Contribution ID: **37** Type: **Oral presentation**

Impact of finite-temperature on electromagnetic dipole transitions

Wednesday 29 May 2024 14:50 (20 minutes)

Finite temperature effects in electric dipole (E1) and magnetic dipole (M1) transitions can have a significant influence on gamma strength functions [1,2]. In this work, we developed a self-consistent finite temperature relativistic quasiparticle random phase approximation (FT-RQRPA) based on relativistic energy density functional with point coupling interaction [3,4]. This study focuses on elucidating the impact of temperature (T) ranging from T=0 to 2 MeV on E1 and M1 transitions in closed- and open-shell Ca and Sn nuclei. With an increase in temperature, E1 giant resonances undergo moderate modifications, however, new low-energy excitations appear at high temperatures due to thermal unblocking effects, particularly in neutron-rich nuclei. In the case of M1 excitations, the transition strength undergoes a notable shift towards lower excitation energies in Ca and Sn nuclei, primarily ascribed to the decrease in spin-orbit splitting energies and the weakening of the residual interaction. Moreover, an interesting result is obtained for 40,60Ca nuclei at higher temperatures, i.e., the appearance of M1 transitions, which are forbidden at zero temperature due to fully occupied (or fully vacant) spin-orbit partner states. Thus, these considerable temperature effects on E1 and M1 transitions are crucial in accurately modeling gamma strength functions, with potential applications in astrophysically relevant nuclear reaction studies.

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