On the resonant spectra of particle-unstable nuclei with a sturmian-based algebraic scattering approach that preserves 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 $\sim$ 10 MeV. The applied sturmian-based algebrization technique determines all bound states, compound and quasi-compound resonances, and 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 collective-model prescription has been used to define the initiating nucleon-nucleus interactions and, by 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. The method allows for target states to be resonances, as well.

Isospin symmetry in mirror scattering systems (all protons change to neutrons and *vice versa*), 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. That is possible since the numbers of neutron-rich isotopes within the neutron drip line usually exceed those on the proton-rich side. Thus the mirror system against which the proton-rich, unstable, system spectroscopy is to be compared will not be particle unstable and often have experimentally known properties.

The MCAS method can give the distorted wave functions and bound state single nucleon functions, derived from the self same matrix of coupling interactions, and as the distorted waves carry the full character of the scattering cross section (smooth background and sharp as well as broad resonances), it is feasible to evaluate capture cross sections for all energies even approaching zero, without orthogonality problems or having to use models for direct and resonant capture.