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Developments of nuclear structure models for isomers

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In the study of isomer excitation and deexcitation, it is important to know the structure properties of isomers, and in addition, the intermediate states with detailed internal transitions (ITs) that connect isomers and the ground state [1,2]. Theoretical study of all these requires the modern many-body technique and knowledge on nuclear interactions. We apply two different shell models, the conventional large-scale shell model for light and spherical nuclei and the Projected Shell Model (PSM) for heavy and deformed nuclei. The original version of the PSM [3] uses restricted configuration space and interactions, which limits the application in the isomer study. Inspired by the Pfaffian method introduced by Robledo [4], a numerical breakthrough has recently been made in the calculation of matrix elements [5]. The configuration space of the PSM has been aggressively expanded (up to 10-qp states) [6,7].

These developments enable us to study detailed ITs and deexcitation of high-K isomeric states. For example, with the introduction of two-body octupole and hexadecupole forces into the Hamiltonian and a larger model space, we are able to discuss the anomalously-fast decay of the 19/2+ 3-qp isomer in 171Tm [8]. We find that only dedicate level-structure information is considered, can isomer deexcitation paths be accurately determined. Our theoretical methods can be applied to cases in normal laboratory environments, as well as to extraordinary cases created by strong lasers [9] and those in astrophysical conditions [10].

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Primary author: SUN, Yang (Shanghai Jiao Tong University)

Presenter: SUN, Yang (Shanghai Jiao Tong University)

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