Intrinsic states at high spin in ^{201}Tl

P. Roy[1], S.K. Tandel[1],* S.G. Wahid[1], S. Suman[1], A. Patel[1], M. Hemalatha[1], A.Y. Deo[2], Pragati[2], S. Rai[3], A. Sharma[4], S.S. Bhattacharjee[5], R.P. Singh[5], and S. Muralithar[5]
[1] *UM-DAE Centre for Excellence in Basic Sciences, Mumbai 400098, India*
[2] *Department of Physics, Indian Institute of Technology Roorkee, Roorkee 247667, India*
[3] *Department of Physics, Visva-Bharati, Santiniketan 731235, India*
[4] *Himachal Pradesh University, Summer Hill Shimla, Shimla 171005, India and*
[5] *Inter University Accelerator Center, Aruna Asaf Ali Marg, New Delhi 110067, India*

Background and Motivation

Isotopes of Tl ($Z = 81$) with $A \approx 200$ allow the opportunity to explore intrinsic states embedded along with weakly collective, oblate deformed levels. Intrinsic states in these isotopes can arise from the coupling of a few to several valence neutrons in the unique-parity $i_{13/2}$ subshell and low-j orbitals with a single-proton hole considering the doubly-magic nucleus ^{208}Pb as the core. The study of these contrasting excitation mechanisms up to high spin can provide considerable nuclear structure insights.

Since it is not possible to populate Tl isotopes with $A \approx 200$ in heavy-ion fusion-evaporation reactions, previous work has been performed using relatively light ions. Excited states in the nucleus ^{201}Tl were first populated using a deuteron-induced fusion reaction with one coaxial and two planer Ge(Li) detectors for detecting γ rays [1]. In a more recent experiment, the ^{198}Pt(^{7}Li,4n) reaction was employed and γ rays were detected with the INGA array of clover Ge detectors [2]. The population of high spin states in the above experiments was limited due to the choice of the light projectile.

Experiment and Data Analysis

The present work encompasses the analysis of data from three experiments, two of these performed using the Gammasphere array consisting of 100 Compton-suppressed Ge detectors located at Argonne National Laboratory, and one with the INGA array comprising 14 Compton-suppressed clover Ge detectors and one planar Ge detector at the Inter-University Accelerator Centre, New Delhi. In the Gammasphere experiments, excited states at high spin were populated through multi-nucleon transfer reactions using heavy-ion ^{207}Pb and ^{209}Bi beams with energies 1430 and 1450 MeV, respectively, incident on a 50 mg/cm^2 ^{197}Au target. In the INGA experiment a ^{7}Li beam of 31-36 MeV energy was incident on a 10 mg/cm^2 enriched ^{198}Pt target. High-fold coincidence data were analyzed for checking the placement of known transitions, identifying new ones and their location in the level scheme, and exploring the data for the presence of high-spin isomers. The analysis was performed primarily using the Radware suite of programs [3]. More details about the data analysis may be found in our earlier publications [4, 5].

Results and Discussion

Levels up to spin $29/2\ \hbar$ have been identified in ^{201}Tl until now. In the present work, the combination of high-statistics Gammasphere data with precise timing information, and complementary evidence on polarization and other aspects obtained using INGA, provided a means to sensitively probe various nuclear structure aspects. The level scheme is extended up to spin $\approx 45/2\ \hbar$ with the observation of many new transitions. Some of the strong transitions evident in the data which were not placed in the earlier level schemes have energies 148, 314, 333 and 853 keV. In

*Electronic address: `sujit.tandel@cbs.ac.in`

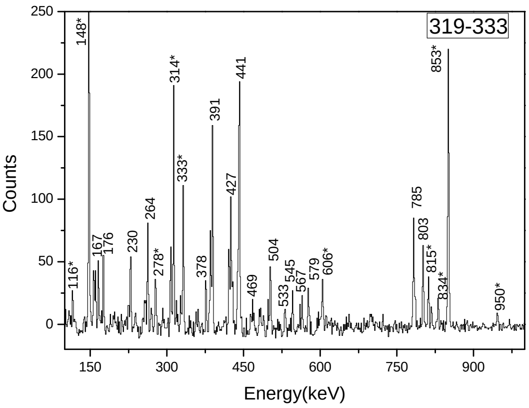

FIG. 1: Triple-coincidence γ-ray spectra (with gating energies indicated), displaying both known and new transitions in ^{201}Tl. The new transitions are marked with "*" signs.

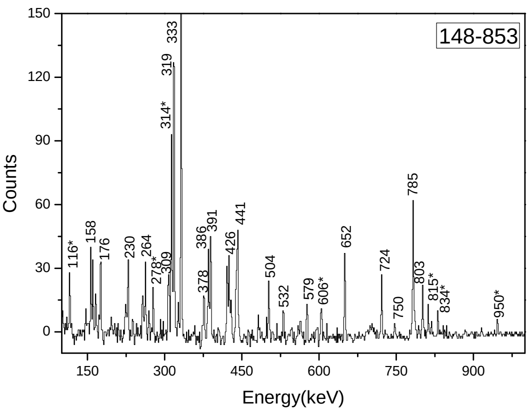

FIG. 2: Triple-coincidence γ-ray spectra with gates on two new transitions of energy 148 and 853 keV displaying known and newly observed γ rays in ^{201}Tl. The new transitions are marked with "*" signs.

addition, several weaker γ rays are clearly visible with energies 116, 815, 834, and 950 keV. A triple-γ coincidence spectrum is displayed in Figure 1 where the gating transitions are 319 and 333 keV reported earlier. Many known and new γ rays are visible in this spectrum.

Figure 2 is obtained by gating on two newly observed strong transitions of energy 148 and 853 keV; these γ rays were observed in the previous work but were not placed in the level scheme. The detailed extended level scheme, including information on the decay properties of intrinsic states in ^{201}Tl, along with an interpretation of the observations, will be presented during the symposium.

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