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Nuclear collective excitation based on the finite-amplitude method for QRPA

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Nuclear collective excitation such as giant resonances provides valuable information on understanding the structure of finite nuclei and the equation of state for infinite nuclear matter. The quasiparticle random-phase approximation (QRPA) is a suitable theoretical framework for describing collective excitation as a superposition of the two-quasiparticle excitation, but it requires a large-dimensional matrix diagonalization and large computational resources.

The finite-amplitude method (FAM) [1] has been proposed as a solution to the QRPA problem under the presence of a one-body external field. The FAM is an iterative approach that makes it possible to calculate the strength function of giant resonance without additional truncation in the two-quasiparticle model space. Combined with a contour integration technique in the complex-energy plane, discrete low-energy collective states can be obtained [2]. The formulation based on the contour integration enables us to compute various QRPA solutions such as the low-energy collective modes, beta-decay rates, zero-energy pairing rotational modes, sum rules, and the nuclear matrix elements of the double-beta decay. I will review the recent progress and applications of the FAM for various problems including recent extensions for further reduction of the computational cost based on the reduced basis method.

[1] T. Nakatsukasa, T. Inakura, and K. Yabana, Phys. Rev. C 76, 024318 (2007).

[2] N. Hinohara, M. Kortelainen, and W. Nazarewicz, Phys. Rev. C 87, 064309 (2013).

Primary author: HINOHARA, Nobuo (University of Tsukuba)

Presenter: HINOHARA, Nobuo (University of Tsukuba)

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