Photo fission cross-section of ^{232}Th, ^{238}U and ^{237}Np

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Introduction

Photo fission has been used extensively in the study of actinide fission near threshold due to the relatively small number of low-lying states excited by the predominantly E1 interaction. Near threshold most excitation energy is converted into nuclear deformation energy, and fission proceeds through only a few low-lying fission channels. This makes interpretation of experimentally measured cross sections easier for fission induced by photons than fission induced by other particles [1]. With this aim we have carried out measurements on fission fragment angular distribution from ^{232}Th, ^{238}U and ^{237}NP induced by bremsstrahlung radiation in range of 7.4 to 9.0MeV.

In the present work, photo fission cross-section of ^{232}Th, ^{238}U and ^{237}Np evaluated with the help of fission fragment angular distribution measurements by using bremsstrahlung radiation from 7.4 MeV to 9.0 MeV have been carried out by employing high efficiency SSNTD technique.

Methodology

To study the ^{232}Th system, a 2 mg/cm^2 thick thorium foil is used as a target. The estimation of the ^{232}Th target has been done by weight method. The target is self supporting and can be mounted on a frame. For the ^{238}U, the target was made by depositing 200 μg /cm^2 thick ^{238}U isotope on an aluminium backing. Amount of electrodeposited ^{238}U target on aluminum was determined by X-ray diffraction method. For the ^{237}Np system, the target was made by depositing 150 μg/cm^2 thick ^{237}Np isotope on an aluminium backing. The thickness of electrodeposited ^{237}Np target was measured by alpha spectrometric technique. The fission chamber used in the experiment was 8cm high and had a diameter of 8cm. The fission fragments were detected using lexan polycarbonate films placed at different angles with respect to the incident beam direction and the target was irradiated for 5hrs. After irradiation the lexan films were cut into equal strips and etched in 6N NaOH solution for about 1hr to develop the fission tracks [2]. These etched lexan films were washed, dried and analyzed under optical microscope with a magnification of 400X for the tracks formed during irradiation. During Photo fission experiments the possible contamination of the bremsstrahlung beam with secondary electron and neutrons were estimated using EGS-4 code and it was found to be negligible [3].

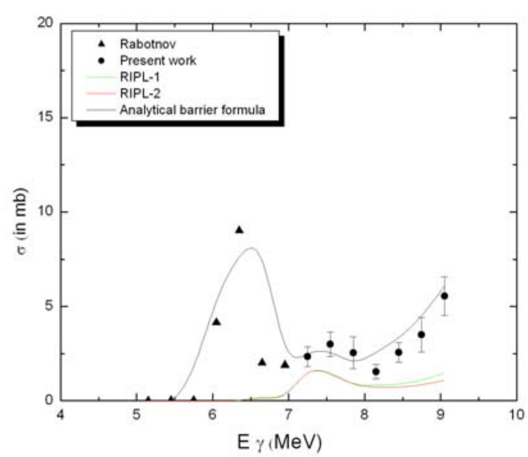

Fig 1: Experimental fission cross- Sections for ^{232}Th compared with EMPIRE- 2.19.

Results and discussion

The model calculations carried out by using Empire-2.19 code [4] for the case of ^{232}Th and

^{238}U reactions. The parameters for the optical model were chosen by a global parameter set. For neutron and proton, the optical model parameter set of Koning et al., [5] were used. The EMPIRE specific level density formalism (BCS + Fermi gas with deformation dependent collective effects) was used. The excitation energy dependence shell correction in the level density included as given by Ignatyuk [6]. The fission barrier values are taken from the calculations of both RIPL-1 and RIPL-2 (reference input parameter library); Fission density at saddle points was taken from the Empire specific. No sub barrier effects were included in the calculation. However, discrete states above the fission barrier for nucleus are considered. The photo absorption of both E1 and E2 are included. For the case of ^{237}Np Empire specific level density formalism (BCS + Fermi gas with deformation dependent collective effects) was used. The excitation energy dependence of the shell correction in the level density parameter was included as given by Nix and Mollers [7]. For the transition spectra default options of Empire II were used. Gamma decay also incorporated.

The calculation was carried out for ^{232}Th (γ, f), ^{238} U (γ, f), ^{237}Np (γ, f), reactions with the above parameters set and the prediction of EMPIRE-2.19 and analytical fission barrier [8] were compared with the present measurements is shown in Fig 1, 2 and 3.

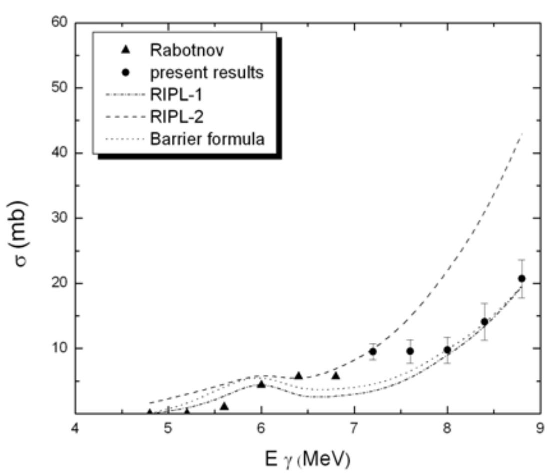

Fig 2: Experimental fission cross- Sections for ^{238}U compared with EMPIRE- 2.19.

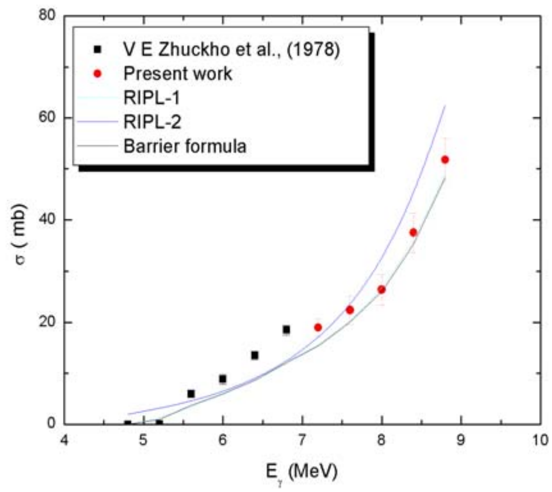

Fig 3: Experimental fission cross- Sections for ^{237}Np compared with EMPIRE- 2.19.

From the figures it was concluded that the present experimental results are in good agreement the results obtained from nuclear reaction code and analytical fission barrier formula.

References

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