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Finite temperature effects in electromagnetic transitions of open- and closed-shell nuclei

The electric dipole (E1) and magnetic dipole (M1) excitations of nuclei are excellent probes to study the nuclear structure and dynamics from both experimental and theoretical point of view. Also, the behavior of dipole excitations is known to be highly sensitive to extreme conditions of temperature and neutron excess [1-4]. In this work, the finite temperature relativistic quasiparticle random phase approximation (FT-RQRPA) based on the relativistic nuclear energy density functional (RNEDF) approach is formulated to study the interplay of temperature and pairing effects on electric and magnetic dipole transitions [1]. The properties of open- and closed-shell nuclei are described within the finite temperature Hartree BCS theory (FT-HBCS) using the relativistic density-dependent point coupling DD-PCX interaction [5]. Using this novel approach, the systematic evaluation of isovector E1 and M1 strength distributions is studied for 40-60Ca and 100-140Sn isotopes at temperatures between T=0-2 MeV. It is shown that E1 strength becomes more fragmented, and new excited states emerge in the low-energy region as the neutron number and temperature of Ca and Sn isotopes increase. This happens because of the unblocking of new transitions above the Fermi level due to pairing and thermal unblocking effects. The temperature dependence of the M1 response within FT-RQRPA is also studied for the first time. M1 transitions take place between spin-orbit (SO) partner states. By increasing temperature, the SO gap energies start to decrease, and the M1 response significantly shifts to lower energies. The absolute silent M1 response in 40,60Ca suddenly appeared at higher temperatures due to the thermal unblocking of new transitions between the SO partners. In addition, new low-lying M1 excitation modes are obtained below E<5 MeV in neutron-rich Ca and Sn nuclei.

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