^{228}Ac - Comments on Evaluation Decay Data
By Andy Pearce

This evaluation was completed in September 2009 drawing in part from the mass-chain evaluation of Artna-Cohen[1]. The literature available up until January 2009 was included. There is some evidence the decay scheme is not complete based upon the calculated beta emissions.

1 Decay Scheme

^{228}Ac decays almost entirely by beta- decay to excited states in ^{228}Th. The decay scheme (energies, half lives, spins and parities of levels in ^{228}Th) are based upon the adopted levels and gammas from Artna-Cohen[1], which in turn are largely derived from the work of Dalmasso et al[2]. The assignments of gammas to levels are also largely derived from Dalmasso et al.

Baltzer et al[3] place gammas at 56.8 keV and 137.4 keV originating from a 1588 keV 4- level in ^{228}Pa decay. Gamma emissions of similar energies have been observed in ^{228}Ac decay but not placed, and it is assumed these are the same transitions. Inserting this level in the ^{228}Ac decay allows for alternative placement of the 356 keV gamma, for which the predicted multipolarity (E2) did not match the measured conversion coefficient[4] (α=0.3-4). Placement from the 1945 keV level to the 1588 keV level indicates a multipolarity of E1+M2; the mixing ratio has been tentatively estimated at δ=0.5 giving α_T=0.35.

Decay via alpha emission to ^{224}Fr has been reported[5] with a probability of $(5.5 \pm 2.2) \times 10^{-6}$ per 100 decays, but this is unconfirmed.

2 Nuclear Data

For the purposes of this evaluation it is assumed ^{228}Ac decays entirely to ^{228}Th and any alpha branching present is negligibly small. The Q-value of beta decay is taken from Audi, Wapstra & Thibault[6] and is 2123.8 (27) keV. The effective Q-value calculated from the individual decay rates and energies calculated with the RADLST[7] program is 2010 (100) keV; this is low compared with the value from Audi, Wapstra & Thibault and serves to confirm that the decay scheme is incomplete.

There have been only two measurements of the half life reported in the open literature, Hahn and Erbacher[8] at 6.13 hours (quoted in Curie[9], however the corresponding publication could not be identified) and Skanemarg & Skalberg[10] at 6.15 (3) hours. No uncertainty is given for the value of Hahn & Erbacher, but it serves to give confidence in the recommended value of 6.15 (3) hours taken from Skanemarg and Skalberg. From an evaluators' point of view more data are required to provide a definitive half life, however in practice this radionuclide will generally be encountered in secular equilibrium with either the ^{228}Ra or ^{232}Th decay parents, and the exact value of the half life will likely be of no great concern to the user.

3 Atomic Data

All values of atomic data (ω_K, ω_L, η_{KL}, relative probabilities of X-ray and Auger emissions) were derived from Schönfeld and Janßen[11].

4 Gamma-ray Transitions and Internal Conversion Coefficients

Gamma-ray transition energies are calculated from the differences in level energies from Artna-Cohen[1].

Internal conversion coefficients have been determined using the BrIcc code[12], with the gamma-ray multipolarities and mixing ratios from the evaluation of Artna-Cohen[1]. For many emissions the multipolarity is undetermined, and no conversion coefficients could be calculated. Where a multipolarity is available but no mixing ratio given, a default value of 1 is assumed and the uncertainty of the derived conversion coefficients is increased accordingly.

Internal conversion coefficients have been measured by Herment and Vieu[4] and Mahajan and Bidarkundi[13] and these are compared in table 3 with the recommended values calculated with BrIcc. The agreement of the total conversion coefficients for the K and L shells is generally good. The 204 keV transition has been reassigned to M2 based upon the measured K conversion coefficient in 1982Ma52; the authors assign 96 % M2 + 4% E1 however the theoretical coefficients calculated using BrIcc for pure M2 are very close to the measured values.

Devare and Devare[24] have measured accurately the L_{II}/L_I conversion ratios for the 184 keV transition from the 1153 keV level and have assigned the multipolarity as predominantly E0 + M1 with a mixing ratio of $\delta \approx 0.3$. It is not possible with BrIcc to calculate conversion coefficients of mixed type transitions incorporating an E0 element, therefore the K-shell conversion coefficient has been estimated at 80 (30) from the measured data as the median of values measured by Herment and Vieu and Mahajan and Bidarkundi and the total coefficient of 100 (40) calculated from the calculated K/total ratio derived from BrIcc with the multipolarity and mixing ratio as above.

5 Electron Emissions

5.1 Beta-particle Emissions

There are no published measurements of the beta emissions in the open literature. Beta-particle transition energies have therefore been determined from the Q-value and level energies, and the emission probabilities from the balance of the decay scheme using the program 'GTOL'[14].

A normalisation factor for the gamma emission probabilities of 0.0454 (11) has been used to determine absolute gamma emission intensities; however, applying this same value when deriving level feedings implies a ~7 % feeding direct to the ground state. Such a transition would be a 2nd forbidden unique decay and such a high branching seems unreasonable. By assuming negligible feeding to the ground state leads a normalisation factor of 0.0475 (11) is calculated, and this value is used to calculate beta particle emission intensities with GTOL. There is therefore an unexplained ~7 % discrepancy between the beta and gamma emissions in this decay; Artna-Cohen[1] suggests there are missing gammas in the decay scheme. Given the available data it seems such gammas would need to decay direct to the ground state and be of such character as to be difficult to detect, for example low energy or E0 transitions. Further measurements of the gamma data, particularly at low energy, would be of benefit, as would coincidence studies to validate the placement of gammas in the level scheme.

The Q-value coupled with the presence of a level in the decay scheme at 2123.1 (3) keV implies a beta emission with an end-point energy of 0.7 keV; it seems unlikely such a low energy emission could have a significant emission probability. This may indicate a deficiency in either the placement of gammas in the decay scheme or in the Q-value.

5.2 Auger & Conversion Electron Emissions

Auger and conversion electron emissions per 100 decays were calculated from the gamma-ray data and conversion coefficients according to the method of Schönfeld and Janßen[11] using version 3.10 of the code EMISSION.

6 Photon Emissions

6.1 X-ray Emissions

The X-ray intensities per 100 decays have been calculated from the gamma-ray data and conversion coefficients using version 3.10 of the code EMISSION. No measurements of the X-ray emissions have been published so it is not possible to make a comparison of calculated and measured data. A comparison with values in the NUDAT database is given in table 4.

6.2 Gamma-ray Emissions

The gamma-ray emission energies have been taken from Helmer[15] where possible, in which precise measurements were made by measuring energy differences against accepted calibration standards. Only the directly measured values have been taken, as the decay scheme used to derive further values was incomplete. These values have been adjusted to reflect the updated calibration standards given in Helmer and van der Leun[16]. Where gamma-ray lines are not present in Helmer[15], weighted means of the values in Herment and Vieu[4], Taylor[17], Kurcewicz et al[18], Borner et al[19], Dalmasso et al[2] and Baltzer et al[3] were taken. The uncertainties of Borner et al were expanded based upon the detector resolution stated in the publication. The values in these publications were first rescaled by a least-squares fit to be compatible with Helmer[15]. In most cases the energy shift incurred by doing so was very small.

Gamma emission probabilities were determined by a weighted mean of values in Arnoux and Gizon[20], Herment and Vieu[4], Mahajan and Bidarkundi[13], Sadasivan and Raghunath[21], Schötzig and Debertin[22], Dalmasso et al[2], Lin and Harbottle[23] and Baltzer et al[3]. Uncertainties were expanded to match the minimum input uncertainty where appropriate. Values were first renormalised to 100 for the 463 keV emission. Baltzer et al relates to ^{228}Pa decay, however additional information could be obtained from this publication for relative gamma emission probabilities originating from the 1431 keV level. Measured and evaluated relative emission probabilities are compared in appendices II and III. While there are several publications covering some of the emissions the intensities of many transitions have been derived solely from Dalmasso et al; where alternative data exists the agreement is often poor.

Several of the gamma emission probabilities measured by Mahajan and Bidarkundi have been rejected on technical grounds. The radionuclides used for calibration stated by the authors were ^{152}Eu, ^{160}Tb and ^{192}Ir. The lowest energy of any gamma line which could reliably be used for efficiency calibration belongs to ^{152}Eu at 122 keV; therefore, gamma emission intensities reported below this energy were rejected. Furthermore, in the energy region 321 keV to 338 keV there seems to be a consistent high bias to the data (see appendix I); two out of three measurements were rejected by Chauvenet's criterion. The remaining measurement passed Chauvenet's criterion but appears high and was rejected due to the obvious trend.

It is not clear that the data in Arnoux and Gizon[20] and Herment and Vieu[4] are independent; in many cases, the data are numerically identical, and appear to correspond to the work of the same research group. In cases where the same emission has been reported by both authors, only the data from the latter publication have been used in the analysis.

Absolute gamma emissions were measured by Schötzig and Debertin[22] and Lin and Harbottle[23]. The intensities of the 463 keV emissions were used to derive normalisation factors and these values are 0.0450 (12) and 0.0441 (11) respectively. The weighted mean of these two values at 0.0445 (11) was used to convert relative intensities into absolute intensities. However, this value is not consistent with expected beta decay characteristics (see section 5.1), suggesting deficiencies in either the adopted decay scheme or the measured data.

There are twenty gammas which cannot be placed in the level scheme. The total intensity is less than 0.25 % (accounting for some internal conversion). These are listed in table 2. The intensity of these gamma emissions is insufficient to account for the discrepancies observed in the decay scheme.

The 18.4 keV gamma has been observed but the probability not directly measured in ^{228}Ac decay; a nominal value of 0.14 (3) for the total transition probability has been derived based upon coincidence measurements on ^{228}Pa[16]. This implies a gamma emission probability of 0.019 (4).

