Fission Barrier Heights of Actinide Nuclei Obtained in Multi-Nucleon Transfer Reactions of $^{18}O + ^{237}Np$

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The validity of multi-nucleon transfer reaction approach for the measurements of fission barrier heights, using heavy ion beam $^{18}O$with ^{237}Np target, was investigated in JAEA tandem accelerator facility. In this study, fission barrier heights were obtained for $^{237-239}Np$ and $^{239,240}Pu$ isotopes, and these results are compared with the RIPL2 experimental data and with theoretical predictions of the recent FRLDM, Hartree-Fock-BCS. The systematic fission barrier heights and fission probability will be the subject of future study.

Keywords: multi-nucleon transfer reaction, fission barrier height

Fission cross section is very important in many domains, such as nuclear physics, nuclear astrophysics and applications in nuclear technology. Fission barrier height is an essential input information to evaluate the fission cross section. Experimental determination of fission cross sections or barrier heights for short-lived nuclei by neutron-induced fission approach is practically impossible due to the lack of available target material. Instead multi-nucleon transfer reactions have been applied to determine fission barrier. In other laboratories, light ion beams, for instance $^{3,4}He$, have been used for these purposes. However, we used more heavier ions, ^{18}O, because we can study more wider range of isotopes in a single experiment compared to lighter ions [1]. In this work, we investigate the validity of multi-nucleon transfer reaction approach for measuring fission barrier heights by using ^{18}O. The experiment was carried out using a 162.-MeV ^{18}O beam (0.5pnA) from the JAEA tandem accelerator. The beam bombarded the ^{237}Np target having thickness of 80μg/cm^2. The ejectile nuclides were identified by a ΔE-E silicon telescope. Therefore, the corresponding compound nuclides can be identified. Fission fragments were detected by two pairs of multi-wire proportional counters (MWPCs). One fission event is determined as a coincidence between a detection of fission fragments by a pair of MWPCs and a detection of an ejectile by the telescope. The results of fission barrier height have been preliminarily obtained for $^{237-239}Np$ and $^{239,240}Pu$ as 5.58 MeV, 6.67 MeV, 5.71 MeV, 6.45 MeV, 7.42 MeV, respectively. These data are compared with literature data from RIPL2 [2], Hartree_Fock_BCS [3] calculations, the recent FRLDM [4]. Our measured data agree with those rom RIPL2 within ~4% for $^{238,239}Np$ and ^{239}Pu, ~11% for ^{237}Np, ~22% for ^{240}Pu. The FRLDM estimates lower than our measurements. Hartree-Fock-BCS estimates much larger barrier height than our data. The conclusion will be discussed later. The systematic fission barrier heights and fission probability will be the subject of future study by using this method.

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