Fission Dynamics at High Excitation Energy in Complete Kinematic Measurements of the Reaction ^{208}Pb+p at 500 A MeV

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Fission is an extremely complex mechanism that requires a dynamical approach to describe the evolution of the process in terms of intrinsic and collective excitations of the nuclear constituents. The first to consider the dynamics of nuclear fission was Kramers [1], who proposed an interpretation of fission as a diffusion process, where a particle moves in a heat bath. In this process appears two terms, a diffusion term and a friction term that transfers the energy between the collective degrees of freedom and the heat bath, this effect is known as dissipation and is characterized by the dissipation coefficient β. The quantitative determination of this coefficient and possible temperature and deformation dependencies are still under debate [2].

The ideal scenario for studying this process requires high excitation energies ($E^* > 100$ MeV), where the dissipation coefficient depends strongly on the temporal evolution of the fissioning system [3], low angular momentum and small deformation [4]. Moreover, one needs observables such as the evolution of the fission probability with the violence of the reaction or the particles emitted by the hot fissioning nuclei before or after scission. All these requirements were met in an experiment recently performed at the ALADIN-LAND cave at GSI.

In this experiment we investigated proton induced fission on lead at relativistic energies using inverse kinematics. This reaction mechanism guarantees that fission reactions take place at large values of excitation energy and low values of angular momentum and deformation. Moreover, we use a complex experimental setup [5] providing for the first time, an almost complete kinematic measurement of these kind of reactions.

A high-resolution twin-ionisation chamber provides an unambiguous determination of the atomic number of both fission fragments. Accurate tracking measurements using multi-wire chambers and the drift time in the ionisation chamber, together with an extremely accurate time-of-fight measurement and the bending of the fragments flying through the ALADIN magnet will make possible to determine the mass number of both fission fragments. Moreover, a segmented plastic-scintillator wall and the neutron detector LAND were used to detect and identify light-charge particles (LCP) and neutrons emitted during the fission process.

In Fig. 1 we show some preliminary results. In this figure we report the sum of the atomic numbers of the two fission fragments obtained from their energy loss in the twin ionisation chamber for different multiplicities of light-charged particles determined with the segmented plastic-scintillator wall. As can be seen in the figure, the average charge of the fissioning nucleus (Z_1+Z_2) clearly scales with the multiplicity of light-charged particles and then with the violence of the reaction.

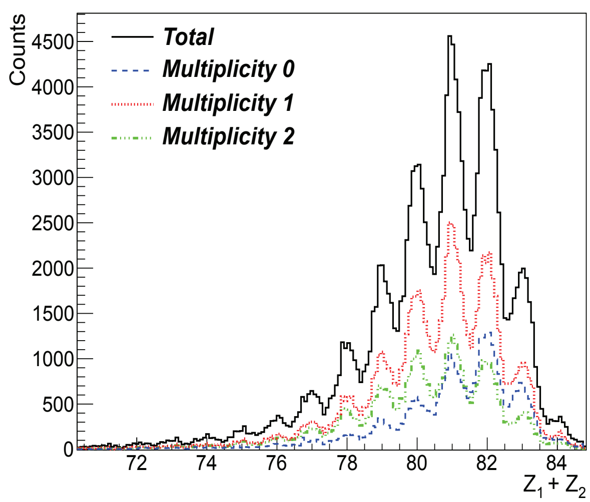

Figure 1: Charge distribution of the fissioning system (Z_1+Z_2) as a function of the LCP multiplicity.

References

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