A Semi-microscopic description of isoscalar giant multipole resonances in medium-mass closed shell nuclei

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Being a microscopically based extension of the standard [1] and nonstandard [2] versions of the continuum-random-phase approximation (cRPA), by taking the spreading effect into account, the semi-microscopic particle-hole (p-h) dispersive optical model (PHDOM) has been proposed [3] and successfully implemented for describing properties of various giant resonances (GRs) in medium-heavy mass closed-shell nuclei (See Ref. [4] and references therein). Within the model, the main relaxation modes of (p-h)-type states, associated with GRs, are together taken into account. These modes are: (i) Landau damping; (ii) coupling mentioned states to the single-particle continuum, and; (iii) coupling to many-quasiparticle configurations (the spreading effect). Landau damping and coupling to the continuum are described microscopically (in terms of a phenomenological mean field and Landau-Migdal p-h interaction), while the spreading effect is treated phenomenologically (in terms of the energy-averaged p-h self-energy term). That allows one to describe within PHDOM the main GR characteristics for a wide excitation-energy interval: (i) double transition density; (ii) strength distribution, and one-body "projected" transition density both related to an appropriate probing operator, and (iii) probabilities of direct one-nucleon decay.

The PHDOM version proposed in Ref. [3] in a rather general form has been adopted in Ref. [4] for describing main characteristics of isoscalar Multipole GRs in medium-heavy mass closed-shell nuclei. The L = 0 - 3 multipole resonances together with L = 0, and 2 multipole overtones have been considered. A rather reasonable description of available experimental data has been obtained for the ^{208}Pb nucleus [4], taken as an appropriate example. Some of the results obtained within cRPA (i.e., in neglecting the spreading effect) were found to be in agreement with the results obtained within the microscopic RPA-based approach of self-consistent Hartree-Fock, using Skyrme-type forces [5].

The present work is a direct continuation of the above-described study of Ref. [4]. The study is extended to medium-mass closed-shell nuclei ^{40,48}Ca, ^{90}Zr, and ^{132}Sn. Calculation results are compared with available experimental data [6]. Some of cRPA results are compared with the results of Hartree-Fock (HF)-based RPA of Ref. [5].

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