High Resolution Study of the Fission Resonances in the $^{235}U(d,pf)^{236}U$ Reaction ◇

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The fission probability of ^{236}U has been studied as a function of the excitation energy by measuring the protons from the ^{235}U(d,p) reaction in coincidence with fission fragments in order to get information about the hyperdeformed (HD) states lying in the third well of the potential barrier (see fig. 1.).

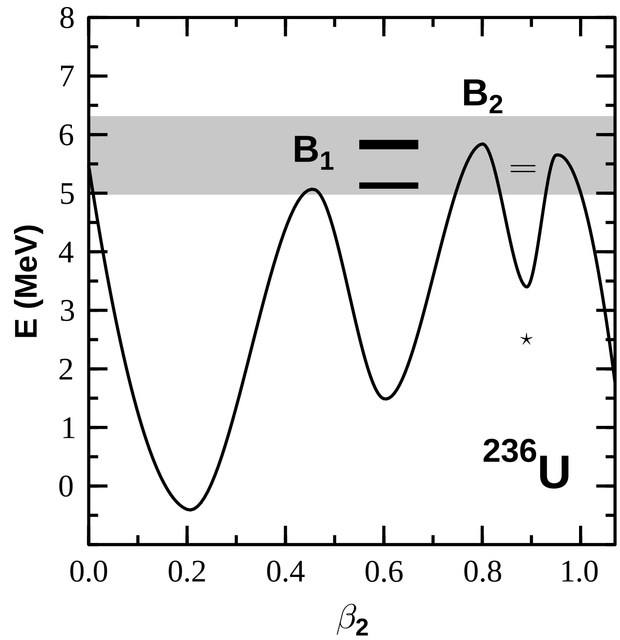

Fig. 1: Potential energy curve for ^{236}U as a function of the quadrupole deformation parameter β_2. The different values for the depth of the third well (see *) were taken from literature [1,2]. The shadowed excitation energy region was presently investigated.

The experiment has been carried out at the Munich Tandem accelerator at $E_d = 13$ MeV. A 88 $\mu g/cm^2$ thick enriched (99.89 %) $^{235}UO_2$ target has been used and the energy of the outgoing protons was analyzed by the Q3D magnetic spectrograph ($\Theta = 130^o$) equipped with the 1.7 m long focal plane detector. For the fission fragments two position sensitive avalanche detectors (PSAD) were installed very close to the target in order to cover a large solid angle ($\Omega = 0.14$ of 4π).

The coincident proton spectrum is shown in fig. 2 in the excitation region around E*=5.5 MeV. Two highly damped superdeformed (SD) vibrational resonances, which were known, are seen at 5.15 and 5.80 MeV separated by $\hbar\omega = 0.65$ MeV. Their strong damping is due to coupling with the normal states lying at energies near the top of the first barrier B1. Between these two broad bumps we observed some sharper peaks (FWHM $\approx$ 30 keV) similarly to our previous results [3,4]. These resonances do not appear to be noticeably damped even at $E^* \approx 5.5$ MeV above the top of the inner barrier. They cannot be associated to SD states lying in the second well.

In our earlier work [4] we supposed that each of the resonances consists of a complete rotational band. Fitting the shape of the resonances we obtained an inertia parameter ($\hbar^2/2\Theta$=2 keV) corresponding to a HD shape. Although the energy resolution in this work was definitely better than in our previous experiments, the natural width of the members of the rotational bands washes out the fine structure of the observed peaks.

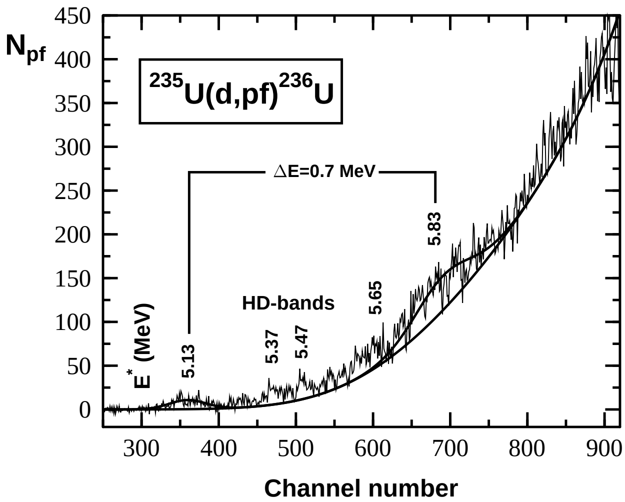

Fig. 2: Proton spectrum in coincidence with the fission fragments as a function of the excitation energy. The energy resolution was ≈5 keV (≤3 channels).

In spite of that these results also support the presence of a deep HD minimum as predicted by Ćwiok et al [2]. In this potential well our transmission resonances observed in the fission probability of ^{236}U, together with the resonances presently reanalyzed in ^{234}U [5] might be caused by some higher-lying two neutron quasiparticle states built on the basic vibrational excitations.

References

[1] W. M. Howard and P. Möller, At. Data and Nucl. Data Tables **25** (1980) 219
[2] S. Ćwiok *et al.*, Phys. Lett. **B322** (1994) 304
[3] A. Krasznahorkay *et al.*, Acta Phys. Polonica **27** (1996) 139
[4] A. Krasznahorkay *et al.*, Proc. Int. Conf. on Large Scale Collective Motion in At. Nuclei, Brolo (Messina) (1996)
[5] A. Krasznahorkay, ATOMKI Ann. Rep. 1996 (in print)

◇ This work has been supported by the DAAD, the Hungarian OTKA Foundation No. 7486, the Nederlandse Organisatie vor Wetenschapelijk Onderzoek and the DFG under IIC4-Gr 894/2.