Non-perturbative Formulation of the Cluster Theory for Exotic Nuclei

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Energy spectra and electromagnetic transitions of nuclei are strongly influenced by the correlations of the bound nucleons. Correlations are responsible for the scattering of the valence particle to higher shell model states and for the excitations of the shell model reference vacuum. In this work the influence of the correlations on the level structure and ground state distributions (matter and charge) of open shell light nuclei is analyzed via a non-perturbative formulation of the cluster theory. The theory is based on the unitary operator e^S (S is the correlation operator) formalism which, in this paper, is treated within high order approximations. The application of the derived equations to n-body systems is realized in terms of generalized linearization approximations (GLA) and via the cluster factorization theory (CFT). Within the linearization method and the CFT theory, the amplitudes of the single particle and of the collective modes of the n-body systems are calculated by using the equation of motion theory (EOM). Applications of the theory to systems containing up to 6-body valence clusters are discussed. The theory is easily extendable heavy nuclei and to relativistic particles.