       10.9                  MTK69 2   18
ENDDATA              5                                             MTK69 2   19
ENDSUBENT            2                                             MTK69 299999
ENDENTRY             2                                             MTK699999999
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O+75

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ENTRY            O+75           0                                   O+75 0    1
SUBENT        O+75  1           0                                   O+75 1    1
BIB                 13         55                                   O+75 1    2
INSTITUTES (AULAML)                                                 O+75 1    3
           (AUL,STATE COLLEGE OF VICTORIA AT MELBOURNE,             O+75 1    4
           PARKVILLE, VICTORIA)                                     O+75 1    5
           (USACAL)                                                 O+75 1    6
REFERENCE  (J,AUJ,28,155,1975)                                      O+75 1    7
AUTHORS    (R.O'BRIEN,Z.E.SWITKOWSKI,A.K.SMITH,D.G.SARGOOD)         O+75 1    8
TITLE      TOTAL YIELD MEASUREMENTS IN 31P(P,GAMMA)32S              O+75 1    9
FACILITY   NOT GIVEN IN THIS PAPER. MENTIONED IN AN EARLIER         O+75 1   10
           REFERENCE BY SWITKOWSKI ET AL. (SEE COMMENTS BELOW).     O+75 1   11
INC-PART   (P) PROTONS.                                             O+75 1   12
TARGETS    RED PHOSPHORUS. TARGET PREPARED FROM A STRONGLY          O+75 1   13
           HEATED PHOSPHORUS ATMOSPHERE PRODUCED INITIALLY          O+75 1   14
           BY EVAPORATION. METHOD IS DISCUSSED IN AN EARLIER        O+75 1   15
           PAPER BY HOOTEN REFERENCED IN THIS WORK (SEE COMMENTS    O+75 1   16
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           BELOW).                                               O+75 1   17
METHOD     DETAILS ARE GIVEN IN AN EARLIER PAPER BY SWITKOWSKI   O+75 1   18
           ET AL. (SEE COMMENTS BELOW). EXCITATION FUNCTIONS     O+75 1   19
           WERE MEASURED FOR THE GAMMA-RAY ENERGY RANGE          O+75 1   20
           3.0 - 12.0 AND 7.5 - 12.0 KEV. THE PROTON ENERGY      O+75 1   21
           RANGE STUDIED WAS EP = 0.33 - 1.75 MEV. THE PRESENT   O+75 1   22
           WORK CONSISTS OF ABSOLUTE MEASUREMENTS OF RESONANCE   O+75 1   23
           STRENGTHS AND NONRESONANT YIELD. RESONANCE WIDTH AND  O+75 1   24
           SPACING PERMITTED SEMI-THICK TARGET MEASUREMENTS      O+75 1   25
           TO BE MADE FOR 17 OF THE 28 RESONANCES IDENTIFIED     O+75 1   26
           IN THIS ENERGY RANGE. THE EXCITATION FUNCTIONS WERE   O+75 1   27
           MEASURED IN 1-2 KEV INTERVALS. GAMMA-RAY SPECTRA      O+75 1   28
           WERE COLLECTED AT EACH ENERGY. THE TOTAL CHARGE       O+75 1   29
           COLLECTED FOR EACH POINT WAS IN THE RANGE 50 -        O+75 1   30
           300 MICROCOULOMB. BEAM CURRENTS IN THE RANGE 0.4 -    O+75 1   31
           4 MICROAMP WERE USED. THE CHOICE DEPENDED ON THE      O+75 1   32
           OBSERVED COUNT RATE. IN CASES WHERE THIN TARGETS      O+75 1   33
           HAD TO BE USED TO DETERMINE RESONANCE STRENGTHS,      O+75 1   34
           THE MEASUREMENTS WERE ALL MADE RELATIVE TO THE        O+75 1   35
           642-KEV RESONANCE. PROTON ENERGY STEPS OF 1 - 2       O+75 1   36
           KEV WERE USED TO TRACE OUT THE RESONANCES. LARGER     O+75 1   37
           STEPS WERE USED AWAY FROM RESONANCES. GENERALLY       O+75 1   38
           150 MICROCOULOMB OF CHARGE WERE COLLECTED FOR         O+75 1   39
           EACH PROTON ENERGY. UNRESOLVED RESONANCES WERE        O+75 1   40
           SEPARATED USING A METHOD DISCUSSED IN THE EARLIER     O+75 1   41
           PAPER BY SWITKOWSKI ET AL. (SEE COMMENTS BELOW).      O+75 1   42
DETECTOR   NOT MENTIONED IN THIS PAPER. AUTHORS REFER TO AN      O+75 1   43
           EARLIER PAPER BY SWITKOWSKI ET AL. (SEE COMMENTS      O+75 1   44
           BELOW). FROM THE DISCUSSION, IT IS INFERRED THAT      O+75 1   45
           ONE OR MORE NAI(TL) SCINTILLATION DETECTORS WERE      O+75 1   46
           EMPLOYED IN THE EXPERIMENT.                           O+75 1   47
MONITOR    (CI) CURRENT INTEGRATOR.                              O+75 1   48
CORRECTION DATA CORRECTED FOR DETECTOR EFFICIENCY.               O+75 1   49
ERR-ANALYS ERRORS IN GAMMA-RAY DETECTOR COUNTS WERE ESTIMATED    O+75 1   50
           TO BE NO MORE THAN 5 PERCENT AND TYPICALLY WERE JUST  O+75 1   51
           2 PERCENT.                                            O+75 1   52
COMMENTS   THE PRESENT PAPER REFERS FREQUENTLY TO THE FOLLOWING  O+75 1   53
           EARLIER REFERENCES FOR DETAILS: Z.E. SWITKOWSKI, R.   O+75 1   54
           O'BRIEN, A.K. SMITH, AND D.G. SARGOOD, AUSTRALIAN     O+75 1   55
           JOURNAL OF PHYSICS, 28, 141 (1975); B.W.HOOTON,       O+75 1   56
           NUCLEAR INSTRUMENTS AND METHODS 27, 338 (1964).       O+75 1   57
ENDBIB             55                                            O+75 1   58
ENDSUBENT           1                                            O+75 199999
SUBENT        O+75  2          0                                 O+75 2    1
BIB                 2         10                                 O+75 2    2
REACTION   31P(P,GAMMA)32S                                       O+75 2    3
COMMENTS   STRENGTHS AND WIDTHS ARE GIVEN FOR RESONANCES IN THE  O+75 2    4
           31P(P,GAMMA)32S REACTION. DATA ARE TAKEN FROM TABLE 1 O+75 2    5
           OF THE ORIGINAL PAPER. EP = RESONANCE PROTON ENERGY.  O+75 2    6
           EP-ERR = ERROR IN EP. GAM(T) = RESONANCE TOTAL WIDTH. O+75 2    7
           ERR-GAM(T) = ERROR IN GAM(T). S = RESONANCE STRENGTH  O+75 2    8
           = (2J+1)*GAM(P)*GAM(G)/GAM(T), WHERE J = RESONANCE    O+75 2    9
           SPIN, GAM(P) = PROTON WIDTH, AND GAM(G) = GAMMA-RAY   O+75 2   10
           WIDTH. S-ERR = ERROR IN RESONANCE STRENGTH. A BLANK   O+75 2   11
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          SPACE INDICATES VALUE IS NOT PROVIDED IN THE TABLE.      O+75 2   12
ENDBIB              10                                             O+75 2   13
DATA                 6         28                                  O+75 2   14
EP         EP-ERR     GAM(T)     GAM(T)-ERR S          S-ERR       O+75 2   15
KEV        KEV        KEV        KEV        EV         EV          O+75 2   16
 355.                                        0.017      0.002      O+75 2   17
 439.                                        0.13       0.02       O+75 2   18
 541.                                        0.51       0.06       O+75 2   19
 620.                                        0.006      0.004      O+75 2   20
 642.                                        0.25       0.03       O+75 2   21
 811.                                        1.06       0.11       O+75 2   22
 821.                                        0.23       0.04       O+75 2   23
 874.                  1.                    0.06       0.02       O+75 2   24
 888.                                        0.034      0.017      O+75 2   24
 895.                                        0.31       0.07       O+75 2   25
 984.                                        0.091      0.014      O+75 2   26
 994.       3.         4.0        0.8        0.3                   O+75 2   27
 1016.      3.                               0.031      0.009      O+75 2   28
 1057.                                       0.55       0.06       O+75 2   29
 1090.                                       0.19       0.06       O+75 2   30
 1121.                                       1.04       0.13       O+75 2   31
 1151.                                       1.85       0.22       O+75 2   32
 1155.                                       0.66       0.08       O+75 2   33
 1251.                 1.5        0.8        4.6        0.6        O+75 2   34
 1400.                                       0.7        0.2        O+75 2   35
 1403.                                       2.0        0.6        O+75 2   36
 1411.                                       0.5        0.1        O+75 2   37
 1438.                                       4.8        0.6        O+75 2   38
 1473.                                       1.2        0.2        O+75 2   39
 1515.      3.         5.8        1.2        0.8        0.2        O+75 2   40
 1557.                                       4.2        0.5        O+75 2   41
 1583.                                       4.6        0.6        O+75 2   42
 1699.                                       0.70       0.15       O+75 2   43
ENDDATA             30                                             O+75 2   44
ENDSUBENT            2                                             O+75 299999
SUBENT        O+75  3          0                                   O+75 3    1
BIB                  2         6                                   O+75 3    2
REACTION   31P(P,GAMMA)32S                                         O+75 3    3
COMMENTS   RESONANCE STRENGTHS MEASURED WITH PHOSPHORUS AND ZN3P2  O+75 3    4
           TARGETS ARE COMPARED. EP = RESONANCE PROTON ENERGY.     O+75 3    5
           S = RESONANCE STRENGTH = (2J+1)*GAM(P)*GAM(G)/GAM(T).   O+75 3    6
           S-ERR = ERROR IN S (S1,PHOSPHORUS; S2, ZN3P2). SEE      O+75 3    7
           DESCRIPTION ABOVE. DATA FROM TABLE 2 OF ORIGINAL PAPER. O+75 3    8
ENDBIB               6                                             O+75 3    9
DATA                 5         3                                   O+75 3   10
EP         P1         P1-ERR     P2         P2-ERR                 O+75 3   11
KEV        EV         EV         EV         EV                     O+75 3   12
 642.       0.25       0.03       0.27       0.03                  O+75 3   13
 1121.      1.04       0.13       1.14       0.15                  O+75 3   14
 1583.      4.6        0.6        4.7        0.8                   O+75 3   15
ENDDATA              5                                             O+75 3   16
ENDSUBENT            3                                             O+75 399999
SUBENT        O+75  4          0                                   O+75 4    1
BIB                  2         7                                   O+75 4    2
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REACTION   31P(P,GAMMA)32S                                      O+75 4    3
COMMENTS   PARAMETERS OF BROAD UNRESOLVED RESONANCES ARE GIVEN.  O+75 4    4
           DATA FROM TABLE 3 OF ORIGINAL PAPER. EP = RESONANCE   O+75 4    5
           PROTON ENERGY. EX = EXCITATION ENERGY IN 32S. S =     O+75 4    6
           RESONANCE STRENGTH = (2J+1)*GAM(P)*GAM(G)/GAM(T),     O+75 4    7
           WHERE J = RESONANCE SPIN, GAM(P) = PROTON WIDTH,      O+75 4    8
           GAM(G) = GAMMA-RAY WIDTH, AND GAM(T) = TOTAL WIDTH.   O+75 4    9
ENDBIB              7                                            O+75 4   10
DATA                4          5                                 O+75 4   11
EP         EX          S          GAM(T)                         O+75 4   12
KEV        MEV         EV         KEV                            O+75 4   13
 875.       9.713       0.045      95.                           O+75 4   14
 995.       9.829       0.140      140.                          O+75 4   15
 1150.      9.978       0.098      60.                           O+75 4   16
 1250.      10.076      0.095      80.                           O+75 4   17
 1360.      10.183      0.178      60.                           O+75 4   18
ENDDATA             7                                            O+75 4   19
ENDSUBENT           4                                            O+75 499999
ENDENTRY            4                                            O+759999999
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P+55

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ENTRY            P+55          0                                 P+55 0    1
SUBENT        P+55  1          0                                 P+55 1    1
BIB                12         62                                 P+55 1    2
INSTITUTE  (CANCRC)                                              P+55 1    3
REFERENCE  (J,PR,99,5,1339,1955)                                 P+55 1    4
AUTHORS    (E.B.PAUL,H.E.GOVE,A.E.LITHERLAND,G.A.BARTHOLOMEW)    P+55 1    5
TITLE      PROTON CAPTURE GAMMA RAYS FROM THE REACTION           P+55 1    6
           31P(P,GAMMA)32S LEADING TO THE GROUND AND FIRST       P+55 1    7
           EXCITED STATES OF 32S                                 P+55 1    8
FACILITY   (VDG) ELECTROSTATIC ACCELERATOR, CHALK RIVER          P+55 1    9
           LABORATORY, AECL, CHALK RIVER, ONTARIO, CANADA.       P+55 1   10
INC-PART   (P) PROTONS.                                          P+55 1   11
TARGETS    ZN3P2 EVAPORATED ON 20-MIL TANTALUM BACKINGS TO A     P+55 1   12
           THICKNESS OF ABOUT 700 EV FOR THE YIELD MEASUREMENTS  P+55 1   13
           AND ABOUT 10 KEV THICKNESS FOR ANGULAR DISTRIBUTION   P+55 1   14
           MEASUREMENTS, BOTH AT 1.25 MEV PROTON ENERGY.         P+55 1   15
METHOD     PROTONS WITH ENERGIES IN THE RANGE EP = 0.68 - 2.35   P+55 1   16
           MEV WERE OBTAINED FROM THE CHALK RIVER ELECTROSTATIC  P+55 1   17
           ACCELERATOR. THESE PROTONS WERE ANALYZED IN ENERGY    P+55 1   18
           BY A 90-DEGREE MAGNET WHOSE FIELD WAS MONITORED AND   P+55 1   19
           STABILIZED BY A PROTON RESONANCE FLUXMETER WITH       P+55 1   20
           FEEDBACK. A PAIR OF TANTALUM PLATES FORMED A          P+55 1   21
           HORIZONTAL SLIT AT THE EXIT OF THIS MAGNET. THE       P+55 1   22
           SLIT CURRENT WAS USED TO CONTROL THE CORONA LOAD      P+55 1   23
           ON THE ACCELERATOR. BY THIS MEANS, THE ENERGY WAS     P+55 1   24
           STABILIZED TO 0.1 PERCENT. THE PROTONS TRAVELLED      P+55 1   25
           ALONG A 15-FOOT SECTION OF EVACUATED TUBING WHICH     P+55 1   26
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           WAS TERMINATED BY A HOLLOW BRASS CYLINDER WITH          P+55 1   27
           1/16-TH INCH WALLS CONTAINING THE TARGET. THE BEAM      P+55 1   28
           WAS DEFINED ON TARGET TO ABOUT 1/4-TH INCH DIAMETER     P+55 1   29
           BY A 1/8-TH INCH APERTURE IN A 20-MIL TANTALUM DISK     P+55 1   30
           SITUATED ABOUT 8 FEET FROM THE TARGET. THE BEAM         P+55 1   31
           CURRENTS USED IN THIS EXPERIMENT WERE IN THE RANGE      P+55 1   32
           5 - 20 MICROAMPS. A DETECTOR WAS PLACED AT 90 DEGREES   P+55 1   33
           FOR THE GAMMA-RAY YIELD MEASUREMENTS. IT WAS SITUATED   P+55 1   34
           ABOUT 3 INCHES FROM THE TARGET CENTER. AN EXCITATION    P+55 1   35
           FUNCTION OF GAMMA-RAY YIELDS TO THE GROUND STATE AND    P+55 1   36
           2.25-KEV FIRST-EXCITED STATE IN 32S WERE MEASURED.      P+55 1   37
           AT EACH RESONANCE, GAMMA-RAY SPECTRA WERE MEASURED      P+55 1   38
           USING A 30-CHANNEL PULSE-HEIGHT ANALYZER. THE TARGET    P+55 1   39
           THICKNESS WAS MEASURED IN AN ADDITIONAL EXPERIMENT IN   P+55 1   40
           WHICH THE ENERGY LOSS IN THE TARGET WAS DETERMINED      P+55 1   41
           BY COMPARING THE STEP IN THE THICK-TARGET YIELD CURVE   P+55 1   42
           WITH THE AREA UNDER THE THIN-TARGET YIELD FOR THE       P+55 1   43
           WELL-ISOLATED RESONANCE AT EP = 1.248 MEV. ANGULAR      P+55 1   44
           DISTRIBUTIONS WERE MEASURED WITH A SINGLE NAI DETECTOR  P+55 1   45
           SITUATED 5 INCHES FROM THE CENTER OF THE TARGET. IT     P+55 1   46
           COULD BE ROTATED BETWEEN 0 AND 150 DEGREES. A SECOND    P+55 1   47
           IDENTICAL DETECTOR WAS PLACED ON THE OTHER SIDE OF      P+55 1   48
           THE TARGET AT 90 DEGREES AND A DISTANCE OF 4 INCHES     P+55 1   49
           FROM THE TARGET FOR USE AS A MONITOR. THE ANGULAR       P+55 1   50
           DISTRIBUTIONS WERE FOUND TO BE INSENSITIVE TO TARGET    P+55 1   51
           THICKNESS. THE ANGULAR DISTRIBUTION DATA WERE FITTED    P+55 1   52
           WITH LEGENDRE POLYNOMIAL EXPANSIONS UP TO 4-TH ORDER    P+55 1   53
           BY THE METHOD OF LEAST SQUARES.                         P+55 1   54
DETECTORS  (SCINT) 2-INCH X 2-INCH NAI(TL) SCINTILLATION           P+55 1   55
           CRYSTAL DETECTORS.                                      P+55 1   56
MONITORS   (CI) CURRENT INTEGRATOR.                                P+55 1   57
           (SCINT) NAI(TL) SCINTILLATION CRYSTAL DETECTOR.         P+55 1   58
CORRECTION GAMMA-RAY DATA WERE CORRECTED FOR ABSORPTION IN THE     P+55 1   59
           TANTALUM BACKING OF THE TARGET. THIS CORRECTION WAS     P+55 1   60
           ON THE ORDER OF 10 PERCENT.                             P+55 1   61
ERR-ANALYS AN UNCERTAINTY OF 10 PERCENT WAS ASSUMED TO ACCOUNT     P+55 1   62
           FOR EXTRAPOLATION OF THE COMPTON DISTRIBUTION TO ZERO   P+55 1   63
           PULSE HEIGHT.                                           P+55 1   64
ENDBIB             62                                              P+55 1   65
ENDSUBENT           1                                              P+55 199999
SUBENT         P+55  2          0                                  P+55 2    1
BIB                 2          11                                  P+55 2    2
REACTION   31P(P,GAMMA-0)32S                                       P+55 2    3
COMMENTS   ANGULAR DISTRIBUTION COEFFICIENTS ARE GIVEN FOR THE     P+55 2    4
           GROUND-STATE GAMMA-RAY TRANSITION FROM SEVERAL          P+55 2    5
           RESONANCES. EP = PROTON ENERGY OF THE RESONANCE.        P+55 2    6
           COEFFICIENTS BI (B1, B2, B3, AND B4) CORRESPONDING      P+55 2    7
           TO THE EXPANSION W = P0 + B1*P1 + B2*P2 +B3*P3 +        P+55 2    8
           B4*P4 ARE PROVIDED. PI IS A LEGENDRE POLYNOMIAL OF      P+55 2    9
           I-TH ORDER (I = 0, 1, 2, 3, AND 4). DATA TAKEN FROM     P+55 2   10
           TABLE I OF THE ORIGINAL PAPER. NO ERRORS ARE GIVEN.     P+55 2   11
           BI-ERR = ERROR IN COEFFICIENT BI (I = 1, 2, 3, 4). A    P+55 2   12
           BLANK SPACE INDICATES THAT THE VALUE IS UNAVAILABLE.    P+55 2   13
ENDBIB             11                                              P+55 2   14
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DATA                9          9                                 P+55 2   15
EP         B1         B1-ERR     B2         B2-ERR     B3        P+55 2   16
B3-ERR     B4         B4-ERR                                     P+55 2   17
MEV        NO-DIM     NO-DIM     NO-DIM     NO-DIM     NO-DIM    P+55 2   18
NO-DIM     NO-DIM     NO-DIM                                     P+55 2   19
 0.825      0.07       0.05      -0.56       0.07       0.10     P+55 2   20
 0.08      -0.19       0.08                                      P+55 2   21
 1.117      0.02       0.04      -0.27       0.06       0.07     P+55 2   22
 0.07      -0.05       0.06                                      P+55 2   23
 1.248                            0.4        0.1                 P+55 2   24
                                                                 P+55 2   25
 1.892      0.04       0.03      -0.51       0.04       0.06     P+55 2   26
 0.06      -0.06       0.06                                      P+55 2   27
 1.985     -0.01       0.04      -0.01       0.05      -0.02     P+55 2   28
 0.06       0.06       0.06                                      P+55 2   29
 2.027      0.09       0.02      -0.14       0.02      -0.08     P+55 2   30
 0.02       0.04       0.02                                      P+55 2   31
 2.120      0.04       0.04      -0.58       0.06       0.16     P+55 2   32
 0.06      -0.07       0.06                                      P+55 2   33
 2.320      0.13       0.03       0.08       0.03      -0.05     P+55 2   34
 0.04       0.02       0.04                                      P+55 2   35
 2.340      0.01       0.02      -0.01       0.03       0.07     P+55 2   36
 0.03      -0.09       0.03                                      P+55 2   37
ENDDATA            22                                            P+55 2   38
ENDSUBENT           2                                            P+55 299999
SUBENT        P+55  3          0                                 P+55 3    1
BIB                 2         11                                 P+55 3    2
REACTION   31P(P,GAMMA-1)32S                                     P+55 3    3
COMMENTS   ANGULAR DISTRIBUTION COEFFICIENTS ARE GIVEN FOR THE   P+55 3    4
           FIRST-EXCITED STATE GAMMA-RAY TRANSITION FROM SEVERAL P+55 3    5
           RESONANCES. EP = PROTON ENERGY OF THE RESONANCE.      P+55 3    6
           COEFFICIENTS BI (B1, B2, B3, AND B4) CORRESPONDING    P+55 3    7
           TO THE EXPANSION W = P0 + B1*P1 + B2*P2 +B3*P3 +      P+55 3    8
           B4*P4 ARE PROVIDED. PI IS A LEGENDRE POLYNOMIAL OF    P+55 3    9
           I-TH ORDER (I = 0, 1, 2, 3, AND 4). DATA TAKEN FROM   P+55 3   10
           TABLE II OF THE ORIGINAL PAPER. NO ERRORS ARE GIVEN.  P+55 3   11
           BI-ERR = ERROR IN COEFFICIENT BI (I = 1, 2, 3, 4).    P+55 3   12
           A BLANK SPACE INDICATES THAT THE VALUE IS UNAVAILABLE.P+55 3   13
ENDBIB             11                                            P+55 3   14
DATA                9          3                                 P+55 3   15
EP         B1         B1-ERR     B2         B2-ERR     B3        P+55 3   16
B3-ERR     B4         B4-ERR                                     P+55 3   17
MEV        NO-DIM     NO-DIM     NO-DIM     NO-DIM     NO-DIM    P+55 3   18
NO-DIM     NO-DIM     NO-DIM                                     P+55 3   19
 0.816     -0.02       0.02       0.37       0.03      -0.02     P+55 3   20
 0.04       0.06       0.04                                      P+55 3   21
 1.146     -0.02       0.02       0.17       0.02                P+55 3   22
                                                                 P+55 3   23
 1.248      0.04       0.01       0.31       0.01       0.04     P+55 3   24
 0.02      -0.03       0.01                                      P+55 3   25
ENDDATA            10                                            P+55 3   26
ENDSUBENT           3                                            P+55 399999
SUBENT        P+55  4          0                                 P+55 4    1
BIB                 2         11                                 P+55 4    2
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REACTION   31P(P,GAMMA-0)32S                                       P+55 4    3
COMMENTS   RESONANCE STRENGTHS AND WIDTHS ARE GIVEN FOR SEVERAL    P+55 4    4
           RESONANCES IN 32S FORMED BY RADIATIVE PROTON CAPTURE.   P+55 4    5
           ONLY THE STRENGTH OF THE GROUND-STATE TRANSITION IS     P+55 4    6
           GIVEN. DATA OBTAINED FROM TABLE V OF THE ORIGINAL       P+55 4    7
           PAPER. EP = RESONANCE PROTON ENERGY. GAM(T) = TOTAL     P+55 4    8
           WIDTH OF THE RESONANCE. GAM(G-0) = GROUND-STATE         P+55 4    9
           RADIATIVE TRANSITION WIDTH. RESONANCE STRENGTH =        P+55 4   10
           S0 = (2J+1)*GAM(P)*GAM(G-0)/GAM(T), WHERE J = SPIN      P+55 4   11
           OF THE RESONANCE, AND GAM(P) = PROTON WIDTH. A BLANK    P+55 4   12
           SPACE SIGNIFIES THAT THE VALUE IS UNAVAILABLE.          P+55 4   13
ENDBIB              11                                             P+55 4   14
DATA                 4          9                                  P+55 4   15
EP         S0         GAM(G-0)   GAM(T)                            P+55 4   16
MEV        EV         EV         KEV                               P+55 4   17
 0.825      0.09       0.12                                        P+55 4   18
 1.117      0.47       0.63                                        P+55 4   19
 1.248      0.06       0.048                                       P+55 4   20
 1.892      9.2        12.0       24.                              P+55 4   21
 1.985      3.3        4.4        10.                              P+55 4   22
 2.027      6.5        8.7        24.                              P+55 4   23
 2.120      1.0        1.3        5.                               P+55 4   24
 2.320      5.0        6.7        8.                               P+55 4   25
 2.340      16.0       21.0       8.                               P+55 4   26
ENDDATA             11                                             P+55 4   27
ENDSUBENT            4                                             P+55 499999
ENDENTRY             4                                             P+559999999
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PKS78

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ENTRY            PKS78          0                                 PKS78 0    1
SUBENT        PKS78  1          0                                 PKS78 1    1
BIB                 12         83                                 PKS78 1    2
INSTITUTE  (AULAML)                                               PKS78 1    3
REFERENCE  (J,PR/C,17,5,1550,1978)                                PKS78 1    4
AUTHORS    (B.M.PAINE,S.R.KENNETT,D.G.SARGOOD)                    PKS78 1    5
TITLE      (P,GAMMA) RESONANCE STRENGTHS IN THE S-D SHELL         PKS78 1    6
FACILITY   (VDG) 5-MV PELLETRON ACCELERATOR, SCHOOL OF PHYSICS,   PKS78 1    7
           UNIVERSITY OF MELBOURNE, PARKVILLE, VICTORIA,          PKS78 1    8
           AUSTRALIA.                                             PKS78 1    9
INC-PART   (P) PROTONS.                                           PKS78 1   10
TARGETS    TARGET MATERIALS WERE EVAPORATED ONTO CARBON BACKINGS  PKS78 1   11
           WITH THICKNESSES OF 10 AND 40 MICROGRAM/CM**2. THESE   PKS78 1   12
           CARBON FOILS WERE MOUNTED ON TANTALUM FRAMES. VARIOUS  PKS78 1   13
           TARGET MATERIALS WERE USED. EACH TARGET CONTAINED AT   PKS78 1   14
           LEAST TWO OF THE ELEMENTS BEING CONSIDERED SO RATIOS   PKS78 1   15
           COULD BE DETERMINED. FOR MEASUREMENTS INVOLVING        PKS78 1   16
           PHOSPHORUS, THE COMPOUND USED WAS NA4P2O7. A THIN      PKS78 1   17
           LAYER OF ALUMINUM WAS ALSO EVAPORATED ONTO THE TARGET  PKS78 1   18
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          SO STRENGTH DATA COULD BE NORMALIZED TO THE KNOWN       PKS78 1   19
          ABSOLUTE STRENGTH OF THE EP = 633-KEV RESONANCE IN      PKS78 1   20
          27AL(P,GAMMA)28SI. TARGET ANALYSIS WAS ACCOMPLISHED     PKS78 1   21
          USING RUTHERFORD SCATTERING OF ALPHA PARTICLES AT       PKS78 1   22
          ENERGIES IN THE RANGE 3 - 4 MEV AND AT ANGLES OF        PKS78 1   23
          120 - 145 DEGREES. ANALYSIS OF THE NA4P2O7 TARGET       PKS78 1   24
          ELASTIC ALPHA-PARTICLE SCATTERING DATA SHOWED THAT      PKS78 1   25
          THE RATIO OF SODIUM TO PHOSPHORUS WAS CLOSER TO         PKS78 1   26
          UNITY THAN TO THE EXPECTED RATIO OF 2 IMPLIED BY        PKS78 1   27
          THE CHEMICAL FORMULA. THIS EXPERIMENTAL RATIO           PKS78 1   28
          WAS FOUND TO BE STABLE UNDER PROTON BOMBARDMENT.        PKS78 1   29
METHOD    THE EXPERIMENTAL ARRANGEMENT IS SHOWN SCHEMATICALLY     PKS78 1   30
          IN FIGURE 2 OF THE ORIGINAL PAPER. THE TARGET WAS       PKS78 1   31
          MOUNTED IN VACUUM IN A SCATTERING CHAMBER. PROTON       PKS78 1   32
          BEAMS WERE PROVIDED BY THE 5-MV MELBOURNE PELLETRON     PKS78 1   33
          ACCELERATOR. BEAM CURRENTS OF ABOUT 0.5 MICROAMP        PKS78 1   34
          WITH AN ENERGY RESOLUTION OF 300 EV WERE USED.          PKS78 1   35
          THE PROTON BEAM WAS COLLIMATED TO 2-MM IN DIAMETER      PKS78 1   36
          AND SECONDARY ELECTRON EMISSION WAS SUPPRESSED BY       PKS78 1   37
          HOLDING THE COLLIMATOR APERTURES AT -600 VDC.           PKS78 1   38
          SINCE MOLECULAR HYDROGEN BEAMS WERE USED FOR SOME       PKS78 1   39
          OF THE (P,GAMMA) MEASUREMENTS AND SINGLY-CHARGED        PKS78 1   40
          HELIUM BEAMS WERE USED FOR SOME OF THE RUTHERFORD       PKS78 1   41
          SCATTERING, THE CHARGE COLLECTED ON THE FARADAY         PKS78 1   42
          CUP COULD NOT BE RELIED UPON TO GIVE AN ACCURATE        PKS78 1   43
          REPRESENTATION OF THE CHARGE ON TARGET. THEREFORE,      PKS78 1   44
          THE TARGET LADDER WAS HELD AT +630 VDC AND THE          PKS78 1   45
          CURRENT RECORDED FROM IT WAS ADDED TO THE FARADAY       PKS78 1   46
          CUP CURRENT TO GIVE THE TOTAL TARGET CURRENT.           PKS78 1   47
          THE EXCITATION FUNCTIONS WERE TRACED OUT IN STEPS OF    PKS78 1   48
          ABOUT 0.25 KEV ACROSS THE REGION OF INTEREST. THE       PKS78 1   49
          GAMMA-RAY YIELD WAS MEASURED BY OBSERVING THE           PKS78 1   50
          STRONGEST ONE OR TWO FULL-ENERGY PEAKS IN SPECTRA       PKS78 1   51
          OBTAINED WITH THE GE(LI) DETECTOR PLACED AT 90          PKS78 1   52
          DEGREES AND ABOUT 1 CM AWAY FROM THE TARGET. THE        PKS78 1   53
          ABSOLUTE EFFICIENCY OF THIS DETECTION TECHNIQUE         PKS78 1   54
          WAS WAS ESTABLISHED BY OBSERVING AN ISOLATED            PKS78 1   55
          RESONANCE WHICH PRODUCED A CLEAN GAMMA-RAY SPECTRUM     PKS78 1   56
          THAT COULD BE MEASURED USING THE NAI DETECTOR.          PKS78 1   57
          THIS DETECTOR WAS PLACED AT 125 DEGREES, A KNOWN        PKS78 1   58
          NODE OF THE LEGENDRE POLYNOMIAL FUNCTION P2.            PKS78 1   59
          THE EFFICIENCY OF THE NAI DETECTOR WAS CALCULATED       PKS78 1   60
          USING KNOWN PHOTON CROSS SECTIONS FROM THE              PKS78 1   61
          LITERATURE AND VALIDATED BY MEASUREMENTS USING          PKS78 1   62
          CALIBRATED RADIOACTIVE GAMMA-RAY SOURCES. THE           PKS78 1   63
          RUTHERFORD-SCATTERED ALPHA PARTICLES WERE DETECTED      PKS78 1   64
          WITH A SILICON SURFACE-BARRIER DETECTOR. THIS           PKS78 1   65
          DETECTOR HAD A 1-MM APERTURE PLACED 4.7 CM FROM         PKS78 1   66
          THE TARGET SPOT. FOR THE MOST PART, THE SPECTRUM        PKS78 1   67
          PEAKS CORRESPONDING TO ALPHA-PARTICLE SCATTERING        PKS78 1   68
          FROM VARIOUS TARGET ELEMENTS WERE RESOLVED. THE         PKS78 1   69
          RESONANCE STRENGTH RATIO DATA WERE ULTIMATELY           PKS78 1   70
          NORMALIZED TO THE KNOWN STRENGTH OF 3.26 EV (WITH       PKS78 1   71
          AN ERROR OF 0.4 EV) OF THE EP = 633-KEV RESONANCE       PKS78 1   72
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           IN 27AL(P,GAMMA)28SI TO GENERATE ABSOLUTE STRENGTHS.    PKS78 1   73
DETECTORS  (GELI) 70-CM**3 GE(LI) DETECTOR.                        PKS78 1   74
           (SCINT) 12.7-CM X 15.2-CM NAI(TL) SCINTILLATION         PKS78 1   75
           CRYSTAL DETECTOR.                                       PKS78 1   76
           (SOLST) 200 MICROMETER-THICK SILICON SURFACE            PKS78 1   77
           BARRIER DETECTOR.                                       PKS78 1   78
MONITOR    (CI) CURRENT INTEGRATOR.                                PKS78 1   79
CORRECTION CORRECTIONS FOR GAMMA-RAY ATTENUATION AND DETECTOR      PKS78 1   80
           EFFICIENCY WERE APPLIED.                                PKS78 1   81
ERR-ANALYS THE ABSOLUTE ERROR IN GAMMA-RAY DETECTION EFFICIENCY    PKS78 1   82
           WAS FOUND TO BE ABOUT 4 PERCENT. THE ERRORS IN RATIOS   PKS78 1   83
           OF RESONANCE STRENGTHS WERE ESTIMATED TO BE ABOUT 2     PKS78 1   84
           PERCENT.                                                PKS78 1   85
ENDBIB              83                                             PKS78 1   86
ENDSUBENT            1                                             PKS78 199999
SUBENT        PKS78  2          0                                  PKS78 2    1
BIB                  2         13                                  PKS78 2    2
REACTIONS  A: 31P(P,GAMMA)32S                                      PKS78 2    3
           B: 27AL(P,GAMMA)28SI                                    PKS78 2    4
COMMENTS   ABSOLUTE RESONANCE STRENGTH IS GIVEN. EP = PROTON       PKS78 2    5
           RESONANCE ENERGY. S = RESONANCE STRENGTH =              PKS78 2    6
           (2J+1)*GAM(P)*GAM(G)/GAM(T), WHERE J = RESONANCE        PKS78 2    7
           SPIN, GAM(P) = PROTON WIDTH, GAM(G) = GAMMA-RAY         PKS78 2    8
           WIDTH, AND GAM(T) = TOTAL WIDTH. S-ERR = ERROR IN       PKS78 2    9
           S. EPA = PROTON RESONANCE ENERGY FOR REACTION "A".      PKS78 2   10
           EPB = PROTON RESONANCE ENERGY FOR REACTION B.           PKS78 2   11
           SA = STRENGTH OF REACTION "A". SB = STRENGTH OF         PKS78 2   12
           REACTION "B". MEASURED REACTION IS "A". STANDARD        PKS78 2   13
           REACTION IS "B". VALUE OF SB IS OBTAINED FROM THE       PKS78 2   14
           LITERATURE. DATA FROM TABLE II.                         PKS78 2   15
ENDBIB              13                                             PKS78 2   16
DATA                 6          1                                  PKS78 2   17
EPA        SA         SA-ERR     EPB        SB         SB-ERR      PKS78 2   18
KEV        EV         EV         KEV        EV         EV          PKS78 2   19
 811.       0.95       0.20       633.       3.26       0.4        PKS78 2   20
ENDDATA              3                                             PKS78 2   21
ENDSUBENT            2                                             PKS78 299999
ENDENTRY             2                                             PKS789999999
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PS79

