

Experimental report

13/09/2023

Proposal: 3-17-59

Council: 10/2022

Title: Odd isomeric ratios in odd Pt isotopes

Research area: Nuclear and Particle Physics

This proposal is a new proposal

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Samples: 192Pt
196Pt
190Pt
198Pt

Instrument	Requested days	Allocated days	From	To
FIPPS	147	35	04/04/2023 22/05/2023	18/04/2023 12/06/2023

Abstract:

We intend to study the structures of odd-A 191,193,197,199Pt isotopes, making use of the neutron capture reaction on the 190,192,196,198Pt enriched targets and γ - γ coincidence technique at the FIPPS γ -ray spectroscopy facility. The reactions will populate a large number of excitations below the neutron separation energies in the investigated nuclei. This will be crucial for: i) extracting the fraction of the population of the 13/2+ isomers, being of high importance in nuclear medicine, and ii) tracing the emergence of the shape coexistence phenomenon in these nuclei, which may serve as a test bench for different theoretical approaches in nuclear physics.

EXPERIMENT 3-17-59

The experiment 3-17-59 “Odd isomeric ratios in odd Pt isotopes” was performed at FIPPS prompt γ rays facility in ILL. The goal of this measurement was to study the structures of odd-A Pt isotopes populated in thermal neutron capture reactions, making use of the γ - γ coincidence technique. The experiment consisted of two parts: the first devoted to the ^{199}Pt and the second to the ^{191}Pt isotope.

The setup consisted of 63 (or 59 in the second part) HPGe crystals: 8 clovers of FIPPS arranged in annular geometry around the target and 8 (or 7 in the second part) clovers provided by IFIN-HH (Bucharest, Romania), placed at 45° with respect to the beam-line. The HPGe detectors were equipped with BGO shields.

The first part of the experiment started on the 04/04/2023 and finished on the 18/04/2023. A total of 265 hours of $^{198}\text{Pt}(n,\gamma)^{199}\text{Pt}$ measurement was performed. A 55-mg target of ^{198}Pt (96% enriched) was used.

In both parts of the experiment the targets were put in the holder inside the Li tube to prevent from the scattered neutrons, as shown in Fig.1.



Fig.1. The placement of the target, ^{198}Pt (left) and ^{190}Pt (right) in the target holder.

The collected data were sorted online into a γ - γ coincidence matrix using preliminary energy calibration and alignment coefficients. The good statistics obtained for the ^{199}Pt isotope allowed to perform preliminary analysis of γ -coincidence spectra (the representative examples are shown in Fig. 2). As a result, 22 new transitions and 3 new levels were found and placed in the ^{199}Pt capture state's decay scheme – they are marked in red in Fig.3.

Further analysis of γ -coincidence data on ^{199}Pt will provide extended information on the level scheme of this nucleus while the angular correlations of γ rays will allow to determine spin and parity of the states.

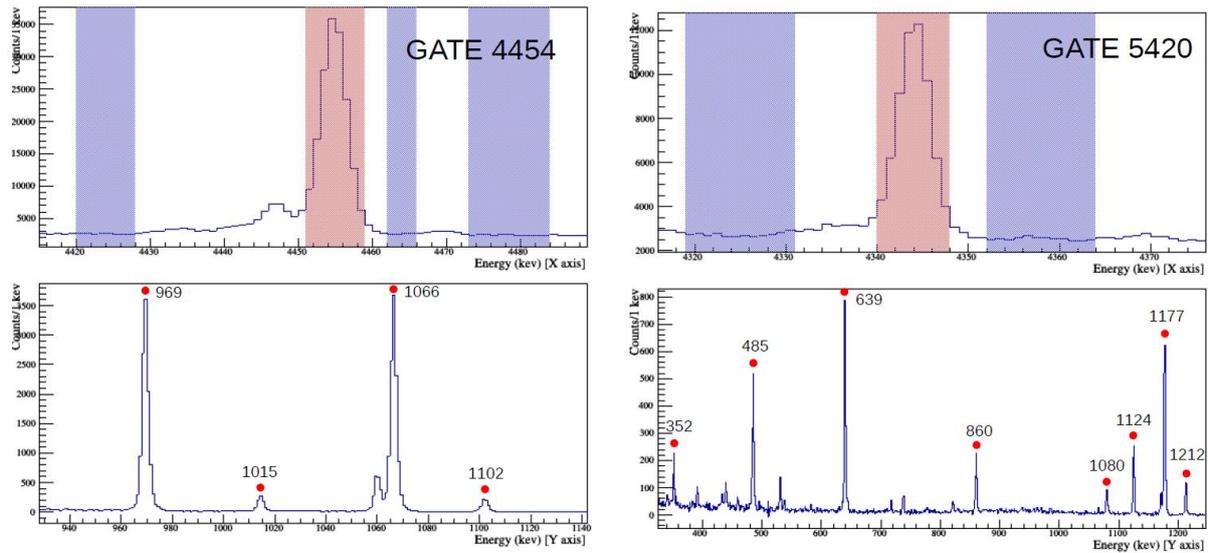


Fig.2. Representative γ -coincidence spectra of ^{199}Pt (bottom panels) obtained by gating on the primary γ -ray transitions at 4454 keV and 5420 keV in the projection of γ - γ matrix (top panels).

