Comments on evaluation of decay data
by M.M. Bé and E. Schönfeld

1. Decay Scheme

The decay scheme tries to be complete : the confirmed gamma rays (even the weakest, are placed), the questionable gamma transitions are mentioned but not placed.
The J^{π} values and the level half-lives are taken from NDS 64,2 (1991).

2. Nuclear Data

- To determine the half-life of ^{169}Yb the following values have been taken in account ($T_{1/2}$ in d):

1	31,83(21)	Walker 1949 (49Wa23)
2	31,97(5)	Lagoutine et al. 1975 (75La16)
3	32,022(8)	Houtermans et al. 1980 (80Ho17)
4	32,015(9)	Rutledge et al. 1980 (80RuZY)
5	32,032(20)	Funck et al. 1983 (83Fu12)
6	32,07(8)	Kits et al. 1988 (88Ki12)
7	31,88(12)	Parker 1990 (90Pa08)
8	32,0147(93)	Unterweger et al. 1992 (92Un01)
9	32,001(34)	Iwahara et al. 1999
10	32,018(5)	weighted mean, adopted value

Value 1 was measured with a Geiger counter, value 2 with a proportional counter, value 7 with a Ge(Li) detector. For all the other measurements an ionisation chamber was used.
This set is a consistent one with a reduced χ^2 of 0,59. The largest weights are those of values 3 (36 %), 4 (28 %) and 8 (27 %).

Several others values with greater or without uncertainty can be found : 33,0 (15) d (Bothe 1946) ; 32,4 d (Cork 1954), 33,0 (15) d (Don Martin 1951), 32 d (Michel, 1954), 30,6 (2) d (Cork 1956).

- The Q value is from Audi and Wapstra (1995).

2.1 Electron Capture Transitions

The probabilities and uncertainties are deduced from the gamma transition probability balance on each level.

The balance on level 13 (570 keV) introduces the possible existence of a second forbidden transition to populate this level. This solution is preferred to those of a possible gamma transition from level 19 (878 keV) with energy 307,5 keV, this gamma line being not mentioned in any publication. The existence of gamma rays from levels 14, 16, 17 has not been pointed out in any process.

From spin and parity it follows that a transition to the ground state ($\Delta J^{\pi} = 3^{+}$) would be unique second forbidden and an EC transition to the 8,4 keV ($\Delta J^{\pi} = 2^{+}$) level would be non-unique second forbidden. If theses transitions exit, the limits of their probabilities, which are based on lg *ft* systematics, are 0,001% and 0,1% respectively.

EC transitions to the 118 keV ($J^{\pi} = 5/2^{+}$) and 139 keV ($J^{\pi} = 7/2^{+}$) levels of the rotational band ($K^{\pi} = 1/2^{+}$) could also be possible and would both be allowed. Nevertheless the projection of the angular momentum J on the rotational symmetry axis K, is ½, this involves a transfer of 3 units of angular momentum rather than the 0 or 1 unit indicated by the J value. Due to the fact that this nucleus is a deformed nucleus and from lg *ft* > 9, it results that the intensities of the EC transitions, if exist, are very low.

In the proposed decay scheme the sum of the electron capture transition probabilities is 100,0 (19)

From experimental emission probabilities and balancing conditions, and taking into account the uncertainties of the gamma transitions feeding and leaving these levels, it seems not necessary to introduce the EC transitions mentioned to the 118 keV and 139 keV levels.

The fractional capture probabilities given in section 2.1 have been calculated on the basis of the table of Schönfeld (1998) and the Q value of Audi and Wapstra (1995). Sahota *et al.* (1982) have determined experimental values of P_K with a relative uncertainty of 3 to 5 % [P_K (472) = 0,812(29) ; P_K (379) = 0,823(34) ; P_K (316) = 0,825(43)] ; their values agree within the uncertainties with the more accurate theoretical values.

The lg *ft* values were calculated from the half-life, the evaluated EC transition probabilities and the transition energies using the log-*f* tables for beta decay of Gove and Martin (1971).

2.2 Gamma Transitions

Precise γ-ray energies of the main γ-rays have been determined by Borchert *et al.* 1975 and Kessler *et al.* 1979. The values of nine lines (i. e., 63, 93, 109, 118, 130, 177, 197, 261, and 307) given in the table in Section 4.2 are taken from Helmer (2000He14). They are based on a value of 411,80205(17) keV for the 412 keV line following the ^{198}Au decay. The energies of the weaker γ-rays are taken from Vagner (1990). The remaining energies (316, 328, 425, 614 keV) were computed from these energies and the relationships in the decay scheme. In order to calculate the level differences which are given in section 2.2 the recoil energies have been taken in account. The γ-ray energies can be found in section 4.2.

The transition probabilities $P_{\gamma+ce}$ were calculated from the measured relative γ-ray emission probabilities (see section 4.2), the total conversion coefficients and from the absolute intensity value of the 198 keV line 35,93(12) which was derived from statistical treatment of measured values (see section 4.2).