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ENTRY             PS79          0                                   PS79 0    1
SUBENT         PS79  1          0                                   PS79 1    1
BIB                 12         77                                   PS79 1    2
INSTITUTE  (AULAML)                                                 PS79 1    3
REFERENCE  (J,NP/A,331,389,1979)                                    PS79 1    4
AUTHORS    (B.M.PAINE,D.G.SARGOOD)                                  PS79 1    5
TITLE      (P,GAMMA) RESONANCE STRENGTHS IN THE S-D SHELL           PS79 1    6
FACILITY   (VDG) 5-MV PELLETRON ACCELERATOR, SCHOOL OF PHYSICS,     PS79 1    7
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	UNIVERSITY OF MELBOURNE, PARKVILLE, VICTORIA,	PS79 1	8
	AUSTRALIA.	PS79 1	9
INC-PART	(P) PROTONS.	PS79 1	10
TARGETS	TARGET MATERIALS WERE EVAPORATED ONTO CARBON BACKINGS.	PS79 1	11
	NATURAL MATERIALS WERE USED WHERE THE MEASUREMENT WAS	PS79 1	12
	ON THE MOST COMMON ISOTOPE. OTHERWISE ENRICHED SAMPLES	PS79 1	13
	WERE USED. THE LATTER DID NOT APPLY FOR PHOSPHORUS	PS79 1	14
	WHICH IS MONOISOTOPIC. THE COMPOUND USED WAS NA4P2O7.	PS79 1	15
	EACH TARGET CONTAINED AT LEAST TWO OF THE ELEMENTS	PS79 1	16
	CONSIDERED SO STRENGTH RATIOS COULD BE DETERMINED.	PS79 1	17
	TARGETS FOR THE ABSOLUTE MEASUREMENTS WERE 99.999	PS79 1	18
	PERCENT PURE ALUMINUM OF THICKNESS 47 MICROGRAM/CM**2	PS79 1	19
	AND 99.7 PERCENT PURE SIO2 OF THICKNESS 23 MICROGRAM/	PS79 1	20
	CM**2 ON 40 MICROGRAM/CM**2 CARBON FOILS. THE TARGET	PS79 1	21
	PREPARATION PROCEDURES ARE DISCUSSED IN AN EARLIER	PS79 1	22
	PAPER (B.M. PAINE ET AL., PHYS. REV C17, 1550, 1978).	PS79 1	23
	TARGET THICKNESSES WERE MEASURED BY RUTHERFORD	PS79 1	24
	SCATTERING OF PROTONS AT 0.985 MEV FOR THE ALUMINUM	PS79 1	25
	TARGET AND 1.000 MEV FOR THE 30SI ENRICHED TARGET.	PS79 1	26
	TARGETS WERE FOUND TO BE STABLE DURING MEASUREMENTS.	PS79 1	27
	BOTH THIN AND SEMI-THICK TARGETS WERE USED IN THIS	PS79 1	28
	EXPERIMENT. THE RUTHERFORD SCATTERING DETERMINATIONS	PS79 1	29
	WERE MADE BOTH BEFORE AND AFTER THE MEASUREMENTS.	PS79 1	30
METHOD	THE MEASUREMENT TECHNIQUES ARE DESCRIBED IN ANALYTIC	PS79 1	31
	TERMS IN SECTION 2.1 OF THE ORIGINAL PAPER. TARGETS	PS79 1	32
	WERE MOUNTED AT THE CENTER OF A 15.2-CM DIAMETER	PS79 1	33
	SCATTERING CHAMBER. A SHIELDED NAI(TL) SCINTILLATION	PS79 1	34
	DETECTOR WAS PLACED AT 125 DEGREES. A GE(LI) DETECTOR	PS79 1	35
	WAS SITUATED AT 90 DEGREES VERY CLOSE TO THE TARGET.	PS79 1	36
	CHARGED-PARTICLE BEAMS WERE PROVIDED BY THE MELBOURNE	PS79 1	37
	5-MV PELLETRON ACCELERATOR. DETAILS OF THE EXPERIMENT	PS79 1	38
	ARE DESCRIBED IN AN EARLIER PAPER (B.M. PAINE ET AL.,	PS79 1	39
	PHYS. REV C17, 1550, 1978). TARGET COMPOSITION WAS	PS79 1	40
	DETERMINED BY RUTHERFORD SCATTERING. THE DETECTOR	PS79 1	41
	CALIBRATION PROCEDURES ARE DESCRIBED IN EARLIER PAPER.	PS79 1	42
	RESONANCES IN 27AL(N,GAMMA)28SI AT EP = 632 AND 992	PS79 1	43
	KEV WERE CHOSEN AS STANDARDS TO NORMALIZE RESONANCE	PS79 1	44
	STRENGTH DATA. 30SI(P,GAMMA)31P WAS EXAMINED AS A	PS79 1	45
	SECONDARY STANDARD. ABSOLUTE MEASUREMENTS WERE MADE	PS79 1	46
	WITH VERY CAREFUL CONTROL OF THE GEOMETRY. THE SOLID	PS79 1	47
	ANGLE OF THE CHARGED-PARTICLE DETECTOR WAS ESTABLISHED	PS79 1	48
	TO AN ACCURACY OF ABOUT 1.5 PERCENT. THE SETUP USED	PS79 1	49
	FOR ABSOLUTE MEASUREMENTS DIFFERED ONLY MODESTLY FROM	PS79 1	50
	THE ARRANGEMENT USED FOR RELATIVE MEASUREMENTS. FOR	PS79 1	51
	ABSOLUTE STUDIES RUTHERFORD BACKSCATTERING OF PROTONS	PS79 1	52
	WAS EMPLOYED. MEASUREMENTS FOR THE ALUMINUM TARGET	PS79 1	53
	WERE PERFORMED AT EP = 0.985 MEV WHILE THOSE FOR THE	PS79 1	54
	SILICON TARGET INVOLVED EP = 1.000 MEV. MEASUREMENTS	PS79 1	55
	WERE MADE BOTH BEFORE AND AFTER THE RESONANCE STRENGTH	PS79 1	56
	DETERMINATIONS. IN THE RELATIVE MEASUREMENTS, THE	PS79 1	57
	PROTON BEAM CURRENT WAS KEPT BELOW 0.6 MICROAMP AND	PS79 1	58
	THE ALPHA-PARTICLE BEAMS WERE KEPT BELOW 0.2 MICROAMP.	PS79 1	59
	HOWEVER, IN THE CASE OF THE ABSOLUTE MEASUREMENTS, THE	PS79 1	60
	PROTON BEAMS WERE KEPT BELOW 0.3 MICROAMP AND THE	PS79 1	61

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          COLLECTED BEAM CHARGE WAS MONITORED WITH A CURRENT       PS79 1   62
          DIGITIZER TO AN ACCURACY OF ABOUT 1 PERCENT. THE         PS79 1   63
          PROTON BEAM ENERGY RESOLUTION WAS 230 EV AND THE         PS79 1   64
          EXCITATION FUNCTIONS WERE TRACED IN 0.25-KEV STEPS.      PS79 1   65
DETECTORS  (GELI) 70-CM**3 GE(LI) DETECTOR.                        PS79 1   66
          (SCINT) 12.7-CM X 15.2-CM NAI(TL) SCINTILLATION          PS79 1   67
          CRYSTAL DETECTOR.                                        PS79 1   68
          (SOLST) 200 MICROMETER-THICK SILICON SURFACE             PS79 1   69
          BARRIER DETECTOR.                                        PS79 1   70
MONITOR    (CI) CURRENT INTEGRATOR WITH AN ACCURACY OF 1 PERCENT.  PS79 1   71
CORRECTION NO CORRECTIONS WERE APPLIED FOR GAMMA-RAY ANGULAR       PS79 1   72
          DISTRIBUTION EFFECTS. CORRECTIONS WERE APPLIED FOR       PS79 1   73
          GAMMA-RAY BACKGROUND AND APERTURE SCATTERING.            PS79 1   74
ERR-ANALYS THE ABSOLUTE ERROR IN GAMMA-RAY DETECTION EFFICIENCY    PS79 1   75
          WAS FOUND TO BE ABOUT 4 PERCENT. THE ERRORS IN RATIOS    PS79 1   76
          OF RESONANCE STRENGTHS ESTIMATED TO BE 2 PERCENT. FOR    PS79 1   77
          ABSOLUTE RESONANCE STRENGTH MEASUREMENTS, STATISTICAL    PS79 1   78
          ERROR WAS 3 PERCENT AND THE TOTAL ERROR WAS 6 PERCENT.   PS79 1   79
ENDBIB             77                                              PS79 1   80
ENDSUBENT           1                                              PS79 199999
SUBENT        PS79  2          0                                   PS79 2    1
BIB                 2         10                                   PS79 2    2
REACTIONS  A: 31P(P,GAMMA)32S                                      PS79 2    3
          B: 27AL(P,GAMMA)28SI                                     PS79 2    4
          C: 30SI(P,GAMMA)31P                                      PS79 2    5
COMMENTS   ABSOLUTE RESONANCE STRENGTHS ARE GIVEN. EP = THE        PS79 2    6
          RESONANCE PROTON ENERGY. S = RESONANCE STRENGTH =        PS79 2    7
          (2J+1)*GAM(P)*GAM(G)/GAM(T), WHERE J = RESONANCE         PS79 2    8
          SPIN, GAM(P) = PROTON WIDTH, GAM(G) = GAMMA-RAY          PS79 2    9
          WIDTH, AND GAM(T) = TOTAL WIDTH. S-ERR = ERROR IN        PS79 2   10
          S. MEASURED REACTION IS "A". STANDARDS ARE "B" AND       PS79 2   11
          "C". DATA OBTAINED FROM TABLE 3 IN ORIGINAL PAPER.       PS79 2   12
ENDBIB             10                                              PS79 2   13
DATA                4          5                                   PS79 2   14
REACTION   EP         S          S-ERR                             PS79 2   15
NO-DIM     KEV        EV         EV                                PS79 2   16
 A          642.       0.22       0.02                             PS79 2   17
 A          811.       0.93       0.12                             PS79 2   18
 B          632.       3.21       0.22                             PS79 2   19
 B          992.       23.2       1.6                              PS79 2   20
 C          620.       4.0        0.4                              PS79 2   21
ENDDATA             7                                              PS79 2   22
ENDSUBENT           2                                              PS79 299999
ENDENTRY            2                                              PS799999999
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PSM69

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ENTRY            PSM69         0                                  PSM69 0    1
SUBENT        PSM69  1         0                                  PSM69 1    1
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BIB                 12         53                                  PSM69 1    2
INSTITUTE  (USAORE)                                                PSM69 1    3
REFERENCE  (J,PR,181,4,1555,1969)                                  PSM69 1    4
AUTHORS    (C.J.PILUSO,G.C.SALZMAN,D.K.MCDANIELS)                  PSM69 1    5
TITLE      LIFETIME AND ANGULAR DISTRIBUTION MEASUREMENTS          PSM69 1    6
           FROM THE 31P(P,GAMMA)32S REACTION                       PSM69 1    7
FACILITY   (VDG) 4-MV VAN DE GRAAFF ACCELERATOR, DEPT. OF          PSM69 1    8
           PHYSICS, UNIVERSITY OF OREGON, EUGENE, OREGON.          PSM69 1    9
INC-PART   (P) PROTONS.                                            PSM69 1   10
TARGETS    PHOSPHORUS TARGET MADE FROM 99.999%-PURE ZN3P2          PSM69 1   11
           EVAPORATED ONTO 0.010-INCH THICK GOLD BACKING WAS       PSM69 1   12
           USED FOR MOST OF THE MEASUREMENTS. A FLUORINE TARGET    PSM69 1   13
           MADE FROM BAF2 EVAPORATED ONTO A 0.010-INCH THICK       PSM69 1   14
           TANTALUM BACKING WAS USED FOR SYSTEM ASYMMETRY          PSM69 1   15
           DETERMINATIONS.                                         PSM69 1   16
METHOD     8-10 KEV THICK PHOSPHORUS TARGETS WERE USED IN THE      PSM69 1   17
           MEASUREMENTS. THE GE(LI) DETECTOR WAS PLACED 1.6        PSM69 1   18
           INCHES FROM THE TARGET AT 55 DEGREES AND 90 DEGREES     PSM69 1   19
           RELATIVE TO THE INCIDENT PROTONS. GAMMA-RAY SPECTRA     PSM69 1   20
           WERE OBTAINED FOR PROTON ENERGIES CORRESPONDING TO      PSM69 1   21
           THE 1.248-, 1.438-, 1.556- AND 1.583-MEV RESONANCES     PSM69 1   22
           IN THE 31P(P,GAMMA)32S REACTION. THE GE(LI)             PSM69 1   23
           DETECTOR ENERGY SCALE CALIBRATION WAS ESTABLISHED,      PSM69 1   24
           AND PEAK CENTROIDS WERE LOCATED AS DESCRIBED IN THE     PSM69 1   25
           ORIGINAL PAPER AND OTHER REFERENCES CITED THEREIN.      PSM69 1   26
           THE LIFETIMES OF SEVERAL LEVELS WERE DETERMINED BY      PSM69 1   27
           THE DOPPLER-SHIFT-ATTENUATION METHOD. THE 1.438-        PSM69 1   28
           AND 1.556-MEV RESONANCES WERE THE MOST USEFUL FOR       PSM69 1   29
           THESE LIFETIME MEASUREMENTS. ANGULAR DISTRIBUTION       PSM69 1   30
           MEASUREMENTS WERE MADE WITH THE GE(LI) DETECTOR         PSM69 1   31
           LOCATED 2.7 INCHES FROM THE TARGET AT 90, 75, 60,       PSM69 1   32
           52, 41, 30, AND 0 DEGREES RELATIVE TO THE INCIDENT      PSM69 1   33
           PROTONS. THE NAI(TL) DETECTOR WAS PLACED 6 INCHES       PSM69 1   34
           FROM THE TARGET AT 130 DEGREES DURING THESE             PSM69 1   35
           MEASUREMENTS. ALL THE ANGULAR DISTRIBUTIONS WERE        PSM69 1   36
           MEASURED AT THE 1.248- AND 1.438-MEV RESONANCES.        PSM69 1   37
           SYSTEM ASYMMETRY WAS CHECKED BY OBSERVING THE           PSM69 1   38
           ISOTROPIC 6.129-MEV GAMMA RAY FROM THE                  PSM69 1   39
           19F(P,ALPHA-GAMMA)16O REACTION.                         PSM69 1   40
DETECTORS  (GELI) 20-CM**3 GE(LI) DETECTOR.                        PSM69 1   41
           (NAI)  3-INCH X 3-INCH NAI(TL) SCINTILLATION            PSM69 1   42
           CRYSTAL DETECTOR.                                       PSM69 1   43
MONITORS   (CI) CURRENT INTEGRATOR.                                PSM69 1   44
           (SCINT) NAI(TL) SCINTILLATION CRYSTAL DETECTOR.         PSM69 1   45
CORRECTION CORRECTED DATA FOR BACKGROUND COUNTS, FINITE            PSM69 1   46
           SOLID ANGLE, AND INSTRUMENTAL ANISOTROPIES.             PSM69 1   47
ERR-ANALYS THE MAJOR SOURCE OF SYSTEMATIC ERROR WAS THE            PSM69 1   48
           POSSIBLE DEVIATION OF THE PROTON BEAM FROM THE          PSM69 1   49
           CENTER OF ROTATION OF THE GE(LI) DETECTOR.              PSM69 1   50
           ANOTHER SOURCE OF ERROR WAS GAIN SHIFTS IN THE          PSM69 1   51
           NAI(TL) DETECTOR WHICH ALTERED NORMALIZATION OF         PSM69 1   52
           THE DATA. PEAK AREA UNCERTAINTIES WERE THE MOST         PSM69 1   53
           IMPORTANT SOURCE OF ERROR IN ANALYZING ANGULAR          PSM69 1   54
           DISTRIBUTION DATA.                                      PSM69 1   55
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ENDBIB              53                                               PSM69 1   56
ENDSUBENT            1                                               PSM69 199999
SUBENT        PSM69  2          0                                    PSM69 2    1
BIB                  2          9                                    PSM69 2    2
REACTION   31P(P,GAMMA)32S                                           PSM69 2    3
COMMENTS   GAMMA-RAY BRANCHING RATIOS FOR DECAY OF RESONANCES        PSM69 2    4
           IN 31P(P,GAMMA)32S ARE GIVEN. EP = RESONANCE PROTON       PSM69 2    5
           ENERGY. EX = EXCITATION ENERGY IN 32S. EI = INITIAL       PSM69 2    6
           STATE FOR GAMMA-RAY TRANSITION. EF = FINAL STATE.         PSM69 2    7
           B = BRANCHING RATIO. B-ERR = ERROR IN B. THESE ERRORS     PSM69 2    8
           ARE GENERALLY 10 PERCENT. DATA FROM TABLE I OF THE        PSM69 2    9
           ORIGINAL PAPER. PCT = PERCENT. BLANK ENTRIES IMPLY        PSM69 2   10
           VALUE IS NOT AVAILABLE IN THE ORIGINAL PAPER.             PSM69 2   11
ENDBIB               9                                               PSM69 2   12
DATA                 6         31                                    PSM69 2   13
EP         EX         EI         EF         B          B-ERR         PSM69 2   14
MEV        MEV        MEV        MEV        PCT        PCT           PSM69 2   15
 1.248      10.073     10.073     0.         2.         0.2          PSM69 2   16
 1.248      10.073     10.073     2.230      29.        2.9          PSM69 2   17
 1.248      10.073     10.073     4.280      2.         0.2          PSM69 2   18
 1.248      10.073     10.073     4.694      2.         0.2          PSM69 2   19
 1.248      10.073     10.073     5.006      14.        1.4          PSM69 2   20
 1.248      10.073     10.073     5.410      4.         0.4          PSM69 2   21
 1.248      10.073     10.073     6.226      47.        4.7          PSM69 2   22
 1.438      10.257     10.257     0.         0.1                     PSM69 2   23
 1.438      10.257     10.257     2.230      1.         0.1          PSM69 2   24
 1.438      10.257     10.257     4.459      9.         0.9          PSM69 2   25
 1.438      10.257     10.257     5.006      5.         0.5          PSM69 2   26
 1.438      10.257     10.257     6.623      76.        7.6          PSM69 2   27
 1.438      10.257     10.257     7.952      9.         0.9          PSM69 2   28
 1.556      10.371     10.371     0.         0.5                     PSM69 2   29
 1.556      10.371     10.371     2.230      11.        1.1          PSM69 2   30
 1.556      10.371     10.371     4.280      40.        4.           PSM69 2   31
 1.556      10.371     10.371     4.694      11.        1.1          PSM69 2   32
 1.556      10.371     10.371     5.006      2.         0.2          PSM69 2   33
 1.556      10.371     10.371     5.410      12.        1.2          PSM69 2   34
 1.556      10.371     10.371     5.544      4.         0.4          PSM69 2   35
 1.556      10.371     10.371     6.226      3.         0.3          PSM69 2   36
 1.556      10.371     10.371     6.664      13.        1.3          PSM69 2   37
 1.556      10.371     10.371     7.188      1.         0.1          PSM69 2   38
 1.556      10.371     10.371     7.485      2.         0.2          PSM69 2   39
 1.583      10.398     10.398     0.         0.5                     PSM69 2   40
 1.583      10.398     10.398     2.230      1.                      PSM69 2   41
 1.583      10.398     10.398     4.280      2.         0.2          PSM69 2   42
 1.583      10.398     10.398     4.459      1.         0.1          PSM69 2   43
 1.583      10.398     10.398     5.006      7.         0.7          PSM69 2   44
 1.583      10.398     10.398     6.623      85.        8.5          PSM69 2   45
 1.583      10.398     10.398     7.952      4.         0.4          PSM69 2   46
ENDDATA             33                                               PSM69 2   47
ENDSUBENT            2                                               PSM69 299999
SUBENT        PSM69  3          0                                    PSM69 3    1
BIB                  2          9                                    PSM69 3    2
REACTION   31P(P,GAMMA)32S                                           PSM69 3    3
COMMENTS   DOPPLER-SHIFT-ATTENUATION MEASUREMENTS OF 32S STATE       PSM69 3    4
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          LIFETIMES ARE GIVEN. EX = LEVEL EXCITATION ENERGY.      PSM69 3    5
          TAU = MEAN LIFETIME OF THE INDICATED LEVEL. SOME OF     PSM69 3    6
          THE ERRORS ARE ASYMMETRIC. THEREFORE TWO COMPONENTS     PSM69 3    7
          MUST BE GIVEN. TAU-ERR(+) = POSITIVE LOBE. TAU-ERR(-)   PSM69 3    8
          = NEGATIVE LOBE. A BLANK ENTRY INDICATES THAT NO        PSM69 3    9
          VALUE IS AVAILABLE. DATA OBTAINED FROM TABLE II OF      PSM69 3   10
          THE ORIGINAL PAPER. PICOSEC = 10**(-12) SECOND.         PSM69 3   11
ENDBIB             9                                              PSM69 3   12
DATA               4         10                                   PSM69 3   13
EX        TAU        TAU-ERR(+) TAU-ERR(-)                        PSM69 3   14
MEV       PICOSEC    PICOSEC    PICOSEC                           PSM69 3   15
 3.775     0.52       0.30       0.10                             PSM69 3   16
 4.280     0.029      0.002      0.002                            PSM69 3   17
 4.694     0.53       0.05       0.05                             PSM69 3   18
 5.006     1.50       2.50       0.70                             PSM69 3   19
 5.410     0.097      0.005      0.005                            PSM69 3   20
 5.544     0.043      0.035      0.035                            PSM69 3   21
 6.226     0.11       0.05       0.03                             PSM69 3   22
 6.623     0.37       0.08       0.08                             PSM69 3   23
 6.664     0.054      0.013      0.009                            PSM69 3   24
 7.952     0.01                                                   PSM69 3   25
ENDDATA           12                                              PSM69 3   26
ENDSUBENT          3                                              PSM69 399999
SUBENT       PSM69  4         0                                   PSM69 4    1
BIB                2         12                                   PSM69 4    2
REACTION  31P(P,GAMMA)32S                                         PSM69 4    3
COMMENTS  LEAST-SQUARE-FIT ANGULAR DISTRIBUTION COEFFICIENTS      PSM69 4    4
          FOR GAMMA RAYS FROM THE DECAY OF THE RESONANCES IN      PSM69 4    5
          THE 31P(P,GAMMA)32S REACTION ARE GIVEN. DATA FROM       PSM69 4    6
          TABLE III OF THE ORIGINAL PAPER. EP = RESONANCE         PSM69 4    7
          PROTON ENERGY. EX = EXCITATION ENERGY IN 32S. EI =      PSM69 4    8
          INITIAL ENERGY OF GAMMA-RAY TRANSITION. EF = FINAL      PSM69 4    9
          ENERGY. A2 = COEFFICIENT OF P2 TERM IN THE LEGENDRE     PSM69 4   10
          POLYNOMIAL EXPANSION OF ANGULAR DISTRIBUTION. A2-ERR    PSM69 4   11
          = ERROR IN A2. A4 = COEFFICIENT OF P4 TERM IN           PSM69 4   12
          THE LEGENDRE POLYNOMIAL EXPANSION OF ANGULAR            PSM69 4   13
          DISTRIBUTION. A4 = ERROR IN A4.                         PSM69 4   14
ENDBIB            12                                              PSM69 4   15
DATA               8         13                                   PSM69 4   16
EP        EX         EI         EF         A2         A2-ERR      PSM69 4   17
A4        A4-ERR                                                  PSM69 4   18
MEV       MEV        MEV        MEV        NO-DIM     NO-DIM      PSM69 4   19
NO-DIM    NO-DIM                                                  PSM69 4   20
 1.248     10.073     10.073     6.226      0.238      0.015      PSM69 4   21
 0.044     0.014                                                  PSM69 4   22
 1.248     10.073     10.073     5.410     -0.172      0.090      PSM69 4   23
-0.046     0.100                                                  PSM69 4   24
 1.248     10.073     10.073     5.006     -0.130      0.024      PSM69 4   25
 0.042     0.027                                                  PSM69 4   26
 1.248     10.073     10.073     2.230      0.278      0.032      PSM69 4   27
 0.015     0.034                                                  PSM69 4   28
 1.248     10.073     10.073     0.0        0.516      0.129      PSM69 4   29
 0.004     0.130                                                  PSM69 4   30
 1.248     10.073     6.226      2.230      0.100      0.004      PSM69 4   31
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 0.001      0.004                                                     PSM69 4   32
 1.248      10.073     5.410      2.230      0.066      0.040         PSM69 4   33
 0.077      0.041                                                     PSM69 4   34
 1.248      10.073     5.006      2.230     -0.279      0.027         PSM69 4   35
-0.063      0.030                                                     PSM69 4   36
 1.438      10.257     10.257     6.623      0.655      0.028         PSM69 4   37
 0.028      0.031                                                     PSM69 4   38
 1.438      10.257     10.257     5.006     -0.305      0.038         PSM69 4   39
-0.223      0.040                                                     PSM69 4   40
 1.438      10.257     10.257     4.459      0.609      0.055         PSM69 4   41
 0.010      0.056                                                     PSM69 4   42
 1.438      10.257     6.623      5.006      0.491      0.037         PSM69 4   43
 0.224      0.041                                                     PSM69 4   44
 1.438      10.257     6.623      4.459      0.559      0.020         PSM69 4   45
-0.031      0.022                                                     PSM69 4   46
ENDDATA             30                                                PSM69 4   47
ENDSUBENT            4                                                PSM69 499999
SUBENT        PSM69  5          0                                     PSM69 5    1
BIB                  2          8                                     PSM69 5    2
REACTION   31P(P,GAMMA)32S                                            PSM69 5    3
COMMENTS   M1/E2 MULTIPOLE MIXING RATIOS DERIVED FROM MEASURED        PSM69 5    4
           ANGULAR DISTRIBUTIONS ARE GIVEN. DATA OBTAINED FROM        PSM69 5    5
           TABLE V OF THE ORIGINAL PAPER. EI = ENERGY OF INITIAL      PSM69 5    6
           32S STATE FOR GAMMA-RAY TRANSITION. EF = ENERGY OF         PSM69 5    7
           FINAL STATE. DELTA = M1/E2 MULTIPOLE MIXING RATIO.         PSM69 5    8
           DELTA-ERR = ERROR IN DELTA. AMBIGUOUS VALUES FROM          PSM69 5    9
           THE TABLE IN THE ORIGINAL PAPER ARE NOT GIVEN.             PSM69 5   10
ENDBIB               8                                                PSM69 5   11
DATA                 4          5                                     PSM69 5   12
EI         EF         DELTA      DELTA-ERR                            PSM69 5   13
MEV        MEV        NO-DIM     NO-DIM                               PSM69 5   14
 10.073     2.230       0.06       0.02                               PSM69 5   15
 10.073     5.006       0.02       0.03                               PSM69 5   16
 10.073     6.226      -0.07       0.03                               PSM69 5   17
 6.226      2.230      -0.14       0.02                               PSM69 5   18
 5.006      2.230      -3.5        0.8                                PSM69 5   19
ENDDATA              7                                                PSM69 5   20
ENDSUBENT            5                                                PSM69 699999
ENDENTRY             5                                                PSM699999999
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R+95