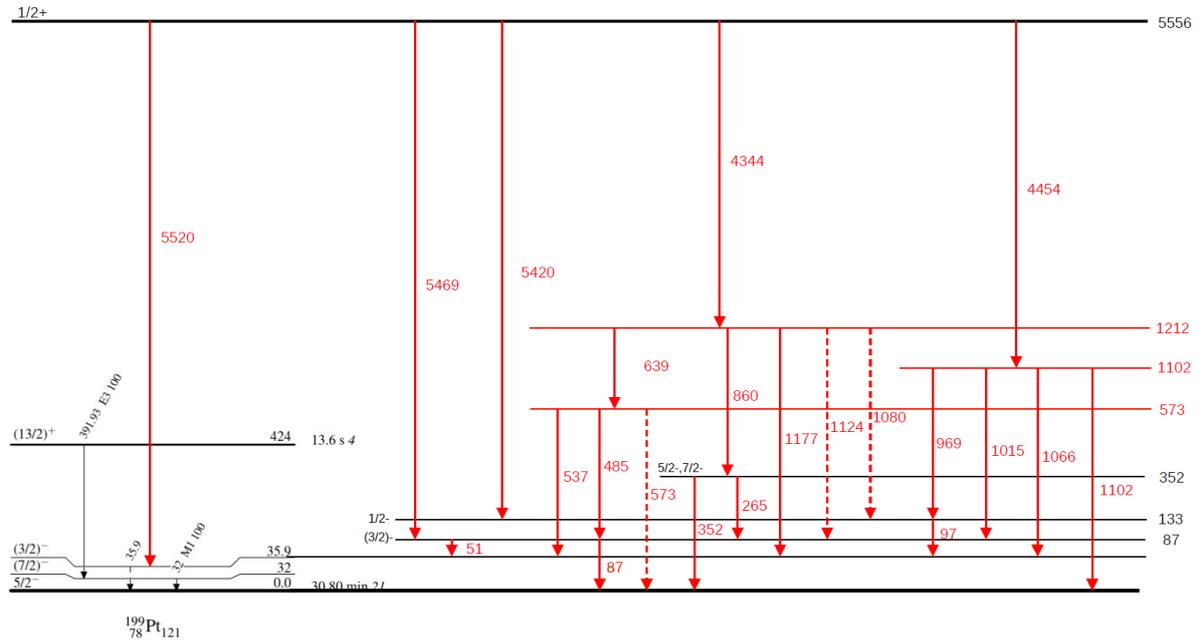


Fig.3. A very preliminary level scheme of the decay of capture state in ^{199}Pt isotope resulted from the online analysis of the partial $^{198}\text{Pt}(n,\gamma)^{199}\text{Pt}$ data collected during the 3-17-59 experiment. The energy levels and gamma transitions marked in red were newly observed.

The second part of the experiment took place from 22/05/2023 to 12/06/2023. A total of 498 hours of $^{190}\text{Pt}(n,\gamma)^{191}\text{Pt}$ measurement was performed. A 12.1-mg ^{198}Pt enriched target was used.

The collected data from this part of the measurement were sorted online into the γ - γ coincidence matrix, similarly as in the ^{199}Pt case. Since it was the first time when a thermal neutron capture reaction on ^{190}Pt was used to study the structure of the ^{191}Pt nucleus, no previous information on the population of the excited states in this reaction was known. Therefore, a systematic checks of the primary γ rays from the capture state at neutron binding energy ($S_n = 6448(7)$ keV) in ^{191}Pt populating the low-spin excitations known from other reactions were performed. As a result, the previously-known 452-keV level was found to be fed by the 5990-keV transition directly from the capture state of ^{191}Pt (Fig. 4).

Further analysis of collected γ -spectroscopy data will provide first information on the level scheme of ^{191}Pt resulting from the thermal neutron-capture reaction.

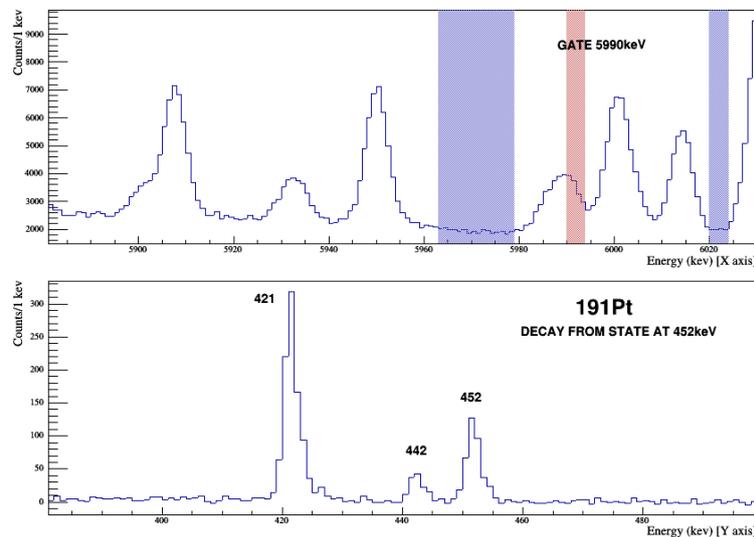


Fig.4. The γ -coincidence spectrum of ^{191}Pt (bottom panel) obtained by gating on the primary γ -ray transition 5990 keV in the projection of γ - γ matrix (top panel).