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ONE-LINE γ RAY SPECTROSCOPIC INVESTIGATION OF THE $^{180}\text{Hg}(T^{1/2} = 3 \text{ s})$ DECAY CHAIN

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Résumé. — Avec le séparateur ISOLDE 2 reconstruit, nous avons étudié en ligne pour la première fois les produits de désintégration du ^{180}Hg . Les périodes de désintégration, les intensités des principales transitions γ des désintégrations du $^{180}\text{Hg}(T^{1/2} = 3,0 \pm 0,3 \text{ s})$ et de $^{180}\text{Au}(T^{1/2} = 8,1 \pm 0,3 \text{ s})$ et un schéma partiel des états excités de ^{180}Pt sont présentés.

Abstract. — With the rebuilt ISOLDE 2 facility we have investigated on-line the ^{180}Hg decay products. The decay half-lives, the energies and intensities of the main γ lines of both

$^{180}\text{Hg}(T^{1/2} = 3.0 \pm 0.3 \text{ s})$ and $^{180}\text{Au}(T^{1/2} = 8.1 \pm 0.3 \text{ s})$,

and a tentative decay scheme of ^{180}Pt are given.

1. Introduction. — Using the ISOLDE 2 facility one-line with the reconstructed 600 MeV-proton synchrocyclotron, we have investigated the $A = 180$ mercury decay products for the first time with our new tape transport system. The molten lead target is bombarded by 600 MeV protons, spallation reactions ($p, 3pxn$) are induced and neutron deficient mercury nuclei are produced and mass-separated by the ISOLDE 2 separator. The weakness of the cross-section for the reaction ($p, 3p\ 26n$) is such that an increased intensity of the proton beam will be necessary for further studies.

Before this work the α -decay systematic study of Hg isotopes and also the delayed-proton emission characteristics were studied by another ISOLDE team [1, 2]. In this letter we present the half-life measurements based on multianalysis for the main γ transitions belonging to the ^{180}Au decay. Although no γ - γ coincidence experiments could be performed, we propose a possible low-energy decay scheme of the ^{180}Pt nucleus.

2. Experimental procedure. — Due to the γ background and to the low production of this mass (~ 10 at/s) we performed a β - γ coincidence experiment. The separated beam of ^{180}Hg ions was deposited on the tape of the new moving tape collector system. The tape is then moved to the centre of a 4π plastic scintillator detector. A LASCO 50 cm³ Ge(Li) detector is positioned in front of this detector; the activity of interest is enhanced by proper timing selection of collection, delay and counting time; this procedure is repeated as long as is required. The γ energy spectrum in coincidence with the plastic β counter pulses is converted in an Analog to Digital Converter (Inter technique CT 103) on-line with a Plurimat computer system. The experimental set up arrangement is similar to that described by F. K. Wohn *et al.* [3].

Two experiments were done simultaneously during a 48 hours period. On the Plurimat computer system a time- γ energy multianalysis ($8 \times \Delta t \times 1\ 024$ channels) was recorded ($\Delta t_1 = 4 \text{ s}$, $\Delta t_2 = 6 \text{ s}$). On a separate

multichannel analyser a 4 k γ -energy spectrum was constantly accumulated during the multianalysis experiment.

3. Results. — We have identified the main γ lines belonging to both mercury and gold decays (see Table I, Fig. 1, 2). We have followed the decay of the main γ lines in order to measure the half-lives and to confirm the attribution of the transitions to both decays. With a least-squares fitting code we obtain

for $^{180}\text{Hg} \rightarrow ^{180}\text{Au}$ the half-life $T^{1/2} = 3.0 \pm 0.3$ s
for $^{180}\text{Au} \rightarrow ^{180}\text{Pt}$ the half-life $T^{1/2} = 8.1 \pm 0.3$ s.

A preliminary result from the ISOLDE Group [4] for the gold decay gave

$$T^{1/2} \sim 8.5 \text{ s.}$$

The first value for the $2^+ \rightarrow 0^+$ transition energy in $^{180}\text{Au} \rightarrow ^{180}\text{Pt}$ given by P. Hornshøj *et al.* [2] was 150 ± 15 keV, obtained from the delayed-proton emission study of ^{181}Hg ; we find 152.3 ± 0.3 keV.

