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Ernest O. Lawrence Radiation Laboratory

ANGULAR DISTRIBUTIONS OF GAMMA RAYS EMITTED IN $^{197}Au(p, 2n)^{196}Hg$ AND $^{197}Au(p, 4n)^{194}Hg$ REACTIONS

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ANGULAR DISTRIBUTIONS OF GAMMA RAYS EMITTED IN $^{197}Au(p,2n)^{196}Hg$ AND $^{197}Au(p,4n)^{194}Hg$ REACTIONS[†]

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ABSTRACT

Study of angular distribution of gamma rays in $^{197}Au(p,2n)$ and $^{197}Au(p,4n)$ reactions has established levels of ^{196}Hg and ^{194}Hg and determined the level spins and transition multipolarities as follows (energy in keV): 425, 2+; 1035, 2+; 1060, 4+; 1755, 5-; 1785, 6+ in ^{196}Hg and 426, 2+; 1061, 4+; 1795, 6+; 1808, 5-; 1907, 7- in ^{194}Hg.

[†]Work performed under the auspices of the U. S. Atomic Energy Commission.

The angular distributions of gamma rays emitted in $^{197}Au(p,2n)^{196}Hg$ and $^{197}Au(p,4n)^{194}Hg$ were measured with use of lithium-drifted germanium detectors in the beam of the Berkeley 88" cyclotron.

The gamma-ray spectrum at E_p = 12 ~ 16 MeV revealed gamma rays in ^{196}Hg involving the 1_2^+, 2_2^+, 4^+, 5^-, and 6^+ levels (see Fig. 1). The $0^+ - 1_2^+ - 4^+ - 5^-$ sequence was recently found by Petry, Naumann, and Evans[1] in the decay of ^{196m}Tl. The angular distributions are illustrated in Fig. 2 and also tabulated in Table I. All of these are consistently explained assuming the level scheme and spins and parities given in Fig. 1. The A_2 value of the $6^+ \rightarrow 4^+$ gamma ray is very large, being close to the average value ~0.3 observed in heavy ion induced reactions,[2] while those of other transitions decrease appreciably as the spin decreases because of many possible processes of population that gives rise to smearing out the alignment. The negative value of $A_2(695)$ uniquely assigns the $5^-(E1)4^+$ sequence. The present results agree with the anisotropy measurements on gamma rays and conversion electrons carried out by the Tokyo group.[3] The gamma-ray spectrum at E_p = 35 MeV predominantly showed gamma rays of ^{194}Hg associated with the level scheme presented in Fig. 1. The 2^+, 4^+, 5^-, and 7^- levels were also studied by Petry, Naumann, and Evans from the decay of ^{194m}Tl. In Table II are shown A_2 values which were deduced from $I_\gamma(158^\circ)/I_\gamma(90^\circ)$ by assuming $A_4 = 0$. These values are consistent with the given level scheme.

Further experiments and analyses are in progress. It is apparent that study of angular distributions of gamma rays in nuclear reactions of this kind is a powerful tool to determine level spins and transition multipolarities.

REFERENCES

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2. R. M. Diamond, E. Matthias, J. O. Newton and F. S. Stephens, UCRL-16889, May 1966.

3. H. Ejiri, M. Ishihara, M. Sakai, K. Katori, and T. Inamura, Phys. Letters 18, 314 (1965); INS-Report 94 to be published; H. Ejiri, M. Ishihara, K. Katori, and T. Inamura, private communication.

Table I. Angular distribution of gamma rays of ^{196}Hg emitted in $^{197}Au(p,2n)$ reaction at E_p = 16 MeV.

Transition	Energy (keV)	Angular distribution	
		A_2	A_4
$^1 2^+ \rightarrow 0^+$ E2	425	0.073±0.009	0.007±0.014
$^2 2^+ \rightarrow {}^1 2^+$ E2 + M1	610	0.068±0.041	0.051±0.063
$4^+ \rightarrow {}^1 2^+$ E2	635	0.121±0.008	-0.003±0.012
$5^- \rightarrow 4^+$ E1	695	-0.120±0.011	0.004±0.017
$6^+ \rightarrow 4^+$ E2	725	0.235±0.056	-0.045±0.085

Table II. Angular anisotropy of gamma rays of ^{194}Hg emitted in $^{197}Au(p,4n)$ reaction at E_p = 35 MeV.

Transition		Energy (keV)	$I_\gamma(158^\circ)/I_\gamma(90^\circ)$	A_2[a]
$2^+ \rightarrow 0^+$	E2	426	1.24	0.14±0.02
$4^+ \rightarrow 2^+$	E2	635	1.24	0.14±0.02
$6^+ \rightarrow 4^+$	E2	734	1.51	0.25±0.05
$5^- \rightarrow 4^+$	E1	747	0.86	-0.10±0.03
$7^- \rightarrow 5^-$	E2	99	1.27	0.15±0.02
$7^- \rightarrow 6^+$	E1	112	0.90	-0.07±0.02

[a] Deduced from $I_\gamma(158^\circ)/I_\gamma(90^\circ)$ by assuming $A_4 = 0$.