The conversion coefficients were interpolated from the table of Rösel *et al.* 1978. Mixing ratios are taken from angular correlation measurements and from $L_1/L_2/L_3$ ratios respectively $M_1/M_2/M_3/M_4/M_5$ ratios (Günther *et al.* 1969, Agnihotry *et al.* 1972, Krane *et al.* 1972, Akhmetov *et al.* 1985, Davaa *et al.*. 1987, Kracikova *et al.* 1987, Wagner *et al.* 1990). The mixing ratio were derived by comparing the subshell ratios from theory and experiment.

The uncertainties of the conversion coefficients are assumed to be 1,5 % for the three well studied transitions 2,1 ; 4,3 ; 4,2 ; 10 % for the less accurate measured transitions 6,3 ; 7,3 ; 7,4 and those above 330 keV, and 3 % for all other transitions.

Recently Dey *et al.* (1997) found from angular correlation measurements evidence for a pure M1 character of the 94 keV transition, almost pure E2 character for the 198 keV transition and only 4 % E2 admixture in the 177 keV transition. The corresponding change in α_t (94) from 3,89 to 3,88 is negligible, the change in α_t (177) from 0,59 to 0,62 is small, but α_t (198) would become markedly lower and lead to disagreement when determining the normalisation factor from different cuts through the decay scheme. Also, considering the recent measurements carried out by Baratova *et al.* (1993) who found a E2 admixture of : 3,4 % in the 94 keV ; 16 % in the 177 keV and, 11 % in the 198 keV transition these results being in agreement with the other experiments ; the values of Dey *et al.* (1997) were not used for the present evaluation.

Comparison between measured α_k and theoretical value from Rösel and from new tables of Band *et al.*

(1993) for some important lines which are M1+E2 or E2 :

Eγ	93,6	109,8	130	177,2	198	307,8
Adopted admixture %E2	3,25 (25)	2,17 (4)	100	15,8 (3)	9,0 (6)	100
Grabowski (1962)	3,3 (3)	2,15 (20)		0,52 (4)	0,41 (3)	0,048 (5)
Agnihotry (1972)				0,445 (35)	0,30 (2)	0,049
Zheltonozhsky (1995)		2,04 (2)	0,545 (5)	0,515 (5)	0,388 (4)	
α_K theoretical Rösel	3,18 (10)	2,03 (3)	0,538 (17)	0,484 (7)	0,370 (6)	0,0482 (15)
α_K theoretical Band	3,06 (10)	1,95 (3)	0,529 (16)	0,467 (6)	0,358 (5)	0,0477 (14)

3. Atomic data

- The values of ω_K, ϖ_L, n_{KL} are taken from Schönfeld and Janßen 1996.
- The energies of the X rays are based on the wavelengths given by Bearden (1967).

4.1 X-ray emissions

- The emission intensities of the L- and K- X-rays are calculated with the EMISSION program (version 102) from the data set evaluated in this study : electron capture transition probabilities, gamma emission probabilities and from the internal conversion coefficients (α_K , α_{L1} , α_{L2} , α_{L3}) from Rösel *et al.* and the partial capture coefficients P_K , P_L taken from the PTB EC-CAPTURE program with the ratio P_{L2} / P_{L1} = 0,0527.

These values are compared with experimental values (see table enclosed), they are generally in good agreement within the uncertainty limits. The measurements were performed with a Si-Li detector for Reference 1-E, an HP-Ge for References 7-E, 10-E1,10-E2 and 3, a Si-Li and HP-Ge for References 1 and 2 and a low energy photon spectrometer for Reference 4.

4.2 Gamma Emissions

- The gamma emission probabilities taken in consideration are from the EUROMET exercise 410 (Morel *et al.*) and from several other authors.

List of laboratories which took part in the EUROMET exercise (all details can be found in the report-1999MoZV) :
- Institute for Physics and Nuclear Engineering (Romania)
- Institut de Radiophysique Appliquée (Switzerland)
- Institute for Reference Materials and Measurements (Belgium)
- V.G. Khlopin Radium Institute (Russia)
- Laboratorio Nacional de Metrologia das Radiações Ionizantes (Brazil- Iwahara *et al.*)
- Laboratoire Primaire des Rayonnements Ionisants (France)
- National Physical Laboratory (U.K.)
- National Office of Measures (Hungary)
- Radioisotope Centre POLATOM (Poland)
- Physikalish-Technische Bundesanstalt (Germany – Schönfeld *et al.*)
- D.I.Mendeleyev Institute for Metrology (Russia – Sazonova *et al.*)

An arbitrary code number was assigned to each participant. The same code number is used here to reference the results.

The recent references : Schönfeld *et al.* (1999), Sazonova *et al.*(2000), Iwahara *et al.* (2000) have not been included as independent reference because they were participants in the EUROMET exercise and then, their results are *de facto* included.
In the EUROMET exercise 410, references 1-E to 11-E, the values were given in absolute value, they have been converted relatively to the 198 keV line.
The other references used are :
1: Artomonova *et al.* 1976 (below 308 keV) and Balalaev *et al.* 1972 (above 308 keV), in this reference the values are given relatively to the 307 keV gamma-ray. As described, from V.S Aleksandrov the absolute intensity for this ray was taken as 10,1 (5) % and those of the 198 keV gamma-ray is 34,34 (264). For this study the values given by Balalaev were converted relatively to the 198 keV ray taken as 100, with respect to the above absolute values used in the quoted paper.
2: Gehrke *et al.* 1977
3: Funck *et al.* 1983 (below 308 keV), Georgieva and Tumbev 1976 (above 308 keV)
4: Mehta *et al.* 1986 (uncertainties above 130 keV multiplied by a factor 2 to be compatible with the results of other authors)
5: Vagner et al. 1990, this work is supposed to be the continuation of the work of I. Adam, V. Vagner *et al.* (1986).
6: Bhattacharya *et al.* 1996
7: Miyahara 1998

