# Magnetic Moment measurement of $^{140}$Ba nuclei using transient field technique

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## Introduction

Mixed Symmetry states have been identified in the neutron proton version of the Interacting Boson Model [1,3]. The motivation of this experiment is to identify uniquely one phonon mixed symmetry states in $^{140}$Ba nuclei by g factor measurement of the states. Magnetic moments measurements [2] provide substantial information on the microscopic structure of the nuclei as the magnetic moment of a nuclei is described by the wave function of one state only.

In this present paper we report the preliminary results of the g factor measurement of the first $2^+$ state of $^{140}$Ba.

## Experimental Details

g factor of first $2_1^+$ state of $^{140}$Ba was measured using the transient field technique in inverse kinematics. The excited states of $^{140}$Ba nuclei were populated using the alpha transfer reaction $^{12}$C ($^{136}$Xe, 2$\alpha$)$^{140}$Ba. $^{136}$Xe beam was used from the UNILAC at GSI, at energy of 4 MeV/u. Beam current was limited to about 1pnA to prevent the burning of the target. A multilayered target was used throughout the precision measurement. It consisted of a carbon layer (0.33 mg/cm$^2$) to facilitate the alpha transfer reaction and to also enable projectile excitation of the beam. This was followed by an externally magnetized gadolinium layer (9.96 mg/cm$^2$), through which the $^{140}$Ba ions recoiled and experienced the transient field and were finally stopped in a non magnetic backing layer of copper (5.32 mg/cm$^2$). Initially, during the run a carbon target ( 0.45 mg/cm$^2$) was used.

The gadolinium foil was polarized perpendicular to the beam direction using an external electromagnet at a magnetic field of 300 Gauss. The direction of the magnetic field was reversed periodically after every 200 sec. to minimize the systematic errors. The target was cooled to liquid nitrogen temperature throughout the measurement.

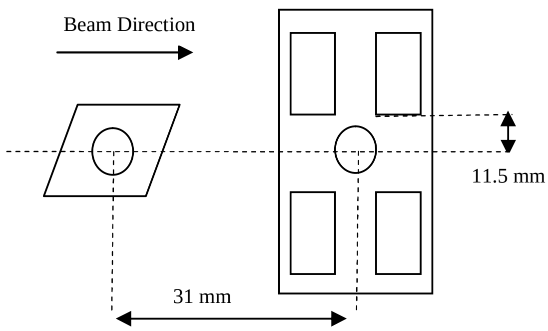


**Fig.1** Schematic arrangement showing the geometry of the Si pin diodes with respect to the target plane. Later, a E-ΔE detector setup was used during the precision measurement.

Four Euroball cluster detectors were symmetrically placed at angle an 65° ( where the particle – gamma angular correlation for E2 transitions have maximum slope ) at a distance of 13.6 cm from the target chamber, with respect to the beam direction, in the forward and backward plane. One cluster detector was placed at 0° to monitor the $\gamma$ rays. The forward scattered carbon ions and $\alpha$ particles were detected in Si pin diodes, which were placed along the beam direction as shown in Fig1. The data was recorded event by event using a particle $\gamma$ trigger.

## Analysis

The analysis has been performed using ROOT and GO4 software program [4,5].

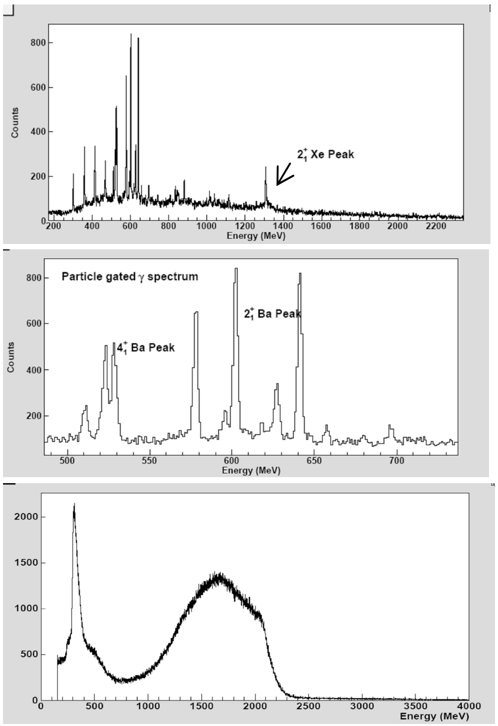


**Fig. 2** The energy spectrum generated by gating on the scattered $\alpha$ particles. The centre figure clearly shows the low lying excited states of $^{140}$Ba. The bottom figure shows the particle spectrum recorded in a Si detector obtained using a carbon target. The $\alpha$ particles are well separated from the carbon ions.

The backward placed Si diodes were used to tag the de- exciting gamma rays from the $^{140}$Ba nuclei, as only alpha particles would reach the detectors and the carbon ions would get stopped initially in the forward detectors. The particle $\gamma$ angular correlation was plotted as shown in Fig.3. Further analysis is in progress to extract the precision angle and hence the g factor.

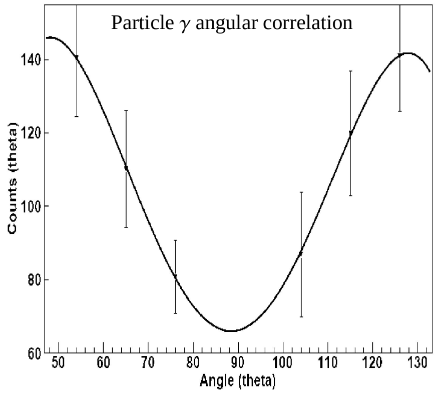


**Fig. 3** The measured particle $\gamma$ angular correlation plot. The solid line is the polynomial fit to the data.

## Summary

g factor measurement was performed using transient field technique for $^{140}$Ba, whose excited stats were populated by alpha transfer mechanism. Particle $\gamma$ angular correlation was obtained.

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