Investigation of α-Cluster Transfer in Peripheral Collisions of ^{40}Ca at 12.3 MeV/nucleon

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The investigation of α-clustering is pivotal for elucidating nuclear structure and reaction dynamics within light and medium-mass systems. In this study, we present a preliminary analysis of experimental data derived from the reaction of a ^{40}Ca beam (12.3 MeV/nucleon) on ^{27}Al and ^{124}Sn targets, conducted at the Cyclotron Institute of Texas A&M University using the MARS recoil separator. Our primary objective is the identification of projectile-like fragments (PLFs) resulting from α-cluster transfer mechanisms.

Event-by-event particle identification encompassing atomic number (Z), ionic charge (q), and mass number (A), was achieved utilizing a two-element silicon detector telescope (ΔE, E_r) at the MARS focal plane. This was facilitated by applying calibrated correlations of energy loss, residual energy, and magnetic rigidity. For the ^{40}Ca + ^{27}Al reaction, we focus on the extracted isotopic yields, momentum (p/A) distributions, and excitation energy spectra. These experimental observables are compared with theoretical calculations from the Deep Inelastic Transfer (DIT) model to evaluate the prevalence of direct transfer processes and the impact of the ^{40}Ca cluster substructure.

Furthermore, we present a preliminary analysis of the ^{40}Ca + ^{124}Sn reaction, where the utilization of a heavier target enables a systematic examination of the effects of target mass and neutron-to-proton (N/Z) ratios on clustering dynamics. Collectively, this research provides significant insights into multinucleon dynamics during the transition from the Coulomb barrier to the Fermi energy regime.

References

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