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THE NUCLEUS ^{198}Au INVESTIGATED WITH NEUTRON CAPTURE AND TRANSFER REACTIONS. I. EXPERIMENTS AND EVALUATION

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The transfer reaction ^{197}Au(d,p)^{198}Au was measured at the Tandem Accelerator in Munich. The ^{197}Au(n,γ)^{198}Au and ^{197}Au(n,e)^{198}Au reactions were performed at the High Flux Reactor of ILL, Grenoble. Up to 1560 keV a total of 111 levels were observed by the (d,p) reaction and 125 by the (n,γ) reaction. For many of the levels, spins and parities were assigned. Additional information was obtained from summed (n,$\gamma\gamma$) coincidences measured in Dubna.

1. Introduction

For many decades the nucleus ^{198}Au belonged to the group of nuclei which were extremely difficult to interpret. ^{198}Au lies in the transition region between spherical and deformed nuclei and is expected to be triaxial or γ-soft. As an odd–odd nucleus, it has a high level density already at low excitation energy. During the last ten years, the interacting boson model (IBM) was extended and the odd proton and odd neutron were included in the description resulting in the interacting boson–fermion–fermion model (IBFFM). This model is expected to be applicable to ^{198}Au and theoretical physicists asked for a more detailed level scheme of ^{198}Au. Consequently, our group started very elaborate investigations. Many results and especially the complete level scheme up to 400 keV was already published [1,2]. Previous publications on ^{198}Au can be found in these references.

In order to obtain an extensive level scheme of ^{198}Au with the best precision which is presently available, new measurements were performed with the bent crystal spectrometers GAMS for (n,γ) radiation, the conversion electron spectrometer BILL at the Institut Laue Langevin (ILL), Grenoble, for the (n,e) reaction, and with the Q3D spectrograph at the Munich Tandem Accelerator for the (d,p) reaction. Summed coincidences following the (n,γ) reaction were measured at the IBR-30 reactor in Dubna. Details of the present investigation can be found in Ref. 3.

2. Measurements with the GAMS spectrometer at ILL

The reaction ^{197}Au(n,γ)^{198}Au was investigated at ILL using the gamma spectrometers GAMS1 and GAMS2/3 [4]. The target consisted of a ^{197}Au foil (0.05 mm$\times$4 mm$\times$37 mm). The neutron flux at the target was 5.5×10^{14} n cm^{-2}s^{-1}. Gamma–ray spectra from 30 to 1600 keV gamma energy were measured. In the range from 35 to 1600 keV 1201 gamma–ray lines were fitted. The energies of gamma–rays were calibrated with the 411.80205(17) keV line of ^{198}Hg [5].

Determination of intensities of the gamma–ray lines is not easy, because ^{197}Au irradiated with thermal neutrons undergoes single and double neutron capture to ^{198}Au and ^{199}Au, respectively, with yields depending on the neutron flux. Using the branching ratio of the two reactions from ^{198}Au to ^{199}Au and ^{198}Hg, the ^{198}Au gamma–ray intensities can be calibrated with the intensity of the 411.8 keV gamma–ray line of ^{198}Hg [5]. An absolute intensity of 20.22 events per 100 neutrons was found for this line. Data on measured gamma–ray lines, including intensities, are given in Table 1.

3. Measurements with the BILL spectrometer at ILL

The reaction ^{197}Au(n,e-)^{198}Au was investigated at ILL with the electron spectrometer BILL [6] in order to determine the multipolarities of the corresponding gamma–ray transitions. The target consisted of 50 μg/cm^2 ^{197}Au (size 1 cm$\times$12 cm) evaporated upon a 0.1 mm thick aluminium foil. The neutron flux at the target was 3×10^{14} n cm^{-2}s^{-1}. The energy range from 18 to 300 keV was scanned twice. Higher electron energies (300 to 1600 keV) were measured using 300 μg/cm^2 foil of ^{197}Au (size 3 cm$\times$12 cm), evaporated on a 0.1 mm thick aluminium foil as target. In the range 18 to 300 keV, 357 electron lines were fitted and in the range 300 to 1600 keV another 717 electron lines could be resolved. The conversion electron intensities and the gamma–ray intensities were used to calculate conversion coefficients which were compared with theoretical values [7]. The resulting multipolarities are given in Table 1.

TABLE 1.

γ–lines, with multipolarities and their placement in the level scheme (a: taken from Ref. 12; m: multiply placed in the level scheme). The given intensity errors are statistical fitting errors. For absolute intensities a systematic error of ±20% has to be added.

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
35.819(3)	.56a	4	M1	91.007 →	55.181	135.615(6)	.13	25		1375.988→	1240.387
55.181(1)	2.64a	5	95M1+5E2	55.181 →	.000	137.450(6) m	.18	31		1434.582→	1297.130
66.391(3)	.57	25		259.341 →	192.944	137.450(6) m	.18	31		1475.616→	1338.156
75.208(4)	.12	25	M1	—		137.763(1)	.95	4	M1	192.944 →	55.181
82.356(1)	3.09	11	E1	1453.868→	1371.541	138.014(4)	.23	25		544.008 →	406.018
82.524(1)	1.92	18		1536.391→	1453.868	142.242(6)	.07	29	M1	—	
83.142(8)	.23	40		1240.387→	1157.234	142.918(3)	.46	11	M1	548.934 →	406.018
91.002(2)	.64	20	E2	91.007 →	.000	144.605(3)	.25	16	M1	406.018 →	261.404
97.249(2)	7.10	17	E1	312.219 →	214.971	145.154(1)	.63	7	E1	381.201 →	236.045
99.330(5)	.16	30	M1	346.905 →	247.572	146.343(2)	.42	9	M1	339.291 →	192.944
101.495(6)	.16	35	M1	—		146.670(3)	.38	10	M1	406.018 →	259.341
101.936(1)	5.09	5	M1	192.944 →	91.007	148.589(14) m	.05	49	M1	495.517 →	346.905
103.560(1)	1.54	14	M1	362.891 →	259.341	148.589(14) m	.05	49	M1	511.518 →	362.891
106.909(4)	.22	25	M1	453.824 →	346.905	153.962(8)	.08	25	(M1)	346.905 →	192.944
107.485(1)	2.03	9		—		154.057(9)	.06	29	(M1)	786.535 →	632.480
108.911(2)	1.28	13	M1	368.254 →	259.341	154.793(2) m	.52	7	M1	637.139 →	482.325
113.511(7)	.12	35	M1+E2	328.477 →	214.971	154.793(2) m	.52	7	M1	703.730 →	548.934
118.022(2)	.91	13		—		156.561(4)	.12	20	M1	247.572 →	91.007
121.084(6)	.15	30	M1	449.571 →	328.477	158.520(24)	.91	4	M1	983.093 →	824.592
122.652(1)	1.10	9		1409.388→	1286.734	159.281(6)	.12	20		1191.586→	1032.243
123.227(1)	1.44	7		—		164.713(1)	.28	10		1061.283→	896.569
123.786(1)	1.12	9		1487.129→	1363.342	166.229(2)	.48	6	E1	381.201 →	214.971
125.346(9)	.10	40	M1	453.824 →	328.477	167.012(15) m	.03	18	M1	1061.283→	894.249
130.699(1)	.95	8		—		167.012(15) m	.03	18	M1	1505.191→	1338.156
131.952(7)	.23	30	E2	346.905 →	214.971	168.334(1)	6.92	1	M1	259.341 →	91.007
132.851(4)	.14	19		1496.208→	1363.342	169.225(8)	.10	20	M1	801.706 →	632.480

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
169.964(8) m	.17	15		362.891 →	192.944	213.545(9)	.02	18	M1	449.571 →	236.045
169.964(8) m	.17	15		406.018 →	236.045	214.852(4)	.26	20		918.589 →	703.730
170.103(1)	2.25	2	M1	482.325 →	312.219	214.971(1)	12.91	3	E2	214.971 →	.000
170.395(3)	.51	5		261.404 →	91.007	215.295(2)	.26	7	M1	786.535 →	571.242
170.789(13)	.05	44		1475.616 →	1304.821	215.535(5)	.06	19	M1	544.008 →	328.477
173.355(10)	.05	29		918.589 →	745.222	218.045(5)	.08	21	M1	789.298 →	571.242
175.309(6)	.14	16		368.254 →	192.944	218.830(3)	.19	9	(M1)	672.651 →	453.824
175.858(15)	.03	42		625.426 →	449.571	218.907(8)	.06	20	(M1)	1554.423 →	1335.521
180.317(3)	.05	8	E2	696.685 →	516.381	219.352(1)	.40	4	M1	—	
180.863(1)	.85	3	E2	236.045 →	55.181	223.078(8)	.04	19		672.651 →	449.571
181.966(9)	.08	26	M1	1306.853 →	1124.881	224.341(4)	.09	17		571.242 →	346.905
182.283(11)	.07	29		529.168 →	346.905	226.471(6)	.06	19		632.480 →	406.018
184.998(14)	.04	33	E1	810.425 →	625.426	227.826(15)	.03	34		1038.270 →	810.425
188.166(2)	.86	3	M1	449.571 →	261.404	229.979(6)	.02	14		—	
189.148(6)	.03	13		—		230.212(6)	.02	15		1390.200 →	1160.001
191.182(4)	.24	9	M1	530.480 →	339.291	232.899(7)	.02	14		—	
192.392(1)	5.21	1	M1	247.572 →	55.181	234.109(3)	.11	9	M1	495.517 →	261.404
192.946(1)	2.30	1	E2	192.944 →	.000	234.607(7) m	.06	22		449.571 →	214.971
194.341(6)	.04	20		—		234.607(7) m	.06	22		1191.586 →	956.956
197.171(20)	.01	35		—		234.763(12)	.02	15		—	
201.015(12)	.03	29	M1	1293.896 →	1092.877	235.28(3) m	.02	50		764.483 →	529.168
202.006(3)	.12	11	M1	1306.853 →	1104.827	235.28(3) m	.02	50		1475.616 →	1240.387
202.866(14) m	.04	43		835.374 →	632.480	235.28(3) m	.02	50		1536.391 →	1301.049
202.866(14) m	.04	43		1038.270 →	835.374	236.047(2)	5.54	1	M1+E2	236.045 →	.000
202.987(1)	.35	4	M1	571.242 →	368.254	236.160(4)	.35	20		495.517 →	259.341
204.162(1)	.80	10	M1	516.381 →	312.219	237.611(12)	.03	24		786.535 →	548.934
206.227(1)	.30	5	M1	261.404 →	55.181	238.477(16)	.06	24		1363.342 →	1124.881
206.741(9)	.02	15		1513.585 →	1306.853	239.077(4)	.09	11		—	
208.33(4)	.00	81		571.242 →	362.891	239.634(15) m	.02	34		1286.734 →	1047.125
213.066(3)	.13	9	M1	406.018 →	192.944	239.634(15) m	.02	34		1505.191 →	1265.537