Several doublets have been reported in ^{228}Ac decay. The measured gamma emission intensities have been divided between the components where possible by comparing with ^{228}Pa decay[3]:

168.53 (12) keV

The 1344 keV level has not being reported in ^{228}Pa decay, therefore the intensity of the 168 keV emission from the 1928 keV level was derived from the ratio of the 168 keV emission to the 1741 keV and 1870 keV emissions in ^{228}Pa:

Intensity 168 keV (^{228}Ac, 1928 keV) = intensity 168 keV ^{228}Pa / intensity 1741 keV ^{228}Pa × intensity 1741 keV ^{228}Ac

and:

Intensity 168 keV (^{228}Ac, 1928 keV) = intensity 168 keV ^{228}Pa / intensity 1870 keV ^{228}Pa × intensity 1870 keV ^{228}Ac

The calculated values are 0.0715 (18) and 0.0407 (43) respectively; these are not consistent so a median of the two values is taken, with an uncertainty large enough to cover the difference.

The assigned relative intensities are 0.056 (15) from the 1928 keV level and 0.25 (6) from the 1344 keV keV level. The absolute intensities are therefore 0.0025 (7) and 0.0111 (27) respectively.

278.80 (15) keV

The total relative intensity is 5.28 (28) determined by LRSW weighted mean of the measured data[2,13,20]. The intensity has been split between transitions from the 1153 keV and 1431 keV levels by comparing the emission intensities in ^{228}Ac decay and ^{228}Pa decay. The relative intensities are therefore 4.6 (5) and 0.69 (7) for transitions from the 1153 keV and 1431 keV levels respectively.

649.02 (12) keV

The measured relative intensity is 0.94 (10) from Dalmasso et al[2]. The intensity has been split between transitions from the 1168 keV and 1617 keV levels by comparing the emission intensities in ^{228}Ac decay and ^{228}Pa decay. The relative intensities are therefore 0.75 (8) and 0.189 (20) for transitions from the 1168 keV and 1617 keV levels respectively.

666.451 (46) keV

The measured relative intensity is 2.4 (2) from Dalmasso et al[2]. The intensity has been split between transitions from the 1645 keV and 1892 keV levels by comparing the emission intensities in ^{228}Ac decay and ^{228}Pa decay. The relative intensities are therefore 2.27 (23) and 0.128 (13) for transitions from the 1645 keV and 1892 keV levels respectively.

688.117 (42) keV

Dalmasso et al[2] suggests this emission originates from the 874 keV level; Baltzer et al[4] suggest dual placement from the 874 keV and 1016 keV levels. The measured relative intensity is 1.58 (14) from Dalmasso et al. The intensity has been split by comparing the emission intensities in ^{228}Ac decay and ^{228}Pa decay. The relative intensities are therefore 0.161 (16) and 1.42 (14) for transitions from the 1645 keV and 1892 keV levels respectively.

791.43 (8) keV

The measured relative intensity is 0.54 (17) from Dalmasso et al[2]. The intensity has been split between transitions from the 1760 keV and 1944 keV levels by comparing the emission intensities in ^{228}Ac decay

and ^{228}Pa decay. The relative intensities are therefore 0.23 (7) and 0.31 (10) for transitions from the 1760 keV and 1944 keV levels respectively.

853.96 (8) keV

Artna-Cohen[1] indicates a doublet between an unplaced transition and a transition originating from the 1944 keV level. The energy measured by Dalmasso et al[2] is 853.19 (10) keV however a transition of this energy does not readily fit in to the level scheme as it stands. In the absence of confirmatory measurements it is assumed this transition is the same as that observed at 853.96 keV by Baltzer et al[4] in ^{228}Pa decay. The entire measured intensity of 0.0124 (20) is assigned to the 1944 keV level, and the energy is determined from ^{228}Pa decay.

921.87 (12) keV

Artna-Cohen indicates a doublet between the 979 keV and 1925 keV levels. However, the transition from the 1925 keV level was reported separately by Baltzer et al[4] in ^{228}Pa decay at an energy of 922.5 keV. Based upon the reported energy, it is assumed the transition measured in ^{228}Ac decay is predominantly from the 979 keV level. This emission has therefore been assigned in it's entirety to decay from the 979 keV level.

930.99 (6) keV

The total measured intensity is 0.0129 (20) from 1987Da28. The intensity has been split between transitions from the 1450 keV and 1899 keV levels by comparing the emission intensities in ^{228}Ac decay and ^{228}Pa decay. The absolute intensities are therefore 0.0040 (10) and 0.0025 (23) for transitions from the 1760 keV and 1944 keV levels respectively.

1016.44 (8) keV

Observed in both ^{228}Ac and ^{228}Pa decay. Dalmasso et al[2] suggests a multiple placing, originating from both the 1016 keV and 1344 keV levels of ^{228}Th. Baltzer et al[4] gives only a "less than" value for the 1016 keV transition. The 1344 keV level is not indicated as being fed in ^{228}Pa decay, and assuming the intensity in ^{228}Pa decay is half the "less than" value gives a branching ratio very similar to that observed in ^{228}Ac decay. The intensity has therefore been assigned in its entirety to the transition from the 1016 keV level.

1110.604 (9) keV

The total measured intensity is 0.311 (24) from a weighted mean of Arnoux and Gizon[20] and Dalmasso et al[2]. The intensity has been split between transitions from the 1168 keV and 1297 keV levels by comparing the emission intensities in ^{228}Ac decay and ^{228}Pa decay (1995Ba42). The relative intensities are therefore 6.4 (5) and 0.60 (5) for transitions from the 1168 keV and 1297 keV levels respectively.

Table 1. Comparison of beta transition probabilities calculated using the gamma normalisation factor derived from measurements using a normalisation factor of 0.0445 (11) [A] and from assuming zero feeding to the ground state with a normalisation factor of 0.0474 (11) [B]. Where the calculated beta transition probability is within one standard deviation of zero, a "less than" value is stated. In these cases the emission is not assumed to occur with significant probability. The values calculated assuming zero feeding to the ground state have been recommended.

Level energy /keV	Beta endpoint energy /keV	Feeding /per 100 decays		log *ft*	Transition type
		[A]	[B]		
ground state	2123.8 (27)	7 (3)	<6	-	2nd forbidden unique
57.759 (4)	2066.0 (27)	6 (4)	6 (4)	9.0 (4)	allowed
186.823 (4)	1937.0 (27)	0.6 (5)	0.6 (5)	10 (4)	allowed
328.003 (4)	1795.8 (27)	0.67 (22)	0.72 (23)	10.65 (20)	1st forbidden unique
378.179 (10)	1745.6 (27)	0.138 (19)	0.147 (21)	12.29 (16)	2nd forbidden unique
396.078 (5)	1727.7 (27)	11.6 (5)	12.4 (5)	8.40 (15)	1st forbidden unique
519.192 (6)	1604.6 (27)	<0.07	<0.07	-	1st forbidden unique
831.823 (10)	1292.0 (27)	<0.01	<0.05	-	1st forbidden unique
874.473 (18)	1249.3 (27)	0.16 (10)	0.17 (10)	9.7 (3)	allowed
938.58 (7)	1185.2 (27)	<0.01	<0.01	-	2nd forbidden unique
944.196 (13)	1179.6 (27)	0.081 (15)	0.087 (16)	9.95 (17)	allowed /1t forbidden
968.369 (20)	1155.4 (27)	0.17 (3)	0.18 (3)	9.60 (16)	1st forbidden
968.968 (5)	1154.8 (27)	29 (3)	31 (4)	7.37 (16)	allowed
979.499 (14)	1144.3 (27)	0.224 (19)	0.238 (20)	9.47 (15)	allowed
1016.406 (21)	1107.4 (27)	0.36 (6)	0.39 (6)	9.20 (16)	allowed/1st forbidden
1022.527 (6)	1101.3 (27)	2.8 (4)	3.0 (4)	8.31 (16)	allowed
1059.93 (3)	1063.9 (27)	0.093 (11)	0.099 (11)	9.74 (15)	1st forbidden
1091.017 (8)	1032.8 (27)	0.16 (7)	0.16 (7)	9.48 (24)	allowed
1122.951 (6)	1000.8 (27)	6.27 (17)	6.67 (18)	7.81 (15)	1st forbidden
1153.467 (10)	970.3 (27)	6 (3)	6 (3)	7.8 (3)	allowed
1168.375 (5)	955.4 (27)	3.18 (11)	3.39 (11)	8.04 (15)	1st forbidden
1174.508 (18)	949.3 (27)	<	<		allowed
1175.39 (5)	948.4 (27)	0.155 (18)	0.166 (19)	9.34 (15)	allowed
1226.565 (7)	897.2 (27)	0.63 (7)	0.67 (8)	8.65 (15)	1st forbidden
1297.423 (10)	826.4 (27)	1.37 (10)	1.46 (11)	8.18 (15)	1st forbidden unique
1344.078 (11)	779.7 (27)	0.208 (18)	0.208 (18)	8.94 (15)	1st forbidden
1416.11 (6)	707.7 (27)	0.060 (8)	0.060 (8)	9.34 (16)	allowed /1st forbidden
1431.979 (6)	691.8 (27)	1.6 (5)	1.6 (5)	7.88 (20)	allowed
1450.394 (10)	673.4 (27)	0.25 (8)	0.26 (9)	8.63 (21)	1st forbidden
1531.474 (6)	592.3 (27)	<3	<3	-	allowed
1539.21 (9)	584.6 (27)	<0.01	0.030 (6)	9.36 (17)	allowed
1588.335 (14)	535.5 (27)	8.2 (22)	8.8 (23)	6.77 (19)	1st forbidden
1617.78 (7)	506.0 (27)	0.067 (10)	0.071 (10)	8.78 (16)	allowed
1638.284 (9)	485.5 (27)	1.16 (6)	1.23 (6)	7.48 (15)	allowed
1643.125 (15)	480.7 (27)	0.82 (3)	0.82 (3)	7.64 (15)	1st forbidden
1645.954 (12)	477.8 (27)	4.12 (20)	4.12 (20)	6.94 (15)	allowed
1682.81 (3)	441.0 (27)	1.21 (4)	1.21 (4)	7.35 (15)	allowed
1683.82 (5)	440.0 (27)	0.20 (3)	0.20 (3)	8.13 (16)	1st forbidden
1688.394 (11)	435.4 (27)	2.50 (16)	2.50 (16)	7.02 (15)	allowed
1724.283 (6)	399.5 (27)	1.81 (8)	1.93 (8)	7.01 (15)	allowed
1735.45 (25)	388.4 (27)	0.140 (10)	0.149 (11)	8.08 (15)	allowed
1743.89 (3)	379.9 (27)	0.355 (15)	0.378 (16)	7.65 (15)	allowed
1758.24 (12)	365.6 (27)	0.056 (8)	0.06 (8)	8.39 (16)	allowed
1760.218 (24)	363.6 (27)	0.130 (11)	0.139 (12)	8.02 (15)	allowed
1795.90 (10)	327.9 (27)	0.033 (5)	0.035 (6)	8.48 (16)	allowed
1797.65 (8)	326.2 (27)	0.048 (8)	0.051 (8)	8.30 (16)	allowed
1892.996 (17)	230.8 (27)	0.102 (8)	0.109 (8)	7.50 (15)	allowed
1899.95 (4)	223.9 (27)	0.064 (7)	0.069 (8)	7.65 (15)	allowed

