

## Exotic halos and collective excitations in weakly-bound deformed nuclei

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The excitation states of weakly-bound deformed nuclei provide great possibilities for studies of continuum effects, halos or deformed halos, novel excitation modes and effective nuclear interactions. In this work the low-energy collective excitations has been studied by the finite-amplitude QRPA method [1] based on the Skyrme Hartree-Fock-Bogoliubov approach in large coordinate-spaces. We demonstrate that the coordinate-space HFB can provide self-consistent treatment of deformations, pairing and weak binding effects, which is unique by using the hybrid parallel calculations in Tianhe supercomputers. Interesting insights such as the continuum contributions to deformed halos have been discussed. With large coordinate spaces, the accuracy of HFB solutions of broad quasiparticle resonances and non-resonant continuum can be improved which is useful for further studies of novel structures and excitation modes in weakly-bound deformed nuclei so that one is sure that they do not arise from uncontrolled approximations[2]. Therefore we have implemented the finite amplitude method for quasiparticle random phase approximation (FAM-QRPA) based on the deformed coordinate-space HFB approach. For different excitation energy points, the distributed parallel calculations are adopted. Besides, for each point the multi-thread parallel is employed within each node. This is an efficient way to study the low-energy collective excitations of weakly-bound deformed nuclei with continuum effects [3]. While the standard deformed QRPA based on coordinate-space HFB would be tremendously expensive and prohibit systematic calculations. The monopole strengths of weakly-bound deformed nuclei have been investigated as an example and pygmy monopole modes are predicted towards the neutron drip line.

[1] P. Avogadro and T. Nakatsukasa, Phys. Rev. C 84, 014314(2011).

[2] J.C. Pei, Y.N. Zhang, F.R. Xu, Phys. Rev. C 87, 051302 (R)(2013)

[3] J.C. Pei, M. Kortelainen, Y.N. Zhang, F.R. Xu, in preparation.