Pairing Correlations and Continuum Effects in Drip Line Nuclei

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Pairing correlations in the ground state of weakly-bound nuclei are commonly described by the Hartree-Fock-Bogoliubov (HFB) and Relativistic-Hartree-Bogoliubov (RHB) equations. In most of the existing calculations the continuum is discretized by solving the HFB or RHB equations with box boundary conditions. In this way genuine continuum effects such as the widths of resonant states are not properly described. Recently, the HFB equations were solved also with correct boundary conditions, both for a zero range [1] and a finite range [2] pairing force. It was thus found that close to the drip line the box HFB calculations overestimates the pairing correlations compared to the exact continuum HFB results. It was also shown [1] that pairing correlations are well described by the resonant continuum HF-BCS approach [3], in which the continuum is included through a few low-lying resonant states. A similar resonant Relativistic Mean Field-BCS approach has been recently developed and applied for analysing the halo structure of Ca and Zr netron-rich isotopes [6].

Based on the continuum HFB solutions, the continuum QRPA equations have been also derived in Ref. [4]. In this formalism the residual interaction is determined self- consistently from the HFB energy functional. By using this QRPA approach the excitations of neutron-rich oxygen isotopes have been analysed. These calculations predict a lowering of the B(E2) value for ^{24}O in comparison with the lighter isotopes, which shows that N=16 behaves like a new magic number.

In the nuclei close to the drip lines some of the low-lying two-particle excitations can have a resonant structure. In order to evaluate accurately such two-particle resonant states a continuum shell model formalism has been developed [5]. This formalism is based on a complete single-particle bases formed by bound states, resonant states (i.e.Gamow functions) and complex scattering states. By using this basis it was shown how one could isolate in the complex energy plane the poles corresponding to the physical two-particle excitations.

References

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