Observation of isomeric state at $I^{\pi} = (3^{-})$ in ^{118}I

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I. INTRODUCTION

Iodine nuclei ($Z = 53$) lie in a transitional region between the vibrator of Te ($Z = 52$) and the deformed rotator of Xe ($Z = 54$). For light mass iodine isotopes, the proton Fermi surface lies in the lower part of the $h_{11/2}$ orbital while the neutron Fermi surface lies in the $h_{11/2}$ midshell. A strong driving force exert on the γ-soft core by these high-j valence particles: protons in the lower part of the $h_{11/2}$ subshell favor a collectively rotating prolate shape ($\gamma \geq 0^{\circ}$) while neutrons in the middle part of the $h_{11/2}$ subshell favor a collectively rotating triaxial shape ($\gamma \approx 30^{\circ}$). The low lying states of iodine isotopes $^{(116,118,120)}$I are well studied in the Ref. [1–3]. An excited state isomeric state based on the coupling of the proton $g_{9/2}$ orbital to the neutron $h_{11/2}$ orbital with $I^{\pi} = 7^{-}$ had also been identified in these isotopes. Several low-lying excited states with small γ-ray energies between the positive parity band based $\pi h_{11/2} \nu h_{11/2}$ configuration and ground states band are reported in these nuclei. Isomeric states at low energy level were observed in the ^{120}I nuclei. In the present work, the half-life time of the (3^{-}) state at level energy 57 keV was measured with the electronic timing of high-purity germanium (HPGe) detectors.

II. EXPERIMENTAL DETAILS

The excited states of ^{118}I were populated through ^{109}Ag(^{13}C, 4nγ)^{118}I reaction at a beam energy of 54 MeV. The ^{13}C beam, provided by the 14UD pelletron accelerator (TIFR) was incident on a ^{109}Ag target of thickness 1.05 mg/cm^2 backed with 10 mg/cm^2 of Au. The emitted γ rays were detected in the Indian National Gamma Array (INGA), which consisted of 18 Compton-suppressed clover HPGe detectors. A total of 1.66×10^9 $\gamma\gamma$ coincidence events were collected into a two-dimensional matrix format by using RADWARE software [4]. After the energy calibration of all the HPGe detectors, the time-stamped coincidence data were sorted using the Multi pARameter timestamped based COincidence Search (MARCOS) code, developed at TIFR, Mumbai [5].

III. RESULTS AND DISCUSSION

The γ-ray energy spectrum gate on 392 keV transition shown in Fig. 1 depicts the transitions feeding and decaying from (3^{-}) state of ^{118}I. The half-life of the isomeric state is ex-

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tracted by using the time difference spectrum between two transitions E_γ = 129.6 and 57.4 keV respectively.

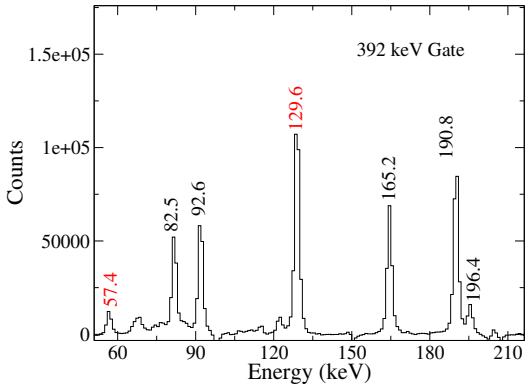

FIG. 1: $\gamma - \gamma$ coincidence spectrum is obtained using gate on 392-keV (^{118}I) transition. The gamma transitions shown in red are decay and feeding transitions at level (3^-). The gamma transitions shown in the black colour are observed at the low energy level of ^{118}I [2].

The time-stamped data were used to create four conditional time spectra: $T_{p1,p2}$, $T_{p1,bg2}$, $T_{bg1,p2}$, and $T_{bg1,bg2}$. Here $T_{p1,p2}$ represents the time difference spectrum obtained with energy gate around the $E_{\gamma 1}$ and $E_{\gamma 2}$ peaks, while $T_{p1,bg2}$ represents the same for energy gate around the $E_{\gamma 1}$ peak and background near $E_{\gamma 2}$. Similarly, it is self-explanatory for $T_{bg1,p2}$, and $T_{bg1,bg2}$. The half-lives of the states were extracted by fitting the time-difference spectra with a convoluted Gaussian and an exponential function considering the detector response function. A detailed description of this method is given in ref. [6]. The half-life of the (3^-) state have been found to be $T_{1/2}$ = 56.5(20) ns. The reduced transition probability was extracted using the formula in Ref. [7]. The measured value of B($M1$) is 8.7×10^{-4} μ_N^2, which is suppressed by 100 times compared to the normal B($M1$) rate. The value of reduced transition probability calculated by using the Weisskopf estimate is 3.3×10^{-4} μ_N^2. The observed value is close to the Weisskopf estimates, which shows the single particle excitation at this isomeric level. Further, this isomeric state will be discussed in the framework of a relevant model during the conference.

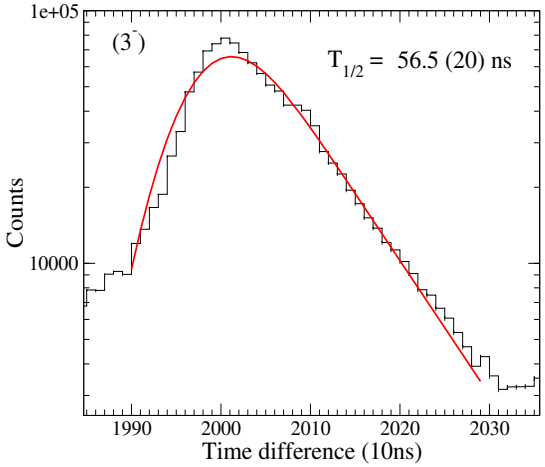

FIG. 2: Time difference spectrum is generated using the 129.6- and 57.4-keV transitions feeding and decaying from the (3^-) isomeric level, respectively.

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