Mass-Asymmetry Impact on Fusion Probability: Insights from the ^{220}Th System Using Multidimensional Stochastic Dynamics

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In a recent study [1], we introduced a six-dimensional Langevin-based formalism as a proof of principle for modeling heavy-ion fusion dynamics. This approach, incorporating elongation, neck, and asymmetry variables with fully unrestricted motion, naturally produces overdamped dynamics and rapid neck stabilization. Using a Yukawa-plus-exponential folding potential and Gaussian random forces, we achieved excellent agreement with experimental spin distributions and fusion cross-sections for the reactions ^{64}Ni + ^{92,96}Zr, thereby validating the robustness of the model.

In this contribution, we extend this formalism to investigate the impact of entrance-channel mass asymmetry on fusion probability in the collisions of multiple pairs of projectiles and targets, all forming ^{220}Th. We allow mass asymmetry to evolve freely alongside shape and angular variables, enabling the system to dynamically explore optimal fusion pathways. Suppression factors related to the Coulomb parameter $Z_1 Z_2$ and compound nucleus excitation energy are analyzed in detail.

Our model includes full mass, diffusion, and friction tensors, accounting for off-diagonal couplings, to capture the complex interplay between neck formation, elongation, and entrance-channel symmetry. We focus on different types of reactions ranging from the highly asymmetric ^{16}O + ^{204}Pb to more symmetric configurations. The results highlight a strong dependence of spin distributions and fusion probabilities on the projectile-target combination, confirming the predictive power of six-dimensional stochastic dynamics for compound nucleus formation.

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