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OBLATE COLLECTIVITY IN THE YRAST STRUCTURE OF ^{194}Pt*

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A deep inelastic reaction using a 460 MeV ^{82}Se beam incident upon a thick ^{192}Os target was performed at the Legnaro National Laboratory, Italy. The resulting γ-decays were measured using the GASP array. Results for ^{194}Pt extend the known level scheme of the yrast structure from spin $I = (12\ \hbar)$ to $(20\ \hbar)$. The irregularities in the sequence of the new transition energies and total Routhian surface calculations show a breakdown in collectivity with an yrast oblate shape remaining to high spin.

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1. Introduction

Heavy neutron-rich nuclei with $A \sim 190$ are exciting research areas for many nuclear structure phenomena including K-isomerism, γ-softness and oblate-prolate shape change. Little spectroscopy of neutron-rich nuclei in

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this mass region has been performed. Using different reaction techniques such as projectile fragmentation, or deep inelastic reactions combined with sensitive γ-ray spectrometers, it is now possible to access this region and gain valuable information.

2. Experimental details and results

A range of nuclei in the $A \sim 190$ region were excited using deep inelastic multi-nucleon transfer reactions, and their subsequent γ-decays detected with the GASP array at the Laboratori Nazionali di Legnaro, Italy. A ^{82}Se beam at an energy of 460 MeV impinged upon an isotopically enriched (97.8%) 50 mg/cm^2 ^{192}Os target backed with 0.2 mm of ^{181}Ta to stop all reaction products.

Previously unknown γ-ray transitions have been identified for beam-like [1] and target-like [2] fragments. Fig. 1(a) shows a spectrum of transitions associated with ^{194}Pt. Highlighted ($^{\#}$) are transitions in this nucleus that

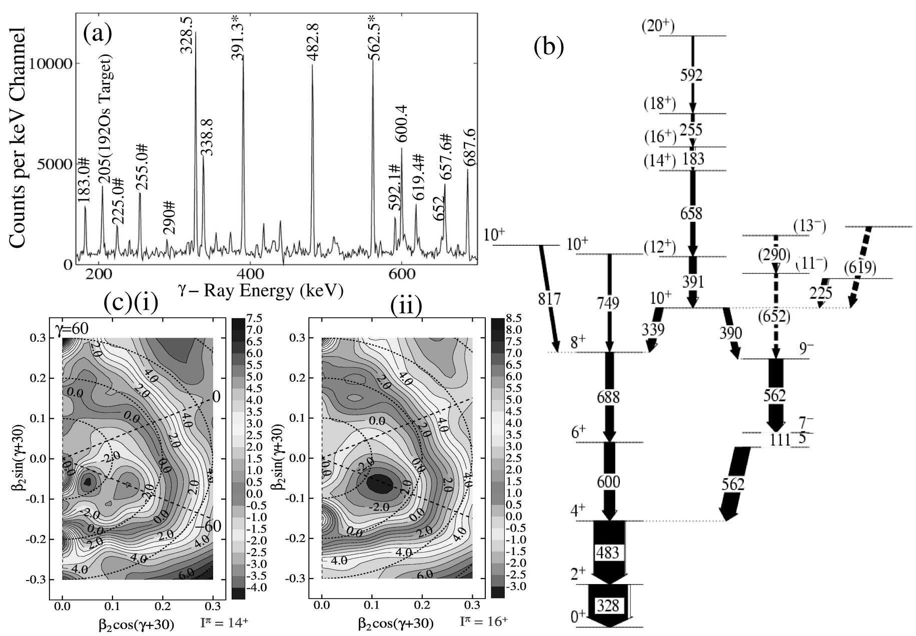

Fig. 1. (a) γ-ray spectrum highlighting the transitions in ^{194}Pt double gated on all previously known yrast transitions from $0^+ \to (12^+)$ where * and $^\#$ denote doublet and new transitions, respectively. (b) Partial level scheme for ^{194}Pt. (c) TRS plots for *(i)* $I = 14\ \hbar$ with an energy minimum offset from the oblate collective axis and a small deformation of $\beta_2 \sim 0.08$; *(ii)* $I = 16\ \hbar$ with an oblate collective minimum at $\beta_2 \sim 0.15$.