Level energy /keV	Beta endpoint energy /keV	Feeding /per 100 decays		log *ft*	Transition type
		[A]	[B]		
1906.64 (10)	217.2 (27)	0.023 (5)	0.025 (5)	8.05 (17)	allowed
1928.57 (6)	195.2 (27)	0.057 (7)	0.061 (7)	7.52 (16)	allowed
1937.16 (9)	186.6 (27)	0.050 (6)	0.053 (6)	7.52 (15)	allowed
1944.895 (11)	178.9 (27)	0.289 (20)	0.307 (22)	6.70 (15)	allowed
1958.72 (22)	165.1 (27)	0.0035 (8)	0.0038 (8)	8.50 (17)	allowed
1964.98 (7)	158.8 (27)	0.0124 (13)	0.0132 (14)	7.91 (15)	allowed
1987.46 (10)	136.3 (27)	0.07 (4)	0.07 (4)	7.0 (3)	allowed
2010.11 (5)	113.7 (27)	0.224 (14)	0.238 (15)	6.20 (15)	allowed
2013.6 (3)	110.2 (27)	0.0030 (9)	0.0032 (10)	8.03 (20)	allowed
2022.84 (10)	101.0 (27)	0.057 (6)	0.061 (6)	6.64 (16)	allowed/1st forbidden
2029.84 (16)	94.0 (27)	0.024 (4)	0.026 (4)	6.91 (16)	allowed
2036.99 (17)	86.8 (27)	0.0065 (11)	0.0069 (10)	7.38 (17)	allowed
2123.1 (3)	0.7 (27)	0.0044 (10)	0.0047 (11)	≤3.3	allowed

Table 2. Unplaced gamma emissions. The following gamma emissions have not been unambiguously placed in the level scheme. The energy lost from the decay scheme is insufficient to explain the deviation in Q_{eff} and the total probability is insufficient to explain the anomalous feeding to the ground state.

Energy /keV	Emission probability per 100 decays	Observed in	Comments
466.40 (10)	0.0299 (34)	1987Da28	-
481.5 (5)	0.024 (5)	1987Da28, 1995Ba42	Placed at 1450 keV level by 1995Ba42, however unreasonable multipolarity of M2 or E3 results (from Artna-Cohen).
634.18 (10)	0.0111 (22)	1987Da28	-
1337.33 (20)	0.0051 (16)	1987Da28	-
1378.23 (10)	0.0062 (19)	1987Da28	-
1385.39 (10)	0.0111 (22)	1987Da28	-
1434.22 (15)	0.0084 (25)	1987Da28	-
1438.01 (10)	0.0062 (17)	1987Da28	-
1480.38 (15)	0.0170 (34)	1987Da28, 1995Ba42	-
1529.01 (34)	0.059 (6)	1969Ar16, 1987Da28, 1995Ba42	Assigned by 1995Ba42 to 1925 keV level, this level not listed in ^{228}Ac decay. If present 1738 keV may be multiply placed.
1671.67 (15)	0.0043 (14)	1987Da28	-
1684.04 (20)	0.0154 (49)	1987Da28	-
1721.49 (30)	0.0059 (19)	1987Da28	-
1745.32 (20)	0.0067 (9)	1987Da28	-
1784.40 (30)	0.0062 (11)	1987Da28, 1995Ba42	-
1787.20 (20)	0.0013 (5)	1987Da28	May correspond to transition placed from 1974 keV level in ^{228}Pa decay
1916.34 (33)	0.00081 (27)	1987Da28, 1995Ba42	May correspond to transition placed from 1974 keV level in ^{228}Pa decay
1919.54 (30)	0.0022 (6)	1987Da28, 1995Ba42	-
1944.24 (20)	0.0022 (6)	1987Da28	-
2001.0 (5)	0.00108 (28)	1987Da28	-
Total Intensity	0.22 (7)		

Table 3. Comparison of experimental and calculated conversion coefficients for selected gamma transitions.

Transition energy /keV	Multipolarity	Subshell	Publication	Measured conversion coefficient	Calculated (BrIcc)
57.759 (4)	E2	L_I+L_{II}	1982Ma52	50 (4)	61.8 (9)
		L_{III}	1982Ma52	35 (3)	50.4 (7)
		L-total	1971He23	117 (6)	112.2 (16)
99.495 (8)	M1	L_I	1982Ma52	1.9 (1)	2.58 (4)
		L_{II}	1982Ma52	0.12 (1)	0.305 (5)
		L_{III}	1982Ma52	0.17 (3)	0.01646 (20)
		L-total	1971He23	2.8 (1)	2.90 (4)
129.064 (6)	E2	L_I	1982Ma52	0.17 (3)	0.1025 (15)
		L_{II}	1982Ma52	1.6 (1)	1.494 (21)
		L_{III}	1982Ma52	~0.97	0.943 (14)
		L-total	1971He23	2.45 (15)	2.54 (4)
137.941 (17)	M1	K	1971He23	4.1 (14)	6.00 (9)
		L-total	1971He23	0.8 (4)	1.146 (16)
204.038 (9)	M2	K	1982Ma52	7.5 (8)	7.26 (11)

Table 4 Comparison of X-rays calculated using EMISSION with those in the NUDAT database. Note X-ray emission probabilities for this evaluation are generally within uncertainties of, but consistently higher than the NUDAT values.

Transition	**NUDAT**		**DDEP**	
	Energy /keV	**Probability /%**	**Energy /keV**	**Probability /%**
K-α1	93.35	3.1 (4)	93.351	4.0 (11)
K-α2	89.957	1.9 (3)	89.954	2.5 (7)
L-total	~13.0	33.7 (21)	11.1-19.5	37 (4)

7 References

[1]. A. Artna-Cohen *Nuclear Data Sheets* 80 (1997) p723.

[2]. J. Dalmasso and H. Maria, G. Ardisson *Physical Review C* 36 (1987) p2510.

[3]. H. Baltzer, K. Frietag, C. Gunther, P. Herzog, J. Manns, U. Muller, R. Paulsen, P. Sevenich, T. Weber and B. Will *Zeitschrift für Physik A* 352 (1995) p47.

[4]. M. Herment, C. Vieu *Comptes Rendus - Académie de Science B* 273 (1971) 1058

[5]. F. Lux and N. Kaubisch *Angewandte Chemie International Edition* 8 (1969) p911.

[6]. G. Audi, A. H. Wapstra and C. Thibault *Nuclear Physics A* 729 (2003) p337 and A. H. Wapstra, G. Audi and C. Thibault *Nuclear Physics A* 729 (2003) p129.

[7]. T. W. Burrows *The Program RADLST* Brookhaven National Laboratory Report BNL-NSC-52142 (1988)

[8]. O. Hahn and O. Erbacher *Zeitschrift für Physik* 27 (1926) p531 (note: this reference is given in ref. [9] but the corresponding article could not be identified).

[9]. M. Curie, A. Debierne, A. S. Eve, H. Geiger, O. Hahn, C. Lind, St. Meyer, E. Rutherford and E. Schweidler *Review of Modern Physics* 3 (1931) p427.

[10]. G. Skarnemark and M. Skålberg *International Journal of Applied Radiation and Isotopes* 36 (1985) p439.

[11]. E. Schönfeld and H. Janßen *Nuclear Instruments and Methods A* 369 (1996) p527.

[12]. T. Kibédi, T. W. Burrows, M. B. Trzhaskovskoya and C. W. Nestor ANU-P/1684 (2004)

[13]. A. S. Mahajan and M. S. Bidarkundi *Indian Journal of Pure and Applied Physics* 20 (1982) p701.

[14]. GTOL, see for example www.nndc.bnl.gov/toolspublications/toolspublications.html

[15]. R. G. Helmer *Nuclear Instruments and Methods* 164 (1979) p355.

[16]. R. G. Helmer and C. van der Leun *Nuclear Instruments and Methods A* 450 (2000) p35.

[17]. H. W. Taylor *International Journal of Applied Radiation and Isotopes* 24 (1973) p593.

[18]. W. Kurcewicz, N. Kaffrell, N. Trautmann, A. Plochocki, J. Zylicz, M. Matul, K. Stryczniewicz *Nuclear Physics A* 289 (1977) p1.

[19]. H. G. Borner, G. Barreau, W. F. Davidson, P. Jeuch, T. von Egidy, J. Almeida, D. H. White *Nuclear Instruments and Methods* 166 (1979) p251.

[20]. M. Arnoux and A. Gizon *Comptes Rendus - Académie de Science B* 269 (1969) p317.

[21]. S. Sadasivan and V. M. Raghunath *Nuclear Instruments and Methods* 196 (1982) p561.

[22]. U. Schötzig and K. Debertin *International Journal of Applied Radiation and Isotopes* 34 (1983) p533.

[23]. W. J. Lin and G. Harbottle *Journal of Radioanalytical and Nuclear Chemistry* 157 (1992) p367.

[24]. S. H. Devare and H. G. Devare *Physical Review C* 9 (1974) p2297.

Appendix I. Tables of gamma emission energies

Energies have been taken from 1979He10[15] where possible, adjusted using the later reference energies of Helmer[16]. All other energies have been taken from a weighted mean of data from 1971He23[4], 1973Ta25[17], 1977Ku01[18], 1979Bo30[19], 1987Da28[2] and 1995Ba42[5]. All energies have been adjusted to be on the same energy scale as 1979He10[15] before taking means. Nominal energies given in table headings are taken from the evaluation of Artna-Cohen[1].

