Gamma Spectroscopy of ^{61}Ni

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Introduction

The structure of nuclei with few nucleons outside the doubly magic ^{56}Ni ($Z = 28, N = 28$) core presents interesting possibilities for spectroscopic pursuits. The low and moderate spin domain of these nuclei can be well described by the shell model configurations involving $p_{3/2}, p_{1/2}, f_{5/2}, g_{9/2}$ orbitals while the higher spin domain exhibits a multitude of phenomena ranging from superdeformed bands feeding the spherical states, triaxial deformation, band termination and magnetic rotation bands [1]. Even in the presence of a sub-shell closure at $N = 40$, as established from the structural investigation of ^{68}Ni ($Z = 28, N = 40$), albeit with an energy gap of $\sim$ 2 MeV between the $p_{1/2}$ and the $g_{9/2}$ single-particle states, all yrast and near yrast levels have been observed to be originating from complex configurations involving cross-shell excitations [2]. The present work pertains to the γ-ray spectroscopy of the ^{61}Ni ($Z = 28, N = 33$) nucleus studied with the objective of observing the aforementioned characteristics of this region with $A \sim 60$ and test the effectiveness of the shell model calculations in interpreting the level structure. Previous studies on the nucleus include that reported by Wadsworth *et al.* [3, 4], following the population of the nucleus in α-induced reaction, and with a setup of two Ge(Li) detectors as the detection system. The level scheme of the nucleus was reported to an excitation energy of $E_x \sim 5.3$ MeV and spin-parity $J^\pi \sim 17/2^+$ though the latter assigment was only tentative for several states. The low lying negative parity states in the nucleus were interpreted from shell model calculations using the $2p_{3/2}, 1f_{5/2}, 2p_{1/2}$ orbitals as the basis space and MSDI and ASDI interactions [4]. The positive parity states in the nucleus were attributed to the coupling of the $g_{9/2}$ particle to the ^{60}Ni-core. Subsequently, the nucleus was investigated using heavy-ion induced reaction by Warburton *et al.* [5] but an insignificant amount of new information, compared to that reported by Wadsworth *et al.*, was obtained therefrom. Thus a detailed spectroscopic study of this nucleus using contemporary experimental tools is in requirement and is expected to contribute in understanding the structural systematics of the nuclei in the vicinity of the ^{56}Ni-core.

Experimental Details and Data Analysis

The ^{61}Ni nucleus was populated in the reaction ^{59}Co($^7Li, \alpha n$) 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

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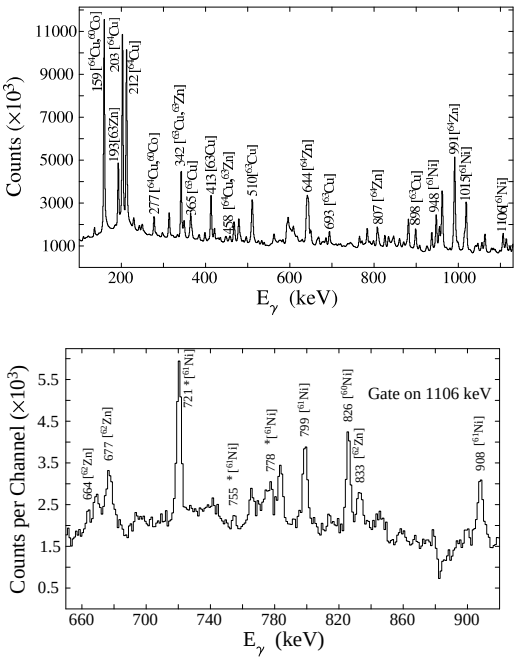

FIG. 1: (Upper Panel) Projection spectrum constructed from the present data, illustrating the different nuclei populated in the present work. (Lower Panel) Representative gated spectrum generated from the present data.

detection system was an array of 11 Compton suppressed Clover detectors distributed at angles $\theta = 157°$ (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 [6]. The acquired data has been sorted into symmetric as well as angle dependent γ-γ matrices using the MARCOS [6] program and is currently being analyzed using the RADWARE [7] package.

Preliminary Results and Outlook

The Fig. 1 shows the projection spectrum from the present data indicating the different nuclei populated herein. The analysis is currently in progress for the nucleus of interest ^{61}Ni. More than 10 new γ-ray transitions have been identified and being placed in the level

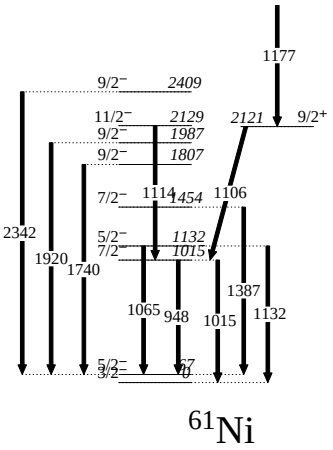

FIG. 2: Part of the known [3] level scheme of the ^{61}Ni nucleus, shown here for reference.

scheme. The analysis is in progress and the results shall be detailed in the Symposium.

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