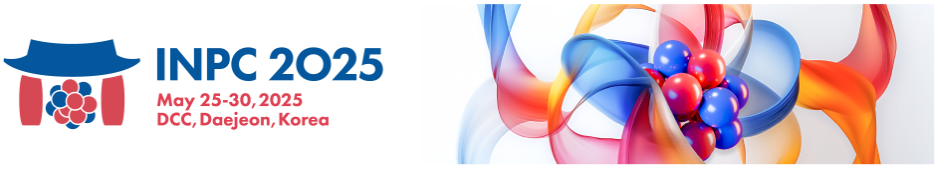

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Dynamical analysis of fission reactions for RI beam production at RAON using the Langevin Method

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RAON, the Korean heavy-ion accelerator, integrates isotope separation on-line (ISOL) and in-flight fragmentation (IF) technologies to explore a novel approach for rare isotope (RI) production. Among these, the ISOL method employs light particle beams, such as protons, neutrons, and deuterons, to induce fission reactions in various target nuclei, including uranium-238, enabling high-yield isotope production at low energy. In this study, we analyze fission reactions initiated by proton beams with energies ranging from 20 to 80 MeV. The primary focus is on uranium-238, which serves as the main target for RI beam generation at RAON. To achieve this, we employ a dynamical model based on the fluctuation-dissipation theorem, which utilizes the Langevin equation to describe stochastic motion. The two-center shell model (TCSM) defines macroscopic reaction coordinates that explain the evolution of nuclear shapes, enabling simulations of fission fragment mass distributions. In addition, we incorporate additional potential landscapes along the isobar line, referencing nuclear stability valleys in the nuclide chart. This approach enables the model to calculate independent fission yields for specific proton numbers (Z) with precision using a 3+1 Langevin equation framework. This dynamical analysis not only reproduces existing experimental data with high accuracy but also provides predictive insights into rare isotope production. Furthermore, this framework can be extended to other actinides and various target nuclei combinations, enabling applications in rare isotope generation and nuclear research at RAON.

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