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ENTRY             R+95          0                                      R+95 0    1
SUBENT        R+95  1           0                                      R+95 1    1
BIB                12          76                                      R+95 1    2
INSTITUTES (USANOT)                                                    R+95 1    3
           (USAPTN)                                                    R+95 1    4
           (USAYAL)                                                    R+95 1    5
REFERENCE  (J,PR/C,52,3,1681,1995)                                     R+95 1    6
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AUTHORS    (J.G.ROSS,J.GOERRES,C.ILIADIS,S.VOUZOUKAS,M.WIESCHER,    R+95 1
           R.P.VOGELAAR,S.UTKU,N.P.T.BATEMAN,P.D.PARKER)            R+95 1
TITLE      INDIRECT STUDY OF LOW-ENERGY RESONANCES IN               R+95 1
           31P(P,ALPHA)28SI AND 35CL(P,ALPHA)32S                    R+95 1
FACILITIES (CYCC) AVF CYCLOTRON, PRINCETON UNIVERSITY, PRINCETON,   R+95 1
           NEW JERSEY.                                              R+95 1
           SNICS ION SOURCE, NOTRE DAME UNIVERSITY, NOTRE DAME,     R+95 1
           INDIANA.                                                 R+95 1
INC-PART   (3HE) HELIUM-3 PARTICLES                                 R+95 1
TARGETS    PHOSPHORUS TARGETS WERE PREPARED BY VACUUM EVAPORATION   R+95 1
           OF A 30 - 50 MICROGRAM/CM**2 CO2P LAYER ONTO A 40        R+95 1
           MICROGRAM/CM**2 CARBON FOIL. A PURE CO TARGET WAS ALSO   R+95 1
           MADE. ISOTOPICALLY PURE 35CL TARGETS WERE PREPARED BY    R+95 1
           60-KEV IMPLANTATION USING THE NOTRE DAME SNICS ION       R+95 1
           IMPLANTATION FACILITY. THE 35CL IONS WERE INTRODUCED     R+95 1
           INTO 40 MICROGRAM/CM**2 CARBON FOILS. THE RESULTING      R+95 1
           THICKNESS OF THE 35CL TARGET WAS 6 MICROGRAM/CM**2.      R+95 1
METHOD     BEAMS OF HELIUM-3 PARTICLES WERE PROVIDED AT 25 MEV      R+95 1
           ENERGY BY THE PRINCETON AVF CYCLOTRON. THE AVERAGE       R+95 1
           BEAM INTENSITY WAS 50 NANOAMP. THE REACTION DEUTERONS    R+95 1
           FROM THE 31P(3HE,D)32S REACTION WERE DETECTED AT         R+95 1
           ZERO DEGREE LABORATORY ANGLE IN THE FOCAL PLANE OF       R+95 1
           THE PRINCETON QDDD MAGNETIC SPECTROMETER. DETAILS ARE    R+95 1
           GIVEN IN A REFERENCE LISTED IN THE ORIGINAL PAPER. THE   R+95 1
           TYPICAL ENERGY RESOLUTION WAS ABOUT 20 KEV WHICH WAS     R+95 1
           SUFFICIENT TO RESOLVE MOST OF THE LEVELS OF INTEREST.    R+95 1
           THE ENERGY CALIBRATION OF THE DEUTERON SPECTROMETER      R+95 1
           WAS PERFORMED USING WELL-KNOWN STRONGLY POPULATED        R+95 1
           LEVELS OF 32S. PROTONS AND ALPHA PARTICLES FROM THE      R+95 1
           DECAY OF THE POPULATED STATES WERE COLLECTED IN          R+95 1
           COINCIDENCE WITH THE CORRESPONDING DEUTERON GROUPS       R+95 1
           USING THREE SILICON SURFACE BARRIER DETECTORS LOCATED    R+95 1
           AT 90, 110, AND 145 DEGREE LABORATORY ANGLES RELATIVE    R+95 1
           TO THE INCIDENT BEAM DIRECTION. THE DETECTORS WERE       R+95 1
           PLACED AT 9.5 CM DISTANCE FROM THE TARGET. THESE         R+95 1
           DETECTORS WERE ENERGY CALIBRATED WITH A 241AM            R+95 1
           ALPHA-PARTICLE SOURCE (E-ALPHA = 5.48 MEV). THEIR        R+95 1
           ENERGY RESOLUTION WAS DETERMINED TO BE ABOUT 100         R+95 1
           KEV. THE DETECTOR SOLID ANGLES WERE CALCULATED FROM      R+95 1
           GEOMETRIC CONSIDERATIONS AND WERE EXPERIMENTALLY         R+95 1
           CONFIRMED USING THE STRONG 19F(3HE,D-ALPHA) REACTION     R+95 1
           TO THE 0+ STATE AT 6.725 MEV IN 20NE WHICH DECAYS        R+95 1
           100 PERCENT INTO THE ISOTROPIC 16O(G.S.)+ALPHA           R+95 1
           CHANNEL. THE USE OF THREE DETECTORS ALLOWED A DIRECT     R+95 1
           MEASUREMENT OF ANGULAR DISTRIBUTIONS WHICH, IN TURN,     R+95 1
           WERE FITTED WITH EVEN-ORDER LEGENDRE-POLYNOMIAL          R+95 1
           EXPANSIONS UP TO ORDER P4. THE GAMMA-RAY DECAY OF        R+95 1
           POPULATED STATES WAS MEASURED USING A NAI DETECTOR       R+95 1
           PLACED IN CLOSE PROXIMITY (5.4 CM) TO THE TARGET AT      R+95 1
           AROUND 90 DEGREES RELATIVE TO THE BEAM DIRECTION.        R+95 1
           A 3-MM THIN LEAD PLATE WAS POSITIONED BETWEEN THIS       R+95 1
           DETECTOR AND THE TARGET TO REDUCE THE COUNT RATE FROM    R+95 1
           LOW-ENERGY GAMMA RAYS. THE GAMMA-RAYS WERE MEASURED      R+95 1
           IN COINCIDENCE WITH THE VARIOUS DEUTERON GROUPS. THE     R+95 1
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           NAI DETECTOR EFFICIENCY WAS CALCULATED FROM KNOWLEDGE    R+95 1   61
           OF THE GEOMETRY AND KNOWN PHOTON CROSS SECTIONS. THE     R+95 1   62
           CALCULATED EFFICIENCY WAS CHECKED BY A COMPARISON WITH   R+95 1   63
           MEASURED GAMMA-RAY YIELDS OBTAINED FROM A CALIBRATED     R+95 1   64
           137CS RADIOACTIVE GAMMA-RAY SOURCE AND FROM THE          R+95 1   65
           GAMMA-RAY DECAY OF A THE WELL-KNOWN STATE AT 9.059       R+95 1   66
           MEV EXCITATION IN 32S. ATTENUATION COEFFICIENTS FOR      R+95 1   67
           LEAD AND ALUMINUM WERE TAKEN FROM STANDARD TABLES.       R+95 1   68
DETECTORS  (SOLST) 450-MM*2 SILICON SURFACE BARRIER DETECTORS.      R+95 1   69
           (SCINT) 12.7-CM X 10.2-CM NAI DETECTOR.                  R+95 1   70
MONITOR    (CI) CURRENT INTEGRATOR.                                 R+95 1   71
CORRECTION DATA WERE CORRECTED FOR GAMMA-RAY ATTENUATION DUE        R+95 1   72
           TO LEAD AND ALUMINUM PLACED BETWEEN THE TARGET AND       R+95 1   73
           THE NAI DETECTOR. CORRECTIONS WERE APPLIED FOR THE       R+95 1   74
           GAMMA-RAY DETECTOR EFFICIENCY.                           R+95 1   75
ERR-ANALYS ERRORS ARE GIVEN BUT FEW DETAILS ARE PROVIDED IN THE     R+95 1   76
           ORIGINAL PAPER CONCERNING THE METHOD FOR ESTIMATING      R+95 1   77
           THESE ERRORS.                                            R+95 1   78
ENDBIB             76                                               R+95 1   79
ENDSUBENT           1                                               R+95 199999
SUBENT        R+95  2          0                                    R+95 2    1
BIB                 2         11                                    R+95 2    2
REACTION   31P(3HE,D-GAMMA)32S                                      R+95 2    3
COMMENTS   RELATIVE GAMMA-RAY WIDTHS OF PROTON UNBOUND STATES IN    R+95 2    4
           32S ARE GIVEN. DATA TAKEN FROM TABLE I OF THE ORIGINAL   R+95 2    5
           PAPER. EX = EXCITATION ENERGY OF RESONANT STATE IN       R+95 2    6
           32S. EP-CM = EQUIVALENT PROTON CM ENERGY OF RESONANCE.   R+95 2    7
           J-PI = SPIN/PARITY OF RESONANCE. A NEGATIVE VALUE        R+95 2    8
           SIGNIFIES NEGATIVE PARITY. OTHERWISE PARITY IS           R+95 2    9
           POSITIVE. T = ISOBARIC SPIN. RATIO = GAM(G)/GAM(T),      R+95 2   10
           WHERE GAM(G) = GAMMA-RAY WIDTH AND GAM(T) = TOTAL        R+95 2   11
           WIDTH. RATIO-ERR = ERROR IN RATIO. A BLANK SPACE         R+95 2   12
           INDICATES THAT THE VALUE IS NOT AVAILABLE.               R+95 2   13
ENDBIB             11                                               R+95 2   14
DATA                6          8                                    R+95 2   15
EX         EP-CM      J-PI       T          RATIO      RATIO-ERR    R+95 2   16
MEV        MEV        NO-DIM     NO-DIM     NO-DIM     NO-DIM       R+95 2   17
 9.023      0.159     -3.         0.         0.75       0.19        R+95 2   18
 9.059      0.194                            1.0        0.2         R+95 2   19
 9.170      0.305      3.         1.         1.0        0.3         R+95 2   20
 9.208      0.344      1.         1.         1.2        0.3         R+95 2   21
 9.236      0.371     -1.         0.         0.15                   R+95 2   22
 9.255      0.390      2.         1.         0.84       0.22        R+95 2   23
 9.290      0.425      1.                    1.03       0.26        R+95 2   24
 9.389      0.524     -2.                    0.05                   R+95 2   25
ENDDATA            10                                               R+95 2   26
ENDSUBENT           2                                               R+95 299999
SUBENT        R+95  3          0                                    R+95 3    1
BIB                 2         14                                    R+95 3    2
REACTION   31P(P,GAMMA)32S                                          R+95 3    3
COMMENTS   RESONANCE ENERGIES AND RESONANCE STRENGTHS ARE GIVEN     R+95 3    4
           FOR THE 31P(P,GAMMA)32S REACTION. EX = EXCITATION        R+95 3    5
           ENERGY IN 32S. EP-CM = PROTON ENERGY IN CM FOR THE       R+95 3    6
           RESONANCE. J-PI = SPIN/PARITY OF THE RESONANCE. A        R+95 3    7
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          NEGATIVE VALUE IMPLIES NEGATIVE PARITY. OTHERWISE THE    R+95 3    8
          PARITY IS POSITIVE. GAM(P)-EF = EFFECTIVE PROTON         R+95 3    9
          WIDTH = (2J+1)*GAM(P), WHERE J = RESONANCE SPIN AND      R+95 3   10
          GAM(P) = PROTON WIDTH. S = RESONANCE STRENGTH =          R+95 3   11
          (2J+1)*GAM(P)*GAM(G)/GAM(T), WHERE GAM(G) = GAMMA-RAY    R+95 3   12
          WIDTH AND GAM(T) = TOTAL WIDTH. S-ERR = ERROR IN S.      R+95 3   13
          DATA OBTAINED FROM TABLE III OF THE ORIGINAL PAPER.      R+95 3   14
          A BLANK SPACE INDICATES THAT THE VALUE IS NOT            R+95 3   15
          AVAILABLE IN THE ORIGINAL PAPER.                         R+95 3   16
ENDBIB              14                                             R+95 3   17
DATA                 6          11                                 R+95 3   18
EX         EP-CM      J-PI       GAM(P)-EFF S          S-ERR       R+95 3   19
MEV        MEV        NO-DIM     NO-DIM     EV         EV          R+95 3   20
 9.023      0.159     -3.         9.1000E-11 5.6000E-11 3.2000E-11 R+95 3   21
 9.059      0.194                 4.9000E-06 1.9200E-06 6.4000E-07 R+95 3   22
 9.065      0.201      4.                    1.3200E-08            R+95 3   23
 9.170      0.305      3.                    1.4800E-04            R+95 3   24
 9.196      0.331      2.                    2.4400E-04            R+95 3   25
 9.208      0.344      1.         0.024      0.0168     0.0028     R+95 3   26
 9.236      0.371     -1.         0.02       2.4000E-04 4.8000E-05 R+95 3   27
 9.255      0.390      2.         0.0026     0.0018     2.8000E-04 R+95 3   28
 9.290      0.425      1.         0.28       0.100        0.016    R+95 3   29
 9.389      0.524     -2.         7.75       0.48         0.08     R+95 3   30
 9.464      0.600      2.                    0.0044       0.0008   R+95 3   31
ENDDATA             13                                             R+95 3   32
ENDSUBENT            3                                             R+95 399999
ENDENTRY             3                                             R+959999999
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RDS77

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ENTRY            RDS77          0                                 RDS77 0    1
SUBENT        RDS77  1          0                                 RDS77 1    1
BIB                 12         46                                 RDS77 1    2
INSTITUTE  (CANOTC)                                               RDS77 1    3
REFERENCE  (J,NP/A,281,345,1977)                                  RDS77 1    4
AUTHORS    (D.W.O.ROGERS,W.R.DIXON,R.S.STOREY)                    RDS77 1    5
TITLE      A STUDY OF THE 28SI(ALPHA,GAMMA)32S RESONANCES BELOW   RDS77 1    6
           E-ALPHA = 3.83 MEV                                     RDS77 1    7
FACILITY   (VDG) NRC 4-MV VAN DE GRAAFF ACCELERATOR, NATIONAL     RDS77 1    8
           RESEARCH COUNCIL OF CANADA, OTTAWA, CANADA.            RDS77 1    9
INC-PART   (4HE) HELIUM-4 (ALPHA) PARTICLES.                      RDS77 1   10
TARGETS    A SILICON CRYSTAL SOLDERED TO A WATER-COOLED COPPER    RDS77 1   11
           BACKING WAS USED FOR MOST OF THE MEASUREMENTS. THIS    RDS77 1   12
           TARGET WAS INFINITELY THICK AND CHEMICALLY VERY PURE.  RDS77 1   13
           MEASUREMENTS AT THE TWO HIGHEST-ENERGY RESONANCES      RDS77 1   14
           WERE PERFORMED USING SILICON TARGETS THAT WERE ONLY    RDS77 1   15
           10 KEV THICK TO 4-MEV ALPHA PARTICLES.                 RDS77 1   16
METHOD     4HE+ BEAM WITH CURRENTS IN THE RANGE 5 - 10 MICROAMP   RDS77 1   17
           WERE OBTAINED FROM THE NRC 4-MV VAN DE GRAAFF          RDS77 1   18
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            ACCELERATOR. BACKGROUND GAMMA RAYS WERE DETERMINED      RDS77 1   29
            BY RECORDING SPECTRA AT ALPHA-PARTICLE ENERGIES JUST    RDS77 1   20
            ABOVE AND JUST BELOW THE RESONANCE BEING STUDIED.       RDS77 1   21
            THE TARGET WAS SUUROUNDED BY A SHROUD KEPT AT LIQUID    RDS77 1   22
            NITROGEN TEMPERATURES TO REDUCE CARBON BUILD UP.        RDS77 1   23
            THIS SHROUD WAS HELD AT -300 VDC TO INSURE PROPER       RDS77 1   24
            MEASUREMENT OF TARGET CURRENT. GAMMA-RAYS YIELDS        RDS77 1   25
            AS A FUNTION OF INCIDENT BEAM ENERGY WERE MEASURED      RDS77 1   26
            WITH A NAI DETECTOR PLACED AT 90 DEGREES. ELEVEN        RDS77 1   27
            RESONANCES WERE EVIDENT FROM STEPS IN THE MEASURED      RDS77 1   28
            EXCITATION FUNCTION. A GE(LI) DETECTOR WAS USED TO      RDS77 1   29
            COLLECT GAMMA-RAY SPECTRA AT NINE ALPHA-PARTICLE        RDS77 1   30
            ENERGIES. THIS DETECTOR WAS PLACED 4.2 CM AWAY FROM     RDS77 1   31
            THE TARGET. CALIBRATION OF THE MEASUREMENT SYSTEM       RDS77 1   32
            WAS ACCOMPLISHED BY USING THE 13C(P,GAMMA)14N           RDS77 1   33
            REACTION AT EP = 1.75 MEV TO GENERATE THE WELL-         RDS77 1   34
            KNOWN GAMMA-RAY LINE AT EG = 9168 KEV AND THE           RDS77 1   35
            28SI(ALPHA)GAMMA)32S REACTION AT E-ALPHA = 2.88         RDS77 1   36
            MEV TO PRODUCE GAMMA-RAY LINES WHICH COULD BE           RDS77 1   37
            USED AS SECONDARY STANDARDS. ALL OF THE GAMMA-RAY       RDS77 1   38
            MEASUREMENTS WERE CARRIED OUT AT 55 DEGREES RELATIVE    RDS77 1   39
            TO THE INCIDENT PARTICLE BEAMS TO MINIMIZE ANGULAR      RDS77 1   40
            DISTRIBUTION EFFECTS.                                   RDS77 1   41
DETECTOR    (SCINT) 12.7-CM X 10.2-CM NAI CRYSTAL SCINTILLATION     RDS77 1   42
            DETECTOR.                                               RDS77 1   43
            (GELI) 14-PERCENT EFFICIENT GE(LI) DETECTOR.            RDS77 1   44
MONITOR     (CI) CURRENT INTEGRATOR.                                RDS77 1   45
CORRECTION DATA WERE CORRECTED FOR DOPPLER EFFECTS.                 RDS77 1   46
ERR-ANALYS ERRORS ARE GIVEN BUT DETAILS OF ERROR ANALYSIS ARE       RDS77 1   47
            VERY LIMITED IN THEORIGINAL PAPER.                      RDS77 1   48
ENDBIB               46                                             RDS77 1   49
ENDSUBENT             1                                             RDS77 199999
SUBENT        RDS77  2          0                                   RDS77 2    1
BIB                   2         5                                   RDS77 2    2
REACTION    28SI(ALPHA,GAMMA)32S                                    RDS77 2    3
COMMENTS    EXCITATION ENERGIES OF LEVELS IN 32S ARE GIVEN.         RDS77 2    4
            DATA OBTAINED FROM TABLE 1 OF THE ORIGINAL PAPER.       RDS77 2    5
            EX = EXCITATION ENERGY OF LEVEL IN 32S. EX-ERR =        RDS77 2    6
            ERROR IN EX.                                            RDS77 2    7
ENDBIB                5                                             RDS77 2    8
DATA                  2        11                                   RDS77 2    9
EX          EX-ERR                                                  RDS77 2   10
KEV         KEV                                                     RDS77 2   11
 8494.       2.                                                     RDS77 2   12
 8690.       2.                                                     RDS77 2   13
 8861.       2.                                                     RDS77 2   14
 9023.       2.                                                     RDS77 2   15
 9065.       2.                                                     RDS77 2   16
 9236.       2.                                                     RDS77 2   17
 9466.       1.5                                                    RDS77 2   18
 9486.       2.                                                     RDS77 2   19
 9712.       2.                                                     RDS77 2   20
 10220.      2.                                                     RDS77 2   21
 10285.      2.                                                     RDS77 2   22
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ENDDATA             13                                                RDS77 2   23
ENDSUBENT            2                                                RDS77 299999
SUBENT        RDS77  3          0                                     RDS77 3    1
BIB                  2         13                                     RDS77 3    2
REACTION   28SI(ALPHA,GAMMA)32S                                       RDS77 3    3
COMMENTS   GAMMA-RAY BRANCHING RATIOS FOR THE DECAY OF EXCITED        RDS77 3    4
           STATES IN 32S ARE GIVEN. DATA OBTAINED FROM FIGURE 3       RDS77 3    5
           OF THE ORIGINAL PAPER. E-ALPHA = ALPHA-PARTICLE            RDS77 3    6
           ENERGY FOR EXCITING THE RESONANCE. EX = EXCITATION         RDS77 3    7
           ENERGY OF THE RESONANT STATE IN 32S. EI = INITIAL          RDS77 3    8
           ENERGY FOR GAMMA-RAY TRANSITION. EF = FINAL ENERGY.        RDS77 3    9
           J-PI(I) = SPIN/PARITY OF INITIAL STATE. J-PI(F) =          RDS77 3   10
           SPIN/PARITY OF FINAL STATE. A NEGATIVE VALUE IMPLIES       RDS77 3   11
           NEGATIVE PARITY. OTHERWISE PARITY IS POSITIVE. B =         RDS77 3   12
           GAMMA-RAY TRANSITION BRANCHING FACTOR. B-ERR = ERROR       RDS77 3   13
           IN B. PCT = PERCENT. A BLANK ENTRY IMPLIES THAT THE        RDS77 3   14
           VALUE IS UNAVAILABLE FROM THE ORIGINAL PAPER.              RDS77 3   15
ENDBIB              13                                                RDS77 3   16
DATA                 8         44                                     RDS77 3   17
E-ALPHA    EX         EI         J-PI(I)    EF         J-PI(F)        RDS77 3   18
B          B-ERR                                                      RDS77 3   19
MEV        MEV        MEV        NO-DIM     MEV        NO-DIM         RDS77 3   20
PCT        PCT                                                        RDS77 3   21
 3.81       10.29      10.29     -3.         0.         0.            RDS77 3   22
 1.                                                                   RDS77 3   23
 3.81       10.29      10.29     -3.         2.23       2.            RDS77 3   24
 6.         1.                                                        RDS77 3   25
 3.81       10.29      10.29     -3.         4.46       4.            RDS77 3   26
 15.        2.                                                        RDS77 3   27
 3.81       10.29      10.29     -3.         5.01      -3.            RDS77 3   28
 79.        2.                                                        RDS77 3   29
 3.74       10.22      10.22     -3.         2.23       2.            RDS77 3   30
 11.        1.                                                        RDS77 3   31
 3.74       10.22      10.22     -3.         4.46       4.            RDS77 3   32
 21.        2.                                                        RDS77 3   33
 3.74       10.22      10.22     -3.         4.70       1.            RDS77 3   34
 2.                                                                   RDS77 3   35
 3.74       10.22      10.22     -3.         5.01      -3.            RDS77 3   36
 68.        2.                                                        RDS77 3   37
 3.74       10.22      10.22     -3.         7.12                     RDS77 3   38
 2.                                                                   RDS77 3   39
 3.16       9.71       9.71       2.         0.         0.            RDS77 3   40
 9.         3.                                                        RDS77 3   41
 3.16       9.71       9.71       2.         2.23       2.            RDS77 3   42
 57.        6.                                                        RDS77 3   43
 3.16       9.71       9.71       2.         4.70       1.            RDS77 3   44
 34.        9.                                                        RDS77 3   45
 2.90       9.49       9.49      -1.         0.         0.            RDS77 3   46
 81.        2.                                                        RDS77 3   47
 2.90       9.49       9.49      -1.         2.23       2.            RDS77 3   48
 4.                                                                   RDS77 3   49
 2.90       9.49       9.49      -1.         3.78       0.            RDS77 3   50
 2.         1.                                                        RDS77 3   51
 2.90       9.49       9.49      -1.         4.28       2.            RDS77 3   52
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10.	1.					RDS77 3	53
2.90	9.49	9.49	-1.	5.01	-3.	RDS77 3	54
5.	1.					RDS77 3	55
2.90	9.49	9.49	-1.	7.12		RDS77 3	56
2.	1.					RDS77 3	57
2.88	9.47	9.47	2.	0.	0.	RDS77 3	58
34.	2.					RDS77 3	59
2.88	9.47	9.47	2.	2.23	2.	RDS77 3	60
26.	2.					RDS77 3	61
2.88	9.47	9.47	2.	3.78	0.	RDS77 3	62
5.	1.					RDS77 3	63
2.88	9.47	9.47	2.	4.46	4.	RDS77 3	64
4.	1.					RDS77 3	65
2.88	9.47	9.47	2.	4.70	1.	RDS77 3	66
20.	2.					RDS77 3	67
2.88	9.47	9.47	2.	5.01	-3.	RDS77 3	68
4.	1.					RDS77 3	69
2.88	9.47	9.47	2.	5.79		RDS77 3	70
4.	1.					RDS77 3	71
2.88	9.47	9.47	2.	5.55		RDS77 3	72
4.	1.					RDS77 3	73
2.61	9.24	9.24	-1.	0.	0.	RDS77 3	74
1.9	0.6					RDS77 3	75
2.61	9.24	9.24	-1.	2.23	2.	RDS77 3	76
58.	2.					RDS77 3	77
2.61	9.24	9.24	-1.	3.78	0.	RDS77 3	78
30.	2.					RDS77 3	79
2.61	9.24	9.24	-1.	4.70	1.	RDS77 3	80
11.	2.					RDS77 3	81
2.42	9.07	9.07		4.28	2.	RDS77 3	82
17.	3.					RDS77 3	83
2.42	9.07	9.07		4.46	4.	RDS77 3	84
41.	2.					RDS77 3	85
2.42	9.07	9.07		5.41		RDS77 3	86
43.	2.					RDS77 3	87
2.37	9.02	9.02		2.23	2.	RDS77 3	88
61.	2.					RDS77 3	89
2.37	9.02	9.02		4.28	2.	RDS77 3	90
20.	2.					RDS77 3	91
2.37	9.02	9.02		5.01	-3.	RDS77 3	92
19.	2.					RDS77 3	93
2.19	8.86	8.86	2.	0.	0.	RDS77 3	94
52.	5.					RDS77 3	95
2.19	8.86	8.86	2.	2.23	2.	RDS77 3	96
34.	4.					RDS77 3	97
2.19	8.86	8.86	2.	3.78	0.	RDS77 3	98
14.	4.					RDS77 3	99
1.99	8.69	8.69	2.	0.	0.	RDS77 3	100
32.	4.					RDS77 3	101
1.99	8.69	8.69	2.	2.23	2.	RDS77 3	102
56.	5.					RDS77 3	103
1.99	8.69	8.69	2.	3.78	0.	RDS77 3	104
12.	4.					RDS77 3	105
1.77	8.50	8.50	-1.	0.	0.	RDS77 3	106

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 62.        5.                                                    RDS77 3  107
 1.77       8.50       8.50      -1.         2.23       2.        RDS77 3  108
 38.        5.                                                    RDS77 3  109
ENDDATA            92                                             RDS77 3  110
ENDSUBENT           3                                             RDS77 399999
SUBENT        RDS77  4          0                                 RDS77 4    1
BIB                 2          20                                 RDS77 4    2
REACTIONS  31P(P,GAMMA)32S                                        RDS77 4    3
           31P(P,ALPHA)28SI                                       RDS77 4    4
           28SI(ALPHA,GAMMA)32S                                   RDS77 4    5
COMMENTS   PARTICLE AND GAMMA-RAY WIDTHS FOR STATES IN 32S ARE    RDS77 4    6
           GIVEN. DATA TAKEN FROM TABLE 4 OF THE ORIGINAL PAPER.  RDS77 4    7
           EX = EXCITATION ENERGY IN 32S. J-PI = SPIN/PARITY OF   RDS77 4    8
           STATE IN 32S. A NEGATIVE VALUE IMPLIES NEGATIVE        RDS77 4    9
           PARITY. OTHERWISE PARITY IS POSITIVE. GAM(G) = GAMMA-  RDS77 4   10
           RAY WIDTH. GAM(G)-ERR = ERROR IN GAM(G). GAM(P) =      RDS77 4   11
           PROTON WIDTH. GAM(P)-ERR = ERROR IN GAM(P). GAM(A) =   RDS77 4   12
           ALPHA-PARTICLE WIDTH. GAM(A)-ERR = ERROR IN GAM(A).    RDS77 4   13
           SPG = (2J+1)*GAM(P)*GAM(G)/GAM(T), WHERE J = SPIN      RDS77 4   14
           OF THE RESONANCE AND GAM(T) = TOTAL RESONANCE WIDTH.   RDS77 4   15
           SAG = (2J+1)*GAM(A)*GAM(G)/GAM(T). SPA0 =              RDS77 4   16
           (2J+1)*GAM(P)*GAM(A0)/GAM(T), WHERE GAM(A0) = WIDTH    RDS77 4   17
           FOR DECAY OF THE STATE IN 32S BY AN ALPHA-PARTICLE     RDS77 4   18
           TRANSITION TO 28SI GROUND STATE. SPG-ERR, SAG-ERR, AND RDS77 4   19
           SPA0-ERR ARE THE ERRORS IN THE RESPECTIVE STRENGTHS.   RDS77 4   20
           MILLIEV = 10**(-3) EV. BLANK ENTRIES INDICATE THAT     RDS77 4   21
           VALUES ARE NOT AVAILABLE IN THE ORIGINAL PAPER.        RDS77 4   22
ENDBIB             20                                             RDS77 4   23
DATA               14          11                                 RDS77 4   24
EX         J-PI       SAG        SAG-ERR    SPG        SPG-ERR    RDS77 4   25
SPA0       SPA0-ERR   GAM(G)     GAM(G)-ERR GAM(A)     GAM(A)-ERR RDS77 4   26
GAM(P)     GAM(P)-ERR                                             RDS77 4   27
MEV        NO-DIM     MILLIEV    MILLIEV    MILLIEV    MILLIEV    RDS77 4   28
MILLIEV    MILLIEV    MILLIEV    MILLIEV    MILLIEV    MILLIEV    RDS77 4   29
MILLIEV    MILLIEV                                                RDS77 4   30
 8.50      -1.         16.        3.                              RDS77 4   31
                       5.3                   5.3                  RDS77 4   32
                                                                  RDS77 4   33
 8.69       2.         12.        2.4                             RDS77 4   34
                       2.4                   2.4                  RDS77 4   35
                                                                  RDS77 4   36
 8.86       2.         16.        3.                              RDS77 4   37
                       3.2        0.7        3.2                  RDS77 4   38
                                                                  RDS77 4   39
 9.02                  52.        10.                             RDS77 4   40
                                                                  RDS77 4   41
                                                                  RDS77 4   42
 9.07                  64.        13.                             RDS77 4   43
                                                                  RDS77 4   44
                                                                  RDS77 4   45
 9.24      -1.         540.       100.       0.15                 RDS77 4   46
 30.                   180.       36.        180.                 RDS77 4   47
 10.                                                              RDS77 4   48
 9.47       2.         720.       150.       60.        18.       RDS77 4   49
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 100.       35.        242.       52.        400.       120.       RDS77 4   50
 34.        8.                                                     RDS77 4   51
 9.49      -1.         830.       170.       520.       80.        RDS77 4   52
 5400.      1600.      480.       60.        4900.      1200.      RDS77 4   53
 3100.      700.                                                   RDS77 4   54
 9.71       2.         630.       130.       290.       90.        RDS77 4   55
                       183.                  125.                  RDS77 4   56
 58.                                                               RDS77 4   57
 10.22     -3.         8100.      1600.      4300.      900.       RDS77 4   58
 90000.     17000.     1800.      300.       38000.     9000.      RDS77 4   59
 20000.     4000.                                                  RDS77 4   60
 10.29     -3.         2300.      400.       210.       60.        RDS77 4   61
 48000.     10000.     360.       70.        83000.     32000.     RDS77 4   62
 7600.      1400.                                                  RDS77 4   63
ENDDATA             39                                             RDS77 4   64
ENDSUBENT            4                                             RDS77 499999
ENDENTRY             4                                             RDS779999999
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RK71