FIGURE CAPTIONS

Fig. 1. The levels and transitions of ^{194}Hg and ^{196}Hg populated in $^{197}Au(p,xn)$ reactions.

Fig. 2. Angular distributions of gamma rays of ^{196}Hg in $^{197}Au(p,2n)^{196}Hg$ reaction at E_p = 16 MeV.

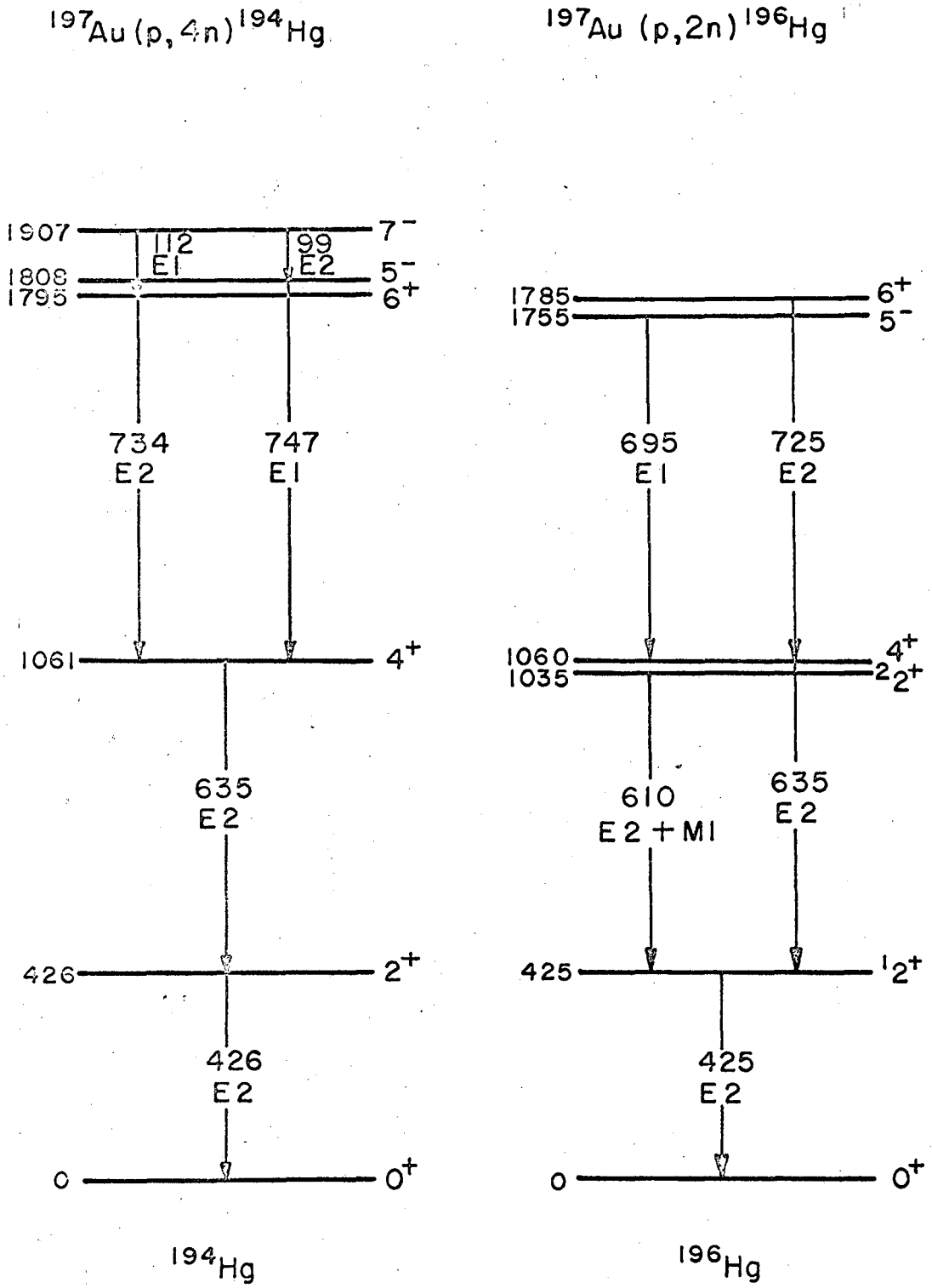
197Au (p, 4n) 194Hg
1907
7−
112
E1
99
E2
1808
5−
1795
6+
734
E2
747
E1
1061
4+
635
E2
426
2+
426
E2
0
0+
194Hg
197Au (p, 2n) 196Hg
1785
6+
1755
5−
695
E1
725
E2
1060
4+
1035
2+
610
E2 + M1
635
E2
425
2+
425
E2
0
0+
196Hg

