Nuclear Reaction Rate Uncertainties in the r-Process: Insights from Self-Consistent FT-RQRPA Calculations of Dipole Transitions

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To comprehensively understand nuclear astrophysical network calculations, especially in the context of processes like the r-process, it is crucial to consider astrophysical reaction rates at a fixed temperature which requires Maxwellian-averaged cross-sections across a wide range of energies for radiative neutron capture processes. Determining these cross-sections and reaction rates within a statistical framework [1–3] primarily relies on three key components: (i) Neutron-Nucleus Optical Model Potential (OMP), (ii) Gamma-ray Strength Function (SF), and (iii) Nuclear Level Density (NLD). While uncertainties in the Neutron-Nucleus Optical Model Potential (OMP) are relatively small, the Gamma-ray Strength Function (SF) and Nuclear Level Density (NLD) have a more significant impact on shaping the calculated neutron capture rates.

In our recent study, we have calculated temperature effects in electric and magnetic dipole (E1 and M1) transitions using a self-consistent finite-temperature relativistic quasiparticle random phase approximation (FT-RQRPA) based on a relativistic energy density functional with point-coupling interactions [4,5]. Currently, we examine their impact on crucial astrophysical reaction rate calculations.

References

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