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Characteristics of fragments at binary nuclear fission

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One of the central challenges in modern theoretical nuclear physics is the detailed description of fission fragment (FF) characteristics. Addressing this problem requires advanced quantum mechanical methods capable of accurately reproducing fission dynamics while ensuring close agreement between theoretical predictions and experimental observations. In this work, an analytical review of recent theoretical developments in this field [1–3] is presented, with a focus on extending and refining the generalized "cold"nucleus model, which provides a unified framework for describing various FF properties.

The proposed model is based on the hypothesis [4], which posits that the nuclear excitation energy remains minimal throughout the fission process. Nearly all excitation energy is redistributed into nonequilibrium deformation degrees of freedom of the fission fragments [1]. Only after scission does thermalization of the fragments occur, accompanied by neutron and gamma-quanta emission. This approach allows the application of methods introduced in [5], simplifying the description by considering only zero transverse and longitudinal oscillation modes.

In this study, the above approaches are adapted to describe asymmetric fission. Within the "cold"fission framework, the projections of FF spins onto the symmetry axis of the fissioning nucleus are evaluated. The obtained results demonstrate that these spin projections are found to vanish, supporting a two-dimensional description of FF spins. This leads to analytical expressions for the distributions of orbital angular momenta, spins, and angular correlations of FFs [2, 3], significantly expanding the applicability of existing theoretical models.

A comparison with other theoretical approaches and experimental data [6–8] reveals strong agreement, indicating the universality of the proposed model. Additionally, the spin-spin correlations of FFs are investigated. Using the liquid-drop model, analytical expressions for spin angular correlations are derived, which align with phenomenological models like FREYA [6] and available experimental data [8].

This study represents a significant advancement in nuclear fission theory, integrating existing approaches and extending their applicability to new domains. The obtained results provide a basis for further model development, including the description of complex processes such as multi-stage fission, where current theoretical methods remain insufficient.

References

1. D. E. Lyubashevsky et al., Chinese Physics C **49**, 034104 (2025).
2. D. E. Lyubashevsky et al., arXiv:2412.04410 (2024).
3. D. E. Lyubashevsky et al., arXiv:2412.04411 (2024).
4. A. Bohr, B. Mottelson, *Nuclear Structure* (1969).
5. J. R. Nix, W. J. Swiatecki, Nucl. Phys. **71**, 1 (1965).
6. J. Randrup, R. Vogt, Phys. Rev. Lett. **127**, 062502 (2021).
7. Stetcu et al., Phys. Rev. Lett. **127**, 222502 (2021).
8. Wilson et al., Nature **590**, 566 (2021).

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