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Pair condensation energy and Higgs response in two-neutron transfer

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Two-neutron transfer reaction is known to be a sensitive probe to the pairing correlation in nuclei. In open shell nuclei, such as stable Sn isotopes, the pair correlated ground state is regarded as a superfluid state with the pairing gap Δ in an analogy to the BCS theory of the superconductors. One of the characteristic features of the neutral superfluid is the presence of pairing collective modes, the Nambu-Goldstone mode (Anderson-Bogoliubov phonon) and the Higgs mode. They correspond to strong ground-to-ground and ground-to-excited transitions of the two-neutron transfer, called the pair rotation and the pair vibration[1].

In the present study, we propose a new viewpoint to the pairing collective modes in nuclei by extending the idea of the pair rotation and pair vibration. As a new observable to probe the two-neutron transfers, we introduce an operator, Higgs operator, combining both pair-addition and -removal operators. We then consider response of the system against the Higgs operator and the associated strength function. With use of the sum-rule technique, we show that the Higgs response carries an information on the pair condensation energy, which characterizes the magnitude of the pair correlation in an aspect different from the pairing gap.

Using numerical examples for Sn isotopes obtained with the Skyrme-Hartree-Fock-Bogoliubov mean-field model and the quasiparticle random-phase approximation, we demonstrate how this new approach works, and the pair condensation energy carries a rich information, shape and depth, of the pairing potential energy.

[1] D. M. Brink and R. A. Broglia, "Nuclear Superfluidity: Pairing in Finite Systems"(Cambridge University Press)

Experimental study on nuclear physics

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