Spin Distributions of Fragments in Binary Asymmetric Nuclear Fission

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Within the framework of quantum fission theory, the spin distributions of the primary fragments of low-energy binary fission of nuclei were considered, which expand the understanding and shed light on the most important dynamic characteristics of this process. The obtained values are crucial for the interpretation of experimental data on the multiplicity and distribution of neutrons and γ-quanta that arise as a result of the fission of actinide nuclei, as well as delayed neutrons emitted from the final fission fragments.

The modern understanding of the occurrence of large values of fragment spins is associated with two collective transverse modes of the fissile nucleus near scission point: wriggling- and bending- vibrations [1]. Based on the concept of the fissile nucleus coldness in the vicinity of its scission point and using the wave functions of wriggling- and bending-vibrations in the ground state in the momentum representation, along with determining the moments of inertia of fission fragments within the framework of the superfluid model of atomic nuclei [2], analytical formulae were obtained for the first time, describing spin distributions and average spin values of fission fragments:

$$P\left(J_{1,2}\right) = 2J_{1,2}d_{1,2}\exp\left(-J_{1,2}^{2}d_{1,2}\right), \qquad \overline{J_{1,2}} = 1/2\sqrt{\pi/d_{1,2}},$$

where $d_{1,2}$ are coefficients depending on the momenta of fission pre-fragments, rigidity and mass parameters, as well as the energies of wriggling- and bending-vibrations.

The calculated spin distributions and their average values are in reasonable agreement with the experimental values [3] observed in the low-energy stimulated fission of ^{238}U and ^{232}Th by neutrons and in the spontaneous fission of ^{252}Cf.

1. J.R. Nix *and* W.J. Swiatecki, Nucl. Phys. A 71, 1 (1965).
2. A.B. Migdal, JETF 37, 249 (1959).
3. J. Wilson *et al.*, Nature 590, 566 (2021).