Investigation of Hyperdeformed Fission Resonances in ^{233}Th ◇

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It is known already for a long time that the neutron induced fission cross section of ^{232}Th shows many broad resonances around the fission barrier. It was widely accepted that they were consequences of the transitional states (bands) built on the top of the fission barriers.

Much sharper resonances were observed by Blons and coworkes [1] and interpreted by them as the consequence of a theoretically predicted (hyperdeformed) third potential minimum. They suggested that the observed resonances appeared at those energies where the nucleus has excited states in the third minimum of the multiple-humped potential barrier. The resonant tunneling via such states would cause the sharp resonances.

Sharp resonance bands were observed for the first time in the fission probability of the ^{234}U [2] and ^{236}U [3] isotopes, supporting the existence of a deep third minimum of the potential barrier, in good agreement with theoretical predictions [4].

In this theory also a deep third minimum is predicted for ^{232}Th. However, even in the latest cross section calculations a very shallow one was successfully used in reproducing the prompt fission cross sections [5].

In order to get more insight into the fission barrier landscape of ^{232}Th a new experiment has been performed at the Munich Tandem accelerator using the ^{232}(d,pf) reaction, which excites higher spin states compared to the (n,f) reaction.

The fission probability of ^{233}Th was measured at a deuteron energy of 14 MeV. The energy of the protons was measured with a high resolution Q3D magnetic spectrograph in coincidence with the fission fragments. The energy resolution of the Q3D spectrometer was determined by measuring the low-lying states of ^{233}Th. Taking into account the long-term stability of the Tandem accelerator, the overall energy resolution in the high excitation energy region was determined as 7 keV.

Fission fragments were detected by two-position sensitive avalanche detectors (PSAD) in coincidence with the protons. One of the fission detectors was sensitive to the angular range of 65^o to 110^o, while the other one detected the fission fragments between 45^o and 80^o. The observed excitation energy region was 6.0 MeV $\leq E_x \leq$ 6.9 MeV.

Fig. 1 shows the (background-corrected, prompt) fission probability as a function of the excitation energy measured in coincidence with the fission fragments detected by the two different detectors. Large differences can be seen eg. around 6.6 MeV. That resonance clearly prefers the smaller angles compared to the others. The determination of the precise angular distribution coefficients (a_2 and a_4) as a function of the excitation energy is in progress.

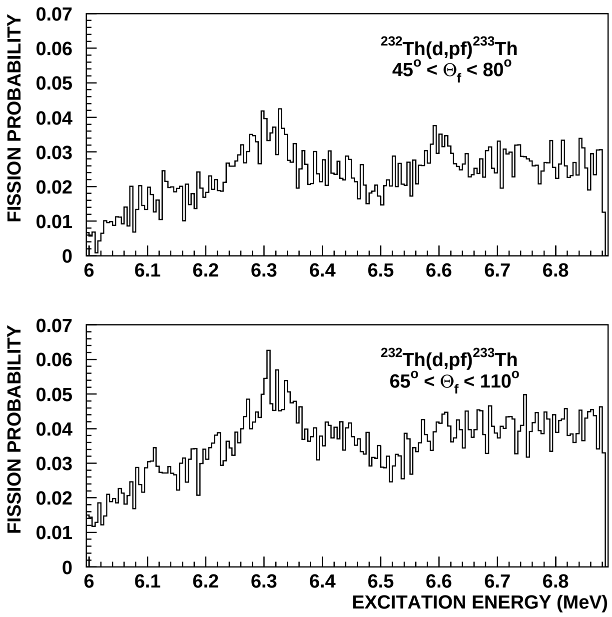

Fig. 1: Fission probability of ^{233}Th following ^{232}Th(d,pf), measured at E_d =14 MeV for two different angular regions: a) $45^o \leq \Theta_f \leq 80^o$, b) $65^o \leq \Theta_f \leq 110^o$.

References

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