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Direct identification of actinides in multinucleon transfer reactions and effect of secondary processes

Multi-nucleon transfer (MNT) reactions between heavy ions at energies close to the Coulomb barrier have been identified as a powerful tool to populate neutron-rich nuclei in the regions of the nuclear chart close to ^{208}Pb and in the actinides [1,2]. The same kind of reactions, but employing neutron-deficient projectiles, can also be envisaged to populate the region of static octupole deformation in the Ra, Th, U chains [3]. These regions are poorly studied due to the difficulty in accessing them with sufficient yields to perform detailed spectroscopy.
Despite the massive effort of different theoretical approaches in predicting absolute and differential cross sections for the production of nuclei in these regions of the nuclear chart [4], experimental information is still scarce. In particular, high-resolution data for such heavy ions (A, Z, Q-value and angular distributions, excitation functions) are largely missing, and the effect on the final yields of secondary processes, such as neutron evaporation and transfer-induced fission, is far from being properly quantified. Since identifying ions with mass $A > 200$ at energies of few MeV/u is extremely challenging, most existing studies rely on indirect methods.
Recently, within the AGATA-PRISMA campaign at INFN LNL, we attempted directly identifying the heavy recoils in the ^{129}Xe+^{232}Th MNT reaction at energies slightly above the Coulomb barrier. Thorium-like ions were detected in the PRISMA magnetic spectrometer, placed close to the grazing angle of the reaction, and the coincident γ rays in the AGATA γ-ray tracking array. Although the low kinetic energy did not allow for the identification of the nuclear charge, we could demonstrate for the first time the possibility of reconstructing in PRISMA a high-resolution mass distribution of heavy ions in the actinide region ($A \sim 230$). We compared the yields obtained for neutron transfer channels with predictions performed with the GRAZING code, based on a semiclassical approach, and found that GRAZING can follow the trend of the cross sections down to the $-6n$ channel when the effect of neutron evaporation is included.
We will present the results of the analysis and possible applications in view of the forthcoming campaign with Uranium beams foreseen with the PRISMA-AGATA setup at LNL in 2026.

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