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Alternative approach for estimating the neck radius of a fissioning nucleus

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The study presents a new method for determining the critical neck in nuclear fission, based on the analysis of fragment spin characteristics. The key difference from other approaches, such as [1,2], lies in using experimental data on fragment spin distributions [3] instead of the conventional analysis of mass distributions. This choice is motivated by the greater sensitivity of spin characteristics to fission dynamics, particularly during the final stages of the process.

The primary focus of the work is the analysis of fissioning nucleus dynamics near the scission point. The dependence of transverse oscillation frequencies on fragment quadrupole deformations was investigated, along with the evolution of the system's moments of inertia. Particular attention was given to analyzing the influence of bending and wriggling vibrational modes of pre-fragments. It is shown that accounting such dynamic effects enhances the consistency between theoretical predictions and experimental results.

The obtained estimates for the neck radius fall within the range of 1 –2.5 fm and show good agreement with existing theoretical models [1,2]. In particular, for actinides, the critical radius is approximately 2 fm, consistent with classical concepts [4] of the balance between Coulomb and nuclear forces at the rupture point. An exception is the case of ^{252}Cf, where simplified models [1] yield values close to nucleon sizes, around 1.2 fm.

The developed approach opens new possibilities for studying nuclear fission dynamics. Specifically, analyzing spin distributions provides additional information about processes occurring in the neck region of the fissioning nucleus.

References

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