ON THE DECAY OF ^{203}Bi.

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Abstract.

The radioactive decay of ^{203}Bi is studied. A level scheme is proposed for ^{203}Pb on the basis of γ ray and electron spectra and γ-γ coincidence measurements. The experimental data are compared with theoretical results obtained in a three quasi particle approximation.

RADIOACTIVITY ^{203}Bi (from Pb(p,xn)); measured E_γ, I_γ, I_{ce}, $\gamma\gamma$-coinc, ^{203}Pb deduced levels, J, π, multipolarities, cc.

1. Introduction

The nuclei surrounding ^{208}Pb, and lying only a few nucleons ($\leq$ 3) away from this doubly magic core, have been and still are intensively studied from both the theoretical and experimental points of view. On the other hand, only little experimental work has been done on the excited states of ^{203}Pb, although some calculations were proposed for this region sometime ago [1) to 5)]. The relatively long period of ^{203}Bi, however, allows precise measurements to be taken, in spite of the complexity of the observed spectra. The only reasonably detailed ^{203}Pb decay scheme, resulting from the more or less recent investigations of the desintegration of ^{203}Bi ($T_{1/2}$ = 11.76 h) [6) to 10)], is that given by J.B. Cross in ref.6). But, because of the lack of information on the transition multipolarities and of the many resulting ambiguities for the level spin values, we decided to try to obtain more complete results on this isotope.

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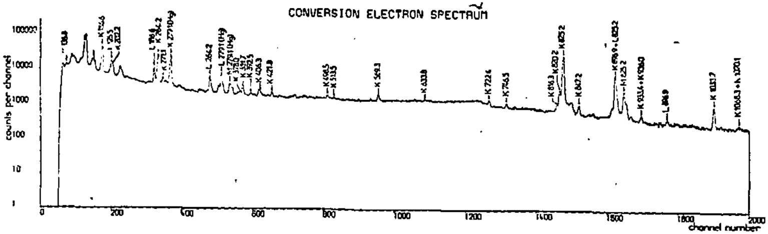
CONVERSION ELECTRON SPECTRUM
counts per channel
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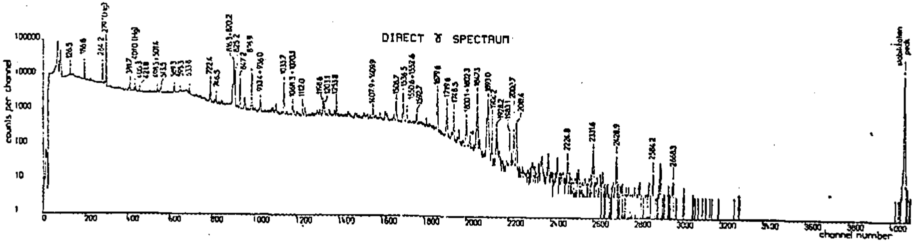

DIRECT γ SPECTRUM
counts per channel
channel number

2. Experimental techniques

^{203}Bi radioactive sources are produced by proton irradiation of natural lead fragments in the Orsay synchrocyclotron with 73 MeV protons (p,xn reaction with n = 5, 6). An electromagnetic separation is then directly performed on the resulting sample in the laboratory's mass separator.

2.1. γ ray detection and γ-γ coincidences

The γ spectra are measured by means of a 30 cm^3 Ge(Li) Quartz et Silice detector (2.7 keV FWHM and efficiency 6% on the 1.33 MeV γ ray of ^{60}Co). The whole linear detection chain is stabilized using, as a reference, a generator peak (whose stability is better than 10^{-5} in 24 h).

A second Ge(Li) counter, with the same characteristics as the first one, is used for bidimensional γ-γ coincidence experiments. The data are stored in sequence by a convenient hard-ware device on a magnetic tape. The coincidence matrix (2048x2048 channels) is then made up on a magnetic disk by an IBM 370-135.

2.2. Conversion electron measurements

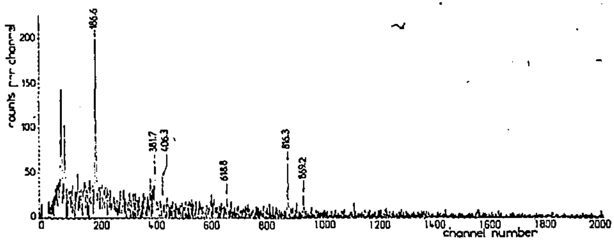
The targets coming out of the mass separator are available for conversion electron spectra measurements without any special treatment,the penetration of the bismuth ions in the aluminium foil being negligible. A 3 mm thick Si(Li) detector (2.5 keV FWHM) is used for this purpose.

