SEARCH FOR RARE SHAPE-PHASE TRANSITIONS IN HEAVY NUCLEI

Indranil Mazumdar, Tata Institute of Fundamental Research, Mumbai, India

The Giant Dipole Resonance (GDR) of the atomic nucleus is possibly the finest example of highly collective oscillation of a correlated quantum many-body system. The quest to understand this phenomenon has enriched the study of quantum many-body system in general and nuclear physics in particular. At the threshold of thirty-fifth year of its discovery, the study of GDR built upon highly excited states, is a highly matured branch of nuclear structure physics. The last three decades are witness to concerted, global efforts from both theorists and experimentalists to understand the underlying physics of the GDR in hot and rotating nuclei. The primary motivation of these studies has been two-fold. To extract information about nuclear shapes and shape changes and to understand reaction dynamics of hot and rotating nuclei produced in heavy-ion induced fusion-evaporation reactions. The extraction of GDR properties and nuclear shape information from the GDR spectra demands exclusive measurements of high energy GDR γ-rays from selected regions of phase-space spanned by angular momentum and temperature of the excited compound nucleus.

The nucleus is expected to undergo a variety of shape transitions in the phase-space landscape with change in temperature and angular momentum. We have been pursuing a programme to look for a very specific, rare, shape-phase transition in a set of very heavy nuclei. The selection of the nuclei have been guided by predictions of sophisticated finite temperature mean field calculations (Finite Temperature Hartree-Fock Bogoliubov Cranked) about rare non-collective prolate phase in a variety of heavy nuclei. These nuclei are characterized by two critical temperatures (T_{c1} and T_{c2} such that $T_{c1} < T_{c2}$). These critical temperatures vary with angular momentum and create a narrow, bounded region in the phase-space where the nucleus has a prolate shape rotating about its symmetry axis. This feature is purely a quantum mechanical effect. We have carried out exclusive measurements of angular momentum gated GDR γ-rays from ^{194}Au, ^{188}Os, ^{192}Pt and ^{196}Hg in search of this rare shape. The demand for exclusive measurements have dictated gradual and significant improvements in our detection facilities from large volume NaI(Tl) detector and a small array of multiplicity filter to large volume Lanthanum Bromide detector and a large 4π array of spin-spectrometer. We have also tried to measure angular momentum gated GDR γ-rays in coincidence with evaporation residues using a gas filled magnetic spectrometer. The GDR γ-rays spectra and their angular anisotropy have been analysed in detail using realistic statistical model calculations. We have also carried out finite temperature microscopic-macroscopic calculations including thermal fluctuations to analyse the experimentally extracted spectra. The result of all these measurements and the conclusions drawn from these measurements will be summarized and presented in this meeting.