ANALYSIS OF THE (N,F) REACTION IN THE PU ISOTOPES

O. BOULAND[1], J.E. LYNN[2], AND P. TALOU[2]
[1]LEPH/DEN, CEA CADARACHE, FRANCE
[2] LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, NM, USA

The description of the decay of the compound nucleus by fission is a multi-dimensional problem, which requires very many parameters. The elucidation and physical understanding of these parameters is an ongoing research process, and in this paper we report on our progress on the study of the fission cross-sections of the full sequence of plutonium isotopes. There are two purposes here: one is to further our understanding of the fission process, the other is for application to evaluating the cross-sections of nuclides for which measurements are unavailable or very poor.

Fission barrier heights are the a priori parameters for the evaluation of cross-sections. Several decades of theoretical work using Strutinsky macroscopic-microscopic or HFB methods, have revealed many of the important trends in the fission barrier topography, but an accurate quantitative evaluation of the heights remains elusive. At this stage of our understanding of fission, we depend on analysis of data to extract these parameters. If this can be done accurately enough, we can interpolate or extrapolate to poorly known nuclei with some reliability. In doing this analysis it is most important to include as detailed a knowledge as we have of the physics of fission, complicated greatly by the double-humped nature of the fission barrier in most of the actinide nuclides. In our AVXSF code we do a full Monte Carlo simulation of the intermediate and fine structure coupling and sample from all the width and spacing distributions to obtain the average cross-sections. When the number of open channels becomes large we use approximation formulae to determine the fluctuation averaging factors. The correct modeling of the intermediate structure and its associated fluctuation properties can change the estimate of barrier heights by some hundreds of keV from values deduced using the simple statistical factor.

For the fissile odd-even targets the barrier height of the even compound nucleus is deduced by similar analysis of experimental data on the (t,pf) reaction. Over the range of Pu isotopes from ^{239}Pu to ^{245}Pu (compound nuclei) we find a pronounced odd-even difference (lower barriers in the even nuclides).

Our analysis of (n,f) cross-section data extends over the full range to 5.5 MeV, i.e. just below the threshold to second-chance fission. At energies above the barrier the densities of the transition states at both barriers are the crucial factors in determining cross-sections. We use a quasiparticle-vibration-rotation model for both the barrier states and the level density of the target nucleus. Our analysis reveals that the pairing gap parameters for barrier densities must be significantly larger than those at the ground state deformation. This correlates with odd-even difference in barrier heights.

In this paper we shall also discuss the use of our results in evaluating unknown cross-sections of other nuclides.

THIRD INTERNATIONAL WORKSHOP ON
COMPOUND NUCLEAR REACTIONS AND RELATED TOPICS
SEP. 19-23, 2011, PRAGUE, CZECH REPUBLIC