A Comparative Study of Measured Neutron Cross Sections with Statistical Model Calculations

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Elastic and inelastic scattering cross sections are of direct relevance for the modeling of the neutron transport in nuclear energy systems. Inelastic scattering cross sections are of particular relevance for accelerator-driven systems since this process determines the degradation of the primary neutron spectrum produced by the spallation source [1]. Usually elastic scattering makes a sizeable contribution to the total neutron interaction cross section. The total and the elastic scattering cross section can be measured with small uncertainties. Hence, the difference of the total and the elastic cross section is an important constraint for the sum of all other reaction cross sections. Since this involves the difference of two numbers of similar magnitudes, precise data are required.

The present work reports about the neutron cross section measurements at different neutron incident energies, using the single-ended 7 MV CN Van de Graaff located at the University of Kentucky Accelerator Laboratory. Proton beams are created with an RF ion source which feeds a chopping and bunching system to produce a ~1 ns pulse every 533 ns. The ^{3}H(p,n) reaction is used to produce a nearly monoenergetic ($\Delta E \sim 80$ keV) neutron fluence in the forward direction emerging from a gas cell 3-cm in length. Neutron production from the gas cell was monitored with a small NE213 scintillator; yields from this detector were used to normalize all angular distributions. Pulse shape discrimination and time-of-flight were used with the monitor and main scintillators to eliminate γ-ray induced events.

Theoretical simulations were performed by using the TALYS-1.4 code at different neutron energies. The optical model with a default set of parameters was used for the present calculations. In addition to the TALYS calculations, we also retrieved results for the n + ^{23}Na reaction from the Evaluated Nuclear Data File (ENDF/B-VII.1). The measured elastic scattering differential cross sections shown in fig.1 are compared with the TALYS-1.4 predictions as well with available ENDF/B-VII.1 information.

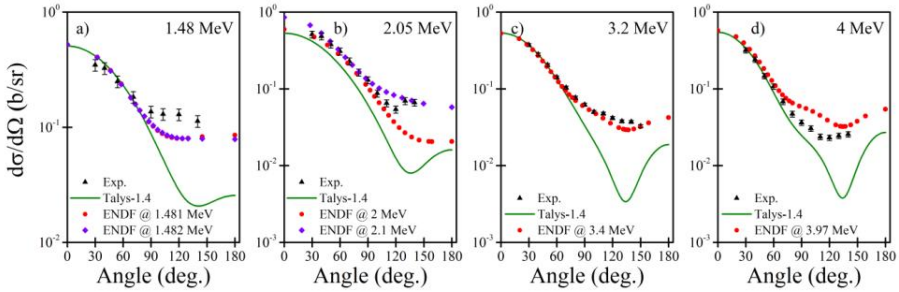

Fig.1. Measured (solid triangles) elastic scattering differential cross sections are compared with the TALYS-1.4 results (solid line) and ENDF/B-VII.1 information (solid and/or open circles).

References:

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