REVISION OF THE ANALYTICAL PROPERTIES OF REACTION AMPLITUDE NEAR THRESHOLDS ON THE EXAMPLE OF MUON-INDUCED PROMPT FISSION

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In muonic atoms of ^{238}U, the nuclei can undergo fission caused by non-radiative transitions of the muon: *2p – 1s, 3p – 1s, 3d – 1s etc*. [1]. This kind of fission is called prompt fission, in contrast with delayed fission, which occurs as a result of the muonic *K*-capture. Main features of the fission dynamics are studied in prompt fission: augmentation of the barrier, dynamics of the saddle-to-scission descent, muonic conversion and characteristic X-rays from fission fragments supply information on the multipolarity of electromagnetic transitions and charge distribution, structure of nuclear transition currents. Our present purpose is to revise the concept, which considers the thresholds in nuclear reactions as the singular branching points of the analytic reaction amplitude, the cross-section increasing with increasing incoming energy just before the thresholds.

Probability of the non-radiative nuclear excitation in the muonic transition $i \to f$ can be expressed in terms of the photoexcitation cross-section $\sigma_\gamma(0 \to \omega)$ as follows [2]:

$$\alpha_\mu^{(d)}(i \to f)(\pi\omega)^2 \sigma_\gamma(0 \to \omega)\,, \tag{1}$$

where $\alpha_\mu^{(d)}(i \to f)$ is analogue of the muonic conversion coefficient, ω – the nuclear transition energy. Satisfactory agreement is attained with experiment [3] for non-radiative transition widths in ^{238}U. Analysis is deployed around comparison of the non-radiative probabilities in ^{235}U and ^{238}U. Energy of the *2p – 1s* transition is the same in both cases: 6.3 MeV. This is above the (γ, n) and (γ, f) thresholds in both cases. The difference is that the nuclear levels of the compound nucleus in one case overlap with one another, in the other they do not overlap. Moreover, due to augmentation of the fission barrier, prompt-fission channel is equally suppressed in the both cases. At the same time, the total photoexcitation cross-section, which includes both neutron and fission channels, is much bigger than that which includes only neutron exit channel. The question naturally arises which cross-section should be substituted in the Eq. (1) above. Discussion is deployed around these peculiarities.

References

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