TABLE 1. *(continuation)*

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
240.945(10)	.02	17		—		264.210(3) m	.08	10		632.480 →	368.254
241.672(17)	.03	33		1202.287→	960.623	264.210(3) m	.08	10		1536.391→	1272.141
242.773(11) m	.03	23		571.242 →	328.477	264.981(10)	.02	12		—	
242.773(11) m	.03	23		1475.616→	1232.811	266.271(8)	.05	21		1475.616→	1209.353
243.343(17)	.03	30		868.768 →	625.426	266.647(1)	.32	3	M1	672.651 →	406.018
245.305(3)	.15	10		1202.287→	956.956	267.774(3)	.10	8		529.168 →	261.404
245.977(17)	.01	23		918.589 →	672.651	269.081(2)	.21	8	M1	530.480 →	261.404
247.570(3)	7.51	6	M1	247.572 →	.000	269.574(7)	.05	21		632.480 →	362.891
247.928(5)	.09	11		495.517 →	247.572	270.160(10)	.02	10		1056.708→	786.535
248.740(3)	.15	6		1209.353→	960.623	270.639(5)	.05	34		1542.751→	1272.141
249.239(18)	.01	16		1505.191→	1255.952	271.144(4) m	.14	8	(M1)	530.480 →	259.341
249.715(14) m	.02	28		745.222 →	495.517	271.144(4) m	.14	8	(M1)	896.569 →	625.426
249.715(14) m	.02	28		1232.811→	983.093	271.144(4) m	.14	8	(M1)	1375.988→	1104.827
249.715(14) m	.02	28		1536.391→	1286.734	271.229(3) m	.23	5	(M1)	801.706 →	530.480
250.118(7)	.07	13		511.518 →	261.404	271.895(2)	.27	4		362.891 →	91.007
252.828(8)	.05	25		1240.387→	987.571	272.564(5)	.09	8		1304.821→	1032.243
252.941(4)	.10	7		—		273.286(15)	.05	33		328.477 →	55.181
253.203(9)	.02	12		956.956 →	703.730	273.519(10)	.02	10		1108.877→	835.374
255.882(10)	.03	19		346.905 →	91.007	275.470(7) m	.06	18		511.518 →	236.045
256.886(4)	.08	11		—		275.470(7) m	.06	18		1293.896→	1018.424
258.022(10)	.02	12		—		275.656(3)	.09	7	M1	—	
258.444(8)	.02	10		—		276.071(3)	.30	8	M1	758.395 →	482.325
259.348(9)	.03	10	M1	259.341 →	.000	277.246(2)	.35	16	M1	368.254 →	91.007
259.467(9)	.03	10		495.517 →	236.045	279.500(12)	.01	13		—	
260.882(1)	1.12	8	M1	453.824 →	192.944	281.432(7)	.05	28		1338.156→	1056.708
261.402(1)	6.76	3	M1	261.404 →	.000	282.893(22)	.02	22	M1	530.480 →	247.572
262.059(12)	.01	14		—		283.076(22)	.02	21	M1	1375.988→	1092.877
262.535(6)	.07	17		625.426 →	362.891	283.316(11)	.04	28		—	
262.712(14)	.02	39		1472.088→	1209.353	283.944(15)	.09	19		916.442 →	632.480
264.062(9)	.02	8		896.569 →	632.480	284.111(3)	.21	14	M1	339.291 →	55.181

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
285.838(9)	.02	11		1202.287→	916.442	311.905(3) m	.64	2	M1	571.242 →	259.341
288.627(8)	.02	9		—		311.905(3) m	.64	2	M1	1359.057→	1047.125
290.183(20)	.02	28		801.706 →	511.518	312.793(14)	.03	11		1209.353→	896.569
291.025(19) m	.02	22		786.535 →	495.517	313.065(4) m	.07	5		368.254 →	55.181
291.025(19) m	.02	22		916.442 →	625.426	313.065(4) m	.07	5		824.592 →	511.518
291.025(19) m	.02	22		1338.156→	1047.125	313.20(5)	.02	47		824.592 →	511.518
291.722(1)	1.42	10	M1	346.905 →	55.181	313.82(3) m	.01	18		1409.388→	1095.512
292.173(12)	.03	19		—		313.82(3) m	.01	18		1418.698→	1104.827
292.258(10)	.05	11		1056.708→	764.483	314.181(9)	.04	9		529.168 →	214.971
293.117(4)	.11	24	M1	529.168 →	236.045	314.916(4)	.36	2	M1	764.483 →	449.571
293.476(14)	.03	19		—		315.240(17) m	.04	25		1115.291→	800.043
294.313(11)	.03	24	M1	—		315.240(17) m	.04	25		1272.141→	956.956
295.109(13)	.04	15		—		316.158(7)	.01	17		—	
296.025(22) m	.01	22		1371.541→	1075.567	317.271(10)	.12	20		1304.821→	987.571
296.025(22) m	.01	22		1404.911→	1108.877	319.597(13)	.02	12		1380.878→	1061.283
296.025(22) m	.01	22		1536.391→	1240.387	320.329(17)	.02	15		891.606 →	571.242
296.528(9)	.03	9		511.518 →	214.971	321.079(7)	.06	6	M1	—	
297.134(14)	.02	14		—		322.77(6) m	.02	43		728.641 →	406.018
297.720(5)	.08	5	M1	703.730 →	406.018	322.77(6) m	.02	43		1191.586→	868.768
299.161(12) m	.03	12		971.820 →	672.651	322.77(6) m	.02	43		1431.632→	1108.877
299.161(12) m	.03	12		1286.734→	987.571	324.916(4)	.14	3		637.139 →	312.219
300.646(7)	.04	6		1396.148→	1095.512	325.319(7)	.01	12		896.569 →	571.242
300.845(12)	.02	10		1232.811→	931.955	325.751(3)	.12	2	M1	672.651 →	346.905
301.118(9)	.02	8		—		326.162(4)	.02	10		—	
301.365(10)	.02	9		548.934 →	247.572	327.215(8)	.01	14		—	
302.608(9)	.02	8		495.517 →	192.944	328.087(8)	.02	9		810.425 →	482.325
304.419(7)	.03	6		1560.380→	1255.952	328.484(3)	2.00	1	M1	328.477 →	.000
306.199(4) m	.07	3	M1	801.706 →	495.517	328.760(4)	.15	1	M1	1115.291→	786.535
306.199(4) m	.07	3	M1	835.374 →	529.168	329.021(8)	.02	6		544.008 →	214.971
307.723(3)	.59	3	M1+E2	362.891 →	55.181	331.558(12)	.01	17		956.956 →	625.426

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i $\rightarrow$ (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i $\rightarrow$ (keV)	E_f (keV)
332.038(15)	.01	23		—		344.172(4) m	.03	6		672.651 →	328.477
332.297(6)	.01	10		—		344.172(4) m	.03	6		1304.821→	960.623
332.548(10)	.01	16		—		344.847(5)	.04	7		—	
332.713(2)	.04	6	M1	786.535 →	453.824	345.21(5) m	.02	39		894.249 →	548.934
333.839(2)	.15	2	M1	1409.388→	1075.567	345.21(5) m	.02	39		916.442 →	571.242
333.970(4)	.04	4		548.934 →	214.971	345.21(5) m	.02	39		1505.191→	1160.001
334.113(11) m	.01	10		1458.982→	1124.881	346.394(3)	.04	4	M1	971.820 →	625.426
334.113(11) m	.01	10		1536.391→	1202.287	346.909(1)	.59	1	M1	346.905 →	.000
334.235(14)	.01	13		702.465 →	368.254	347.877(2) m	.15	2	M1	801.706 →	453.824
335.192(8)	.02	10		571.242 →	236.045	347.877(2) m	.15	2	M1	1304.821→	956.956
335.297(4)	.04	5	M1	1286.734→	951.442	350.115(2)	.05	7		1458.982→	1108.877
335.495(2)	.08	2	M1	—		350.494(8)	.01	16		800.043 →	449.571
335.936(16)	.01	25		—		350.828(1)	1.29	1	M1	406.018 →	55.181
336.054(18)	.01	23		1431.632→	1095.512	351.843(5)	.02	7		—	
336.320(3)	.04	20		1335.521→	999.199	354.553(7)	.01	37		—	
337.533(1)	.24	2	M1	530.480 →	192.944	355.100(5) m	.02	12		987.571 →	632.480
338.055(10)	.01	15		1399.368→	1061.283	355.100(5) m	.02	12		1338.156→	983.093
339.131(8)	.01	11		1530.712→	1191.586	355.530(2)	.42	2	M1	1157.234→	801.706
339.328(5)	.06	6		971.820 →	632.480	356.077(7)	.01	10		1431.632→	1075.567
339.596(3) m	.03	5		702.465 →	362.891	357.91(3) m	.02	20		1318.627→	960.623
339.596(3) m	.03	5		868.768 →	529.168	357.91(3) m	.02	20		1390.200→	1032.243
339.921(8)	.01	12		—		357.91(3) m	.02	20		1396.148→	1038.270
340.19(5)	.04	29		1297.130→	956.956	358.472(7)	.02	10		764.483 →	406.018
341.365(3)	.04	5		—		359.688(2)	.09	3		—	
341.693(8)	.11	17		1434.582→	1092.877	360.208(9)	.01	13		—	
342.217(20)	.02	29		824.592 →	482.325	360.399(3)	.04	5		1124.881→	764.483
342.81(3)	.02	19		1325.845→	983.093	360.859(4)	.03	5		810.425 →	449.571
343.629(1)	1.04	1	E2	—		361.745(6)	.05	14		1255.952→	894.249

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i (keV) →	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i (keV) →	E_f (keV)
361.907(12)	.05	28		—		376.154(7)	.02	8		1104.827→	728.641
362.141(8)	.07	8		987.571 →	625.426	376.795(17)	.04	33		1375.988→	999.199
362.453(5) m	.05	11		891.606 →	529.168	377.043(2)	.48	2		—	
362.453(5) m	.05	11		1380.878→	1018.424	377.874(2)	.08	7		1272.141→	894.249
362.857(5)	.04	6		1554.423→	1191.586	378.302(2)	.24	2	M1	571.242 →	192.944
364.019(3) m	.14	3	M1	625.426 →	261.404	378.756(8)	.02	7		—	
364.019(3) m	.14	3	M1	1232.811→	868.768	381.205(2)	4.02	1	E1	381.201 →	.000
364.421(6)	.02	13		703.730 →	339.291	381.565(9)	.11	2	M1	835.374 →	453.824
364.933(10)	.02	9		—		382.327(3)	.05	4	M1	745.222 →	362.891
365.620(2)	.10	3		1038.270→	672.651	382.992(8)	.02	9		931.955 →	548.934
365.970(13)	.01	16		—		383.295(2)	.32	1		789.298 →	406.018
366.095(3)	.07	7		625.426 →	259.341	383.488(5)	.03	4		—	
366.332(9)	.01	10		1338.156→	971.820	383.699(9)	.01	8		—	
366.963(11) m	.01	13		1191.586→	824.592	384.856(13)	.01	17		—	
366.963(11) m	.01	13		1202.287→	835.374	385.553(15) m	.01	18		1423.795→	1038.270
368.249(7)	.18	1	M1	368.254 →	.000	385.553(15) m	.01	18		1542.751→	1157.234
369.280(7)	.01	11		—		385.726(8)	.02	11		956.956 →	571.242
369.636(5)	.02	9		918.589 →	548.934	385.991(8)	.01	12		—	
371.080(2)	.60	1	M1	632.480 →	261.404	386.193(13)	.01	17		1304.821→	918.589
373.150(11)	.10	15	M1	632.480 →	259.341	386.420(21) m	.00	29		868.768 →	482.325
373.37(3)	.04	29		1434.582→	1061.283	386.420(21) m	.00	29		1418.698→	1032.243
373.765(5)	.04	5		999.199 →	625.426	387.284(3)	.06	10	M1	916.442 →	529.168
374.234(16)	.01	13		—		387.900(22)	.01	15		931.955 →	544.008
374.922(3) m	.07	8		1306.853→	931.955	389.335(19)	.03	25		625.426 →	236.045
374.922(3) m	.07	8		1335.521→	960.623	389.421(4)	.04	4		918.589 →	529.168
374.922(3) m	.07	8		1431.632→	1056.708	391.297(3)	.06	7		—	
375.189(9)	.01	9		—		393.453(5)	.03	5		—	
375.708(17)	.01	18		—		393.881(2)	.30	2	M1	1325.845→	931.955

