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Energy and Deformation Dependence of Collective Enhancement in Nuclear Level Densities

The nuclear level density (NLD) represents the number of accessible energy states in a nucleus at a given excitation energy and is vital for modeling nuclear reactions and decay processes. At lower excitation energies, NLD is significantly enhanced by collective effects, rotational and vibrational motions, which are prominent in deformed nuclei. This phenomenon, referred to as collective enhancement (CELD), is often quantified by a deformation-dependent factor. As excitation energy rises, the ordered nature of collective motion breaks down, marking a shift from a collective to intrinsic single-particle excitation regime. Additionally, nuclear pairing interactions, which suppress level density at low energies, weaken with increasing temperature, further influencing the NLD behavior.
Experimental data across different mass regions consistently support the existence and subsequent fadeout of collective enhancement with rising excitation energy. These observations emphasize the need to incorporate both collective and pairing effects, along with their dependence on energy and deformation, for realistic and predictive NLD models. In the present study, we investigate the behavior of CELD and its fadeout in excited nuclei, emphasizing the correlation with nuclear deformation and excitation energy.

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