

Investigation of the medium-spin level structure of ^{78}Se

K. Mandal^{1,8}, A.K. Mondal¹, A. Chakraborty^{1,*}, S. Ali⁴, R. Banik³,
 S. Bhattacharya³, S. Bhattacharyya³, D.C. Biswas⁵, S. Biswas^{1,7}, S.
 Chattarjee², S.K. Das², A. Dey¹, U.S. Ghosh¹, S.S. Ghugre², A. Goswami⁴,
 Krishichayan⁹, A. Kumar⁶, V. Kumar⁶, B. Mukherjee¹, G. Mukherjee³,
 S. Mukhopadhyay⁵, S. Nandi³, S. Rai¹, R. Raut², and S. Samanta²

¹Department of Physics, Siksha Bhavana,
 Visva-Bharati, Santiniketan 731 235, India

²UGC-DAE-Consortium for Scientific Research, Kolkata 700 098, India

³Variable Energy Cyclotron Centre, 1/AF, Bidhan Nagar, Kolkata 700 064, India

⁴Saha Institute of Nuclear Physics, HBNI, Kolkata 700 064, India

⁵Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai 400 085, India

⁶Department of Physics, Banaras Hindu University, Varanasi 221 005, India

⁷Murshidabad College of Engineering and Technology,
 Berhampore, West Bengal 742 102, India

⁸Chandidas Mahavidyalaya, Khujutipara,

Birbhum, West Bengal 731 215, India and

⁹Triangle Universities Nuclear Laboratory, Durham, North Carolina, 27708, USA

Introduction

The variation of the low-lying spectroscopic properties along the chain of even mass of Se-isotopes is shown in Fig.1. Lying in between the rotor and vibrator line, the transitional nucleus, ^{78}Se is expected to exhibit complex level structure at medium spin regime owing to the competition between the rotation induced deformation effect and the $g_{9/2}$ two proton excitation modes. Due to the difficulty of populating this isotope adequately through heavy-ion induced fusion-evaporation reactions, all the previous investigations on ^{78}Se were carried out through scattering and transfer reactions [1]. The previous investigation with α -induced fusion reaction was carried out [2] using a smaller array of Ge(Li) detectors. Here, we report the preliminary spectroscopic results of ^{78}Se obtained from an experiment with alpha induced fusion reaction where a bigger array consisting of high resolution Compton-suppressed Ge Clover detectors.

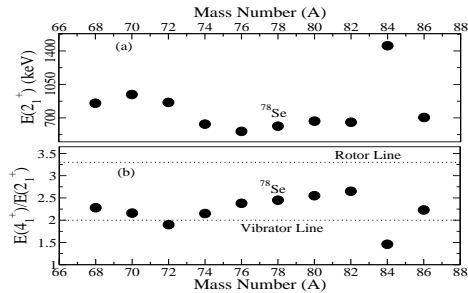


FIG. 1: Variation of (a) energy (in keV) of 2_1^+ states and (b) the ratio between the energies of the first 4^+ and 2^+ states of even-even Se-isotopes.

Experimental Details and Data Analysis

The excited states of ^{78}Se were populated through the $^{76}\text{Ge}(\alpha, 2n)$ fusion-evaporation reaction. The 30 MeV alpha beam was delivered by the K-130 Cyclotron machine at VECC, Kolkata. The target was prepared through the centrifuge process of enriched ^{76}Ge (94% enrichment) powder on mylar backing. The thickness of the target was about 2 mg/cm^2 . Two such targets were stacked together in order to increase the yield of the residual nuclei. The gamma rays emit-

*Electronic address: anagha.chakraborty@visva-bharati.ac.in

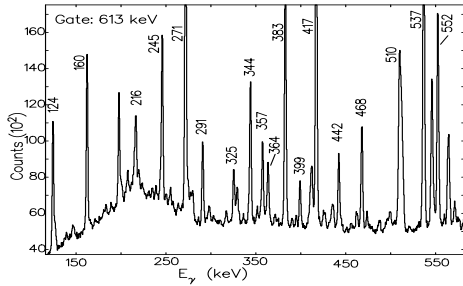


FIG. 2: A representative $\gamma - \gamma$ coincidence spectrum with the gate on 613 ($2^+ \rightarrow 0^+$)-keV ground state feeding transition of ^{78}Se . Majority of the unmarked peaks are the newly observed transitions in ^{78}Se .

ted from the excited states of the residual nuclei were detected by Indian National Gamma Array (INGA). The INGA spectrometer used in this experiment was consisted of seven Compton-suppressed high purity Ge Clover detectors and one Low Energy Photon Spectrometer (LEPS). Four Clover detectors were placed at 90° relative to the beam axis, two at 125° , and one Clover and the LEPS at 40° . The gain-matched data were sorted into $\gamma\gamma$ symmetric and asymmetric matrices using the sorting code ‘‘IUCPIX’’ [3]. A representative $\gamma\gamma$ coincidence spectrum is shown in Fig.2. The peaks labelled with their transition energies belong to ^{78}Se . The preliminary analysis indicates the population of the levels up to $E_x \sim 7$ MeV with $J \sim 15\hbar$.

The multipolarity assignments of the transitions have been carried out through DCO-method. A DCO-matrix was constructed by sorting the data from 90° detectors along the x-axis and the data from 125° detectors along the y-axis. The measured DCO-ratios, with the use of known quadrupole transitions as

gates, for a few transitions belong to ^{78}Se has been shown in Fig. 3. For a pure quadrupole transition, the expected DCO-value is 1; whereas a pure dipole transition should have a DCO-value of 2. The scattered DCO-values for the known dipole transitions are suggestive of the presence of significant mixing from $E2$ -component. The results from

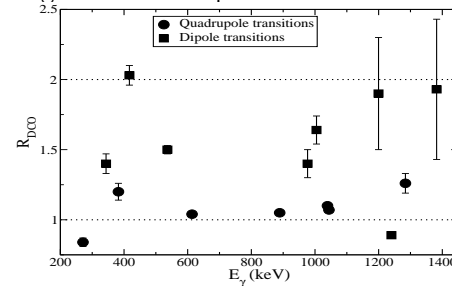


FIG. 3: The plot of the DCO-ratio values of a few dipole and quadrupole transitions in ^{78}Se . The DCO-values have been extracted with the use of known stretched quadrupole transitions as the gating transitions.

the on-going analysis would be presented during the symposium.

Acknowledgement

The help and co-operation received from the crew of the cyclotron machine at VECC is gratefully acknowledged. Special thanks to the members of the target laboratory of VECC for their help in preparing the targets.

References

- [1] www.nndc.bnl.gov
- [2] R. Schwengner *et al.*, Z. Phys. A **326**, 287 (1987).
- [3] S. Das *et al.*, Nucl. Instrum. Methods Phys. Res. A **680**, 90 (2012).