Relation between proton and neutron asymptotic normalization coefficients for light mirror nuclei and its relevance for nuclear astrophysics

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In this talk, relation between proton and neutron Asymptotic Normalization Coefficients (ANCs) for light mirror nuclei will be discussed. This relation follows from charge symmetry of nucleon-nucleon interactions and is given by a simple approximate analytical formula which involves proton and neutron separation energies, charges of residual nuclei and the range of their strong interaction with the last nucleon [1]. This relation is valid both for particle-bound mirror nuclear levels and for mirror pairs in which one of the levels is a narrow resonance. In the latter case, the width of this resonance is related to the ANC of its mirror particle-stable analog.

A link between mirror ANCs also follows from the single-particle model of nuclei if charge symmetry is valid both for miror single-particle potential wells and for mirror one-nucleon spectroscopic factors. Predictions of such a single-particle model are close to the predictions of the simple analytical formula if nucleon separation energies are relatively large. This agreement deteriorates with decrease of separation energies and for weakly-bound s-states with nodes.

Our theoretical study of mirror ANCs for several light nuclei within a framework of microscopic two-, three- and four-cluster models, have shown that the ratio of mirror ANCs changes as predicted by the simple approximate analytical formula [2]. Deviations from this formula do not exceed 12% for bound-bound mirror pairs but can be stronger for bound-unbound mirror levels. We will discuss different effects responsible for these deviations. We will also compare the results from our microscopic calculations to the predictions of the single-particle model and discuss mirror symmetry of spectroscopic factors and single-particle ANCs.

Relation between mirror ANCs, if understood properly, can be used to predict astrophysically relevant non-resonant proton capture cross sections using mirror neutron ANCs measured with stable beams.

The latter usually provide better accuracy for the cross sections than the radioactive beams. Proton capture reactions proceeding via resonances, the proton widths of which are much smaller than their radiative decay widths, can be also studied via ANCs of their mirror particle-stable analogs.

[1] N.K. Timofeyuk, R.C. Johnson et A.M. Mukhamedzhanov, Phys. Rev. Lett. 91, 232501 (2003).
[2] N.K. Timofeyuk and P.Descouvemont, nucl-th/0502072