ID de Contribution: **0** Type: **Non spécifié**

Empirical Isospin Symmetry Breaking Hamiltonians for sd Shell

mardi 19 octobre 2010 15:30 (30 minutes)

Isospin-symmetry breaking in nuclear structure is a small effect, however, it has important consequences for the weak processes in nuclei which can provide tests to fundamental symmetries underlying the Standard Model. With newly updated and extended (in the middle region of sd model space) experimentally measured isotopic mass shift data, we develop an empirical approach to derive the new Hamiltonians describing the isospin symmetry breaking for sd (1s1/2, 0d5/2 and 0d3/2) space calculations. Such Hamiltonians will be able to reproduce experimentally measured isotopic mass shifts with low discrepancies. Apart from the isovector single-particle energies, the two-body part of the Hamiltonian, which breaks the isospin symmetry, was assumed to be the combination(s) of the Coulomb potential, and phenomenological isospin symmetry breaking nucleon-nucleon interactions modeled by Yukawa type potential(s) with leading order central term due to the pion and/or rho-meson exchange with an arbitrary strength. All strength parameters were optimized by least-squares fits to experimental b and c coefficients of the isobaric mass multiplet equation; and no truncation procedure was imposed in obtaining nuclei wave functions used in the fitting procedure. The derived Hamiltonians will enable us to describe such phenomena as isospin-forbidden particle emission and will provide a part of the correction to the superallowed 0+ -> 0+ beta-decay due to the isospin symmetry breaking in nuclear states.

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