Isomers and intrinsic excitations at high spin in ^{201}Tl

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Introduction

Nuclei having several valence nucleons with respect to the doubly-magic ^{208}Pb core exhibit intrinsic excitations and some evidence of collectivity. The isotope ^{201}Tl ($Z = 81$, $N = 120$) is one such candidate having weak oblate deformation near the ground state along with states having intrinsic character. With increasing spin, complex interplay between intrinsic and collective excitations is evident. While there are several low-j orbitals available near the proton and neutron Fermi levels, the high-j $i_{13/2}$ neutron and $h_{11/2}$ proton orbitals play an important role in the realization of intrinsic states with metastable character.

Initial work on ^{201}Tl was reported using a deuteron-induced fusion reaction with one coaxial and two planar Ge(Li) detectors for detecting γ rays [1]. A more recent experiment was performed to study ^{201}Tl where the ^{198}Pt(^{7}Li,4n) reaction was employed [2]. The population of excited states in this experiment was limited to 29/2 $\hbar$ due to the relatively light projectile used.

Experiment and Data Analysis

Data from three different experiments have been analyzed in the present work. More information about the experiments may be found here [3]. Two and higher-fold gamma-ray coincidence data were recorded and analyzed using the Radware suite of programs for establishing the level scheme of ^{201}Tl. A detailed description of the data analysis techniques is provided in our earlier publications [4, 5].

Results and Discussion

Previously, levels up to spin 29/2 $\hbar$ were identified in ^{201}Tl. In the present work, the INGA data combined with high-statistics Gammasphere data having precise timing and complementary high-spin information were utilized to establish various aspects of the structure. Levels up to spin, $I \approx 25$ $\hbar$ and excitation energy around 8 MeV have been established and a total of fifteen newly identified transitions are placed in the level scheme. Several new high-spin isomers, with half-lives ranging between a few ns to around 200 ns, have been identified and a previously reported one with $I^{\pi} = 17/2^{-}$ has been confirmed (Fig. 1). A high-spin isomer with $T_{1/2} = 192(12)$ ns is newly identified and transitions above this level have been established using the delayed-prompt coincidence technique (Fig. 2).

While some amount of collectivity is evident in ^{201}Tl at low spin, the high-spin levels appear to result from primarily intrinsic excitations. The underlying nucleonic configurations of the intrinsic isomeric configurations have been determined. The experimental energies agree well with those obtained from empirical calculations which utilize the experimental 1-quasiparticle energies and residual interactions inferred from multi-quasiparticle states in neighboring nuclei. Additionally, shell model calculations using the Oxbash code [6] with the KHH7B interaction

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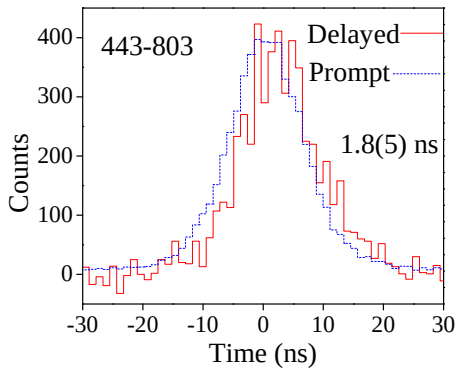

FIG. 1: Time difference between γ-rays deexciting and feeding the $17/2^-$ state; a half-life of 1.8(5) ns is inferred from the observed centroid shift.

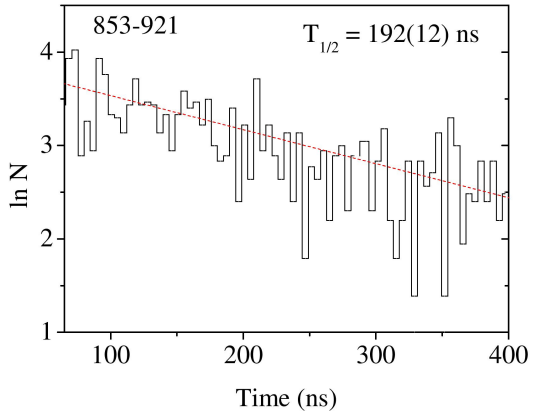

FIG. 2: Decay curve for the isomer at $E_x = 6303$ keV leading to $T_{1/2} = 192(12)$ ns.

have also been performed.

Detailed results will be presented at the symposium.

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