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Probing the Giant Dipole Resonance Using Nuclear Resonance Fluorescence

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The giant dipole resonance (GDR) is one of the most fundamental nuclear excitations and it dominates the dipole response of all nuclei. Since its discovery in the early days of nuclear physics it has consistently attracted a great deal of attention. Its evolution from a single-humped structure in spherical nuclei to a double-humped one in deformed nuclei is considered one of the prime signatures of nuclear deformation. This phenomenon is commonly explained through the geometrical model, which depicts the GDR as an isovector oscillation of the proton against the neutron body. However, the geometrical model also makes strong predictions about the γ-decay behavior of the GDR. Yet, despite decades of research on the GDR, its γ decay, though a key property of the resonance, remains poorly characterized, leaving these predictions largely untested.

To address this long-standing issue, photonuclear experiments on the γ decay of the GDR of the well-deformed nuclide ^{154}Sm and the spherical ^{140}Ce were recently conducted at the High Intensity γ-ray source (HIγS). Individual regions of the GDR were selectively excited using intense, linearly-polarized and quasi-monochromatic γ-ray beams provided by HIγS. This enabled an excitation-energy-resolved determination of the GDR's elastic and 2_1^+ Raman γ-scattering cross sections.

The data obtained from these experiments allow for a novel close experimental assessment of the geometrical model of the GDR, in particular for ^{154}Sm with its double-humped GDR and respective K-quantum-number assignments. The findings establish γ decay of the GDR as an observable sensitive to both the structure of the resonance and the nuclear shape.

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