Observation of 4_2^+ and 6_2^+ states in ^{200}Pb

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Introduction

Investigation of Pb nuclei has been a subject of interest due to co-existance of various nuclear shapes [1]. Although Pb nuclei with $Z = 82$ are spherical in ground state but by varying the number of neutron-hole excited states with different nuclear structure have been observed [2]. In Pb isotopes, Fermi surface of the neutron-holes are near the of $i_{13/2}$, $p_{3/2}$, $f_{5/2}$ orbitals and yrast states and low lying non yrast states are arising due to the involvment of these orbital [3].

The low lying yrast states 2^+, 4^+ show systematically energy varying behavior but the non-yrast states such as, 2_2^+, 4_2^+ and 6_2^+ do not show well systematic behavior for neutron deficient Pb isotopes [4–7].

A 4_2^+ state was reported in ^{196,198}Pb isotopes [6, 7] systematically but, there is not much experimental information available for the non-yrast states of heavier Pb isotopes. Hence more experimental investigation is needed. The aim of the present work, is to search for the non yrast states in ^{200}Pb.

Experimental details

Excited states of ^{200}Pb nucleus were populated by using ^{197}Au(^{7}Li, 4n)^{200}Pb reaction at beam energy E_b = 33 MeV. The experiment was performed using 15UD pelletron accelerator [8, 9] at Inter University Accelerator Center, New Delhi, India. Gamma rays were detected by using clover detectors of Indian National Gamma Array (INGA) facility [10].

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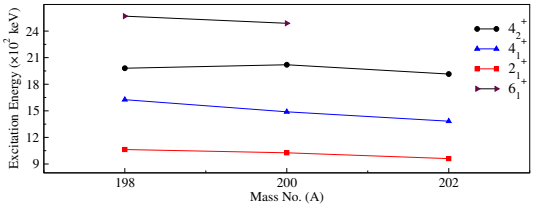

FIG. 1: Systematics of the excitation energies of 0_1^+, 2_1^+, 4_2^+ states of $^{196-204}$Pb isotopes [5–7]

The $\gamma - \gamma$ coincidence data was sorted offline by INGASort [11] program.

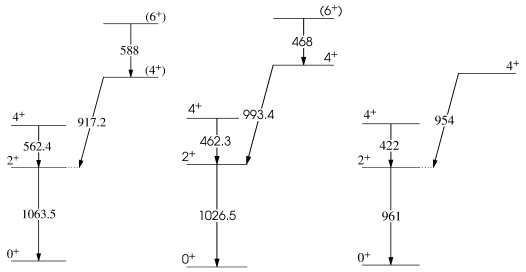

FIG. 2: Partial level scheme of low lying states of ^{198}Pb, ^{200}Pb, ^{202}Pb.

Results and Discussions

Two new states at energy 2019.9 keV and 2487.9 keV were found decaying to 2_2^+ at 1026.5 keV via 993.6 keV and 468 keV γ transitions respectively. Systematic of 4_2^+ and 6_2^+ of ^{198,200,202}Pb are shown in Fig. 1. The energy gated spectrum of γ-ray 993.4 keV confirms the present placement as shown in Fig. 3. Reverse gate of 1026.5 keV aslo confirms the placements. The γ-rays from 4_2^+ and 6_2^+

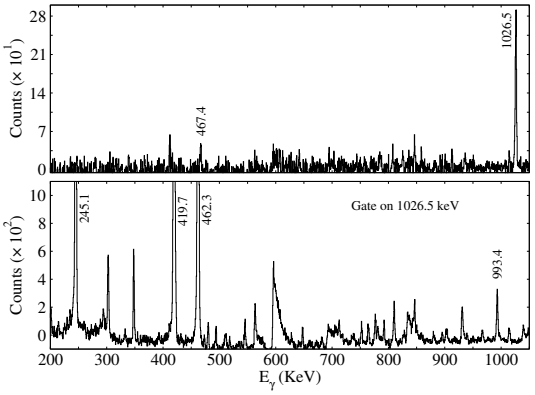

FIG. 3: The background subtracted prompt $\gamma-\gamma$ coincidence spectra gated on 993.4 keV and 1026.5 keV transition of ^{200}Pb nuclei.

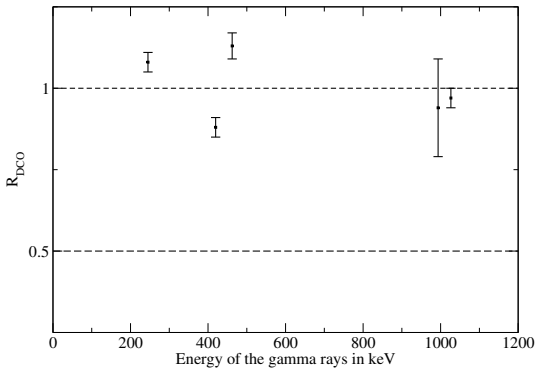

FIG. 4: R_{DCO} of low lying states of ^{200}Pb nuclei.

in ^{200}Pb are shown in Fig. 2. Present states are compared with similar states in neighboring isotopes (Fig. 1) where also seen a smooth energy trend.

The directional ratio of the gamma transitions are also deduced for transitions of the low lying levels. The multipolarity of newly placed 993.4 keV γ transition is found $\triangle I = 2$ (Fig. 4). The positive value of linear polarization asymmetry ($\triangle_{asym} = 0.12 \pm 0.13$) for 993.4 keV γ-ray suggest the electric nature of the gamma ray. Combining R_{DCO} and polarization results suggest positive parity for the energy level at 2019.9 keV.

Conclusion

The low lying states of ^{200} Pb have been populated via fusion evaporation reaction. two new states 4_2^+ and (6_2^+) have been observed in the present work. The spin and parity of the 2019.9 keV state has been confirmed by deducing the $\triangle I = 2$ multipolarity and positive value of polarization.

Acknowledgments

The authors are thankful to the staffs of the target lab, Pelletron accelerator and INGA facilities at IUAC. The first author is thankful to UGC and BHU for the university research fellowship.

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