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
394.120(6)	.02	5		—		409.802(13)	.02	23		—	
394.361(8)	.02	8		449.571 →	55.181	411.010(8)	.02	8		—	
395.703(3)	.09	7	M1	801.706 →	406.018	411.293(8)	.02	8		—	
396.139(4)	.03	10		—		412.757(18)	.05	16		—	
396.426(14)	.01	13		632.480 →	236.045	413.289(5)	.07	3		672.651 →	259.341
397.020(16)	.01	16		—		413.485(2)	.32	1		—	
397.330(14)	.01	13		1293.896→	896.569	414.583(17)	.01	14		1371.541→	956.956
397.672(13)	.01	14		1458.982→	1061.283	414.955(6)	.03	8		868.768 →	453.824
398.293(2)	.13	3		1513.585→	1115.291	418.321(13)	.03	5		786.535 →	368.254
398.650(5)	.07	6		453.824 →	55.181	418.840(2)	.95	1	E2	800.043 →	381.201
398.844(12)	.02	9		1157.234→	758.395	419.199(5)	.10	2	M1	868.768 →	449.571
400.703(11) m	.03	17		1047.125→	646.410	419.802(10)	.03	6		—	
400.703(11) m	.03	17		1496.208→	1095.512	421.646(6)	.04	7		1453.868→	1032.243
400.880(18)	.02	9		—		422.994(19)	.04	34		—	
401.567(11)	.03	6		764.483 →	362.891	423.100(7)	.03	6		918.589 →	495.517
402.297(20)	.01	30		1293.896→	891.606	423.641(8)	.02	6		786.535 →	362.891
403.141(7)	.05	4		1560.380→	1157.234	424.220(4)	.06	4	M1	1056.708→	632.480
403.444(6)	.30	5		—		425.081(8)	.03	4		672.651 →	247.572
404.547(4)	.04	10	M1	495.517 →	91.007	427.176(6)	.05	4		—	
405.102(12)	.01	14		1191.586→	786.535	428.197(10)	.02	6		—	
405.514(8)	.02	9		1297.130→	891.606	430.361(4)	.07	3		—	
406.009(3)	.05	9		406.018 →	.000	432.169(11)	.01	10		1104.827→	672.651
406.397(8) m	.01	11		1108.877→	702.465	432.700(3)	.11	3		—	
406.397(8) m	.01	11		1363.342→	956.956	432.96(10)	.02	57		1232.811→	800.043
406.757(18) m	.01	20		1032.243→	625.426	433.457(6)	.03	5		801.706 →	368.254
406.757(18) m	.01	20		1301.049→	894.249	434.395(16)	.25	30		—	
406.757(18) m	.01	20		1453.868→	1047.125	435.861(24)	.01	17		1061.283→	625.426
408.558(8)	.03	4		1396.148→	987.571	436.037(8)	.02	7		1304.821→	868.768

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
436.614(4)	.04	5		672.651 →	236.045	451.944(12)	.02	7		1423.795→	971.820
437.127(6)	.02	6		800.043 →	362.891	453.147(9)	.04	5		800.043 →	346.905
437.805(4)	.04	5		—		453.385(17)	.02	9		—	
438.805(10)	.01	10		801.706 →	362.891	453.810(4)	.08	3		453.824 →	.000
439.507(3)	.86	1		—		454.887(6) m	.04	4		702.465 →	247.572
439.63(4)	.10	35		786.535 →	346.905	454.887(6) m	.04	4		1487.129→	1032.243
440.11(4)	.10	35		1487.129→	1047.125	456.172(8)	.19	9	M1	703.730 →	247.572
440.331(3)	1.24	1	M1	495.517 →	55.181	456.290(4)	.63	1		1160.001→	703.730
441.065(7)	.12	2	M1	702.465 →	261.404	457.090(15) m	.01	26		987.571 →	530.480
442.081(14)	.02	10		891.606 →	449.571	457.090(15) m	.01	26		1202.287→	745.222
442.379(5) m	.05	4		789.298 →	346.905	457.090(15) m	.01	26		1325.845→	868.768
442.379(5) m	.05	4		1399.368→	956.956	457.65(7) m	.05	35		672.651 →	214.971
443.774(4)	.08	3		—		457.65(7) m	.05	35		1160.001→	702.465
443.85(3) m	.12	15		1335.521→	891.606	458.049(3) m	.39	1	M1	786.535 →	328.477
443.85(3) m	.12	15		1338.156→	894.249	458.049(3) m	.39	1	M1	1418.698→	960.623
443.85(3) m	.12	15		1505.191→	1061.283	458.049(3) m	.39	1	M1	1505.191→	1047.125
444.393(3)	.76	1	M1	703.730 →	259.341	458.369(4)	.22	1	M1	1095.512→	637.139
444.754(6)	.07	3		1363.342→	918.589	459.514(12)	.03	6		1375.988→	916.442
446.177(4)	.08	3	M1	758.395 →	312.219	460.385(5)	.08	4		1092.877→	632.480
446.997(11) m	.02	7		896.569 →	449.571	461.715(21) m	.02	9		824.592 →	362.891
446.997(11) m	.02	7		1434.582→	987.571	461.715(21) m	.02	9		1272.141→	810.425
447.522(5) m	.05	3		810.425 →	362.891	461.715(21) m	.02	9		1297.130→	835.374
447.522(5) m	.05	3		1272.141→	824.592	461.715(21) m	.02	9		1418.698→	956.956
448.004(17)	.01	11		1404.911→	956.956	464.21(3) m	.01	14		1209.353→	745.222
448.566(3)	.16	2		1431.632→	983.093	464.21(3) m	.01	14		1396.148→	931.955
448.924(8)	.03	5		1380.878→	931.955	464.754(21)	.23	34		918.589 →	453.824
449.572(3)	.67	1	M1	449.571 →	.000	466.459(7)	.08	3		1513.585→	1047.125
451.359(18)	.01	11		1286.734→	835.374	466.712(13)	.04	5		—	

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
469.027(7)	.04	4		918.589 →	449.571	488.043(8)	.04	9		1475.616→	987.571
469.294(12)	.11	7	M1	728.641 →	259.341	489.273(5) m	.05	7		1018.424→	529.168
469.701(15)	.02	9		—		489.273(5) m	.05	7		1380.878→	891.606
471.122(13)	.01	10		—		489.273(5) m	.05	7		1536.391→	1047.125
471.739(8)	.03	6		1363.342→	891.606	490.329(5)	.05	12		—	
471.983(8)	.03	6		—		490.616(7)	.05	4		1301.049→	810.425
472.425(10)	.05	4		—		490.948(12)	.04	11		—	
473.219(8)	.02	14		801.706 →	328.477	492.063(3)	.11	2		987.571 →	495.517
473.978(7)	.06	2		529.168 →	55.181	495.955(4)	.05	12		1390.200→	894.249
476.24(9)	.02	11		1286.734→	810.425	496.538(8)	.03	13		—	
476.855(11)	.03	35		—		496.97(4)	.01	18		—	
477.211(19)	.01	11		—		497.687(11)	.03	5		1554.423→	1056.708
478.323(24)	.01	12		960.623 →	482.325	498.049(9)	.02	6		—	
478.83(3)	.02	7		1554.423→	1075.567	498.461(4)	.47	2	M1	—	
480.196(22)	.04	7		571.242 →	91.007	498.882(2)	.31	2		—	
481.945(9)	.08	5		810.425 →	328.477	499.562(19) m	.02	10		1396.148→	896.569
483.305(15) m	.02	8		1032.243→	548.934	499.562(19) m	.02	10		1487.129→	987.571
483.305(15) m	.02	8		1318.627→	835.374	502.030(6)	.03	36		1458.982→	956.956
483.41(5) m	.01	9		1032.243→	548.934	502.463(13)	.22	22		1453.868→	951.442
483.41(5) m	.01	9		1108.877→	625.426	503.890(11)	.02	17		—	
483.41(5) m	.01	9		1402.077→	918.589	504.105(6)	.08	6		1536.391→	1032.243
484.536(15) m	.02	10		1157.234→	672.651	506.145(10)	.02	16		—	
484.536(15) m	.02	10		1472.088→	987.571	507.481(20)	.03	15		—	
485.638(5)	.22	9		1402.077→	916.442	509.72(6)	.13	2		—	
485.891(18)	.05	7		745.222 →	259.341	510.405(11)	.26	32	M1	916.442 →	406.018
487.167(7)	.08	5		1458.982→	971.820	510.785(11)	.04	13		703.730 →	192.944
487.589(3) m	.09	8		983.093 →	495.517	511.103(18)	.15	15		960.623 →	449.571
487.589(3) m	.09	8		1232.811→	745.222	511.517(2)	.92	9	M1	511.518 →	.000

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i (keV) →	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i (keV) →	E_f (keV)
512.581(8)	.23	26	M1	918.589 →	406.018	532.20(5) m	.02	9		1318.627→	786.535
513.44(6)	.11	2		—		532.20(5) m	.02	9		1423.795→	891.606
515.140(4) m	.14	5		1409.388→	894.249	533.748(4)	.08	5		987.571 →	453.824
515.140(4) m	.14	5		1472.088→	956.956	535.77(3)	.02	25		728.641 →	192.944
516.061(2)	.47	2	M1	571.242 →	55.181	537.598(3)	.15	2	M1	—	
516.891(18) m	.02	9		764.483 →	247.572	538.011(17) m	.03	6		987.571 →	449.571
516.891(18) m	.02	9		1318.627→	801.706	538.011(17) m	.03	6		1434.582→	896.569
517.932(8)	.03	5		—		538.991(19)	.02	17		786.535 →	247.572
518.790(6)	.05	7		—		540.298(2)	.66	2	M1	801.706 →	261.404
519.17(3)	.28	38		—		540.915(3)	.19	9	M1	—	
519.50(3)	.25	42		—		542.373(8) m	.14	2		801.706 →	259.341
520.62(4) m	.26	40		1032.243→	511.518	542.373(8) m	.14	2		1306.853→	764.483
520.62(4) m	.26	40		1472.088→	951.442	544.002(3)	.67	3	E2	544.008 →	.000
521.878(13) m	.02	19		868.768 →	346.905	546.143(9)	.04	9		—	
521.878(13) m	.02	19		1453.868→	931.955	547.199(9)	.03	10		—	
522.247(3)	.11	7		971.820 →	449.571	548.246(10)	.03	17		1505.191→	956.956
522.35(3)	.13	1		758.395 →	236.045	548.930(2)	.90	3	M1	548.934 →	.000
522.648(12)	.07	4		—		549.34(3)	.27	41		—	
522.917(9)	.04	10		1018.424→	495.517	549.512(12)	.05	4		764.483 →	214.971
524.744(20)	.36	28		1157.234→	632.480	549.68(3)	.02	21		896.569 →	346.905
525.124(2)	.45	3		786.535 →	261.404	549.68(3) m	.02	21		999.199 →	449.571
525.838(7)	.06	10		1325.845→	800.043	549.68(3) m	.02	21		1061.283→	511.518
527.169(6)	.07	12		786.535 →	259.341	550.227(15)	.04	11		—	
527.842(4)	.15	9	M1	—		550.527(18)	.05	13		786.535 →	236.045
529.170(2)	2.45	3	M1	529.168 →	.000	550.748(22)	.03	15		931.955 →	381.201
529.948(3)	.53	4	M1	789.298 →	259.341	550.939(14)	.05	11		956.956 →	406.018
530.476(6)	.07	3		530.480 →	.000	551.699(9)	.71	6	M1	—	
532.20(5) m	.02	9		1061.283→	529.168	552.127(7)	.17	2		—	

