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Elastic Scattering and Energy-Weighted Integral Evaluation of GDR Models Using the Standard Lorentzian (SLO)

This contribution presents a theoretical study comparing two distinct models for the description of the Giant Dipole Resonance (GDR): a macroscopic geometric model, which interprets the GDR as a collective oscillation of the proton system against the neutron system, and a microscopic model, in which the GDR emerges as a coherent superposition of numerous particle–hole excitations. A central aspect of the analysis is the elastic photon scattering cross section, recently measured for the first time across the GDRs of spherical and deformed nuclei [1] and here derived in both frameworks as analytically as possible and used as a benchmark for comparison.

Special emphasis is placed on the application of the Standard Lorentzian (SLO) model to describe the photoabsorption cross section, which forms the foundation for both elastic scattering and integral evaluations. In particular, energy-weighted integrals of the type
$E^n \sigma_{\mathrm{Abs}}^{\mathrm{SLO}}(E)$,
with exponents ranging from n = −3 to n = 3, are evaluated in closed analytic form. These integrals are used both to derive an antiderivative of the elastic scattering cross section and to determine the energy centroid as a function of the chosen integration range.

The comparative analysis reveals that, despite fundamentally different physical assumptions, both models yield nearly indistinguishable elastic scattering cross sections, indicating a limited discriminatory power of this observable. This outcome highlights the need for additional theoretical refinements and complementary experimental approaches to further constrain and validate GDR models.

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[1] J. Kleemann et al., Phys. Rev. Lett. 134, 022503 (2025)

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