The less accurate values of the following references were not taken into account for the present evaluation:
Alexander and Boehm 1963
Brown and Hatch 1967
Sen *et al.* 1972
Agnihotry *et al.* 1972
Potnis *et al.* 1972
Lavy *et al.* 1973
Aleksandrov *et al.* 1973
Verma *et al.* 1976

• Other remarks :
- The gamma given at the 205,99 energy by Vagner and at the 206,2 energy by Mehta are processed together in the same line.
- The intensity of the 51 keV is from the imbalance of level 7.
- Some weak gamma transitions were seen in only one spectrum :
105,2 ; 193,1 ; 213,9 ; 226,3 ; 291,2 ; 294,5 ; 316,2 ; 328,0 ; 356,7 ; 425,0 ; 500,3 ; 507,8 ; 546,1 ; 614,1 ; 633,3 ; 693,5 ; 710,3 ; 739,4 ; 760,2 and 781,6 lines.
The 616,2 and the 614,1 lines can not be placed in the decay scheme.

- Four EUROMET participants and Funck made the measurement of the resulting gamma emission of the 8,4 keV transition with the $L_{\beta 2}$ and $L_{\beta 15}$ X-rays emission. The LWEIGHT program running on these 5 values gives for this line (γ8,4 + $L_{\beta 2,15}$) = 4,68 (14)%
On the other hand, we obtain with the EMISSION program : $L_{\beta 2,15}$ = 3,93 (10)% for the X-ray emission.

The gamma emission absolute intensity can be deduced : 4,68 - 3,93 = 0,75 (17)%

From the balance on the levels 1 and 0 of the decay scheme, a probability of 95,1 % for the 8,4 keV transition is deduced. As the decay scheme is quite consistent in every part, this value is certainly good.

The consequence is that the deduced ICC total is : 125 (16)
This is not consistent with the theoretical ICC obtained from the Rosel table for a M1+0,108%E2 transition which is = 273 (13)
It can be noted that with a pure M1 transition the Rosel ICC is 177 (8)

The E2 admixture to the M1 multipolarity is deduced from the M1/M2/M3/M4/M5 ratio measured by T.A.Carlsson, *et al.* They compared their measured ratio with those from the Tables of Hager and Seltzer. Their calculations, taking the Rösel *et al.* conversion coefficients, were repeated and confirmed their result of 0,108(5) % E2 admixture. There are also some older less accurate values giving 0,10(2) %.

It also exists an old measurement of α_{MN} = 106 (6) from G. Charpak and F. Suzor (1959).

Without other confirmation of this value, we will stay with the theoretical ICC for a M1+0,108%E2 transition calculated from Rösel *et al.*
This leads to the **adopted absolute value of 0,347 (17)%** for the emission intensity.
This approach was also followed by Artomonova who gave a value of 0,33 (4)% for the 8,4 keV gamma line emission intensity.

- Determination of the absolute emission intensity of the 198 keV line

During the EUROMET exercise the absolute activity measurement of Yb-169 sources was carried out by several methods and the absolute intensity of the 198 gamma-ray line deduced. This gives 8 measurements made by independent laboratories (references from 1-E to 11-E), moreover 3 others absolute measurements are available (references 3, 7, 8). In these conditions a statistical treatment by using the program LWEIGHT has been done to determine the absolute emission intensity of the 198 keV line.
Absolute values of the 198 keV line from EUROMET exercise and others :

1-E	(36,26 ± 0,18)	EUROMET, 1999
3-E	(37,3 ± 0,5)	EUROMET, 1999
4-E	(35,7 ± 0,6)	EUROMET, 1999
7-E	(36,3 ± 1,1)	EUROMET, 1999
8-E	(35,9 ± 0,8)	EUROMET, 1999
9-E	(35,49 ± 0,39)	EUROMET, 1999
10-E1	(36,06 ± 0,15)	EUROMET, 1999
11-E	(35,9 ± 0,5)	EUROMET, 1999
3	(36,0 ± 0,5)	Funck et al. 1983
7	(35,14 ± 0,28)	Miyahara et al. 1999
8	(35,5 ± 0,4)	Coursey et al. 1994

The reference 3-E is rejected due to deviation from the weighted average (Chauvenet criteria), this leads to process 10 values. No value contributes more than 50%, the reduce χ^2 is 1,64 ; the weighted mean and external uncertainty is chosen. Then **the adopted value is *35,93 (12)%***.
This value is quite close to those obtained by Schönfeld et al. (35,91(13)) by considering the balance of the decay scheme.

5. Electron Emissions

Auger Electrons

The energies of the KLL Auger electrons are taken from Larkins (1977), the others are calculated from the binding energies using approximations. The probabilities of L- and K-Auger electrons are calculated with the PTB program Emission (version 102).

