

Gamma Spectroscopy of ^{60}Co

S. Samanta¹, S. Das¹, R. Bhattacharjee¹, R. Raut^{1,*}, S. S. Ghugre¹,
A. K. Sinha², U. Garg³, Neelam⁴, Md. Sazedur R Laskar⁵, F. S. Babra⁵,
S. Biswas⁵, S. Saha⁵, P. Singh⁵, R. Palit⁵, N. Kumar⁶, and P. Jones⁷

¹UGC-DAE CSR, Kolkata Centre, Kolkata 700098, INDIA

²UGC-DAE CSR, Indore 452017, INDIA

³Department of Physics, University of Notre Dame, Indiana 46556, USA

⁴Department of Physics and Astrophysics,
University of Delhi, New Delhi 110007, INDIA

⁵Department of Nuclear and Atomic Physics,
Tata Institute of Fundamental Research, Mumbai 400005, INDIA

⁶Amity Institute of Nuclear Science & Technology,
Amity University, Noida 201303, INDIA and

⁷Department of Nuclear Physics, iThemba Labs, Somerset West 7129, South Africa

Introduction

Structural investigations of nuclei in the vicinity of doubly-magic ^{56}Ni -core ($Z = 28, N = 28$) present myriad possibilities. While the low spin domain of these nuclei is principally dominated by shell model configurations, the same can evolve into moderate to well deformed systems at higher excitation energies and can exhibit intriguing phenomenon such as the Magnetic Rotation (MR) bands [1].

The present work pertains to the spectroscopy of the ^{60}Co ($Z = 27, N = 33$) nucleus, as a part of the systematic structure study of nuclei around the Ni-core [2, 3]. Previous studies on ^{60}Co were carried out by several groups such as Warburton *et al.* [4] and Taylor *et al.* [5] albeit using modest detection setups consisting of small number of Ge(Li) detectors. The observed level structure of the nucleus was largely interpreted within the framework of shell model configurations of type $\pi(1f_{7/2})^{-n} \otimes \nu(2p_{3/2}, 1f_{5/2}, 2p_{1/2})^m$ where $n = 28 - Z$ and $m = N - 28$ [4] which for ^{60}Co are 1 and 5 respectively. However, Warburton *et al.* also reported odd-parity states that could be ascribed to the excita-

tions into the $g_{9/2}$ orbital from level energies ~ 2 MeV and that obscured the correlations between the experimental observations and predictions of the aforementioned fp configurations for higher states. The level structure of the nucleus was reported upto to an excitation energy of ~ 8 MeV with only tentative spin-parity assignments. The present work aspires to re-examine the excitation pattern of the ^{60}Co nucleus using an improved detection setup and compare the experimental findings with refined shell model calculations.

Experimental Details and Data Analysis

In the present work, excited states of the ^{60}Co nucleus were populated in the reaction $^{59}\text{Co}(^7\text{Li}, \alpha p n)$ at $E_{lab} = 22\text{-}24$ MeV. The ^7Li beam was obtained from the 14 UD Pelletron LINAC Facility at the Tata Institute of Fundamental Research (TIFR), Mumbai. The target, fabricated by evaporation technique at the TIFR target laboratory, was 5.2 mg/cm² of ^{59}Co , mono-isotopic in nature, on a 4 mg/cm² thick Tantalum foil backing. The emitted γ -rays were detected using an array of 11 Compton suppressed Clover detectors positioned at angles 157° (3 detectors), 140° (3 detectors), 115° (1 detector) and 90° (4 detectors). The pulse processing and data acquisition was carried out using the PIXIE-16 digitizer, from XIA LLC, based system asso-

*Electronic address: rraut@alpha.iuc.res.in

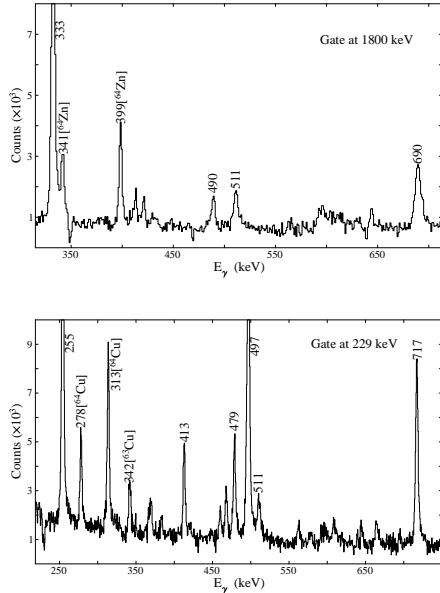


FIG. 1: Typical gated spectrum constructed from the present data, with gate on 1800 keV and 229 keV γ -ray transitions, from the ^{60}Co nucleus. The contaminant transitions from other nuclei populated in the same reaction are labelled.

ciated with the γ -ray detection setup at TIFR [6]. The acquired data was sorted into symmetric as well as angle dependent γ - γ matrices and γ - γ - γ cube using the MARCOS [6] and the RADWARE [7] codes. The RADWARE package is also being used for the subsequent analysis.

Preliminary Results and Outlook

As it has been reported previously [2, 3], the present experiment populated a range of isotopes around the ^{56}Ni -core. Analysis of the level structure for some of these nuclei has been completed or near completion. The analysis is currently in progress for the ^{60}Co nucleus, wherein indications of new γ -ray transitions have been observed and the same are presently being placed in the level scheme. Fig. 1 illustrates typical spectra with gates

on the transitions of ^{60}Co nucleus. The relevant level scheme is depicted in Fig. 2. The

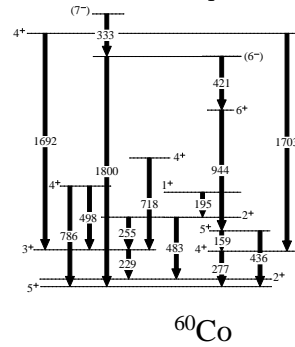


FIG. 2: Part of the known [4] level scheme of the ^{60}Co nucleus, shown here for reference.

results of the analysis shall be detailed in the Symposium.

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References

- [1] D. A. Torres *et al.* Phys. Rev. **C78**, 054318(2008).
- [2] S. Samanta *et al.* Proc. DAE Symp. Nucl. Phys. **61**, 82(2016).
- [3] S. Das *et al.* Proc. DAE Symp. Nucl. Phys. **61**, 172(2016).
- [4] E. K. Warburton *et al.* Phys. Rev. **C16** 1027(1977).
- [5] T. Taylor *et al.* Nucl. Phys. **A295** 77(1978).
- [6] R. Palit *et al.* Nucl. Instr. Meth. Phys. Res. **A680**, 90(2012).
- [7] D C. Radford Nucl. Instr. Meth. Phys. Res. **A361** 306(1995).