Nucleus-nucleus scattering as large amplitude collective motion

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Non-empirical theoretical approaches to structure and reaction of unknown nuclei are becoming more and more important in these days. For this purpose, we are developing a new approach, which is capable of calculating structure and reaction properties and of performing systematic calculations for nuclei across the entire nuclear chart. For studies of heavy-ion reactions, the time-dependent density functional theory (TDDFT) has been a leading theory to provide great insights into nuclear collective dynamics. It is "non-empirical" in the sense that the dynamics is defined by a given energy density functional. On the other hand, its semi-classical nature is a drawback. For instance, it is difficult to obtain sub-barrier fusion reaction in the TDDFT.

The re-quantization of the dynamics is a possible method to overcome this classical nature. However, a conventional theory for the re-quantization requires us to identify a family of periodic orbits in the TDDFT phase space [1]. This is extremely difficult task and has never been realized in realistic applications in nuclear physics. Instead, we are trying to develop a new approach [2,3], based on the adiabatic self-consistent collective coordinate (ASCC) method [4], applicable to nuclear reactions. Recently, we have succeeded to determine the reaction path and associated inertial mass parameters for light nuclei. We will show our recent results on these applications and discuss the remaining problems.

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