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ENTRY            RK71          0                                    RK71 0    1
SUBENT        RK71  1          0                                    RK71 1    1
BIB                12         39                                    RK71 1    2
INSTITUTE  (SAF, UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG)     RK71 1    3
REFERENCE  (J,NC/A,3,2,347,1971)                                    RK71 1    4
AUTHORS    (M.J.RENAN,R.J.KEDDY)                                    RK71 1    5
TITLE      LIFETIMES OF LOW-LYING EXCITED STATES IN 32S             RK71 1    6
FACILITY   (C-W) COCKCROFT-WALTON ACCELERATOR, UNIVERSITY OF THE    RK71 1    7
           WITWATERSRAND, JOHANNESBURG, SOUTH AFRICA.               RK71 1    8
INC-PART   (P) PROTONS.                                             RK71 1    9
TARGETS    RED PHOSPHORUS POWDER (100 PERCENT PHOSPHORUS) WAS       RK71 1   10
           COMPRESSED TO A DENSITY OF 2.2 G/CM**2. EVAPORATED       RK71 1   11
           ZINC PHOSPHIDE TARGETS WERE FOUND, DUE TO ENERGY         RK71 1   12
           LIMITATIONS OF THE ACCELERATOR, TO PRODUCE               RK71 1   13
           ATTENUATED ENERGY SHIFTS TOO SMALL TO BE ACCURATELY      RK71 1   14
           MEASURED.                                                RK71 1   15
METHOD     THE DOPPLER-SHIFT-ATTENUATION METHOD (DSAM) WAS USED     RK71 1   16
           IN THIS EXPERIMENT. THREE RESONANCES WERE INVESTIGATED   RK71 1   17
           AT EP = 459, 541, AND 642 KEV. ALTERNATE SPECTRA WERE    RK71 1   18
           TAKEN AT 0 DEGREE AND 135 DEGREES. THE GAIN AND ZERO     RK71 1   19
           LEVELS OF THE SPECTRUM RECORDING APPARATUS WAS           RK71 1   20
           STABILIZED. STANDARD RADIOACTIVE SOURCES WERE PRESENT    RK71 1   21
           DURING ALL OF THE MEASUREMENTS TO MONITOR GAIN           RK71 1   22
           SHIFTS. THESE MEASUREMENTS YIELDED THE RATIO OF THE      RK71 1   23
           ATTENUATED DOPPLER SHIFT TO THE MAXIMUM SHIFT FOR        RK71 1   24
           RECOILING IONS THAT HAVE NOT BEEN SLOWED DOWN. THE       RK71 1   25
           EXPERIMENTAL VALUES ARE THEN COMPARED WITH VALUES        RK71 1   26
           DEDUCED FROM THE THEORY OF THE SLOWING DOWN OF IONS.     RK71 1   27
           COMPUTER ANALYSIS WAS USED TO DETERMINE THE CENTROIDS    RK71 1   28
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          OF THE GAMMA-RAY FULL-ENERGY PEAKS.                      RK71 1   29
DETECTOR   (GELI) 40-CM**3 GE(LI) DETECTOR WITH A RESOLUTION OF    RK71 1   30
           2.8 KEV FWHM AT 1.33 MEV.                               RK71 1   31
MONITOR    (CI) CURRENT INTEGRATOR.                                RK71 1   32
CORRECTION INSTRUMENTAL GAIN AND ZERO-POINT SHIFTS.                RK71 1   33
ERR-ANALYS THE QUOTED ERRORS INCLUDE THOSE IN THE DETERMINATION    RK71 1   34
           OF THE CENTROIDS OF THE PEAKS BUT DO NOT INCLUDE ANY    RK71 1   35
           UNCERTAINTIES IN THE SLOWING-DOWN THEORY. THE ERROR     RK71 1   36
           IN THE THEORETICAL STOPPING POWER WAS ASSUMED TO BE     RK71 1   37
           15 PERCENT AND IN THE ELECTRONIC STOPPING POWER 20      RK71 1   38
           PERCENT. THESE ERRORS LEAD TO A MAXIMUM ERROR OF        RK71 1   39
           ABOUT 10 PERCENT IN LIFETIMES LONGER THAN 10**(-13)     RK71 1   40
           SECOND AND LESS FOR SHORTER LIFETIMES.                  RK71 1   41
ENDBIB              39                                             RK71 1   42
ENDSUBENT            1                                             RK71 199999
SUBENT         RK71  2          0                                  RK71 2    1
BIB                  2          8                                  RK71 2    2
REACTION   31P(P,GAMMA)32S                                         RK71 2    3
COMMENTS   MEASURED LIFETIMES OF LEVELS IN 32S ARE GIVEN. DATA     RK71 2    4
           OBTAINED FROM TABLE I OF THE ORIGINAL PAPER. EI =       RK71 2    5
           ENERGY OF INITIAL STATE OF GAMMA-RAY TRANSITION. EF     RK71 2    6
           = ENERGY OF FINAL STATE. TAU = MEAN LIFETIME. TAU-ERR   RK71 2    7
           = ERROR IN TAU. FEMTOSEC = 10**(-15) SEC. A BLANK       RK71 2    8
           ENTRY INDICATES THAT THE VALUE IS NOT AVAILABLE IN THE  RK71 2    9
           ORIGINAL PAPER.                                         RK71 2   10
ENDBIB               8                                             RK71 2   11
DATA                 4          4                                  RK71 2   12
EI         EF         TAU        TAU-ERR                           RK71 2   13
MEV        MEV        FEMTOSEC   FEMTOSEC                          RK71 2   14
 2.23       0.         175.       30.                              RK71 2   15
 5.01       2.23       1000.      400.                             RK71 2   16
 6.23       2.23       130.       40.                              RK71 2   17
 9.389      6.23       1.                                          RK71 2   18
ENDDATA              6                                             RK71 2   19
ENDSUBENT            2                                             RK71 299999
SUBENT         RK71  3          0                                  RK71 3    1
BIB                  2         11                                  RK71 3    2
REACTION   31P(P,GAMMA)32S                                         RK71 3    3
COMMENTS   RADIATIVE TRANSITION STRENGTHS IN 32S ARE GIVEN. DATA   RK71 3    4
           ARE OBTAINED FROM TABLE II OF THE ORIGINAL PAPER.       RK71 3    5
           EI = ENERGY OF INITIAL STATE. EF = ENERGY OF FINAL      RK71 3    6
           STATE. J-PI(I) = SPIN/PARITY OF THE INITIAL STATE.      RK71 3    7
           J-PI(F) = SPIN/PARITY OF THE FINAL STATE. A NEGATIVE    RK71 3    8
           VALUE SIGNIFIES NEGATIVE PARITY. OTHERWISE, PARITY      RK71 3    9
           IS POSITIVE. MULT = RADIATION MULTIPOLARITY (E1, M1,    RK71 3   10
           E2). GAMMA(G) = RADIATIVE WIDTH. STRENG = TRANSITION    RK71 3   11
           STRENGTH. MILLEV = 10**(-3) EV. W.U. = WEISSKOPF        RK71 3   12
           UNITS.                                                  RK71 3   13
ENDBIB              11                                             RK71 3   14
DATA                 7          5                                  RK71 3   15
EI         J-PI(I)    EF         J-PI(F)    MULT       GAMMA(G)    RK71 3   16
STRENG                                                             RK71 3   17
MEV        NO-DIM     MEV        NO-DIM     NO-DIM     MILLEV      RK71 3   18
W.U.                                                               RK71 3   19
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 2.23       2.         0.         0.         E2         3.8        RK71 3   20
 13.9                                                               RK71 3   21
 5.01      -3.         2.23       2.         E1         0.66       RK71 3   22
 4.5000E-05                                                         RK71 3   23
 6.23      -2.         2.23       2.         E1         5.1        RK71 3   24
 1.2000E-04                                                         RK71 3   25
 9.389                 6.23      -2.         E1         66000.     RK71 3   26
 3.1                                                                RK71 3   27
 9.389                 6.23      -2.         M1         66000.     RK71 3   28
 0.01                                                               RK71 3   29
ENDDATA            14                                               RK71 3   30
ENDSUBENT           3                                               RK71 399999
ENDENTRY            3                                               RK719999999
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RWK87

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ENTRY            RWK87          0                                  RWK87 0    1
SUBENT        RWK87  1          0                                  RWK87 1    1
BIB                12          58                                  RWK87 1    2
INSTITUTE  (SFHLS)                                                 RWK87 1    3
REFERENCE  (J,NIM/B,28,199,1987)                                   RWK87 1    4
AUTHORS    (J.RAISANEN,T.WITTING,J.KEINONEN)                       RWK87 1    5
TITLE      ABSOLUTE THICK-TARGET GAMMA-RAY YIELDS FOR ELEMENTAL    RWK87 1    6
           ANALYSIS BY 7 AND 9 MEV PROTONS                         RWK87 1    7
FACILITY   (VDG) 5-MV TANDEM VAN DE GRAAFF ACCELERATOR             RWK87 1    8
           EGP-10-11, PHYSICS DEPARTMENT, UNIVERSITY OF            RWK87 1    9
           HELSINKI, HELSINKI, FINLAND.                            RWK87 1   10
INC-PART   (P) PROTONS                                             RWK87 1   11
TARGETS    INP THICK TARGET. PRESSED PELLET 1 MM THICK X           RWK87 1   12
           6 MM IN DIAMETER.                                       RWK87 1   13
METHOD     PROTON BEAMS WERE OBTAINED FROM THE 5-MV TANDEM         RWK87 1   14
           ACCELERATOR AT HELSINKI UNIVERSITY. GAMMA-RAYS          RWK87 1   15
           WERE DETECTED WITH A SHIELDED GE(LI) DETECTOR AT        RWK87 1   16
           55 DEGREES RELATIVE TO THE INCIDENT PROTON BEAM         RWK87 1   17
           IN ORDER TO MINIMIZE ANGULAR DISTRIBUTION EFFECTS.      RWK87 1   18
           UNCERTAINTIES DUE TO SMALL CHANGES IN SOLID ANGLE       RWK87 1   19
           OF THE DETECTOR FOR DIFFERENT TARGETS WERE KEPT TO      RWK87 1   20
           A MINIMUM BY THE USE OF A TARGET-TO-DETECTOR            RWK87 1   21
           DISTANCE OF 27 CM. THE ENERGY AND ABSOLUTE              RWK87 1   22
           EFFICIENCY OF THIS DETECTOR WAS DETERMINED USING        RWK87 1   23
           CALIBRATED SOURCES OF 60CO, 56CO, AND 152EU.            RWK87 1   24
           NEUTRONS WERE DETECTED WITH A BF3 COUNTER LOCATED       RWK87 1   25
           90 CM FROM THE TARGET. THE PROTON BEAM CURRENT WAS      RWK87 1   26
           ADJUSTED TO KEEP THE GAMMA-RAY COUNT RATE CONSTANT      RWK87 1   27
           AND THE DEAD TIME CORRECTION BELOW 1 PERCENT. THE       RWK87 1   28
           CURRENT VARIED BETWEEN 0.1 AND 20 NANOAMP. THE          RWK87 1   29
           CHARGE ON TARGET WAS RECORDED WITH AN ACCURATELY        RWK87 1   30
           CALIBRATED CURRENT INTEGRATOR AND CHARGE SUPPRESOR      RWK87 1   31
           ARRANGEMENT. THE ACCUMULATED CHARGE WAS IN THE          RWK87 1   32
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           RANGE 0.07 TO 31 MICROCOULOMB. ATTENTION WAS           RWK87 1   33
           GIVEN TO A FEW GAMMA-RAYS FOR EACH TARGET THAT         RWK87 1   34
           OFFERED PROMISE FOR SAMPLE ASSAY PURPOSES. IN          RWK87 1   35
           GENERAL, ALL GAMMA-RAYS WITH ENERGIES BELOW 511        RWK87 1   36
           KEV WERE EXCLUDED FROM CONSIDERATION. GENERALLY,       RWK87 1   37
           LOW-ENERGY GAMMA-RAYS WERE POORLY RESOLVED AND         RWK87 1   38
           THEIR YIELDS WERE HARD TO DETERMINE DUE SIGNIFICANT    RWK87 1   39
           ABSORPTION IN THE TARGET AND HOLDER.                   RWK87 1   40
DETECTOR   (PROP) BF3 COUNTER NEUTRON DETECTOR.                   RWK87 1   41
           (GELI) 80-CM**3 CANBERRA GE(LI) DETECTOR WITH A        RWK87 1   42
           RESOLUTION OF 1.9 KEV AT EG = 1.33 MEV AND AN          RWK87 1   43
           EFFICIENCY OF ABOUT 18 PERCENT.                        RWK87 1   44
MONITOR    (CI) CURRENT INTEGRATOR.                               RWK87 1   45
CORRECTION DATA CORRECTED FOR RECORDING SYSTEM DEAD TIME,         RWK87 1   46
           GAMMA-RAY ABSORPTION EFFECTS, AND DETECTOR             RWK87 1   47
           EFFICIENCY.                                            RWK87 1   48
ERR-ANALYS NO ERRORS ARE GIVEN. HOWEVER, IT WAS ESTIMATED         RWK87 1   49
           THAT THE ABSOLUTE GAMMA-RAY YIELD VALUES SHOULD        RWK87 1   50
           BE ACCURATE TO BETTER THAN 10 PERCENT. THE SOURCES     RWK87 1   51
           OF ERROR INCLUDED STOPPING POWER (2 PERCENT), GAMMA-   RWK87 1   52
           RAY INTENSITIES (2-5 PERCENT), AND ABSOLUTE GAMMA-     RWK87 1   53
           RAY DETECTOR EFFICIENCY (5 PERCENT). IN ORDER TO       RWK87 1   54
           STUDY POSSIBLE SYSTEMATIC EFFECTS, THE ELEMENTS        RWK87 1   55
           WERE INCLUDED IN VARIOUS COMPOUNDS. GENERALLY, THE     RWK87 1   56
           AGREEMENT FOR A PARTICULAR ELEMENT IN DIFFERENT        RWK87 1   57
           COMPOUNDS WAS BETTER THAN 20 PERCENT. THE DEVIATIONS   RWK87 1   58
           CAN BE EXPLAINED BY CHANGES IN TARGET STOICHIOMETRY    RWK87 1   59
           LEADING TO AN ERRONEOUS STOPPING POWER.                RWK87 1   60
ENDBIB             58                                             RWK87 1   61
ENDSUBENT           1                                             RWK87 199999
SUBENT        RWK87  2          0                                 RWK87 2    1
BIB                 2          9                                  RWK87 2    2
REACTIONS  A: 31P(P,P')31P                                        RWK87 2    3
           B: 31P(P,ALPHA)28SI                                    RWK87 2    4
           C: 31P(P,GAMMA)32S                                     RWK87 2    5
COMMENTS   ABSOLUTE THICK-TARGET GAMMA-RAY YIELDS ARE GIVEN FOR   RWK87 2    6
           A THICK INP TARGET. EP = INCIDENT PROTON ENERGY.       RWK87 2    7
           EG = CHARACTERISTIC GAMMA RAY. REACTION = SOURCE       RWK87 2    8
           REACTION FOR THE GAMMA RAY (A, B, C OR COMBINATION).   RWK87 2    9
           YLD = ABSOLUTE GAMMA-RAY YIELD. THE YIELD IS GIVEN     RWK87 2   10
           IN "UNIT". 1 UNIT =  1 COUNTS/MICROCOULOMB/STERADIAN.  RWK87 2   11
ENDBIB              9                                             RWK87 2   12
DATA                4          6                                  RWK87 2   13
EP         EG         REACTION   YLD                              RWK87 2   14
MEV        KEV        NO-DIM     UNIT                             RWK87 2   15
 7.         1266.       A          9.7400E+07                     RWK87 2   16
 7.         1779.       B          5.2200E+07                     RWK87 2   17
 7.         2230.       A,C        7.0100E+07                     RWK87 2   18
 9.         1266.       A          1.7400E+08                     RWK87 2   19
 9.         1779.       B          8.1000E+07                     RWK87 2   20
 9.         2230.       A,C        1.3300E+08                     RWK87 2   21
ENDDATA             8                                             RWK87 2   22
ENDSUBENT           2                                             RWK87 299999
ENDENTRY            2                                             RWK879999999
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S+99

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ENTRY            S+99          0                                 S+99 0    1
SUBENT        S+99  1          0                                 S+99 1    1
BIB                12         46                                 S+99 1    2
INSTITUTE  (GRC, INSTITUTE OF NUCLEAR TECHNOLOGY, RADIATION      S+99 1    3
           PROTECTION, NCSR "DEMOKRITOS", AGHIA PARASKEVI,       S+99 1    4
           ATTIKI, GREECE)                                       S+99 1    5
           (GRC, DEPARTMENT OF PHYSICS, THE UNIVERSITY OF        S+99 1    6
           IOANNINA, IOANNINA, GREECE)                           S+99 1    7
           (GRC, INSTITUTE OF NUCLEAR PHYSICS, NCSR "DEMOKRITOS", S+99 1   8
           AGHIA PARASKEVI, ATTIKI, GREECE)                      S+99 1    9
REFERENCE  (J,NIM/B,152,12,1999)                                 S+99 1   10
AUTHORS    (A.SAVIDOU,X.ASLANOGLOU,T.PARADELLIS,M.PILAKOUTA)     S+99 1   11
TITLE      PROTON INDUCED THICK TARGET GAMMA-RAY YIELDS OF LIGHT S+99 1   12
           NUCLEI AT THE ENERGY REGION EP = 1.0 - 4.1 MEV        S+99 1   13
FACILITY   (VDG) 5.5-MV TANDEM TN11 ACCELERATOR, INSTITUTE OF    S+99 1   14
           NUCLEAR PHYSICS, NCSR "DEMOKRITOS", ATHENS, GREECE.   S+99 1   15
INC-PART   (P) PROTONS.                                          S+99 1   16
TARGETS    PELLETS OF POWDER GRAPHITE AND CELLULOSE MIXED WITH   S+99 1   17
           LESS THAN 10 PERCENT OF A COMPOUND CONTAINING         S+99 1   18
           PHOSPHORUS. PARTICULAR COMPOUND WAS NOT MENTIONED.    S+99 1   19
           TARGETS WITH VARIOUS CONCENTRATIONS OF THE ELEMENT    S+99 1   20
           WERE EXAMINED. THESE WERE ALL STOPPING TARGETS.       S+99 1   21
METHOD     USED THE PROTON-INDUCED GAMMA-RAY EMISSION (PIGE)     S+99 1   22
           METHOD. THE PROTON BEAM WAS DIRECTED TO THE TARGET    S+99 1   23
           VIA TWO SETS OF COLLIMATORS OF DIAMETER 4 MM. THE     S+99 1   24
           TARGET WAS PLACED AT AN ANGLE OF 45 DEGREES RELATIVE  S+99 1   25
           TO THE INCIDENT PROTONS. THE TARGET WAS COOLED TO     S+99 1   26
           A TEMPERATURE OF 10 DEGREES CENTIGRADE USING AN       S+99 1   27
           ETHYL ALCOHOL REFRIGERATOR IN ORDER TO WITHSTAND      S+99 1   28
           HIGH BEAM CURRENTS. AN ELECTRICAL POTENTIAL OF 300    S+99 1   29
           VOLTS WAS APPLIED TO SUPPRESS SECONDARY EMISSION OF   S+99 1   30
           ELECTRONS FROM THE TARGET. AN INTRINSIC GE DETECTOR   S+99 1   31
           WAS PLACED AT AN ANGLE OF 90 DEGREES WITH RESPECT     S+99 1   32
           TO THE BEAM. THE SOLID ANGLE AND EFFICIENCY OF THIS   S+99 1   33
           DETECTOR WERE MEASURED USING A 152EU SOURCE OF KNOWN  S+99 1   34
           STRENGTH. BEAM EXPOSURES WERE SUFFICIENT TO INSURE    S+99 1   35
           GOOD STATISTICS IN ALL MEASURED SPECTRA. EXCITATION   S+99 1   36
           FUNCTIONS WERE MEASURED FROM EP = 1.0 - 1.82 MEV IN   S+99 1   37
           STEPS OF 10 KEV AND FROM EP = 2.2 - 4.1 MEV IN 50-    S+99 1   38
           KEV STEPS.                                            S+99 1   39
DETECTOR   (INGE) INTRINSIC GERMANIUM DETECTOR. RESOLUTION OF    S+99 1   40
           1.9 KEV FOR 1333 KEV GAMMA-RAYS.                      S+99 1   41
MONITOR    (CI) CURRENT INTEGRATOR.                              S+99 1   42
CORRECTION DATA WERE CORRECTED FOR DETECTOR EFFICIENCY. GAMMA-   S+99 1   43
           RAY YIELD VALUES WERE REDUCED TO EQUIVALENT MONO-     S+99 1   44
           ATOMIC TARGET VALUES USING AVAILABLE STOPPING POWER   S+99 1   45
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          INFORMATION. ULTIMATELY, A SINGLE GAMMA RAY WAS          S+99 1   46
          SELECTED TO REPRESENT EACH ELEMENT FOR PIGE ANALYSIS.    S+99 1   47
ERR-ANALYS NO ERRORS ARE GIVEN.                                    S+99 1   48
ENDBIB              46                                             S+99 1   49
ENDSUBENT            1                                             S+99 199999
SUBENT        S+99  2          0                                   S+99 2    1
BIB                  2          8                                  S+99 2    2
REACTION   31P(P,GAMMA)32S                                         S+99 2    3
COMMENTS   A CHARACTERISTIC GAMMA-RAY FOR USE IN PIGE ANALYSIS     S+99 2    4
           WITH PHOSPHORUS IS IDENTIFIED. THE ABSOLUTE YIELD OF    S+99 2    5
           THIS GAMMA-RAY IS GIVEN. DATA OBTAINED FROM TABLE 1     S+99 2    6
           OF THE ORIGINAL PAPER. EG = GAMMA-RAY ENERGY. EP =      S+99 2    7
           INCIDENT PROTON ENERGY. YLD = ABSOLUTE THICK-TARGET     S+99 2    8
           GAMMA-RAY YIELD. THE YIELD IS GIVEN IN "UNIT". 1 UNIT   S+99 2    9
           = 1 COUNT/MICROCOULOMB/STERADIAN.                       S+99 2   10
ENDBIB               8                                             S+99 2   11
DATA                 3          2                                  S+99 2   12
EG         EP         YLD                                          S+99 2   13
KEV        MEV        UNIT                                         S+99 2   14
 2230.      1.77       1700.                                       S+99 2   15
 2230.      4.0        100000.                                     S+99 2   16
ENDDATA              4                                             S+99 2   17
ENDSUBENT            2                                             S+99 299999
ENDENTRY             2                                             S+999999999
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T+69

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ENTRY             T+69          0                                  T+69 0    1
SUBENT        T+69  1          0                                   T+69 1    1
BIB                 13         30                                  T+69 1    2
INSTITUTE  (FRGRA)                                                 T+69 1    3
REFERENCE  (J,NP/A,135,281,1969)                                   T+69 1    4
AUTHORS    (J.P.THIBAUD,M.M.ALEONARD,D.CASTERA,P.HUBERT,F.LECCIA,  T+69 1    5
           P.MENNRATH)                                             T+69 1    6
TITLE      MESURES DES VIES MOYENNES DES PREMIERS ETATS EXCITES    T+69 1    7
           DU NOYAU 32S                                            T+69 1    8
FACILITY   (VDG) 4-MV VAN DE GRAAFF ACCELERATOR, CENTRE D'ETUDES   T+69 1    9
           NUCLEAIRES, UNIVERSITE DE BORDEAUX, GRADIGNAN, FRANCE.  T+69 1   10
INC-PART   (P) PROTONS.                                            T+69 1   11
TARGETS    TARGETS WERE PREPARED BY EVAPORATION OF PURE ZN3P2 ON   T+69 1   12
           GOLD SUPPORTS. THE PURITY WAS SUFFICIENTLY HIGH THAT    T+69 1   13
           NO CONTAMINATION FROM 19F(P,ALPHA-GAMMA)16O WAS SEEN.   T+69 1   14
           THE TARGETS WERE A FEW HUNDRED MICROGRAM/CM**2 THICK.   T+69 1   15
METHOD     THE DOPPLER-SHIFT ATTENUATION METHOD (DSAM) WAS USED    T+69 1   16
           TO MEASURE LIFETIMES OF EXCITED LEVELS IN 32S. PROTON   T+69 1   17
           BEAMS WERE OBTAINED FROM THE 4-MV BORDEAUX VAN DE       T+69 1   18
           GRAAFF ACCELERATOR. THE BEAM WAS DEFINED BY ADJUSTABLE  T+69 1   19
           SLITS. WITH THIS ARRANGEMENT, BEAMS WITH CURRENTS OF    T+69 1   20
           SEVERAL MICROAMPS AND ENERGY DEFINITION TO WITHIN       T+69 1   21
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           BETTER THAN 1 KEV WERE OBTAINED. THE ELECTRONICS USED    T+69 1   22
           IN RECORDING GAMMA-RAY SPECTRA FROM THE GE(LI)           T+69 1   23
           DETECTOR WAS SUFFICIENTLY STABLE SO THAT IT WAS NOT      T+69 1   24
           NECESSARY TO MAKE CORRECTIONS.                           T+69 1   25
DETECTOR   (GELI) 40-CM**3 CO-AXIAL GE(LI) DETECTOR. THE DETECTOR   T+69 1   26
           RESOLUTION WAS 4 - 5 KEV FOR 2.614-KEV GAMMA RAYS FROM   T+69 1   27
           228TH.                                                   T+69 1   28
MONITOR    (CI) CURRENT INTEGRATOR.                                 T+69 1   29
CORRECTION DETAILS ARE NOT DISCUSSED.                               T+69 1   30
ERR-ANALYS ERRORS ARE GIVEN BUT FEW DETAILS ARE PROVIDED.           T+69 1   31
COMMENTS   THE ORIGINAL PAPER IS WRITTEN IN FRENCH.                 T+69 1   32
ENDBIB             30                                               T+69 1   33
ENDSUBENT           1                                               T+69 199999
SUBENT        T+69  2          0                                    T+69 2    1
BIB                 2          8                                    T+69 2    2
REACTION   31P(P,GAMMA)32S                                          T+69 2    3
COMMENTS   LIFETIMES OF LEVELS IN 32S ARE GIVEN. DATA TAKEN FROM    T+69 2    4
           TABLE 1 OF THE ORIGINAL PAPER. EX = EXCITATION ENERGY    T+69 2    5
           OF 32S LEVEL. EI = INITIAL STATE OF TRANSITION. EF =     T+69 2    6
           FINAL STATE. EP = PROTON ENERGY FOR EXCITING 32S STATE.  T+69 2    7
           TAU = MEAN LIFETIME. TAU-ERR = ERROR IN TAU. FEMTOSEC    T+69 2    8
           = 10**(-15) SEC. BLANK SPACE MEANS VALUE NOT GIVEN.      T+69 2    9
           ONLY RESULTS DERIVED FROM GAMMA-RAY F.E. PEAKS USED.     T+69 2   10
ENDBIB              8                                               T+69 2   11
DATA                6          7                                    T+69 2   12
EX         EI         EF         EP         TAU        TAU-ERR      T+69 2   13
MEV        MEV        MEV        KEV        FEMTOSEC   FEMTOSEC     T+69 2   14
 2.237      2.237      0.         811.       260.       80.         T+69 2   15
 4.287      4.287      0.         1555.      50.        18.         T+69 2   16
 4.698      4.698      2.237      811.       170.       100.        T+69 2   17
 5.012      5.012      2.237      1248.      250.       50.         T+69 2   18
 5.553                                       58.        20.         T+69 2   19
 6.226      6.226      2.237      1248.      64.        20.         T+69 2   20
 6.621      6.621      5.012      1438.      1000.                  T+69 2   21
ENDDATA             9                                               T+69 2   22
ENDSUBENT           2                                               T+69 299999
SUBENT        T+69  3          0                                    T+69 3    1
BIB                 2         10                                    T+69 3    2
REACTION   31P(P,GAMMA)32S                                          T+69 3    3
COMMENTS   PROBABILITIES FOR E1 AND M1 MULTIPOLE GAMMA-RAY          T+69 3    4
           TRANSITIONS. DATA FROM TABLE 3 OF THE ORIGINAL PAPER.    T+69 3    5
           EI = ENERGY OF INITIAL STATE IN 32S FOR TRANSITION.      T+69 3    6
           EF = ENERGY OF FINAL STATE. MULT = MULTIPOLARITY OF      T+69 3    7
           TRANSITION (E1 OR M1). GAM(G) = GAMMA-RAY WIDTH.         T+69 3    8
           GAM(G)-ERR = ERROR IN GAM(G). TRANS = TRANSITION         T+69 3    9
           PROBABILITY. TRANS-ERR = ERROR IN TRANS. W.U. =          T+69 3   10
           WEISSKOPF UNITS. MILLEV = 10**(-3) EV. BLANK SPACE       T+69 3   11
           INDICATES THAT VALUE IS NOT PROVIDED IN THE TABLE.       T+69 3   12
ENDBIB             10                                               T+69 3   13
DATA                7          6                                    T+69 3   14
EI         EF         MULT       GAM(G)     GAM(G)-ERR TRANS        T+69 3   15
TRANS-ERR                                                           T+69 3   16
MEV        MEV        NO-DIM     MILLEV     MILLEV     W.U.         T+69 3   17
W.U.                                                                T+69 3   18
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 5.012      2.237      E1         2.6        0.5        1.8000E-04  T+69 3   19
 2.3000E-04                                                         T+69 3   20
 6.226      2.237      E1         10.0       2.4        2.5000E-04  T+69 3   21
 6.0000E-05                                                         T+69 3   22
 4.287      2.237      M1         0.43                  2.4000E-03  T+69 3   23
                                                                    T+69 3   24
 4.698      0.         M1         1.3                   6.3000E-04  T+69 3   25
                                                                    T+69 3   26
 4.698      2.237      M1         0.17                  5.7000E-03  T+69 3   27
                                                                    T+69 3   28
 5.553      2.237      M1         40.                   5.3000E-03  T+69 3   29
                                                                    T+69 3   30
ENDDATA            16                                               T+69 3   31
ENDSUBENT           3                                               T+69 399999
SUBENT        T+69  4          0                                    T+69 4    1
BIB                 2          8                                    T+69 4    2
REACTION   31P(P,GAMMA)32S                                          T+69 4    3
COMMENTS   PROBABILITIES FOR E2 MULTIPOLE GAMMA-RAY TRANSITIONS     T+69 4    4
           ARE GIVEN. DATA WERE OBTAINED FROM TABLE 4 OF THE        T+69 4    5
           ORIGINAL PAPER. EI = ENERGY OF INITIAL 32S LEVEL OF      T+69 4    6
           TRANSITION. EF = ENERGY OF FINAL LEVEL. GAM(G) =         T+69 4    7
           GAMMA-RAY WIDTH. TRANS = GAMMA-RAY TRANSITION            T+69 4    8
           PROBABILITY. W.U. = WEISSKOPF UNITS. MILLEV =             T+69 4    9
           10**(-3) EV. NO ERRORS ARE GIVEN.                        T+69 4   10
ENDBIB              8                                               T+69 4   11
DATA                4          3                                    T+69 4   12
EI         EF         GAM(G)     TRANS                              T+69 4   13
 4.698      2.237      0.79       1.7                               T+69 4   14
 5.553      0.         4.3        0.16                              T+69 4   15
 5.553      2.237      1.2        0.61                              T+69 4   16
ENDDATA             5                                               T+69 4   17
ENDSUBENT           4                                               T+69 499999
ENDENTRY            4                                               T+699999999
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V+73a

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ENTRY            V+73A         0                                   V+73A 0    1
SUBENT        V+73A  1         0                                   V+73A 1    1
BIB                13        103                                   V+73A 1    2
INSTITUTE  (FRPAR)                                                 V+73A 1    3
REFERENCE  (J,NP/A,212,493,1973)                                   V+73A 1    4
AUTHORS    (J.VERNOTTE,S.GALES,M.LANGEVIN,J.M.MAISON)              V+73A 1    5
TITLE      RECHERCHE DE RESONANCES ISOBARIQUES ANALOGUES DANS      V+73A 1    6
           32S AU MOYEN DES REACTIONS 31P(P,GAMMA)32S,             V+73A 1    7
           31P(P,P')31P ET 31P(P,ALPHA-0)28SI                      V+73A 1    8
FACILITIES (VDG) 4-MV VAN DE GRAAFF ACCELERATOR, INSTITUT DE       V+73A 1    9
           PHYSIQUE NUCLEAIRE D'ORSAY, ORSAY, FRANCE.              V+73A 1   10
           (VDG) 2-MV VAN DE GRAAFF ACCELERATOR, CENTRE DE         V+73A 1   11
           RECHERCHES NUCLEAIRES DE STRASBOURG-CRONENBOURG,        V+73A 1   12
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	STRASBOURG, FRANCE.	V+73A 1	13
INC-PART	(P) PROTONS.	V+73A 1	14
TARGETS	(P,GAMMA) EXPERIMENT: TARGETS WERE MADE FROM	V+73A 1	15
	RED PHOSPHORUS EVAPORATED IN A VACUUM ON A	V+73A 1	16
	0.2-MM-THICK TUNGSTEN SUPPORT. THE TARGETS WERE	V+73A 1	17
	MOUNTED AT 45 DEGREES RELATIVE TO INCIDENT PROTON	V+73A 1	18
	BEAM AND THEY WERE COOLED WITH AN AIR JET (AT ORSAY)	V+73A 1	19
	OR CIRCULATING WATER (AT STRASBOURG).	V+73A 1	20
	(P,P') AND (P,ALPHA) EXPERIMENT: TARGETS WERE MADE	V+73A 1	21
	OF RED PHOSPHORUS EVAPORATED ON A 15 MICROGRAM/CM**2	V+73A 1	22
	CARBON FOIL. THE TARGETS WERE MOUNTED PERPENDICULAR	V+73A 1	23
	TO THE INCIDENT PROTON BEAM.	V+73A 1	24
METHOD	(P,GAMMA) EXPERIMENT: PROTON BEAMS WERE OBTAINED	V+73A 1	25
	FROM THE 4-MV VAN DE GRAAFF ACCELERATOR AT ORSAY	V+73A 1	26
	AND THE 2-MV VAN DE GRAAFF ACCELERATOR AT	V+73A 1	27
	STRASBOUG. THE PROTON BEAMS PASSED THROUGH A TUBE	V+73A 1	28
	COOLED WITH LIQUID NITROGEN TO REDUCE CARBON BUILD	V+73A 1	29
	UP ON THE TARGETS. NO CONTAMINATING CONTRIBUTIONS	V+73A 1	30
	FROM THE 19F(P,ALPHA-GAMMA)16O WERE OBSERVED IN THE	V+73A 1	31
	MEASUREMENTS. THE PROTON BEAM CURRENTS WERE LIMITED	V+73A 1	32
	TO 2 MICROAMPS AT ORSAY AND 10 MICROAMPS AT	V+73A 1	33
	STRASBOURG. IN BOTH CASES THE TARGETS WITHSTOOD	V+73A 1	34
	THE PROTON BEAMS FOR SEVERAL DAYS WITHOUT DAMAGE.	V+73A 1	35
	FOR GAMMA-RAY ANGULAR DISTRIBUTION MEASUREMENTS,	V+73A 1	36
	EITHER NAI DETECTORS OR A GE(LI) DETECTOR COULD BE	V+73A 1	37
	MOUNTED ON A MOBILE ANGULAR DISTRIBUTION TABLE. IN	V+73A 1	38
	SUCH MEASUREMENTS, A SINGLE NAI DETECTOR SERVED AS	V+73A 1	39
	THE MONITOR. A GAMMA-RAY EXCITATION FUNCTION WAS	V+73A 1	40
	MEASURED OVER THE RANGE EP = 1.24 - 1.60 MEV BY	V+73A 1	41
	OBSERVING SIGNALS DUE TO GAMMA RAYS WITH ENERGIES	V+73A 1	42
	EXCEEDING 3.1 MEV. THIS MEASUREMENT WAS DONE USING	V+73A 1	43
	A 12.7-CM X 12.7-CM NAI DETECTOR PLACED AT 55	V+73A 1	44
	DEGREES RELATIVE TO THE INCIDENT PROTON BEAM. THE	V+73A 1	45
	P TARGET WAS 11 MICROGRAM/CM**2 FOR MEASUREMENTS	V+73A 1	46
	BELOW EP = 1.4 MEV AND 23 MICROGRAM/CM**2 FOR	V+73A 1	47
	MEASUREMENTS ABOVE EP = 1.4 MEV. CALIBRATION OF	V+73A 1	48
	THE PROTON ENERGY SCALE WAS PERFORMED USING THE	V+73A 1	49
	EP = 1747.5-KEV RESONANCE IN 13C(P,GAMMA)14N. FOR	V+73A 1	50
	DETERMINATION OF THE SPECTRA OF DE-EXCITATION	V+73A 1	51
	GAMMA RAYS AT THE RESONANCES, GE(LI) DETECTORS	V+73A 1	52
	WERE USED. THEY WERE CALIBRATED FOR ENERGY AND	V+73A 1	53
	EFFICIENCY USING A STANDARD 56CO SOURCE FOR GAMMA-	V+73A 1	54
	RAY ENERGIES BELOW 3.2 MEV. FOR HIGHER ENERGY	V+73A 1	55
	GAMMA-RAYS, USE WAS MADE OF THE KNOWN GAMMA-RAY	V+73A 1	56
	DECAY MODE OF THE EP = 1555 KEV RESONANCE IN THE	V+73A 1	57
	31P(P,GAMMA)32S REACTION, AS AVAILABLE IN THE	V+73A 1	58
	LITERATURE FROM EARLIER WORK.	V+73A 1	59
	(P,P') AND (P,ALPHA-0) EXPERIMENT: PROTON BEAMS	V+73A 1	60
	WERE OBTAINED FROM THE 4-MV ORSAY VAN DE GRAAFF	V+73A 1	61
	ACCELERATOR. THE BEAM WAS FOCUSSED THROUGH A	V+73A 1	62
	2-MM DIAMETER APERTURE ONTO A TARGET OF RED	V+73A 1	63
	PHOSPHORUS ON CARBON BACKING. THIS TARGET WAS	V+73A 1	64
	SITUATED IN A 50-CM DIAMETER SCATTERING CHAMBER.	V+73A 1	65
	THE BEAM DUMP WAS A FARADAY CAGE ENVELOPED IN	V+73A 1	66

