Giant dipole resonance measurement in ^{28}Si+^{100}Mo reaction at E(^{28}Si)=180 MeV

G. Mishra[1]* , D. R. Chakrabarty[1], Suresh Kumar[1], E. T. Mirgule[1], Abhijit Bhattacharyya[1], A. Mitra[1], P. C. Rout[1], S. P. Behera[1], S. Santra[1], A. Pal[1], R. Chakrabarti[1], V. M. Datar[1], C. Ghosh[2], V. Nanal[2] and R. Kujur[1]
[1]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA*
[2]*Deptartment of Nuclear and Atomic Physics,*
Tata Institute of Fundamental Research, Mumbai - 400085, INDIA
*. * email: gmishra@barc.gov.in*

Introduction

The Giant Dipole Resonance (GDR), as a collective mode of nuclear excitation, has proven to be a unique tool to unravel the average shape of excited and rotating nucleus. There have been several efforts to describe the systematics of the GDR in nuclei as a function of temperature (T) and angular momentum (J). The two main parameters which describe the GDR strength function are the centroid energy (E_D) and width (Γ_D). Though E_D remains stable with T and J, the evolution of Γ_D with T and J still remains to be fully understood over a wide range of these variables. The thermal shape fluctuation model (TSFM) [1] has been extensively used while interpreting this evolution mechanism, although at low temperatures (T≤1.5 MeV) its predictions are not commensurate with experimental observations [2]. The TSFM describes the effective GDR cross section as a thermal average over all possible shapes which a nucleus experiences under the influence of excitation and rotation.

An earlier work in the A~150 mass region [3] showed a discrepancy between TSFM predictions, which assumes inhomogeneous damping as a dominant contributor to $\Gamma_{D,}$ and experimental data even after including the broadening in compound nuclear states. An empirical T, J dependence of Γ_D suggested simultaneous contributions from inhomogeneous and collisional damping to fully describe the data. To explore this effect in different mass regions an experiment [4] in A ~128 was performed using ^{28}Si at 150 MeV on ^{100}Mo target. A systematic study requires the measurements to be done at several excitation energies of the same compound nucleus (CN) in coincidence with low energy multiplicity gamma rays and with residues coming from fusion like events. A simultaneous measurement of charged particle spectra helps in extracting the nuclear level density parameter, which plays a vital role in calculating gamma spectra from statistical model calculation. Here preliminary results of the GDR measurement in the ^{28}Si+^{100}Mo reaction leading to ^{128}Ba compound nuclei at an excitation energy ~118 MeV and angular momenta up to ~67ħ, will be presented.

Experimental Method

The experiment was carried out using 180 MeV pulsed beam of ^{28}Si bombarding an enriched (>98%), 0.97 mg/cm^2 thick ^{100}Mo target at Pelletron Linac Facility, Mumbai. High energy (~5-30 MeV) γ-rays were detected using a hexagonal assembly of seven BaF_2 detectors, each 20 cm long with hexagonal cross section and face to face distance 9 cm. This array was placed at ~50cm distance from the target and at 125^o from the beam direction. The BaF_2 detectors were surrounded by plastic detectors, for active cosmic rejection, as well as 10 cm thick lead shield to reduce cosmic and background γ rays. The γ-ray multiplicity was measured using an array of 38 bismuth germanate (BGO) detectors placed symmetrically above and below the target chamber in two groups, each consisting of 19 detectors. An annular parallel plate avalanche counter was placed symmetrically around beam direction, with an angular span of 4-11^o, to tag the residues from fusion events. Two Si detector telescopes (ΔE - 50μm, E – 2 mm) were placed at 155^o with respect to the beam direction to measure protons and α-particles for constraining the level density parameter. These detectors, with areas of 150 mm^2 and 50 mm^2, were kept at distances of ~91 mm and ~62 mm, respectively, from the target.

