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Magnetic giant resonances in the relativistic energy density functional theory

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Electromagnetic excitations in finite nuclei represent one of the most important probes of relevance in nuclear structure and dynamic. Various aspects of magnetic dipole (M1) mode have been considered due to their relevance for nuclear properties associated e.g., to unnatural-parity states and spin-orbit splittings. Specifically, M1 spin-flip excitations are analog of Gamow-Teller (GT) transitions, meaning that, at the operator level, the dominant M1 isovector component is the synonym to the zeroth component of GT transitions, and can serve as probe for calculations of inelastic neutrino-nucleus cross section essential in the r-process nucleosynthesis calculations.

In this work [2,3,4,5] we have introduced a novel approach to describe M1, 0^+ ground state to 1^+ excited state, transitions in even-even nuclei, based on the RHB + RQRPA framework with the relativistic point-coupling interaction, supplemented with the pairing correlations described by the pairing part of the Gogny force. In addition to the standard terms of the point coupling model with the DD-PC1 parameterization, the residual R(Q)RPA interaction has been extended by the isovector-pseudovector $(IV - PV)$ contact type of interaction that contributes to unnatural parity transitions. This pseudovector type of interaction has been modeled as a scalar product of two pseudovectors. The strength parameter for this channel, α_{IV-PV} , is considered as a free parameter constrained by the experimental data on M1 transitions of ^{48}Ca and ^{208}Pb referent nuclei [2]. As analitical test, a newly developed sume rule for M1 transitions [1] has been applied, which confirmed results of our microscopical calculations [2]. Significance of pariring correlations has been demostrated on open shell nulclei ^{42}Ca and especially ^{50}Ti [2,5] where it has been reproduced two-peaked structure in a strength distribution expected from experimental spectrum in Ref.[6]. A recent experimental publication [7] investigates, by inelastic proton scattering, isotopic dependance of E1 and M1 strength distribution of even-even nuclei in $^{112-124}$Sn isotope chain, that is why theoretically have been explored M1 transitions in Ref. [4] but over the wider isotope range $^{100-140}$Sn. As main results we would like to emphasize reproduced single and double-peaked structure in a strength spectra governed by single-particle evolution over $^{100-140}$Sn isotope chain and significant reduction of spin-quenching $\zeta_s = g^{\sigma}_{eff}/g^{\sigma}_{free} = 0.80 - 0.93$ factor compared to the previous theoretical investigations. Indication in Ref. [6], that part of M1 strength above neutron threshold may be missing, leads to the conclusion that further experimental studies are required.

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