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Angular momentum generation in nuclear fission

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When a heavy atomic nucleus fissions, the resulting fragments are observed to emerge spinning; this phenomenon has been an outstanding mystery in nuclear physics for over 40 years. The internal generation of around 6-7 units of angular momentum in each fragment is particularly puzzling for systems which start with zero, or almost zero, spin. There are currently no experimental observations which enable decisive discrimination between the many competing theories for the angular momentum generation mechanism. Nevertheless, the present consensus is that excitation of collective vibrational modes generate the intrinsic spin before the nucleus splits (pre-scission).

We present comprehensive and unique new data on fission fragment spins from gamma-ray spectroscopy experiments carried out at the ALTO facility of IJC lab in Orsay on three fissioning systems 232Th(n,f), 238U(n,f), and 252Cf(SF). The ν-ball gamma-ray spectrometer was coupled to the LICORNE neutron source to perform precision spectroscopy of fast-neutron-induced fission in an experimental campaign that lasted 7 weeks. The experimental results presented will be used to draw important conclusions on the intrinsic spin generation mechanism in nuclear fission. This new information is not only important for the fundamental understanding and theoretical description of fission, but also has consequences for the ɣ-ray heating problem in nuclear reactors, for the study of the structure of neutron-rich isotopes, and for the synthesis and stability of super-heavy elements.

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