Nominal Energy /keV	**42.46**	**56.86**	**57.766**	**77.34**	**99.509**
1979He10	-	-	57.752 (13)	-	99.505 (12)
1971He23	-	-	57.74 (8)	-	99.49 (11)
1973Ta25	-	-	57.78 (6)	-	99.45 (8)
1977Ku01	-	-	57.77 (7)	-	-
1979Bo30	-	-	-	-	-
1987Da28	42.457 (50)	56.96 (5)	57.761 (6)	77.338 (30)	99.497 (6)
1995Ba42	42.46 (10)	56.852 (32)	57.752 (22)	77.35 (10)	99.461 (61)
LWEIGHT4	42.46 (5)	56.88 (5)	57.760 (13)	77.340 (30)	99.496 (6)
Adopted	**42.46 (5)**	**56.88 (5)**	**57.752 (13)**	**77.34 (3)**	**99.505 (12)**
Comments	wtd mean	wtd mean	1979He10	wtd mean	1979He10

Nominal Energy /keV	**100.41**	**114.54**	**129.065**	**135.51**	**137.95**
1979He10	-	-	129.0652 (30)	-	-
1971He23	100.39 (11)	-	129.09 (11)	135.49 (20)	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	129.07 (7)	-	-
1979Bo30	-	-	129.07 (16)	-	-
1987Da28	100.408 (30)	114.56 (7)	129.067 (7)	135.539 (50)	137.91 (5)
1995Ba42	100.41 (10)	-	129.051 (22)	135.501 (22)	137.941 (22)
LWEIGHT4	100.410 (30)	-	129.071 (8)	135.507 (20)	137.936 (22)
Adopted	**100.41 (3)**	**114.56 (7)**	**129.065 (3)**	**135.507 (22)**	**137.936 (22)**
Comments	wtd mean	1987Da28	1979He10	wtd mean	wtd mean

Nominal Energy /keV	**141.01**	**145.849**	**153.977**	**168.65**	**173.964**
1979He10	-	-	-	-	173.964 (26)
1971He23	140.89 (20)	146.19 (20)	153.99 (20)	-	174.00 (20)
1973Ta25	-	-	-	-	-
1977Ku01	141.0 (5)	-	-	-	-
1979Bo30	-	-	153.956 (19)	-	-
1987Da28	141.019 (30)	145.848 (11)	153.977 (11)	168.650 (11)	173.980 (10)
1995Ba42	140.991 (22)	145.811 (22)	153.941 (22)	168.41 (9)	174.011 (41)
LWEIGHT4	140.999 (20)	145.842 (20)	153.967 (8)	168.53 (12)	173.995 (28)
Adopted	**140.999 (20)**	**145.842 (20)**	**153.967 (11)**	**168.53 (12)**	**173.96 (3)**
Comments	wtd mean	wtd mean	wtd mean	wtd mean	wtd mean

Nominal Energy /keV	**184.54**	**191.353**	**199.407**	**204.026**	**209.253**
1979He10	-	-	-	-	-
1971He23	184.50 (11)	192.10 (30)	-	-	209.20 (20)
1973Ta25	-	-	-	-	-
1977Ku01	-	190.99 (20)	-	-	209.50 (50)
1979Bo30	-	-	-	-	209.238 (21)
1987Da28	184.540 (20)	191.353 (11)	199.408 (15)	204.027 (11)	209.254 (7)
1995Ba42	184.60 (5)	191.341 (21)	199.391 (21)	204.041 (21)	209.251 (21)
LWEIGHT4	184.547 (19)	191.351 (17)	199.402 (12)	204.029 (9)	209.248 (5)
Adopted	**184.547 (19)**	**191.351 (17)**	**199.402 (15)**	**204.029 (11)**	**209.248 (7)**
Comments	wtd mean	wtd mean	wtd mean	wtd mean	wtd mean

Nominal Energy /keV	**214.85**	**223.8**	**231.42**	**257.7**	**263.62**
1979He10	-	-	-	-	-
1971He23	-	223.70	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	214.85 (10)	223.85 (10)	231.42 (10)	257.52 (10)	263.58 (10)
1995Ba42	214.92 (10)	223.791 (21)	231.49 (5)	257.481 (21)	-
LWEIGHT4	214.89 (7)	223.793 (21)	231.477 (45)	257.482 (21)	-
Adopted	**214.89 (10)**	**223.793 (21)**	**231.42 (10)**	**257.482 (21)**	**263.58 (10)**
Comments	wtd mean	wtd mean	1987Da28	wtd mean	1987Da28

The value of 231.49 (5) keV line observed by 1995Ba42 is believed to relate to a separate gamma transition and has not been used.

Nominal Energy /keV	**270.245**	**278.95**	**282.0**	**321.646**	**326.04**
1979He10	270.245 (7)	-	282.022 (40)	321.646 (8)	-
1971He23	270.20 (50)	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	270.19 (21)	-	-	-	-
1979Bo30	270.235 (14)	-	-	-	-
1987Da28	270.245 (7)	278.952 (50)	281.922 (50)	321.653 (50)	326.04 (20)
1995Ba42	270.241 (21)	278.651 (21)	282.001 (21)	321.701 (31)	-
LWEIGHT4	270.255 (7)	278.80 (15)	281.989 (28)	321.688 (26)	-
Adopted	**270.245 (7)**	**278.80 (15)**	**282.02 (4)**	**321.646 (8)**	**326.04 (20)**
Comments	1979He10	wtd mean	1979He10	1979He10	1987Da28

Nominal Energy /keV	**327.44**	**328.00**	**332.37**	**338.32**	**340.98**
1979He10	-	-	332.371 (6)	338.320 (5)	-
1971He23	-	-	-	338.31 (40)	-
1973Ta25	-	-	-	-	-
1977Ku01	-	327.89 (22)	332.29 (10)	338.09 (22)	-
1979Bo30	-	328.003 (11)	-	338.321 (10)	-
1987Da28	-	328.004 (7)	332.374 (50)	338.324 (6)	340.964 (50)
1995Ba42	327.45 (4)	328.02 (4)	332.360 (21)	338.310 (21)	340.970 (21)
LWEIGHT4	-	328.004 (7)	332.366 (35)	338.342 (18)	340.969 (19)
Adopted	**-**	**328.004 (7)**	**332.371 (6)**	**338.320 (5)**	**340.969 (21)**
Comments	not used	wtd mean	1979He10	1979He10	wtd mean

The 327.44 keV line is listed in Artna-Cohen based upon expected presence inferred from ^{228}Pa EC decay. However, only lines directly observed in ^{228}Ac decay are considered here.

Nominal Energy /keV	**356.94**	**372.57**	**377.99**	**384.47**	**389.12**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	356.94 (10)	372.57 (20)	377.99 (10)	384.63 (20)	389.12 (15)
1995Ba42	356.35 (10)	372.590 (31)	377.98 (10)	384.43 (10)	389.40 (10)
LWEIGHT4	356.65 (30)	372.590 (30)	377.99 (7)	384.47 (9)	389.32 (13)
Adopted	**356.7 (3)**	**372.59 (3)**	**377.99 (10)**	**384.47 (9)**	**389.32 (13)**
Comments	wtd mean	wtd mean	wtd mean	wtd mean	wtd mean

Nominal Energy /keV	**397.94**	**399.62**	**409.462**	**416.3**	**419.4**
1979He10	-	-	409.460 (13)	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	409.487 (33)	-	-
1987Da28	397.95 (10)	399.63 (10)	409.456 (10)	416.31 (20)	419.43 (10)
1995Ba42	-	399.93 (7)	409.440 (21)	415.90 (8)	419.34 (10)
LWEIGHT4	-	399.83 (14)	409.464 (25)	415.96 (14)	419.38 (7)
Adopted	**397.95 (10)**	**399.83 (14)**	**409.460 (13)**	**415.96 (14)**	**419.38 (7)**
Comments	1987Da28	wtd mean	1979He10	wtd mean	wtd mean

Nominal Energy /keV	**440.44**	**449.21**	**452.51**	**457.35**	**463.004**
1979He10	440.450 (24)	449.11 (6)	-	-	463.002 (6)
1971He23	-	-	-	-	463.33 (41)
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	463.002 (13)
1987Da28	440.446 (50)	449.26 (10)	452.47 (10)	457.18 (15)	463.023 (10)
1995Ba42	440.390 (40)	449.22 (30)	452.51 (6)	-	463.01 (50)
LWEIGHT4	440.418 (35)	449.24 (7)	452.50 (5)	-	463.048 (15)
Adopted	**440.450 (24)**	**449.11 (6)**	**452.50 (6)**	**457.18 (15)**	**463.002 (6)**
Comments	1979He10	1979He10	wtd mean	1987Da28	wtd mean

Nominal Energy /keV	**466.4**	**470.2**	**471.76**	**474.79**	**478.4**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	478 (1)
1979Bo30	-	-	-	-	-
1987Da28	466.40 (10)	470.26 (20)	471.77 (15)	474.76 (10)	478.337 (50)
1995Ba42	-	469.89 (50)	-	475.09 (30)	478.440 (40)
LWEIGHT4	-	470.21 (19)	-	474.79 (10)	478.399 (37)
Adopted	**466.40 (10)**	**470.21 (20)**	**471.77 (15)**	**474.79 (10)**	**478.40 (5)**
Comments	1987Da28	wtd mean	1987Da28	wtd mean	wtd mean

Nominal Energy /keV	**480.94**	**490.33**	**492.37**	**497.64**	**503.823**
1979He10	-	-	-	-	503.819 (23)
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	503.60 (33)
1979Bo30	-	-	-	-	-
1987Da28	480.95 (20)	490.33 (15)	492.38 (10)	497.50 (15)	503.83 (50)
1995Ba42	482.03 (5)	-	492.21 (10)	497.70 (10)	503.69 (20)
LWEIGHT4	481.5 (5)	-	492.29 (8)	497.64 (9)	503.67 (18)
Adopted	**481.5 (5)**	**490.33 (15)**	**492.29 (8)**	**497.64 (10)**	**503.819 (23)**
Comments	wtd mean	1987Da28	wtd mean	wtd mean	1979He10