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i $\rightarrow$ (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i $\rightarrow$ (keV)	E_f (keV)
552.490(9)	.14	2	M1	800.043 →	247.572	573.750(8)	.13	6		1530.712→	956.956
552.98(15) m	.03	50		789.298 →	236.045	573.953(24)	.45	2		835.374 →	261.404
552.98(15) m	.03	50		1363.342→	810.425	574.373(13)	.20	3	M1	1104.827→	530.480
552.98(15) m	.03	50		1444.383→	891.606	574.83(5)	.14	2		1399.368→	824.592
552.98(15) m	.03	50		1513.585→	960.623	574.993(9)	.06	6		—	
552.98(15) m	.03	50		1536.391→	983.093	575.536(11)	.05	8		1472.088→	896.569
554.144(14)	.02	10		801.706 →	247.572	577.287(4)	.36	2	M1	632.480 →	55.181
555.691(3)	.17	3	M1	918.589 →	362.891	578.959(14)	.05	8		1061.283→	482.325
556.598(6)	.06	3		—		579.296(9)	.71	7		918.589 →	339.291
557.036(18)	.03	10		1475.616→	918.589	579.826(12)	.06	6		—	
557.63(3)	.02	18		—		581.469(23)	.02	6		—	
559.343(18)	.03	3		—		584.160(10)	.10	2	M1	—	
563.97(3) m	.03	14		800.043 →	236.045	584.73(8)	.06	40		1115.291→	530.480
563.97(3) m	.03	14		1075.567→	511.518	585.359(21)	.03	5		—	
563.97(3) m	.03	14		1399.368→	835.374	588.419(6)	.09	2		1423.795→	835.374
564.71(3)	.03	13		1458.982→	894.249	591.228(6)	.11	2		646.410 →	55.181
565.777(5)	.52	1	M1	894.249 →	328.477	591.625(16) m	.04	12		1380.878→	789.298
566.32(3) m	.03	15		1095.512→	529.168	591.625(16) m	.04	12		1402.077→	810.425
566.32(3) m	.03	15		1115.291→	548.934	593.177(13)	.20	6	M1	999.199 →	406.018
566.80(4) m	.03	17		1402.077→	835.374	593.982(20)	.03	14		—	
566.80(4) m	.03	17		1554.423→	987.571	594.19(5) m	.06	17		956.956 →	362.891
567.33(5)	.02	23		1458.982→	891.606	594.19(5) m	.06	17		1418.698→	824.592
568.116(11)	.04	17		896.569 →	328.477	595.423(14)	.03	11		810.425 →	214.971
570.02(10)	.03	6		1371.541→	801.706	597.49(3) m	.03	19		1047.125→	449.571
571.694(5)	.67	4	M1	918.589 →	346.905	597.49(3) m	.03	19		1554.423→	956.956
572.742(13)	.04	9		—		597.71(5) m	.05	7		960.623 →	362.891
573.27(8) m	.17	3		1318.627→	745.222	597.71(5) m	.05	7		1399.368→	801.706
573.27(8) m	.17	3		1505.191→	931.955	598.846(17)	.03	11		1363.342→	764.483

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
602.271(4)	.83	1	M1	—		630.235(14)	.06	8	M1	891.606 →	261.404
607.20(4)	.03	25		1056.708→	449.571	630.945(17)	.04	18		999.199 →	368.254
607.914(13)	.04	9		1240.387→	632.480	632.281(7) m	.23	4	M1	891.606 →	259.341
608.83(4)	.02	25		801.706 →	192.944	632.281(7) m	.23	4	M1	1038.270→	406.018
609.396(5)	.16	5		—		632.502(13)	.11	7		632.480 →	.000
609.815(22)	.03	15		—		633.822(7)	.18	4	M1	—	
611.025(7)	.12	5	M1	—		635.197(10)	.32	4	M1	896.569 →	261.404
612.125(9)	.06	6		1530.712→	918.589	635.848(7)	.11	3	M1	1554.423→	918.589
612.724(6)	.14	3	M1	703.730 →	91.007	636.285(18)	.03	7		999.199 →	362.891
612.93(7) m	.13	19		1399.368→	786.535	638.834(11)	.06	8		—	
612.93(7) m	.13	19		1402.077→	789.298	639.04(3) m	.06	4		1092.877→	453.824
613.844(9)	.06	6		1359.057→	745.222	639.04(3) m	.06	4		1530.712→	891.606
614.98(6) m	.02	37		983.093 →	368.254	639.201(12)	.06	8		951.442 →	312.219
614.98(6) m	.02	37		1240.387→	625.426	639.662(11)	.07	7		1272.141→	632.480
614.98(6) m	.02	37		1318.627→	703.730	640.071(13)	.06	8		1265.537→	625.426
615.582(9) m	.07	6		1402.077→	786.535	640.665(6)	.81	8	M1	987.571 →	346.905
615.582(9) m	.07	6		1404.911→	789.298	642.06(6)	.01	17		1536.391→	894.249
616.386(10)	.06	14		1380.878→	764.483	643.223(19)	.06	4		—	
617.04(3) m	.03	15		1418.698→	801.706	644.039(9)	.08	3		891.606 →	247.572
617.04(3) m	.03	15		1513.585→	896.569	645.477(22)	.05	6		—	
619.105(8)	.10	4		1265.537→	646.410	647.307(6) m	.17	5	M1	702.465 →	55.181
620.398(21) m	.04	11		835.374 →	214.971	647.307(6) m	.17	5	M1	1375.988→	728.641
620.398(21) m	.04	11		1191.586→	571.242	647.652(7)	.16	11	M1	—	
621.570(9)	.06	5		—		648.573(22) m	.04	12		703.730 →	55.181
623.148(12)	.05	8		—		648.573(22) m	.04	12		1458.982→	810.425
623.757(12)	.06	8	M1	1423.795→	800.043	648.573(22) m	.04	12		1542.751→	894.249
625.429(3)	.55	6	M1	625.426 →	.000	648.959(19)	.08	5	M1	896.569 →	247.572
628.715(14)	.05	9		—		649.617(11)	.07	6		—	

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
653.23(4)	.03	17		1325.845 →	672.651	679.84(3)	.03	15		1444.383 →	764.483
653.801(13) m	.06	8		868.768 →	214.971	680.365(16)	.13	6		916.442 →	236.045
653.801(13) m	.06	8		1453.868 →	800.043	681.40(4)	.02	21		1306.853 →	625.426
654.206(7)	.12	7	M1	1418.698 →	764.483	682.805(6)	.15	4		1472.088 →	789.298
655.009(8)	.10	5	M1	916.442 →	261.404	683.728(14)	.07	7		—	
655.529(6)	.28	3	M1	1018.424 →	362.891	684.614(21)	.05	11		—	
656.23(7)	.02	39		—		686.970(5)	.33	2	M1	—	
657.84(6) m	.03	31		1444.383 →	786.535	688.967(5)	.21	8		1513.585 →	824.592
657.84(6) m	.03	31		1554.423 →	896.569	690.037(4)	.53	4	M1	745.222 →	55.181
659.229(7)	.34	2	M1	918.589 →	259.341	691.056(9)	.11	5	M1	—	
659.541(16)	.10	10		—		692.498(18)	.05	6		—	
660.322(13)	.09	7		1418.698 →	758.395	692.934(21)	.05	11		—	
663.42(3)	.05	11		—		694.041(24)	.05	6		—	
664.152(24)	.07	8		1409.388 →	745.222	695.654(14)	.07	5		1399.368 →	703.730
664.476(11)	.19	4	M1	—		696.415(15)	.06	5	M1	1240.387 →	544.008
666.17(6)	.07	29		1560.380 →	894.249	697.628(13)	.10	7		956.956 →	259.341
667.522(24)	.05	12		—		698.304(7)	.20	5	M1	789.298 →	91.007
668.336(16)	.12	7		—		698.939(8)	.18	3		—	
668.572(7)	.22	5		1301.049 →	632.480	700.29(4)	.05	14		1047.125 →	346.905
670.58(3)	.04	14		931.955 →	261.404	701.545(6)	.30	6		—	
670.856(18)	.09	7		—		702.467(4)	.69	1	M1	702.465 →	.000
671.933(22)	.07	19	M1	—		703.78(3) m	.05	10	M1	703.730 →	.000
672.654(3)	.75	4	M1	672.651 →	.000	703.78(3) m	.05	10	M1	1032.243 →	328.477
673.460(8)	.17	7	M1	728.641 →	55.181	705.10(4)	.06	14		1505.191 →	800.043
674.700(22)	.07	8		—		705.358(18)	.13	5	M1	—	
674.99(4)	.14	10	M1	—		707.447(24)	.07	8		1542.751 →	835.374
678.29(4)	.56	26		1513.585 →	835.374	708.54(3)	.04	12		—	
679.135(9)	.10	9		1018.424 →	339.291	709.39(3)	.06	13		956.956 →	247.572

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
709.724(16)	.25	3	M1	—		738.21(5)	.63	29		—	
710.708(18)	.07	8		801.706 →	91.007	739.960(3)	2.05	5	M1+E2	—	
711.674(21)	.06	9		—		741.54(3)	.10	8		—	
712.70(3) m	.05	11		1075.567→	362.891	742.91(10) m	.06	37		1272.141→	529.168
712.70(3) m	.05	11		1338.156→	625.426	742.91(10) m	.06	37		1286.734→	544.008
712.70(3) m	.05	11		1359.057→	646.410	742.91(10) m	.06	37		1542.751→	800.043
713.567(23)	.06	10		1513.585→	800.043	744.857(24) m	.14	6		800.043 →	55.181
716.12(3)	.15	19		—		744.857(24) m	.14	6		1240.387→	495.517
717.32(4) m	.10	22		1056.708→	339.291	745.21(3)	.20	7		745.222 →	.000
717.32(4) m	.10	22		1475.616→	758.395	746.061(19) m	.18	5		1371.541→	625.426
717.66(5)	.05	19		1390.200→	672.651	746.061(19) m	.18	5		1418.698→	672.651
718.518(18)	.06	10		—		748.03(3)	.05	18		—	
720.935(11)	.09	4	M1	956.956 →	236.045	748.86(3)	.07	12		—	
722.446(23)	.05	7		—		749.602(7)	.42	4	M1	—	
723.362(9)	.13	3		—		750.067(22)	.08	9		—	
724.795(10)	.17	5		—		751.085(14)	.30	4	M1	—	
725.474(15)	.09	6		1255.952→	530.480	751.56(4) m	.08	19		987.571 →	236.045
726.15(3)	.06	33		987.571 →	261.404	751.56(4) m	.08	19		999.199 →	247.572
727.269(11)	.12	13	M1	—		754.99(3)	.09	9		—	
728.995(15)	.15	12	M1	1530.712→	801.706	756.999(18) m	.08	8		1018.424→	261.404
730.125(21)	.15	8	M1	—		756.999(18) m	.08	8		1301.049→	544.008
730.83(3) m	.09	31		1363.342→	632.480	759.40(3)	.11	14		—	
730.83(3) m	.09	31		1434.582→	703.730	759.70(3)	.11	13		1209.353→	449.571
732.20(3) m	.14	4	M1	1404.911→	672.651	762.91(6)	.04	15		1306.853→	544.008
732.20(3) m	.14	4	M1	1434.582→	702.465	763.998(8)	.34	3	M1	956.956 →	192.944
733.076(12)	.25	5		—		764.96(3)	.16	13		—	
734.132(15)	.09	7	M1	789.298 →	55.181	765.123(16)	.22	5		1554.423→	789.298
736.90(5)	.07	10		—		765.322(24)	.15	13		—	

