Level Structure of ^{69}Ga

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Introduction

Nuclear structure studies on nuclei around the doubly-magic ^{56}Ni-core ($Z, N = 28$) have been of widespread [1] interest [2, 3] through the recent years. While the level structure of nuclei in the immediate vicinity of the core expectedly exhibits underlying single particle excitations, particularly at low excitations, there are reports on the observation [1, 4] of deformations and collectivity at higher spins. The valence model space outside the Ni-core is largely invoked for interpreting the aforementioned single particle states and consists of orbitals $2p_{3/2}, 1f_{5/2}, 2p_{1/2}, 1g_{9/2}$. The level structure at higher excitations, and the onset of deformation and collectivity therein, is typically ascribed to the occupancy of the $g_{9/2}$ orbital, a deformation driving one. Further to the evolution of the excitation properties in these nuclei, it is also of interest to pursue the changing structural characteristics with increasing number of nucleons outside the Ni-core. Such endeavours are expected to facilitate our understanding of the nucleon-nucleon interactions and their representation/modeling in the theoretical framework such as of the shell model.

The particular nucleus for the current study is ^{69}Ga ($Z = 31, N = 38$). The previous studies on its level structure were largely following light-ion induced reactions and using modest experimental setups of limited number of detectors. Bakoyeorgos *et al.* [5] reported the level scheme of the nucleus upto an excitation energy of ~ 4.5 MeV and spin $9\hbar$ while identifying a positive parity and a negative parity band therein. The level scheme was largely interpreted from the coupling of the particle in $f_{5/2}$ and $g_{9/2}$ orbital with the states of the even-even core. However, it was indicated that the structure beyond the lowest spins could result from more complex mechanisms stemming out of core polarization by the odd proton. Bakoyeorgos *et al.* [5] acknowledged the need for additional data on ^{69}Ga along with lifetime measurements, for conclusive interpretation of its high spin level structure. The present study proposes to investigate the excitation scheme of the ^{69}Ga nucleus populated in a heavy-ion induced reaction and using the tools and methodologies of high-resolution γ-ray spectroscopy.

Experiment and Data Analysis

High spin states of the ^{69}Ga nucleus were populated using ^{59}Co(^{13}C,2pn) reaction at $E_{lab} = 45, 50$ MeV. The beam was delivered by the 15 UD Pelletron facility at IUAC, New Delhi. The target was mono-isotopic ^{59}Co of thickness 5.2 mg/cm^2 evaporated on a 4 mg/cm^2 thick Ta backing. The Indian National Gamma Array (INGA) setup at IUAC

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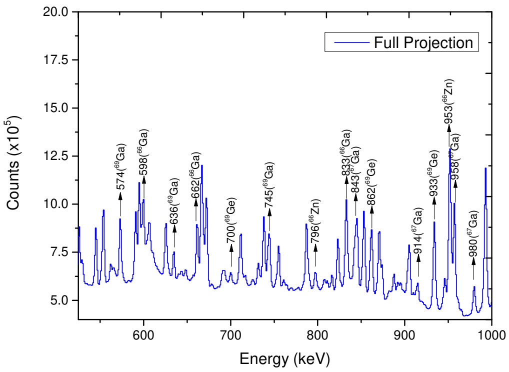

FIG. 1: Total projection of the γ-γ symmetric matrix illustrating the different reaction channels populated in the experiment.

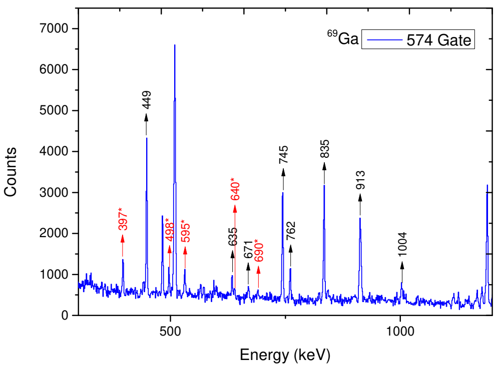

FIG. 2: Partial γ-ray spectrum corresponding to gate set on the 574 keV (ground state) transition of the ^{69}Ga nucleus. The new transitions identified in this study are colored in red.

was used as the detection system. During the experiment, INGA consisted of 15 Compton suppressed HPGe clover detectors positioned at angles 32^o (3), 57^o (1), 90^o (5), 123^o (2) and 148^o (4). The data acquisition system was CAMAC based multi-crate one running on the CANDLE [6] framework at IUAC. The data was acquired subject to the event trigger set on coincidence multiplicity $\geq$ 2. Around 4.2 $\times$ 10^8 γ-γ coincidence events were acquired during the experiment. The data has been sorted into γ-γ matrices and spectra using the SPRINGZ [7] code developed at UGC-DAE CSR, Kolkata Centre and being analyzed using RADWARE [8].

Preliminary Observations and Outlook

Fig. 1 is the total projection spectrum of the γ-γ symmetric matrix and illustrates the different nuclei populated in the experiment. The γ-rays from the nucleus of interest are being identified using the standard coincidence techniques. Fig. 2 illustrates the spectrum corresponding to gate on the ground state 574 keV transition [5] of ^{69}Ga. Further analysis of the coincidence data is currently in progress and will be directed at extending the level scheme of the nucleus to higher spins and investigate the underlying excitation phenomena therein. The observed level scheme will be interpreted in the framework of the large basis shell model calculations.

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