Nominal Energy /keV	**508.959**	**515.06**	**520.151**	**523.131**	**540.76**
1979He10	508.955 (13)	-	520.16 (3)	523.129 (22)	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	508.968 (50)	515.07 (10)	520.18 (5)	523.118 (50)	540.77 (10)
1995Ba42	509.12 (8)	515.19 (11)	520.16 (8)	523.15 (11)	540.650 (50)
LWEIGHT4	509.04 (8)	515.12 (7)	520.17 (6)	523.13 (8)	540.674 (48)
Adopted	**508.955 (13)**	**515.12 (7)**	**520.16 (3)**	**523.129 (22)**	**540.67 (5)**
Comments	1979He10	wtd mean	1979He10	1979He10	wtd mean

Nominal Energy /keV	**546.45**	**548.73**	**555.12**	**562.5**	**570.91**
1979He10	-	-	-	562.496 (7)	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	547 (1)	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	546.479 (50)	548.74 (15)	555.13 (10)	562.529 (30)	570.91 (10)
1995Ba42	546.440 (21)	548.73 (11)	554.59 (30)	562.490 (40)	570.870 (40)
LWEIGHT4	546.445 (19)	548.73 (9)	555.07 (16)	562.509 (29)	570.876 (37)
Adopted	**546.445 (21)**	**548.73 (11)**	**555.07 (16)**	**562.496 (7)**	**570.88 (4)**
Comments	wtd mean	wtd mean	wtd mean	1979He10	wtd mean

Nominal Energy /keV	**572.14**	**583.41**	**590.4**	**610.64**	**616.2**
1979He10	572.10 (5)	-	-	-	616.212 (30)
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	572.30 (10)	583.419 (50)	-	610.65 (10)	616.27 (10)
1995Ba42	572.290 (21)	583.390 (10)	590.64 (11)	-	616.139 (50)
LWEIGHT4	572.290 (20)	583.391 (10)	-	-	616.20 (7)
Adopted	**572.10 (5)**	**583.391 (10)**	**-**	**610.65 (10)**	**616.21 (3)**
Comments	1979He10	wtd mean	not used	wtd mean	1979He10

Nominal Energy /keV	**620.38**	**623.27**	**627.23**	**629.4**	**634.18**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	620.390 (50)	623.27 (20)	627.24 (20)	629.410 (50)	634.18 (10)
1995Ba42	620.259 (50)	623.7 (2)	626.69 (10)	629.39 (20)	-
LWEIGHT4	620.32 (7)	623.48 (22)	626.80 (22)	629.409 (49)	-
Adopted	**620.32 (7)**	**623.48 (22)**	**626.80 (22)**	**629.41 (5)**	**634.18 (10)**
Comments	wtd mean	wtd mean	wtd mean	wtd mean	1987Da28

Nominal Energy /keV	**640.34**	**648.84**	**651.5**	**660.1**	**663.88**
1979He10	640.317 (37)	-	651.526 (28)	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	640.371 (50)	648.85 (10)	651.461 (50)	660.11 (30)	663.83 (10)
1995Ba42	640.319 (50)	649.11 (7)	651.49 (20)	660.17 (30)	663.91 (8)
LWEIGHT4	640.345 (36)	649.02 (12)	651.48 (14)	660.14 (21)	663.88 (6)
Adopted	**640.32 (4)**	**649.02 (12)**	**651.53 (3)**	**660.1 (3)**	**663.88 (8)**
Comments	1979He10	wtd mean	1979He10	wtd mean	wtd mean

Nominal Energy /keV	**666.47**	**672.0**	**674.76**	**677.07**	**684.0**
1979He10	666.451 (46)	-	674.625 (40)	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	666.46 (10)	672.01 (15)	674.61 (10)	677.12 (10)	-
1995Ba42	666.459 (40)	671.93 (10)	674.76 (10)	676.89 (20)	683.99 (30)
LWEIGHT4	666.46 (7)	671.95 (8)	674.69 (7)	677.08 (9)	-
Adopted	**666.45 (5)**	**671.95 (8)**	**674.63 (4)**	**677.08 (10)**	**-**
Comments	1979He10	wtd mean	1979He10	wtd mean	not used

Nomina Energy /keV	**688.11**	**692.47**	**699.08**	**701.747**	**707.41**
1979He10	-	-	-	701.742 (15)	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	688.112 (50)	-	699.09 (15)	701.752 (50)	707.422 (50)
1995Ba42	688.13 (8)	692.46 (7)	698.94 (10)	701.709 (40)	707.39 (30)
LWEIGHT4	688.117 (42)	-	698.99 (8)	701.731 (35)	707.421 (49)
Adopted	**688.12 (4)**	**-**	**698.99 (10)**	**701.742 (15)**	**707.42 (5)**
Comments	wtd mean	not used	wtd mean	1979He10	wtd mean

Nominal Energy /keV	**718.48**	**726.863**	**737.72**	**755.315**	**770.2**
1979He10	-	727.317 (15)	-	755.313 (9)	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	718.49 (15)	726.876 (15)	737.733 (50)	755.325 (15)	-
1995Ba42	718.299 (21)	726.89 (10)	737.79 (20)	755.309 (21)	770.2 (2)
LWEIGHT4	718.303 (26)	726.88 (7)	737.736 (49)	755.317 (15)	-
Adopted	**718.30 (3)**	**726.88 (10)**	**737.74 (5)**	**755.313 (9)**	**-**
Comments	wtd mean	wtd mean	wtd mean	1979He10	not used

The 684 keV, 692 keV and 770 keV emissions have not been observed directly in ^{228}Ac decay and are not included in this evaluation.

There is a considerable discrepancy between data measured for the 727 keV line by 1979He10 and the mean of values measured by 1987Da28 and 1995Ba42. The value measured by 1979He10 is not consistent with the decay scheme; this is possibly due to interference from the ^{212}Bi decay daughter. The weighted mean of 1987Da28 and 1995Ba42 is used instead.

Nominal Energy /keV	**772.291**	**774.1**	**776.52**	**778.1**	**782.142**
1979He10	772.291 (7)	-	-	-	782.140 (6)
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	772.294 (10)	774.11 (20)	776.57 (10)	-	782.154 (50)
1995Ba42	772.269 (21)	774.06 (10)	776.509 (30)	778.09 (20)	782.09 (20)
LWEIGHT4	772.282 (25)	774.07 (9)	776.514 (29)	-	782.12 (14)
Adopted	**772.291 (7)**	**774.07 (10)**	**776.51 (3)**	**-**	**782.140 (6)**
Comments	1979He10	wtd mean	wtd mean	not used	1979He10

Nominal Energy /keV	**791.44**	**792.8**	**794.947**	**813.77**	**816.62**
1979He10	-	-	794.942 (14)	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	817 (1)
1979Bo30	-	-	794.94 (14)	-	-
1987Da28	791.50 (25)	792.8 (10)	794.940 (10)	813.78 (15)	816.71 (10)
1995Ba42	791.42 (9)	792.69 (10)	794.959 (20)	813.92 (10)	816.92 (10)
LWEIGHT4	791.43 (8)	792.69 (10)	794.951 (14)	813.88 (8)	816.82 (7)
Adopted	**791.43 (9)**	**792.69 (10)**	**794.942 (14)**	**813.88 (10)**	**816.82 (10)**
Comments	wtd mean	wtd mean	1979He10	wtd mean	wtd mean

Nominal Energy /keV	**824.934**	**830.486**	**835.71**	**840.377**	**853.17**
1979He10	824.931 (25)	830.481 (8)	835.704 (8)	840.372 (9)	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	824.87 (10)	830.476 (20)	835.708 (20)	840.370 (20)	853.19 (10)
1995Ba42	-	830.469 (30)	835.639 (21)	840.349 (40)	853.96 (8)
LWEIGHT4	-	830.472 (22)	835.674 (35)	840.366 (18)	-
Adopted	**824.931 (25)**	**830.481 (8)**	**835.704 (8)**	**840.372 (9)**	**853.96 (8)**
Comments	1979He10	1979He10	1979He10	1979He10	1995Ba42

The values of the 853 keV line from 1987Da28 and 1995Ba42 are clearly discrepant; the value of 1995Ba42 has been preferred as it better fits the level scheme.

Nominal Energy /keV	**870.45**	**873.11**	**874.45**	**877.39**	**880.76**
1979He10	870.47 (7)	-	874.45 (8)	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	870.456 (50)	873.17 (15)	874.41 (15)	877.48 (10)	880.76 (10)
1995Ba42	870.438 (21)	872.99 (20)	874.49 (20)	877.34 (7)	-
LWEIGHT4	870.441 (19)	873.10 (12)	874.44 (12)	877.38 (6)	-
Adopted	**870.47 (7)**	**873.10 (15)**	**874.45 (8)**	**877.38 (7)**	**880.76 (10)**
Comments	1979He10	wtd mean	1979He10	wtd mean	1987Da28

Nominal Energy /keV	**887.33**	**901.26**	**904.19**	**911.204**	**919.01**
1979He10	-	-	904.20 (5)	911.196 (6)	-
1971He23	-	-	-	911.27 (25)	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	911.166 (40)	-
1987Da28	887.34 (10)	901.25 (15)	904.197 (50)	911.233 (11)	918.99 (10)
1995Ba42	887.18 (10)	90.388 (31)	904.178 (31)	911.188 (21)	919.39 (30)
LWEIGHT4	887.26 (8)	901.383 (30)	904.183 (26)	911.221 (13)	919.03 (12)
Adopted	**887.26 (10)**	**901.38 (3)**	**904.20 (5)**	**911.196 (6)**	**919.03 (12)**
Comments	wtd mean	wtd mean	1979He10	1979He10	wtd mean

