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Fission Dynamics of Odd-Even and Odd-Odd Nuclei within Time-Dependent Density Functional Theory

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In 2016, the first simulation of a compound nucleus'evolution from the outer saddle point to scission, which is the most rapid and highly non-equilibrium stage of fission, to two fully separated fission fragments (FFs) was achieved for realistic initial conditions. This was done in the framework of the time-dependent superfluid local density approximation (TDSLDA) or equivalently time-dependent density functional theory extended to superfluid systems. Since the first study of the fission of 240Pu, TDSLDA has been applied extensively to compound systems 236U, 240Pu, and 252Cf (spontaneous fission), with extensive investigations into energy sharing, the FF intrinsic spins and their correlations, scission neutrons and neck rupture dynamics, entanglement, and the evolution of entropy. The most significant results were demonstrating the essential nature of pairing in fission, and theoretically proving that the dynamics from saddle to scission are overdamped. Very recently this effort has been extended to odd-even nuclei 241Pu, 243Pu, and 239U, and an odd-odd nucleus 238Np. This is the first time the fission dynamics of odd systems have been investigated, beyond the adiabatic approximation, which is inconsistent with the dissipative evolution from saddle to scission. Nuclei with odd number of either protons or neutrons comprise of the majority of nuclear systems and are expected to behave qualitatively different from their even-even counter parts, such as having longer fission times in the case of spontaneous fission. Here I will present the results of our investigations, including the dependence on FF masses, charges, excitation energies, and total kinetic energy (TKE) on spins and excitations of quasiparticles flipped. I will also cover the applicability of the Pauli blocking approximation, taking into account the time-reversal symmetry breaking terms in the evolution Hamiltonian, the redistribution of the occupation probabilities during fission, and the importance of using the full set of the quasi-particle states.

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