3. Experimental results

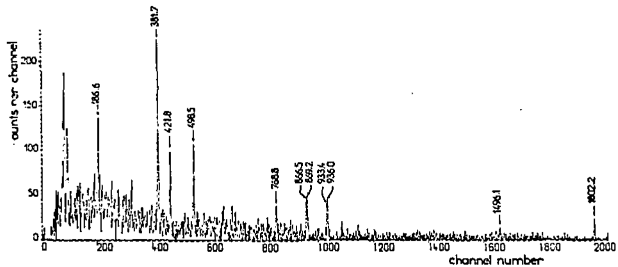
3.1. γ-ray energies and intensities

Several γ spectra have been stored (fig.1) and analysed independently using the SAMPO computer program [11]. When the energy deviation for the main γ rays in the different spectra is smaller than 0.3 keV, the sum of these spectra is analysed in detail. All the transitions detected, with their relative intensities, are listed in table I (the 820.2 keV γ-ray intensity being set equal to 100).

COINCIDENCES WITH THE 746.5 KEV



COINCIDENCES WITH THE 569.3 KEV



3.2. Conversion electron data.

The same method as for the γ transitions has been used for the electron spectra (fig.2). The lower part of these, beneath 100 keV, is disturbed mainly by the X ray emission due to the electronic capture and thus cannot provide much interesting information. The results are given in table II, the normalisation coefficient having been determined by means of the 825.2 keV transition, assumed to be a pure M4 [12]. In the interests of clarity, only the transition energies, the measured conversion coefficients and the tentative multipolarities are listed in the table, the theoretical coefficients being those of Hager and Seltzer [13].

3.3. Coincidence data.

Gates were set on a number of transitions, marked by the letter b in table I, and the corresponding γ coincidence spectra studied. Three coincidence spectra were plotted in each case, firstly with the gate on the transition considered, secondly on a "background" some keV higher in energy, and finally the difference between these two spectra was calculated. The table of all the coincidence results being too unwieldy, those essential for the construction of the level scheme are shown in table III. Two of these coincidence measurements are given in fig.3a and 3b.

4. Decay scheme

The data thus obtained leads to the decay scheme set out in fig.4. In most cases, the basic criteria are the coincidence results. When these are not available, the energy sums must be mutually compatible, within the precisions related to each of the transitions involved. Several weak transitions could be located in different places ; they are drawn in dotted lines in the level scheme. Some ambiguities can be clarified with the help of multipolarity values.

About 75 of all the γ rays measured could not be included in the proposed level scheme. Among these, only ten have an intensity of between 1 and 3%, which makes it possible to compute the log ft values corresponding to the established levels. It is very likely that some low energy transitions occur, below 100 keV (they could, in fact, be the explanation for some of the coincidence results) ; their main effect would be to modify slightly the intensity balance.

The low energy levels identified long ago are found once again [6], among which the 126.4 keV, 186.6 keV, 820.2 keV, 825.2 keV and 1033.7 keV. The other levels proposed are roughly in agreement with those given by J.B. Cross, although supplementary information due to coincidence and even more to multipolarity measurements give rise to many discrepancies in a more detailed approach. Among these, the change in the spin assignment of the 820.2 keV level (which will be discussed later) should be noted.

5. Discussion

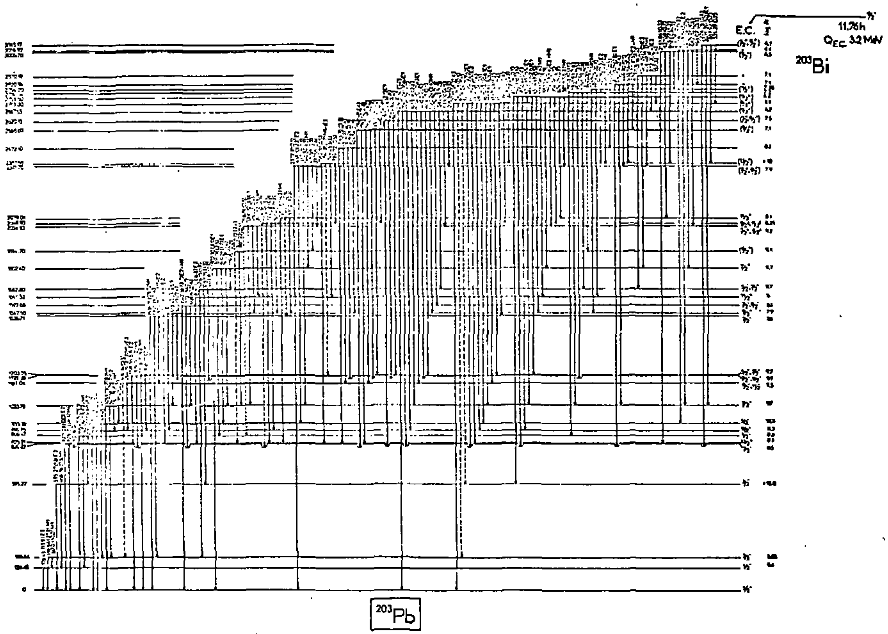
The ^{203}Pb spectrum exhibits three main features :

