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Fission studies using quasi-free scattering reactions in inverse kinematics

Fission reactions induced by relativistic heavy nuclei, in combination with a large acceptance dipole magnet and advance tracking and time-of-flight detectors (SOFIA detection setup at GSI), have recently allowed, for the first time, the complete identification of both fission fragments in atomic and mass number [1].
By using different target materials, one could also favour fission reactions at low and high excitation energies, namely lead inducing coulex and protons inducing spallation. In addition, these kinematic conditions allow the study of a wide variety of unstable fissile nuclei. The first experiments made it possible to addressed the role of shell effects in fission [2] and the dynamics of fission at high excitation energies [3].
More recently, these experiments have been upgraded by merging the SOFIA and R3B/FAIR setups. The R3B target area detectors (silicon tracker and Califa calorimeter) allow the determination of the missing energy in quasi-free scattering (p,2p) reactions using a liquid hydrogen target. In the case of (p,2p)-induced fission reactions the missing energy corresponds to the excitation energy of the fissioning nuclei, which was not accessible in previous measurements. In addition, the new setup is able to measure gamma rays and neutrons emitted during the fission process. This will be the first complete kinematic measurements of fission reactions.
In this contribution we will present the first results obtained in the study of the fission of 238U induced by quasi-free (p,2p) reactions. In particular we will show how the complete identification of both fission fragments and the measurement of the excitation energy of the fissioning nucleus allowed us to study the disappearance of shell effects in the fission yields with temperature and the sharing of the excitation energy between the two fission fragments.
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Author: BENLLIURE ANAYA, JOSE FERNANDO (Instituto de Física Corpuscular (Univ. Valencia - CSIC))

Presenter: BENLLIURE ANAYA, JOSE FERNANDO (Instituto de Física Corpuscular (Univ. Valencia - CSIC))

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