Angular momentum in fission fragments

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We suggest that the generation of angular momentum in fission fragments is obtained by statistical excitation at scission [1]. The magnitude of the angular momentum is determined by excitation energy and shell structure in the level density.

The collective dynamics of the fission process is assumed to be overdamped, and is treated as a Metropolis random walk on a 5D deformation grid [2, 3] guided by combinatorial microscopic level densities [4]. The level densities depend on shell structure, pairing, excitation energy, and the shape of the fissioning nucleus, and determine also the energy partition at scission and the angular momenta of the fragments. The angular momentum vectors of the fission products are assumed to be perpendicular to the fission axis, and are calculated for thermal neutron induced fission of ^{235}U.

The observed [5] sawtooth behavior of the average angular momentum magnitude as function of mass number (figure 1) is discussed in connection with the similar observed behavior of the average neutron multiplicity (see e.g. [6]) and a good understanding is obtained. In particular, the strong correlation between the two observables suggest that a substantial part of the excitation energy of the fission fragments is available already at scission. This is not fulfilled in models suggesting that the excitation energy available for neutron emission mainly emerges due to an equilibration of shape from scission shape to equilibrium.

The magnitudes of the angular momenta of light and heavy fragments are calculated to display a weak negative correlation, -0.03, in accordance with the experimental value of -0.015. The correlation is found to be generated by the stochastic sharing of excitation energy of the fragments at scission, and how the angular momentum vectors of each fragment are chosen at scission.

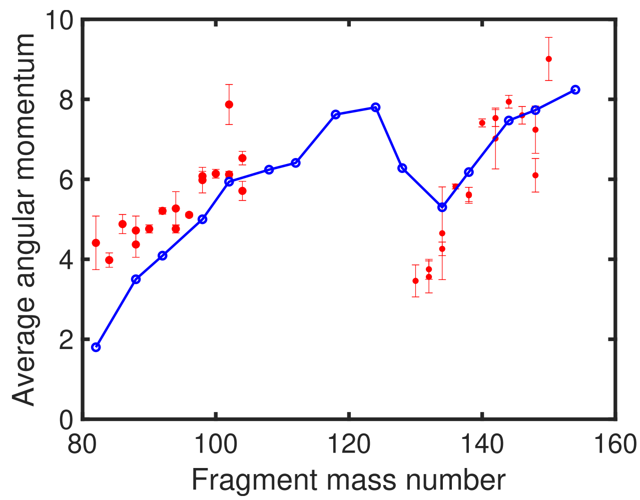

FIG. 1. Calculated average angular momentum magnitude versus fragment mass number [1] is compared to data from [5].

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