have been observed for the first time. The 619 keV transition must be treated as tentative due to it being unresolved from the first-excited transition in the binary partner ^{78}Ge. There is evidence for the previously observed [3] 652 keV transition despite the intense 655 keV transition from the first excited state of the ^{82}Se projectile. Due to the dominance of the 655 keV, and the weakness of the 652 keV transitions, it was not possible to confirm the coincidence of the 652 keV with the 290 keV transition, and the latter should thus be treated as tentative. The 656, 183, 255 and 592 keV transitions are all in coincidence with the lower portions of the ground state and negative parity bands. Table I contains relative γ-ray intensities, total transition intensities and tentative spin assignments for the new states shown in the revised level scheme of Fig. 1(b). The ordering of the new transitions was established by analysing a variety of double-gated spectra and the relative γ-ray intensities were calculated using a double-gated spectrum of the $2^+ \to 0^+$, 328 keV and $4^+ \to 2^+$, 483 keV transitions. The total transition intensities are calculated on the assumption of stretched E2 transitions for the 656, 183, 255, and 592 keV γ-rays. DCO ratios and angular distribution analysis could not determine unambiguously the multipolarities of the new transitions due to their weak intensities. If dipole multipolarities are considered for the four new yrast transitions above 12 $\hbar$, the ordering remains the same, although the intensities of the 183 and 255 keV γ-rays are brought to within one standard deviation, and it is thus increasingly possible that their ordering is reversed.

TABLE I

γ-ray energies, γ-ray intensities I_γ, total transition intensities I_T and level assignments for the new transitions (#) and B(E2) values of transitions from the 10^+ states in ^{194}Pt (847, 749 keV [4], 338.8 keV [5]) measured in Weisskopf units.

E_γ(keV)	I_γ	I_T (E2)	$E_i \to E_f$ (keV)	$J_i^\pi \to J_f^\pi$	B(E2)
183.0#	42 (5)	64 (8)	3670 → 3487	$(16^+) \to (14^+)$	
225.0#	41 (5)		3057 → 2438	$\to (10^+)$	
255.0#	47 (5)	54 (5)	3925 → 3670	$(18^+) \to (16^+)$	
290 #	21 (4)	23 (4)	2990 → 2700	$(13^-) \to (11^-)$	
592.1#	48 (6)	49 (6)	4517 → 3925	$(20^+) \to (18^+)$	
619.4#	92 (7)		2663 → 2438	$\to (10^+)$	
657.6#	91 (7)	92 (7)	3487 → 2829	$(14^+) \to (12^+)$	
338.8	100(11)[a]	107(12)	2438 → 2099	$10^+ \to 8^+$	0.17(3)
749			2848 → 2099	$10^+ \to 8^+$	34 (6)
847			2916 → 2099	$10^+ \to 8^+$	$42\ (^{+8}_{-10})$

Note: [a] The γ-ray intensities are normalised to 100 units for the 338.8 keV transition.

3. Discussion

Previous experiments [3, 4] have identified the yrast structure of ^{194}Pt up to $I = (12\ \hbar)$, which is extended to $(20\ \hbar)$ in the present work. In the Coulomb excitation work of Ref. [4], two $I^\pi = 10^+$ states close in energy to the yrast 10^+ state were identified — a rotationally aligned $\pi(h_{11/2})^{-2}$ state, and a member of the ground state band. The $T_{1/2} = 6.4$ ns [6] isomeric yrast 10^+ state is attributed to a $\nu(i_{13/2})^{-2}$ structure [4]. B(E2) values for these states can be seen in Table I. The B(E2) of the yrast 10^+ isomer is approximately a factor of 20 smaller than those of the transitions from the two other 10^+ states. This indicates a significant change in structure compared to the 8^+ member of the ground state band.

Total Routhian Surface (TRS) plots have been performed for ^{194}Pt using a technique identical to that of Ref. [7]. The parameterisation of Ref. [8] was used for the macroscopic part of the total energy. The TRS plots shown in Fig. 1(c) for spins 14 $\hbar$ and 16 $\hbar$ represent the yrast states of the positive parity of the nucleus. The calculations show that the nucleus is oblate in its ground state and its yrast structure up to 8 $\hbar$ is dominated by an oblate collective minimum with $\beta_2 \sim 0.14$. They show that the nucleus does not exhibit purely collective oblate behaviour between $8\hbar$ and 14 $\hbar$, which is qualitatively consistent with the transition energies and the expected change in structure indicated by the 10^+ isomer. The calculations show a return to oblate collective rotation at 16 $\hbar$ and $18\hbar$, only to exhibit again a non-collective or triaxial nature at 20 $\hbar$, also consistent with the transition energies at these spins.

The observed yrast structure of ^{194}Pt in the $I = (12\hbar) \rightarrow (20\ \hbar)$ region contrasts with the systematics of its isotonic and isotopic partners [3, 9], which have typical rotational yrast structures with an oblate-prolate shape change at high spins. However the TRS calculations for ^{194}Pt show an oblate shape that, unusually, persists to 20 $\hbar$. The oblate shape of ^{194}Pt at low spin is substantiated in the Coulomb excitation work of Ref. [4]. A similar persistance of oblate shapes to high spin has also been predicted in the neutron-rich $A \sim 110$ region [10].

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