Study of resonance and multi scattering effect on Neutron differential cross sections

A. Kumar[*1,3], A. Chakraborty[3], B.P. Crider[3], M.T. Mcellistrem[3], E.E. Peters[2], F.M. Prados-Estevz[3], S.W. Yates[2,3]
[1]*Department of Physics,*
Banaras Hindu University, Varanasi 221005, INDIA

[2]*Department of Chemistry,*
[3]*Department of Physics and Astronomy,*
University of Kentucky, Lexington, Kentucky, 40506 USA

S. F. Hicks, L. J. Kersting, C.J. Luke, P. J. Mcdonough, A. J. Siglitto
Department of Physics, University of Dallas
Irving, Texas 75062 USA

J.R. Vanhoy
Department of Physics, United States Naval Academy
Annapolis, Maryland 21402 USA

*E-mail: atyagi44@yahoo.co.in

Introduction

Well-determined cross sections are needed for nuclear reactors to perform computer modeling calculations for reactor design and safety, for heat transfer properties and shielding, and ^{23}Na cross sections in particular are needed for proliferation resistant thorium fast reactors. Elastic and inelastic neutron cross sections are especially important for use in transport codes and energy loss calculations, and for the inelastic neutron channel, the resulting γ rays can lead to heating of reactor materials. Knowledge of the (n,n) and (n,n') channels are often important for deducing the (n,p) and (n,α) cross sections which are also important for reactor design. For ^{23}Na, the existing inelastic neutron scattering cross sections are known to approximately 30% in the 2-6 MeV region and the desired uncertainties are on the order of 12-13% [1].

The focus of the research presented here is elastic and inelastic neutron differential scattering cross sections measured between 1 and 4 MeV on ^{23}Na.

Elastic and inelastic neutron scattering angular distributions have been measured for ^{23}Na for various incident neutron energies using neutron time-of-flight techniques. The cross sections obtained are important for applications in nuclear reactor development and other areas. Cross-sections were obtained by normalizing Na angular distributions to the well-known n-p cross sections. The multi-scattering effects were observed in the cross-sections due to neutron scattering through samples and to take care of such kind of contributions, Monte Carlo calculation (MULCAT) was performed and hence obtained the corrected values.

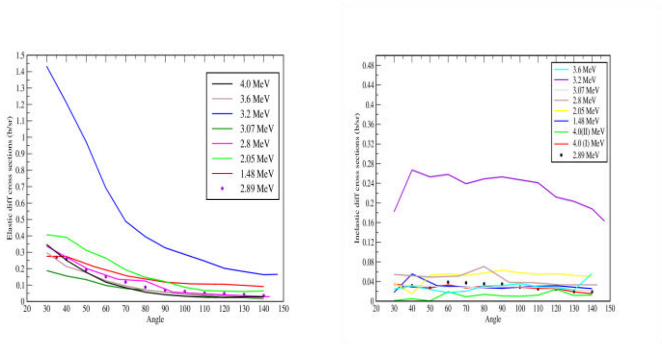

Fig. 1: Elastic and inelastic corrected differential cross sections for ^{23}Na at different neutron incident energies.

The most critical phenomenon of cross section measurements known as 'resonance' was observed at 3.2 MeV, during these measurements, while the optical model calculations TALLYS and evaluated data does not predict any possibility of resonance at this energy. A critical example of such kind of comparison is shown in Fig.2. These kind of observations are very critical and suggests to do more cross- section measurements very carefully at very small bin of neutron energy to find out such kind of possibility.