FAST-NEUTRON ELASTIC SCATTERING FROM ELEMENTAL VANADIUM

by

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ABSTRACT

Differential neutron elastic- and inelastic-scattering cross sections of vanadium were measured from 4.5 to 10.0 MeV. These results were combined with previous 1.5 to 4.0 MeV data from this laboratory, the 11.1 MeV elastic-scattering results obtained at Ohio University, and the reported neutron total cross sections to energies of \( \approx 20.0 \) MeV. to form a data base which was interpreted in terms of the spherical optical-statistical model. A fit to the data was achieved by making both the strengths and geometries of the optical-model potential energy dependent. This energy dependence was large below \( \approx 6.0 \) MeV. Above \( \approx 6.0 \) MeV the energy dependencies are smaller, and similar to those characteristic of global models. Using the dispersion relationship and the method of moments, the optical-model potential deduced from the 0.0 to 11.1 MeV neutron-scattering data was extrapolated to higher energies and to the bound-state regime. This extrapolation leads to predicted neutron total cross sections that are within 3% of the experimental values throughout the energy range 0.0 to 20.0 MeV. Furthermore, the values of the volume-integral-per-nucleon of the real potential are in excellent agreement with those needed to reproduce the observed binding energies of particle- and hole-states. The latter give clear evidence of the Fermi surface anomaly. Using only the 0.0 to 11.1 MeV data, the predicted \( E < 0 \) behavior of the strength and radius of the real shell-model Woods-Saxon potential are somewhat different from those obtained by Mahaux and Sartor in their analysis of nuclei near closed shells. This is attributed to the neglect of higher-energy data in the extrapolation. Because of the dispersion relationship linking the real and imaginary potentials, it is argued that the use of a global optical model for interpreting low-energy data is suspect but, at the same time, probably a reasonable approximation at higher energies.

I. INTRODUCTION

This study of the interaction of fast neutrons with elemental vanadium was motivated by applied and fundamental interests.

Metallic vanadium has unusual properties, notably strength at high temperatures and the ability to contain tritium. These characteristics make it an attractive metal in a number of nuclear applications, particularly those associated with the development of fusion-energy systems. For such applications the neutronic properties of vanadium