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
766.09(4)	.04	34		—		782.01(3)	.08	25		—	
766.73(4)	.04	34		1297.130→	530.480	783.19(3)	.15	16	M1	1232.811→	449.571
767.61(3)	.06	22		—		783.73(3)	.11	35		—	
767.92(4) m	.13	8		1297.130→	529.168	784.36(4)	.04	47		1542.751→	758.395
767.92(4) m	.13	8		1554.423→	786.535	785.37(6) m	.05	24		1431.632→	646.410
768.62(4)	.03	23		—		785.37(6) m	.05	24		1530.712→	745.222
768.95(6)	.03	35		—		786.19(6) m	.08	15		1418.698→	632.480
769.63(3) m	.06	20		1108.877→	339.291	786.19(6) m	.08	15		1458.982→	672.651
769.63(3) m	.06	20		1318.627→	548.934	788.162(18)	.14	13	M1	1318.627→	530.480
769.63(3) m	.06	20		1402.077→	632.480	788.813(14)	.20	9	M1	—	
769.63(3) m	.06	20		1472.088→	702.465	790.137(24)	.09	10	M1	—	
770.21(3)	.13	11		—		793.38(5) m	.03	31		1304.821→	511.518
770.828(7)	.29	6	E2	1032.243→	261.404	793.38(5) m	.03	31		1418.698→	625.426
771.34(3)	.08	13		—		794.174(10)	.24	5	M1	1338.156→	544.008
772.12(4)	.04	19		—		796.221(9)	.20	7		1032.243→	236.045
772.56(3)	.05	14		987.571 →	214.971	796.93(4)	.14	32		—	
773.82(6) m	.07	26		1399.368→	625.426	797.102(20)	.08	17		1160.001→	362.891
773.82(6) m	.07	26		1560.380→	786.535	798.417(16) m	.11	11	M1	1293.896→	495.517
774.07(6)	.08	15		1399.368→	625.426	798.417(16) m	.11	11	M1	1423.795→	625.426
775.05(4)	.07	18		—		800.05(4)	.09	20		800.043 →	.000
775.719(15)	.13	8		—		800.31(5)	.04	27		1371.541→	571.242
776.627(22) m	.16	10		1272.141→	495.517	801.713(10)	.26	4	M1	801.706 →	.000
776.627(22) m	.16	10		1402.077→	625.426	802.42(4)	.06	16	(M1)	—	
777.696(14)	.12	12	M1	1306.853→	529.168	803.510(13)	.20	5	M1	—	
778.28(7)	.03	51		1542.751→	764.483	804.188(20)	.23	10	M1	—	
779.03(4) m	.06	13		1038.270→	259.341	806.13(3)	.09	11		1431.632→	625.426
779.03(4) m	.06	13		1232.811→	453.824	807.04(5)	.06	16		1318.627→	511.518
780.96(5)	.09	11		—		810.119(6)	.35	2	M1	1359.057→	548.934

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i (keV) →	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i (keV) →	E_f (keV)
811.710(14)	.11	6		1265.537→	453.824	831.815(16)	.17	8		—	
812.576(7)	.20	8	(M1)	—		833.915(13)	.14	9		1536.391→	702.465
813.57(7) m	.03	30		868.768 →	55.181	835.339(14)	.55	4		—	
813.57(7) m	.03	30		1061.283→	247.572	835.726(5)	1.32	11		—	
815.56(5)	.06	23		—		836.405(9)	.64	13	M1	891.606 →	55.181
815.964(17)	.14	15	M1	1265.537→	449.571	837.46(4)	.12	43		—	
816.63(4)	.06	21		1453.868→	637.139	838.23(4)	.17	16		1409.388→	571.242
817.16(3)	.09	14		—		839.53(4)	.99	24		1075.567→	236.045
817.835(19)	.12	10		—		840.78(8)	.08	31		1513.585→	672.651
818.29(3)	.10	14		1272.141→	453.824	844.468(10)	.33	20	M1	—	
819.399(11)	.26	7	M1	—		846.15(5)	.14	19		1390.200→	544.008
820.49(4)	.11	10		—		849.56(5)	.11	19	M1	1108.877→	259.341
821.63(5)	.86	27	E1	—		851.374(10)	.27	6	(E2)	—	
822.539(20) m	.14	11		1272.141→	449.571	853.222(14)	.34	23	M1	—	
822.539(20) m	.14	11		1304.821→	482.325	854.60(3)	.20	11	M1	1487.129→	632.480
822.983(18)	.12	9		—		856.58(6)	.11	19		1560.380→	703.730
824.12(7)	.04	33		1335.521→	511.518	857.19(7) m	.10	22		1104.827→	247.572
824.58(4)	.08	18		824.592 →	.000	857.19(7) m	.10	22		1306.853→	449.571
825.472(6)	.42	10	M1	1018.424→	192.944	857.86(6)	.10	21		1560.380→	702.465
826.567(15)	.12	9	M1	—		863.01(3) m	.20	11		1191.586→	328.477
827.31(4)	.06	21		—		863.01(3) m	.20	11		1202.287→	339.291
827.99(9)	.05	38		1209.353→	381.201	864.04(10)	.06	32		—	
828.316(18)	.15	10		—		864.77(3)	.10	17		1318.627→	453.824
828.85(6) m	.07	20		1157.234→	328.477	866.54(8)	.07	29		—	
828.85(6) m	.07	20		1191.586→	362.891	867.38(6)	.11	23		—	
829.32(8)	.04	35		1475.616→	646.410	867.98(5)	.17	15	M1	—	
830.78(3)	.10	13	M1	1402.077→	571.242	868.757(9)	.57	10	M1	868.768 →	.000
831.31(5)	.08	16		—		871.42(3)	.12	10	M1	—	

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TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i $\rightarrow$ (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i $\rightarrow$ (keV)	E_f (keV)
872.86(4) m	.13	13		1108.877→	236.045	909.61(4) m	.12	13		1157.234→	247.572
872.86(4) m	.13	13		1402.077→	529.168	909.61(4) m	.12	13		1363.342→	453.824
876.87(3)	.21	15		—		910.57(5)	.10	15	M1	—	
877.07(3)	.25	19		—		913.588(16)	.30	8		—	
877.33(3)	.29	21	M1	1124.881→	247.572	913.752(16)	.41	14	M1	1363.342→	449.571
879.47(3)	.19	11	M1	—		913.994(21)	.20	16		—	
879.65(3)	.13	21		—		915.91(3) m	.09	17		1108.877→	192.944
881.04(6) m	.10	20		1209.353→	328.477	915.91(3) m	.09	17		1297.130→	381.201
881.04(6) m	.10	20		1363.342→	482.325	915.91(3) m	.09	17		1487.129→	571.242
881.04(6) m	.10	20		1513.585→	632.480	916.406(11)	.34	5	M1	916.442 →	.000
881.99(7)	.08	24		—		917.39(6)	.05	22	M1	1542.751→	625.426
885.647(16)	.23	11	M1	1434.582→	548.934	920.10(6)	.11	23	M1	1431.632→	511.518
886.143(14)	1.42	5	E1	—		920.89(5)	.15	18	M1	—	
887.34(4)	.13	19	M1	—		921.78(6)	.12	21	M1	1554.423→	632.480
888.60(11) m	.08	36		1124.881→	236.045	922.77(4)	.09	19		—	
888.60(11) m	.08	36		1338.156→	449.571	923.86(7) m	.11	8		1160.001→	236.045
889.53(9)	.10	22		1418.698→	529.168	923.86(7) m	.11	8		1286.734→	362.891
891.16(4)	.11	40		1297.130→	406.018	926.60(12) m	.04	10		1375.988→	449.571
891.600(23)	.13	20		891.606 →	.000	926.60(12) m	.04	10		1475.616→	548.934
891.97(6)	.24	32		—		927.39(7) m	.42	38		1018.424→	91.007
895.20(4)	.19	12		—		927.39(7) m	.42	38		1255.952→	328.477
896.74(6)	.16	19		—		929.03(4)	.17	12	M1	1554.423→	625.426
897.733(21)	.16	38		—		930.46(6)	.10	19		—	
898.53(5) m	.20	15		1160.001→	261.404	931.370(15)	.32	11	M1	—	
898.53(5) m	.20	15		1380.878→	482.325	933.89(7)	.64	27		1505.191→	571.242
902.500(15)	.52	9		1431.632→	529.168	934.33(4)	.07	7		1297.130→	362.891
902.78(3)	.32	13		—		935.18(3)	.11	5		—	
906.108(17)	.28	8	M1	—		936.10(4)	.06	17		1431.632→	495.517

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i $\rightarrow$ (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i $\rightarrow$ (keV)	E_f (keV)
938.70(3)	.11	5	M1	1306.853→	368.254	979.46(7)	.10	19		1318.627→	339.291
939.60(4)	.09	8	M1	—		983.00(4) m	.13	8		983.093 →	.000
941.22(3)	.13	11	M1	—		983.00(4) m	.13	8		1038.270→	55.181
942.51(3)	.09	17	M1	—		983.00(4) m	.13	8		1513.585→	530.480
943.22(3)	.09	14		—		984.92(8)	.14	21		1434.582→	449.571
944.484(9)	.46	4	M1	—		986.03(5)	.19	5		—	
946.45(3)	.13	4		1475.616→	529.168	989.49(3)	.17	18	M1	—	
947.56(6)	.09	27		1458.982→	511.518	990.60(6)	.09	32	(M1)	1444.383→	453.824
947.94(3)	.43	3	M1	1209.353→	261.404	993.191(14)	.56	6	M1+E2	—	
949.59(7)	.06	19		—		993.72(3)	.28	18		1505.191→	511.518
950.38(5)	.08	11	M1	1318.627→	368.254	995.77(6)	.13	5		—	
952.485(19)	.26	7	(E2)	1402.077→	449.571	996.10(6) m	.12	18		1359.057→	362.891
953.38(4)	.12	33		—		996.10(6) m	.12	18		1402.077→	406.018
953.75(5)	.39	5	M1	—		999.74(3)	.31	5	M1+E2	1380.878→	381.201
955.11(3)	.13	8		—		1000.40(5)	.14	17		1363.342→	362.891
957.18(3)	.17	6	M1	—		1003.66(6)	.11	7	M1	—	
960.47(4)	.10	8		1472.088→	511.518	1005.36(5)	.18	12		1554.423→	548.934
962.774(12)	.29	10		—		1005.71(5)	.18	5		—	
963.958(24)	.18	6	E2	—		1006.32(8) m	.13	9		1061.283→	55.181
965.14(4)	.11	4		1536.391→	571.242	1006.32(8) m	.13	9		1265.537→	259.341
971.20(7)	.16	6		—		1008.26(3)	.24	8	M1	—	
973.207(20)	.42	4	M1	—		1009.507(21)	.29	11	M1+E2	—	
975.186(20)	.20	6		—		1011.11(6)	.20	4		—	
976.48(7) m	.08	22		1191.586→	214.971	1012.79(13) m	.08	9		1272.141→	259.341
976.48(7) m	.08	22		1304.821→	328.477	1012.79(13) m	.08	9		1375.988→	362.891
976.48(7) m	.08	22		1458.982→	482.325	1012.79(13) m	.08	9		1380.878→	368.254
976.48(7) m	.08	22		1472.088→	495.517	1012.79(13) m	.08	9		1418.698→	406.018
978.85(5)	.19	7		1325.845→	346.905	1016.34(16) m	.05	15		1209.353→	192.944

