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Isoscalar and isovector spin-M1 transition strengths and tensor force effect in N=Z and even-even nuclei

Gamow-Teller (GT) quenching problem, GT strength experimentally observed is missing in comparison with the model independent sum rule, has been a long standing problem. The missing strength has been found to be not due to excitations to Δ particle but due to excitations with 2-particle-2-hole configuration mixing mainly because of tensor force correlation. It is interesting if quenching phenomena is observed in isoscalar and isovector spin-M1 transition strengths because their transition operators are mediated by σ and στ_z, respectively, where the latter is analogous to the operator for GT transition.

We performed (p,p') measurement at 0^o on N=Z and even-even nuclei in the sd-shell region for investigation of spin-M1 transitions. Because target nuclei are T=0, isoscalar and isovector components can be separately observed. Angular distribution of differential cross section observed is compared with distorted wave impulse approximation calculation for assignment of 1+ transition and isospin. The differential cross section at 0o was converted to nuclear transition matrix element using a proportional factor, unit cross section, which was deduced from experimental data of β- or γ-decay life times in literature assuming isospin symmetry. Obtained matrix elements were accumulated up to 16~MeV in excitation energy for each nucleus. They were compared with the shell model calculation based on the USD, and the new USD interactions. A quenching factor, a ratio of the total experimental sum to the total calculation one, for isovector spin-M1 transition was 0.6, which is consistent with the quenching factor of GT transition obtained by the shell model calculation. However, the quenching factor for isoscalar spin-M1 transition was 1.0, which is inconsistent theories that have predicted 2-particle-2-hole configuration mixing as the GT quenching. Thus, it is suggested that we do not still fully understand the GT quenching problem. Combining the isoscalar and the isovector quenching factors, however, the experimental result may suggest tensor force effect in the ground state, which is consistent with the picture that the GT quenching is due to 2-particle-2-hole configuration mixing.

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