Deformation, Angular Momentum and Excitation Energy of Fission Fragments in the Neutronless Fission of ^{252}Cf(sf)

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Nuclear fission is a dynamic process by which a heavy nucleus, under the action of single particle and collective effects, is separated in two lighter, highly excited fragments. Excitation energy and angular momentum is released by the newly produced fragments through neutron and gamma-ray emission. The experimental study of fission is a real challenge, since the complete characterization of the process's exit channel requires identifying two heavy ions among the hundred of possible fragments, and to measure in coincidence the neutrons and gamma-rays emitted by these fragments. To the best of our knowledge there is no such comprehensive dataset.

Neutronless fission, i.e. fission where the fragments are produced below their neutron separation energy, offers a great simplification to this challenge. Indeed, because of conservation of energy and momentum, efficient and accurate fragment identification can be achieved. Moreover, in the absence of neutron emission, gamma rays are the only means by which the fragments can evacuate both excitation energy and angular momentum.

In this presentation, I will show how using a twin Frish-grid ionization chamber loaded with an ultra thin ^{252}Cf sample we were able to observe the rare events of neutronless fission (yield of the order of 10^{-3}). Combined with an array of 54 NaI detectors, we measured in coincidence the γ-rays emitted by the fragments. I will focus the discussion of the results on two particular cases.

The first one is the exceptional fragmentation ^{120}Cd/^{132}Sn, where the doubly magic nucleus is produced in its ground state. The measured gamma ray spectrum therefore solely reflects the properties of ^{120}Cd at scission. The reproduction of this spectrum allows us to deduce the spin distribution and the scission deformation of ^{120}Cd [1]. The nucleus appears to be more deformed than previously thought for a fragment produced via neutronless fission.

The second case to be discussed is the ^{118}Pd/^{134}Te fragmentation, only two protons away from the previous one. In this case, low lying transitions from both fragments are found in the measured gamma ray spectrum. The reproduction of the spectrum strongly depends on the excitation energy sharing between the two fragments, an information that is extracted for the first time using a genetic algorithm [2].

References

[1] A. Francheteau *et al.*, Phys. Rev. Lett. **132** (2023) 2024.
[2] A. Francheteau *et al.*, In preparation, to be submitted to Phys. Rev. Lett.