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
1016.34(16) m	.05	15		1363.342→	346.905	1050.728(16)	.38	11	M1	1286.734→	236.045
1016.34(16) m	.05	15		1560.380→	544.008	1053.53(3)	.42	5	E2	—	
1018.02(8)	.15	19		1399.368→	381.201	1053.93(5)	.21	17		1536.391→	482.325
1018.36(3)	.25	6		1018.424→	.000	1059.59(5)	.12	5		—	
1018.75(6)	.21	14		—		1060.937(21)	.26	6	M1	1423.795→	362.891
1024.25(3)	.21	4	M1	—		1062.55(8)	.11	5		1409.388→	346.905
1025.48(13) m	.06	8		1240.387→	214.971	1064.45(7)	.13	5		1325.845→	261.404
1025.48(13) m	.06	8		1286.734→	261.404	1064.78(9) m	.20	20		1301.049→	236.045
1025.48(13) m	.06	8		1431.632→	406.018	1064.78(9) m	.20	20		1560.380→	495.517
1025.48(13) m	.06	8		1554.423→	529.168	1065.867(24)	.40	4	M1	—	
1027.12(9)	.09	6		1390.200→	362.891	1068.52(11) m	.07	7		1304.821→	236.045
1028.19(5)	.14	24		1409.388→	381.201	1068.52(11) m	.07	7		1431.632→	362.891
1028.613(14)	.62	7	M1	1434.582→	406.018	1074.93(4)	.20	9		—	
1030.83(3)	.17	3	M1	—		1075.71(5)	.16	28	M1	—	
1033.08(10) m	.07	7	M1	1396.148→	362.891	1076.38(10) m	.09	16		1335.521→	259.341
1033.08(10) m	.07	7	M1	1487.129→	453.824	1076.38(10) m	.09	16		1404.911→	328.477
1034.48(8)	.08	6		1293.896→	259.341	1076.38(10) m	.09	16		1444.383→	368.254
1036.94(8)	.07	17		—		1076.81(5) m	.15	13		1338.156→	261.404
1037.95(3)	.23	4	M1	—		1076.81(5) m	.15	13		1423.795→	346.905
1040.77(11) m	.12	5		1255.952→	214.971	1076.81(5) m	.15	13		1530.712→	453.824
1040.77(11) m	.12	5		1536.391→	495.517	1078.40(13)	.10	28		—	
1042.25(4)	.26	3	(E2)	—		1079.191(17)	.32	8	(M1,E2)	1272.141→	192.944
1045.01(3)	.24	18	M1	—		1081.60(5)	.13	23		1444.383→	362.891
1046.16(8)	.15	6		1293.896→	247.572	1082.037(23)	.22	18		—	
1047.09(7) m	.21	3		1047.125→	.000	1083.58(7)	.08	33		—	
1047.09(7) m	.21	3		1542.751→	495.517	1085.49(5)	.26	4		1453.868→	368.254
1047.72(7)	.13	6		1453.868→	406.018	1088.54(5)	.09	20		—	
1049.23(5)	.14	10	M1	1396.148→	346.905	1090.05(8)	.12	18	M1	1496.208→	406.018

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
1091.41(4)	.18	10		—		1183.42(8)	.45	17	(M1,E2)	—	
1092.57(4)	.16	8		—		1183.79(4)	.43	7	(M1,E2)	1530.712→	346.905
1099.592(24)	.40	3	M1	—		1184.70(8)	.34	19	E2	—	
1101.86(4)	.23	4	M1	1363.342→	261.404	1185.89(10)	.18	8		1554.423→	368.254
1107.01(4)	.26	15	M1	1453.868→	346.905	1186.31(10)	.22	25		1554.423→	368.254
1107.67(5)	.70	14	E2	1513.585→	406.018	1187.32(12) m	.21	5		1402.077→	214.971
1109.29(5)	.66	17	M1+E2	1472.088→	362.891	1187.32(12) m	.21	5		1434.582→	247.572
1111.64(7)	.50	9	M1+E2	1359.057→	247.572	1187.73(9) m	.20	22		1380.878→	192.944
1114.51(5)	.24	5		1375.988→	261.404	1187.73(9) m	.20	22		1423.795→	236.045
1117.93(3)	.29	7		—		1189.3(3) m	.11	8		1404.911→	214.971
1120.54(10)	.10	10		1335.521→	214.971	1189.3(3) m	.11	8		1536.391→	346.905
1122.40(9)	.08	24	M1	—		1189.77(7)	.14	22		1404.911→	214.971
1123.70(5)	.19	4	M1	—		1195.50(7)	.20	7		1431.632→	236.045
1126.11(4)	.20	8	M1	—		1196.60(6)	.27	6	M1	—	
1128.52(6)	.19	4	E2	1375.988→	247.572	1200.75(12)	.14	8	M1	1255.952→	55.181
1132.93(3)	.34	13	M1	1325.845→	192.944	1203.81(4)	.49	4	M1	—	
1139.516(15)	.64	15	M1	—		1205.68(4)	.86	8		—	
1141.83(5)	.15	7	M1	—		1210.72(7)	.27	9		1472.088→	261.404
1148.65(5)	.36	4	M1	1396.148→	247.572	1216.62(8) m	.29	6	E2	1409.388→	192.944
1150.55(8)	.34	7	M1	1513.585→	362.891	1216.62(8) m	.29	6	E2	1431.632→	214.971
1157.25(6)	.18	27	M1	1157.234→	.000	1217.39(9)	.24	14		—	
1161.38(6)	.23	13	M1	—		1219.05(5)	.33	19	E2	—	
1163.80(13)	.14	6		—		1225.51(4)	1.08	13	(E1,E2)	—	
1164.10(11)	.24	21		—		1226.01(3)	.37	4	M1+E2	1554.423→	328.477
1167.32(5)	.28	23	M1	—		1230.35(6)	.15	12		—	
1170.95(5)	.56	22	M1+E2	—		1232.49(6)	.16	20	M1	—	
1179.90(7)	.16	39	M1+E2	1542.751→	362.891	1234.36(6)	.19	6	M1	—	
1181.60(5)	.25	14	M1	—		1239.590(19) m	.66	11	E2	1475.616→	236.045

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
1239.590(19) m	.66	11	E2	1487.129→	247.572	1338.09(8)	.16	14	M1	1338.156→	.000
1252.12(10)	.17	13		1513.585→	261.404	1344.26(7)	.22	14	M1	1399.368→	55.181
1253.24(8)	.22	10		—		1352.13(12)	.16	17		—	
1254.06(6)	.66	18	E1	—		1354.286(24)	.84	7	M1	—	
1256.36(10)	.53	25	(E1,E2)	—		1355.71(10)	.25	12	M1	—	
1258.83(6)	.23	16	M1	—		1361.41(5)	.36	8	M1	1554.423→	192.944
1262.946(16)	1.50	10		—		1363.39(6)	.35	7	M1	1363.342→	.000
1272.16(11) m	.13	11		1272.141→	.000	1365.18(12)	.27	12		—	
1272.16(11) m	.13	11		1363.342→	91.007	1365.51(10)	.24	8		—	
1272.16(11) m	.13	11		1487.129→	214.971	1373.59(9)	.23	12		—	
1273.48(7)	.88	8		—		1377.70(10)	.19	11		—	
1275.05(6)	.35	10	M1	1536.391→	261.404	1379.35(8)	.19	9	M1	1434.582→	55.181
1276.75(4)	.66	13	M1	—		1383.74(17)	.11	18		—	
1281.55(9)	.66	21	(E1,E2)	1542.751→	261.404	1388.44(9)	.25	9		—	
1283.47(13)	.47	29		1542.751→	259.341	1389.04(4)	.25	52	M1	—	
1285.39(8)	.26	22	M1	—		1394.01(4)	.52	6	(M1)	—	
1291.15(13)	.50	25	E2	—		1395.58(9)	.28	10		—	
1291.69(5)	.27	11		—		1396.09(15) m	.19	9	M1	1396.148→	.000
1297.137(17)	.58	20	M1	1297.130→	.000	1396.09(15) m	.19	9	M1	1487.129→	91.007
1300.92(7)	.20	41		1301.049→	.000	1397.73(16)	.13	19	M1	—	
1304.76(6)	.34	16		1304.821→	.000	1407.903(24)	1.09	12		—	
1306.82(5)	.95	2	E2	1306.853→	.000	1411.54(20)	.09	26		—	
1308.45(17)	.16	17	M1	1363.342→	55.181	1411.90(12)	.13	28		—	
1316.52(9)	.29	10		1371.541→	55.181	1413.18(17)	.11	14		—	
1318.51(4)	1.18	2	E2	—		1415.73(21)	.07	37		—	
1324.41(6)	.26	11	M1	1560.380→	236.045	1422.65(15)	.10	20		1513.585→	91.007
1326.82(7)	.24	11	M1	—		1430.99(9)	.28	8	M1	—	
1335.51(5)	.22	20	M1	1335.521→	.000	1431.42(13)	.20	21		1431.632→	.000

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
1432.04(14)	.31	10		1487.129→	55.181	1516.19(10)	.35	5		—	
1434.04(11)	.13	11		—		1516.68(18)	.36	11		—	
1437.53(14)	.12	19		—		1519.42(4)	.64	31	M1	—	
1441.60(10)	.18	12	M1	—		1524.40(14)	.10	50		—	
1443.98(13)	.15	15		—		1526.5(3)	.12	24		—	
1445.50(10)	.19	17		1536.391→	91.007	1530.60(8)	.41	8		1530.712→	.000
1450.90(10)	.18	12		—		1533.14(4)	.64	29	(M1,E2)	—	
1452.33(10)	.30	19		—		1537.72(15)	.32	13		—	
1454.22(6)	.25	10	M1	—		1539.96(16)	.27	15		—	
1460.22(7)	.28	25		—		1547.10(11)	.36	10		—	
1460.84(17)	.15	11		—		1550.49(8)	.49	7		—	
1461.65(22)	.09	36		—		1554.51(7)	.34	36		1554.423→	.000
1462.12(18)	.14	17		—		1566.79(16)	.17	10		—	
1466.58(6)	.40	28		—		1567.13(6)	.59	4	M1	—	
1467.96(10)	.48	8		—		1574.89(7)	.36	6		—	
1470.00(12)	.16	9		—		1578.47(11)	.27	9		—	
1474.580(19)	.89	26	M1	—		1597.91(20)	.22	12		—	
1477.95(9)	.23	24		—		1604.01(7)	.67	7		—	
1487.31(12) m	.27	12	M1	1487.129→	.000	1611.43(15)	.44	9		—	
1487.31(12) m	.27	12	M1	1542.751→	55.181	1615.96(22)	.13	23		—	
1488.77(8)	.52	7		—		1620.35(15)	.21	19		—	
1490.88(19)	.13	17		—		1630.61(20)	.18	22		—	
1500.58(5)	.26	61		—		1633.36(19)	.70	24		—	
1504.44(14)	.17	13		—		1634.06(7)	.50	16		—	
1505.50(23) m	.11	14		1505.191→	.000	1638.5(3)	.19	21		—	
1505.50(23) m	.11	14		1560.380→	55.181	1642.7(3)	.28	14		—	
1513.31(5)	.91	3	M1+E2	—		1645.12(10)	.81	6		—	
1514.8(4)	.43	12		—		1651.1(4)	.13	32		—	