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           GRAPHITE AND LOCATED 150 CM BEYOND THE TARGET.          V+73A 1   67
           THE PROTON ENERGY AND RESOLUTION WERE MEASURED          V+73A 1   68
           AT THE 13C(P,GAMMA)14 EP = 1747.6 KEV RESONANCE.        V+73A 1   69
           THE TARGET ATOMS WERE MEASURED USING RUTHERFORD         V+73A 1   70
           SCATTERING OF PROTONS AT ENERGIES BELOW THE             V+73A 1   71
           RESONANCES. THE TARGETS WERE FOUND TO SURVIVE           V+73A 1   72
           WELL DURING SEVERAL DAYS OF EXPOSURE AT BEAM            V+73A 1   73
           CURRENTS BELOW 0.5 MICROAMP. THE SURFACE BARRIER        V+73A 1   74
           DETECTORS WERE USED TO MEASURE EMITTED PROTONS          V+73A 1   75
           AND ALPHA PARTICLES AT ANGLES BETWEEN 124 - 160         V+73A 1   76
           DEGREES. CONVENTIONAL ELECTRONICS COMPONENTS            V+73A 1   77
           WERE USED. GAMMA-RAYS WITH ENERGIES ABOVE 3             V+73A 1   78
           MEV WERE MEASURED SIMULTANEOUSLY USING A 3.8-CM         V+73A 1   79
           X 3.8-CM NAI DETECTOR.                                  V+73A 1   80
           FURTHER DETAILS ON THIS EXPERIMENT CAN BE FOUND IN      V+73A 1   81
           THE ORIGINAL PAPER.                                     V+73A 1   82
DETECTORS  (SCINT) SEVERAL 12.7-CM X 12.7-CM NAI(TL)               V+73A 1   83
           SCINTILLATION CRYSTAL DETECTORS. THE DETECTORS          V+73A 1   84
           WERE SHIELDED WITH LEAD.                                V+73A 1   85
           (SCINT) A 3.8-CM X 3.8-CM NAI(TL) SCINTILLATION         V+73A 1   86
           CRYSTAL DETECTOR (ORSAY).                               V+73A 1   87
           (GELI) 37-CM**3 GE(LI) DETECTOR WITH 3.5 KEV            V+73A 1   88
           RESOLUTION FOR 1.33 MEV 60CO GAMMA RAYS AND             V+73A 1   89
           15 KEV RESOLUTION FOR 10 MEV GAMMA RAYS (ORSAY).        V+73A 1   90
           (GELI) 80-CM**3 GE(LI) DETECTOR WITH 2.5 KEV            V+73A 1   91
           RESOLUTION FOR 1.33 MEV 60CO GAMMA RAYS AND             V+73A 1   92
           11 KEV FOR 10 MEV GAMMA RAYS (STRASBOURG).              V+73A 1   93
           (SOLST) THREE SURFACE BARRIER DETECTORS WERE USED       V+73A 1   94
           FOR CHARGED-PARTICLE MEASUREMENTS. EACH SUBTENDED       V+73A 1   95
           A SOLID ANGLE OF 0.55 X 10**(-3) STERADIAN.             V+73A 1   96
MONITORS   (CI) CURRENT INTEGRATORS.                               V+73A 1   97
           (SCINT) 12.7-CM X 12.7-CM NAI(TL) SCINTILLATION         V+73A 1   98
           CRYSTAL DETECTOR.                                       V+73A 1   99
CORRECTION CORRECTIONS FOR DETECTOR EFFICIENCY WERE APPLIED        V+73A 1  100
ERR-ANALYS THE ESTIMATED UNCERTAINTY IN THE GE(LI) DETECTOR        V+73A 1  101
           EFFICIENCY CALIBRATION WAS 10 PERCENT. FURTHER          V+73A 1  102
           DETAILS ON THE ERROR ANALYSIS ARE GIVEN IN THE          V+73A 1  103
           ORIGINAL PAPER.                                         V+73A 1  104
COMMENTS   THE ORIGINAL PAPER IS WRITTEN IN FRENCH.                V+73A 1  105
ENDBIB             103                                             V+73A 1  106
ENDSUBENT            1                                             V+73A 199999
SUBENT        V+73A  2          0                                  V+73A 2    1
BIB                  2          9                                  V+73A 2    2
REACTION   31P(P,GAMMA)32S                                         V+73A 2    3
COMMENTS   RESONANCE ENERGIES AND STRENGTHS ARE GIVEN. DATA ARE    V+73A 2    4
           OBTAINED FROM TABLE 1 OF THE ORIGINAL PAPER. EP =       V+73A 2    5
           RESONANCE PROTON ENERGY. EP-ERR = ERROR IN EP. S =      V+73A 2    6
           RESONANCE STRENGTH = (2J+1)*GAM(P)*GAM(G)/GAM(T),       V+73A 2    7
           WHERE J = RESONANCE SPIN, GAM(P) = PROTON WIDTH,        V+73A 2    8
           GAM(G) = GAMMA-RAY WIDTH, AND GAM(T) = TOTAL WIDTH.     V+73A 2    9
           S-ERR = ERROR IN S. BLANK ENTRIES IMPLY DATA ARE NOT     V+73A 2   10
           AVAILABLE OR ARE AMBIGUOUS. PCT = PERCENT.              V+73A 2   11
ENDBIB               9                                             V+73A 2   12
DATA                 4         14                                  V+73A 2   13
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EP          EP-ERR      S           S-ERR                                     V+73A 2   14
KEV         KEV         EV          PCT                                       V+73A 2   15
 1247.4      1.5         11.8        20.                                      V+73A 2   16
 1279.1      1.5         0.25        20.                                      V+73A 2   17
 1399.3      0.8         1.3         20.                                      V+73A 2   18
 1401.9      1.5         3.8         20.                                      V+73A 2   19
 1405.1      1.5         0.25        40.                                      V+73A 2   20
 1410.6      0.8         1.0         20.                                      V+73A 2   21
 1437.3      1.5         8.3         20.                                      V+73A 2   22
 1469.0      1.5         0.15        20.                                      V+73A 2   23
 1472.1      1.5         1.5         20.                                      V+73A 2   24
 1474.3      1.5         0.38        20.                                      V+73A 2   25
 1514.7      1.5         2.2         20.                                      V+73A 2   26
 1555.4      1.5         8.7         20.                                      V+73A 2   27
 1581.1      1.5         7.9         20.                                      V+73A 2   28
 1585.2      1.5                                                              V+73A 2   29
ENDDATA             16                                                        V+73A 2   30
ENDSUBENT            2                                                        V+73A 299999
SUBENT        V+73A  3           0                                            V+73A 3    1
BIB                  2          13                                            V+73A 3    2
REACTION    31P(P,GAMMA)32S                                                   V+73A 3    3
COMMENTS    BRANCHING FACTORS FOR THE GAMMA-RAY DECAY OF 32S                  V+73A 3    4
            RESONANCES ARE GIVEN. THE DATA ARE OBTAINED FROM                  V+73A 3    5
            TABLE 2 OF ORIGINAL PAPER. EP = RESONANCE PROTON                  V+73A 3    6
            ENERGY. EX = EXCITATION ENERGY IN 32S. EX-ERR =                   V+73A 3    7
            ERROR IN EX. EI = ENERGY OF INITIAL STATE FOR                     V+73A 3    8
            TRANSITION. J-PI(I) = SPIN/PARITY OF INITIAL STATE.               V+73A 3    9
            A NEGATIVE VALUE SIGNIFIES NEGATIVE PARITY.                       V+73A 3   10
            OTHERWISE PARITY IS POSITIVE. EF = ENERGY OF FINAL                V+73A 3   11
            STATE. J-PI(F) = SPIN/PARITY FOR FINAL STATE. B =                 V+73A 3   12
            GAMMA-RAY DECAY BRANCHING FACTOR. A BLANK ENTRY                   V+73A 3   13
            SIGNIFIES THAT NO VALUE IS PROVIDED IN THE TABLE                  V+73A 3   14
            OR VALUES ARE AMBIGUOUS. PCT = PERCENT.                           V+73A 3   15
ENDBIB              13                                                        V+73A 3   16
DATA                 8          88                                            V+73A 3   17
EP          EX          EX-ERR      EI          J-PI(I)     EF                V+73A 3   18
J-PI(F)     B                                                                 V+73A 3   19
MEV         MEV         MEV         MEV         NO-DIM      MEV               V+73A 3   20
NO-DIM      PCT                                                               V+73A 3   21
 1.247       10.072      0.002       10.072     -2.          0.               V+73A 3   22
 0.          1.8                                                              V+73A 3   23
 1.247       10.072      0.002       10.072     -2.          2.23             V+73A 3   24
 2.          28.                                                              V+73A 3   25
 1.247       10.072      0.002       10.072     -2.          4.28             V+73A 3   26
 2.          1.6                                                              V+73A 3   27
 1.247       10.072      0.002       10.072     -2.          4.70             V+73A 3   28
 1.          0.9                                                              V+73A 3   29
 1.247       10.072      0.002       10.072     -2.          5.01             V+73A 3   30
-3.          12.                                                              V+73A 3   31
 1.247       10.072      0.002       10.072     -2.          5.41             V+73A 3   32
 3.          4.                                                               V+73A 3   33
 1.247       10.072      0.002       10.072     -2.          6.22             V+73A 3   34
-2.          50.                                                              V+73A 3   35
 1.247       10.072      0.002       10.072     -2.          7.11             V+73A 3   36
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	0.7					V+73A 3	37
1.247	10.072	0.002	10.072	-2.	8.13	V+73A 3	38
	0.3					V+73A 3	39
1.247	10.072	0.002	10.072	-2.	8.30	V+73A 3	40
	0.4					V+73A 3	41
1.247	10.072	0.002	10.072	-2.	8.50	V+73A 3	42
	0.2					V+73A 3	43
1.279	10.102	0.002	10.102		2.23	V+73A 3	44
2.	46.					V+73A 3	45
1.279	10.102	0.002	10.102		4.28	V+73A 3	46
2.	14.					V+73A 3	47
1.279	10.102	0.002	10.102		4.46	V+73A 3	48
4.	18.					V+73A 3	49
1.279	10.102	0.002	10.102		5.01	V+73A 3	50
-3.	12.					V+73A 3	51
1.279	10.102	0.002	10.102		5.41	V+73A 3	52
3.	6.					V+73A 3	53
1.279	10.102	0.002	10.102		5.55	V+73A 3	54
2.	4.					V+73A 3	55
1.399	10.219	0.002	10.219	3.	2.23	V+73A 3	56
2.	12.					V+73A 3	57
1.399	10.219	0.002	10.219	3.	4.28	V+73A 3	58
2.	7.					V+73A 3	59
1.399	10.219	0.002	10.219	3.	4.46	V+73A 3	60
4.	8.					V+73A 3	61
1.399	10.219	0.002	10.219	3.	4.70	V+73A 3	62
1.	22.					V+73A 3	63
1.399	10.219	0.002	10.219	3.	5.41	V+73A 3	64
3.	4.					V+73A 3	65
1.399	10.219	0.002	10.219	3.	5.55	V+73A 3	66
2.	8.					V+73A 3	67
1.399	10.219	0.002	10.219	3.	7.11	V+73A 3	68
	39.					V+73A 3	69
1.402	10.222	0.002	10.222	-3.	2.23	V+73A 3	70
2.	12.					V+73A 3	71
1.402	10.222	0.002	10.222	-3.	4.46	V+73A 3	72
4.	22.					V+73A 3	73
1.402	10.222	0.002	10.222	-3.	5.01	V+73A 3	74
-3.	66.					V+73A 3	75
1.411	10.230	0.002	10.230	1.	0.	V+73A 3	76
0.	7.					V+73A 3	77
1.411	10.230	0.002	10.230	1.	2.23	V+73A 3	78
2.	7.					V+73A 3	79
1.411	10.230	0.002	10.230	1.	3.78	V+73A 3	80
0.	2.					V+73A 3	81
1.411	10.230	0.002	10.230	1.	4.28	V+73A 3	82
2.	11.					V+73A 3	83
1.411	10.230	0.002	10.230	1.	4.70	V+73A 3	84
1.	8.					V+73A 3	85
1.411	10.230	0.002	10.230	1.	5.41	V+73A 3	86
3.	5.					V+73A 3	87
1.411	10.230	0.002	10.230	1.	5.55	V+73A 3	88
2.	4.					V+73A 3	89
1.411	10.230	0.002	10.230	1.	6.22	V+73A 3	90

-2.	5.					V+73A 3	91
1.411	10.230	0.002	10.230	1.	7.00	V+73A 3	92
	41.					V+73A 3	93
1.411	10.230	0.002	10.230	1.	7.11	V+73A 3	94
	6.					V+73A 3	95
1.411	10.230	0.002	10.230	1.	7.54	V+73A 3	96
	4.					V+73A 3	97
1.437	10.256	0.002	10.256	-4.	2.23	V+73A 3	98
2.	0.6					V+73A 3	99
1.437	10.256	0.002	10.256	-4.	4.46	V+73A 3	100
4.	8.					V+73A 3	101
1.437	10.256	0.002	10.256	-4.	5.01	V+73A 3	102
-3.	4.					V+73A 3	103
1.437	10.256	0.002	10.256	-4.	5.41	V+73A 3	104
3.	0.4					V+73A 3	105
1.437	10.256	0.002	10.256	-4.	6.41	V+73A 3	106
	1.					V+73A 3	107
1.437	10.256	0.002	10.256	-4.	6.62	V+73A 3	108
-4.	75.					V+73A 3	109
1.437	10.256	0.002	10.256	-4.	6.76	V+73A 3	110
	3.2					V+73A 3	111
1.437	10.256	0.002	10.256	-4.	7.35	V+73A 3	112
	1.0					V+73A 3	113
1.437	10.256	0.002	10.256	-4.	7.70	V+73A 3	114
	0.5					V+73A 3	115
1.437	10.256	0.002	10.256	-4.	7.95	V+73A 3	116
	6.4					V+73A 3	117
1.469	10.287	0.002	10.287	-3.	2.23	V+73A 3	118
2.	11.					V+73A 3	119
1.469	10.287	0.002	10.287	-3.	4.46	V+73A 3	120
4.	15.					V+73A 3	121
1.469	10.287	0.002	10.287	-3.	5.01	V+73A 3	122
-3.	74.					V+73A 3	123
1.472	10.289	0.002	10.289	-2.	0.	V+73A 3	124
0.	2.2					V+73A 3	125
1.472	10.289	0.002	10.289	-2.	2.23	V+73A 3	126
2.	32.					V+73A 3	127
1.472	10.289	0.002	10.289	-2.	4.28	V+73A 3	128
2.	1.5					V+73A 3	129
1.472	10.289	0.002	10.289	-2.	5.01	V+73A 3	130
-3.	19.					V+73A 3	131
1.472	10.289	0.002	10.289	-2.	5.41	V+73A 3	132
3.	1.5					V+73A 3	133
1.472	10.289	0.002	10.289	-2.	5.78	V+73A 3	134
-1.	1.6					V+73A 3	135
1.472	10.289	0.002	10.289	-2.	6.22	V+73A 3	136
-2.	36.					V+73A 3	137
1.472	10.289	0.002	10.289	-2.	6.67	V+73A 3	138
	2.3					V+73A 3	139
1.472	10.289	0.002	10.289	-2.	7.00	V+73A 3	140
	1.5					V+73A 3	141
1.472	10.289	0.002	10.289	-2.	8.13	V+73A 3	142
	2.4					V+73A 3	143
1.515	10.331	0.002	10.331	-1.	0.	V+73A 3	144

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 0.         12.                                                           V+73A 3  145
 1.515      10.331     0.002      10.331    -1.         2.23        V+73A 3  146
 2.         61.                                                           V+73A 3  147
 1.515      10.331     0.002      10.331    -1.         4.70        V+73A 3  148
 1.         15.                                                           V+73A 3  149
 1.515      10.331     0.002      10.331    -1.         5.55        V+73A 3  150
 2.         6.                                                            V+73A 3  151
 1.515      10.331     0.002      10.331    -1.         8.13        V+73A 3  152
            6.                                                            V+73A 3  153
 1.555      10.369     0.002      10.369     2.         0.          V+73A 3  154
 0.         0.5                                                           V+73A 3  155
 1.555      10.369     0.002      10.369     2.         2.23        V+73A 3  156
 2.         11.                                                           V+73A 3  157
 1.555      10.369     0.002      10.369     2.         4.28        V+73A 3  158
 2.         40.                                                           V+73A 3  159
 1.555      10.369     0.002      10.369     2.         4.70        V+73A 3  160
 1.         11.                                                           V+73A 3  161
 1.555      10.369     0.002      10.369     2.         5.01        V+73A 3  162
-3.         2.                                                            V+73A 3  163
 1.555      10.369     0.002      10.369     2.         5.41        V+73A 3  164
 3.         12.                                                           V+73A 3  165
 1.555      10.369     0.002      10.369     2.         5.55        V+73A 3  166
 2.         4.                                                            V+73A 3  167
 1.555      10.369     0.002      10.369     2.         6.22        V+73A 3  168
-2.         3.                                                            V+73A 3  169
 1.555      10.369     0.002      10.369     2.         6.67        V+73A 3  170
            13.                                                           V+73A 3  171
 1.555      10.369     0.002      10.369     2.         7.19        V+73A 3  172
            1.                                                            V+73A 3  173
 1.555      10.369     0.002      10.369     2.         7.49        V+73A 3  174
            2.                                                            V+73A 3  175
 1.581      10.395     0.002      10.395    -4.         2.23        V+73A 3  176
 2.         0.5                                                           V+73A 3  177
 1.581      10.395     0.002      10.395    -4.         4.46        V+73A 3  178
 4.         1.3                                                           V+73A 3  179
 1.581      10.395     0.002      10.395    -4.         5.01        V+73A 3  180
-3.         5.8                                                           V+73A 3  181
 1.581      10.395     0.002      10.395    -4.         6.22        V+73A 3  182
-2.         0.7                                                           V+73A 3  183
 1.581      10.395     0.002      10.395    -4.         6.62        V+73A 3  184
-4.         83.                                                           V+73A 3  185
 1.581      10.395     0.002      10.395    -4.         6.76        V+73A 3  186
            2.3                                                           V+73A 3  187
 1.581      10.395     0.002      10.395    -4.         6.85        V+73A 3  188
            1.0                                                           V+73A 3  189
 1.581      10.395     0.002      10.395    -4.         7.70        V+73A 3  190
            0.5                                                           V+73A 3  191
 1.581      10.395     0.002      10.395    -4.         7.95        V+73A 3  192
            4.9                                                           V+73A 3  193
 1.585      10.399     0.002      10.399    -0.         5.78        V+73A 3  194
-1.         76.                                                           V+73A 3  195
 1.585     10.399      0.002      10.399    -0.         8.13        V+73A 3  196
            24.                                                           V+73A 3  197
ENDDATA            180                                                    V+73A 3  198
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ENDSUBENT            3                                          V+73A 399999
SUBENT        V+73A  4          0                               V+73A 4    1
BIB                  2          5                               V+73A 4    2
REACTION   31P(P,GAMMA)32S                                      V+73A 4    3
COMMENTS   MEASURED EXCITATION ENERGIES OF BOUND LEVELS IN 32S  V+73A 4    4
           ARE GIVEN. DATA ARE OBTAINED FROM TABLE 3 OF ORIGINAL V+73A 4    5
           REFERENCE. EX = EXCITATION ENERGY. EX-ERR = ERROR IN V+73A 4    6
           EX.                                                  V+73A 4    7
ENDBIB               5                                          V+73A 4    8
DATA                 2         10                               V+73A 4    9
EX         EX-ERR                                               V+73A 4   10
KEV        KEV                                                  V+73A 4   11
 2231.1     1.0                                                 V+73A 4   12
 3778.1     1.4                                                 V+73A 4   13
 4280.8     1.0                                                 V+73A 4   14
 4696.0     1.0                                                 V+73A 4   15
 5007.8     1.4                                                 V+73A 4   16
 5413.8     1.4                                                 V+73A 4   17
 5550.3     1.7                                                 V+73A 4   18
 7000.8     1.4                                                 V+73A 4   19
 7112.8     1.4                                                 V+73A 4   20
 7536.0     1.4                                                 V+73A 4   21
ENDDATA             12                                          V+73A 4   22
ENDSUBENT            4                                          V+73A 499999
SUBENT        V+73A  5          0                               V+73A 5    1
BIB                  2          9                               V+73A 5    2
REACTION   31P(P,GAMMA)32S                                      V+73A 5    3
COMMENTS   COEFFICIENTS OF LEGENDRE-POLYNOMIAL FITS TO GAMMA-   V+73A 5    4
           RAY ANGULAR DISTRIBUTION DATA ARE GIVEN. DATA ARE    V+73A 5    5
           OBTAINED FROM TABLE 4 OF THE ORIGINAL PAPER. EP =    V+73A 5    6
           RESONANCE PROTON ENERGY. EI = ENERGY OF INITIAL      V+73A 5    7
           32S LEVEL FOR TRANSITION. EF = ENERGY OF FINAL       V+73A 5    8
           LEVEL. A2 = COEFFICIENT OF P2 LEGENDRE POLYNOMIAL    V+73A 5    9
           TERM. A2-ERR = ERROR IN A2. A4 = COEFFICIENT OF      V+73A 5   10
           P4 LEGENDRE POLYNOMIAL TERM. A4-ERR = ERROR IN A4.   V+73A 5   11
ENDBIB               9                                          V+73A 5   12
DATA                 7         31                               V+73A 5   13
EP         EI         EF         A2         A2-ERR     A4       V+73A 5   14
A4-ERR                                                          V+73A 5   15
KEV        MEV        MEV        NO-DIM     NO-DIM     NO-DIM   V+73A 5   16
NO-DIM                                                          V+73A 5   17
 1247.      10.07      0.         0.50       0.03      -0.07    V+73A 5   18
 0.04                                                           V+73A 5   19
 1247.      10.07      2.23       0.43       0.02      -0.04    V+73A 5   20
 0.03                                                           V+73A 5   21
 1247.      10.07      5.01      -0.02       0.03      -0.06    V+73A 5   22
 0.03                                                           V+73A 5   23
 1247.      10.07      6.22       0.35       0.03      -0.06    V+73A 5   24
 0.03                                                           V+73A 5   25
 1247.       6.22      2.23       0.21       0.02      -0.04    V+73A 5   26
 0.02                                                           V+73A 5   27
 1247.       5.01      2.23      -0.17       0.03      -0.03    V+73A 5   28
 0.03                                                           V+73A 5   29
 1399.      10.22      2.23      -0.76       0.08       0.09    V+73A 5   30
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 0.06                                                                V+73A 5   31
 1399.       10.22      4.70        0.52        0.07       -0.27     V+73A 5   32
 0.09                                                                V+73A 5   33
 1399.       10.22      7.11       -0.20        0.03       -0.00     V+73A 5   34
 0.03                                                                V+73A 5   35
 1399.       7.11       2.23        0.28        0.05       -0.11     V+73A 5   36
 0.06                                                                V+73A 5   37
 1402.       10.22      2.23       -0.19        0.02       -0.01     V+73A 5   38
 0.01                                                                V+73A 5   39
 1402.       10.22      4.46       -0.03        0.02       -0.04     V+73A 5   40
 0.02                                                                V+73A 5   41
 1402.       10.22      5.01        0.37        0.05       -0.03     V+73A 5   42
 0.05                                                                V+73A 5   43
 1411.       10.23      0.         -0.08        0.03        0.03     V+73A 5   44
 0.02                                                                V+73A 5   45
 1411.       10.23      4.28        0.04        0.02       -0.03     V+73A 5   46
 0.02                                                                V+73A 5   47
 1411.       10.23      7.00       -0.05        0.03       -0.03     V+73A 5   48
 0.03                                                                V+73A 5   49
 1411.       7.00       2.23        0.02        0.02       -0.04     V+73A 5   50
 0.02                                                                V+73A 5   51
 1437.       10.26      4.46        0.51        0.09       -0.02     V+73A 5   52
 0.10                                                                V+73A 5   53
 1437.       10.26      5.01       -0.54        0.08        0.04     V+73A 5   54
 0.08                                                                V+73A 5   55
 1437.       10.26      6.62        0.42        0.03       -0.01     V+73A 5   56
 0.04                                                                V+73A 5   57
 1437.       6.62       5.01        0.27        0.02        0.25     V+73A 5   58
 0.02                                                                V+73A 5   59
 1437.       6.62       4.46        0.25        0.02        0.07     V+73A 5   60
 0.03                                                                V+73A 5   61
 1472.       10.29      2.23        0.42        0.04       -0.09     V+73A 5   62
 0.05                                                                V+73A 5   63
 1472.       10.29      5.01        0.16        0.02       -0.10     V+73A 5   64
 0.03                                                                V+73A 5   65
 1472.       10.29      6.22        0.22        0.02       -0.05     V+73A 5   66
 0.02                                                                V+73A 5   67
 1472.       6.22       2.23        0.23        0.02       -0.09     V+73A 5   68
 0.03                                                                V+73A 5   69
 1472.       5.01       2.23       -0.18        0.04       -0.07     V+73A 5   70
 0.04                                                                V+73A 5   71
 1581.       10.40      5.01        0.04        0.05        0.02     V+73A 5   72
 0.09                                                                V+73A 5   73
 1581.       10.40      6.62        0.38        0.04       -0.04     V+73A 5   74
 0.05                                                                V+73A 5   75
 1581.       6.62       5.01        0.28        0.03        0.18     V+73A 5   76
 0.03                                                                V+73A 5   77
 1581.       6.62       4.46        0.23        0.04       -0.03     V+73A 5   78
 0.04                                                                V+73A 5   79
ENDDATA             66                                               V+73A 5   80
ENDSUBENT            5                                               V+73A 599999
SUBENT        V+73A  6          0                                    V+73A 6    1
BIB                  2         12                                    V+73A 6    2
REACTION   31P(P,GAMMA)32S                                           V+73A 6    3
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COMMENTS   SPINS AND PARITIES OF RESONANT STATES AND GAMMA-RAY     V+73A 6    4
           TRANSITION MULTIPOLE MIXING RATIOS ARE GIVEN. DATA      V+73A 6    5
           OBTAINED FROM TABLE 5 OF THE ORIGINAL PAPER. EP =       V+73A 6    6
           PROTON ENERGY OF THE RESONANCE. J-PI = SPIN/PARITY      V+73A 6    7
           OF RESONANT STATE. A NEGATIVE SIGN INDICATES NEGATIVE   V+73A 6    8
           PARITY. OTHERWISE, PARITY IS POSITIVE. EI = ENERGY      V+73A 6    9
           OF INITIAL STATE OF GAMMA-RAY TRANSITION. EF = FINAL    V+73A 6   10
           STATE OF TRANSITION. J-PI(F) = SPIN/PARITY OF FINAL     V+73A 6   11
           STATE. MIX = MULTIPOLE MIXING FACTOR. MIX-ERR =         V+73A 6   12
           ERROR IN MIX. A BLANK SPACE INDICATES THAT VALUE        V+73A 6   13
           IS NOT AVAILABLE IN THE TABLE OR IS AMBIGUOUS.          V+73A 6   14
ENDBIB              12                                             V+73A 6   15
DATA                 7          27                                 V+73A 6   16
EP         J-PI       EI         EF         J-PI(F)    MIX         V+73A 6   17
KEV        NO-DIM     MEV        MEV        NO-DIM     NO-DIM      V+73A 6   18
MIX-ERR                                                            V+73A 6   19
NO-DIM                                                             V+73A 6   20
 1247.     -2.         10.07      0.         0.                    V+73A 6   21
                                                                   V+73A 6   22
 1247.     -2.         10.07      2.23       2.        -0.10       V+73A 6   23
 0.02                                                              V+73A 6   24
 1247.     -2.         10.07      5.01      -3.         0.08       V+73A 6   25
 0.05                                                              V+73A 6   26
 1247.     -2.         10.07      6.22      -2.        -0.02       V+73A 6   27
 0.02                                                              V+73A 6   28
 1247.     -2.         5.01       2.23       2.        -0.03       V+73A 6   29
 0.02                                                              V+73A 6   30
 1247.     -2.         6.22       2.23       2.        -0.05       V+73A 6   31
 0.04                                                              V+73A 6   32
 1399.      3.         10.22      2.23       2.                    V+73A 6   33
                                                                   V+73A 6   34
 1399.      3.         10.22      4.70       1.        -0.04       V+73A 6   35
 0.06                                                              V+73A 6   36
 1399.      3.         10.22      7.11       2.        -0.06       V+73A 6   37
 0.03                                                              V+73A 6   38
 1399.      3.         7.11       2.23       2.                    V+73A 6   39
                                                                   V+73A 6   40
 1402.     -3.         10.22      2.23       2.         0.07       V+73A 6   41
 0.01                                                              V+73A 6   42
 1402.     -3.         10.22      4.46       4.         0.07       V+73A 6   43
 0.02                                                              V+73A 6   44
 1402.     -3.         10.22      5.01      -3.         0.02       V+73A 6   45
 0.05                                                              V+73A 6   46
 1411.      1.         10.23      0.         0.                    V+73A 6   47
                                                                   V+73A 6   48
 1411.      1.         10.23      7.00       1.                    V+73A 6   49
                                                                   V+73A 6   50
 1437.     -4.         10.26      4.46       4.        -0.07       V+73A 6   51
 0.13                                                              V+73A 6   52
 1437.     -4.         10.26      5.01      -3.         0.15       V+73A 6   53
 0.03                                                              V+73A 6   54
 1437.     -4.         10.26      6.62      -4.         0.03       V+73A 6   55
 0.02                                                              V+73A 6   56
 1437.     -4.         6.62       5.01      -3.        -6.2        V+73A 6   57
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 0.3                                                            V+73A 6   58
 1437.     -4.         6.62       4.46       4.         0.21    V+73A 6   59
 0.05                                                           V+73A 6   60
 1472.     -2.         10.29      2.23       2.        -0.11    V+73A 6   61
 0.04                                                           V+73A 6   62
 1472.     -2.         10.29      5.01      -3.         0.29    V+73A 6   63
 0.06                                                           V+73A 6   64
 1472.     -2.         10.29      6.22      -2.         0.10    V+73A 6   65
 0.04                                                           V+73A 6   66
 1581.     -4.         10.40      5.01      -3.        -0.21    V+73A 6   67
 0.04                                                           V+73A 6   68
 1581.     -4.         10.40      6.62      -2.         0.05    V+73A 6   69
 0.04                                                           V+73A 6   70
 1581.     -4.         6.62       5.01      -3.        -5.7     V+73A 6   71
 0.03                                                           V+73A 6   72
 1581.     -4.         6.62       4.46       4.         0.24    V+73A 6   73
 0.04                                                           V+73A 6   74
ENDDATA            58                                           V+73A 6   75
ENDSUBENT           6                                           V+73A 699999
SUBENT        V+73A  7          0                               V+73A 7    1
BIB                 2          10                               V+73A 7    2
REACTION   31P(P,P)31P                                          V+73A 7    3
COMMENTS   CHARACTERISTICS OF RESONANCES IN THE ELASTIC         V+73A 7    4
           SCATTERING OF PROTONS FROM 31P. EP = RESONANCE       V+73A 7    5
           PROTON ENERGY. J-PI = SPIN/PARITY OF THE RESONANCE.  V+73A 7    6
           A NEGATIVE VALUE INDICATES NEGATIVE PARITY.          V+73A 7    7
           OTHERWISE, PARITY IS POSITIVE. GAM(P) = PROTON       V+73A 7    8
           WIDTH. GAM(P)-ERR = ERROR IN GAM(P). GAM(T) = TOTAL  V+73A 7    9
           WIDTH. GAM(T)-ERR = ERROR IN GAM(T). A BLANK ENTRY   V+73A 7   10
           SIGNIFIES THAT VALUE IS NOT AVAILABLE OR AMBIGUOUS.  V+73A 7   11
           DATA OBTAINED FROM TABLE 6 OF THE ORIGINAL PAPER.    V+73A 7   12
ENDBIB             10                                           V+73A 7   13
DATA                6          12                               V+73A 7   14
EP         J-PI       GAM(P)     GAM(P)-ERR GAM(T)     GAM(T)-ERR V+73A 7   15
KEV        NO-DIM     EV         EV         EV         EV       V+73A 7   16
 1247.4    -2.         1600.      240.       1600.      240.    V+73A 7   17
 1399.3     3.         10.                   10.                V+73A 7   18
 1401.9    -3.         16.         6.        65.        25.     V+73A 7   19
 1410.6     1.         25.        10.        25.        10.     V+73A 7   20
 1437.3    -4.         45.        20.        45.        20.     V+73A 7   21
 1469.0     3.         9.         4.         180.       60.     V+73A 7   22
 1472.1    -2.         125.       20.        125.       20.     V+73A 7   23
 1474.3     2.         15.                   105.               V+73A 7   24
 1514.7    -1.         3800.      600.       7600.      800.    V+73A 7   25
 1555.4     2.         30.        10.        30.        10.     V+73A 7   26
 1581.1    -4.         25.                   25.                V+73A 7   27
 1585.2    -0.         8300.      1300.      8300.      1300.   V+73A 7   28
ENDDATA            14                                           V+73A 7   29
ENDSUBENT           7                                           V+73A 799999
SUBENT        V+73A  8          0                               V+73A 8    1
BIB                 2          12                               V+73A 8    2
REACTION   31P(P,GAMMA)32S                                      V+73A 8    3
COMMENTS   ELECTROMAGNETIC TRANSITION STRENGTHS ARE GIVEN. DATA V+73A 8    4
           OBTAINED FROM TABLE 8 OF THE ORIGINAL PAPER. EI =    V+73A 8    5
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          ENERGY OF INITIAL 32S STATE FOR TRANSITION. EF =        V+73A 8    6
          ENERGY OF FINAL STATE. TS(E1) = E1 TRANSITION           V+73A 8    7
          STRENGTH. TS(E1)-ERR = ERROR IN TS(E1). TS(M1) =        V+73A 8    8
          M1 TRANSITION STRENGTH. TS(M1)-ERR = ERROR IN           V+73A 8    9
          TS(M1). TS(E2) = E2 TRANSITION STRENGTH. TS(E2)-ERR     V+73A 8   10
          = ERROR IN TS(E2). TS(M2) = M2 TRANSITION STRENGTH.     V+73A 8   11
          TS(M2)-ERR = ERROR IN TS(M2). W.U. = WEISSKOPF UNITS.   V+73A 8   12
          A BLANK ENTRY INDICATES THAT VALUE IS MISSING FROM      V+73A 8   13
          TABLE, IS AMBIGUOUS, OR DOES NOT APPLY.                 V+73A 8   14
ENDBIB             12                                             V+73A 8   15
DATA               10         80                                  V+73A 8   16
EI         EF         TS(E1)     TS(E1)-ERR TS(M1)     TS(M1)-ERR V+73A 8   17
TS(E2)     TS(E2)-ERR TS(M2)     TS(M2)-ERR                       V+73A 8   18
MEV        MEV        W.U.       W.U.       W.U.       W.U.       V+73A 8   19
W.U.       W.U.       W.U.       W.U.                             V+73A 8   20
 10.072     0.                                                    V+73A 8   21
                       2.8        1.5                             V+73A 8   22
 10.072     2.23       2.0000E-03 5.0000E-04                      V+73A 8   23
                       1.6        0.5                             V+73A 8   24
 10.072     4.28       3.0000E-04 1.6000E-04                      V+73A 8   25
                                                                  V+73A 8   26
 10.072     4.70       2.0000E-04 1.0000E-04                      V+73A 8   27
                                                                  V+73A 8   28
 10.072     5.01                             0.105      0.025     V+73A 8   29
 0.13       0.11                                                  V+73A 8   30
 10.072     5.41       1.4000E-03 8.0000E-04                      V+73A 8   31
                                                                  V+73A 8   32
 10.072     6.22                             1.00       0.25      V+73A 8   33
 0.13       0.13                                                  V+73A 8   34
 10.072     7.11       9.0000E-04 5.0000E-04                      V+73A 8   35
                                                                  V+73A 8   36
 10.072     8.13       1.4000E-03 8.0000E-04                      V+73A 8   37
                                                                  V+73A 8   38
 10.072     8.30       2.5000E-03 1.5000E-03 0.081      0.044     V+73A 8   39
                                                                  V+73A 8   40
 10.072     8.50                             0.059      0.030     V+73A 8   41
                                                                  V+73A 8   42
 10.219     2.23                             2.0000E-03 1.1000E-03 V+73A 8  43
 0.01       0.005                                                 V+73A 8   44
 10.219     4.28                             3.0000E-03 1.6000E-03 V+73A 8  45
                                                                  V+73A 8   46
 10.219     4.46                             3.8000E-03 2.1000E-03 V+73A 8  47
                                                                  V+73A 8   48
 10.219     4.70                                                  V+73A 8   49
 1.6        0.4                                                   V+73A 8   50
 10.219     5.41                             3.2000E-03 1.7000E-03 V+73A 8  51
                                                                  V+73A 8   52
 10.219     5.55                             7.0000E-03 3.8000E-03 V+73A 8  53
                                                                  V+73A 8   54
 10.219     7.11                             0.116      0.027     V+73A 8   55
 0.25       0.15                                                  V+73A 8   56
 10.222     2.23       7.6000E-04 2.2000E-04                      V+73A 8   57
                       0.3        0.1                             V+73A 8   58
 10.222     4.46       3.6000E-03 9.0000E-04                      V+73A 8   59
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		2.5	0.9			V+73A 8	60
10.222	5.01			0.488	0.112	V+73A 8	61
0.04	0.04					V+73A 8	62
10.230	0.			1.1000E-03	6.0000E-04	V+73A 8	63
						V+73A 8	64
10.230	2.23			2.2000E-03	1.2000E-03	V+73A 8	65
						V+73A 8	66
10.230	3.78			1.2000E-03	6.0000E-04	V+73A 8	67
						V+73A 8	68
10.230	4.28			8.4000E-03	2.5000E-03	V+73A 8	69
						V+73A 8	70
10.230	4.70			7.6000E-03	4.1000E-03	V+73A 8	71
						V+73A 8	72
10.230	5.41					V+73A 8	73
1.3	0.7					V+73A 8	74
10.230	5.55			6.3000E-03	3.4000E-03	V+73A 8	75
						V+73A 8	76
10.230	6.22	3.8000E-04	2.1000E-04			V+73A 8	77
						V+73A 8	78
10.230	7.00			8.5000E-03		V+73A 8	79
3.5						V+73A 8	80
10.230	7.11			0.032	0.017	V+73A 8	81
						V+73A 8	82
10.230	7.54			0.033	0.018	V+73A 8	83
						V+73A 8	84
10.256	2.23					V+73A 8	85
		1.1	0.6			V+73A 8	86
10.256	4.46	5.6000E-04	3.1000E-04			V+73A 8	87
		0.4	0.4			V+73A 8	88
10.256	5.01			0.012	0.0065	V+73A 8	89
0.04	0.02					V+73A 8	90
10.256	5.41	5.0000E-05	3.0000E-05			V+73A 8	91
						V+73A 8	92
10.256	6.41	2.4000E-04	1.3000E-04	7.8000E-03	4.0000E-03	V+73A 8	93
2.	1.					V+73A 8	94
10.256	6.62			0.70	0.16	V+73A 8	95
0.20	0.14					V+73A 8	96
10.256	6.76	1.0000E-03	6.0000E-04	0.033	0.018	V+73A 8	97
						V+73A 8	98
10.256	7.35	6.0000E-04	4.0000E-04	0.018	0.010	V+73A 8	99
						V+73A 8	100
10.256	7.70	4.0000E-04	2.0000E-04	0.013	0.007	V+73A 8	101
						V+73A 8	102
10.256	7.95			0.233	0.126	V+73A 8	103
						V+73A 8	104
10.287	2.23	1.4000E-04	9.0000E-05			V+73A 8	105
						V+73A 8	106
10.287	4.46	4.8000E-04	3.2000E-04			V+73A 8	107
						V+73A 8	108
10.287	5.01			0.104	0.067	V+73A 8	109
						V+73A 8	110
10.289	0.					V+73A 8	111
		0.4	0.2			V+73A 8	112
10.289	2.23	2.6000E-04	7.0000E-05			V+73A 8	113

