The spectra of weakly-bound or particle-unstable light nuclei with a sturmian approach that includes the Pauli principle

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A Multi-Channel Algebraic Scattering (MCAS) theory has been used to study the properties of nucleon scattering from light-mass nuclei, defining bound states (if any) as well as resonances of the compound nucleus. With this approach it was possible to describe the low-energy properties in the compound nuclei, up to ~ 10 MeV. The applied sturmian-based algebrization technique determines all bound states, compound and quasi-compound resonances. In the cases considered, the nuclear spectra so determined match to data where such is known. Predictions of other states in nuclei are made when experimental information is lacking. A simple collective model has been used to define the initiating nucleon-nucleus interactions where low-lying target excitations are explicitly included. Using orthogonalizing pseudo-potentials, account is made of the Pauli principle. The approach takes into account Pauli blocked, Pauli allowed, and Pauli hindered states in which the incoming nucleon is prohibited, allowed, and partially allowed to be captured into a specific single particle orbit to form a state in the compound nucleus. Isospin symmetry in mirror scattering systems, save only for inclusion/exclusion of the Coulomb interaction, has been used with MCAS to estimate the spectra of nuclei that are just outside of the proton drip line. ^{15}F is one such case. In addition, the $A = 7$ system has been considered with one and the same nuclear potential, and the level structures of ^{7}He, ^{7}Li, ^{7}Be and ^{7}B have been explained with inclusion/exclusion of the Coulomb potential and by changing the Pauli constraints in the OPP term. It is concluded that, with the MCAS approach, one can construct nucleon-nucleus potentials that are free of spurious states and describe bound and resonant spectra across isobar lines up to weakly bound or unbound nuclei. The MCAS construction generates the nucleon-nucleus potential that can be safely used as input for three-body calculations for treating complex nuclear systems such as N-N-core systems, with explicit treatment of collective-type core excitations.

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