Modern aspects of nuclear fission study and synthesis of superheavy elements

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Abstract

Nuclear fission is the key physics process as a base in nuclear technologies, especially for estimation of inventory of radioactive nuclei in spent nuclear fuel and material damage. Nuclear fission is also important in understanding origin of elements in r-process nucleosynthesis in the cosmos, since fission recycling is believed to occur in binary neutron-star merger scenario, gravitational wave and signature of heavy elements from which have been observed and now are important parts of "multimessenger astronomy". Here, not only mass distribution but also kinetic energy of FF is important as a source of local heating Understanding of nuclear fission is essential in the synthesis of superheavy elements (SHE) as well, since fission prevents formation of SHE as a major competing process. Due to complexity of the process, however, nuclear fission still offers a field of big challenges to nuclear physics, especially, the process from formation of excited compound nucleus to scission is still a mysterious part of it.

Many observables arise as a result of fission, e.g., fission fragment yield, TKE, population of prompt neutrons and gammas which is followed by a series of β-decay, and they must be comprehended in a consistent manner, which is still a formidable task. These quantities, either as a single physics quantity or their correlations, have been treated in a phenomenological way in the past. It is also the case for the subject of SHE formation.

We have been treating the process before scission by several theories, such as Langevin equation, Antisymmetrized Molecular Dynamics and Time-Dependent Hartree-Fock, and their outcomes are to be connected to statistical decay model and theory of β-decay. The methodology can be also applied for the study of formation of SHE, especially, for Z=120 elements, which can eliminate most of the free

parameters present in the phenomenological theories. In this talk, I will present these modern methodologies and some of the recent results we obtained with them [1], which might be excellent subjects to be studied further at RAON.

[1] M.D. Usang et al., Scientific Reports 9, 1525(2019).