Low Lying States in ^{200}Pb

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Introduction

The Hg-Pb region near Z=82 shell closer is a very good testing ground for the co-existence of various nuclear shapes. A wealth of literature exist on the co-existence of spherical, prolate, super deformed prolate and oblate nuclear shapes in various combinations in different isotopes in this region.

In Pb nuclei with spherical ground state, the most of the yrast states were associated with $i_{13/2}$, $p_{3/2}$, $f_{5/2}$ neutron excitation [1]. In the neutron deficient even mass lead isotopes, a slightly oblate $I_\pi = 0_2^+$ state [2] has been observed and interpreted as a proton-hole excitation across the Z=82 shell gap. Collective rotational bands with moderate oblate deformation have also been found in $^{197-200}$Pb [3–6] nuclei. Therefore, the neutron deficient lead isotopes are good candidates to study the shape co-existence phenomenon.

In ^{198}Pb a (5) level, decaying to 4^+ level at 1626 keV, has been reported at 1996 keV [7]. But no such (5) state has been reported in the case of ^{200}Pb. Also, the configuration of the (5) state is not clear, although, the yrast 2^+, 4^+, 5^- states have been studied well [8].

With the motivation of finding the (5) state and its configuration, the γ-ray spectroscopy of ^{200}Pb has been carried out with heavy ion fusion-evaporation reaction.

Experimental Details

In-beam γ-ray spectroscopy of ^{200}Pb has been carried out using the 15UD pelletron accelerator [9, 10] at Inter University Accelerator Center, New Delhi. The high spin states in ^{200}Pb have been populated via ^{197}Au(^{7}Li, 4nγ)^{200}Pb fusion-evaporation reaction at E$_{beam}$= 33 MeV. Fifteen Compton suppressed clover detectors of Indian National Gamma Array (INGA) [11] have been used to detect the de-exciting γ-rays. The clover detectors of INGA were arranged as: four each at 90° and 148°, three at 32° and two each at 57° and 123° to the beam direction. A CAMAC based analogue data acquisition system has been used to record the valid events. The offline data analysis has been carried out using the computer code INGAsort [12]. A number of matrices have been formed by sorting of the gain matched list mode data in order to carry out the γ-γ coincidence, angular correlation and linear polarization data analysis.

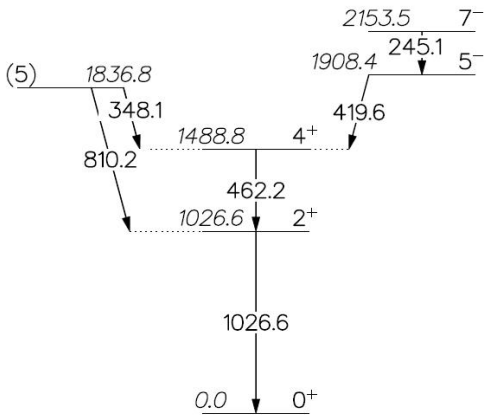

FIG. 1: Partial level scheme of ^{200}Pb based on the present work. The level and γ-ray energies are given in keV.

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Results and Discussion

The low lying states in ^{200}Pb have been populated via fusion-evaporation reaction. A partial level scheme of ^{200}Pb, deduced from this work, has been shown in Fig.1.

A typical background subtracted γ-γ coincidence spectrum with gate on 1026.6 keV γ-ray has been shown in Fig.2. The strongly populated γ-rays are shown in the inset.

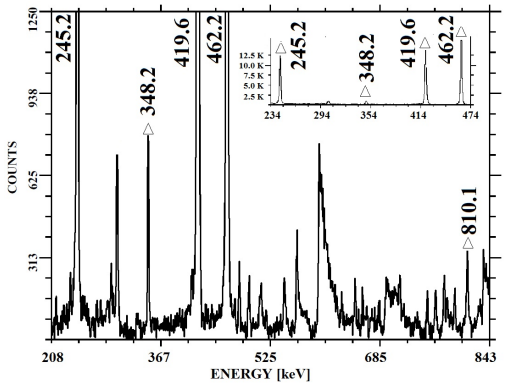

FIG. 2: The background subtracted prompt γ-γ coincidence spectra gated by 1026.6 keV γ-transition, belonging to ^{200}Pb.

In the present study, new γ-rays having energy of 348.1 keV and 810.2 keV (Fig.1), decaying from 1836.8 keV level to 1488.8 keV and 1026.6 keV level respectively, have been placed in the level scheme of ^{200}Pb. It is found similar to the transition reported in ^{198}Pb [7].

The multipolarity of several γ-rays have been determined from the Directional Correlation of Oriented states (DCO) ratio, obtained from angular correlation measurement.

$$R_{DCO} = \frac{I_{\gamma_1} \text{ at } \theta_1, \text{ gated by } \gamma_2 \text{ at } \theta_2}{I_{\gamma_1} \text{ at } \theta_2, \text{ gated by } \gamma_2 \text{ at } \theta_1}$$

The values of R_{DCO} confirms the previously assigned quadrupole nature of 1026.6 keV, 462.2 keV and 245.2 keV γ-lines [8], determined from the angular distribution measurement. The R_{DCO} values for 419.8 keV, 348.1 keV and 810.2 keV γ-rays indicate tentatively dipole nature (Fig.3).

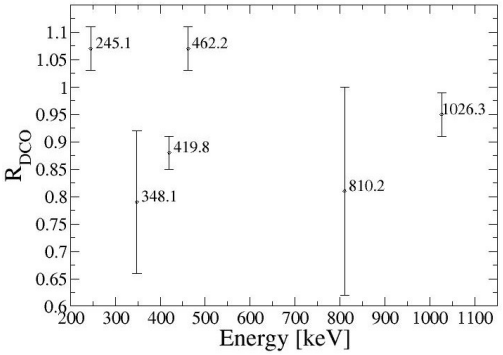

FIG. 3: Plot shows the DCO ratio of various γ-transitions belonging to ^{200}Pb, determined from the energy gate of 1026.6 keV and 462.2 keV quadrupole transitions.

Conclusion

The high spin states of ^{200}Pb have been populated via ^{197}Au(^{7}Li, 4nγ)^{200}Pb fusion-evaporation reaction at 33 MeV. Few new γ-lines have been placed in the level scheme. The multipolarity of the γ-transitions have been determined from angular correlation data and the spin of the corresponding level have been reconfirmed.

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