		0.2	0.1			V+73A 8	114
10.289	4.28	3.0000E-05	2.0000E-05			V+73A 8	115
						V+73A 8	116
10.289	5.01			0.0175	0.0045	V+73A 8	117
0.23	0.07					V+73A 8	118
10.289	5.41	6.0000E-05	3.0000E-05			V+73A 8	119
						V+73A 8	120
10.289	5.78			2.6000E-03	1.4000E-03	V+73A 8	121
						V+73A 8	122
10.289	6.22			0.077	0.019	V+73A 8	123
0.22	0.10					V+73A 8	124
10.289	6.67	2.1000E-04	1.1000E-04			V+73A 8	125
						V+73A 8	126
10.289	7.00	1.9000E-04	1.1000E-04			V+73A 8	127
						V+73A 8	128
10.289	8.13	1.1000E-03	6.0000E-04			V+73A 8	129
						V+73A 8	130
10.331	0.	2.3000E-04	1.9000E-04			V+73A 8	131
						V+73A 8	132
10.331	2.23	2.4000E-03	6.0000E-04			V+73A 8	133
						V+73A 8	134
10.331	4.70	1.8000E-03	5.0000E-04			V+73A 8	135
						V+73A 8	136
10.331	5.55	1.2000E-03	7.0000E-04			V+73A 8	137
						V+73A 8	138
10.331	8.13	0.012	0.007			V+73A 8	139
						V+73A 8	140
10.369	0.					V+73A 8	141
0.015						V+73A 8	142
10.369	2.23			0.017	0.005	V+73A 8	143
						V+73A 8	144
10.369	4.28			0.15	0.04	V+73A 8	145
0.02	0.02					V+73A 8	146
10.369	4.70			0.050	0.015	V+73A 8	147
0.02	0.01					V+73A 8	148
10.369	5.01	3.3000E-04	1.8000E-04			V+73A 8	149
						V+73A 8	150
10.369	5.41			0.083	0.025	V+73A 8	151
0.005	0.005					V+73A 8	152
10.369	5.55			0.030	0.016	V+73A 8	153
						V+73A 8	154
10.369	6.22	1.1000E-03	6.0000E-04			V+73A 8	155
						V+73A 8	156
10.369	6.67			0.22	0.05	V+73A 8	157
0.02	0.02					V+73A 8	158
10.369	7.19			0.026	0.014	V+73A 8	159
						V+73A 8	160
10.369	7.49			0.07	0.04	V+73A 8	161
						V+73A 8	162
10.395	2.23					V+73A 8	163
		0.8	0.5			V+73A 8	164
10.395	4.46	8.0000E-05	4.0000E-05			V+73A 8	165
						V+73A 8	166
10.395	5.01			0.015	0.008	V+73A 8	167

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 0.10       0.06                                                V+73A 8  168
 10.395     6.41       1.4000E-04 8.0000E-05 4.7000E-03 3.0000E-03 V+73A 8  169
 1.2        0.7                                                 V+73A 8  170
 10.395     6.62                             0.65       0.15       V+73A 8  171
 0.5        0.4                                                 V+73A 8  172
 10.395     6.76       6.0000E-04 3.0000E-04 0.020      0.011      V+73A 8  173
                                                                V+73A 8  174
 10.395     6.85       3.0000E-04 2.0000E-04 0.010      0.005      V+73A 8  175
                                                                V+73A 8  176
 10.395     7.70       3.0000E-04 2.0000E-04 0.011      0.006      V+73A 8  177
                                                                V+73A 8  178
 10.395     7.95                             0.14       0.08       V+73A 8  179
                                                                V+73A 8  180
ENDDATA           164                                           V+73A 8  181
ENDSUBENT           8                                           V+73A 899999
ENDENTRY            8                                           V+73A9999999
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V+73b

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ENTRY            V+73B          0                               V+73B 0    1
SUBENT        V+73B  1          0                               V+73B 1    1
BIB                12          72                               V+73B 1    2
INSTITUTE  (FRPAR)                                              V+73B 1    3
REFERENCE  (J,PR/C,8,1,178,1973)                                V+73B 1    4
AUTHORS    (J.VERNOTTE,S.GALES,M.LANGEVIN,J.M.MAISON)           V+73B 1    5
TITLE      INVESTIGATION OF THE LOWEST T=2 STATE OF 32S IN THE  V+73B 1    6
           31P+P REACTIONS                                      V+73B 1    7
FACILITY   (VDG) 4-MV VAN DE GRAAFF ACCELERATOR, INSTITUT DE    V+73B 1    8
           PHYSIQUE NUCLEAIRE, ORSAY, FRANCE.                   V+73B 1    9
INC-PART   (P) PROTONS.                                         V+73B 1   10
TARGETS    RED PHOSPHORUS TARGETS WERE PREPARED BY VACUUM       V+73B 1   11
           EVAPORATION ONTO 0.2-MM TUNGSTEN BACKING FOR THE     V+73B 1   12
           GAMMA-RAY EXPERIMENT. RED PHOSPHORUS TARGETS WERE    V+73B 1   13
           PREPARED BY EVAPORATION ONTO 10 - 20 MICROGRAM/CM**2 V+73B 1   14
           CARBON FOIL FOR THE CHARGED PARTICLE MEASUREMENTS.   V+73B 1   15
           THE THICKNESS OF PHOSPHORUS WAS 9.0 MICROGRAM/CM**2  V+73B 1   16
           FOR THESE LATTER TARGETS.                            V+73B 1   17
METHOD     PROTON BEAMS WERE OBTAINED FROM THE 4-MV VAN DE      V+73B 1   18
           GRAAFF ACCELERATOR AT INSTITUT DE PHYSIQUE NUCLEAIRE, V+73B 1   19
           ORSAY. THE BEAM WAS MOMENTUM ANALYZED BY A 90-DEGREE V+73B 1   20
           MAGNET WHICH WAS CALIBRATED WITH THE 13C(P,N)13N     V+73B 1   21
           REACTION AT THE THRESHOLD ENERGY EP = 3.2357 MEV.    V+73B 1   22
           FOR THE (P,GAMMA) MEASUREMENTS, THE PROTON BEAM      V+73B 1   23
           PASSED THROUGH A LIQUID NITROGEN TRAP WHICH SERVED   V+73B 1   24
           TO REDUCE CARBON BUILDUP ON THE TARGET CONSIDERABLY. V+73B 1   25
           DUE TO THE IMPORTANT CONTRIBUTION OF GAMMA RAYS FROM V+73B 1   26
           THE 31P(P,P'-GAMMA)31P AND 13P(P,ALPHA1-GAMMA)28SI   V+73B 1   27
           REACTIONS THE BEAM INTENSITY WAS KEPT TO LESS THAN   V+73B 1   28
           2 MICROAMP ON A 2-MM-DIA. SPOT SIZE. THE TARGET WAS  V+73B 1   29
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           WOBBLED ELECTROMAGNETICALLY TO DISPERSE THE BEAM        V+73B 1   30
           HEAT ON TARGET AND NO DETERIORATION WAS OBSERVED        V+73B 1   31
           EVEN AFTER SEVERAL DAYS OF IRRADIATION. GAMMA RAYS      V+73B 1   32
           WERE DETECTED WITH THE LARGER NAI DETECTORS AS WELL     V+73B 1   33
           AS A GE(LI) DETECTOR. IN THE CASE OF THE CHARGED-       V+73B 1   34
           PARTICLE MEASUREMENTS, RUTHERFORD SCATTERING OF         V+73B 1   35
           PROTONS IN A RESONANCE-FREE ENERGY REGION WAS USED      V+73B 1   36
           TO DETERMINE TARGET ATOM CONTENT. THE PROTON BEAM       V+73B 1   37
           CURRENT WAS KEPT BELOW 300 NANOAMP DURING THESE         V+73B 1   38
           MEASUREMENTS AND NO DETERIORATION OF THE THIN TARGETS   V+73B 1   39
           USED WAS OBSERVED HERE EITHER. THE ENERGY RESOLUTION    V+73B 1   40
           FOR THE CHARGED-PARTICLE MEASUREMENTS WAS OPTIMIZED     V+73B 1   41
           BY ADJUSTING THE BEAM OPTICS AS WELL AS MOMENTUM        V+73B 1   42
           ANALYSIS. IT WAS FOUND TO BE IN THE RANGE OF            V+73B 1   43
           (2.5 - 3.0) X 10**(-4), AS MEASURED AT THE EP =         V+73B 1   44
           1.7476-MEV SHARP RESONANCE OF THE 13C(P,GAMMA)13N       V+73B 1   45
           REACTION. THE BEAM WAS ULTIMATELY STOPPED IN THE        V+73B 1   46
           GRAPHITE LINING OF A FARADAY CUP SITUATED 150 CM        V+73B 1   47
           DOWNSTREAM FROM THE TARGET. THE SCATTERED CHARGED       V+73B 1   48
           PARTICLES WERE DETECTED WITH SURFACE BARRIER            V+73B 1   49
           DETECTORS MOUNTED IN A 50-CM-DIA. SCATTERING CHAMBER.   V+73B 1   50
           GAMMA RAYS WITH ENERGIES EXCEEDING 3 MEV WERE RECORDED  V+73B 1   51
           AT THE SAME TIME AS THE SCATTERED CHARGED PARTICLES.    V+73B 1   52
           THIS DETECTOR WAS PLACED AT 45 DEGREES RELATIVE TO THE  V+73B 1   53
           INCIDENT PROTON BEAM AND 5 CM DISTANCE FROM THE         V+73B 1   54
           TARGET. GAMMA-RAY DETECTOR EFFICIENCY CURVES WERE       V+73B 1   55
           MEASURED USING A 56CO SOURCE FOR GAMMA RAYS WITH        V+73B 1   56
           ENERGIES BELOW 3.2 MEV AND WITH THE GAMMA-RAY           V+73B 1   57
           SPECTRA FROM THE DECAY OF THE EP = 1.555 MEV            V+73B 1   58
           RESONANCE IN 31P(P,GAMMA)32S REACTION FOR GAMMA         V+73B 1   59
           RAYS WITH ENERGIES ABOVE 3.2 MEV.                       V+73B 1   60
DETECTORS  (SCINT) 12.7-CM X 12.7-CM NAI(TL) DETECTORS.            V+73B 1   61
           (GELI) 37-CM**3 GE(LI) DETECTOR WITH A RESOLUTION       V+73B 1   62
           OF 4 KEV FWHM FOR 1.33-MEV 60CO GAMMA RAYS AND 25       V+73B 1   63
           KEV FOR 8 MEV GAMMA RAYS.                               V+73B 1   64
           (SOLST) THREE SURFACE-BARRIER DETECTORS WERE USED.      V+73B 1   65
           EACH SUBTENDED A SOLID ANGLE OF 0.55 X 10**(-3)         V+73B 1   66
           STERADIAN.                                              V+73B 1   67
           (SCINT) 3.8-CM X 3.8-CM NAI(TL) DETECTOR.               V+73B 1   68
MONITOR    (CI) CURRENT INTEGRATOR.                                V+73B 1   69
CORRECTION THE GAMMA-RAY YIELD DATA WERE APPARENTLY CORRECTED FOR  V+73B 1   70
           DETECTOR EFFICIENCY. OTHER DETAILS ARE MENTIONED IN     V+73B 1   71
           THE ORIGINAL PAPER.                                     V+73B 1   72
ERR-ANALYS THE GAMMA-RAY DETECTOR EFFICIENCY CONTRIBUTION WAS      V+73B 1   73
           10 PERCENT.                                             V+73B 1   74
ENDBIB             72                                              V+73B 1   75
ENDSUBENT           1                                              V+73B 199999
SUBENT        V+73B  2          0                                  V+73B 2    1
BIB                 2          19                                  V+73B 2    2
REACTION   31P(P,GAMMA)32S                                         V+73B 2    3
COMMENTS   ELECTROMAGNETIC DECAY PROPERTIES OF 12.044-MEV          V+73B 2    4
           LEVEL IN 32S ARE GIVEN. DATA OBTAINED FROM TABLE I      V+73B 2    5
           OF THE ORIGINAL PAPER. EX = EXCITATION ENERGY OF        V+73B 2    6
           32S LEVEL. EX-ERR = ERROR IN EX. J-PI = SPIN/PARITY     V+73B 2    7
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          OF THE LEVEL. A NEGATIVE VALUE INDICATES NEGATIVE      V+73B 2    8
          PARITY. OTHERWISE PARITY IS POSITIVE. T = ISOBARIC     V+73B 2    9
          SPIN OF THE RESONANT STATE. S = RESONANCE STRENGTH     V+73B 2   10
          = (2J+1)*GAM(P)*GAM(G)/GAM(T), WHERE J = RESONANCE     V+73B 2   11
          SPIN, GAM(P) = PROTON WIDTH, GAM(G) = GAMMA-RAY        V+73B 2   12
          WIDTH, AND GAM(T) = TOTAL WIDTH. S-ERR = ERROR IN S.   V+73B 2   13
          EI = INITIAL LEVEL IN 32S FOR GAMMA-RAY TRANSITION.    V+73B 2   14
          EF = FINAL LEVEL. TYPE = TRANSITION MULTIPOLARITY      V+73B 2   15
          (M1 OR M2). J-PI(F) = SPIN/PARITY OF FINAL STATE.      V+73B 2   16
          TF = ISOBARIC SPIN OF FINAL STATE. TRANS = RADIATION   V+73B 2   17
          TRANSITON STRENGTH. B = BRANCHING RATIO. B-ERR =       V+73B 2   18
          ERROR IN B. TRANS-ERR = ERROR IN TRANS. W.U. =         V+73B 2   19
          WEISSKOPF UNITS. PCT = PERCENT. A BLANK ENTRY          V+73B 2   20
          INDICATES THAT NO VALUE IS GIVEN IN THE TABLE.         V+73B 2   21
ENDBIB             19                                            V+73B 2   22
DATA               14          2                                 V+73B 2   23
EX        EX-ERR     J-PI       T          S          S-ERR      V+73B 2   24
EF        J-PI(F)    TF         TYPE       B          B-ERR      V+73B 2   25
TRANS     TRANS-ERR                                              V+73B 2   26
MEV       MEV        NO-DIM     NO-DIM     EV         EV         V+73B 2   27
MEV       NO-DIM     NO-DIM     NO-DIM     PCT        PCT        V+73B 2   28
W.U.      W.U.                                                   V+73B 2   29
 12.044     0.004     -4.         1.         7.0        1.4      V+73B 2   30
 5.006    -3.         0.         M1         99.                  V+73B 2   31
 0.13       0.03                                                 V+73B 2   32
 12.044     0.004     -4.         1.         7.0        1.4      V+73B 2   33
 2.232      2.         0.         M2         1.                  V+73B 2   34
 0.7                                                             V+73B 2   35
ENDDATA            12                                            V+73B 2   36
ENDSUBENT           2                                            V+73B 299999
SUBENT       V+73B  3          0                                 V+73B 3    1
BIB                 2         21                                 V+73B 3    2
REACTION  31P(P,GAMMA)32S                                        V+73B 3    3
COMMENTS  ELECTROMAGNETIC DECAY PROPERTIES OF 12.050-MEV         V+73B 3    4
          LEVEL IN 32S ARE GIVEN. DATA OBTAINED FROM TABLE II    V+73B 3    5
          OF THE ORIGINAL PAPER. EX = EXCITATION ENERGY OF       V+73B 3    6
          32S LEVEL. EX-ERR = ERROR IN EX. J-PI = SPIN/PARITY    V+73B 3    7
          OF THE LEVEL. A NEGATIVE VALUE INDICATES NEGATIVE      V+73B 3    8
          PARITY. OTHERWISE PARITY IS POSITIVE. T = ISOBARIC     V+73B 3    9
          SPIN OF THE RESONANT STATE. S = RESONANCE STRENGTH     V+73B 3   10
          = (2J+1)*GAM(P)*GAM(G)/GAM(T), WHERE J = RESONANCE     V+73B 3   11
          SPIN, GAM(P) = PROTON WIDTH, GAM(G) = GAMMA-RAY        V+73B 3   12
          WIDTH, AND GAM(T) = TOTAL WIDTH. S-ERR = ERROR IN S.   V+73B 3   13
          EI = INITIAL LEVEL IN 32S FOR GAMMA-RAY TRANSITION.    V+73B 3   14
          EF = FINAL LEVEL. TYPE = TRANSITION MULTIPOLARITY      V+73B 3   15
          (M1 OR E2). J-PI(F) = SPIN/PARITY OF FINAL STATE.      V+73B 3   16
          TF = ISOBARIC SPIN OF FINAL STATE. TRANS = RADIATION   V+73B 3   17
          TRANSITON STRENGTH. B = BRANCHING RATIO. B-ERR =       V+73B 3   18
          ERROR IN B. TRANS-ERR = ERROR IN TRANS. W.U. =         V+73B 3   19
          WEISSKOPF UNITS. PCT = PERCENT. A BLANK ENTRY          V+73B 3   20
          INDICATES THAT NO VALUE IS GIVEN IN THE TABLE.         V+73B 3   21
          TRANSITION STRENGTH CALCULATED WITH PROTON WIDTH       V+73B 3   22
          EQUAL TO 75 PERCENT OF TOTAL WIDTH.                    V+73B 3   23
ENDBIB             21                                            V+73B 3   24
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DATA                14         5                                  V+73B 3   25
EX          EX-ERR     J-PI       T          S          S-ERR     V+73B 3   26
EF          J-PI(F)    TF         TYPE       B          B-ERR     V+73B 3   27
TRANS       TRANS-ERR                                             V+73B 3   28
MEV         MEV        NO-DIM     NO-DIM     EV         EV        V+73B 3   29
MEV         NO-DIM     NO-DIM     NO-DIM     PCT        PCT       V+73B 3   30
W.U.        W.U.                                                  V+73B 3   31
 12.050      0.004      0.         2.         2.4        0.5      V+73B 3   32
 7.001       1.         1.         M1         6.         1.       V+73B 3   33
 0.07        0.02                                                 V+73B 3   34
 12.050      0.004      0.         2.         2.4        0.5      V+73B 3   35
 8.126       1.         1.         M1         83.        8.       V+73B 3   36
 2.1         0.6                                                  V+73B 3   37
 12.050      0.004      0.         2.         2.4        0.5      V+73B 3   38
 9.207       1.         1.         M1         11.        2.       V+73B 3   39
 0.73        0.02                                                 V+73B 3   40
 12.050      0.004      0.         2.         2.4        0.5      V+73B 3   41
 9.07        1.         1.                                        V+73B 3   42
                                                                  V+73B 3   43
 12.050      0.004      0.         2.         2.4        0.5      V+73B 3   44
 2.231       2.         0.         E2         0.8                 V+73B 3   45
 0.06                                                             V+73B 3   46
ENDDATA             21                                            V+73B 3   47
ENDSUBENT            3                                            V+73B 399999
ENDENTRY             3                                            V+73B9999999
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V+74

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ENTRY             V+74         0                                   V+74 0    1
SUBENT         V+74  1         0                                   V+74 1    1
BIB                 12        34                                   V+74 1    2
INSTITUTES  (FRPAR)                                                V+74 1    3
            (FRASTR)                                               V+74 1    4
REFERENCE   (CONF,74AMSTER, INT'L CONFERENCE ON NUCLEAR STRUCTURE  V+74 1    5
            AND SPECTROSCOPY, NUCLEAR MODELS IN THEORY AND         V+74 1    6
            EXPERIMENT, AMSTERDAM, SEPTEMBER 9-13, 1974, THE       V+74 1    7
            NETHERLANDS PHYSICAL SOCIETY, EDS. H.P. BLOCK AND      V+74 1    8
            A.E.L. DIEPERINK, VOL. 1, CONTRIBUTED PAPERS, 79,      V+74 1    9
            1974)                                                  V+74 1   10
AUTHORS     (J.VERNOTTE,J.M.MAISON,C.MIEHE,A.CHEVALLIER,A.HUCK,    V+74 1   11
            G.WALTER)                                              V+74 1   12
TITLE       ELECTROMAGNETIC DECAY OF THE EX = 6621 LEVEL OF 32S    V+74 1   13
FACILITY    (VDG) 3-MV VAN DE GRAAFF ACCELERATOR, CENTRE DE        V+74 1   14
            RECHERCHES NUCLEAIRES ET UNIVERSITE LOUIS-PASTEUR,     V+74 1   15
            STRASBOURG-CRONENBOURG, FRANCE.                        V+74 1   16
INC-PART    (P) PROTONS.                                           V+74 1   17
TARGETS     RED PHOSPHORUS EVAPORATED ON A GOLD BACKING. NO        V+74 1   18
            DETAILS GIVEN.                                         V+74 1   19
METHOD      PROTON BEAMS WERE OBTAINED FROM THE STRASBOURG-        V+74 1   20
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           CRONENBOURG VAN DE GRAAFF ACCELERATOR. MEASUREMENTS      V+74 1   21
           WERE MADE AT TWO STRONG RESONANCES FOR INCIDENT          V+74 1   22
           PROTONS, NAMELY, EP = 1437 AND 1581 KEV. THESE WERE      V+74 1   23
           USED TO POPULATE THE BOUND STATE AT EX = 6621 KEV        V+74 1   24
           THROUGH GAMMA-RAY TRANSITIONS FROM THE RESONANT          V+74 1   25
           STATE. THE DOPPLER SHIFT ATTENUATION METHOD WAS USED     V+74 1   26
           FOR A LIFETIME MEASUREMENT OF THIS STATE. MEASUREMENTS   V+74 1   27
           WERE MADE AT 0 DEGREE, 90 DEGREES, AND 130 DEGREES.      V+74 1   28
           GAMMA-RAY SPECTRA AND TRANSITION STRENGTHS AND MIXING    V+74 1   29
           RATIOS WERE DEDUCED FROM MEASUREMENTS WITH A GE(LI)      V+74 1   30
           DETECTOR. FEW DETAILS ARE PROVIDED IN THIS SHORT         V+74 1   31
           CONFERENCE COMMUNICATION.                                V+74 1   32
DETECTOR   (GELI) 69-CM**3 GE(LI) DETECTOR.                         V+74 1   33
MONITORS   NOT MENTIONED.                                           V+74 1   34
CORRECTION NOT MENTIONED.                                           V+74 1   35
ERR-ANALYS NOT MENTIONED.                                           V+74 1   36
ENDBIB             34                                               V+74 1   37
ENDSUBENT           1                                               V+74 199999
SUBENT        V+74  2           0                                   V+74 2    1
BIB                 2          15                                   V+74 2    2
REACTION   31P(P,GAMMA)32S                                          V+74 2    3
COMMENTS   THE LIFETIME OF THE 6621-KEV STATE IN 32S, GAMMA-RAY     V+74 2    4
           TRANSITION MIXING RATIOS, AND GAMMA-RAY TRANSITION       V+74 2    5
           STRENGTHS ARE GIVEN. TAU = MEAN LIFETIME OF THE 6621-    V+74 2    6
           KEV STATE IN 32S. TAU-ERR = ERROR IN TAU. EI = ENERGY    V+74 2    7
           OF INITIAL STATE FOR GAMMA-RAY TRANSITION. EF =          V+74 2    8
           ENERGY OF FINAL STATE. B = BRANCHING RATIO. B-ERR =      V+74 2    9
           ERROR IN B. MIXRAT = MIXING RATIO. MIXRAT-ERR = ERROR    V+74 2   10
           IN MIXRAT. TYPE = TRANSITION TYPE (E1, M1, E2, M2, E3).  V+74 2   11
           TRANS = TRANSITION STRENGTH. TRANS-ERR = ERROR IN        V+74 2   12
           TRANS. W.U. = WEISSKOPF UNITS. PCT = PERCENT. FSEC =     V+74 2   13
           FEMTOSECOND = 10**(-15) SECOND. WHENEVER A PARTICULAR    V+74 2   14
           VALUE IS NOT GIVEN IT MEANS IT IS NOT AVAILABLE. THE     V+74 2   15
           DATA WERE TAKEN FROM THE TEXT AND A SMALL TABLE THAT     V+74 2   16
           APPEAR IN THE ORIGINAL CONFERENCE COMMUNICATION.         V+74 2   17
ENDBIB             15                                               V+74 2   18
DATA               12          7                                    V+74 2   19
EX         TAU        TAU-ERR    EI         EF         B            V+74 2   20
B-ERR      MIXRAT     MIXRAT-ERR TYPE       TRANS      TRANS-ERR    V+74 2   21
KEV        FSEC       FSEC       KEV        KEV        PCT          V+74 2   22
PCT        NO-DIM     NO-DIM     NO-DIM     W.U.       W.U.         V+74 2   23
 6621.      975.       200.       6621.      2231.      1.7         V+74 2   24
 0.2        0.44       0.07       M2         0.040      0.023       V+74 2   25
 6621.      975.       200.       6621.      2231.      1.7         V+74 2   26
 0.2        0.44       0.07       E3         2.6        1.7         V+74 2   27
 6621.      975.       200.       6621.      4459.      22.         V+74 2   28
 2.         0.056      0.021      E1         2.2000E-05 6.0000E-06  V+74 2   29
 6621.      975.       200.       6621.      4459.      22.         V+74 2   30
 2.         0.056      0.021      M2         0.066      0.042       V+74 2   31
 6621.      975.       200.       6621.      5006.      75.         V+74 2   32
 5.        -5.5        0.2        M1         1.8000E-04 5.0000E-05  V+74 2   33
 6621.      975.       200.       6621.      5006.      75.         V+74 2   34
 5.        -5.5        0.2        E2         9.3        2.4         V+74 2   35
 6621.      975.       200.       6621.      5414.      1.6         V+74 2   36
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 0.2        0.                   E1        9.0000E-06 3.0000E-06  V+74 2   37
ENDDATA             18                                            V+74 2   38
ENDSUBENT            2                                            V+74 299999
ENDENTRY             2                                            V+749999999
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V+76

