Quasi-γ and semi-decoupled band structures in ^{188}Pt

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Introduction

A unique and complex transitional region of nuclei, represented by Pt isotopes around N=110, exists between well deformed W and Os nuclei and the spherical Pb nuclei with Z=82. In general, the high-spin level structure of even-A Pt nuclei around N=110 are characterized by the following features: (i) backbending behavior in the positive parity yrast sequences at about spin I=10$\hbar$; (ii) prolate-oblate shape coexistence; (iii) quasi-γ or γ-vibrational band structure, and (iv) semi-decoupled 5^- band. The quasi-γ or γ-vibrational band structures in the even-A Pt nuclei lie very low in excitation energy. Such low-lying γ-bands are predicted for nuclei which are not axially symmetric. The semi-decoupled 5^- band occurs systematically across the even-A Pt and Hg nuclei with the energy of the 5^- state being lower in Pt than Hg. The intrinsic structure of such bands in the even-A Hg nuclei in this mass region was suggested to be dominated by two quasi-particle components involving a decoupled $i_{13/2}$ neutron and a low-j neutron partner [1, 2].

The experimental data on the excited states of ^{188}Pt are rather sparse. In addition, the quasi-γ band and the $K^\pi = 5^-$ band in this nucleus lack proper description. A detailed analysis and interpretation on these two structures are presented here in this paper.

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Experimental details

High-spin states in the residual nucleus ^{188}Pt were populated in the fusion-evaporation reaction ^{174}Yb(^{18}O,4n) using a 85 MeV beam provided by the Pelletron-Linac facility, TIFR, Mumbai. The enriched ^{174}Yb target (thickness$\sim$1.14 mg/cm^2) was prepared by electro-deposition on an Al foil of thickness $\sim$750 μg/cm^2. Emitted γ rays from the ^{188}Pt residual nucleus were detected by the Indian National Gamma Array (INGA) spectrometer which was comprised of eighteen Compton-suppressed clover Ge detectors at the time of the measurement.

Results and discussion

A. the quasi-γ-vibrational band

The quasi-γ-vibrational band, reported earlier by Richter *et al* [3] has been observed in the present work (Fig. 1). We suggest the 10_2^+ level at excitation energy, E$_x$ = 2663.3 keV, as part of this band. All the interband (from the quasi-γ to the ground-band) ΔJ = 0 and ΔJ = 2 transitions including the previously unobserved 1062.1 keV ($8_2^+ \rightarrow 6_1^+$) and 226.5 keV ($10_2^+ \rightarrow 10_1^+$) transitions have been observed in the present work and their relative intensities have been measured.

In order to substantiate the previous quasi-γ band interpretation for this sequence, the experimental branching ratios for the interband transitions were compared with Alaga intensity rules [4]. With Alaga values differing from the experimental branching ratios by almost an order of magnitude, Davydov model was invoked to estimate the magnitude of γ deformation associated with this band [5].

This exercise has revealed that, indeed, triaxiality is associated with this sequence with γ degrees of freedom ranging from 20° to 28°. Therefore, this quasi-γ band in ^{188}Pt cannot be described as γ vibration of a prolate deformed rotor since the value of γ is considerably different from zero, especially with increasing spin in the g-band.

B. the $K^\pi = 5^-$ band

This negative parity band with a rather irregular structure has been observed up to spin $I = 17^-$ in the present data (Fig. 1). It should be noted that the γ rays in this sequence were known earlier from private communications to NNDC [6]. However, ambiguity prevails till date in the Evaluated Nuclear Structure Data File (ENSDF) of NNDC over their correct order above the 2179.4 keV level [6]. In the present work, the longstanding ambiguity has been removed from the analysis of triple-γ coincidence data. The correct sequence of γ rays over the 2179.4 keV level as proposed from the present data is: 523.3-, 548.7-, 451.2-, 471.5-keV.

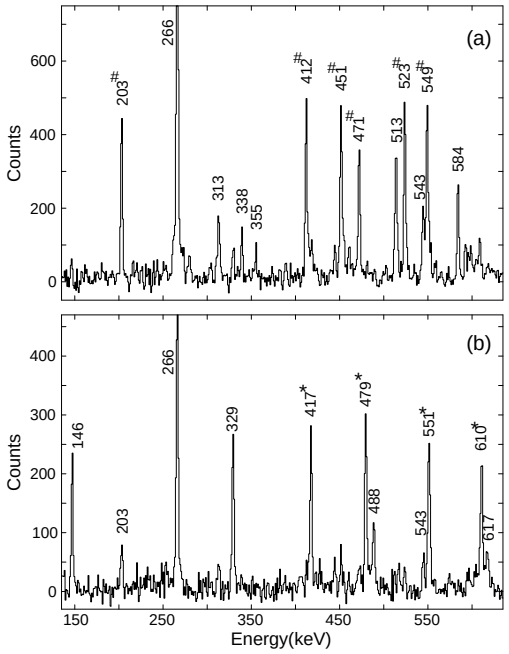

FIG. 1: Representative gated spectrum showing the transitions in the $K^\pi = 5^-$ semi-decoupled (a) and $K^\pi = 2^+$ quasi-γ band (b) in ^{188}Pt. The interband transitions in these two sequences are marked with "#" and "$*$" symbols, respectively. Contaminated peaks are not labeled.

The "semi-decoupled model" proposed by Neergård, Vogel and Radomski has been more effective in explaining the existence and evolution of such low-lying odd-parity states in even-A Pt-Hg nuclei in this mass region [2]. The possibility of describing this 5^-, 7^-, 9^-, ... sequence in the context of a $K^\pi = 0^-$ octupole band does not seem to be favorable in the present case because the lower-lying 3^- and 1^- states have not been observed. In addition, the band near its origin decay out to two different sequences (ground- and quasi-γ bands) with $K^\pi = 0^+$ and $K^\pi = 2^+$. On the other hand, the systematic comparison of this sequence in ^{188}Pt with similar 5^-, 7^-, 9^-, ... sequences in the other Pt isotopes (already established as "semi-decoupled structures") clearly depicts that all these bands fall into one single group.

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