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Fission: review of recent major advances and selected results

Nuclear fission owes its name by the fact that, at the macroscopic level, it resembles the division of a living cell, with the nucleus slowly deforming until it breaks into two pieces. This a priori harmless split hides a complex re-arrangement of a many-body quantum system. The excited fragments emerging at scission quickly return to equilibrium by emitting neutrons and gamma-rays. As such, fission is a rich laboratory for studying both fundamental nuclear properties and reaction dynamics. It has a crucial impact in astrophysics and for various societal applications. However, due to its complexity, its understanding still constitutes a challenge for theory.

At the same time, fission is certainly the mechanism with the largest amount of quantities that are observable in the laboratory. These include cross sections, fragment mass, charge, energy and angular distributions, isomeric ratios, as well as neutron and gamma-ray multiplicities, energy and angular distributions. High-fold coincidence measurements between these quantities are the pre-requisite for unambiguously constraining models.

Since a few years, an increasingly huge effort is being invested in Europe to improve the understanding on fission, both on the experimental and theoretical fronts, with an arsenal of approaches, probes and observables. The complete and high-resolution characterization of the fission fragments, and of their de-excitation by neutron and gamma-ray emission is exploited to address longstanding questions pertaining to fission, like the influence of shell effects and pairing correlations, the generation of excitation energy and angular momentum, and their sharing between the fragments at scission, to cite a few. The study of these aspects over the region of the nuclear chart from rare earths to heavy actinides in a comprehensive manner is now within reach. Recent experimental data, combined with innovative theoretical developments, permit to establish a firm step into the direction of a universal understanding of fission. A selection of results from various facilities will be discussed, and some exciting perspectives will be given.

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