Study of GDR in Ba isotopes at $\sim$ 5 MeV/A

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Introduction

The atomic nucleus being a quantum many body system exhibits many interesting phenomena, one of which is the occurrence of Giant Dipole Resonance (GDR). The GDR has been proven to be an unique experimental tool for studying nuclear shape at high excitation energy and angular momentum (J). The GDR strength function is described by two parameters, the centroid energy (E_D) and the width (Γ_D) of the GDR. The centroid energy of GDR is empirically described as $79A^{-1/3}$, ranging from $\sim$10 to $\sim$30 MeV. It should be noted that the other contribution coming in this energy region is from nucleon-nucleon bremsstrahlung. Vojtech *et al*. studied the γ-ray spectra in 5-40 MeV range using ^{12}C+^{112,124}Sn reactions at incident energies of 7.5 and 10.5 MeV/nucleon [1] to investigate the effect of neutron excess on high energy γ-ray spectra. While significant differences were observed for yields of $E_\gamma > 20$ MeV, an exclusive measurement of GDR parameters in these system has not been reported till now. To study the GDR parameters and their variation with temperature and angular momentum, the reactions ^{12}C+^{112}Sn and ^{12}C+^{124}Sn are studied at 5.3 and 4.3 MeV/nucleon, respectively. The beam energies were chosen to produce the compound nuclei at same excitation energies (E^*-$E_{rot} \sim 49$ MeV), allowing to explore the isospin effect on GDR width. The preliminary results of the measurement are presented here.

Experimental Details

The experiment was carried out at PLF, Mumbai using 64 and 52 MeV pulsed ^{12}C beam bombarding enriched targets of ^{112}Sn (2.27 mg/cm^2) and ^{124}Sn (1.9 mg/cm^2), respectively. The high energy γ-ray spectra were measured with an array of 7 close-packed hexagonal BaF_2 detectors [2], placed at 125^o with respect to the beam direction and at a distance of 57 cm from the target for time-of-flight (TOF) measurement. The energy calibration of the detectors was monitored periodically using radioactive sources ^{60}Co, ^{22}Na, ^{238}Am-^{9}Be and ^{239}Pu-^{13}C covering γ-rays energies from 0.511 to 6.130 MeV and drift was found to be less than $\pm$ 1%. The individual detector amplified pulse was fed to two different QDCs with 200 ns and 2 μs gate width for rejection of pileup. The angular momentum information is derived from the multiplicity of low energy γ-rays. The multiplicity is obtained from the measured fold distribution (no. of detectors triggered within 50 ns) with an array of 14 hexagonal BGO detectors (7.6 cm long and face-to-face distance 5.6 cm). These detectors were divided into two groups of 7 detectors each in close-packed geometry placed above and below the target. For in-beam background estimation data was taken with blank target and found to be negligible. The measured high energy γ-ray spectra can

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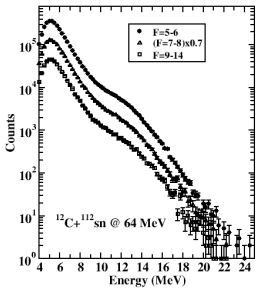

FIG. 1: γ-ray spectra for different fold windows for ^{12}C+^{112}Sn reaction at E=64 MeV.

have contribution from light impurities (like Carbon and Oxygen) in the target. For estimation of high energy γ-ray contribution from these impurities, ^{12}C(^{12}C,γ) and ^{12}C(WO_3, γ) reactions were studied at the above specified beam energies. For impurity assessment on both the targets, (p,γ) resonance reactions were studied in ^{112}Sn, ^{124}Sn, ^{12}C and WO_3 targets with E_p = 7.78 and 7.46 MeV [3, 4]. For high energy calibration of the BaF_2 detectors, the ^{11}B(p,γ) reaction was studied with E_p = 7.2 MeV. Data was taken event-by-event mode for 0.25 pmC and 0.53 pmC of incident beam particles with ^{112}Sn and ^{124}Sn target, respectively using CAMAC based acquisition-cum-analysis software LAMPS [5].

Data Analysis

The prompt time gates in BaF_2 and BGO, and no pileup conditions were used to select γ-ray events of interest from target. Doppler correction due to finite source velocity was also incorporated. Spectra were also generated for a 'chance' gate in TOF spectra and subtracted from the prompt gated γ-ray spectra with suitable normalization. A two dimensional spectrum of fold vs γ-ray energy was created and fold gated γ-ray spectra were obtained with projections for different fold windows. The γ-ray spectra for fold windows 5-6, 7-8 and 9-14 for ^{112}Sn target are shown in Fig. 1, while Fig. 2 shows the same for fold windows 5-6 and 7-14 for ^{124}Sn target. The extraction of GDR parameters using Statistical Model Analysis is under process.

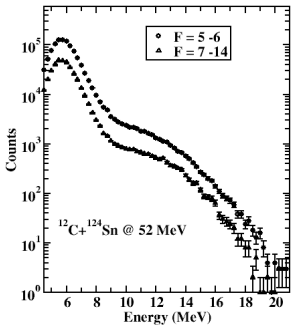

FIG. 2: γ-ray spectra for different fold windows for ^{12}C+^{124}Sn reaction at E=52 MeV.

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References

[1] R.J. Vojtech *al.*, Phys. Rev. C, **40**, R2441 (1989).
[2] D.R. Chakrabarty et al., J. Phys. G 37, 055105 (2010).
[3] R.L. Dangle *al.*, Phys. Rev., **133**, B647 (1964).
[4] A.C.L. Barnard *al.*, Nucl. Phys., **86**, 130 (1966).
[5] www.tifr.res.in/∼pell/lamps.htm