

## Directional Correlation of Oriented nuclei(DCO) ratios and Polarization Asymmetry ( $\Delta$ ) measurements in $^{67}\text{Ga}$

S. Kumar<sup>1,\*</sup>, Nandini<sup>1</sup>, P. S. Rawat<sup>1</sup>, Anuj<sup>1</sup>, Naveen Kumar<sup>1</sup>,  
S.K. Mandal<sup>1</sup>, and S. Saha<sup>2</sup>, J. Sethi<sup>2</sup>, T. Trivedi<sup>2,3</sup>, R. Palit<sup>2</sup>

<sup>1</sup>Department of Physics and Astrophysics,  
University of Delhi, New Delhi-110007, INDIA

<sup>2</sup>Department of Nuclear and Atomic Physics,

Tata Institute of Fundamental Research, Mumbai-400005, INDIA and

<sup>3</sup>Department of Physics, University of Allahabad, Allahabad 211002, INDIA

### Introduction

The  $^{67}\text{Ga}$  nucleus has low-lying states having a single particle structure arising from the coupling of odd protons to the collective states of corresponding even-even cores. These states were nicely explained by the interacting boson-fermion plus broken pair model [1].

The low-lying and intermediate states in  $^{67}\text{Ga}$  were populated previously via single neutron transfer, radio-active decay, and other reactions as given in ref [2]. Using the  $^{56}\text{Fe}(^{12}\text{C},\text{pn}\gamma)$  reaction, the angular distribution and linear polarization (Three-crystal Ge(Li) Compton polarimeter) were reported [3, 4].

In the present work, we report on the DCO ratios and polarization asymmetry measurements (clover detector, i.e. four-crystal HPGe Compton polarimeter) for the strong  $\gamma$ -ray transition in  $^{67}\text{Ga}$ .

### Experimental Detail

The excited states of the  $^{67}\text{Ga}$  nucleus were populated through the  $^{56,57}\text{Fe}(^{13}\text{C},\text{p}2\text{n}\gamma/\text{pn}\gamma)$  reaction at 45 MeV beam energy. The  $^{13}\text{C}$  beam was obtained from the 14 UD pelletron accelerator at the Tata Institute of Fundamental Research (TIFR), Mumbai. The de-exciting gamma rays were detected using the Indian National Gamma Array (INGA) spectrometer, and more information about the ex-

periment and data analysis can be found in Refs. [5, 6].

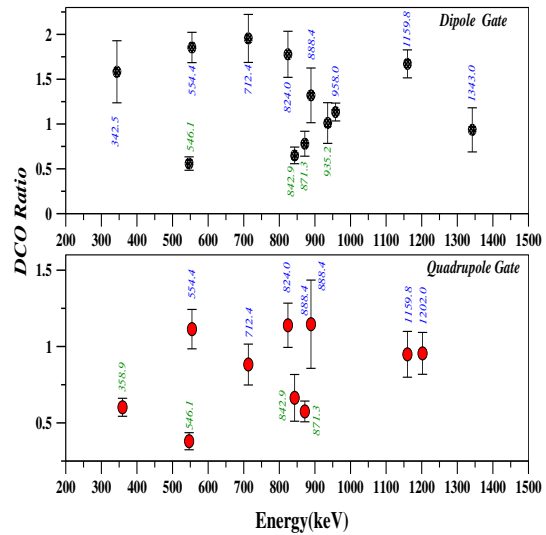


FIG. 1: The DCO ratios of different  $\gamma$ -ray transitions with gate on quadrupole transition ( $\Delta I=2$ ) is shown lower panel. The upper panel, the DCO ratios different  $\gamma$ -ray transitions with gate on ( $\Delta I=1$ ) are plotted. The energy of the  $\gamma$ -ray transition is also labelled.

### Results and Discussion

The detailed spectroscopy of  $^{67}\text{Ga}$  is reported in ref. [1]. The value of the angular distribution ratio was used to assign the spin and parity of the states. Based on polarization measurements obtained with a three-crystal Ge(Li) Compton polarimeter [3, 4], multipolarity was assigned for some strong-

\*Electronic address: sursvmk123@gmail.com

ray transitions. In the present paper, the re-investigation of low-lying states is done using two-fold and three-fold coincidences. Our result for the DCO ratio [7] measurement is presented in Fig. 1 . The 342.5-, 554.4-, 712.4-, 824.0-, 888.4-, 958.0-, 1159.8-,1202.0 keV  $\gamma$ -ray transitions have quadrupole character with  $\Delta I=2$  or  $\Delta I=0$ .

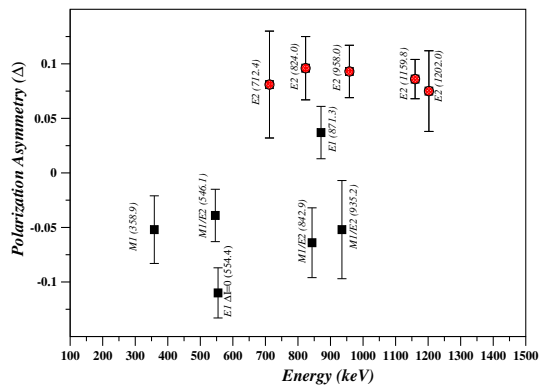


FIG. 2: The polarization asymmetry ( $\Delta$ ) of strong  $\gamma$ -ray transitions belongs to  $^{67}\text{Ga}$  is shown. The energy and multi-polarity of the  $\gamma$ -ray transition is also labelled. Red filled circle shows the E2 character and filled black square is for other multipolarity.

For 358.9-, 546.1-, 842.9-, 871.3-, and 935.2 keV  $\gamma$ -ray transitions, the dipole character is established. Based of polarization asymmetry as shown in Fig. 2, the 712.4-, 824.0-, 888.4-, 958.0-, 1159.8-, and 1202.0 keV  $\gamma$ -ray transitions are E2, while the 871.3 keV  $\gamma$ -ray transition is E1. The 554.4  $\gamma$ -ray transition has negative polarization asymmetry value and has E1  $\Delta I=0$  character. Other transitions, such as 358.9-, 546.1-, and 842.9 keV have M1/E2 character.

The degree of polarisation is calculated using the polarisation sensitivity taken from ref. [3] and measured polarization asymmetry as shown in Fig. 2. In Table I, the current results on degree of polarisation are compared with the three-crystal Ge(Li) Compton polarimeter[3, 4]. The multipolarity assign-

ment obtained from present work is consistent with that reported in Refs. [3, 4].

TABLE I: Comparison of degree of polarization using INGA (present study) with the three-crystal Ge(Li) Compton polarimeter[3, 4] in  $^{67}\text{Ga}$ .

$E_\gamma$	P([3, 4])	P(INGA)	Multipolarity
546.1	-0.135(13)	-0.26(16)	M1/E2
554.4	-0.67(5)	-0.74(17)	E1 $\Delta I=0$
712.4	0.642(30)	0.54(33)	E2
824.0	0.545(30)	0.64(19)	E2
871.3	0.30(3)	0.25(16)	E1
958.0	0.73(6)	0.63(16)	E2

The work to find the value of the mixing ratio is in progress.

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