Beyond the 2-body Interaction Paradigm in Modeling Nuclear Structure: The Case for Extended A-body Paring Interaction in Nuclei

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In this talk, we review the argument in support of going beyond the 2-body interaction paradigm in the modeling of nuclear structure [1] by viewing the pairing interaction as dynamical symmetry of the nuclear hamiltonian. We start with the important example related to the need of NNN-contact interaction terms suggested by QCD derived Chiral Perturbation Theory (ChPT) effective interaction [2]; higher many-body interaction terms (e.g. NNNN-interaction terms) are also part of the interaction as derived from QCD via ChPT [3] – thus, further support the need for study of A-body nuclear interactions. Another justification for A-body interaction terms is based on the Okubo-Lee-Suzuki (OLS) [4,5] effective interaction method employed in solving the nuclear many-body problem within a finite model space. All this seems to be pointing to the need of A-body interactions for the description of the nuclear structure. It also raises the question about the importance of the A-body interactions in very heavy nuclei. Fortunately, there is an exactly solvable A-body model – *the extended pairing model* – that is applicable as an A-body interaction to very heavy nuclei; therefore, it can help to address this question [6]. The extended pairing interaction, like the usual 2-body pairing interaction [9], is exactly solvable A-body model that can be applied to heavy nuclei with a long isotopic chain. Thus, the exactly solvable Extended Pairing model is a relevant model for studying the applicability of the A-body interactions to very heavy nuclei [6-8]. In particular, the studies of Sn, Yb, and Pb isotope chains illustrate a remarkable systematics of extended pairing strength $G(A)$ as function of A. In the case of Sn and Pb isotopes there is a simple relationship between the extended pairing strength $G(A)$ and the size of the valence space dim(A): $G(A) = \alpha \mathrm{dim}(A)^{-\beta}$, where α is specific for each of the isotope chines, while $\beta \approx 1$. Similar behavior of the A-body interaction terms have also been observed in q-deformation models [10]. All these cases present evidence for the need of better understanding of the NNN-, NNNN-, and A-body interactions in nuclei either derived from ChPT or from a phenomenological considerations.

References

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