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i → (keV)	E_f (keV)
1656.72(7)	.90	7		—		5149.9(10)	.62	12		6512.483→	1363.342
1660.15(16)	.38	16		—		5153.5(11)	.78	56		6512.483→	1359.057
1669.2(3)	.73	34		—		5174.7(8)	.30	34		6512.483→	1338.156
1693.314(23)	7.10	17		—		5206.4(10) m	.21	38		6512.483→	1304.821
1706.0(3)	.58	34		—		5206.4(10) m	.21	38		6512.483→	1306.853
4897.4(14)	.36	26		—		5217.8(10) m	.21	38		6512.483→	1293.896
4905.5(10)	.42	23		—		5217.8(10) m	.21	38		6512.483→	1297.130
4931.6(10)	.23	42		—		5223.1(14)	.18	29		6512.483→	1286.734
4940.3(16)	.08	67		—		5226.1(8)	.57	17		6512.483→	1286.734
4958.2(10)	.85	12		6512.483→	1554.423	5244.4(14) m	.69	38		6512.483→	1265.537
4973.1(15) m	.08	56		6512.483→	1536.391	5244.4(14) m	.69	38		6512.483→	1272.141
4973.1(15) m	.08	56		6512.483→	1542.751	5272.1(14)	.52	50		6512.483→	1240.387
4980.5(15)	.12	36		6512.483→	1530.712	5279.5(8)	.49	25		6512.483→	1232.811
4999.1(10)	.42	25		6512.483→	1513.585	5303.0(14)	.26	27		6512.483→	1209.353
5007.5(15)	.08	67		6512.483→	1505.191	5418.8(9) m	.13	33		6512.483→	1092.877
5024.6(10)	.13	60		6512.483→	1487.129	5418.8(9) m	.13	33		6512.483→	1095.512
5035.2(9)	.25	38		6512.483→	1475.616	5456.0(12)	.10	50		6512.483→	1056.708
5042.5(12)	.25	38		6512.483→	1472.088	5462.9(8)	.30	23		—	
5053.7(14)	.08	33		6512.483→	1458.982	5474.4(24) m	.28	25		6512.483→	1032.243
5080.9(10)	.33	16		6512.483→	1431.632	5474.4(24) m	.28	25		6512.483→	1038.270
5086.3(9)	.67	8		6512.483→	1423.795	5493.7(8)	.57	21		6512.483→	1018.424
5103.0(9)	1.18	7		6512.483→	1409.388	5524.4(10)	1.08	11		6512.483→	987.571
5109.5(14) m	.21	21		6512.483→	1399.368	5539.9(10)	.23	30		6512.483→	971.820
5109.5(14) m	.21	21		6512.483→	1402.077	5594.75(7)	.61	6		—	
5109.5(14) m	.21	21		6512.483→	1404.911	5620.6(9) m	.46	23		6512.483→	891.606
5118.7(16) m	.25	17		6512.483→	1390.200	5620.6(9) m	.46	23		6512.483→	894.249
5118.7(16) m	.25	17		6512.483→	1396.148	5643.4(9)	.08	56		6512.483→	868.768
5141.1(10)	.47	17		6512.483→	1371.541	5677.3(9)	.07	63		6512.483→	835.374

TABLE 1. (continuation)

Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i $\rightarrow$ (keV)	E_f (keV)	Transition energy (keV)	I $\frac{1}{100n}$	$\frac{\Delta I}{I}$ (%)	El+Ml	E_i $\rightarrow$ (keV)	E_f (keV)
5710.70(6)	1.71	5		6512.483→	801.706	6106.43(14)	.63	7		6512.483→	406.018
5724.3(8) m	.74	27		6512.483→	786.535	6145.3(10)	.39	56		6512.483→	368.254
5724.3(8) m	.74	27		6512.483→	789.298	6149.55(7)	1.00	5		6512.483→	362.891
5766.5(12)	.12	36		6512.483→	745.222	6165.5(9)	.23	30		6512.483→	346.905
5783.7(11)	.10	50		6512.483→	728.641	6251.05(17)	1.94	16		6512.483→	261.404
5808.2(9) m	.33	32		6512.483→	702.465	6253.11(13)	3.28	10		6512.483→	259.341
5808.2(9) m	.33	32		6512.483→	703.730	6264.9(10)	.61	20		6512.483→	247.572
5839.7(8)	.21	46		6512.483→	672.651	6276.8(8)	1.19	15		6512.483→	236.045
5880.0(9)	.40	26		6512.483→	632.480	6319.23(6)	3.24	5	E1	—	
5941.32(7)	.62	6		6512.483→	571.242	6457.37(6)	2.66	5	E1	6512.483→	55.181
5983.19(6)	1.38	5		6512.483→	529.168	6512.63(7)	1.82	5	E1	6512.483→	.000

4. Measurement with the Q3D spectrograph at Munich

The reaction ^{197}Au(d,p)^{198}Au was investigated with the Munich Q3D magnetic spectrograph [8]. The target consisted of a 1 mm×4 mm, 30 μg/cm^2 thick strip of Au metal evaporated on 4 μg/cm^2 carbon backing. The transfer reaction was measured at four different angles. At 35°, the target was irradiated with deuterons of 20 MeV energy and 3 μA beam intensity. The experimental data were recorded with a multiwire proportional counter [9]. Since the detector did not cover the whole energy range up to 1600 keV excitation energy, several overlapping runs were made. A resolution of 3.5 keV FWHM was obtained. Up to 1560 keV excitation energy, 106 levels were resolved.

At 15°, 30° and 45°, the Au target was irradiated with deuterons of 22 MeV energy and 1.5 μA beam intensity. The data were recorded with a new detector system [10] covering a larger energy range per measurement. At each angle, three overlapping spectra were measured. A resolution of 5 keV FWHM was obtained. The intensity was monitored by measuring the elastic ^{197}Au(d,d')^{197}Au line with a monitor detector. All (d,p) energies were calibrated with the level energies from the (n,γ) level scheme. The (d,d') intensities were used to calculate the differential cross–sections of the (d,p) spectra. By comparing the angular dependence of the differential cross–sections with DWBA calculations, it was possible to estimate the momentum transfer $\Delta\ell$. Up to 1560 keV excitation energy, 111 levels could be identified. Energies, differential cross–sections and momentum transfer $\Delta\ell$ of the (d,p) reaction are listed in Table 2.

TABLE 2.

^{197}Au(d,p)^{198}Au*: Level energies and differential cross–sections in μb at 15°, 30° and 45° laboratory scattering angle. Δl was derived from comparison of experiment and DWBA calculation. D indicates doublet structure. The (d,p) level energies are averaged from measurements at different angles.*

$E_{(n,\gamma)}$	$E_{(d,p)}$	$\Theta = 15°$ $(\frac{d\sigma}{d\Omega})$	$\Theta = 15°$ $\frac{\Delta(\frac{d\sigma}{d\Omega})}{(\frac{d\sigma}{d\Omega})}$	$\Theta = 30°$ $(\frac{d\sigma}{d\Omega})$	$\Theta = 30°$ $\frac{\Delta(\frac{d\sigma}{d\Omega})}{(\frac{d\sigma}{d\Omega})}$	$\Theta = 45°$ $(\frac{d\sigma}{d\Omega})$	$\Theta = 45°$ $\frac{\Delta(\frac{d\sigma}{d\Omega})}{(\frac{d\sigma}{d\Omega})}$	Δl
[keV]	[keV]	[μb]	[%]	[μb]	[%]	[μb]	[%]	
0.000(0)	0.0(2)	390	14.3	330	14.5	180	14.7	3
55.181(1)	55.3(6)	66	15.7	25	18.9	18	22.4	(1,3)
91.007(2)	90.8(6)	21	20.2	14	22.8	8.7	30.2	(1,3)
192.945(1)	192.7(5)	300	14.4	87	15.5	71	15.9	(1,3)
214.972(2)	215.2(5)	550	14.2	300	14.6	220	14.6	(1,3)
236.046(1)	231.0(8)	120	15.0	18	20.1	7.9	63.4	(1,3)
247.574(2)	248.2(5)	300	14.4	200	14.8	210	15.6	1
259.343(2)								
261.405(1)	265.9(16)	580	14.2	200	43.0	150	36.4	D(1,3)
312.222(2)	311.9(6)	11	27.4	6.9	30.2	13	26.2	*
328.481(3)	328.8(5)	330	14.3	230	14.7	200	14.7	1
339.293(3)	339.4(5)	97	16.0	60	17.9	—	—	(1,3)
346.906(1)	346.7(5)	330	14.4	240	14.8	180	14.8	1
362.904(1)	362.5(6)	84	16.7	120	16.2	85	28.4	(1,3)
368.256(2)	368.2(6)	160	15.1	100	16.5	68	34.3	(1,3)
381.202(3)	377.4(19)	—	—	—	—	11	32.7	
406.011(2)	405.7(5)	84	15.4	56	16.4	36	17.4	(1,3)
449.566(3)	450.2(4)	370	16.5	350	37.1	220	36.9	D(1,3)

TABLE 2. (continuation)

$E_{(n,\gamma)}$	$E_{(d,p)}$	$\Theta = 15^\circ$ $\left(\frac{d\sigma}{d\Omega}\right)$	$\frac{\Delta(\frac{d\sigma}{d\Omega})}{(\frac{d\sigma}{d\Omega})}$	$\Theta = 30^\circ$ $\left(\frac{d\sigma}{d\Omega}\right)$	$\frac{\Delta(\frac{d\sigma}{d\Omega})}{(\frac{d\sigma}{d\Omega})}$	$\Theta = 45^\circ$ $\left(\frac{d\sigma}{d\Omega}\right)$	$\frac{\Delta(\frac{d\sigma}{d\Omega})}{(\frac{d\sigma}{d\Omega})}$	Δl
[keV]	[keV]	[μb]	[%]	[μb]	[%]	[μb]	[%]	
453.827(1)								
482.327(4)								
495.516(5)	494.0(4)	17	20.0	14	17.8	9.2	20.7	(1,3)
511.519(4)	511.3(8)	5.8	42.6	3.5	32.1	—	—	(1,3)
516.385(2)								
529.170(3)	529.8(4)	110	14.5	74	14.7	57	15.1	D(1)
530.483(2)								
544.012(5)	543.3(4)	100	17.9	61	17.9	50	15.3	1
548.935	548.4(4)	23	50.6	16	41.3	17	18.2	*
571.246(2)	573.8(7)	11	29.5	13	18.1	9.3	20.9	*
	595.7(8)	26	19.6	—	—	—	—	
625.432(3)	624.4(4)	20	19.5	15	18.1	14	18.9	1
632.487(2)	631.9(4)	37	16.5	20	17.4	16	20.1	(1,3)
637.140(9)	640.1(7)	—	—	6.1	27.0	9.9	23.9	(2,4)
646.415(7)	648.3(14)	—	—	—	—	3.1	45.2	
	662.6(10)	—	—	5.5	35.1	—	—	
672.658(2)	672.3(4)	96	14.7	73	14.7	56	15.2	1
696.703	694.9(4)	39	16.9	50	18.1	48	15.8	(4,6)
702.734(5)	702.3(4)	61	15.6	44	18.2	34	16.8	D(1,3)
703.741(3)								
728.658(9)	728.2(4)	110	14.6	78	14.7	52	15.2	(1,3)
745.229(3)	744.5(4)	18	20.1	7.1	22.6	12	24.4	(1,3)
758.399(4)								
764.461(8)	765.6(4)	44	16.1	24	16.3	9.0	32.1	(1,3)
786.538(3)	788.7(5)	24	22.0	11	18.2	8.9	21.8	(1,3)
789.302(3)								
800.043(5)								
801.430(5)	802.4(10)	—	—	5.3	34.0	—	—	
810.427(4)	810.7(4)	25	18.3	17	17.3	16	21.4	1
824.609(14)	820.7(11)	44	16.0	20	16.9	19	20.0	*
835.372(8)	833.4(4)	—	—	—	—	6.5	28.4	
868.774(4)								
891.613(7)								
894.265(12)	894.2(5)	44	42.1	49	37.3	64	15.6	D
896.576(6)								
916.444(6)								
918.594(3)	924.7(16)	—	—	20	33.8	15	32.2	*
931.962(8)								
951.440(8)	951.0(13)	—	—	—	—	8.1	28.2	
956.964(4)	956.3(6)	13	32.8	9.5	23.9	7.9	28.2	D(1,3)
960.620(12)								
971.823(3)								
983.070(13)	983.3(10)	18	19.9	16	17.4	8.0	28.2	D(1,3)
987.577(2)								
999.200(4)								
1018.429(5)	1019.4(5)	19	24.0	11	19.7	8.5	27.7	(1,3)
1032.267(11)	1033.1(15)	—	—	6.2	37.1	—	—	
1038.279(4)								
1047.376(7)	1047.5(6)	11	31.9	15	21.9	9.1	24.9	*
1056.717(5)	1056.9(4)	19	20.4	12	20.1	17	19.8	(1,3)
1061.290(5)	1063.4(4)	23	19.0	16	18.8	—	—	(1,3)
1075.557(6)	1075.3(4)	110	14.7	84	14.6	63	14.9	1
1092.885(7)	1093.0(4)	33	17.0	25	16.0	14	18.9	(2,4)
1095.510(11)								
1104.826(7)	1105.2(4)	14	23.1	15	17.6	—	—	(1,3)
1108.878(5)								

