MICROSTRUCTURE MANIFESTATIONS IN NUCLEAR REACTIONS

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Many nuclear reactions are described in macroscopic approach that involves only potential and excitation energies, statistical equations and macroscopic parameters such as radius, level density, rotational energy, and so on. At the case of direct reactions, the initial and final states are known as definite quantum states, and the theory must account the matrix element of this quantum transition. That is hardly applicable when the continuum of microstates is populated on the stages of intermediate compound-nucleus, or even of the final product formation. However, this does not mean that the nucleon orbits filled in the target nucleus and the final-product quantum numbers must be completely neglected. The problem is formulated, how to find the manifestation of microstructure peculiarities in the experimental data on cross sections and yields of studied reactions. Inelastic neutron acceleration (INNA) process has been recently approved [1, 2] to have much higher cross section compared to the standard-theory predictions for the ^{177m}Lu and ^{178m2}Hf isomeric targets. This special reaction with thermal/cold neutrons involves the transition from isomeric to lower-lying level with energy release to the neutron kinetic energy (acceleration). Such a transition is normally accompanied with the transfer of a great orbital momentum to the accelerated neutron. Thus, the process probability is restricted due to low transmission coefficients $T_l << 1$ for $l \geq 3$. Experimental INNA cross sections exceed the predicted ones by an order of magnitude. The only explanation could be drawn that the intrinsic orbital-momentum distribution influences the neutron emission. The single-particle shell model predicts that in medium and heavy nuclei only about 30% of all neutrons sit at the orbits with the lowest moments $l = 0, 1, 2$. Their emission is regulated by normal T_l values but only for 30% of neutrons in the nucleus. Therefore, the integral emission rate is suppressed by a factor of about 0.3. The statistical neutron-emission width Γ_n must be respectively reduced. This must be manifested in experimentally-tested time scale of the compound-nucleus decay. Emission of neutrons from the orbits with $l = 3 - 5$ and greater is hindered by the centrifugal barrier, but could happen after the orbital moments exchange with the re-arrangement of orbits – the dynamical process inside the nucleus. A minor addition into the total emission rate is yet expected. Moreover, both direct neutron emission and past re-arrangement could not provide a great orbital momentum release being useless for explanation of the enhanced INNA probability. The new mechanism must be introduced for virtual penetration of a neutron pair through the centrifugal barrier. The pair possesses zero angular momentum in sum and could virtually penetrate to the external space. Remind that the energy conservation hinders a real penetration of the pair. But in virtual process, the pair could split: one of neutrons is ejected with a great orbital momentum and the second one returns back to its initial bound orbit. The INNA probability arises strongly while total emission rate is changed only slightly.

1. O.Roig, V.Meot, B.Rosse, *et al.* // Phys. Rev. C. 2011. V.83. 064617.
2. S.A.Karamian, J.J.Carroll // Phys. Rev. C. 2011. V.83. 024604.