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ENTRY            V+76          0                                  V+76 0    1
SUBENT        V+76  1          0                                  V+76 1    1
BIB                 12        75                                  V+76 1    2
INSTITUTES (FRPAR)                                                V+76 1    3
           (FRSTR)                                                V+76 1    4
REFERENCE  (J,PR/C,13,3,984,1976)                                 V+76 1    5
AUTHORS    (J.VERNOTTE,J.M.MAISON,A.CHEVALLIER,A.HUCK,C.MIEHE,    V+76 1    6
           G.WALTER)                                              V+76 1    7
TITLE      ELECTROMAGNETIC PROPERTIES OF THE 6621- AND 7950-KEV   V+76 1    8
           LEVELS IN 32S                                          V+76 1    9
FACILITY   (VDG) 3-MV VAN DE GRAAFF ACCELERATOR, CENTRE DE        V+76 1   10
           RECHERCHES NUCLEAIRES, STRASBOURG-CRONENBOURG, FRANCE. V+76 1   11
INC-PART   (P) PROTONS                                            V+76 1   12
TARGETS    RED PHOSPHORUS EVAPORATED IN A VACUUM ON A CAREFULLY   V+76 1   13
           CLEANED 0.2-MM-THICK GOLD BACKING. TARGETS OF 40,      V+76 1   14
           60, AND 90 MICROGRAM/CM**2 PHOSPHORUS WERE PREPARED.   V+76 1   15
           THESE TARGETS WERE PLACED AT 45 DEGREES WITH RESPECT   V+76 1   16
           TO THE BEAM DIRECTION IN AN AIR-COOLED TARGET HOLDER.  V+76 1   17
METHOD     PROTON BEAMS WERE OBTAINED FROM THE 3-MV VAN DE        V+76 1   18
           GRAAFF ACCELERATOR AT CENTRE DE RECHERCHES NUCLEAIRES, V+76 1   19
           STRASBOURG-CRONENBOURG. THE BEAM PASSED THROUGH A      V+76 1   20
           LIQUID NITROGEN TRAP WHICH HELPED CONSIDERABLY TO      V+76 1   21
           REDUCE CARBON BUILDUP ON THE TARGET DURING THE         V+76 1   22
           MEASUREMENTS. THE GAMMA RAYS WERE DETECTED USING       V+76 1   23
           GE(LI) DETECTORS. A 49-CM**3 DETECTOR LOCATED 9 CM     V+76 1   24
           FROM THE TARGET WAS USED AT THE 1247- AND 1402-KEV     V+76 1   25
           RESONANCES WHILE A 69-CM**3 DETECTOR LOCATED 8 CM      V+76 1   26
           FROM THE TARGET WAS USED AT THE 1437- AND 1581-KEV     V+76 1   27
           RESONANCES. EACH DETECTOR HAD A RESOLUTION OF 3 KEV    V+76 1   28
           FWHM AT THE 1.33-KEV 60CO LINE. EACH DETECTOR WAS      V+76 1   29
           MOUNTED ON AN ARM THAT COULD ROTATE AROUND THE         V+76 1   30
           BEAM IMPACT POINT FOR THE DETERMINATION OF ANGULAR     V+76 1   31
           DISTRIBUTIONS. A THIRD GE(LI) DETECTOR WAS FIXED       V+76 1   32
           AT 90 DEGREES TO SERVE AS A MONITOR. THE ANISOTROPY    V+76 1   33
           OF THE ARRANGEMENT WAS CHECKED BY MEASURING IN THE     V+76 1   34
           SAME GEOMETRY THE ANGULAR DISTRIBUTION FOR THE         V+76 1   35
           ISOTROPICALLY-EMITTED 844-KEV GAMMA RAY FROM THE       V+76 1   36
           27AL(P,P'-GAMMA)27AL REACTION AT THE 1683-KEV          V+76 1   37
           RESONANCE. THE GE(LI) DETECTOR EFFICIENCIES WERE       V+76 1   38
           MEASURED USING A 56CO SOURCE FOR EG < 3.2 MEV AND      V+76 1   39
           GAMMA-RAY TRANSITIONS OF KNOWN INTENSITIES EMITTED     V+76 1   40
           AT THE 992-KEV RESONANCE OF THE 27AL(P,GAMMA)28SI      V+76 1   41
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           REACTION FOR EG > 3.2 MEV. THE EFFICIENCIES WERE ALSO    V+76 1   42
           DETERMINED USING A MONTE CARLO PROCEDURE. THE RESULTS    V+76 1   43
           FROM THE EXPERIMENTAL AND ANALYTICAL METHODS AGREED      V+76 1   44
           WELL. THE EXPERIMENT INCLUDED SEVERAL ASPECTS: GAMMA-    V+76 1   45
           RAY SPECTRA AND ANGULAR DISTRIBUTIONS WERE TAKEN         V+76 1   46
           AT 0, 30, 45, 60, AND 90 DEGREES FOR FOUR PROTON-        V+76 1   47
           ENERGY RESONANCES, NAMELY, EP = 1247, 1402, 1437,        V+76 1   48
           AND 1581 KEV. A TOTAL PROTON CHARGE ON TARGET OF         V+76 1   49
           60 MILLICURIE WAS REQUIRED TO OBTAIN A STATISTICAL       V+76 1   50
           ACCURACY OF 10 PERCENT FOR THE GAMMA-RAY TRANSITION      V+76 1   51
           6621 TO 2230 KEV IN 32S. ELSEWHERE, EXPOSURES OF 50      V+76 1   52
           MILLICURIE WERE FOUND TO BE ADEQUATE. BRANCHING          V+76 1   53
           RATIOS WERE DEDUCED FROM THE MEASURED SPECTRA AND        V+76 1   54
           THESE WERE COMPARED WITH OTHER VALUES FROM THE           V+76 1   55
           LITERATURE. ALL THE ANGULAR DISTRIBUTION DATA WERE       V+76 1   56
           FITTED WITH EVEN-ORDER LEGENDRE POLYNOMIAL EXPANSIONS    V+76 1   57
           UP TO FOURTH ORDER. MULTIPOLE MIXING RATIOS WERE ALSO    V+76 1   58
           DERIVED FROM THIS ANALYSIS. LIFETIMES OF SEVERAL 32S     V+76 1   59
           LEVELS HAVE BEEN MEASURED USING THE DOPPLER SHIFT        V+76 1   60
           ATTENUATION METHOD (DSAM). PHOSPHORUS TARGET             V+76 1   61
           THICKNESSES OF 60 AND 90 MICROGRAMS/CM**2 WERE USED      V+76 1   62
           TO INSURE THAT THE RECOILING SULFUR IONS STOPPED IN      V+76 1   63
           THE TARGET LAYER. GAMMA-RAY SPECTRA WERE MEASURED AT     V+76 1   64
           THE 1402-, 1437-, AND 1581-KEV RESONANCES AND AT         V+76 1   65
           0, 90, AND 130 DEGREES. ANALYSIS OF THE PEAK-SHAPE       V+76 1   66
           DATA WAS ACCOMPLISHED USING STANDARD TECHNIQUES THAT     V+76 1   67
           ARE DISCUSSED IN THE ORIGINAL PAPER.                     V+76 1   68
DETECTORS  (GELI) 49-CM**3 GE(LI) DETECTOR.                         V+76 1   69
           (GELI) 69-CM**3 GE(LI) DETECTOR.                         V+76 1   70
MONITORS   (CI) CURRENT INTEGRATOR.                                 V+76 1   71
           (GELI) UNSPECIFIED GE(LI) DETECTOR.                      V+76 1   72
CORRECTION DATA WERE CORRECTED FOR GAMMA-RAY ATTENUATION,           V+76 1   73
           GEOMETRY DETAILS, AND DETECTOR EFFICIENCY.               V+76 1   74
ERR-ANALYS THE UNCERTAINTY IN THE GE(LI) DETECTOR EFFICIENCY WAS    V+76 1   75
           ESTIMATED TO BE ABOUT 10 PERCENT. THE ACCURACY OF THE    V+76 1   76
           MEASURED BRANCHING RATIOS IS 15 PERCENT.                 V+76 1   77
ENDBIB             75                                               V+76 1   78
ENDSUBENT           1                                               V+76 199999
SUBENT        V+76  2          0                                    V+76 2    1
BIB                 2         11                                    V+76 2    2
REACTION   31P(P,GAMMA)32S                                          V+76 2    3
COMMENTS   GAMMA-RAY DECAY BRANCHING RATIOS OF RESONANCE LEVELS     V+76 2    4
           ARE GIVEN. DATA ARE OBTAINED FROM TABLE I OF THE         V+76 2    5
           ORIGINAL PAPER. EP = RESONANCE PROTON ENERGY. EX =       V+76 2    6
           EXCITATION ENERGY IN 32S. EI = ENERGY OF INITIAL         V+76 2    7
           STATE FOR TRANSITION IN 32S. J-PI(I) = SPIN/PARITY OF    V+76 2    8
           INITIAL STATE. A NEGATIVE VALUE MEANS NEGATIVE PARITY.   V+76 2    9
           OTHERWISE PARITY IS POSITIVE. EF = ENERGY OF FINAL       V+76 2   10
           STATE. J-PI(F) = SPIN/PARITY OF FINAL STATE. B =         V+76 2   11
           BRANCHING FACTOR. PCT = PERCENT. A BLANK SPACE IMPLIES   V+76 2   12
           THAT THE VALUE IS NOT PROVIDED IN THE TABLE.             V+76 2   13
ENDBIB             11                                               V+76 2   14
DATA                7         37                                    V+76 2   15
EP         EX         EI         J-PI(I)    EF         J-PI(F)      V+76 2   16
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B                                                                    V+76 2   17
MEV        MEV        MEV        NO-DIM     MEV        NO-DIM        V+76 2   18
PCT                                                                  V+76 2   19
 1.247      10.072     10.072    -2.         0.          0.          V+76 2   20
 1.8                                                                 V+76 2   21
 1.247      10.072     10.072    -2.         2.23        2.          V+76 2   22
 28.                                                                 V+76 2   23
 1.247      10.072     10.072    -2.         4.28        2.          V+76 2   24
 1.6                                                                 V+76 2   25
 1.247      10.072     10.072    -2.         4.70        1.          V+76 2   26
 0.9                                                                 V+76 2   27
 1.247      10.072     10.072    -2.         5.01       -3.          V+76 2   28
 12.                                                                 V+76 2   29
 1.247      10.072     10.072    -2.         5.41        3.          V+76 2   30
 4.                                                                  V+76 2   31
 1.247      10.072     10.072    -2.         6.22       -2.          V+76 2   32
 50.                                                                 V+76 2   33
 1.247      10.072     10.072    -2.         7.11                    V+76 2   34
 0.7                                                                 V+76 2   35
 1.247      10.072     10.072    -2.         8.13                    V+76 2   36
 0.3                                                                 V+76 2   37
 1.247      10.072     10.072    -2.         8.30                    V+76 2   38
 0.4                                                                 V+76 2   39
 1.247      10.072     10.072    -2.         8.50                    V+76 2   40
 0.2                                                                 V+76 2   41
 1.402      10.222     10.222    -3.         2.23        2.          V+76 2   42
 12.                                                                 V+76 2   43
 1.402      10.222     10.222    -3.         4.46        4.          V+76 2   44
 22.                                                                 V+76 2   45
 1.402      10.222     10.222    -3.         5.01       -3.          V+76 2   46
 66.                                                                 V+76 2   47
 1.437      10.256     10.256    -4.         2.23        2.          V+76 2   48
 0.5                                                                 V+76 2   49
 1.437      10.256     10.256    -4.         4.28        2.          V+76 2   50
 0.1                                                                 V+76 2   51
 1.437      10.256     10.256    -4.         4.46        4.          V+76 2   52
 8.                                                                  V+76 2   53
 1.437      10.256     10.256    -4.         5.01       -3.          V+76 2   54
 4.                                                                  V+76 2   55
 1.437      10.256     10.256    -4.         5.41        3.          V+76 2   56
 0.1                                                                 V+76 2   57
 1.437      10.256     10.256    -4.         6.41        4.          V+76 2   58
 0.5                                                                 V+76 2   59
 1.437      10.256     10.256    -4.         6.62       -4.          V+76 2   60
 77.                                                                 V+76 2   61
 1.437      10.256     10.256    -4.         6.76                    V+76 2   62
 4.1                                                                 V+76 2   63
 1.437      10.256     10.256    -4.         6.85                    V+76 2   64
 0.8                                                                 V+76 2   65
 1.437      10.256     10.256    -4.         7.35                    V+76 2   66
 1.                                                                  V+76 2   67
 1.437      10.256     10.256    -4.         7.70                    V+76 2   68
 0.5                                                                 V+76 2   69
 1.437      10.256     10.256    -4.         7.95                    V+76 2   70
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 6.2                                                                V+76 2   71
 1.581      10.395     10.395    -4.         2.23       2.          V+76 2   72
 0.3                                                                V+76 2   73
 1.581      10.395     10.395    -4.         4.28       2.          V+76 2   74
 0.1                                                                V+76 2   75
 1.581      10.395     10.395    -4.         4.46       4.          V+76 2   76
 1.1                                                                V+76 2   77
 1.581      10.395     10.395    -4.         5.01      -3.          V+76 2   78
 5.6                                                                V+76 2   79
 1.581      10.395     10.395    -4.         5.41       3.          V+76 2   80
 0.2                                                                V+76 2   81
 1.581      10.395     10.395    -4.         6.41       4.          V+76 2   82
 0.5                                                                V+76 2   83
 1.581      10.395     10.395    -4.         6.62      -4.          V+76 2   84
 84.                                                                V+76 2   85
 1.581      10.395     10.395    -4.         6.76                   V+76 2   86
 2.7                                                                V+76 2   87
 1.581      10.395     10.395    -4.         6.85                   V+76 2   88
 1.3                                                                V+76 2   89
 1.581      10.395     10.395    -4.         7.70                   V+76 2   90
 0.7                                                                V+76 2   91
 1.581      10.395     10.395    -4.         7.95                   V+76 2   92
 4.2                                                                V+76 2   93
ENDDATA             78                                              V+76 2   94
ENDSUBENT            2                                              V+76 299999
SUBENT        V+76   3          0                                   V+76 3    1
BIB                  2          7                                   V+76 3    2
REACTION   31P(P,GAMMA)32S                                          V+76 3    3
COMMENTS   GAMMA-RAY BRANCHING RATIOS OF SOME BOUND LEVELS OF 32S   V+76 3    4
           ARE GIVEN. DATA ARE OBTAINED FROM TABLE II. EXI =        V+76 3    5
           INITIAL STATE OF TRANSITION. EXI-ERR = ERROR IN EXI.     V+76 3    6
           EXF = FINAL STATE OF TRANSITION. B = BRANCHING RATIO.    V+76 3    7
           B-ERR = ERROR IN B. PCT = PERCENT. BLANK ENTRIES         V+76 3    8
           CORRESPOND TO MISSING VALUES IN THE ORIGINAL PAPER.      V+76 3    9
ENDBIB               7                                              V+76 3   10
DATA                 5         13                                   V+76 3   11
EXI        EXI-ERR   EXF        B          B-ERR                    V+76 3   12
KEV        KEV       KEV        PCT        PCT                      V+76 3   13
 5006.2     0.3       0.         3.4        0.4                     V+76 3   14
 5006.2     0.3       2230.      96.6       0.4                     V+76 3   15
 6224.3     0.9       0.         0.5                                V+76 3   16
 6224.3     0.9       2230.      97.        2.                      V+76 3   17
 6224.3     0.9       5006.      3.         2.                      V+76 3   18
 6621.1     0.3       2230.      1.7        0.3                     V+76 3   19
 6621.1     0.3       4459.      22.        3.                      V+76 3   20
 6621.1     0.3       5006.      75.        3.                      V+76 3   21
 6621.1     0.3       5413.      1.4        0.2                     V+76 3   22
 6761.7     0.3       0.         1.                                 V+76 3   23
 6761.7     0.3       4459.      35.        10.                     V+76 3   24
 7950.0     0.4       4459.      15.                                V+76 3   25
 7950.0     0.4       5006.      65.        7.                      V+76 3   26
ENDDATA             15                                              V+76 3   27
ENDSUBENT            3                                              V+76 399999
SUBENT        V+76   4          0                                   V+76 4    1
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BIB                  2         12                                       V+76 4     2
REACTION    31P(P,GAMMA)32S                                             V+76 4     3
COMMENTS    LEGENDRE POLYNOMIAL COEFFICIENTS CORRESPONDING TO FITS      V+76 4     4
            TO MEASURED GAMMA-RAY ANGULAR DISTRIBUTION DATA ARE         V+76 4     5
            GIVEN ALONG WITH VALUES OF THE MIXING RATIO. DATA ARE       V+76 4     6
            OBTAINED FROM TABLE III OF THE ORIGINAL PAPER. EP =         V+76 4     7
            RESONANCE PROTON ENERGY. EXI = ENERGY OF INITIAL STATE      V+76 4     8
            OF TRANSITION. EXF = ENERGY OF FINAL STATE. A2 =            V+76 4     9
            COEFFICIENT OF P2 LEGENDRE TERM. A2-ERR = ERROR IN          V+76 4    10
            A2. A4 = COEFFICIENT OF P4 LEGENDRE TERM. A4-ERR =          V+76 4    11
            ERROR IN A4. MIX = MIXING RATIO. A BLANK ENTRY              V+76 4    12
            INDICATES THAT EITHER THE VALUE IS MISSING FROM THE         V+76 4    13
            TABLE OR IT IS AMBIGUOUS.                                   V+76 4    14
ENDBIB              12                                                  V+76 4    15
DATA                 9         41                                       V+76 4    16
EP          EXI         EXF         A2          A2-ERR      A4          V+76 4    17
A4-ERR      MIX         MIX-ERR                                         V+76 4    18
KEV         MEV         MEV         NO-DIM      NO-DIM      NO-DIM      V+76 4    19
NO-DIM      NO-DIM      NO-DIM                                          V+76 4    20
 1247.       10.07       0.          0.43        0.01       -0.02       V+76 4    21
 0.01                                                                   V+76 4    22
 1247.       10.07       2.23        0.36        0.02       -0.01       V+76 4    23
 0.02       -0.02        0.03                                           V+76 4    24
 1247.       10.07       4.28        0.29        0.08        0.01       V+76 4    25
 0.08        0.05        0.09                                           V+76 4    26
 1247.       10.07       5.01       -0.03        0.01        0.00       V+76 4    27
 0.01        0.06        0.01                                           V+76 4    28
 1247.       10.07       5.41       -0.11        0.02        0.03       V+76 4    29
 0.02        0.00        0.03                                           V+76 4    30
 1247.       10.07       6.22        0.33        0.03        0.00       V+76 4    31
 0.03        0.02        0.03                                           V+76 4    32
 1247.       6.22        2.23        0.14        0.01       -0.01       V+76 4    33
 0.01        0.07        0.03                                           V+76 4    34
 1247.       5.41        2.23       -0.12        0.06        0.07       V+76 4    35
 0.07        20.                                                        V+76 4    36
 1247.       5.01        2.23       -0.23        0.03       -0.02       V+76 4    37
 0.03        0.00        0.03                                           V+76 4    38
 1399.       10.22       4.70        0.51        0.07       -0.26       V+76 4    39
 0.09       -0.02        0.04                                           V+76 4    40
 1399.       10.22       7.12       -0.25        0.01       -0.04       V+76 4    41
 0.01       -0.04        0.01                                           V+76 4    42
 1399.       7.12        2.23        0.38        0.03        0.02       V+76 4    43
 0.03                                                                   V+76 4    44
 1402.       10.22       5.01        0.39        0.01        0.01       V+76 4    45
 0.01        0.02        0.02                                           V+76 4    46
 1402.       5.01        2.23       -0.23        0.01       -0.02       V+76 4    47
 0.01        0.00        0.02                                           V+76 4    48
 1437.       10.26       2.23        0.44        0.02       -0.25       V+76 4    49
 0.02        0.02        0.01                                           V+76 4    50
 1437.       10.26       4.46        0.46        0.01       -0.03       V+76 4    51
 0.01       -0.03        0.04                                           V+76 4    52
 1437.       10.26       5.01       -0.52        0.02        0.00       V+76 4    53
 0.02        0.11        0.02                                           V+76 4    54
 1437.       10.26       6.41        0.55        0.03        0.00       V+76 4    55
```

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 0.04                                                                V+76 4   56
 1437.      10.26      6.62       0.46       0.01      -0.02         V+76 4   57
 0.01      -0.02       0.04                                          V+76 4   58
 1437.      10.26      6.76      -0.25       0.03       0.01         V+76 4   59
 0.03                                                                V+76 4   60
 1437.      10.26      7.95       0.31       0.01      -0.03         V+76 4   61
 0.01       0.18       0.02                                          V+76 4   62
 1437.      7.95       5.01      -0.15       0.02       0.18         V+76 4   63
 0.02       7.9        1.5                                           V+76 4   64
 1437.      6.62       2.23       0.05       0.05      -0.30         V+76 4   65
 0.05                                                                V+76 4   66
 1437.      6.62       4.46       0.35       0.01      -0.03         V+76 4   67
 0.01       0.06       0.02                                          V+76 4   68
 1437.      6.62       5.01       0.32       0.01       0.21         V+76 4   69
 0.01      -5.5        0.3                                           V+76 4   70
 1437.      6.41       2.23       0.17       0.09      -0.15         V+76 4   71
 0.09                                                                V+76 4   72
 1437.      5.41       2.23       0.32       0.04       0.22         V+76 4   73
 0.04                                                                V+76 4   74
 1581.      10.40      2.23       0.36       0.05      -0.12         V+76 4   75
 0.05       0.00       0.06                                          V+76 4   76
 1581.      10.40      4.46       0.43       0.03      -0.02         V+76 4   77
 0.03       0.02       0.06                                          V+76 4   78
 1581.      10.40      5.01       0.06       0.01      -0.03         V+76 4   79
 0.01      -0.19       0.02                                          V+76 4   80
 1581.      10.40      6.62       0.41       0.01      -0.01         V+76 4   81
 0.01       0.05       0.03                                          V+76 4   82
 1581.      10.40      6.76      -0.07       0.05       0.01         V+76 4   83
 0.06                                                                V+76 4   84
 1581.      10.40      6.85       0.57       0.09      -0.03         V+76 4   85
 0.10                                                                V+76 4   86
 1581.      10.40      7.95       0.41       0.06      -0.02         V+76 4   87
 0.07       0.05       0.11                                          V+76 4   88
 1581.      7.95       5.01      -0.13       0.08       0.29         V+76 4   89
 0.09       11.        2.                                            V+76 4   90
 1581.      6.85       4.28       0.48       0.04      -0.10         V+76 4   91
 0.04                                                                V+76 4   92
 1581.      6.76       4.46      -0.04       0.02      -0.03         V+76 4   93
 0.03                                                                V+76 4   94
 1581.      6.62       2.23       0.02       0.03      -0.28         V+76 4   95
 0.03                                                                V+76 4   96
 1581.      6.62       4.46       0.35       0.02      -0.02         V+76 4   97
 0.02       0.05       0.02                                          V+76 4   98
 1581.      6.62       5.01       0.31       0.01       0.22         V+76 4   99
 0.01      -5.5        0.4                                           V+76 4  100
 1581.      5.41       2.23       0.17       0.05       0.12         V+76 4  101
 0.06                                                                V+76 4  102
ENDDATA            86                                                V+76 4  103
ENDSUBENT           4                                                V+76 499999
SUBENT        V+76  5          0                                     V+76 5    1
BIB                 2         10                                     V+76 5    2
REACTION   31P(P,GAMMA)32S                                           V+76 5    3
COMMENTS   LIFETIMES OF 32S BOUND LEVELS MEASURED BY THE DOPPLER-    V+76 5    4
           -SHIFT ATTENUATION METHOD ARE GIVEN. DATA ARE TAKEN       V+76 5    5
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          FROM TABLE IV. EX = EXCITATION OF LEVEL FOR WHICH THE    V+76 5    6
          LIFETIME HAS BEEN MEASURED. EI = ENERGY OF INITIAL       V+76 5    7
          LEVEL OF OBSERVED TRANSITION. EF = ENERGY OF FINAL       V+76 5    8
          LEVEL. EP = PROTON ENERGY OF RESONANCE. TAU = MEAN       V+76 5    9
          LIFETIME OF LEVEL. TAU-ERR(+) = POSITIVE LOBE OF TAU     V+76 5   10
          ERROR BAR. TAU-ERR(-) = NEGATIVE LOBE OF TAU ERROR       V+76 5   11
          BAR. FSEC = FEMTOSECOND = 10**(-15) SECOND.              V+76 5   12
ENDBIB             10                                              V+76 5   13
DATA                7          8                                   V+76 5   14
EX        EI         EF         EP         TAU        TAU-ERR(+)   V+76 5   15
TAU-ERR(-)                                                         V+76 5   16
KEV       MEV        MEV        KEV        FSEC       FSEC         V+76 5   17
FSEC                                                               V+76 5   18
 5006.     5.01       2.23       1247.      580.       60.         V+76 5   19
 40.                                                               V+76 5   20
 5006.     5.01       2.23       1402.      620.       190.        V+76 5   21
 90.                                                               V+76 5   22
 5413.     5.41       2.23       1247.      160.       30.         V+76 5   23
 30.                                                               V+76 5   24
 6224.     6.22       2.23       1247.      75.        10.         V+76 5   25
 10.                                                               V+76 5   26
 6621.     6.62       5.01       1437.      1000.      350.        V+76 5   27
 200.                                                              V+76 5   28
 6621.     6.62       5.01       1581.      950.       350.        V+76 5   29
 200.                                                              V+76 5   30
 7950.     7.95       5.01       1437.      115.       20.         V+76 5   31
 20.                                                               V+76 5   32
 7950.     7.95       5.01       1581.      145.       20.         V+76 5   33
 20.                                                               V+76 5   34
ENDDATA            20                                              V+76 5   35
ENDSUBENT           5                                              V+76 599999
SUBENT        V+76  6          0                                   V+76 6    1
BIB                 2          18                                  V+76 6    2
REACTION  31P(P,GAMMA)32S                                          V+76 6    3
COMMENTS  STRENGTHS OF TRANSITIONS BETWEEN SOME BOUND STATES IN    V+76 6    4
          32S ARE GIVEN. DATA TAKEN FROM TABLE VI OF THE ORIGINAL  V+76 6    5
          PAPER. EXI = ENERGY OF INITIAL 32S STATE OF TRANSITION.  V+76 6    6
          J-PI(I) = SPIN/PARITY OF INTIAL STATE. A NEGATIVE        V+76 6    7
          VALUE INDICATES NEGATIVE PARITY. OTHERWISE PARITY IS     V+76 6    8
          POSITIVE. EXF = ENERGY OF FINAL 32S STATE. J-PI(F) =     V+76 6    9
          SPIN/PARITY OF FINAL STATE. B = BRANCHING RATIO OF       V+76 6   10
          TRANSITION. B-ERR = ERROR IN B. PCT = PERCENT. MIX =     V+76 6   11
          MIXING RATIO. MIX-ERR = ERROR IN MIX. TS(E1) = E1        V+76 6   12
          TRANSITION STRENGTH. TS(E1)-ERR = ERROR IN TS(E1).       V+76 6   13
          TS(M1) = M1 TRANSITION STRENGTH. TS(M1)-ERR = ERROR      V+76 6   14
          IN TS(M1). TS(E2) = E2 TRANSITION STRENGTH. TS(E2)-ERR   V+76 6   15
          = ERROR IN TS(E2). TS(M2) = M2 TRANSITION STRENGTH.      V+76 6   16
          TS(M2)-ERR = ERROR IN TS(M2). TS(E3) = E3 TRANSITION     V+76 6   17
          STRENGTH. TS(E3)-ERR = ERROR IN TS(E3). W.U. =           V+76 6   18
          WEISSKOPF UNITS. A BLANK SPACE INDICATES THAT VALUE IS   V+76 6   19
          NOT PROVIDED, IS AMBIGUOUS, OR IS IRRELEVANT.            V+76 6   20
ENDBIB             18                                              V+76 6   21
DATA               18          11                                  V+76 6   22
EXI       J-PI(I)    EXF        J-PI(F)    B          B-ERR        V+76 6   23
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MIX         MIX-ERR     TS(E1)      TS(E1)-ERR TS(M1)      TS(M1)-ERR   V+76 6   24
TS(E2)      TS(E2)-ERR TS(M2)      TS(M2)-ERR TS(E3)      TS(E3)-ERR   V+76 6   25
MEV         NO-DIM      MEV         NO-DIM      PCT         PCT          V+76 6   26
NO-DIM      NO-DIM      W.U.        W.U.        W.U.        W.U.         V+76 6   27
W.U.        W.U.        W.U.        W.U.        W.U.        W.U.         V+76 6   28
