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Recent Developments of the Gamow Shell Model for Nuclear Structure and Reaction

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Dripline nuclei exhibit different properties compared to those lying close to the valley of stability. The ground states of those systems can form halo structures or can even be unbound to particle emission. In fact, dripline nuclei are open quantum systems, for which the proximity of the continuum of unbound scattering states must be taken into account theoretically.
To this end, the Gamow Shell Model (GSM) has been successfully introduced to study loosely bound and resonant nuclear many-body states [1]. The GSM is rooted in the one-body Berggren basis, comprising bound, resonant and scattering states. The continuum degrees of freedom are thus included at basis level, and the configuration mixing between many-body basis states contributes to inter-nucleon correlations. For very large GSM matrices, where Lanczos and Davidson methods can no longer be used, the Density Matrix Renormalization Group (DMRG) has been introduced [2].
In order to use GSM to describe nuclear reactions, the Resonating Group Method (RGM) has been applied [3]. In the RGM method, a basis of channels is constructed from target and projectile states, which generate compound many-body basis states. Target states and projectile states are calculated in GSM, as they consist of bound or resonant eigenstates of the GSM Hamiltonian. Scattering wave functions and reaction cross sections can then be calculated. In this presentation, various GSM applications to structure and reactions of light nuclei will be presented. They include: 18Ne(p,p) [3] and 14O(p,p) [4] reactions, where the proton-rich 19Na and 15F nuclei are unbound, as well as 6Li(p,gamma)7Be, 6Li(n,gamma)7Li [5], 7Be(p,gamma)8B, and 7Li(n,gamma)8Li radiative capture reactions [6] of astrophysical interest.
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