Dynamical approach to heavy-ion induced fission using actinide target nuclei at energies around the Coulomb barrier

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In order to success the synthesis of superheavy elements, it is indispensable to clarify the fusion-fission mechanism, which is included a role of the nuclear structure of colliding nuclei and the deformation of them in the fusion process. For this purpose, a large amount of experimental data is available, including the mass and total kinetic energy distribution of fission fragments, excitation function of each cross section, mass-angle distributions and so on. Using such experimental data, we verify of the model and establish a reliable model to describe the fusion-fission process.

We analyzed the experimental data using the unified model which can treat all reaction processes in heavy- and superheavy mass regions [1]. It takes into account the time evolution from the diabatic potential to the adiabatic potential. We then perform a trajectory calculation on the time-dependent unified potential energy surface using the Langevin equation [2].

To describe heavy-ion fusion reactions around the Coulomb barrier with an actinide target nucleus, we propose a model which combines the coupled-channels approach and a fluctuation-dissipation model for dynamical calculations. Fusion-fission, quasi-fission and deep quasi-fission are separated as different Langevin trajectories on the potential energy surface.

Using the new model, we calculate the capture and fusion cross sections in the reaction ^{34},^{36}S+^{238}U and ^{30}Si+^{238}U and compare the experimental data [3]. We calculate mass distribution of fission fragments (MDFF) and discuss the fusion-fission and quasi-fission events in MDFF. Also, we analyze the mass-angle distribution of fission fragments, which gives the reaction time scales [4]. Using our model, we discuss the reaction mechanism in the reaction ^{30}Si,^{31}P,^{36}S,^{40}Ar +^{238}U, ^{64}Ni,^{48}Ti,^{34}S+^{184}W at several incident energies. Such discussion is very important to understand the dynamical process.

References

[1] V. Zagrebaev and W. Greiner, J. Phys. G **31**, 825 (2005).
[2] Y. Aritomo, Phys. Rev. C **80**, 064604 (2009).
[3] K. Nishio *et al.*, Phys. Rev. C **77**, 064607 (2008); **82**, 024611 (2010); **82**, 044604 (2010).
[4] R. du Rietz *et al.*, Phys. Rev. Lett. **106**, 052701 (2011).