Effect of isoscalar spin-triplet pairings on spin-isospin responses†

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The spin-isospin response is a fundamental process in nuclear physics and astrophysics. The Gamow-Teller (GT) transition induced by $\mathcal{S}t_\pm$ and, in a no-charge-exchange channel, magnetic dipole (M1) transitions are extensively observed in a broad region of the mass table. Recent high-resolution proton inelastic scattering measurements at $E_p = 295$ MeV have revealed that the isoscalar (IS) quenching is substantially smaller than the isovector (IV) quenching in the spin M1 excitations for several $N = Z$ sd-shell nuclei. In this paper, we study the effect of IS spin-triplet pairing correlations on the IS and IV spin M1 responses based on modern shell model effective interactions for the same set of $N = Z$ nuclei as those in Ref. 1.

We consider the IS and IV spin M1 operators, which are given as $\hat{O}_\text{IS} = \sum_i \mathcal{S}_i$ and $\hat{O}_\text{IV} = \sum_i \mathcal{S}_i \mathcal{T}_i$, respectively. The proton-neutron spin-spin correlations are obtained via an enhanced isoscalar pairing interaction. The Δ−transition, and the empirical spin-spin correlations in the ground states are reproduced well by a combined effect of the IS pairing and a quenching factor of $q = 0.9$ on the IV spin transition matrix elements.

In summary, we studied the IS and IV spin M1 transitions in even-even $N = Z$ sd-shell nuclei using shell model calculations with USDB interactions in full sd-shell model space. The quenching effects on the spin M1 transition matrices are larger in the IV case than in the IS case. Positive contributions for the spin-spin correlations are obtained via an enhanced isoscalar spin-triplet pairing interaction. The effect of the Δ-hole coupling is also examined on the IV spin transition, and the empirical spin-spin correlations in the ground states are reproduced well by a combined effect of the IS pairing and a quenching factor of $q = 0.9$ on the IV spin transition matrix elements.

Reference


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