Study of Quaternary Spontaneous Fission of ^{252}Cf

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This work presents the results of experiment on quaternary fission (QF) in spontaneous fission of ^{252}Cf. QF can arise from two primary pathways: "pseudo" QF via the decay of unstable species within ternary particles (LCPs, e.g., ^{7}Li*, ^{8}Be*, ^{9}Be*) and "true" QF through the independent emission of two LCPs [1, 2]. Previous studies faced limitations in acquiring high statistics and pricisely measuring angular correlations between particles from decaying LCPs (e.g., ^{7}Li*(α, t) and ^{8}Be*(α, α)) [1, 2, 3]. This work overcomes these challenges by employing a particle telescope comprising 15 μm and 150 μm ΔE detectors and a 600 μm Timepix detector. This setup enables efficient identification of (α, α) and (α, t) decay pairs from excited LCPs. The detection system geometry was restricted and covered an angular range between 0°–50° and 130°–180° for the mutual opening angles (θ) between two measured LCPs. The geometry of detection system had to be simulated in order to make correction on obtained experimental results.

The observed angular distribution of α-particles from (α, α) coincidences aligns well with calculations simulating the decay kinematics of ^{8}Be from its ground and first excited states. Despite limited statistics, the energy spectrum of (α, t) pairs from the second excited state of ^{7}Li, detected on a single detector, was analyzed and compared to data from ternary Li particles. Additionally, results involving (α, α) and (α, t) pairs detected in opposite detectors are presented. Particle yields and energies were determined per 10^{4} ternary alphas and reported.

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