In-beam spectroscopic study of ^{209}At

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Introduction

Nuclei in the close proximity of the doubly magic shell closure of the Pb (Z = 82) mainly exhibit single particle excitation. But with the few proton particles above Z = 82 and the few neutron holes below N =126 shell closure, the nuclear structure will be dominated by the multiparticle configurations. Also, the neutron core excitation plays an important role for the generation of the higher angular momentum in this region.

For odd-A At (Z =85) isotopes below N =126 shell closures, the lower spin-states are mainly generated by the excitations of the three valence protons at $h_{9/2}$ orbital. So, it will be interesting to explore how the multiparticle configurations and the neutron core excitation becomes important at the higher spins and excitation energies. In this regard, the study of high-spin states of ^{209}At with the high resolution and high efficiency HpGe Clover detector array will be significant. The level structure of ^{209}At has already been reported by different groups [1, 2]. However, the $25/2^+$ isomeric state which is systematically present for all odd A At isotopes [3–5], was absent in ^{209}At from the previous works. In the present work, several new transitions have been observed and the level scheme has been extended upto an excitation energy of 6.3 MeV.

Experimental Details

The high spin states of ^{209}At were populated in the alpha induced reaction ^{209}Bi(α,4n)^{209}At. The alpha beam was pro-

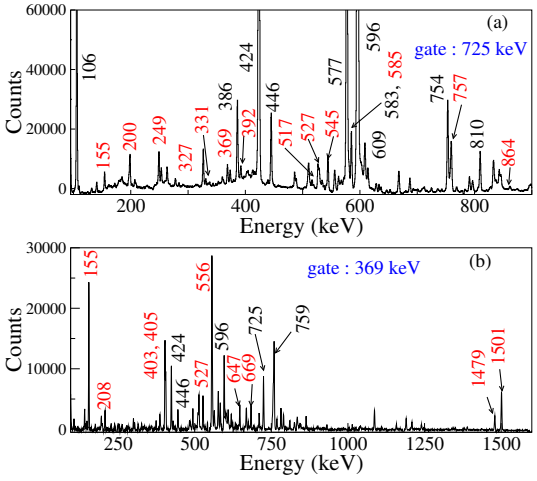

FIG. 1: Coincidence spectra corresponding to the γ ray gates of (a) 725 keV and (b) 396 keV. The new transitions are marked with red colour.

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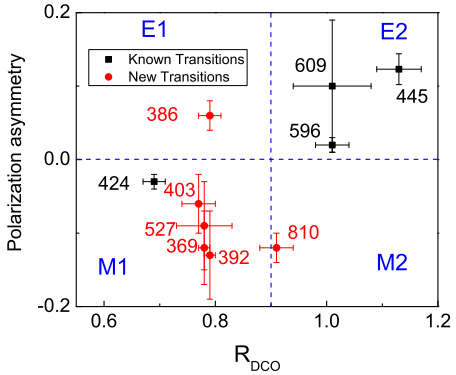

FIG. 2: Plot of R_{DCO}(at the gate of streched E2 transition) vs. polarization asymmetry.

vided by K-130 Cyclotron of VECC, Kolkata at the beam energy of 52 MeV.The de-exciting γ rays were detected using 11 Compton suppressed Clover detectors and one LEPS detector mounted on the modified INGA support structure at VECC, Kolkata. Time-stamped digital data has been acquired by Pixie-16 digitizer [6]. The data were sorted using the IUCPIX [6] and the data analysis has been carried out using RADWARE and BINDAS.

Data Analysis and results

From the present analysis, several new γ ray transitions have been observed and placed on the basis of coincidence relationship between the γ rays as obtained from the γ-γ symmetric matrix. Fig. 1 shows the coincidence spectrum corresponding to the gate of (a) 725 keV ground state transition and (b) 369 keV transition which is a new transition obtained at the gate of 725 keV transition. To assign the spin-parity of the states, the directional correlation of oriented states (DCO) ratio and polarization asymmetry of the decaying γ rays have been determined from the two asymmetric γ-γ matrices. Fig. 2 shows the plot of R_{DCO} vs. polarization asymmetry for the new transitions along with few previously known transitions. It clearly illustrates that the two gamma rays 386 and 810 kev, decaying from the 2237 keV level, has the multipolarities E1 and M2 respectively, which confirms the spin-parity(J^{π}) of 2237 keV level as $25/2^{+}$ state. Further, the $13/2^{+}$ state, generated from $\pi i_{13/2}$ configuration, has also been observed at the several odd A At isotopes which decays via E1 and M2 transitions to the $11/2^{-}$ and $9/2^{-}$ ground states respectively. Similar kind of decay patterns have been observed for 1242 keV level in the present work which is tentatively assigned as $13/2^{(+)}$ state. The systematic evolution of $13/2^{+}$ state along with that of $25/2^{+}$ state has been shown in the fig. 3 for $^{205-211}$At isotopes and it is observed that it matches well with the systematics. Also, many new transitions have been observed above the $29/2^{+}$ isomeric state. Two higher energy transitions of 1501 and 1479 keV have been newly observed above the $29/2^{+}$ isomeric state in the present work (fig.1 (b)), which are very similar to the 1535 keV transition decaying from the $31/2^{+}$ state above the same isomeric state in ^{211}At [5]. This involves neutron core excitation.

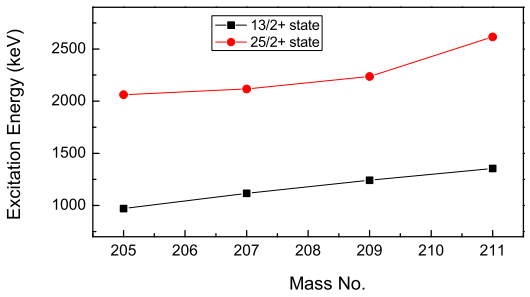

FIG. 3: Plot of excitation energies of $13/2^{+}$ and $25/2^{+}$ states for $^{205-211}$At isotopes.

Acknowledgments

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