Conversion Electron Emissions
The energies were calculated from the gamma transition energies and from the binding electron energies on the electronic shells.
The emission probabilities were calculated using the adopted gamma emission probabilities and conversion coefficients.

The comparison between measured internal conversion electron intensities and calculated values gives a good agreement which confirms the consistency of the evaluated data set.

E gamma	Agnihotry (1972)	Artamonova (1976)	Calculated
8,4 keV - Ie M		71 (7)	75,6 (53)
20,7 keV - Ie L Ie M		7,5 (4) 1,7 (1)	8,6 (3) 1,93 (7)
63 keV - Ie K - Ie L		36 (7) 7,16 (15)	39,6 (12) 7,2 (3)
93 keV - Ie K - Ie L		7,5 (7) 1,5 (1)	8,18 (27) 1,4 (5)
109 keV - Ie K - Ie L		34,9 (11) 5,7 (1)	35,24 (55) 5,68 (9)
118 keV - Ie K - Ie L		1,28 (6)	1,30 (4) 1,37 (4)
130 keV - Ie K - Ie L		6,2 (3) 5,4 (2)	6,1 (2) 5,3 (2)
177 keV - Ie K - Ie L	10,1 (5)	10,7 (7) 2,1 (1)	10,8 (2) 1,94 (3)
198 keV - Ie K - Ie L	10,8 (5)	13,5 (5) 2,16 (5)	13,29 (22) 2,17 (3)
240 keV - Ie K - Ie L	0,0043 (4)	0,0045 (5) 0,0010 (5)	0,0042 (5) 0,00075 (8)
261 keV - Ie K - Ie L	0,047 17)	0,040 (4)	0,040 (1) 0,0060 (2)
307 keV - Ie K - Ie L	0,53	0,50 (2) 0,15 (2)	0,484 (15) 0,142 (4)

6. Main Production Modes

From Firestone (1996) and Shirley (1991)

References of the programs used
LWEIGHT : A computer program to calculate averages, D.MacMahon, E.Browne
EC-CAPTURE : Calculation of electron capture probabilities. PTB
EMISSION-102 : Calculation of X-rays and Auger electrons emission probabilities. PTB
ICC Database : ICC computer code, CEA-BNM/LNHB technical note LPRI/98/002

References not used
Von W. Bothe. Z. naturforschg. 1 (1946) 173
J.M.Cork *et al.* Phys. Rev. 78,2 (1950) 95
Don S.Martin *et al.* Phys. Rev. 82,5 (1951) 579
M.C.Michel *et al.* Phys. Rev. 93 (1954) 1422
J.M.Cork *et al.* Phys. Rev. 101,3 (1956) 1042
E.N.Hatch *et al.* Phys. Rev. 104,3 (1956) 745

keV	8,4 (g+Lb2)	20,7	63,1	93,6	105,19	109,8	117,4	118,2	130,5
Code number		**(3,2)**	**(8,4)**	**(11,8)**	**(11,7)**	**(2,1)**	**(10,4)**	**(2,0)**	**(3,1)**
1-E	(13,8 ± 1,5)	(0,586 ± 0,033)	(122,7 ± 1,4)	(7,12 ± 0,09)		(47,97 ± 0,42)			(31,56 ± 0,25)
3-E			(115,9 ± 2,9)	(6,86 ± 0,16)		(46,0 ± 0,9)		(5,17 ± 0,12)	(31,2 ± 0,6)
4-E			(123,5 ± 3,1)	(7,28 ± 0,21)		(48,8 ± 1,1)			(32,4 ± 0,7)
7-E	(12,1 ± 0,9)	(0,535 ± 0,033)	(123 ± 6)	(7,05 ± 0,32)		(47,2 ± 2,1)	(0,121 ± 0,022)	(5,33 ± 0,25)	(31,4 ± 1,4)
8-E		(0,450 ± 0,038)	(121,4 ± 3,9)	(6,87 ± 0,24)		(46,1 ± 1,6)		(5,15 ± 0,18)	(31,2 ± 1,0)
9-E		(0,514 ± 0,028)	(121,4 ± 1,5)	(7,44 ± 0,15)		(48,9 ± 1,1)		(5,13 ± 0,09)	(30,7 ± 0,6)
10-E1	(14,4 ± 0,6)	(0,547 ± 0,008)*	(123,3 ± 0,8)	(7,195 ± 0,041)		(48,46 ± 0,31)	(0,129 ± 0,011)	(5,205 ± 0,034)	(31,81 ± 0,16)
11-E		(0,55 ± 0,05)	(121,2 ± 3,3)	(6,72 ± 0,18)		(48,3 ± 1,0)			(32,4 ± 0,7)
1		(0,49±0,05)	(121±3)	(6,5±0,3)		(47,4±1,5)		(4,94±0,26) **	(30,7±1,3)
2			(116±6)	(7,1±0,4)		(48,5±1,5)		(5,31±0,16)	(32,0±1,0)
3		(0,53±0,06)	(124,2±2,4)	(7,22±0,15)		(48,6±0,9)		(5,17±0,09)	(31,3±0,5)
4			(124,9±1,7)	(7,28±0,10)		(48,9±0,5)	(0,081±0,010)	(5,24±0,05)	(31,68±0,25)
5			(120±3)	(7,31±0,13)	(0,0072±0,0021)	(49,0±0,7)	(0,116±0,006)*	(5,26±0,08)	(31,7±0,5)
6			(120±5)	(6,6±0,5)		(47,1±1,0)		(5,13±0,10)	(31,6±1,0)
7				(7,01±0,09)		(48,80±0,57)		(5,18±0,07)	(31,60±0,36)
Adopted	**see X-Table**	**(0,536 ± 0,012)**	**(122,6 ± 0,5)**	**(7,156 ± 0,040)**	**(0,007 ± 0,002)**	**(48,33 ± 0,18)**	**(0,111 ± 0,010)**	**(5,204 ± 0,022)**	**(31,67 ± 0,10)**
N		8	14	15	1	15	4	11	15
chi2/N-1**		1,37	0,92	1,97		1,09	4,12	0,34	0,56
Method		LWM, ext	WM, int	WM, ext		WM, ext	LWM, ext	WM, int	WM, int
Absolute value		**(0,1925 ± 0,0043)**	**(44,05 ± 0,24)**	**(2,571 ± 0,017)**	**(0,0026 ± 0,0008)**	**(17,36 ± 0,09)**	**(0,0398 ± 0,0036)**	**(1,870 ± 0,010)**	**(11,38 ± 0,05)**

