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Nuclear response at zero and finite temperature

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Recent developments of the relativistic nuclear field theory (NFT) on the fermionic correlation functions will be presented. The general non-perturbative equation of motion framework is formulated in terms of a closed system of non-linear equations for one-body and two-body propagators. The present formulation provides a direct link to ab-initio theories and extends the explicit treatment of many-body correlations beyond the standard NFT level. The novel approach to the nuclear response, which includes configurations with two quasiparticles coupled to two phonons (2q⊗2phonon), is discussed in detail for electromagnetic excitations in medium-mass nuclei. The proposed developments are implemented numerically on the basis of the relativistic effective meson-nucleon Lagrangian and compared to the models confined by 2q and 2q⊗phonon configurations, which are considered the state-of-the-art for the response theory in nuclear structure calculations. The results obtained for the dipole response of ^{42,48}Ca and ^{68}Ni nuclei in comparison to available experimental data show that the higher-complexity configurations are necessary for a successful description of both gross and fine details of the spectra in both high-energy and low-energy sectors.

The approach confined by the 2q⊗phonon configurations has been extended recently to the case of finite temperature for both neutral and charge-exchange nuclear response. Within this approach, we investigate the temperature dependence of nuclear spectra in various channels, such as the monopole, dipole, quadrupole and spin-isospin ones, for even-even medium-heavy nuclei. The special focus is put on the giant dipole resonance’ s width problem, the low-energy strength distributions and the influence of temperature on the equation of state. The temperature dependence of the Gamow-Teller and spin dipole excitations will be discussed in the context of its potential impact on the astrophysical modeling of supernovae and neutron-star mergers.

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