Results

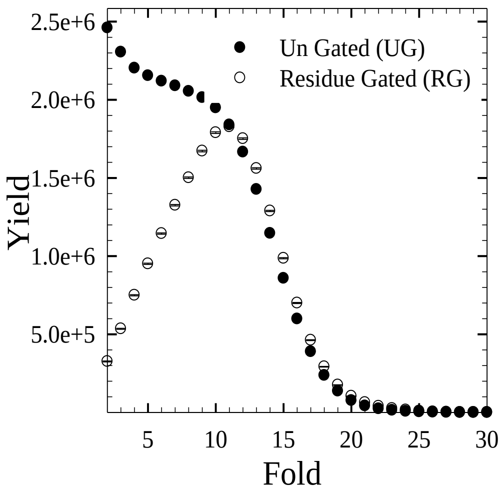

Fig.1: Fold spectra with and without residue gating.

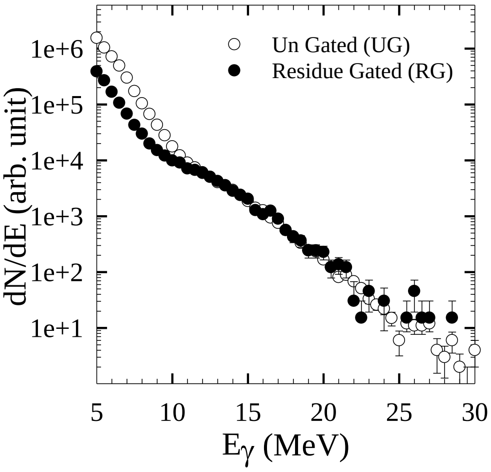

Fig.2: Energy spectra (Eγ) with and without residue gating in Fold (1-5).

Fig.1 shows the UG and RG fold (F) spectra in 1-30 MeV gamma energy window normalized at (F=11)). Here, F is defined as the number of BGO detectors producing signal simultaneously (within ~50 ns) in one event. It is evident from the plot that at lower folds (F<11) the contribution from non fusion like events becomes dominant and hence residue gating plays a very important role while extracting GDR spectra at low folds.

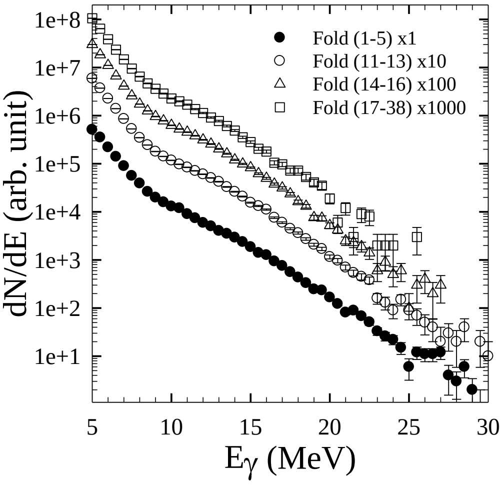

Fig.3: Fold gated high energy gamma ray spectra in coincidence with fusion residues.

High energy (5-30 MeV) Doppler corrected Eγ spectra were extracted from the list mode data. Fig.2 depicts the departure of RG Eγ spectra at low energy (Eγ ≤11 MeV) when compared with UG spectra. In Fig.3 high energy gamma ray spectra (5-30 MeV) has been shown for different fold windows. At low folds the UG spectra, after proper normalization with RG spectra, are used for E_γ>11 MeV to improve the statistics in the GDR region. These spectra are being compared with statistical model calculations, to extract the GDR width Γ_D. This, along with the Γ_D parameter extracted from the experiment at 150 MeV in the same CN system, will then be compared with the TSFM prescription.

We would like to thank M. Pose for his help during the experiment.

References

[1] M. Gallardo et al., NP A 443, 415 (1985).
[2] S. Mukhopadhyay et al., Phys. Lett. B 709, 9 (2012).
[3] D. R. Chakrabarty et al., J. Phys. G 37, 055105 (2010).
[4] G. Mishra et al., DAE Symp. On Nucl. Phys. 57, 190 (2012).