Contribution ID: **44** Type: **not specified**

Angular Momentum in Fission through 241Am(2nth, f) Isomeric Ratio measurements with the Lohengrin spectrometer

Thursday, 12 March 2026 09:50 (15 minutes)

Despite decades of study, accurate modeling of nuclear fission remains difficult, as a wide variety of theoretical approaches—microscopic, macroscopic, and phenomenological models—are based on different underlying assumptions. To date, despite this diversity of approaches, none of the currently existing models can predict the angular-momentum generation mechanism with satisfactory accuracy. To complement and compare with existing studies, we adopt an indirect approach based on the measurement of isomeric ratios (IRs), defined as the independent yield of the isomer divided by the total independent yields of both the ground and isomeric states. IRs are particularly valuable because they retain information about the fragment's initial angular momentum immediately after prompt-particle emission. A recent experimental campaign was conducted at the LOHENGRIN recoil spectrometer of the Institut Laue–Langevin (ILL) in Grenoble to measure the kinetic-energy dependence of the isomeric ratio for several fission products produced from the 241Am(2nth, f) reaction. The IRs were extracted using γ-ray spectrometry with two clover High-Purity Germanium (HPGe) detectors operated in coincidence with an ionisation chamber located at the focal plane of the spectrometer. These measurements provide a sensitive probe of the total angular momentum generated in the fission fragments. The choice of the 241Am(2nth,f) reaction represents a unique case study, as the first neutron capture populates 242Am in both a long-lived metastable state with $t_{1/2,m}$ = 141 y and $J\pi$ = 5−, and a ground state with a half-life of $t_{1/2,g}$ = 16 h and $J\pi$ = 1−. These two competing states, which differ significantly in both half-life and angular momentum, undergo fission independently after capturing a second neutron and forming the compound nucleus 243Am∗. Furthermore, due to variations in reactor power over the course of the measurements, it is possible to determine the relative contributions of fission originating from the metastable and ground states of 242Am as a function of time. The time evolution of the IR, as well as its dependence on kinetic energy, has been extracted for several isotopes. Promising preliminary results show, for the first time, a clear kinetic-energy dependence of the IR for the isotope 100Nb. To interpret the experimental data, the FIFRELIN Monte Carlo code will be used to simulate the de-excitation of the fission fragments. By combining the measured IRs with FIFRELIN calculations, we aim to determine the angular-momentum distributions of the fission fragments as a function of their kinetic energy. This analysis will ultimately enable a deeper understanding of angular-momentum generation mechanisms in nuclear fission.

Type of contribution

Regular Abstract

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Session Classification: session 11 (Chair: A. Goergen)