1-E to 11-E : Euromet 410, final report, Morel et al.

1 : Artomonova et al.(below 308 keV) + Balalev and Dzelepov (above 308 keV)

2 : Gehrke et al.

3 : Funck et al. (below 308 keV) + Georgevia and Tumbev (above 308 keV)

4 : Mehta et al.

5 : Vagner et al.

6 : Bhattacharya et al.

7 : Miyahara et al.

N : number of values used, ** rejected value due to Chauvenet criteria

chi**2/N-1 : reduced chi**2 when weighed average is adopted

Method : UWM = unweighted mean, WM = weighted mean, LWM = one input uncertainty (*) was increased to limit its relative weight to 50%

ext = external uncertainty is adopted, int = internal uncertainty, exp = the uncertainty was expanded to recover the most precise value

keV	156,7	177,2	193,15	198	205,99	213,936	226,3	240,3	261,1
Code number	(11,4)	(4,3)	(5,3)	(4,2)	(6,3)	(5,2)	(6,2)	(8,3)	(8,2)
1-E	(0,029 ± 0,006)	(61,92 ± 0,49)		(100,0 ± 0,7)				(0,282 ± 0,015)	(4,643 ± 0,040)
3-E		(61,9 ± 1,3)		(100,0 ± 2,0)				(0,334 ± 0,010)	(4,65 ± 0,10)
4-E		(62,7 ± 1,6)		(100,0 ± 2,5)				(0,358 ± 0,023)	(4,84 ± 0,12)
7-E	(0,026 ± 0,006)	(62,6 ± 2,8)		(100,0 ± 4,4)				(0,261 ± 0,016)	(4,60 ± 0,20)
8-E		(62,2 ± 1,9)		(100,0 ± 3,0)				(0,396 ± 0,031) **	(4,70 ± 0,18)
9-E		(63,1 ± 0,8)		(100,0 ± 1,6)				(0,333 ± 0,008)	(5,00 ± 0,09) **
10-E1	(0,0298 ± 0,0043)	(61,95 ± 0,36)		(100,0 ± 0,6)				(0,288 ± 0,012)	(4,654 ± 0,046)
11-E		(62,4 ± 1,3)		(100,0 ± 2,1)				(0,284 ± 0,029)	(4,73 ± 0,13)
1		(63±4)		100					(4,8±0,5)
2		(62,2±1,9)		(100±3)					(4,69±0,14)
3		(62,3±1,1)		100				(0,301±0,006)	(4,67±0,11)
4	(0,027±0,001)	(62,4±0,5)		(100,0±0,8)	(0,0116±0,0001)			(0,334±0,004)	(4,75±0,03)
5	(0,0278±0,0009)	(61,7±1,1)	(0,0207±0,0029)	100	(0,0071±0,0004)	(0,0081±0,0006)	(0,0007±0,0005)	(0,332±0,017)	(4,66±0,07)
6		(62,2±1,0)		100				(0,314±0,005)	(4,66±0,10)
7		(61,89±0,71)		(100,00±0,79)					(4,69±0,05)
Adopted	**(0,0275 ± 0,0007)**	**(62,13 ± 0,20)**	**(0,0207 ± 0,0029)**	**(100,00 ± 0,33)**	**(0,0094 ± 0,0022)**	**(0,0081 ± 0,0006)**	**(0,0007 ± 0,0005)**	**(0,319 ± 0,015)**	**(4,695 ± 0,017)**
N	5	15	1	11	2	1	1	11	14
chi2/N-1**	0,19	0,2						6,02	0,64
Method	WM, int	WM, int		WM, int	UWM, n=2			WM, ext+ exp	WM, int
Absolute value	**(0,00990 ± 0,00025)**	**(22,32 ± 0,10)**	**(0,0074 ± 0,0010)**	**(35,93 ± 0,12)**	**(0,0034 ± 0,0008)**	**(0,00291 ± 0,00022)**	**(0,00025 ± 0,00018)**	**(0,115 ± 0,005)**	**(1,687 ± 0,008)**

1-E to 11-E : Eurome
1 : Artomonova et al.
2 : Gehrke et al.
3 : Funck et al. (belov
4 : Mehta et al.
5 : Vagner et al.
6 : Bhattacharya et a
7 : Miyahara et al.

