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Catching the spin - Isomeric yield ratios by direct ion counting for studies in fission dynamics

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The fission process forms highly excited fragments carrying significant amounts of angular momentum. This formation is generally described via a shape evolution on the potential energy landscape of the fissioning system. Among the aspects that are still hard to describe in this process is the generation of the fragment angular momenta, highlighted by the work of Wilhelmy et al. in the early 1970s. Isomeric yield ratios (IYR) offer the possibility to address this question.

Traditionally, gamma-spectrometry has been used to measure IYR but risk suffering from incomplete information on the nuclear level scheme and decay branching ratios. To avoid this problem, we employ direct ion counting using mass measurement techniques and unambiguously determine IYR from fission. With recent advances such as the Phase-Imaging Ion-Cyclotron-Resonance (PI-ICR) technique [1], isomers with mass differences as low as a few tens of keV can be resolved. Over the past years, IYR for a total of 40 different isotopes produced from 232Th(p,f), 232Th(a,f), and 238U(p,f) could be obtained using JYFLTRAP at IGISOL of the University of Jyväskylä [2-5].

To interpret the data with respect to the quest for the fragment angular momentum generation, the average angular momentum of a specific fragment can be derived via extensive modeling of the de-excitation process of the neutron rich nuclei [4]. An important ingredient is the spin distribution in the nuclear level density which has to be significantly narrower than generally employed [6].

We have been able to extend the observations by Wilson et al. [7] to the symmetry region. While a sawtooth-like picture of the dependence of fragment angular momenta on mass emerges, it seems not possible to explain the data with the rubber-band model proposed by Wilson et al. [4]. We also provide evidence that at least 30% of an increase of the spin of compound fissioning system is transmitted to the fragment angular momenta [6].

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Author: POMP, Stephan (Uppsala University)

Co-authors: AL-ADILI, Ali (Uppsala University); CANNAROZZO, Simone (Uppsala University); ERONEN, Tommi (University of Jyväskylä); KANKAINEN, Anu (University of Jyväskylä); LANTZ, Mattias (Uppsala University); MOORE, Iain (University of Jyväskylä); PENTTILÄ, Heikki (University of Jyäskylä); SOLDERS, Andreas (Uppsala University); IGISOL TEAM, and the (University of Jyäskylä)

Presenter: POMP, Stephan (Uppsala University)

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