Fig. 1

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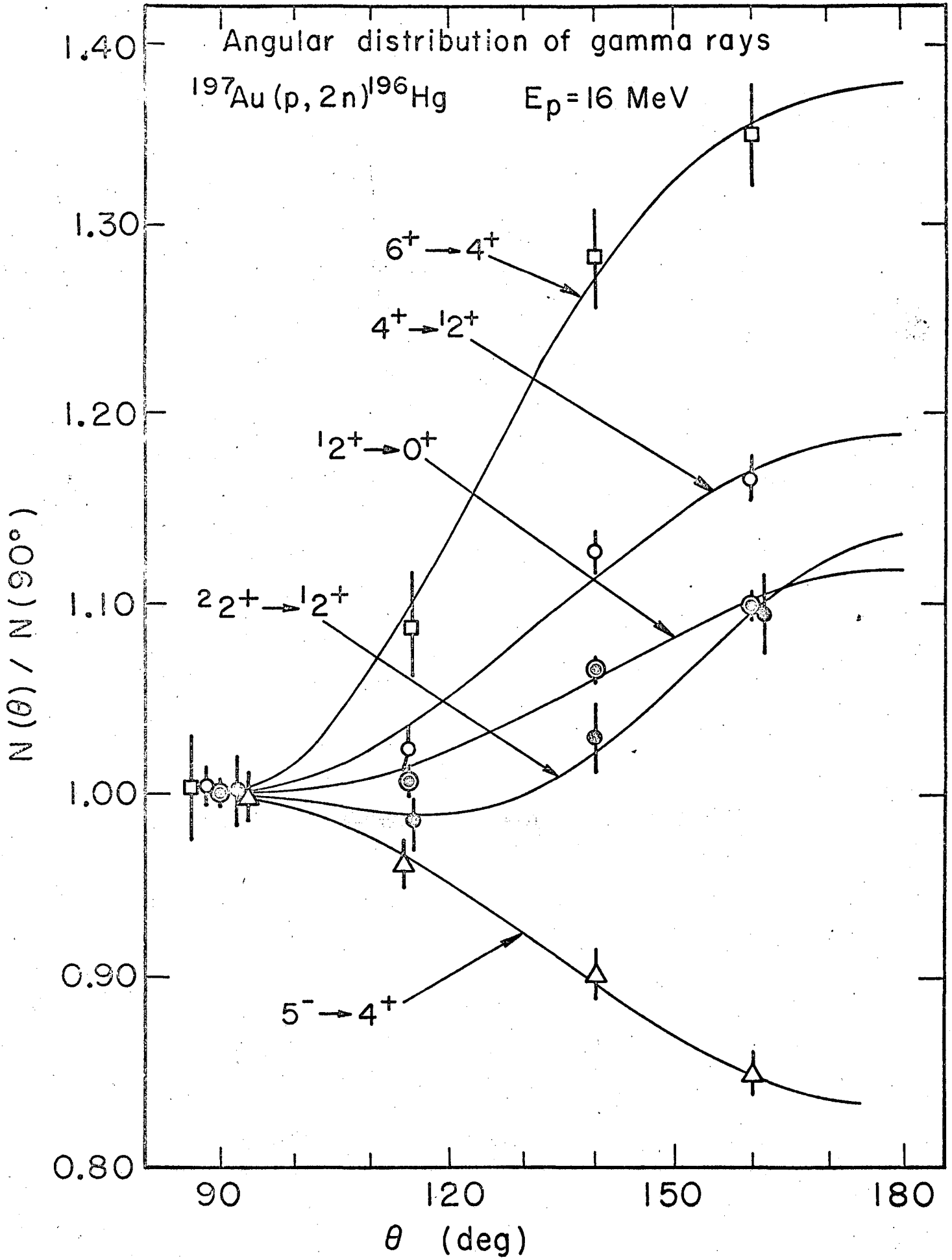
Angular distribution of gamma rays
$^{197}Au(p,2n)^{196}Hg$ $E_p = 16$ MeV
$6^+ \rightarrow 4^+$
$4^+ \rightarrow 2^+$
$2^+ \rightarrow 0^+$
$2_2^+ \rightarrow 2^+$
$5^- \rightarrow 4^+$
N(θ) / N(90°)
θ (deg)
1.40
1.30
1.20
1.10
1.00
0.90
0.80
90
120
150
180

Fig. 2