Giant Dipole Resonances in hot nuclei studies using proton beams

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The Giant Dipole Resonance (GDR) is the collective excitation of nucleus described by the oscillations of neutrons against protons. It delivers information on nuclear structure, for example, single particle levels evolution, effective shapes of hot nuclei as a function of temperature/spin, damping mechanism and isospin mixing. These are experimentally obtained from the measurement of high-energy gamma rays emitted in the GDR decay.

In heavy ion fusion reactions, GDR gamma decay is used to probe nuclear shape/deformation and the temperature dependence of GDR damping mechanism. The nuclei produced in such processes are characterized with spin and temperature distributions and therefore it is difficult to distinguish the spin induced phenomena from the temperature one.

The use of proton beams provides an alternative approach for the investigation of nuclear structure using the GDR as a probe. In proton induced fusion-evaporation reactions, the fused compound nuclei have an extremely low angular momentum values, making possible the study of nuclei at a well-defined temperature. Performing fusion-evaporation reactions using high energy proton beams offers the possibility to investigate nuclei in a high temperature region without the influence of angular momentum.

We propose to study the temperature evolution of the GDR properties. Such study will be performed using the compound nuclei produced in fusion reactions using proton beams of energies up to 200-230 MeV. The predicted maximum temperature is of the order of 3-6 MeV, depending on the mass, of the selected compound nucleus. As stated before, the angular momentum transferred in such reactions is small (up to 10-18 $\hbar$) and doesn't change significantly with beam energy. The high energy gamma rays from the GDR decay could be measured by large volume BaF_2 crystals from HECTOR array or $LaBr_3$/NaI phoswich detectors from PARIS prototype. For very high beam energy other reactions e.g. fission, spallation, multifragmentation are possible to occur. In such cases, events corresponding to the compound nucleus decay could be chosen by the discrete transitions measured in evaporation residues identification or by tagging the fusion residue.