TABLE I

Energies and relative intensities of the main γ transitions observed

$^{180}\text{Au} \rightarrow ^{180}\text{Pt}$		$^{180}\text{Hg} \rightarrow ^{180}\text{Au}$	
E_γ (keV)	I_r (relative intensity)	E_γ (keV)	I_r (relative intensity)
152.2 $\pm$ 0.3	100	125.0 $\pm$ 0.4	9.7 $\pm$ 2
256.4 $\pm$ 0.3	29.6 $\pm$ 6	300.5 $\pm$ 0.3	100
324.0 $\pm$ 0.3	17.7 $\pm$ 3.4	381.2 $\pm$ 0.4	69.3 $\pm$ 14
343.4 $\pm$ 0.3	13.6 $\pm$ 2.8	(405.0 $\pm$ 0.5)	$\sim$ 17
(450.5 $\pm$ 0.5) ⁽¹⁾	$\sim$ 7	(450.5 $\pm$ 0.5) ⁽¹⁾	$\sim$ 16
524.2 $\pm$ 0.3	44 $\pm$ 6.6	479.9 $\pm$ 0.4	23 $\pm$ 4.5
(552.4 $\pm$ 0.4)	$\sim$ 6.5		
676.5 $\pm$ 0.4	20 $\pm$ 4		
(707.7 $\pm$ 0.5)	$\sim$ 4		
808.4 $\pm$ 0.4	30 $\pm$ 6		
859.7 $\pm$ 0.6	35 $\pm$ 7		
1 032.1 $\pm$ 0.7	23 $\pm$ 4.5		

(¹) Transition belonging to both decays transitions in ( ) are weak.

FIG. 1. — Accumulated γ -ray spectra from $\text{Hg} \rightarrow \text{Au} \rightarrow \text{Pt}$ decays of mass 180 (+ $\text{Hg} \rightarrow \text{Au}$, $\bullet$ $\text{Au} \rightarrow \text{Pt}$, Δ $\text{Pt} \rightarrow \text{Ir} \rightarrow \text{Os}$). Spectrum 1 is recorded with 8 s collection, 0 s delay, and 8×4 s measurement ($\text{Hg} \rightarrow \text{Au} \rightarrow \text{Pt}$ favoured). Spectrum 2 is recorded with 15 s collection, 8 s delay, and 8×6 s measurement ($\text{Au} \rightarrow \text{Pt} \rightarrow \text{Ir} \rightarrow \text{Os}$ favoured).

FIG. 2.—Example of the half-life determination in the A = 180 chain.

It is possible that some of our γ lines attributions are perturbed by the decay of the parallel chain coming from the α branching of

Unfortunately the γ transitions of these decays are unknown [5]. We have considered that only the γ lines whose relative intensity with respect to the strongest γ line at 152.3 keV was conserved with two different timing measurements could be assigned to the ¹⁸⁰Au decay. On the other hand no ambiguity occurs for the γ lines attributed to the ¹⁸⁰Hg $\rightarrow$ ¹⁸⁰Au decay.

4. Discussion. — Due to the weakness of the production we could not perform any γ - γ or e^- - γ coincidence experiments to support our level scheme proposal.

By performing simple sum relationships calculations with the transition energies and comparing with the excited levels systematics of the heavier platinum nuclei [6, 7] (see Fig. 3) we propose a partial scheme (see Fig. 4). We believe we have identified the 2^+_1 , 4^+_1 , 2^+_2 , 3^+_1 , 2^+_3 states.

FIG. 4. — Partial decay scheme of ¹⁸⁰Au $\rightarrow$ ¹⁸⁰Pt.

FIG. 3. — Systematics of the excited levels of ^{180,182,184,186}Pt nuclei.

These assumptions are in agreement with our previous interpretation [6, 7] of the behaviour of the neutron deficient platinum isotopes : in fact, the prolate-oblate shape transition occurs from ^{186}Pt to ^{188}Pt and the three nuclei $^{180,182,184}\text{Pt}$ show a rather similar level structure not yet perturbed, slowly varying with little energy differences. In particular the ^{180}Pt nucleus cannot be considered as truly rotational : the ratio

$$\frac{B(E2; 2_2^+ \rightarrow 0_1^+)}{B(E2; 2_2^+ \rightarrow 2_1^+)} \simeq 0.14$$

is still far from the 0.7 rotational limit value as is the energy ratio $E4_1^+/E2_1^+ = 2.68$ compared to the 3.3 limit; the three nuclei $^{180,182,184}\text{Pt}$ remain slightly deformed ($\beta > 0$) but still transitional.

In conclusion, other experiments are necessary to confirm this tentative interpretation of the ^{180}Pt nucleus (0_2^+ excited state location, etc...) but we believe that this nucleus, far from the β stability line, is slightly prolate, and below 1.2 MeV, shows similar properties to those of $^{182,184}\text{Pt}$ nuclei.

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