N : number of values
chi**2/N-1 : reduced
Method : UWM = unv
ext = exter

keV	291,19	294,5	307,7	316,2	328	333,9	336,6	356,74
Code number	(9,3)	(10,3)	(4,1)	(4,0)	?	(11,3)	(6,1)	(12,2)
1-E			(27,95 ± 0,18)			(0,0078 ± 0,0044)		
3-E			(27,4 ± 0,6)					
4-E			(28,5 ± 0,6)					
7-E			(28,1 ± 1,2)					
8-E			(28,3 ± 0,9)					
9-E			(29,67 ± 0,46) **					
10-E1			(28,01 ± 0,14)			(0,00433 ± 0,00029)		
11-E			(28,2 ± 0,6)					
1			(28,3±1,1)			(0,0048±0,0007)	(0,029±0,003)	
2			(27,5±0,8)					
3			(28,1±0,8)			(0,0045±0,0008)	(0,032±0,002)	
4			(27,94±0,20)	(0,0092±0,0008)	(0,0187±0,0012)	(0,0070±0,0009)	(0,0284±0,0016)	
5	(0,0120±0,0004)	(0,0027±0,0007)	(27,5±0,4)			(0,00493±0,00015)	(0,0248±0,0004)*	(0,000392±0,000017)
6			(27,1±1,0)					
7			(28,09±0,32)					
Adopted	**(0,0120 ± 0,0004)**	**(0,0027±0,0007)**	**(27,96 ± 0,09)**	**(0,0092 ± 0,0008)**	**(0,0187 ± 0,0012) ?**	**(0,00477 ± 0,00024)**	**(0,0272 ± 0,0024)**	**(0,00039 ± 0,00002)**
N	1	1	14	1	1	6	4	1
chi2/N-1**			0,37			1,89	3,67	
Method			WM, int			LWM, ext	LWM, ext + exp	
Absolute value	**(0,00431 ± 0,00014)**	**(0,0011 ± 0,0005)**	**(10,046 ± 0,045)**	**(0,0033 ± 0,0003)**	**(0,00672 ± 0,00043)**	**(0,00171 ± 0,00009)**	**(0,0098 ± 0,0009)**	**(0,000141 ± 0,000006)**
1-E to 11-E : Eurome								
1 : Artomonova et al.								
2 : Gehrke et al.								
3 : Funck et al. (belo								
4 : Mehta et al.								
5 : Vagner et al.								
6 : Bhattacharya et a								
7 : Miyahara et al.								
N : number of values								
chi**2/N-1 : reduced								
Method : UWM = unv								
ext = exter								

keV	370,8	379,3	386,673	425	452,62	465,751	474,973
Code number	(8,1)	(8,0)	(16,5)	(10,1)	(13,2)	(17,4)	(12,0)
1-E	(0,0096 ± 0,0050) **						
3-E							
4-E							
7-E	(0,00181 ± 0,00013)						
8-E							
9-E							
10-E1		(0,00171 ± 0,00031)					
11-E							
1	(0,0031±0,0003)	(0,0011±0,0002)	(0,0011±0,0002)		(0,00015±0,00006)	(0,00071±0,00009)	(0,00059±0,00008)
2							
3	(0,0034±0,0009)	(0,00084±0,00028)					
4	(0,0228±0,0016) **	(0,0034±0,0005) **	(0,0013± 0,0003)	(0,0045±0,0008)			
5	(0,00267±0,00010)*	(0,000490±0,000029)*	(0,00093±0,00002)*		(0,000046±0,000010)	(0,000578±0,000013)	(0,000540±0,000012)
6							
7							
Adopted	**(0,00235 ± 0,00032)**	**(0,00083 ± 0,00034)**	**(0,00105 ± 0,00012)**	**(0,0045 ± 0,0008)**	**(0,00010 ± 0,00005)**	**(0,00064 ± 0,00007)**	**(0,000565 ± 0,000025)**
N	4	4	3	1	2	2	2
chi2/N-1**	10,73	5,15	0,64				
Method	LWM, ext + exp	LWM, ext + exp	LWM, int		UWM	UWM	UWM
Absolute value	**(0,00085 ± 0,00011)**	**(0,00030 ± 0,00012)**	**(0,00038 ± 0,00004)**	**(0,00162 ± 0,00029)**	**(0,000035 ± 0,000019)**	**(0,000231 ± 0,000024)**	**(0,000203 ± 0,000009)**
1-E to 11-E : Eurome							
1 : Artomonova et al.							
2 : Gehrke et al.							
3 : Funck et al. (belov							
4 : Mehta et al.							
5 : Vagner et al.							
6 : Bhattacharya et a							
7 : Miyahara et al.							
N : number of values							
chi**2/N-1 : reduced							
Method : UWM = unv							
ext = exter							