Nominal Energy /keV	**921.98**	**924.03**	**930.93**	**939.87**	**944.196**
1979He10	-	-	-	-	944.191 (30)
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	922.00 (10)	-	930.95 (10)	939.89 (15)	944.178 (50)
1995Ba42	921.75 (10)	924.29 (20)	931.01 (7)	-	944.30 (6)
LWEIGHT4	921.87 (12)	-	930.99 (6)	-	944.23 (6)
Adopted	**921.87 (12)**	**-**	**930.99 (7)**	**939.89 (15)**	**944.19 (3)**
Comments	wtd mean	not used	wtd mean	1987Da28	1979He10

Nominal Energy /keV	**947.982**	**958.61**	**964.766**	**968.971**	**975.98**
1979He10	947.976 (24)	958.591 (38)	964.786 (8)	968.960 (9)	-
1971He23	-	-	964.48 (43)	968.88 (34)	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	964.68 (9)	969.161 (34)	-
1987Da28	947.968 (50)	958.638 (50)	964.783 (11)	968.989 (11)	975.978 (50)
1995Ba42	-	958.68 (11)	964.788 (21)	968.668 (21)	975.987 (50)
LWEIGHT4	-	958.645 (46)	964.783 (36)	968.90 (10)	975.983 (36)
Adopted	**947.976 (24)**	**958.59 (4)**	**964.786 (8)**	**968.960 (9)**	**975.98 (5)**
Comments	1979He10	1979He10	1979He10	1979He10	wtd mean

Nominal Energy /keV	**979.48**	**987.88**	**988.63**	**1000.69**	**1013.58**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	979.50 (10)	987.73 (10)	988.65 (20)	1000.71 (15)	1013.60 (20)
1995Ba42	979.39 (40)	987.91 (10)	-	1000.67 (10)	1013.53 (13)
LWEIGHT4	979.49 (10)	987.87 (9)	-	1000.68 (8)	1013.55 (11)
Adopted	**979.49 (10)**	**987.87 (10)**	**988.65 (20)**	**1000.68 (10)**	**1013.55 (13)**
Comments	wtd mean	wtd mean	1987Da28	wtd mean	wtd mean

Nominal Energy /keV	**1016.44**	**1017.92**	**1019.86**	**1033.248**	**1039.84**
1979He10	-	-	-	1033.244 (23)	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1016.46 (15)	1017.94 (20)	1019.88 (10)	1033.240 (20)	1039.67 (15)
1995Ba42	1016.4 (10)	-	-	1033.26 (7)	1039.86 (6)
LWEIGHT4	1016.44 (8)	-	-	1033.241 (19)	1039.83 (7)
Adopted	**1016.44 (10)**	**1017.94 (20)**	**1019.88 (10)**	**1033.244 (23)**	**1039.83 (7)**
Comments	wtd mean	1987Da28	1987Da28	1979He10	wtd mean

Nominal Energy /keV	**1040.92**	**1053.09**	**1054.22**	**1062.55**	**1065.19**
1979He10	-	-	-	-	1065.168 (15)
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1040.94 (15)	1053.11 (20)	1054.13 (20)	1062.57 (15)	1065.200 (50)
1995Ba42	-	-	-	-	1065.20 (7)
LWEIGHT4	-	-	-	-	1065.200 (41)
Adopted	**1040.94 (15)**	**1053.11 (20)**	**1054.13 (20)**	**1062.57 (15)**	**1065.168 (15)**
Comments	1987Da28	1987Da28	1987Da28	1987Da28	1979He10

Nominal Energy /keV	**1074.71**	**1088.18**	**1095.679**	**1103.43**	**1110.61**
1979He10	-	-	1095.671 (23)	-	1110.604 (9)
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1074.73 (15)	1088.20 (15)	1095.711 (50)	1103.43 (10)	-
1995Ba42	-	-	1095.73 (14)	-	1110.537 (51)
LWEIGHT4	-	-	1095.713 (47)	-	-
Adopted	**1074.73 (15)**	**1088.20 (15)**	**1095.671 (23)**	**1103.43 (10)**	**1110.604 (9)**
Comments	1987Da28	1987Da28	1979He10	1987Da28	1979He10

Nominal Energy /keV	**1117.63**	**1135.24**	**1142.85**	**1148.16**	**1153.52**
1979He10	-	-	-	-	1153.266 (35)
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1117.65 (10)	1135.26 (15)	1142.87 (15)	1148.14 (15)	1153.502 (50)
1995Ba42	-	1135.4 (10)	1142.8 (10)	1148.19 (14)	1153.59 (30)
LWEIGHT4	-	1135.26 (15)	1142.87 (15)	1148.17 (10)	1153.505 (50)
Adopted	**1117.65 (10)**	**1135.26 (15)**	**1142.87 (15)**	**1148.17 (14)**	**1153.27 (4)**
Comments	1987Da28	wtd mean	wtd mean	wtd mean	1979He10

Nominal Energy /keV	**1157.14**	**1164.55**	**1175.31**	**1190.83**	**1217.03**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1157.16 (15)	1164.52 (7)	1175.33 (10)	1190.83 (20)	1217.03 (10)
1995Ba42	-	1164.57 (7)	-	1190.9 (10)	-
LWEIGHT4	-	1164.55 (7)	-	1190.83 (20)	-
Adopted	**1157.16 (15)**	**1164.55 (7)**	**1175.33 (10)**	**1190.83 (20)**	**1217.03 (10)**
Comments	1987Da28	wtd mean	1987Da28	wtd mean	1987Da28

Nominal Energy /keV	**1229.4**	**1245.16**	**1247.08**	**1250.04**	**1276.69**
1979He10	-	-	1247.10 (5)	1250.062 (44)	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1229.42 (15)	1245.07 (20)	1247.065 (50)	1249.77 (15)	1276.72 (10)
1995Ba42	-	1245.16 (6)	1247.056 (51)	1249.69 (20)	-
LWEIGHT4	-	1245.15 (6)	1247.061 (36)	1249.74 (12)	-
Adopted	**1229.42 (15)**	**1245.15 (6)**	**1247.10 (5)**	**1250.06 (5)**	**1276.72 (10)**
Comments	1987Da28	wtd mean	1979He10	1979He10	1987Da28

Nominal Energy /keV	**1286.27**	**1287.78**	**1309.71**	**1315.31**	**1337.33**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1286.30 (20)	1287.71 (20)	1309.74 (20)	1315.37 (10)	1337.33 (20)
1995Ba42	1286.29 (30)	1287.78 (8)	1310.2 (10)	1315.19 (20)	-
LWEIGHT4	1286.29 (17)	1287.77 (7)	1309.76 (20)	1315.33 (10)	-
Adopted	**1286.29 (20)**	**1287.77 (8)**	**1309.76 (20)**	**1315.33 (10)**	**1337.33 (20)**
Comments	wtd mean	wtd mean	wtd mean	wtd mean	1987Da28

Nominal Energy /keV	**1344.59**	**1347.5**	**1357.78**	**1365.71**	**1374.24**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1344.62 (15)	1347.50 (15)	1357.81 (15)	1365.73 (15)	1374.24 (7)
1995Ba42	1344.6 (10)	-	-	1365.71 (12)	1374.25 (7)
LWEIGHT4	1344.62 (15)	-	-	1365.71 (12)	1374.24 (6)
Adopted	**1344.62 (15)**	**1347.50 (15)**	**1357.81 (15)**	**1365.71 (12)**	**1374.24 (7)**
Comments	wtd mean	1987Da28	1987Da28	wtd mean	1987Da28

Nominal Energy /keV	**1378.23**	**1385.39**	**1401.49**	**1415.55**	**1430.95**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1378.23 (10)	1385.39 (10)	1401.52 (10)	1415.69 (10)	1430.98 (10)
1995Ba42	-	-	-	1415.41 (10)	1432.0 (10)
LWEIGHT4	-	-	-	1415.55 (14)	1430.99 (10)
Adopted	**1378.23 (10)**	**1385.39 (10)**	**1401.52 (10)**	**1415.55 (14)**	**1430.99 (10)**
Comments	1987Da28	1987Da28	1987Da28	wtd mean	wtd mean

Nominal Energy /keV	**1434.22**	**1438.01**	**1451.4**	**1459.138**	**1469.71**
1979He10	-	-	-	1459.131 (22)	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1434.22 (15)	1438.01 (10)	1451.43 (15)	1459.15 (15)	1469.74 (15)
1995Ba42	-	-	1451.4 (10)	1459.19 (20)	-
LWEIGHT4	-	-	1451.43 (15)	1459.16 (12)	-
Adopted	**1434.22 (15)**	**1438.01 (10)**	**1451.43 (15)**	**1459.131 (22)**	**1469.74 (15)**
Comments	1987Da28	1987Da28	wtd mean	1979He10	1987Da28

Nominal Energy /keV	**1480.37**	**1495.93**	**1501.57**	**1529.02**	**1537.87**
1979He10	-	1495.904 (16)	-	1529.010 (34)	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1480.37 (15)	1495.80 (5)	1501.600 (51)	-	1537.92 (10)
1995Ba42	1480.4 (3)	1496.14 (6)	1501.49 (20)	1529.01 (6)	1537.79 (20)
LWEIGHT4	1480.38 (15)	1495.97 (17)	1501.59 (5)	-	1537.89 (10)
Adopted	**1480.38 (15)**	**1495.904 (16)**	**1501.59 (5)**	**1529.01 (4)**	**1537.89 (10)**
Comments	wtd mean	1979He10	wtd mean	1979He10	wtd mean

Nominal Energy /keV	**1548.65**	**1557.1**	**1559.78**	**1571.52**	**1573.26**
1979He10	1548.65 (6)	1557.13 (7)	-	-	1573.23 (8)
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1548.64 (10)	1557.102 (51)	1559.88 (20)	1571.55 (20)	1573.39 (10)
1995Ba42	-	1557.05 (6)	-	-	1573.29 (30)
LWEIGHT4	-	1557.079 (39)	-	-	1573.38 (10)
Adopted	**1548.65 (6)**	**1557.13 (7)**	**1559.88 (20)**	**1571.55 (20)**	**1573.23 (8)**
Comments	1979He10	1979He10	1987Da28	1987Da28	1979He10

