Giant Dipole and Spin Magnetic Quadrupole Resonances within Wigner Function Moments method

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The nuclear collective motion of the rotational type was comprehensively investigated within the Wigner Function Moments (WFM) method in the series of papers [1-3]. The present study is devoted to Giant Dipole Resonance (GDR) and Spin Magnetic Quadrupole Resonance in heavy even-even nuclei. The calculations are based on the Time Dependent Hartree–Fock (TDHF) equations for the density matrix.
The microscopic Hamiltonian is the harmonic oscillator with the spin-orbital potential plus separable dipole-dipole, quadrupole-quadrupole and spin-dipole interactions. The Fourier (Wigner) transform converts the initial TDHF equations
into the equations for the spin-dependent Wigner function. Integrating these equations over the phase space (**r**, **p**) with the weights r_μ and p_μ one gets the equations that describe the coupled dynamics of irreducible tensors associated with the electrical dipole ($E1$) and magnetic quadrupole ($M2$) responses. The derived equations are solved in the small amplitude approximation.

The energies of $M2$ isovector and isoscalar excitations as well as the spin contribution to the corresponding transition strengths, determined by first-rank tensors, are estimated for ^{208}Pb and ^{90}Zr. The energy position of the GDR and the corresponding transition probability are also calculated. The results of the calculations are compared with the available experimental data and with the recent microscopic analysis of 2^- excitations
in even-even nuclei within the framework of the relativistic energy density functional theory [4].

References

1. E. B. Balbutsev, I. V. Molodtsova, and P. Schuck, Phys. Rev. C **88**, 014306 (2013); *ibid.*, **91**, 064312 (2015); **97**, 044316 (2018);

2. E. B. Balbutsev, I. V. Molodtsova, A. V. Sushkov, N. Yu. Shirikova, and P. Schuck, Phys. Rev. C **105**, 044323 (2022).

3. E. B. Balbutsev and I. V. Molodtsova, Eur. Phys. J. A **59**, 207 (2023); *ibid.*, **60**, 185 (2024).

4. G. Kruzic, T. Oishi, and N. Paar, Eur. Phys. J. A **59**, 50 (2023).