Gamma Spectroscopy of ^{64}Cu

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Introduction

The level structure of nuclei around the doubly-magic ^{56}Ni ($Z = 28, N = 28$) are of spectroscopic interest for several reasons. The low-spin domain in these nuclei is dominated by the shell model configurations while at higher spins, the occupation of high-j orbitals can lead to deformed structures based on multiparticle-multihole excitations across the ^{56}Ni-core. Following the complete alignment of the individual particle spins outside the closed shells, the rotational band can also exhibit a termination and the same has been observed in this region [1].

The present work pertains to the structural investigation of the ^{64}Cu ($Z = 29, N = 35$) nucleus through γ-ray spectroscopy. This is one of the maiden instances when the nucleus has been studied using heavy-ion induced fusion-evaporation reaction and detection system for high resolution γ-ray spectroscopy. One of the previous studies on the nucleus was reported by Chan *et al.* [2] using α and proton induced reactions and a setup comprising of Ge(Li) detectors. The level structure was established upto an excitation energy of $\sim$ 4 MeV but largely with no spin-parity assignments. The low energy ($\lesssim$ 1 MeV) domain of the level scheme was also probed by Green *et al.* [3] using proton induced reactions and Ge(Li) detectors, wherein spin-parity assignments were made based on angular distribution and polarization measurements. In the light of these studies, carried out more than four decades back and with modest experimental arrangements, it may be stated that the data on ^{64}Cu is still sparse and a comprehensive study of the same can lead to observations of the aforementioned characteristic features of this region and provide important reference for model calculations.

Experimental Details and Data Analysis

The ^{64}Cu nucleus was populated in the reaction ^{59}Co($^{7}Li, pn$) at E_{lab} = 22-24 MeV. The ^{7}Li beam was provided by the Pelletron LINAC Facility at the Tata Institute of Fundamental Research (TIFR), Mumbai. The target, fabricated at the TIFR target laboratory, was 5.2 mg/cm^2 of mono-isotopic ^{59}Co evaporated on a 4 mg/cm^2 Tantalum foil. The detection system was an array of 11 Compton suppressed Clover detectors distributed at angles $\theta = 157^\circ$ (3 detectors), 140° (3 detectors), 115° (1 detector) and 90° (4 detectors). The pulse processing and data acquisition system was based on the PIXIE-16 digitizer modules from XIA LLC, installed with the γ-ray detection setup at TIFR [4]. The acquired data has been sorted into symmetric as well as angle dependent

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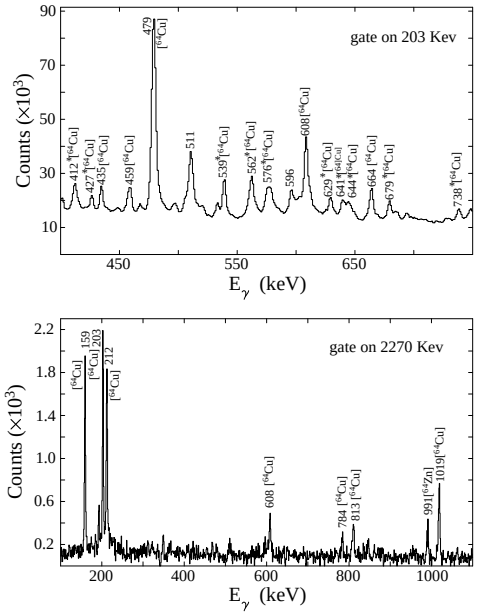

FIG. 1: Gated spectra constructed from the present data, to identify the coincidences between the observed γ-ray transitions.

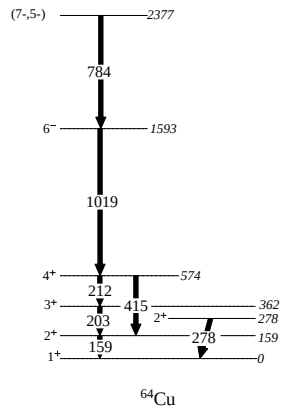

FIG. 2: Part of the known [2] level scheme of the ^{64}Cu nucleus, shown here for reference.

γ-γ matrices using the MARCOS [4] program and is currently being analyzed using the RADWARE [5] package.

Preliminary Results and Outlook

The nuclei ^{62,63,64}Zn, ^{62,63,64}Cu, ^{60,61}Ni and ^{60}Co have been populated in the reaction used in the present study. The analysis is currently in progress for the primary nucleus of interest ^{64}Cu. More than 30 new γ-ray transitions have been identified (Fig. 1) and being placed in the level scheme. The asymmetric angle dependent matrices shall be used for determination of the Ratio of Directional Correlation from Oriented (R_{DCO}) nuclei and angular anisotropy of the observed γ-ray transitions for multipolarity assignments of the same. Polarization asymmetry of the γ-rays shall be extracted from the angle dependent polarization matrices, for determining their electromagnetic character. Large basis shell model calculations have been carried out for interpreting the level structure of other nuclei in this mass region (for instance, Ref. [6]). Similar calculations are being initiated in the present study for validation and comaprison of the experimental results.

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