# High-spin structure of $^{188}$Pt nucleus

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## Introduction

Shape coexistence is a major theme in nuclear structure research, and it has been observed in many nuclei in the A∼180 mass region [1]. The shape-coexistence picture in the Pt nuclei has generated a lot of theoretical interest in recent years. In particular, whether the shape evolution in the Pt isotopes involves intruder orbitals or can be understood without invoking the intruder states has been a subject of major discussion. The shape-transitional nucleus $^{188}$Pt presents an excellent example of prolate and oblate shape coexistence. The possibility of a new type of shape phase transition occurring along its yrast cascade has already been predicted in this nucleus [2]. Similar type of shape phase transition, occurring along the yrast line between states of prolate and oblate shape, was predicted in $^{190}$W, which is yet to be studied in detail in experiments due to its neutron-richness. Following such theoretical expectation and present experimental limitation vis-a-vis $^{190}$W, a detailed spectroscopic investigation on the high-spin level structure of $^{188}$Pt is imperative, which will, in turn, also be useful to extrapolate the explanations on shape phase transition to $^{190}$W in greater detail.

The experimental data on the excited states of $^{188}$Pt are rather sparse. The latest work on this nucleus was reported by Yuan *et al.* where the $^{176}$Yb($^{18}$O,6n) reaction was used with a moderate array of thirteen HPGe detectors [2]. In that work, it was suggested that the rotation alignment of $i_{13/2}$ neutrons drives the yrast sequence to change suddenly from prolate to oblate shape at angular momentum $10\hbar$. The continuation of the yrast sequence was reported up to I = $(20^+)\hbar$ [2].

## Experimental details

In the present experimental investigation, the reaction $^{174}$Yb($^{18}$O,4n) at a beam energy of 85 MeV was used to populate the high-spin states of $^{188}$Pt at the Pelletron-Linac facility, TIFR, Mumbai. The enriched $^{174}$Yb target was prepared by electro-depositing on an Al foil of thickness ∼750 $\mu$g/cm$^2$. The thickness of the actual target was 1.14 mg/cm$^2$. The de-exciting $\gamma$ rays were detected by the Indian National Gamma Array (INGA) facility, stationed at TIFR. During this measurement, INGA was comprised of eighteen Compton suppressed clover Ge detectors, out of which, four were at 90°, three at 40°, two at 65°, three at 115°, three at 140°, and the remaining three were at 157° with respect to the beam direction. Due to the incorporation of digi-

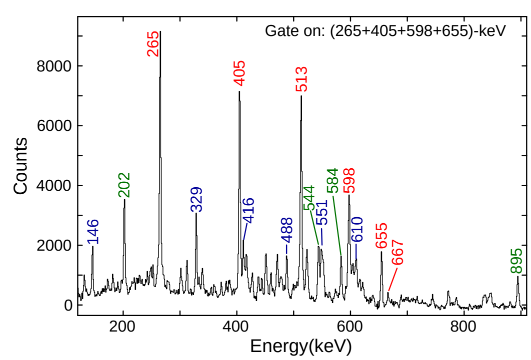


FIG. 1: Representative gated spectrum of $^{188}$Pt.

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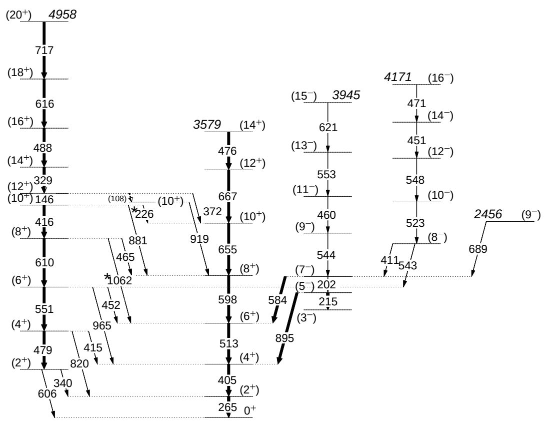


FIG. 2: Partial level scheme of $^{188}$Pt as deduced from a part of the present data set. Transitions marked with $*$ are newly observed.

tal data acquisition system in the INGA campaign at TIFR, more than two billion two- and higher fold time-stamped coincidence events were recorded for further offline analysis. The acquired data were sorted into conventional symmetric $\gamma$-$\gamma$ matrices after proper energy calibration and software gain-matching over the entire range of the energy.

## Data analysis and results

From a preliminary analysis using a part of the total acquired data set, we can see all the $\gamma$ transitions that have been reported till date. In addition, several other transitions which seem to be potential candidates to be placed in its level scheme are there in the gated spectra. These, of course, need to be confirmed from the analysis of 3-dimensional $\gamma^3$ cube at a later stage. A representative gated spectrum is shown in Fig. 1, where several gates in the ground state band were added together. Apart from the prolate band built on the ground state and the oblate band based on the 605.5 keV state, the negative parity side band reported by Richter *et al.* was vividly seen in the present data [3].

From the preliminary analysis, the $12^+_1$ and the $7^-$ isomeric levels are seen (Fig. 2). In the case of $7^-$ isomer, a delayed side feeding component with $T_{1/2} = 0.66$ ns was observed earlier in a half-life measurement [4]. A $\gamma$-ray with energy of 689-keV ($9^- \to 7^-$) was anticipated as the corresponding transition. In the present data set, this 689-keV transition, depopulating the $9^-$ level at $E_x = 2456$ keV, is clearly seen. It would be interesting to check if there is any connecting transition between the isomeric yrast $12^+$ level and this $9^-$ level, or if there is any branching between one of the $10^+$ levels to the $9^-$ level at 2456 keV. The observation of any such transition will imply that the half-life of the $9^-$ level at $E_x = 2456$ keV may not be similar to the isomeric $12^+_1$ level ($T_{1/2} = 0.66$ ns) of this nucleus. Detailed spin and parity measurements following the standard DCO (directional correlations of the $\gamma$ rays de-exciting oriented states) and IPDCO (integrated polarizational directional correlation from oriented nuclei) methods, respectively, are planned to be performed for the newly found levels as well as for the levels that were reported earlier. The analysis is in progress, and the results will be presented at length during the symposium.

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