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Isospin Symmetry Violation in sd Shell Nuclei

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The influence of isospin nonconservation is important for testing the fundamental symmetries underlying the Standard Model, e.g., corrections to superallowed 0+ -> 0+ -decay rates [Towner and Hardy (2010)], and is pivotal for computing theoretical amplitudes for nucleon transfer reaction which violates isospin selection rule [Blank and Borge (2008)]. Recently, we have constructed a realistic isospin-nonconserving (INC) shell-model Hamiltonian in sd shell. The INC Hamiltonian consists of an isospin-conserving Hamiltonian, i.e. either USD [Brown and Wildenthal (1988)], or USDA, or USDB interactions [Richter and Brown (2008)], a Coulomb interaction, and a phenomenological charge-dependent forces of nuclear origin. All charge-dependent strengths were determined by a least-squares fit to reproduce newly compiled experimental coefficients of the isobaric multiplet mass equation (IMME) [Y.H.L. et al. (2013)] with very low root-mean-square deviation values 33 keV [Y.H.L. et al. (2013)]. This INC Hamiltonian provides an accurate theoretical description of the isospin mixing in nuclear states.
We present two of the important applications: (a) the microscopic description of staggering behavior of IMME isovector and isotensor coefficients; and (b) the breaking of the quadratic IMME in A = 24 , 28 , 32 quintets. Overall, this new INC Hamiltonian shows its robustness in providing an accurate theoretical description of the isospin mixing in nuclear states of sd shell nuclei.

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