

Neutron-induced fission of ^{232}Th : calculation of the reaction cross-section

Tuesday, 27 October 2026 19:25 (5)

Neutron-induced fission of ^{232}Th : calculation of the reaction cross-section

A.K. Grigoriev

National Research Nuclear University MEPhI, Moscow, Russia

This work investigates the feasibility of reproducing the dependence of the ^{232}Th fission cross-section on incident neutron energy in the 0.1-40 MeV range using the TALYS-2.2 code [1]. This study represents the first stage of a project aimed at describing the differential fission cross-section - or, equivalently, the angular distribution of fission fragments - defined as the ratio of the differential cross-section to the total cross-section (integrated over all fragment emission angles). While the fission cross-section is primarily determined by the shape of the fission barrier and the nuclear level density at the barrier, the angular distribution depends on the distribution of these states with respect to the projection K of the nuclear spin onto the axis of elongation of the fissioning nucleus (see, e.g., [2]) - a characteristic to which the fission cross-section itself is insensitive. Insights into the distribution of the quantum number K derived from experimental data could accelerate the development of modern approaches to modeling the dynamics of fissioning nuclei with non-zero spin.

The ^{232}Th nucleus is one of the few for which experimental data exist regarding the energy dependence of not only the neutron-induced fission cross-section (see, e.g., [3]) but also the angular anisotropy of fission fragments [4, 5]. Additional interest in the ^{232}Th nucleus stems from experimental evidence indicating the existence of a third hump in the fission barrier of the compound nucleus ^{233}Th . However, it has been found that calculations performed using the TALYS-2.2 code with default parameters yield an overestimated fission cross-section.

To refine the description, the heights and widths of the fission barriers were varied for the compound nucleus ^{233}Th and for thorium isotopes with mass numbers 232-228, whose fission contributes to the observed total fission cross-section via the $(n,1nf)$ - $(n,5nf)$ channels. The sensitivity of the fission cross-section to the excited-level density and the shape of the fissioning nuclei at the barriers was also investigated. A triple-humped barrier model for ^{233}Th provides a smooth overall description of the energy dependence of the fission cross-section; however, a double-humped barrier parameterization yields similar results, leaving the question of the necessity of a third hump unresolved. The resulting parameter values can serve as a basis for the next stage of the work: calculating the differential cross-section for the $^{232}\text{Th}(n,f)$ reaction.

1. A.J. Koning, S. Hilaire, S. Goriely. EPJA, v. 59, p. 131 (2023).
2. R. Vandenbosch, J.R. Huizenga. Nuclear Fission. - New York, Academic Press, Inc., 1973.
3. O.A. Shcherbakov et al. JNST, v. 39, suppl. 2, p. 230 (2002).
4. I.V. Ryzhov et al. Nucl. Phys. A, v. 760, p. 19 (2005).
5. Vorobyev A.S. et al. JETP Letters, v. 102, p. 203 (2015).

Primary author(s) : GRIGOREV, Aleksey

Presenter(s) : GRIGOREV, Aleksey

Session Classification : Poster session

Track Classification : Nuclear physics