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# Projectile breakup effects in case of fusion reactions

The study of projectile breakup in heavy-ion interactions has been a topic of interest in recent years. At energies slightly above the Coulomb barrier, reactions are typically characterized by complete fusion (CF) and incomplete fusion (ICF)/breakup fusion (BUF) processes, with their relative contributions varying based on the incident energy. Recent experiments have shown that the breakup fusion processes start competing with CF even at energies close to the Coulomb barrier. To delve deeper into this phenomenon, several experiments were conducted at the Pelletron accelerator facility of the Inter University Accelerator Center (IUAC) in New Delhi, India, using beams of 16O, and 14N on 181Ta target to measure the excitation functions (EFs) of various reaction residues, which were expected to be populated via CF and/or ICF processes. The stacked foil activation technique followed by -ray spectroscopy have been used to determine the reaction cross-sections for different reaction residues at several projectile energies. The alpha transmission method was used to determine the thickness of each target. This method is based on the measurement of energy lost by the alpha particles while passing through the target thickness. Isotopically pure targets (purity 99.98%) and aluminum catcher/energy-degrader foils (thickness ≈ 1.2-1.7 mg/cm2) were prepared by using rolling technique. The Al-catcher foils were used for the dual purpose of degrading the incident beam energy and also to trap the reaction residues ejecting out from the target foil. The irradiations were carried out in the General-Purpose Scattering Chamber (GPSC) having an in-vacuum transfer facility (ITF). Keeping in view the half-lives of interest, the irradiation for each stack was carried out for 8-10 hrs. The activities induced in each sample was recorded separately at increasing time intervals using an HPGe detector (100cc active volume). The energy and efficiency calibrations of the gamma ray spectrometer were done prior to its use by employing the standard gamma sources, viz., 22Na, 60Co, 133Ba, and 152Eu. The experimentally measured EFs over a broad range of energy were analyzed within the framework of statistical model code PACE4. Analysis indicates a significant contribution from ICF processes. Moreover, the contribution from BUF reactions in these systems at several energies was determined in terms of its strength function, and its dependence on various entrance channel parameters has been studied. The findings provide valuable insights in the projectile breakup processes in heavy-ion interactions, which could have important implications for the development of theoretical models for predicting ICF contributions at low energies (≈ 4-7 MeV/A). The experimental fusion functions for these systems, as well as other systems available in literature, have also been obtained within the universal fusion function (UFF) framework to obtain systematics in terms of breakup threshold energy of the projectile. Further in-depth analysis of the present measurements will be presented.

## Section

Nuclear physics (Section 1)

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