- in the low energy region, existence of a few levels which can very easily be interpreted as single quasi-particle states.

- around 1 MeV, a group of levels of negative parity which seem to be more complex in character.

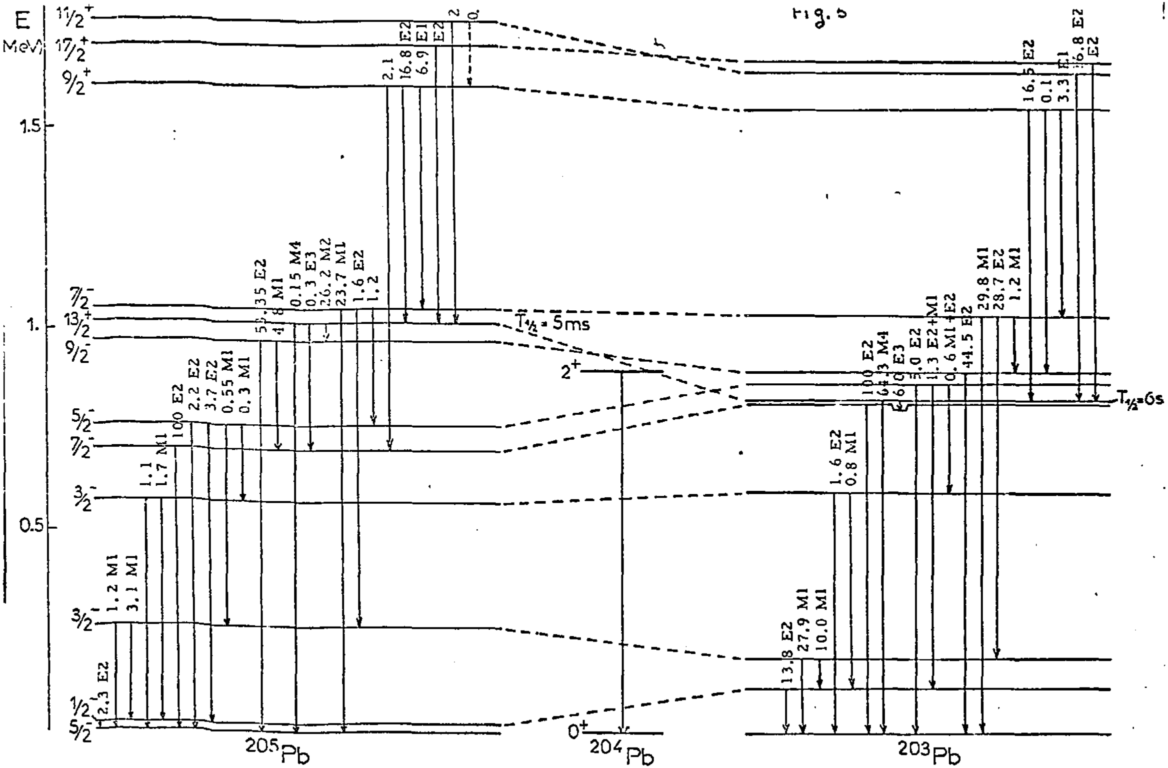
- at about 2.6 MeV, a rather high density of levels with spins $7/2^+$, $9/2^+$ and $11/2^+$ whose de-excitation favours the levels around 1 MeV.

