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Study of the dependence of the $^{238}\text{U}(\text{n},\text{f})$ reaction cross-section on neutron energy

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The $^{238}\text{U}(\text{n},\text{f})$ reaction plays an important role in modern nuclear energy, so to date many measurements of the cross-section of this process as a function of incident neutron energy have been performed. In most works, the energy interval below 20 MeV, which is most relevant for modern reactor technologies, has been studied. At the same time, the 20–200 MeV region, which will be in demand in future technologies, has been studied somewhat less – see, for example, [1]. In particular, if the uncertainty of the evaluated $^{238}\text{U}(\text{n},\text{f})$ cross-section in the 1–20 MeV region does not exceed 1.5%, then in the 30–50 MeV interval this uncertainty increases to 2–2.5%, and above 100 MeV it exceeds 4% [2].

It is important, however, to understand that experimental data on fission cross-sections can be obtained only for relatively stable isotopes of heavy elements irradiated by neutrons. But in nuclear facilities, short-lived isotopes, which also fission under neutron action, are produced in reactions of the type (n,2n) or (n,p). The fission cross-sections of such isotopes cannot be measured, but they can be estimated using model approaches. At the same time, a method based on such approaches can be developed only by calculating the fission cross-sections of relatively stable isotopes, such as ^{238}U , and comparing the results with measured cross sections.

In this work, the energy dependence of the $^{238}\text{U}(\text{n},\text{f})$ fission cross-section induced by neutrons in the range from 0.1 to 50 MeV has been modeled using the TALYS-2.2 code [3]. At the first stage, the results of calculations performed with default parameters (which, as a rule, are parameters from the RIPL-3 library [4]) were compared with experimental data from the EXFOR library [5]. Discrepancies between the calculated and measured cross-sections were revealed in a number of energy intervals. At the next stage, possibilities for minimizing the discrepancies were studied by adjusting the fission barrier parameters, using alternative approaches for calculating the level density of excited states, as well as for modeling pre-equilibrium processes. As a result, fission barrier and collective enhancement parameters for the nuclei $^{239-232}\text{U}$ were determined, allowing the main features of the measured energy dependence of the $^{238}\text{U}(\text{n},\text{f})$ cross-section to be reproduced. A high sensitivity of the cross-section to the parameters of rotational enhancement of the level density and to the shape of the nucleus at the fission barriers has also been established.

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