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Role of the isospin 3/2 component in nd elastic scattering and breakup

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Charge-independence breaking (CIB) is well established in the two-nucleon (2N) system in the 1S0 state as evidenced by the different values of the scattering lengths for the neutron-proton (np), proton-proton (pp) and neutron-neutron (nn) systems. That knowledge of CIB is incorporated into modern, high precision NN potentials, as exemplified by the standard semi-phenomenological models such as e.g. Av18, CD˜Bonn, or NijmI and NijmII, as well as by the chiral nucleon-nucleon (NN) forces. Treating neutrons and protons as identical particles requires that nuclear systems are described not only in terms of the momentum and spin but also isospin states.

The isospin violating 2N forces induce an admixture of the total isospin T=3/2 state to the dominant T={1/2 state in the three-nucleon (3N) system. The CIB of the NN interaction thus affects 3N observables. We present the exact treatment of the 3N system with CIB NN forces and three-nucleon forces (3NF's) included. In the calculations performed with the standard semi-phenomenological potentials we use the UrbanaIX (UIX) 3NF, while the chiral N2LO 3N force is used in addition to the recent and most accurate chiral NN interactions.

Based on such dynamics we present the results and discuss the role of the three-nucleon isospin T=3/2 amplitude in elastic neutron-deuteron (nd) scattering and in the deuteron breakup reaction. The contribution of this amplitude originates from charge-independence breaking of the NN potential and is driven by the difference between nn and np forces.
We study the magnitude of that contribution to the elastic scattering and breakup observables by taking the locally regularized chiral N4LO nucleon-nucleon potential supplemented by the chiral N2LO three-nucleon force. For comparison we employ also the Av18 nucleon-nucleon potential combined with the Urbana IX three-nucleon force. We find that the isospin T=3/2 component is important for the breakup reaction and the proper treatment of charge-independence breaking in this case requires the inclusion of the 1S0 state with isospin T=3/2. For neutron-deuteron elastic scattering the T=3/2 contributions are insignificant and charge-independence breaking can be accounted for by using the effective t-matrix generated with the so-called "2/3-1/3" rule.

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