Properties of isoscalar giant multipole resonances in medium-heavy closed-shell nuclei: a semi-microscopic description

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The particle-hole (p-h) dispersive optical model (PHDOM) [1], was adopted and implemented [2] for describing main properties of Isoscalar Giant Multipole Resonances (ISGMPR) up to L=3 in medium-heavy closed-shell nuclei. The overtones of the monopole and quadrupole isoscalar giant resonances were also studied. The main properties, considered in a large excitation-energy interval., include the following energy-averaged quantities: (i) the strength function related to an appropriate probing operator; (ii) the projected one-body transition density (related to the corresponding operator), and; (iii) partial probabilities of direct one-nucleon decay. Unique abilities of PHDOM are conditioned by a joint description of the main relaxation processes of high-energy p-h configurations associated with a given giant resonance (GR). Two processes (Landau damping and coupling the mentioned configurations to the single-particle continuum [3]) are described microscopically in terms of Landau-Migdal p-h interaction and a phenomenological mean field, partially consistent with this interaction. Another mode, the coupling to many quasiparticle states (the spreading effect) is described phenomenologically in terms of the imaginary part of the properly parameterized energy-averaged p-h self-energy term. The imaginary part determines the real one via a microscopically-based dispersive relationship. The model parameters related to a mean field and p-h interaction are taken from independent data with the isospin symmetry, and translation invariance of the model Hamiltonian also taking into account. Parameters of the strength of self-energy term imaginary part were adjusted to reproduce in PHDOM-based calculations of total width (the full width at half maximum) of ISGMPR for the considered closed-shell nuclei ^{40,48}Ca, ^{90}Zr, ^{132}Sn, ^{208}Pb. The calculation results were compared with available experimental data. Some of results were compared with those obtained in microscopic Hartree-Fock based RPA calculations [4]. These comparisons confirm the statement that PHDOM is a powerful tool for describing ISGMPR in medium-heavy closed-shell nuclei. Extension of the model by taking nucleon-nucleon pairing interaction into account in open-shell nuclei is in order.

As an example we present in the Fig. 1 below the relative energy-weighted strength functions, $y_L(\omega)$, (Fig. 1a) and the projected transition density, $\rho_{V_L}(r,\omega)$ (Figure 1b) for the overtone of the isoscalar giant monopole resonance (ISGMR2) in the closed shell nuclei ^{40,48}Ca, ^{90}Zr, ^{132}Sn and ^{208}Pb. Evaluated within PHDOM, the transition densities were taken at the peak energy of the respective ISGMR2.

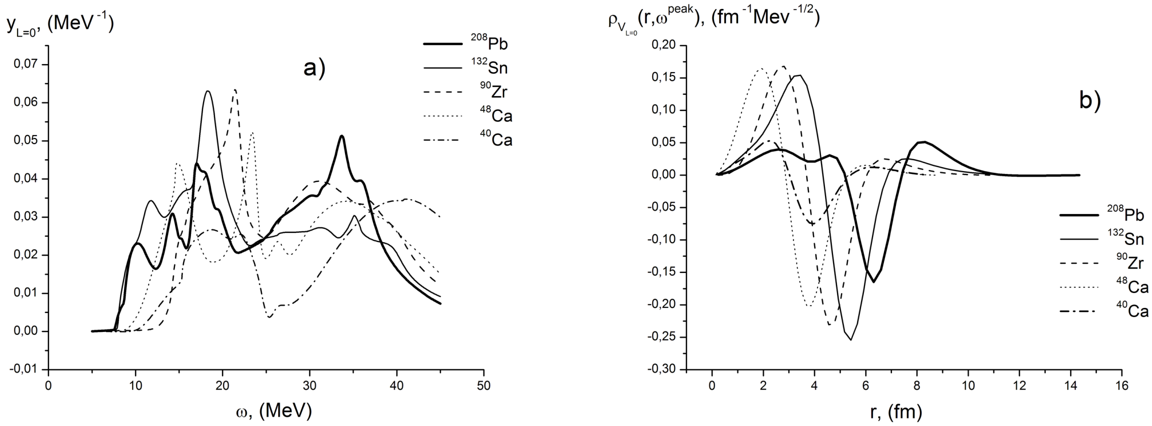

Fig. 1. Evaluated within PHDOM for the overtone of the isoscalar giant monopole resonance (ISGMR2) in ^{40,48}Ca, ^{90}Zr, ^{132}Sn and ^{208}Pb nuclei : a) the relative energy-weighted strength function; b) the projected transition density taken at the resonance peak-energy.

[1] M.H. Urin, Phys. Rev. C **87**, 044330 (2013).

[2] M.L. Gorelik, S. Shlomo, B.A. Tulupov, and M.H. Urin, to be published.

[3] S. Shlomo and G. Bertsch, Nucl. Phys. **A243,** 507 (1975).

[4] G. Bonasera, M.R. Anders, and S. Shlomo, Phys. Rev. C **98**, 054316 (2018).