keV	494,36	500,35	507,8	515,1	528,572	546,16	562,413
Code number	(14,3)	(18,5)	(15,3)	(14,2)	(15,2)	(19,5)	(13,1)
1-E							
3-E							
4-E							
7-E							
8-E							
9-E							
10-E1							
11-E							
1	(0,0045±0,0005)			(0,012±0,001)	(0,00036±0,00005)		(0,00040±0,00006)
2							
3				(0,0132±0,0011)			
4	(0,0048±0,0008)			(0,0111±0,0008)	(0,0057±0,0008)		(0,0015±0,0003)
5	(0,00408±0,00007)*	(0,0000246±0,0000021)	(0,0000041±0,0000022)	(0,01154±0,00018)*	(0,000333±0,000008)*	(0,0000041±0,0000011)	(0,000329±0,000007)*
6							
7							
Adopted	**(0,00437 ± 0,00033)**	**(0,000025 ± 0,000002)**	**(0,000004 ± 0,000002)**	**(0,01176 ± 0,00043)**	**(0,00036 ± 0,00017)**	**(0,000004±0,000001)**	**(0,0004 ± 0,0001)**
N	3	1	1	4	3	1	3
chi2/N-1**	0,35			0,85	22,42		7,39
Method	LWM, int			LWM, int	LWM,ext		LWM, ext
Absolute value	**(0,00157 ± 0,00012)**	**(0,0000088 ± 0,0000008)**	**(0,0000015 ± 0,0000008)**	**(0,00422 ± 0,00016)**	**(0,00013 ± 0,00006)**	**(0,0000015 ± 0,0000004)**	**(0,00014 ± 0,00004)**
1-E to 11-E : Eurome							
1 : Artomonova et al.							
2 : Gehrke et al.							
3 : Funck et al. (belov							
4 : Mehta et al.							
5 : Vagner et al.							
6 : Bhattacharya et a							
7 : Miyahara et al.							
N : number of values							
chi**2/N-1 : reduced							
Method : UWM = unv							
ext = exter							

keV	570,893	579,854	600,607	614,1	624,9	633,32	642,877
Code number	**(13,0)**	**(16,3)**	**(16,2)**	**?**	**(14,1)**	**(14,0)**	**(17,3)**
1-E							
3-E							
4-E							
7-E							
8-E							
9-E							
10-E1							
11-E							
1	(0,00038±0,00005)	(0,0056±0,0006)	(0,0034±0,0003)	(0,00027±0,00004)	(0,0144±0,0015)		(0,00024±0,00003)
2							
3					(0,0154±0,0012)		
4	(0,0009±0,0002)	(0,0063±0,0010)	(0,0026±0,0005)		(0,0116±0,0008)		
5	(0,000297±0,000020)*	(0,00535±0,00009)	(0,00317±0,00006)*		(0,01390±0,00025)*	(0,0000192±0,0000013)	(0,000212±0,000005)
6							
7							
Adopted	**(0,00035 ± 0,00007)**	**(0,00569 ± 0,00045)**	**(0,00318 ± 0,00020)**	**(0,00027± 0,00004) ?**	**(0,0135 ± 0,0007)**	**(0,0000192 ± 0,0000013)**	**(0,000225 ± 0,000015)**
N	3	3	3	1	4	1	2
chi2/N-1**	4,55	0,25	0,94		2,98		
Method	LWM, ext	WM, int	LWM, int		LWM, ext		UWM
Absolute value	**(0,000127 ± 0,000026)**	**(0,00204 ± 0,00016)**	**(0,00114 ± 0,00007)**	**(0,000097 ± 0,000014)**	**(0,00484 ± 0,00027)**	**(0,0000070 ± 0,0000005)**	**(0,000081 ± 0,000005)**
1-E to 11-E : Eurome							
1 : Artomonova et al.							
2 : Gehrke et al.							
3 : Funck et al. (belov							
4 : Mehta et al.							
5 : Vagner et al.							
6 : Bhattacharya et a							
7 : Miyahara et al.							
N : number of values							
chi**2/N-1 : reduced							
Method : UWM = unv							
ext = exter							

keV	663,603	693,46	710,358	739,42	760,24	773,39	781,64
Code number	(17,2)	(18,3)	(16,1)	(19,3)	(19,2)	(17,1)	(17,0)
1-E							
3-E							
4-E							
7-E							
8-E							
9-E							
10-E1							
11-E							
1	(0,00060±0,00006)		(0,00114±0,00009)			(0,00064±0,00007)	
2							
3							
4							
5	(0,000528±0,000017)	(0,0000242±0,0000012)	(0,000087±0,000006)	(0,0000051±0,0000006)	(0,0000023±0,0000006)	(0,000578±0,000010)	(0,0000084±0,0000007)
6							
7							
Adopted	**(0,00564 ± 0,00042)**	**(0,0000242 ± 0,0000012)**	**(0,000087± 0,000006) ?**	**(0,0000051 ± 0,0000006)**	**(0,0000023 ± 0,0000006)**	**(0,0061 ± 0,0003)**	**(0,0000084 ± 0,0000007)**
N	2	1	1	1	1	2	1
chi2/N-1**	0,72						
Method	UWM					UWM	
Absolute value	**(0,00203 ± 0,00015)**	**(0,0000087 ± 0,0000004)**	**(0,0000313 ± 0,0000022)**	**(0,00000183 ± 0,00000022)**	**(0,00000083 ± 0,00000022)**	**(0,00219 ± 0,00011)**	**(0,0000030 ± 0,0000003)**
1-E to 11-E : Eurome							
1 : Artomonova et al.							
2 : Gehrke et al.							
3 : Funck et al. (belov							
4 : Mehta et al.							
5 : Vagner et al.							
6 : Bhattacharya et a							
7 : Miyahara et al.							
N : number of values							
chi**2/N-1 : reduced							
Method : UWM = unv							
ext = exter							