For the low energy levels, the ground state $5/2^-$, the first excited states $1/2^-$ at 126.4 keV, $3/2^-$ at 186.6 keV and $13/2^+$ at 825.2 keV are single quasi-particle levels expected at these energies. The various one quasi-particle calculations performed for the odd mass lead isotopes [1][2][3] predict the position of these states in good agreement with the experimental values ; these states correspond to independent particle ones identified in ^{207}Pb. The transition probabilities measured, in ^{203}Pb, show the features usually found for this type of levels : the hindrance factor of the M4 transition is rather small, whereas the p3/2-f5/2 transition belongs to the group of the forbidden M1 transitions.



E.C.
11.76h
Q_{EC} 3.2 MeV
^{203}Bi
^{203}Pb

When looking at fig.5, it is tempting to explain a number of levels, some of them near 1 MeV, by the weak coupling theory, before trying any more sophisticated approach. According to that interpretation, the coupling of each single nucleon state of spin j with the 2^+ core of the neighbouring even isotope should give rise to a multiplet of levels with all spin values between $|j-2|$ and $j+2$. The energy distance between the center of gravity of this multiplet and the original single state is roughly equal to the first 2^+ level energy in the even isotope. One of the most important features concerns transition probabilities. In fact, the model provides for : $B(E2 ; j' \to j) \approx B(E2 ; 2^+ \to 0^+)$ and $B(M1 ; j' \to j) = 0$ in which j' comes from the coupling of the single nucleon state j with the 2^+ state. In the ^{203}Pb ground state case, the $5/2^- \otimes 2^+$ coupling is expected to give a multiplet with spin values $1/2^-$ to $9/2^-$. It will be possible to assign only the $9/2^-$ level to this single configuration, as the other spin values up to $7/2^-$ and $5/2^-$ respectively can be due to admixtures from the multiplets generated by the other single particle states $3/2^-$ and $1/2^-$, close to the ground state and which also couple with the 2^+ level. This assignment is justified by the energy of the $9/2^-$ level at 896.7 keV, actually near to that of the first 2^+ level of ^{204}Pb (899 keV), and by the only observed γ ray emitted from this state, a pure E2 to the $5/2^-$ ground state. The $7/2^-$ and $5/2^-$ levels at 820.2 keV and 866.5 keV, decaying only (for the first one) or preferentially by E2 transitions to the ground state, can be considered mainly as members of the $5/2^- \otimes 2^+$ multiplet, though contributions from the $3/2^- \otimes 2^+$ and $1/2^- \otimes 2^+$ disturb their energy and multipolarity behaviour and they cannot provide a good test. The $3/2^-$ level at 595.3 keV comes also partly from the $5/2^- \otimes 2^+$ coupling but it is, in fact, a strong admixture of the three components with a resulting decrease of the level energy. Another rather complex state, the $7/2^-$ level at 1033.7 keV, which de-excitation leads to the $3/2^-$ and $5/2^-$ levels, might be interpreted in a similar way. However, the intensity of the M1 transition $7/2^- \to 5/2^-$ suggests the influence of other components. Apart from the $1/2^-$ level, which has little chance of being populated and thus observed, all the members of the $5/2^- \otimes 2^+$ multiplet, with a more or less "pure" configuration are identified, but only the $9/2^-$ is quantitatively available. A similar, but less disturbed, multiplet should be observed in the coupling

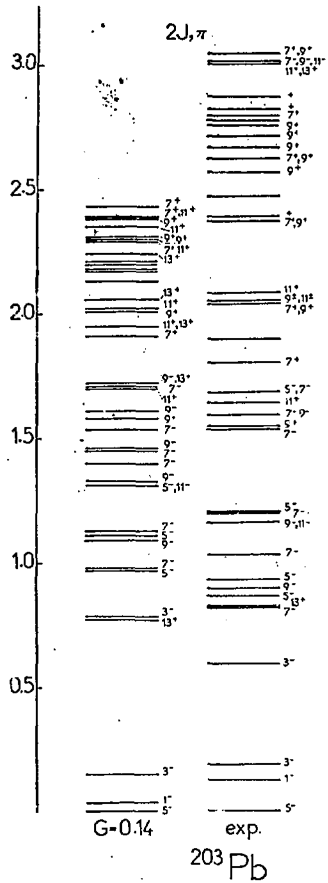


SIMILAR LEVELS IN ^{205}Pb AND ^{203}Pb RELATED TO THE ^{204}Pb 2^{+} CORE of the $13/2^+$ state with the 2^+ core and give the levels $9/2^+$ to $17/2^+$ at about 1700 keV. In fact, two levels with spins $9/2^+$ at 1547.6 keV and $11/2^+$ at 1641.5 keV, decaying towards the $13/2^+$ level by quasi pure E2 transitions, are actually found in the decay of ^{203}Bi which is unable to populate the higher spin states of this multiplet. In a recent report from Stockholm, the $17/2^+$ level is identified at 1664 keV [14], the nucleus ^{203}Pb* being produced by (α,xn) reaction. The behaviour of the levels discussed above looks very much like that of the corresponding ones known in ^{205}Pb, as can be seen from fig.5.

