Polarization asymmetry measurements of the ^{76}Ge(^{13}C,xn) reaction at beam energy of 45 MeV in Indian National Gamma Array (INGA)

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Introduction

The polarization asymmetry measurements are a unique way to assign the electric or magnetic character of a γ-ray transition [1, 2]. The segmented clover detector has been used to measure the linear polarization of γ-ray by making it a simple Compton polarimeter which take advantage of the polarization dependence of the Compton scattering [3, 4]. In fact, the angular distribution, Directional Correlation of the Oriented Nuclei (DCO) and polarization asymmetry measurements help us to know the multipole character of the γ-ray transition. In the present work, the experimental results of both polarization asymmetry and DCO measurements were discussed to assign the multipole character of the γ-ray transitions in the ^{85,86}Sr nuclei. In this work, the multipole character was confirmed for the stretched and unstretched γ-ray transitions. Apart from it, the polarization asymmetry was measured as a function of γ-ray energies for stretched γ-ray transitions (E2, E1 and M1).

Experimental details

High spin states in ^{85,86}Sr were populated by the reaction ^{76}Ge(^{13}C,xn)^{85,86}Sr using ^{13}C beam of 45 MeV from the Pelletron accelerator at Tata Institute of Fundamental Research (TIFR), Mumbai. The ^{76}Ge target was of 850 μg/cm^2 thickness with 7.6 mg/cm^2 ^{181}Ta backing. The de-exciting gamma-rays were detected using Indian National Gamma Array (INGA) which at the time of the experiment consisted of 15 Compton-suppressed clover HPGe detectors. The detail of the experimental set-up and data analysis is given in the Refs. [5, 6].

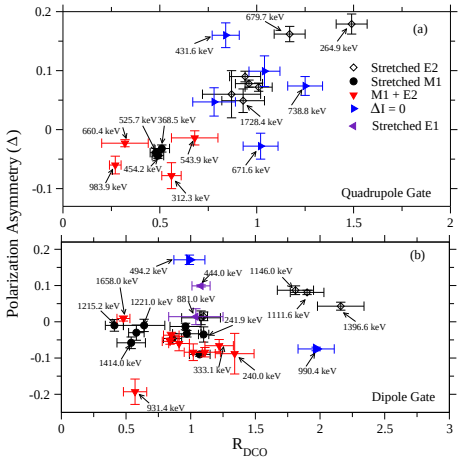

FIG. 1: Figure shows the polarization asymmetry vs DCO for different transitions at different gating transitions in ^{85}Sr.

An asymmetric matrix was created by the events detected in clover detectors at 157° on one axis and 90° clover detectors on the other axis, to obtain information on multipolarities of $\gamma-$rays transitions from the DCO ratios. The DCO ratios for a particular γ-ray transition was obtained by setting gates on stretched transitions of known multipolarity in the asymmetric matrix. In the present INGA array, the R_{DCO} value for the known stretched quadrupole transition is 1.0, and it is 0.52 for known pure stretched dipole transitions, when gate is set on stretched quadrupole transitions. If the gate is set on a pure stretched dipole transition, then the R_{DCO} value for known quadrupole transitions is 1.92 and it is 1.0 for the pure stretched dipole transition.

The character (electric or magnetic) of transitions were determined from a measurement of the linear polarization of the γ - ray transitions us-

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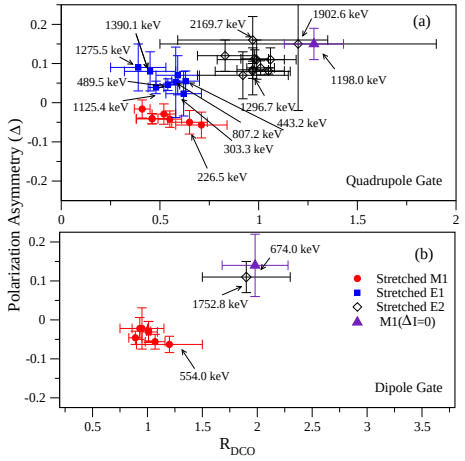

FIG. 2: Figure shows the polarization asymmetry vs DCO for different transitions at different gating transitions ^{86}Sr.

ing the integrated polarization direction correlation method (IPDCO) for the clovers placed at 90° angle. In this method the experimental asymmetry of Compton-scattered polarized photons is defined as,

$$\Delta = \frac{a(E_\gamma)N_\perp - N_\parallel}{a(E_\gamma)N_\perp + N_\parallel} \qquad (1)$$

where $N_\perp$ and $N_\parallel$ denote the number of coincidence counts between the segments of the clover detector in the direction perpendicular and parallel to the emission plane, respectively. The $a(E_\gamma)$ denotes the correction due to the asymmetry in the response of the perpendicular and parallel clover segments. The experimentally determined value of 'a(E_γ)' was 1.023(3) for the γ-rays in the energy range of 300 to 2000 keV.

Results and Discussion

The results of both linear polarization asymmetry and DCO measurements are shown in Fig. 1 and 2 for the ^{85,86}Sr nuclei [5, 6]. In the present geometry , the Δ = 0.06 to 0.15 (with R_{DCO}=1.0, gate on stretched quadrupole transition) is obtained for E2 stretched transition, Δ = -0.01 to -0.07(with R_{DCO}=0.50 to 0.60, gate on stretched quadrupole transition) for M1 stretched transition, Δ = 0.04 to 0.12 (with R_{DCO}=0.54 to 0.64, gate on stretched quadrupole transition) for E1 stretched transition, Δ = -0.07(2)(with R_{DCO}=1.0 to 1.2, gate on stretched quadrupole transition) for E1

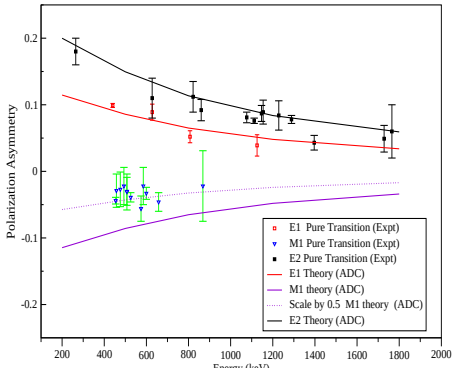

FIG. 3: Figure shows the polarization asymmetry vs Energy for different transitions belongs to the ^{85,86}Sr nuclei having pure E2, E1 and M1 character.

(δJ = 0) unstretched transition and Δ = 0.14 to 0.19 (with R_{DCO}=1.0 to 1.2, gate on stretched quadrupole transition) for M1 (δJ = 0) unstretched transition. In the Fig. 3, the measured polarization asymmetry is compared with the theoretical calculation [7] as a function of γ -ray energies for the stretched E2, E1 and M1 character.

Acknowledgments

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