 5.01       -3.          0.          0.          3.4        0.4          V+76 6   29
 0.                                                                      V+76 6   30
                                                 20.         5.          V+76 6   31
 5.01       -3.          2.23        2.          96.6        0.4         V+76 6   32
 0.00        0.02        7.2000E-05 1.6000E-05                           V+76 6   33
                         0.02                                            V+76 6   34
 5.41        3.          2.23        2.          100.                    V+76 6   35
 20.                                             2.0000E-04              V+76 6   36
 2.5         0.6                                                         V+76 6   37
 6.22       -2.          2.23        2.          97.         2.          V+76 6   38
 0.07        0.03        2.0000E-04 4.0000E-05                           V+76 6   39
                         0.27                                            V+76 6   40
 6.41                    2.23        2.          100.                    V+76 6   41
                                                                         V+76 6   42
                                                                         V+76 6   43
 6.62       -4.          2.23        2.          1.7         0.3         V+76 6   44
                                                                         V+76 6   45
                                                                         V+76 6   46
 6.62       -4.          4.46        4.          22.         3.          V+76 6   47
 0.06        0.02        2.2000E-05 6.0000E-06                           V+76 6   48
                         0.07        0.05                                V+76 6   49
 6.62       -4.          5.01       -3.          75.         3.          V+76 6   50
-5.5         0.3                                 1.8000E-04 6.0000E-05   V+76 6   51
 9.0         2.5                                                         V+76 6   52
 6.62       -4.          5.41        3.          1.4         0.3         V+76 6   53
 0.0         0.5         8.0000E-06 4.0000E-06                           V+76 6   54
                         5.                                              V+76 6   55
 6.85                    4.28        2.          70.         10.         V+76 6   56
                                                                         V+76 6   57
                                                                         V+76 6   58
 7.95       -4.          5.01       -3.          65.         7.          V+76 6   59
 10.         3.                                  1.3                     V+76 6   60
 3.0         0.7                                                         V+76 6   61
ENDDATA             39                                                   V+76 6   62
ENDSUBENT            6                                                   V+76 699999
ENDENTRY             6                                                   V+769999999
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VF74b

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ENTRY            VF74B           0                                      VF74B 0    1
SUBENT        VF74B  1           0                                      VF74B 1    1
BIB                 12          40                                      VF74B 1    2
INSTITUTE  (SFHLS)                                                      VF74B 1    3
REFERENCE  (J,ZP,269,173,1974)                                          VF74B 1    4
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AUTHORS    (M.VIITASALO,I.FORSBLOM)                              VF74B 1    5
TITLE      AN INVESTIGATION OF EXCITED STATES IN 32S BY THE      VF74B 1    6
           31P(P,GAMMA)32S REACTION                              VF74B 1    7
FACILITY   (VDG) 3-MV VAN DE GRAAFF ACCELERATOR, HELSINKI        VF74B 1    8
           UNIVERSITY, HELSINKI, FINLAND.                        VF74B 1    9
INC-PART   (P) PROTONS.                                          VF74B 1   10
TARGETS    PHOSPHORUS TARGETS WERE PREPARED BY IN VACUO          VF74B 1   11
           EVAPORATION OF ZN3P2 ONTO 0.2-MM TANTALUM BACKINGS.   VF74B 1   12
METHOD     PROTONS WERE ACCELEATED BY THE HELSINKI UNIVERSITY    VF74B 1   13
           3-MV VAN DE GRAAFF ACCELERATOR. THE ENERGY SCALE      VF74B 1   14
           CALIBRATION WAS BASED ON THE KNOWN EP = 991.88-KEV    VF74B 1   15
           RESONANCE IN THE 27AL(P,GAMMA)28SI REACTION. THIS     VF74B 1   16
           LED TO A VALUE OF Q = 8865.1 KEV FOR THE REACTION     VF74B 1   17
           31P(P,GAMMA)32S. GAMMA-RAY SPECTRA TAKEN WITH TWO     VF74B 1   18
           GE(LI) DETECTORS WERE RECORDED WITH A NUCLEAR DATA    VF74B 1   19
           ND-160 4096-CHANNEL PULSE-HEIGHT ANALYZER. THE        VF74B 1   20
           GAMMA-RAY PEAK ENERGIES WERE CALIBRATED USING         VF74B 1   21
           56CO AND 208TL RADIOACTIVE SOURCES. THE DETECTOR      VF74B 1   22
           EFFICIENCIES WERE MEASURED USING A 60CO SOURCE        VF74B 1   23
           AT A DISTANCE OF 25 CM. SINGLE SPECTRA WERE TAKEN     VF74B 1   24
           ON THE RESONANCES AT 55 DEGREES WITH THE DETECTOR     VF74B 1   25
           PLACED 2 CM FROM THE TARGET. HOWEVER, TO ASCERTAIN    VF74B 1   26
           THE EFFECTS OF DOPPLER BROADENING, DATA WERE ALSO     VF74B 1   27
           ACQUIRED AT 90 DEGREES. THE ANGULAR DISTRIBUTION      VF74B 1   28
           MEASUREMENTS WERE MADE ONLY AT THE EP = 1400-KEV      VF74B 1   29
           RESONANCE. ANGULAR DISTRIBUTIONS WERE ANALYZED        VF74B 1   30
           BY FITTING EVEN-ORDER LEGENDRE POLYNOMIAL FUNCTIONS   VF74B 1   31
           UP TO 4-TH ORDER BY THE LEAST-SQUARES METHOD.         VF74B 1   32
           FURTHER ANALYSIS LED TO ASSIGNMENT OF MULTIPOLE       VF74B 1   33
           MIXING RATIOS.                                        VF74B 1   34
DETECTOR   (GELI) 38-CM**3 PHILLIPS GE(LI) DETECTOR.             VF74B 1   35
           (GELI) 58-CM**3 CANBERRA GE(LI) DETECTOR.             VF74B 1   36
MONITOR    (CI) CURRENT INTEGRATOR.                              VF74B 1   37
CORRECTION GAMMA-RAY YIELDS WERE CORRECTED FOR DETECTOR          VF74B 1   38
           EFFICIENCY. NO OTHER DETAILS ARE GIVEN IN THE         VF74B 1   39
           ORIGINAL PAPER.                                       VF74B 1   40
ERR-ANALYS ERRORS ARE GIVEN BUT DETAILS ARE NOT PROVIDED IN THE  VF74B 1   41
           ORIGINAL PAPER.                                       VF74B 1   42
ENDBIB              40                                           VF74B 1   43
ENDSUBENT            1                                           VF74B 199999
SUBENT        VF74B  2          0                                VF74B 2    1
BIB                  2         13                                VF74B 2    2
REACTION   31P(P,GAMMA)32S                                       VF74B 2    3
COMMENTS   RELATIVE INTENSITIES OF GAMMA RAYS IN THE DECAY OF    VF74B 2    4
           RESONANCE STATES IN 31P(P,GAMMA)32S ARE GIVEN. THE    VF74B 2    5
           INFORMATION IS OBTAINED FROM TABLE 1 OF PAPER. EP =   VF74B 2    6
           RESONANCE PROTON ENERGY. EX = EXCITATION ENERGY IN    VF74B 2    7
           32S (CORRESPONDS TO INITIAL ENERGY OF GAMMA-RAY       VF74B 2    8
           TRANSITION). J-PI(I) = SPIN/PARITY OF RESONANCE       VF74B 2    9
           STATE. A NEGATIVE VALUE INDICATES NEGATIVE PARITY.    VF74B 2   10
           OTHERWISE PARITY IS POSITIVE. EF = FINAL STATE OF     VF74B 2   11
           GAMMA-RAY TRANSITION. J-PI(F) = SPIN/PARITY OF        VF74B 2   12
           FINAL STATE. B = GAMMA-RAY BRANCH FACTOR. PCT =       VF74B 2   13
           PERCENT. ABSENCE OF A VALUE INDICATES THAT VALUE      VF74B 2   14
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	IS NOT PROVIDED OR IS AMBIGUOUS.					VF74B 2	15
ENDBIB		13				VF74B 2	16
DATA		6	109			VF74B 2	17
EP	EX	J-PI(I)	EF	J-PI(F)	B	VF74B 2	18
KEV	KEV	NO-DIM	KEV	NO-DIM	PCT	VF74B 2	19
355.	9209.		0.	0.	38.	VF74B 2	20
355.	9209.		2230.	2.	35.	VF74B 2	21
355.	9209.		3776.	0.	4.	VF74B 2	22
355.	9209.		5546.	2.	5.	VF74B 2	23
355.	9209.		5797.	-1.	9.	VF74B 2	24
355.	9209.		6223.		9.	VF74B 2	25
439.	9290.	1.	0.	0.	32.	VF74B 2	26
439.	9290.	1.	2230.	2.	21.	VF74B 2	27
439.	9290.	1.	4696.	1.	13.	VF74B 2	28
439.	9290.	1.	6223.		4.	VF74B 2	29
439.	9290.	1.	7116.	2.	19.	VF74B 2	30
439.	9290.	1.	7536.		11.	VF74B 2	31
541.	9389.	-2.	0.	0.	1.	VF74B 2	32
541.	9389.	-2.	2230.	2.	68.	VF74B 2	33
541.	9389.	-2.	4281.	2.	3.	VF74B 2	34
541.	9389.	-2.	4696.	1.	1.	VF74B 2	35
541.	9389.	-2.	5005.	-3.	8.	VF74B 2	36
541.	9389.	-2.	5546.	2.	1.	VF74B 2	37
541.	9389.	-2.	5797.	-1.	2.	VF74B 2	38
541.	9389.	-2.	6223.		14.	VF74B 2	39
541.	9389.	-2.	6621.		1.	VF74B 2	40
541.	9389.	-2.	8128.		2.	VF74B 2	41
642.	9487.	-1.	0.	0.	77.	VF74B 2	42
642.	9487.	-1.	4281.	2.	12.	VF74B 2	43
642.	9487.	-1.	5005.	-3.	4.	VF74B 2	44
642.	9487.	-1.	5797.	-1.	4.	VF74B 2	45
642.	9487.	-1.	7116.	2.	3.	VF74B 2	46
811.	9651.	2.	0.	0.	0.3	VF74B 2	47
811.	9651.	2.	2230.	2.	59.	VF74B 2	48
811.	9651.	2.	3776.	0.	0.6	VF74B 2	49
811.	9651.	2.	4696.	1.	37.	VF74B 2	50
811.	9651.	2.	5005.	-3.	0.7	VF74B 2	51
811.	9651.	2.	5410.	-3.	1.8	VF74B 2	52
811.	9651.	2.	5546.	2.	0.6	VF74B 2	53
821.	9660.		0.	0.	78.	VF74B 2	54
821.	9660.		2230.	2.	12.	VF74B 2	55
821.	9660.		3776.	0.	2.	VF74B 2	56
821.	9660.		4696.	1.	4.	VF74B 2	57
821.	9660.		5546.	2.	2.	VF74B 2	58
821.	9660.		7192.		2.	VF74B 2	59
888.	9725.		5005.	-3.	44.	VF74B 2	60
888.	9725.		6223.		14.	VF74B 2	61
888.	9725.		6621.		42.	VF74B 2	62
895.	9732.		0.	0.	4.	VF74B 2	63
895.	9732.		2230.	2.	17.	VF74B 2	64
895.	9732.		4281.	2.	25.	VF74B 2	65
895.	9732.		4696.	1.	1.	VF74B 2	66
895.	9732.		5005.	-3.	1.	VF74B 2	67
895.	9732.		5546.	2.	2.	VF74B 2	68

895.	9732.		5797.	-1.	22.	VF74B 2	69
895.	9732.		6223.		27.	VF74B 2	70
895.	9732.		7116.	2.	1.	VF74B 2	71
895.	9732.		8128.		3.	VF74B 2	72
983.	9817.		0.	0.	1.	VF74B 2	73
983.	9817.		2230.	2.	22.	VF74B 2	74
983.	9817.		4281.	2.	12.	VF74B 2	75
983.	9817.		4458.	4.	4.	VF74B 2	76
983.	9817.		5005.	-3.	43.	VF74B 2	77
983.	9817.		5797.	-1.	3.	VF74B 2	78
983.	9817.		6223.		7.	VF74B 2	79
983.	9817.		7116.	2.	8.	VF74B 2	80
1016.	9849.		0.	0.	9.	VF74B 2	81
1016.	9849.		2230.	2.	56.	VF74B 2	82
1016.	9849.		5797.	-1.	8.	VF74B 2	83
1016.	9849.		7116.	2.	27.	VF74B 2	84
1053.	9886.		0.	0.	1.	VF74B 2	85
1053.	9886.		2230.	2.	10.	VF74B 2	86
1053.	9886.		4281.	2.	7.	VF74B 2	87
1053.	9886.		4696.	1.	5.	VF74B 2	88
1053.	9886.		5546.	2.	11.	VF74B 2	89
1053.	9886.		7004.	1.	23.	VF74B 2	90
1053.	9886.		7116.	2.	44.	VF74B 2	91
1087.	9918.		2230.	2.	41.	VF74B 2	92
1087.	9918.		5546.	2.	35.	VF74B 2	93
1087.	9918.		6852.		7.	VF74B 2	94
1087.	9918.		7116.	2.	14.	VF74B 2	95
1087.	9918.		7483.		3.	VF74B 2	96
1117.	9947.		0.	0.	74.	VF74B 2	97
1117.	9947.		2230.	2.	10.	VF74B 2	98
1117.	9947.		3776.	0.	3.	VF74B 2	99
1117.	9947.		4281.	2.	2.	VF74B 2	100
1117.	9947.		4696.	1.	2.	VF74B 2	101
1117.	9947.		7004.	1.	0.5	VF74B 2	102
1117.	9947.		7116.	2.	1.5	VF74B 2	103
1117.	9947.		8128.		7.	VF74B 2	104
1400.	10221.	3.	0.	0.	0.6	VF74B 2	105
1400.	10221.	3.	2230.	2.	12.	VF74B 2	106
1400.	10221.	3.	4281.	2.	9.	VF74B 2	107
1400.	10221.	3.	4458.	4.	9.	VF74B 2	108
1400.	10221.	3.	4696.	1.	19.	VF74B 2	109
1400.	10221.	3.	5410.	-3.	5.	VF74B 2	110
1400.	10221.	3.	5546.	2.	6.	VF74B 2	111
1400.	10221.	3.	7116.	2.	40.	VF74B 2	112
1402.	10223.	-3.	2230.	2.	11.	VF74B 2	113
1402.	10223.	-3.	4458.	4.	18.	VF74B 2	114
1402.	10223.	-3.	4696.	1.	1.	VF74B 2	115
1402.	10223.	-3.	5005.	-3.	69.	VF74B 2	116
1402.	10223.	-3.	7116.	2.	2.	VF74B 2	117
1410.	10231.	2.	0.	0.	7.	VF74B 2	118
1410.	10231.	2.	2230.	2.	8.	VF74B 2	119
1410.	10231.	2.	3776.	0.	1.	VF74B 2	120
1410.	10231.	2.	4281.	2.	14.	VF74B 2	121
1410.	10231.	2.	4696.	1.	7.	VF74B 2	122

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 1410.      10231.     2.         5005.     -3.         1.         VF74B 2  123
 1410.      10231.     2.         5410.     -3.         6.         VF74B 2  124
 1410.      10231.     2.         6223.                 7.         VF74B 2  125
 1410.      10231.     2.         7004.      1.         42.        VF74B 2  126
 1410.      10231.     2.         7116.      2.         4.         VF74B 2  127
 1410.      10231.     2.         7536.                 5.         VF74B 2  128
ENDDATA           111                                              VF74B 2  129
ENDSUBENT           2                                              VF74B 299999
SUBENT        VF74B  3          0                                  VF74B 3    1
BIB                 2          9                                   VF74B 3    2
REACTION   31P(P,GAMMA)32S                                         VF74B 3    3
COMMENTS   EXCITATION ENERGIES AND GAMMA-DECAY BRANCHING FACTORS   VF74B 3    4
           FOR BOUND LEVELS IN 32S ARE GIVEN. DATA OBTAINED FROM   VF74B 3    5
           TABLE 2 OF ORIGINAL PAPER. EX = EXCITATION ENERGY OF    VF74B 3    6
           32S STATE. EX-ERR = ERROR IN EX. EF = ENERGY OF FINAL   VF74B 3    7
           STATE FOR GAMMA-RAY DECAY TRANSITION. B = BRANCHING     VF74B 3    8
           FACTOR. B-ERR = ERROR IN B. PCT = PERCENT. A MISSING    VF74B 3    9
           ENTRY IMPLIES THAT THE VALUE IS NOT AVAILABLE IN        VF74B 3   10
           ORIGINAL PAPER.                                         VF74B 3   11
ENDBIB              9                                              VF74B 3   12
DATA                5         41                                   VF74B 3   13
EX         EX-ERR     EF         B          B-ERR                  VF74B 3   14
KEV        KEV        KEV        PCT        PCT                    VF74B 3   15
 2230.0     0.3        0.         100.                             VF74B 3   16
 3776.0     1.2        2230.      100.                             VF74B 3   17
 4281.2     1.0        0.         84.        2.                    VF74B 3   18
 4281.2     1.0        2230.      16.        2.                    VF74B 3   19
 4458.4     0.8        2230.      100.                             VF74B 3   20
 4695.6     0.5        0.         45.        3.                    VF74B 3   21
 4695.6     0.5        2230.      55.        3.                    VF74B 3   22
 5005.4     0.8        0.         4.         2.                    VF74B 3   23
 5005.4     0.8        2230.      96.        2.                    VF74B 3   24
 5410.4     1.5        2230.      100.                             VF74B 3   25
 5546.2     1.2        0.         45.        5.                    VF74B 3   26
 5546.2     1.2        2230.      55.        5.                    VF74B 3   27
 5797.2     1.9        0.         100.                             VF74B 3   28
 6222.9     0.8        2230.      100.                             VF74B 3   29
 6410.      2.         2230.      100.                             VF74B 3   30
 6620.6     0.8        2230.      2.         1.                    VF74B 3   31
 6620.6     0.8        4458.      22.        4.                    VF74B 3   32
 6620.6     0.8        5005.      76.        4.                    VF74B 3   33
 6851.5     1.5        4281.      80.        10.                   VF74B 3   34
 6851.5     1.5        4458.      10.        5.                    VF74B 3   35
 6851.5     1.5        5410.      10.        5.                    VF74B 3   36
 7004.4     1.6        2230.      90.        5.                    VF74B 3   37
 7004.4     1.6        3776.      10.        5.                    VF74B 3   38
 7115.7     1.0        0.         7.         3.                    VF74B 3   39
 7115.7     1.0        2230.      80.        10.                   VF74B 3   40
 7115.7     1.0        3776.      3.         2.                    VF74B 3   41
 7115.7     1.0        4281.      3.         2.                    VF74B 3   42
 7115.7     1.0        4696.      7.         3.                    VF74B 3   43
 7192.4     2.0        0.         100.                             VF74B 3   44
 7348.      2.         4696.      100.                             VF74B 3   45
 7434.      3.         0.         60.        15.                   VF74B 3   46
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 7434.      3.         2230.      20.        10.                        VF74B 3   47
 7434.      3.         4281.      20.        10.                        VF74B 3   48
 7482.6     1.2        0.         100.                                  VF74B 3   49
 7535.7     1.0        4696.      100.                                  VF74B 3   50
 7701.      2.         2230.      100.                                  VF74B 3   51
 8128.0     1.5        0.         85.        5.                         VF74B 3   52
 8128.0     1.5        2230.      15.        5.                         VF74B 3   53
 8294.      3.         0.         60.        20.                        VF74B 3   54
 8294.      3.         2230.      40.        20.                        VF74B 3   55
 8504.                                                                  VF74B 3   56
ENDDATA            43                                                   VF74B 3   57
ENDSUBENT           3                                                   VF74B 399999
SUBENT        VF74B  4          0                                       VF74B 4    1
BIB                 2          15                                       VF74B 4    2
REACTION   31P(P,GAMMA)32S                                              VF74B 4    3
COMMENTS   EXPERIMENTAL ANGULAR DISTRIBUTION COEFFICIENTS AND           VF74B 4    4
           MULTIPOLE MIXING RATIOS ARE GIVEN FOR MEASURED GAMMA-        VF74B 4    5
           RAY TRANSITIONS. DATA OBTAINED FROM TABLE 3 OF THE           VF74B 4    6
           ORIGINAL PAPER. EP = RESONANCE PROTON ENERGY. EX =           VF74B 4    7
           EXCITATION ENERGY OF RESONANCE IN 32S. EI = INITIAL          VF74B 4    8
           LEVEL ENERGY FOR TRANSITION. EF = FINAL LEVEL                VF74B 4    9
           ENERGY. EG = GAMMA-RAY TRANSITION ENERGY. A2 =               VF74B 4   10
           COEFFICIENT OF P2 TERM OF LEGENDRE-POLYNOMIAL                VF74B 4   11
           EXPANSION. A2-ERR = ERROR IN A2. A4 = COEFFICIENT            VF74B 4   12
           OF P4 TERM OF LEGENDRE-POLYNOMIAL EXPANSION. A4-ERR          VF74B 4   13
           = ERROR IN A4. MIX = MULTIPOLE MIXING PARAMETER.             VF74B 4   14
           MIX-ERR = ERROR IN MIX. A MISSING ENTRY INDICATES            VF74B 4   15
           THAT VALUE WAS NOT PROVIDED IN THE TABLE OR THERE            VF74B 4   16
           WAS AMBIGUITY.                                               VF74B 4   17
ENDBIB             15                                                   VF74B 4   18
DATA               11           6                                       VF74B 4   19
EP         EX         EI         EF         EG         A2               VF74B 4   20
A2-ERR     A4         A4-ERR     MIX        MIX-ERR                     VF74B 4   21
KEV        KEV        KEV        KEV        KEV        NO-DIM           VF74B 4   22
NO-DIM     NO-DIM     NO-DIM     NO-DIM     NO-DIM                      VF74B 4   23
 1400.      10221.     10221.     2230.      7991.     -0.825           VF74B 4   24
 0.092      0.210      0.085      0.702      0.049                      VF74B 4   25
 1400.      10221.     10221.     4281.      5940.     -0.677           VF74B 4   26
 0.108      0.093      0.103                                            VF74B 4   27
 1400.      10221.     10221.     4696.      5525.      0.426           VF74B 4   28
 0.060     -0.277      0.070      0.223      0.077                      VF74B 4   29
 1400.      10221.     10221.     7116.      3105.     -0.281           VF74B 4   30
 0.041     -0.052      0.040     -0.233      0.017                      VF74B 4   31
 1400.      10221.     7116.      2230.      4886.      0.332           VF74B 4   32
 0.043     -0.132      0.048     -0.381      0.037                      VF74B 4   33
 1400.      10221.     4696.      2230.      2466      -0.375           VF74B 4   34
 0.092      0.142      0.088      0.075      0.103                      VF74B 4   35
ENDDATA            16                                                   VF74B 4   36
ENDSUBENT           4                                                   VF74B 499999
ENDENTRY            4                                                   VF74B9999999
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ZL86

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ENTRY            ZL86          0                                   ZL86 0    1
SUBENT        ZL86  1          0                                   ZL86 1    1
BIB                12         73                                   ZL86 1    2
INSTITUTE  (NEDUTR)                                                ZL86 1    3
REFERENCE  (J,NP/A,460,181,1986)                                   ZL86 1    4
AUTHORS    (F.ZIJDERHAND,C.VAN DER LEUN)                           ZL86 1    5
TITLE      STRONG M2 TRANSITIONS                                   ZL86 1    6
FACILITY   (VDG) 3-MV VAN DE GRAAFF ACCELERATOR, UNIVERSITY OF     ZL86 1    7
           UTRECHT, UTRECHT, THE NETHERLANDS.                      ZL86 1    8
INC-PART   (P) PROTONS.                                            ZL86 1    9
TARGETS    99.99 PERCENT PURE 31P WAS SPUTTERED ONTO 0.5-MM-       ZL86 1   10
           THICK COPPER BACKINGS. THE THICKNESS WAS 10 TO 20       ZL86 1   11
           MICROGRAM/CM**2 OF 31P. COPPER WAS USED FOR A BACKING   ZL86 1   12
           SINCE IT PROVIDED BETTER HEAT CONDUCTIVITY AND          ZL86 1   13
           MINIMIZED DETERIORATION OF THE PHOSPHORUS TARGETS       ZL86 1   14
           UNDER PROTON BOMBARDMENT.                               ZL86 1   15
METHOD     PROTONS BEAMS WERE OBTAINED FROM THE UTRECHT 3-MV       ZL86 1   16
           VAN DE GRAAFF ACCELERATOR. A 90-DEGREE ANALYZING        ZL86 1   17
           MAGNET WITH STABILIZING SLITS LED TO PROTON ENERGY      ZL86 1   18
           RESOLUTION OF ABOUT 200 EV AT EP = 1 MEV. THE BEAM      ZL86 1   19
           CURRENT RANGED FROM 5 - 150 MICROAMPS ON TARGET         ZL86 1   20
           DEPENDING ON TARGET STABILITY AND COUNTING RATE         ZL86 1   21
           CONSIDERATIONS. THE VACUUM IN THE BEAM LINES AND        ZL86 1   22
           TARGET CHAMBER WAS MAINTAINED TO BETTER THAN 10**(-6)   ZL86 1   23
           TORR. A LIQUID NITROGEN COOLING TRAP WAS PLACED         ZL86 1   24
           IN FRONT OF THE TARGET TO REDUCE BUILD UP OF            ZL86 1   25
           CONTAMINANTS ON THE TARGETS. FLUORINE AND SODIUM        ZL86 1   26
           IMPURITIES WERE REDUCED TO VERY LOW LEVELS BY           ZL86 1   27
           HEATING THE TARGET BACKING IN VACUUM BEFORE             ZL86 1   28
           DEPOSITING THE SELECTED TARGET MATERIAL - IN THIS       ZL86 1   29
           CASE, PHOSPHORUS. THE BEAM SPOT ON TARGET WAS           ZL86 1   30
           NORMALLY LESS THAN 2-MM X 2-MM. TO FURTHER REDUCE       ZL86 1   31
           DETERIORATION THE TARGETS WERE WOBBLED AND WATER        ZL86 1   32
           COOLED. INDIVIDUAL TARGETS WERE REMOVED AFTER           ZL86 1   33
           THE GAMMA-RAY YIELD WAS OBSERVED TO DECLINE             ZL86 1   34
           BY 30 PERCENT UNDER FIXED CONDITIONS. THE GE AND        ZL86 1   35
           GE(LI) DETECTORS USED IN THIS EXPERIMENT HAD            ZL86 1   36
           RESOLUTIONS IN THE RANGE 1.8 TO 2.1 KEV FWHM AT         ZL86 1   37
           EG = 1.33 MEV. THE GAMMA-RAY EFFICIENCY CURVES FOR      ZL86 1   38
           ALL THE DETECTORS WERE MEASURED USING VARIOUS           ZL86 1   39
           CALIBRATED RADIOACTIVE SOURCES AS WELL AS KNOWN         ZL86 1   40
           GAMMA-RAY SPECTRA FROM PROTON-CAPTURE RESONANCES        ZL86 1   41
           AT EP = 767 AND 1317 IN 27AL(P,GAMMA)28SI, AT           ZL86 1   42
           EP = 1020, 1317, AND 1417 KEV IN 23NA(P,GAMMA)24MG,     ZL86 1   43
           AND EP = 675 AND 1388 KEV IN 11B(P,GAMMA)12C. LEAD      ZL86 1   44
           ABSORBERS 5 MM THICK WERE PLACED IN FRONT OF ALL        ZL86 1   45
           THE GAMMA-RAY DETECTORS TO MINIMIZE THE NUMBER OF       ZL86 1   46
           DETECTED LOW-ENERGY GAMMA-RAYS AND THUS TO REDUCE       ZL86 1   47
           THE COUNTING RATE DUE TO USELESS EVENTS. THE GAMMA-     ZL86 1   48
           RAY DETECTORS WERE PLACED 4 CM FROM THE TARGET AT       ZL86 1   49
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           55 DEGREES TO REDUCE ANGULAR DISTRIBUTION EFFECTS.       ZL86 1   50
           THE GENERAL EXPERIMENTAL PROCEDURE INVOLVED              ZL86 1   51
           DETERMINING THE SHAPE OF A RESONANCE AND THE             ZL86 1   52
           CORRESPONDING BACKGROUND. A YIELD CURVE WAS              ZL86 1   53
           MEASURED OVER EACH RESONANCE. A GAMMA-RAY SPECTRUM       ZL86 1   54
           WAS MEASURED FOR EACH PROTON ENERGY CONSIDERED.          ZL86 1   55
           ONE REASON FOR THIS WAS TO SEARCH FOR POSSIBLE           ZL86 1   56
           MULTIPLET RESONANCES. THE GAMMA-RAY WIDTH WAS            ZL86 1   57
           MEASURED AT THE RESONANCE ENERGIES. THESE                ZL86 1   58
           MEASUREMENTS GENERALLY INVOLVED YIELD COMPARISONS        ZL86 1   59
           RELATIVE TO STANDARD RESONANCES. IN THE CASE OF          ZL86 1   60
           THE EP = 1251 KEV RESONANCE STUDIED FOR THE              ZL86 1   61
           REACTION 31P(P,GAMMA)32S, MEASUREMENTS WERE TAKEN        ZL86 1   62
           IN STEPS OF 0.5 KEV. THE REFERENCE RESONANCE WAS         ZL86 1   63
           AT EP = 811 KEV IN 31P(P,GAMMA)32S.                      ZL86 1   64
DETECTORS  (GE) A HYPERPURE N-TYPE GERMANIUM DETECTOR WITH          ZL86 1   65
           VOLUME = 100-CM**3.                                      ZL86 1   66
           (GELI) FOUR GE(LI) DETECTORS WITH VOLUME = 100-CM**3.    ZL86 1   67
MONITORS   (CI) CURRENT INTEGRATOR.                                 ZL86 1   68
CORRECTION DATA WERE CORRECTED FOR OFF-RESONANCE YIELD, DEAD TIME,  ZL86 1   69
           AND COINCIDENT AND RANDOM SUMMING EFFECTS. THE LATTER    ZL86 1   70
           EFFECTS AMOUNTED TO NO MORE THAN 10 PERCENT AT THE       ZL86 1   71
           STRONGEST RESONANCES. GAMMA-RAY YIELD DATA WERE          ZL86 1   72
           CORRECTED FOR ABSORPTION EFFECTS AND DETECTOR            ZL86 1   73
           EFFICIENCY.                                              ZL86 1   74
ERR-ANALYS SEE ORIGINAL PAPER FOR DETAILS.                          ZL86 1   75
ENDBIB              73                                              ZL86 1   76
ENDSUBENT            1                                              ZL86 199999
SUBENT        ZL86  2          0                                    ZL86 2    1
BIB                  2         16                                   ZL86 2    2
REACTION   31P(P,GAMMA)32S                                          ZL86 2    3
COMMENTS   PROPERTIES OF THE 31P(P,GAMMA)32S RESONANCE AT EP =      ZL86 2    4
           1251-KEV RESONANCE ARE GIVEN. ALL GAMMA-RAY              ZL86 2    5
           TRANSITIONS ARE FROM THE RESONANCE AT EX = 10.08         ZL86 2    6
           MEV EXCITATION IN 32S TO THE INDICATED FINAL STATES.     ZL86 2    7
           EF = ENERGY OF FINAL STATE. B = GAMMA-RAY BRANCH.        ZL86 2    8
           B-ERR = ERROR IN B. PCT= PERCENT. S = RESONANCE          ZL86 2    9
           STRENGTH = (2J+1)*GAM(P)*GAM(G)/GAM(T), WHERE J =        ZL86 2   10
           SPIN OF RESONANT STATE, GAM(P) = PROTON WIDTH, GAM(G)    ZL86 2   11
           = GAMMA-RAY WIDTH, GAM(T) = TOTAL WIDTH, GAM(G0) =       ZL86 2   12
           WIDTH CORRESPONDING TO DECAY OF THE RESONANCE TO         ZL86 2   13
           THE GROUND STATE OF 32S BY A DIRECT GAMMA-RAY. S-ERR     ZL86 2   14
           = ERROR IN S. GAM(G)-ERR = ERROR IN GAM(G),              ZL86 2   15
           GAM(G0)-ERR = ERROR IN GAM(G0). TR(M2) = M2              ZL86 2   16
           TRANSITION STRENGTH. TR(M2)-ERR = ERROR IN TR(M2).       ZL86 2   17
           W.U. = WEISSKOPF UNITS. DATA FROM TABLE 7 OF PAPER.      ZL86 2   18
ENDBIB              16                                              ZL86 2   19
DATA                11          7                                   ZL86 2   20
EF         B          B-ERR      S          S-ERR      GAM(G)       ZL86 2   21
GAM(G)-ERR GAM(G0)    GAM(G0)-ERRTRANS      TRANS-ERR               ZL86 2   22
MEV        PCT        PCT        EV         EV         EV           ZL86 2   23
EV         EV         EV         W.U.       W.U                     ZL86 2   24
 0.          1.7        0.1        4.3        0.5        0.86       ZL86 2   25
 0.11        0.0015     0.0002     0.93       0.13                  ZL86 2   26
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 2.23       29.6       1.5        4.3        0.5        0.86        ZL86 2   27
 0.11       0.0015     0.0002     0.93       0.13                   ZL86 2   28
 4.28       1.5        0.1        4.3        0.5        0.86        ZL86 2   29
 0.11       0.0015     0.0002     0.93       0.13                   ZL86 2   30
 4.70       0.7        0.1        4.3        0.5        0.86        ZL86 2   31
 0.11       0.0015     0.0002     0.93       0.13                   ZL86 2   32
 5.01       13.8       0.7        4.3        0.5        0.86        ZL86 2   33
 0.11       0.0015     0.0002     0.93       0.13                   ZL86 2   34
 5.41       4.3        0.3        4.3        0.5        0.86        ZL86 2   35
 0.11       0.0015     0.0002     0.93       0.13                   ZL86 2   36
 6.22       49.        2.         4.3        0.5        0.86        ZL86 2   37
 0.11       0.0015     0.0002     0.93       0.13                   ZL86 2   38
ENDDATA             18                                              ZL86 2   39
ENDSUBENT            2                                              ZL86 299999
ENDENTRY             2                                              ZL869999999
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THE END