Microscopic calculations have also been performed, on the basis of the first five single particle states of ^{207}Pb, in a three quasi-particle formalism, using a Tamm-Dancoff (TD3) approximation and a surface delta interaction with an intensity of 0.14. This value describes at one and the same time : the mass differences, the first one q.p. states in the odd mass nuclei and the low energy and low spin states in the even isotopes. The comparison between the calculated and experimental spectra is shown in fig.6 and the general agreement can be considered reasonable. The levels discussed before are found here slightly too high in energy, as happens for the 2^+ state of ^{204}Pb coming out of a 2 q.p. calculation performed exactly in the same way (TD2) and with the same interaction. This suggests, at least, that there is no contradiction between the two interpretations. In addition, the 3 q.p. treatment predicts a large number of other states, among which a group of positive parity levels $7/2^+$, $9/2^+$ and $11/2^+$ around 2.2 MeV corresponding most probably to those observed experimentally at about 2.6 MeV. However, the comparison between experimental and theoretical results is difficult in these regions, only the high spin states might be identified more easily with those obtained from the computation.

Transition probabilities.

The 825.2 keV level half-life being known (6.1 sec.), the reduced transition probability between this level and the 820.2 keV level can easily be evaluated. The results obtained by R.E. Doebler et al. [15] show that the 5.0 keV transition intensity is nearly 8% of the total de-excitation. If the 820.2 keV level has a spin $9/2^-$, the 5.0 keV M2 transi-


2J,π
3.0
2.5
2.0
1.5
1.0
0.5
G=0.14
exp.
203 Pb

tion leads to the following value : $B(M2)_{exp} = 2.08\ 10^{-5}(\frac{e\hbar}{2Mpc})^2\ fm^6$. This value is to be compared with those obtained in the neighbouring nuclei where the $13/2^+ \rightarrow 9/2^-$ transition is well established :

	^{203}Pb	^{205}Pb	^{205}Po	^{207}Po
$B(M2)_{exp}(\frac{e\hbar}{2Mpc})^2\ fm^6$	$2.08\ 10^{-5}$	$6.71\ 10^{-2}$	$5.03\ 10^{-2}$	1.52
$F_{sp} = \frac{B_{exp}}{B_{sp}}$	$\sim 10^{-7}$	$3.7\ 10^{-4}$	$2.74\ 10^{-4}$	$8.33\ 10^{-3}$

The F_{sp} value is obtained in the simple hypothesis of a transition between single particle states $i13/2^+$ and $h9/2^-$. The hindrance factor may appear normal for the last three isotopes, as the h9/2 component of the wave function of the low energy $9/2^-$ level is very weak. On the other hand, there is an *unnacountable* discrepancy for ^{203}Pb.

The hypothesis of a spin $7/2^-$ for the 820.2 keV level gives, for an E3 transition :

	^{203}Pb	^{205}Pb
$B(E3)_{exp}\ e^2 fm^6$	3.3	6
$F_{sp} = \frac{B_{exp}}{B_{sp}}$	$2.5\ 10^{-3}$	$5\ 10^{-4}$

The F_{sp} being calculated this time for an $i13/2^+ \rightarrow f7/2^-$ transition. The order of magnitude is reasonable and the two values obtained are close.

When the calculation is performed with the wave functions resulting from a computation using the TD3 approximation and a surface delta interaction whose intensity $G = 0.14$, one finds :

$$B(E3)_{TD3} = 11.4\ e^2 fm^6 \quad \text{and} \quad F_{TD3} = \frac{B_{exp}}{B_{sp}} = 0.33$$

The agreement is excellent. Thus it seems that the 820.2 keV level properties are better explained if its spin is $7/2^-$.