TABLE 2. (continuation)

$E_{(n,\gamma)}$	$E_{(d,p)}$	$\Theta = 15°$ $(\frac{d\sigma}{d\Omega})$	$\Theta = 15°$ $\frac{\Delta(\frac{d\sigma}{d\Omega})}{(\frac{d\sigma}{d\Omega})}$	$\Theta = 30°$ $(\frac{d\sigma}{d\Omega})$	$\Theta = 30°$ $\frac{\Delta(\frac{d\sigma}{d\Omega})}{(\frac{d\sigma}{d\Omega})}$	$\Theta = 45°$ $(\frac{d\sigma}{d\Omega})$	$\Theta = 45°$ $\frac{\Delta(\frac{d\sigma}{d\Omega})}{(\frac{d\sigma}{d\Omega})}$	Δl
[keV]	[keV]	[μb]	[%]	[μb]	[%]	[μb]	[%]	
1115.2944(4)	1115.7(4)	15	22.9	19	16.7	7.7	22.1	3
1124.829(12)	1124.2(4)	38	16.6	32	15.5	15	18.1	3
	1147.9(10)	—	—	—	—	4.6	38.8	
1157.246(3)	1157.3(4)	56	15.7	54	14.9	30	18.5	3
1160.027(6)	1165.7(4)	30	18.0	35	15.4	22	20.1	(3,5)
	1175.1(4)	41	16.7	36	15.3	21	17.3	3
1191.571(15)	1199.4(7)	87	15.6	55	14.9	30	16.8	3
1202.271(5)	1203.3(4)	98	16.6	—	—	—	—	
1209.360(10)	1209.8(4)	56	16.7	16	18.4	19	19.2	(1,3)
	1217.3(6)	41	19.6	—	—	—	—	
	1224.5(7)	48	18.5	—	—	—	—	
1232.803(16)	1232.4(7)	77	16.6	—	—	—	—	
1240.394(6)	1239.0(7)	120	17.8	—	—	—	—	
1255.994(9)	1255.4(5)	60	17.1	13	18.3	3.2	47.5	(1,3)
1265.531(9)	1266.1(6)	60	17.3	11	22.4	9.0	28.5	(1,3)
1272.142(4)	1271.7(6)	64	17.1	13	30.9	—	—	(1,3)
1286.903(15)	1287.7(6)	—	—	11	19.0	—	—	
1293.903(10)	1294.2(6)	9.9	41.9	13	21.0	8.5	26.8	*
1297.140(12)								
1301.053(9)	1300.5(4)	30	22.0	45	15.1	32	18.3	5
1304.827(7)	1305.7(6)	12	39.6	6.7	38.7	14	25.0	(1,3)
1306.833(11)								
1318.622(23)	1318.3(6)	8.6	42.4	11	22.7	7.8	28.2	*
1325.849(10)	1326.1(5)	10	38.0	12	21.6	8.8	26.7	*
1335.522(5)	1335.7(6)	9.2	40.0	6.3	29.4	6.9	28.6	*
1338.161(8)								
1359.066(9)								
1363.344(6)	1363.5(10)	11	37.3	—	—	—	—	
1371.530(7)	1368.8(11)	8.0	47.6	—	—	4.6	65.3	*
1376.000(11)	1375.0(7)	26	22.2	—	—	—	—	
1380.878(13)	1379.3(6)	19	26.0	20	19.5	18	24.3	*
1390.228(9)	1386.0(10)	10	36.3	—	—	—	—	
1396.150(8)	1398.3(6)	17	22.2	15	22.7	9.2	31.4	D(1,3)
1399.371(16)								
1402.082(8)								
1404.959(50)								
1409.397(6)	1411.2(19)	—	—	—	—	6.0	40.6	
1418.684(15)								
1423.795(12)	1423.4(8)	—	—	22	19.5	9.7	25.8	D(3,5)
1431.637(11)								
1434.594(12)	1434.8(9)	—	—	13	22.6	5.0	36.0	D(1,3,5)
1444.393(29)	1446.3(7)	18	27.6	6.7	30.9	—	—	(1,3)
1453.886(10)	1452.5(7)	19	31.3	16	22.2	3.9	40.8	3
1458.994(5)	1457.6(8)	13	44.5	8.8	31.1	—	—	*
1472.112(11)	1474.6(6)	6.1	57.3	17	19.1	9.4	27.8	D(5)
1475.617(9)								
1487.131(5)	1482.1(14)	47	17.9	47	15.9	17	20.6	3
1496.197(8)	1498.3(5)	39	18.7	34	16.8	19	20.2	(1,3)
1505.204(11)	1506.2(6)	36	20.4	19	19.1	14	22.1	(1,3)
1513.588(6)	1511.5(5)	48	18.5	47	16.0	—	—	(1,3)
	1517.9(5)	24	23.2	15	21.1	21	19.3	1
1530.713(5)	1529.7(6)	17	29.6	16	20.5	17	20.5	*
1536.409(9)	1535.4(8)	—	—	7.3	28.8	—	—	
1542.784(8)	1546.6(7)	11	37.9	13	26.3	16	20.8	(5,7)
1554.432(6)								
1560.402(8)	1559.7(8)	19	22.2	15	48.9	3.3	39.2	(1,3)

5. *Measurements of summed γ-γ coincidences at Dubna*

The experiments were carried out at the IBR–30 pulsed reactor (JINR, Dubna). Coincident γ-rays emitted after thermal neutron capture were measured. Details of the experiment and data processing are described in Ref. 11. Coincident pulses of corresponding energies E_1 and E_2 were added, and the resulting sum spectra ($E_1 + E_2$) and the singles spectra (E_1 and E_2) were analysed in order to obtain information on populated levels. The spectrometer consisted of two Ge(Li) detectors of 10% efficiency and 4.5 keV energy resolution at 1332 keV. The time resolution was about 10 to 12 ns for a ^{60}Co source. The target consisted of 10 g of gold. The data acquisition time was about 400 hours. γ-rays have been detected after having passed a 2.5 g/cm^2 lead filter to minimize the detection of backscattered γ-quanta. The spectrum of amplitude sums of coinciding pulses ($E_1 + E_2$) is shown in Fig. 1. Figure 2 displays a singles spectrum E_1 of coincidences going to the level at 193 keV: $E_2 = B_n - E_1 - 193$ keV, with $B_n = 6512.3$ keV = neutron binding energy. Detailed coincidence data have been published in Ref. 13.

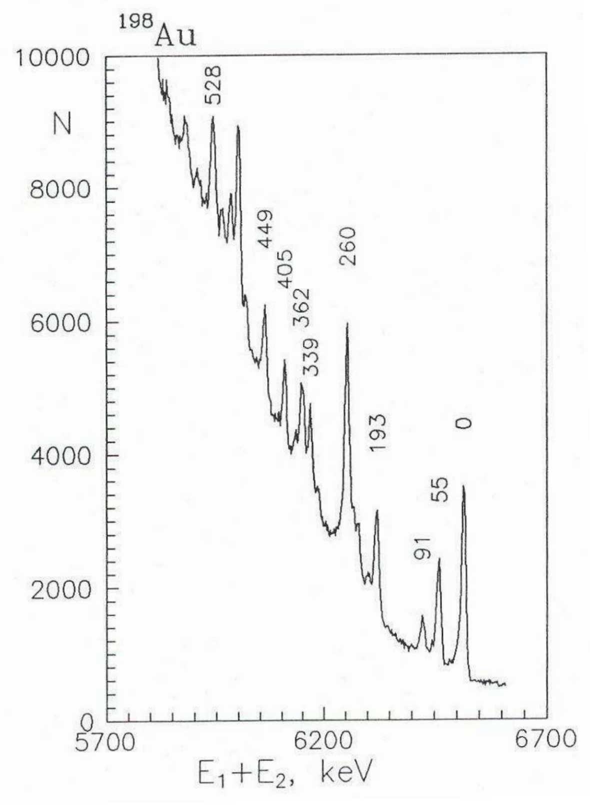

Fig. 1. The spectrum of amplitude sums of coinciding pulses.

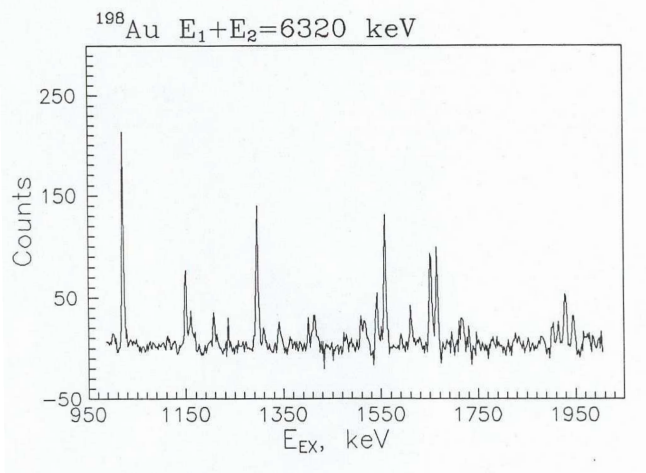

Fig. 2. Partial spectrum E_1 of summed coincidences going to the the level at 193 keV *($E_1 + E_2 = B_n - 193$ keV). After the efficiency correction, the total area of this spectrum is equal to the area of the corresponding peak in the spectrum of Fig. 1.*

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PROUČAVANJE JEZGRE ^{198}Au POMOĆU NEUTRONSKOG UHVATA I (d,p) REAKCIJOM
I. EKSPERIMENTI I PROCJENA

Načinjena su mjerenja relacije ^{197}Au(d,p)^{198}Au pomoću tandem Van de Graaff akceleratora u Münchenu, a reakcije ^{197}Au(n,γ)^{198}Au i ^{197}Au(n,e)^{198}Au proučavane su pri nuklearnom reaktoru u Institutu Lane–Laugevin u Grenoblu. Reakcijom (d,p) opaženo je do energije uzbude od 156 keV ukupno 111 nivoa, a reakcijom (n,γ) 125 nivoa. Za mnoge nivoe utvrđeni su momenti impulsa i parnosti. Dodatni su podaci postignuti mjerenjem zbrojnih (n,$\gamma\gamma$) sudara u Institutu u Dubni.