High spin spectroscopy of ^{201}Po

Sahab Singh[1],* K. Yadav[1], D. Choudhury[1], B. Maheshwari[2], R. Roy[1], R. Palit[3], P. Dey[3], B. Das[3], A. Kundu[3], V. Malik[3], Md. S. R. Laskar[3], D. Negi[3], S. Nag[4], M. Prajapati[4], S. Jadhav[3], B. S. Naidu[3], and A. V. Thomas[3]

[1]*Department of Physics, Indian Institute of Technology, Ropar-140001, India*
[2]*Grand Accélérateur National d'Ions Lourds, CEA/DSM-CNRS/IN2P3, Bvd Henri Becquerel, BP 55027, F-14076 Caen, France*
[3]*Deptartment of Nuclear and Atomic Physics, Tata Institute of Fundamental Research, Mumbai-400005, India and*
[4]*Department of Physics, Indian Institute of Technology BHU, Varanasi-221005, India*

Introduction

Nuclei in the mass range $A = 190 - 200$ are known to display a diverse array of collective and single-particle characteristics, making them remarkable examples of shape coexistence. The low lying excited states in the nuclei in the vicinity of the doubly magic shell clousre at ($Z = 82, N = 126$) have dominant contribution from single particle excitations, whereas the higher excitation energies and spins manifest a variety of collective rotational behaviour including superdeformation [1]. In 1990s, regular structures with oblate deformed states connected by M1 transitions were first observed in ^{198,199,200}Pb [2, 3]. No such bands have yet been reported in the neighboring Po isotopes.

Shell model has been the most reliable microscopic description of the nuclei around $Z = 82, N = 126$. A key focus of nuclear structure studies has been refining the theoretical models for the predication of the observed experimental data, aided by advances in computational resources, especially for heavier systems like Pb ($Z = 82$). The $Z = 82$ closure was found to be stable against collective excitations [4], but light Hg ($Z = 80$) isotopes showed collectivity, with similar predictions for the light Po ($Z = 84$) nuclei [5] on the proton-rich side.

The only prior spectroscopic study of the ^{201}Po nucleus ($Z = 84, N = 119$) after its population in a fusion-evaporation reaction ^{194}Pt(^{12}C, 5n) was conducted by T. Weckstrm et al. [5]. From their data, a level scheme for the nucleus was established, reaching excitation energies of approximately 4.0 MeV and spins of around 18$\hbar$. However, only a limited number of γ-ray transitions, likely the strongest ones, and energy levels were identified above the $25/2^+$ state. The spin-parity assignments for these levels were quite tentative. The aim of the present work is to explore the possible features in the excitation scheme of the nucleus using a large array of high-resolution (HPGe) γ-ray detectors and to evaluate the consistency of the observed level energies with shell-model calculations.

Experimental details

The excited states of ^{201}Po were populated using the ^{195}Pt(^{12}C, 5n) reaction at a beam energy of 86 MeV produced by the 14-UD BARC-TIFR Pelletron LINAC facility in Mumbai. The ^{12}C beam was bombarded on a 3.2 mg/cm^2 thick ^{195}Pt target with a ^{197}Ag catcher foil. The de-exciting γ-rays were detected using a hybrid array of 16 Compton-suppressed HPGe clover detectors arranged in six rings, viz. $-23°$, $\pm 40°$, $\pm 65°$, and $90°$ with respect to the beam direction, coupled with 14 $2'' \times 2''$ LaBr$_3$(Ce) scintillators. The time-stamped data were collected (in list mode format) with two- and higher-fold coincidence condition using an XIA-based digital data-acquisition system (DDAQ) [7, 8]. Two crate synchronization method was used, with one crate for digitizer modules with 100MHz sam-

*Electronic address: sahab.19phz0002@iitrpr.ac.in

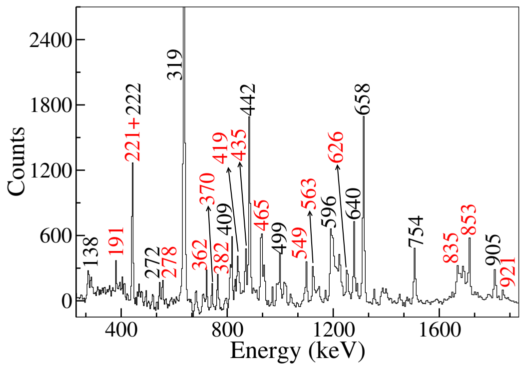

FIG. 1: Double gated spectrum with gate on 612- and 556-keV transitions, showing the γ-ray transitions belonging to ^{201}Po. Newly observed transtions are marked in red.

pling frequency (for the HPGe clovers) and the other one for modules with 250MHz sampling frequency (for the LaBr3 (Ce) detectors).

Data Analysis and Results

After the energy calibration and gain-matching of all the HPGe clover detectors, the time-stamped coincidence data were sorted into $\gamma - \gamma$ symmetric and angle dependent asymmetric matrices along with $\gamma - \gamma - \gamma$ cube by Multi-pARameter timestamped based CO-incidence Search (MARCOS) code [7]. These matrices and cubes were further analyzed by RADWARE [9] to generate the coincident γ-rays and the time differences between different detectors. Multipolarity of the γ-transitions were determined using Directional Correlation of γ-ray de-exciting Oriented states (DCO ratio method) [10] and integrated polarization directional correlation from the oriented nuclei (IPDCO) method [11].

Previously known level scheme of ^{201}Po [5] has been confirmed and about 20 new transitions have been identified. A double gated coincidence spectrum is displayed in Fig. 1 showing the known (black) and several of the new (red) transitions. The multipolarity of the already known as well as the new transitions have been identified using the measured DCO ratio and the Δ_{IPDCO} values obtained for these transitions, whenever possible. Shell model calculations are underway for comprehensive understanding of the observed level structure. The detailed experimental results along the extended level scheme will be presented during the symposium.

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