6. Conclusion

A large amount of experimental data was collected on the decay of ^{203}Bi, leading to a complex, if not complete, decay scheme for ^{203}Pb. Because of the density of experimental levels, it is however difficult to decide which might be the best theoretical interpretation. A three q.p. calculation, using a surface delta interaction with $G = 0.14$, accounts for most of the observed levels, but it is interesting to note that some of them could equally well be predicted in a weak coupling description. The study of the levels behaviour in more deficient odd isotopes, produced either by bismuth decay or by (heavy ion,xn) reactions, would provide a better test of the validity and limits of theoretical approaches.

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Table I.

Energies and relative intensities of ^{203}Pb gamma rays*

E_γ (keV)	I_γ	E_γ (keV)	I_γ	E_γ (keV)	I_γ	E_γ (keV)	I_γ
100.47	0.19	468.76	0.76	816.32[b]	13.6	1151.49	0.47
119.95	0.19	476.98	0.29	820.28[b]	100	1153.45	0.66
126.46[b]	4.07	483.81	0.90	825.21	49.3	1166.86	0.53
136.78	0.84	486.62	0.39	847.18[b]	28.7	1176.97	0.37
157.33	0.20	490.24	0.37	861.22[b]	0.45	1184.35	1.65
166.7[illegible]	0.29	498.49[b]	2.24	866.47[b]	5.02	1188.16	0.43
1[illegible]3.64[b]	10.5	501.40[b]	0.63	869.21[b]	1.67	1198.55[b]	6.81
[illegible]96.07	0.29	508.20[b]	0.55	871.04	0.79	1203.05[b]	5.19
202.20	0.25	511.00	1.04	880.00	0.30	1206.17	0.50
212.52	0.92	513.46[b]	<3.37	896.85[b]	44.1	1214.26	0.75
220.37	0.10	531.21	0.31	904.13	0.72	1223.70	2.46
252.22	0.35	542.77	0.76	906.70	0.64	1228.36	0.74
264.19[b]	17.7	546.97	0.58	911.70	0.75	1246.07	1.79
271.12	0.48	558.87	0.55	924.54	0.68	1253.83[b]	4.16
295.84	0.28	569.29[b]	4.11	927.68[b]	0.67	1261.86	0.39
299.34	0.39	590.85	0.43	933.39[b]	4.85	1274.24	0.32
306.10	0.10	595.27[b]	1.59	935.99[b]	2.50	1303.29	1.65
311.11	0.22	618.77	1.21	951.64	0.77	1307.54	0.57
322.04	0.51	621.02	1.39	974.34	0.28	1310.97	0.42
325.49	0.22	623.93	0.57	982.32	0.61	1337.26	1.26
331.29	0.70	626.73	1.20	984.97	1.04	1343.35	0.57
337.68	0.58	633.80[b]	4.49	995.13[b]	0.51	1350.33	0.37
339.72	0.55	647.02	0.50	1000.31[b]	3.31	1358.14	0.20
349.13	0.43	651.53	0.15	1006.88	0.37	1365.50	0.42
375.09	1.20	657.92	0.75	1024.25	0.41	1370.07	1.22
378.00	0.97	665.03	0.36	1033.73[b]	29.8	1374.18	0.36
381.67[b]	4.34	674.78	0.34	1043.95[b]	0.82	1381.27	0.95
392.52[b]	1.13	697.36	0.54	1058.77	0.35	1385.61	1.27
406.31[b]	1.25	704.38	0.48	1068.29[b]	2.03	1395.55	1.04
416.13	0.31	719.03[b]	1.34	1070.12[b]	2.37	1407.88[b]	3.19
421.80[b]	1.29	722.39[b]	16.1	1074.76[b]	0.97	1409.91	2.40
429.04	0.08	740.09[b]	1.28	1087.75[b]	1.31	1417.07	0.65
432.54	0.45	746.45(2)[b]	3.87	1091.73	0.57	1421.07	0.85
449.90	0.13	759.01[b]	0.9	1096.62	0.39	1431.01	0.41
452.80	0.33	768.81[b]	1.38	1111.96[b]	2.42	1438.10	2.15
459.48	0.21	772.74[b]	0.71	1120.24[b]	2.44	1464.75	2.07
462.15	0.59	779.90	0.39	1123.93[b]	1.02	1469.20	1.46
465.81	0.28	788.15	0.31	1143.80	0.35	1496.15[b]	1.83

Table I (continued).

