Towards exascale simulations of nuclear dynamics at low energies

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Induced fission and collisions at low energies of medium or heavy nuclei are examples of nuclear processes, which can be viewed as time evolution involving hundreds of strongly interacting fermions. The inherent feature of these nuclear reactions is superfluidity, which is the key ingredient of theoretical description, in particular, if non-magic nuclei are involved. Fully microscopic description of nuclear reactions is a long standing goal and a problem of great practical and fundamental interest. Its complexity is due to the large number of strongly coupled degrees of freedom which makes this problem computationally challenging. Presently, the superfluid extension of Time Dependent Density Functional Theory (TDDFT) offers the possibility to provide a fully microscopic description of low energy nuclear reactions. Using leadership class computers of hybrid (CPU+GPU) architecture, it has become possible to study a real-time 3D dynamics without any symmetry restrictions evolving up to hundred of thousands of superfluid fermions. It represents a true qualitative leap in quantum simulations of nonequilibrium systems, allowing to make quantitative predictions and to reach limits inaccessible in laboratories. During the talk I will review open problems in nuclear induced fission and collisions, discussing certain experimentally accessible quantities, which would shed light on our understanding of nuclear processes and which would help to improve theoretical description.