Code number	1-E	7-E	10-E1	10-E2	1	2	3	4	Calculated	Evaluated****
Energy (keV)										
6.3 (Ll)	(1,34 ± 0,46)	(1,17 ± 0,06)	(1,15 ± 0,17)	(1,276 ± 0,040)	(0,93 ± 0,08)	(1,4 ± 0,7)			**(0,956 ± 0,025)**	(1,18 ± 0,05)
7.1 (Lα,η)	(23,9 ± 1,7)	(22,8 ± 1,1)	(23,0 ± 0,6)	(22,24 ± 0,45)	(20,1 ± 0,8)	(25,3 ± 1,1)			**(22,2 ± 0,5)**	(22,6 ± 0,5)
8.1 (Lβ1,3,4)	(18,0 ± 1,4)	(16,9 ± 0,8)	(17,53 ± 0,44)	(17,61 ± 0,21)	(15,9 ± 0,9)				**(18,3 ± 0,5)**	(17,51 ± 0,18)
γ+8.4 (Lβ2,15)	(5,0 ± 0,6)	(4,39 ± 0,28)	(5,18 ± 0,22)	(4,56 ± 0,05)	(4,5 ± 0,3)				***(3,93 ± 0,10)****	(4,57 ± 0,05)
9.4 (Lg1)	(2,69 ± 0,46)	(2,53 ± 0,12)	(2,74 ± 0,07)	(2,67 ± 0,07)	(2,19 ± 0,13)				**(3,01 ± 0,09)**	(2,62 ± 0,05)
9.7 (Lg2,3)	(0,96 ± 0,34)	(0,929 ± 0,049)	(0,882 ± 0,046)	(0,988 ± 0,017)	(0,73 ± 0,05)				**(0,58 ± 0,01)**	(0,91 ± 0,04)
Tot. 6.3 to 9.7	(51,9 ± 2,4)	(48,7 ± 1,5)	(50,5 ± 0,7)	(49,35 ± 0,49)						(49,7 ± 0,4)
10.1 (Lg4)			(0,176 ± 0,027)	(0,173 ± 0,012)					**(0,0779 ± 0,0026)**	(0,173 ± 0,011)
Total g+LX	(52,1 ± 2,4)	(48,9 ± 1,5)	(50,7 ± 0,6)	(49,53 ± 0,50)	(44,35 ± 1,25)				***(49,4 ± 0,8)****	(49,7 ± 0,4)
49.8 (Ka2)	(54,1 ± 0,9)	(50,7 ± 2,2)	(52,8 ± 0,8)	(52,9 ± 0,7)	(53,5 ± 1,1)	(56,1 ± 0,8)	(56,4 ± 1,5)	(54,9 ± 0,5)	**(52,9 ± 0,8)**	(54,3 ± 0,5)
50.7 (Ka1)	(95,6 ± 1,7)	(90,4 ± 3,4)	(93,8 ± 1,4)	(93,8 ± 1,2)	(94,5 ± 2,1)	(97,9 ± 1,6)	(97,3 ± 3,3)	(97,3 ± 0,8)	**(93,5 ± 1,3)**	(95,6 ± 0,6)
49.8+50.7(Ka)	(149,6 ± 1,9)	(141,0 ± 4,1)	(146,5 ± 1,6)	(146,6 ± 1,5)					**(146,4 ± 2,1)**	(146,9 ± 1,0)
57.4 (Kb1,3,5)	(31,1 ± 1,4)	(29,6 ± 1,0)	(29,35 ± 0,29)	(30,36 ± 0,40)	(30,9 ± 0,7)	(30,0 ± 0,5)	(28,3 ± 0,8)	(32,0 ± 0,8)	**(30,6 ± 0,6)**	(30,0 ± 0,3)
59.0 (Kb2,4,O)	(8,26 ± 0,38)	(7,77 ± 0,27)	(8,16 ± 0,16)	(8,17 ± 0,11)	(7,90 ± 0,17)	(8,19 ± 0,15)	(7,18 ± 0,19)	(8,26 ± 0,36)	**(7,95 ± 0,21)**	(8,11 ± 0,07)
57.4+59.0(Kb)	(39,4 ± 1,5)	(37,3 ± 1,0)	(37,51 ± 0,34)	(38,53 ± 0,42)					**(38,5 ± 0,7)**	(38,0 ± 0,4)

1-E to 10-E2 : Euromet 410, final report, Morel et al. ; absolute measurements

1 : Funck et al. ;

2 : Mehta ; 3 : Vagner ; 4 : Bhattacharya ; recalculated from relative values with P(198 keV) = 35,93 (12)

The calculated values are from the Emission program, ** : X-rays only

****These values were determined by D. MacMahon by applying the Normalised Residuals and Rajeval techniques to the experimental data in the table