E_γ (keV)	I_γ	E_γ (keV)	I_γ	E_γ (keV)	I_γ	E_γ (keV)	I_γ
1506.70[b]	12.4	1738.96	0.86	1930.88	0.5[illegible]	2224.78	0.56
1510.43	1.19	1743.50	0.85	1939.31	0.43	2270.24	0.11
1536.46[b]	25.5	1740.48[b]	6.39	1951.80	0.11	2331.57	1.1
1550.62[b]	2.60	1770.72	1.71	1968.00	0.10	2362.20	0.14
1552.55[b]	5.0	1779.12	0.14	1983.14[b]	2.98	2372.31	0.14
1562.51	0.47	1787.50	0.64	1991.03	0.40	2428.91	0.87
1576.03	0.46	1800.10[b]	3.1	2000.71[b]	2.79	2527.18	0.10
1578.50	0.13	1802.30[b]	3.1	2011.39[b]	5.96	2567.42	0.10
1582.00	0.10	1812.32	0.27	2075.16	0.12	2584.22	0.22
1589.34	0.67	1816.35	1.36	2078.23	1.57	2650.96	0.08
1592.66[b]	3.69	1841.91	1.64	2084.01	0.2	2668.30	0.20
1608.38	0.41	1847.29[b]	38.6	2113.18	0.39	2682.82	0.03
1633.96	2.18	1856.49	0.98	2118.24	0.59	2712.95	0.08
1646.76	0.35	1888.02	6.54	2144.16	0.79	2716.69	0.01
1679.59[b]	29.6	1893.00[b]	27.6	2158.94	0.13	2884.34	0.02
1716.33	1.87	1900.17[b]	1.15	2181.64	0.46	2945.40	0.07
1719.65[b]	11.5	1928.16[b]	3.79	2196.26	0.08		

*The accuracy limits on these values are as follows :

- If $I_\gamma \geq 10$ then $\Delta E_\gamma \leq 0.5$ keV and $\frac{\Delta I_\gamma}{I_\gamma} \leq 5$ %
- If $I_\gamma \leq 1$ then ΔE_γ may reach 1 keV and $\frac{\Delta I_\gamma}{I_\gamma}$, 20%.

Table II

Conversion coefficients and multipolarities

Energy (keV)	K conversion coefficients *L * *	Assumed multipolarities
126.46	1.15(-1) ± 1.1*	E2
135.78	1.33 (0) ± 0.23	M1(+E2)
	4.19(-1) ± 1.07*	
166.64	1.29 (0) ± 0.12	M1
	2.14(-1) ± 0.2*	
202.20	4.59(-1) ± 0.77	E2,M1?
252.22	2.55(-1) ± 0.5	M1(+E2)
264.19	4.4 (-1) ± 0.5	M1+20% E2
	9.9 (-2) ± 1.06*	
271.12	1.8 (-1) ± 0.54	E2(+M1)
375.09	7.8 (-2) ± 1.6	M1(+E2)
376.00	2.0 (-1) ± 0.4	M1
381.57	1.52(-1) ± 0.3	M1
392.52	1.22(-1) ± 0.23	M1
406.31	1.32(-1) ± 0.4	M1
421.80	4.6 (-2) ± 0.5	E2
462.15	9.5 (-2) ± 2.8	M1
465.81	9.45(-2) ± 1.8	M1
468.76	8.4 (-2) ± 1.5	M1
498.49	7.7 (-2) ± 0.81	M1
513.48	1.36(-2) ± 0.3	E1(+M2)
558.87	8.25(-2) ± 2.1	M1
569.29	6.77(-2) ± 0.67	M1
590.85	6.90(-2) ± 2.9	M1
595.27	1.91(-2) ± 2.9	E2
626.73	2.9 (-2) ± 0.8	E2(+M1)
633.80	2.01(-2) ± 0.45	E2(+M1)
719.03	2.6 (-2) ± 0.84	M1(+E2)
728.39	8.72(-3) ± 1.4	E2
740.007	1.39(-2) ± 0.69	E2
746.45(2)	2.71(-2) ± 0.48	M1(+E2)?
816.32	9 (-3) ± 1.4	E2
820.23	8.3 (-3) ± 0.9	E2
847.18	7.03(-3) ± 1.56	E2
856.47	7.46(-3) ± 1.69	E2
859.268(2)	5.82(-3) ± 3.7	E1
896.85	7.5 (-3) ± 0.9	E2
933.39	2.15(-2) ± 0.33	M1
935.99	4.45(-3) ± 2.07	E1
1000.31	2.96(-3) ± 1.56	E1
1033.73	1.14(-2) ± 0.13	M1+30% E2
1068.29	5.3 (-3) ± 1.68	E2 ?
1070.12		E2 ?
1111.96	1.0 (-2) ± 0.26	M1
1120.24	1.17(-2) ± 0.8	M1
1123.93	1.38(-2) ± 0.53	M1
1184.35	6.94(-3) ± 2.75	M1 , E2
1198.55	4.01(-3) ± 0.98	E2
1203.05	7.98(-3) ± 1.57	M1
1223.70	2.78(-3) ± 1.15	E1 , E2
1246.07	7.15(-3) ± 1	M1
1253.63	6.71(-3) ± 3.15	M1 , E2 ?
1436.10	3.6 (-3) ± 2	E2
1506.70	1.05(-3) ± 0.33	E1
1536.46	4.06(-3) ± 0.76	M1
1550.62	7.36(-4) ± 4.6	E1 ?
1552.55		
1592.66	3.11(-3) ± 0.8	M1 , E2
1679.59	7.3 (-4) ± 1.15	E1
1719.65	6.75(-4) ± 2.38	E1
1748.48	3.36(-4) ± 1.72	E1(+M2)
1787.60	5.29(-3) ± 2.02	M1 ?
1800.10	6.64(-4) ± 2.5	E1 ?
1802.30		E1 ?
1847.29	5.33(-4) ± 0.88	E1
1888.02	1.46(-3) ± 0.2	E2
1893.00	5.56(-4) ± 0.94	E1
1928.16	1.31(-3) ± 0.38	E2(M1?)
1983.14	1.55(-3) ± 0.65	E2
1991.03	1.99(-3) ± 1.25	E2 , M1
2000.71	4.60(-4) ± 2.34	E1
2011.39	5.18(-4) ± 1.44	E1