Nominal Energy /keV	**1580.53**	**1588.19**	**1609.41**	**1625.06**	**1630.627**
1979He10	1580.531 (25)	1588.200 (25)	-	1625.092 (35)	1630.618 (20)
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1580.522 (51)	1588.202 (51)	1609.44 (15)	1625.023 (51)	1630.663 (51)
1995Ba42	1580.49 (30)	1588.136 (52)	-	1624.99 (20)	1630.62 (6)
LWEIGHT4	1580.52 (5)	1588.170 (36)	-	1625.021 (49)	1630.644 (39)
Adopted	**1580.531 (25)**	**1588.200 (25)**	**1609.44 (15)**	**1625.09 (4)**	**1630.618 (20)**
Comments	1979He10	1979He10	1987Da28	1979He10	1979He10

Nominal Energy /keV	**1638.281**	**1666.523**	**1671.64**	**1677.67**	**1684.01**
1979He10	1638.272 (23)	1666.514 (13)	-	1677.66 (6)	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1638.304 (51)	1666.55 (51)	1671.67 (15)	1677.704 (51)	1684.04 (20)
1995Ba42	1638.29 (7)	1666.52 (6)	-	-	-
LWEIGHT4	1638.297 (41)	1666.52 (6)	-	-	-
Adopted	**1638.272 (23)**	**1666.514 (13)**	**1671.67 (15)**	**1677.66 (6)**	**1684.04 (20)**
Comments	1979He10	1979He10	1987Da28	1979He10	1987Da28

Nominal Energy /keV	**1686.12**	**1700.59**	**1702.44**	**1706.17**	**1713.49**
1979He10	1686.22 (11)	-	1702.40 (8)	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1686.095 (51)	1700.62 (20)	1702.57 (10)	1706.23 (10)	1713.51 (20)
1995Ba42	1686.14 (7)	-	1702.59 (30)	1706.15 (7)	1713.1 (10)
LWEIGHT4	1686.11 (4)	-	1702.57 (10)	1706.17 (6)	1713.49 (20)
Adopted	**1686.22 (11)**	**1700.62 (20)**	**1702.40 (8)**	**1706.17 (7)**	**1713.49 (20)**
Comments	1979He10	1987Da28	1979He10	wtd mean	wtd mean

Nominal Energy /keV	**1721.4**	**1724.2**	**1738.22**	**1740.4**	**1742.09**
1979He10	-	1724.188 (43)	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1721.49 (30)	1724.28 (10)	1738.26 (25)	1740.46 (30)	1742.09 (30)
1995Ba42	-	1723.99 (20)	1738.465 (52)	-	-
LWEIGHT4	-	1724.22 (12)	1738.46 (5)	-	-
Adopted	**1721.5 (3)**	**1724.19 (5)**	**1738.46 (5)**	**1740.5 (3)**	**1742.1 (3)**
Comments	1987Da28	1979He10	wtd mean	1987Da28	1987Da28

Nominal Energy /keV	**1745.28**	**1750.54**	**1758.11**	**1772.2**	**1784.4**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1745.32 (20)	1750.58 (20)	1758.15 (10)	1772.22 (30)	1784.40 (30)
1995Ba42	-	-	1758.095 (53)	-	-
LWEIGHT4	-	-	1758.106 (47)	-	-
Adopted	**1745.32 (20)**	**1750.58 (20)**	**1758.11 (5)**	**1772.2 (3)**	**1784.4 (3)**
Comments	1987Da28	1987Da28	wtd mean	1987Da28	1987Da28

Nominal Energy /keV	**1787.2**	**1795.15**	**1797.5**	**1800.86**	**1823.21**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1787.30 (50)	1795.14 (50)	1797.50 (50)	1800.90 (20)	1823.26 (10)
1995Ba42	1787.18 (20)	1795.13 (6)	-	-	1823.17 (10)
LWEIGHT4	1787.20 (20)	1795.13 (6)	-	-	1823.22 (7)
Adopted	**1787.20 (20)**	**1795.13 (6)**	**1797.5 (5)**	**1800.90 (20)**	**1823.22 (10)**
Comments	wtd mean	wtd mean	1987Da28	1987Da28	wtd mean

Nominal Energy /keV	**1826.7**	**1835.29**	**1842.14**	**1850.13**	**1870.81**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1826.78 (30)	1835.47 (10)	1842.17 (10)	1850.17 (20)	1870.87 (9)
1995Ba42	-	1835.244 (53)	1842.13 (8)	-	1870.78 (9)
LWEIGHT4	-	1835.29 (9)	1842.15 (6)	-	1870.82 (7)
Adopted	**1826.8 (3)**	**1835.29 (10)**	**1842.15 (8)**	**1850.17 (20)**	**1870.82 (9)**
Comments	1987Da28	wtd mean	wtd mean	1987Da28	wtd mean

Nominal Energy /keV	**1879.6**	**1887.12**	**1900.14**	**1907.13**	**1916.6**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1879.60 (30)	1887.139 (51)	1900.11 (20)	1907.22 (20)	1915.94 (40)
1995Ba42	-	1887.113 (53)	1900.28 (30)	1907.11 (11)	1916.58 (30)
LWEIGHT4	-	1887.127 (37)	1900.16 (17)	1907.14 (10)	1916.34 (33)
Adopted	**1879.6 (3)**	**1887.13 (5)**	**1900.16 (20)**	**1907.14 (11)**	**1916.3 (4)**
Comments	1987Da28	wtd mean	wtd mean	wtd mean	wtd mean

Nominal Energy /keV	**1919.5**	**1929.78**	**1936.2**	**1944.2**	**1952.37**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1919.54 (30)	1929.78 (20)	1936.34 (30)	1944.24 (20)	1952.37 (15)
1995Ba42	-	-	-	-	1952.37 (10)
LWEIGHT4	-	-	-	-	1952.37 (8)
Adopted	**1919.5 (3)**	**1929.78 (20)**	**1936.3 (3)**	**1944.24 (20)**	**1952.37 (10)**
Comments	1987Da28	1987Da28	1987Da28	1987Da28	wtd mean

Nominal Energy /keV	**1955.9**	**1958.4**	**1965.22**	**1971.9**	**1979.3**
1979He10	-	-	-	-	-
1971He23	-	-	-	-	-
1973Ta25	-	-	-	-	-
1977Ku01	-	-	-	-	-
1979Bo30	-	-	-	-	-
1987Da28	1955.94 (50)	1958.41 (30)	1965.28 (20)	1971.96 (30)	1979.32 (30)
1995Ba42	-	-	1965.20 (12)	-	-
LWEIGHT4	-	-	1965.22 (10)	-	-
Adopted	**1955.9 (5)**	**1958.4 (3)**	**1965.22 (12)**	**1972.0 (3)**	**1979.3 (3)**
Comments	1987Da28	1987Da28	wtd mean	1987Da28	1987Da28

Nominal Energy /keV	**2000.9**	**2029.4**
1979He10	-	-
1971He23	-	-
1973Ta25	-	-
1977Ku01	-	-
1979Bo30	-	-
1987Da28	2000.98 (50)	2029.39 (50)
1995Ba42	-	-
LWEIGHT4	-	-
Adopted	**2001.0 (5)**	**2029.4 (5)**
Comments	1987Da28	1987Da28

Appendix II. Relative emission probabilities

Normalised to 100 for the 463 keV emission. Values marked with an asterisk (*) have been rejected from the weighted mean based on statistical evidence or on technical grounds. Where multiplets occur, the intensity is listed here once (in italics) and is the total measured intensity. Normalised values are also given - note the normalisation factor of 0.0445 (11) has been applied before rounding.

Nominal Energy /keV	**18.4**	**42.46**	**56.88**	**57.752**	**77.34**	**99.505**
1969Ar16	-	-	-	10.5 (5)*	-	30.6 (5)*
1971He23	-	-	-	10.5 (3)	-	28.3 (3)
1982Ma52	-	-	-	6.2 (4)*	-	36.5 (8)*
1982Sa36	-	-	-	11.4 (9)	-	31.0 (22)
1983Sc13	-		-	-	-	-
1987Da28	-	0.212 (61)	0.454 (94)	10.2 (11)	0.60 (12)	26.7 (33)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	10.57 (28)	-	28.33 (30)
Adopted	**calc.**	**0.21 (6)**	**0.45 (9)**	**10.6 (3)**	**0.60 (12)**	**28.3 (3)**
Normalised	-	0.009 (3)	0.020 (5)	0.470 (17)	0.027 (6)	1.26 (4)
Comments	no data	1987Da28	1987Da28	wtd mean	1987Da28	wtd mean

Nominal Energy /keV	**100.41**	**114.56**	**129.065**	**135.507**	**137.936**	**141.000**
1969Ar16	-	-	56.4 (4)*	-	-	0.80 (20)
1971He23	2.60 (10)	-	56.4 (4)	0.70 (10)	0.70 (10)	0.80 (20)
1982Ma52	-	-	54.1 (11)	-	-	-
1982Sa36	-	-	64.3 (56)	-	-	-
1983Sc13	-	-	49.6 (34)	-	-	-
1987Da28	2.18 (32)	0.23 (5)	61.2 (67)	0.41 (9)	0.55 (11)	1.18 (19)
1992Li05	-	-	55.3 (43)	-	-	~0.94
1995Ba42	-	-	-	-	-	-
LWEIGHT4	2.56 (12)	-	56.1 (5)	0.54 (14)	0.63 (10)	1.00 (19)
Adopted	**2.56 (12)**	**0.23 (5)**	**56.1 (5)**	**0.54 (14)**	**0.63 (10)**	**1.00 (19)**
Normalised	0.114 (6)	0.0102 (22)	2.50 (7)	0.024 (6)	0.028 (4)	0.045 (9)
Comments	wtd mean	1987Da28	wtd mean	wtd mean	wtd mean	wtd mean

