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Tensor correlations probed by electroweak responses

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Nuclear response functions for electroweak interactions provide us with important information on the resonant and continuum structure of the nuclear system as well as the detailed property of the underlying interactions. In this contribution, we present our recent study on the electroweak response functions with realistic nuclear forces and discuss their relation to tensor correlations in the ground state.

Recently the present authors and Arai have presented an *ab initio* calculation for the photoabsorption of ^{4}He [1]. In the energy region around 26 MeV, photoabsorption reaction occurs mainly through the electric dipole transition. The paper shows that the experimental data above 30 MeV is reproduced very well, and the one-pion-exchange terms in the nucleon-nucleon potential, especially the tensor term, are essential in accounting for the energy-weighed sum rule. We extend the discussion to the spin-dipole response function. Since the operator can change the spin wave function of the ground state, a study of the spin-dipole response functions is expected to be more advantageous than that by the electric-dipole one. The study is also interesting as its importance for the scenario of a supernova explosion. In the final stage of a core collapse supernova, ^{4}He is exposed to intense flux of neutrino. The ν-^{4}He reaction is expected to play a significant role, and the reaction rate is proportional to the weak responses, for example, due to Gamow-Teller, spin-dipole, etc. operators.

A reliable method is needed to describe above mentioned electroweak reactions. In this study, we calculate the response functions based on a full four-body calculation with realistic nuclear forces. The wave functions are approximated in a combination of explicitly correlated Gaussians reinforced with a global vector representation for the angular motion [2,3]. Final state interactions and two- and three-body decay channels are taken into account. The excited states of ^{4}He are all in the continuum and are treated properly with the complex scaling method.

The observed resonance energies and widths of the negative-parity levels are all in fair agreement with those calculated from both the spin-dipole and electric-dipole strength functions. Spin-dipole sum rules are discussed in relation to tensor correlations in the ground state of ^{4}He [4]. Possible observables are suggested to probe the tensor correlations in the ground state.

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