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In-beam γ-ray spectroscopy of ^{63}Zn

U. S. Ghosh[1],* S.Rai[1],† B. Mukherjee[1], A. Biswas[1], A. K. Mondal[1], K.Mandal[1]
A. Chakraborty[1], G. Mukherjee[2], S. Nandi[2], S. Chakraborty[3], A. Sharma[4],
S.S. Bhattacharjee[5], I. Bala[5], R. Garg[5], S. Muralithar[5], and R.P. Singh[5]
[1]*Department of Physics, Visva-Bharati, Santiniketan-731235, India*
[2]*Variable Energy Cyclotron centre, 1/AF Bidhannagar, Kolkata-700064, India*
[3]*Department of Physics, Banaras Hindu University, Varanasi-221005, India*
[4]*Department of Physics, Himachal Pradesh University, Shimla-171005, India, and*
[5]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi - 110067, India*

Introduction

Detail study of nuclear structure in mass region A$\sim$60 reveals various interesting phenomena. Both single particle and collective excitations with various shapes, namely, prolate, oblate and triaxial have been observed in this region. Here, the active orbitals are $2p_{3/2}$, $1f_{5/2}$, $2p_{1/2}$ in the upper fp shell and an intruder $1g_{9/2}$ orbital. The lower excitations are due to the negative parity $2p_{3/2}$, $1f_{5/2}$ and $2p_{1/2}$ orbitals but most of the high spin states are mainly due to the presence of the high j $1f_{7/2}$ and $1g_{9/2}$ intruder orbitals. Presence of holes in $1f_{7/2}$ orbital and particles in $1g_{9/2}$ leads to a transition from spherical towards deformed shapes and enhances the possibility of collective rotational excitations [1]. Among the ^{61,63,65}Zn isotopes, ^{61}Zn is interesting as it has several normal and super deformed bands [2]. Strongly coupled rotational band was first observed in ^{64}Zn [3] in this mass region and this band showed similar characteristics of those smoothly terminating rotational bands in the Sn-Sb nuclei of the A$\sim$110 region [4]. A rotational band was also observed in ^{65}Zn [5], built on $g_{9/2}$ neutron orbital and it exhibits a band crossing at high rotational frequency. Previous studies on ^{63}Zn [6] predicted rotational states at lower excitation energy rather than at higher excitation energy and probable origin of the states is the coupling of neutron single-particle motion in $1g_{9/2}$ orbital to the collective vibration of the ^{62}Zn core. Earlier investigations on ^{63}Zn [6] were performed using 12 Compton suppressed HPGe detectors along with 14 BGO detectors. The present experiment was performed with Indian National Gamma Array (INGA) [7], which consists of fourteen Compton suppressed HPGe clover detectors to get more insight into the nuclear structure of ^{63}Zn.

Experimental Details

The experiment [8] was conducted using 15-UD pelletron accelerator [9] at Inter University Accelerator Centre (IUAC), New Delhi. In this fusion-evaporation reaction, a beam of ^{18}O at 72.5 MeV bombarded onto a ^{52}Cr (isotopic abundance$\sim$99%) target of thickness 1mg-cm^{-2}, ^{70}Ge being formed as compound nuclei. Excited states of ^{63}Zn were then produced via the evaporation of one α-particle and three neutrons. The target was prepared on a 8.0 mg-cm^{-2} Au backing, via vapor-deposition technique [10]. A total of 2.12×10^9 events, in which at least two clover detectors have fired in coincidence, were collected during a beam time of around five days in a list mode format using CANDLE [11] a CAMAC based analog data acquisition software developed at IUAC. The raw data in the list-mode format were then sorted into several symmetric E_γ–E_γ and angle dependent matrices after gain-matching the energy of each clover detector to 1.0 keV/channel. Further analysis of the data was performed with the help of the

*Electronic address: usghosh88@gmail.com
†Presently at Salesian College, Siliguri Campus, Siliguri 734001, West Bengal

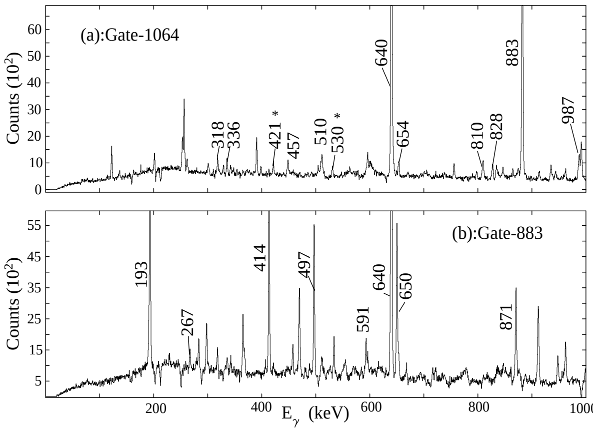

FIG. 1: Low energy part of the $\gamma - \gamma$ coincidence spectra for ^{63}Zn gated on (a) 1064 keV ($7/2^- \rightarrow 3/2^-$) and on (b) 883 keV ($13/2^- \rightarrow 9/2^-$) transitions.

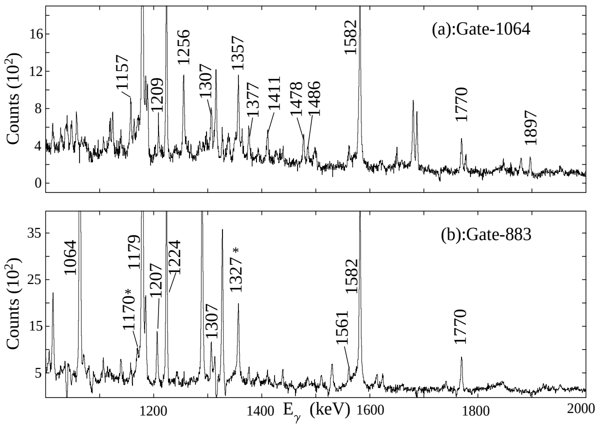

FIG. 2: Same as FIG.1 for high energy part.

standard analysis packages viz. Radware [12] and INGASORT [13].

Results and Discussion

Preliminary analysis of the data confirms the presence of many of the previously observed transitions. Using multiple gates on known uncontaminated transitions, we observed some new transitions in ^{63}Zn. Here we have shown [Fig.1 & Fig.2] two spectra obtained by putting gates on 1064 keV ($7/2^- \rightarrow 3/2^-$) and 883 keV ($13/2^- \rightarrow 9/2^-$) transitions, showing the previously reported transitions along with some new transitions. We have measured DCO ratios from angle dependent asymmetric matrices to determine the spins and parities of the excited states and compared them with the previously reported values. We are extracting linear polarization information for ^{63}Zn - which has not been reported elsewhere. Detailed analysis are in progress and will be presented in the symposium.

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