Nuclear Structure Studies in the A∼200 Region using INGA at IUAC

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Introduction

Spectroscopy of trans-lead nuclei with A∼200 is of interest for multiple reasons. The low-spin level structure of these nuclei cater for a testing ground for shell model calculations in the actinide region. It is envisaged that the experimental data from the spectroscopic endeavours will facilitate refinements of the interactions and validation of the truncation schemes used for the purpose. In the higher spin domain, these nuclei are expected to exhibit deformation characteristics following the occupation of high-j (deformation driving) orbitals as well as other intriguing structures such as Magnetic Rotation (MR) bands. It is interesting to note that though the MR phenomenon was first observed in the neutron-defecient Pb isotopes, it has not been well studied in the neighbouring nuclei [1]. The possibility of observing an evolution of the level structure from shell model configurations at lower excitations to regular bands at higher spin domain in these nuclei provide an impetus for their spectroscopic pursuits. A programme for systematic structural investigation of the A∼200 nuclei has been undertaken and the first experiment with particular objective of studying the ^{202,203}Po ($Z = 84, N = 118, 119$) isotopes has recently been carried out. The last published work on the ^{203}Po nucleus was by Fant *et al.* [2] using α-induced reaction and a modest detection setup consisting of small number of Ge(Li) detectors. The level structure of the nucleus was established upto an excitation energy of $\sim$ 4.3 MeV and spin-parity assignments of $\sim 17\hbar$. The configurations of the excited states in ^{203}Po were ascribed to the coupling of the neutron hole to the excitations of the even-even core of ^{204}Po, that are basically the excitations of the two proton particles outside the $Z = 82$ (Pb) core to a maximum of $J = 8$ in the $(h_{9/2})^2$ configuration and $J = 11$ in the $(h_{9/2}i_{13/2})$ configuration. The ^{202}Po isotope was also studied by Fant *et al.* [3] using both heavy-ion as well as α-induced reactions and small number of Ge(Li) detectors. It was identified that the even-even light Po isotopes exhibit a competition between the two proton particles and two neutron holes configurations.

The present work aspired to investigate the level structure of ^{202,203}Po nuclei following their population through heavy-ion induced fusion-evaporation reaction and using high resolution γ-ray detection setup in order to extend their level structure beyond the hitherto known domain and explore the excitations therein.

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Experimental Details and Data Analysis

High spin states of the nuclei of interest, ^{202,203}Po, were populated using the reaction ^{194}Pt(^{13}C,xn) at E_{lab} = 74 MeV. The target was 13 mg/cm^2 Pt-foil enriched to 99% in ^{194}Pt. The ^{13}C beam was provided at a charge state 5+ and an average current of 0.5 pnA by the 15 UD Pelletron at the Inter University Accelerator Centre (IUAC), New Delhi. The detection system used was the Indian National Gamma Array (INGA), currently operational at IUAC, then consisting of 18 Compton suppressed Clover detectors distributed at 148^o (4), 123^o (4), 90^o (6), 57^o (2) and 32^o (2). Listmode data was acquired under the condition of atleast two Compton suppressed Clovers firing in coincidence. Around 1.5 x 10^9 two and higher fold events were acquired during the run. The acquired data has been sorted into γ-γ symmetric matrix using the programs CANDLE [5], INGASORT [4] and SPRINGZ [7] and is being analyzed using the RADWARE [6] package for coincidence relations between the observed transitions. Angle dependent and polarization matrices are being generated to facilitate determination of multipolarity and electromagnetic character of the γ-ray transitions for spin-parity assignments of the excited levels.

Preliminary Results and Outlook

The total projection spectra, indicating the nuclei populated in the present experiment, is illustrated in Fig. 1 and establishes the production of nuclei of interest ^{202,203}Po. A typical gated spectrum with gate applied on the 613 keV transition of ^{203}Po is shown in Fig. 2. New γ-ray transitions have been observed and are now being placed in the level scheme of the nucleus. Data analysis is in progress and plans to, as already mentioned, extend the level structure of these nuclei to higher excitations followed by theoretical interpretaion of the experimental observations.

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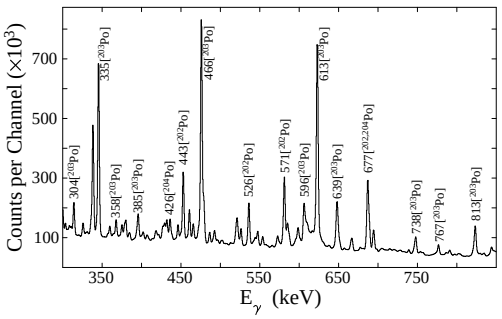

FIG. 1: Total projection spectrum obtained from the present study. The γ-ray transitions corresponding to the population of different nuclei are labelled accordingly.

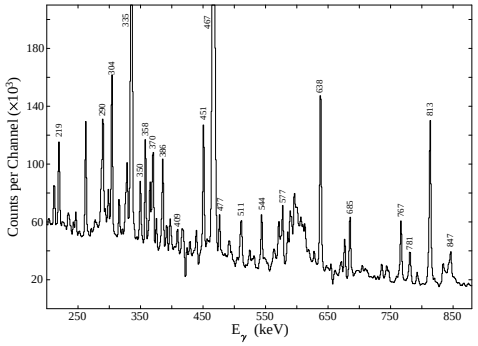

FIG. 2: Spectrum with gate applied on the 613 keV γ-ray of the ^{203}Po nucleus showing the transitions belonging to the same.

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