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Understanding the complex dynamics of fusion reactions/融合反応における複雑なダイナミクスの解明

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At present, using the fusion reaction between the projectile and target nuclei, up to Og has been successfully synthesized and projects to synthesis of new superheavy elements (SHEs) are underway at several facilities around the world. However, the synthesis probability of SHEs is extremely low, and most of them undergo quasi-fission, which cannot sustain a compound nucleus after contact. Therefore, this study aims to elucidate the complex dynamics of quasi-fission by systematically investigating the reaction mechanism.
To understand the dynamics of the fusion process, we focused on the correlation between fragment mass and its emitting angle of quasi-fission [1]. Our group has succeeded in reproducing the mass angular distribution (MAD) of the emitted nuclei by using a dynamical model, considering the deformation of the target nuclei [2]. The dynamical model is based on the liquid drop model and the shell effect to determine the shape of the nucleus and its potential at that time, and the time evolution of the shape from fusion to fission can be traced by solving the langevin equation. Calculations of fusion reactions require fitting of indefinite parameters from experimental data, such as energy dissipation due to friction between nuclei and the transition from diabatic to adiabatic potentials, which are suitable for equilibration of the system.
In this study, we calculated the 42 systems experimented in Ref. [1] under identical conditions except for the number of nucleons and summarized the MAD. Among these, we correct the uncertain parameters and systematically evaluate ^{64}Ni+^{170}Er, ^{48}Ti+^{186}W, and ^{32}S+^{202}Hg, which form the compound nucleus of ^{234}Cm.

References
[1] R. du Rietz et al., “Mapping quasifission characteristics and timescale in heavy element formation reactions” , Phys. Rev. C 88, 054618 (2013)
[2] Shota Amano et al., “Effects of neck and nuclear orientations on the mass drift in heavy ion collisions”, Phys. Rev. C 109, 034603 (2024)

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