Table III

Results of some coincidence studies

e energy (keV)	γ rays in the coincidence spectrum (keV)
381.67	186.64 - 569.29 - 595.27 - 719.03 - 722.39 - 740.09 - 746.45 - 768.81 - 816.32 - 847.18 - 866.47 - 869.21 - 896.65 - 933.39 - 935.99 - 1033.73 - 1087.75 - 1438.10 - 1496.15 - 1716.33 - 1802.30 .
421.80	186.64 - 569.29 - 953.39 - 935.99 - 1198.55 - 1438.10 - 1716.33 - 1802.30.
498.49	186.64 - 569.29 - 933.39 - 935.99 - 1438.10 - 1716.33 - 1802.30.
513.40	186.64 - 508.20 - 633.80 - 847.18 - 896.85 - 1033.73 - 1120.24.
569.29	186.64 - 295.84 - 381.67 - 421.80 - 468.76 - 498.49 - 595.27 - 768.81 - 847.18 - 866.47 - 869.21 - 933.39 - 935.99 - 1087.75 - 1496.15 - 1802.30.
633.80	186.64 - 1000.31 - 1033.73.
722.39	381.67 - 501.40 - 924.54 - 995.13 - 1058.77 - 1120.24 - 1166.86 - 1246.07.
746.45	186.64 - 381.67 - 406.31 - 618.77 - 816.32 - 869.21 - 1438.10 - 1841.91.
768.81	186.64 - 381.67 - 569.29 - 847.18 - 1033.75 - 1068.29.
816.32	392.52 - 406.31 - 542.77 - 618.77 - 746.45 - 1111.96- 1153.45.
861.22	186.64 - 847.18 - 896.85 - 1033.73.
869.21	186.64 - 381.67 - 421.80 - 508.20 - 569.29 - 746.45 - 933.35 - 1068.29
933.39	381.67 - 421.80 - 498.49 - 569.29 - 869.21 - 1068.29 - 1438.10 - 1679.59 - 1719.65.
935.99	381.67 - 421.80 - 498.49 - 569.29 - 740.09 - 866.47 - 1068.29.
1068.29	866.47 - 869.21 - 933.39 - 935.99 - 1802.30.
1074.76	186.64 - 847.18 - 1033.73 - 1592.66.
1198.55	212.52 - 984.77 - 1370.07 - 1421.07 - 1469.20.
1496.15	186.64 - 220.37 - 264.19 - 381.69 - 569.29 - 1070.12.
1550.62 } 1552.55 }	166.64 - 264.19 - 896.85 - 1203.05.
1679.59	126.46 - 136.78 - 186.64 - 406.31 - 847.18 - 896.85 - 904.13 - 933.39 - 1033.79.