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Study of Isotopic dependence of IVGDR width at low temperature near Sn region

The isovector giant dipole resonance (IVGDR)—a macroscopic oscillation where neutrons and protons move out of phase—serves as a key probe for studying the structure of many-body quantum systems. Generally, the width (Γ_G) of IVGDR is related to the various damping mechanism of this collective vibration and is an important observable to understand the structural details of excited nuclei. Experimentally, it has been observed that Γ_G increases with temperature (T) within the range of 1 MeV $\leq$ T $\leq$ 3 MeV and further increase in T beyond this range may lead to the saturation in Γ_G [1]. However, exploring the low-temperature regime (T $\leq$ 1 MeV) remains challenging due to difficulties in populating nuclei at such energies, primarily because of the Coulomb barrier in the entrance channel. Only a few studies exist in this regime and they reveal that microscopic effects such as shell structure and pairing fluctuations suppress the thermal broadening of Γ_G at low temperatures [2-6]. The Thermal Shape Fluctuation Model (TSFM) [7] is widely used to explain the mid-temperature behavior of Γ_G, while the Phonon Damping Model (PDM) [8] and the Critical Temperature Fluctuation Model (CTFM) [5] successfully describe the suppression at low temperatures. This suppression appears to be a general trend across a broad mass range (A $\approx$ 30–208), though an exception has been reported in ^{114}Sn [9]. In a recent experiment, measurement of high-energy γ -rays have been performed for ^{124,136}Ba at temperature around 1.1 MeV to study the properties of IVGDR over a wide N/Z range [10]. It has been observed that for ^{124}Ba, Γ_G shows little sensitivity to temperature, whereas for ^{136}Ba, it increases significantly. This difference suggests a dominant role of shell-closure effects in ^{136}Ba. A more systematic investigation across a wider mass range is needed to fully understand the influence of N/Z asymmetry and other microscopic properties on the variation of Γ_G with temperature.

Motivated by the need to explore the temperature dependence of the IVGDR width (Γ_G) in systems where shell effects are minimal, we conducted a systematic study across an isotopic chain of tellurium (Te) nuclei. The isotopes ^{116,120,128}Te were populated in the low-temperature regime (T $\approx$ 0.8–1.2 MeV) via α-induced fusion reactions using the K-130 cyclotron at VECC, India. The high-energy γ-rays ($E_\gamma \geq$ 4 MeV) emitted from the decay of the excited Te isotopes were detected using the Large Area Modular BaF_2 Detector Array (LAMBDA) [11]. A multiplicity filter [12], comprising 50 BaF_2 elements (each 3.5×3.5×5 cm^3), was employed to measure the angular momentum (J) of the compound nucleus on an event-by-event basis. A detailed offline analysis was performed within the CERN ROOT framework to extract the GDR spectra from raw data after applying necessary corrections and selection cuts. The measured spectra were analyzed using the statistical model code TALYS. Our results indicate that Γ_G remains nearly constant up to T $\approx$ 1 MeV for all studied isotopes, beyond which it exhibits a clear increase with temperature. A complementary theoretical analysis was performed using Thermal Shape Fluctuation Model (TSFM), incorporating microscopic inputs derived from nuclear energy density functional calculations. This approach enables a self-consistent treatment of temperature-dependent nuclear properties while maintaining crucial connections to the underlying microscopic structure. Further details and implications of these findings will be presented at the conference.

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