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Shell-model description of isospin-symmetry breaking in nuclei

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Although the breaking of the isospin symmetry in nuclei is small,
there are numerous demands for its accurate description by theoretical models. In particular, the effects of the Coulomb force are vital for understanding the structure of proton-rich nuclei and for description of isospin-forbidden decay modes. Another important issue is calculation of isospin-symmetry breaking corrections to nuclear beta decay in relation to precision tests of the Standard Model.

We have recently constructed a new empirical sd shell-model Hamiltonian which reproduces accurately splittings of isobaric multiplets [1,2]. The Hamiltonian contains on top of the isospin-conserving realistic sd-shell interaction (USD/USDA/USDB), the Coulomb interaction and a phenomenological term of Yukawa type which models
the isospin-symmetry breaking part of the effective nucleon-nucleon interaction. The latter represents about 1-2% of the residual shell-model interaction. The values of strength parameters are adjusted by a least-squares fit to the experimentally deduced coefficients of the isobaric-mass-multiplet equation (IMME). Thus, solution of the eigenproblem by numerical diagonalization in proton-neutron formalism allows to get nuclear states of mixed isospin. The empirical isospin-nonconserving Hamiltonian represents a modern high-precision version of the previous work [3].

A few applications will be discussed. First, we analyze a particular behaviour of the IMME coefficients as a function of the mass number.
Second, calculation of isospin-symmetry breaking correction to the superallowed 0+ -> 0+ beta-decay for sd-shell emitters in comparison with the existing results [4,5].

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