Nominal Energy /keV	**145.82**	**153.967**	***168.53***	**173.964**	**184.547**	**191.351**
1969Ar16	3.6 (3)*	18.5 (4)*	-	-	2.2 (10)	3.9 (7)
1971He23	3.80 (10)	17.1 (4)	-	0.80 (20)	1.9 (6)	3.1 (3)
1982Ma52	-	17.1 (4)	-	-	0.70 (20)	-
1982Sa36	3.81 (30)	18.8 (15)	-	-	-	2.86 (27)
1983Sc13	-	15.6 (8)	-	-	-	-
1987Da28	3.6 (4)	18.2 (20)	*0.30 (6)*	0.82 (13)	1.64 (20)	3.03 (34)
1992Li05	-	15.8 (13)	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	3.79 (9)	16.94 (40)	-	0.81 (11)	1.21 (43)	2.98 (27)
Adopted	**3.79 (10)**	**16.9 (4)**	***0.30 (6)***	**0.81 (13)**	**1.2 (4)**	**3.0 (3)**
Normalised	0.169 (6)	0.754 (23)	-	0.036 (5)	0.054 (19)	0.133 (8)
Comments	wtd mean	wtd mean	*1987Da28*	wtd mean	wtd mean	wtd mean

Nominal Energy /keV	**199.402**	**204.029**	**209.248**	**214.890**	**223.793**	**231.477**
1969Ar16	6.0 (5)	3.0 (5)	93 (4)	-	1.6 (5)	-
1971He23	-	-	93 (4)*	-	-	-
1982Ma52	-	2.4 (2)	-	-	-	-
1982Sa36	7.4 (6)	2.38 (26)	93 (6)	-	-	-
1983Sc13	-	-	84.7 (34)	-	-	-
1987Da28	7.4 (8)	3.09 (34)	98 (9)	0.69 (11)	1.27 (14)	0.58 (9)
1992Li05	-	-	89.1 (35)	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	6.7 (5)	2.56 (17)	89.3 (19)	-	1.30 (13)	-
Adopted	**6.7 (5)**	**2.56 (20)**	**89 (4)**	**0.69 (11)**	**1.30 (14)**	**0.58 (9)**
Normalised	0.299 (23)	0.114 (8)	3.97 (13)	0.031 (5)	0.058 (6)	0.026 (4)
Comments	wtd mean	wtd mean	wtd mean	1987Da28	wtd mean	1987Da28

Nominal Energy /keV	**257.482**	**263.580**	**270.245**	***278.80***	**282.022**	**321.646**
1969Ar16	-	-	76.0 (40)	*5.6 (5)*	-	5.0 (10)
1971He23	-	-	78.0 (40)	-	-	-
1982Ma52	-	-	82.3 (20)	*6.0 (4)*	-	7.9 (5)
1982Sa36	-	-	79 (6)	-	2.62 (27)	5.24 (54)
1983Sc13	-	-	76.4 (29)	-	-	5.44 (53)
1987Da28	0.70 (8)	0.94 (11)	78 (7)	*4.49 (37)*	1.46 (14)	5.09 (44)
1992Li05	-	-	80.0 (27)	-	-	6.08 (12)
1995Ba42	0.626 (44)	0.97 (7)	-	-	-	-
LWEIGHT4	0.642 (39)	0.96 (6)	79.9 (13)	*5.28 (49)*	2.0 (6)	5.22 (28)
Adopted	**0.64 (5)**	**0.96 (7)**	**79.9 (20)**	***5.3 (5)***	**2.0 (6)**	**5.2 (5)**
Normalised	0.0286 (19)	0.043 (3)	3.55 (10)	*0.235 (22)*	0.09 (3)	0.232 (14)
Comments	wtd mean	wtd mean	wtd mean	*wtd mean*	wtd mean	wtd mean

Nominal Energy /keV	**326.040**	**328.004**	**332.370**	**338.320**	**340.969**	**356.65**
1969Ar16	-	68.0 (20)	7.2 (5)	250 (5)	10 (4)	-
1971He23	-	-	-	255 (5)	-	-
1982Ma52	-	78.3 (20)	-	282 (6)	-	-
1982Sa36	-	69.0 (58)	9.3 (11)	255 (17)	9.0 (10)	-
1983Sc13	-	-	6.2 (7)	250 (9)	9.0 (6)	-
1987Da28	0.78 (13)	69.7 (50)	9.8 (8)	256 (18)	7.7 (7)	0.400 (47)
1992Li05	-	-	10.57 (56)	260 (9)	9.8 (18)	-
1995Ba42	-	-	-	-	9.2 (6)	-
LWEIGHT4	-	68.3 (18)	8.4 (12)	255.1 (38)	9.09 (39)	-
Adopted	**0.78 (13)**	**68.3 (20)**	**8.4 (12)**	**255 (5)**	**9.1 (6)**	**0.40 (5)**
Normalised	0.035 (6)	3.04 (11)	0.37 (6)	11.4 (4)	0.405 (20)	0.0178 (21)
Comments	1987Da28	wtd mean	wtd mean	wtd mean	wtd mean	1987Da28

Nominal Energy /keV	**372.590**	**377.99**	**384.47**	**389.32**	**397.95**	**399.83**
1969Ar16	-	-	-	-	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.158 (37)	0.576 (67)	0.158 (37)	0.242 (38)	0.642 (68)	0.691 (75)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	-	-	-
Adopted	**0.16 (4)**	**0.58 (7)**	**0.16 (4)**	**0.24 (4)**	**0.64 (7)**	**0.69 (8)**
Normalised	0.0070 (17)	0.026 (3)	0.0070 (17)	0.0108 (17)	0.029 (3)	0.031 (4)
Comments	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**409.46**	**415.96**	**419.38**	**440.45**	**449.11**	**452.50**
1969Ar16	44 (2)	-	-	3.0 (5)	-	-
1971He23	-	-	-	-	-	-
1982Ma52	46.5 (10)	-	-	-	-	-
1982Sa36	42.9 (31)	-	-	-	-	-
1983Sc13	43.3 (19)	-	-	-	-	-
1987Da28	44.8 (33)	0.309 (51)	0.48 (8)	2.85 (23)	1.12 (13)	0.36 (12)
1992Li05	45.1 (23)	-	-	-	-	-
1995Ba42	44.7 (32)	-	-	-	-	0.456 (42)
LWEIGHT4	45.3 (7)	-	-	2.87 (21)	-	0.466 (40)
Adopted	**45.3 (10)**	**0.31 (5)**	**0.48 (8)**	**2.87 (23)**	**1.12 (13)**	**0.47 (4)**
Normalised	2.02 (6)	0.0138 (23)	0.022 (3)	0.128 (10)	0.050 (6)	0.0199 (19)
Comments	wtd mean	1987Da28	1987Da28	wtd mean	wtd mean	wtd mean

Nominal Energy /keV	**457.18**	**466.40**	**470.21**	**471.77**	**474.79**
1969Ar16	-	-	-	-	-
1971He23	-	-	-	-	-
1982Ma52	-	-	-	-	-
1982Sa36	-	-	-	-	-
1983Sc13	-	-	-	-	-
1987Da28	0.352 (57)	0.67 (8)	0.30 (6)	0.76 (8)	0.52 (8)
1992Li05	-	-	-	-	-
1995Ba42	-	-	-	-	-
LWEIGHT4	-	-	-	-	-
Adopted	**0.35 (6)**	**0.67 (8)**	**0.30 (6)**	**0.76 (8)**	**0.52 (8)**
Normalised	0.016 (3)	0.30 (4)	0.014 (3)	0.034 (4)	0.023 (4)
Comments	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**478.399**	**481.50**	**490.34**	**492.29**	**497.64**	**503.819**	**508.955**
1969Ar16	5.7 (10)	-	-	-	-	3.0 (5)	12.0 (10)
1971He23	-	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	4.2 (9)	-
1987Da28	4.91 (44)	0.55 (11)	0.261 (56)	0.552 (61)	0.139 (43)	4.24 (37)	10.7 (12)
1992Li05	-	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-	-
LWEIGHT4	5.04 (40)	-	-	-	-	3.85 (41)	11.5 (8)
Adopted	**5.0 (5)**	**0.55 (11)**	**0.26 (6)**	**0.55 (6)**	**0.14 (4)**	**3.9 (4)**	**11.5 (10)**
Normalised	0.224 (19)	0.024 (5)	0.0116 (25)	0.025 (3)	0.0062 (19)	0.171 (19)	0.51 (4)
Comments	wtd mean	wtd mean	1987Da28	1987Da28	1987Da28	wtd mean	wtd mean

Nominal Energy /keV	**515.12**	**520.159**	**523.129**	**540.674**	**546.445**	**548.73**	**555.07**
1969Ar16	-	-	3.0 (1)	-	4.0 (5)	-	-
1971He23	-	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-	-
1987Da28	1.14 (13)	1.58 (14)	2.42 (22)	0.61 (7)	4.73 (38)	0.54 (8)	1.08 (12)
1992Li05	-	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-	-
LWEIGHT4	-	-	2.90 (22)	-	4.46 (35)	-	-
Adopted	**1.13 (13)**	**1.58 (14)**	**2.90 (22)**	**0.61 (7)**	**4.5 (4)**	**0.54 (8)**	**1.08 (12)**
Normalised	0.051 (6)	0.070 (7)	0.129 (10)	0.027 (3)	0.199 (16)	0.024 (4)	0.048 (6)
Comments	1987Da28	1987Da28	wtd mean	wtd mean	wtd mean	wtd mean	1987Da28

Nominal Energy /keV	**562.496**	**570.876**	**572.10**	**583.391**	**610.65**	**616.212**
1969Ar16	21 (2)	6.5 (10)	-	3.0 (5)	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	21.4 (26)	-	-	-	-	-
1983Sc13	19.8 (12)	-	-	-	-	-
1987Da28	18.8 (15)	3.82 (41)	3.52 (40)	2.61 (27)	0.54 (11)	1.88 (15)
1992Li05	20.3 (10)	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	20.0 (6)	4.2 (9)	-	2.70 (24)	-	-
Adopted	**20.0 (10)**	**4.2 (9)**	**3.5 (4)**	**2.7 (3)**	**0.54 (11)**	**1.88 (15)**
Normalised	0.89 (4)	0.19 (5)	0.156 (18)	0.120 (11)	0.024 (5)	0.084 (7)
Comments	wtd mean	wtd mean	1987Da28	wtd mean	1987Da28	1987Da28

Nominal Energy /keV	**620.32**	**623.48**	**626.80**	**629.409**	**634.18**	**640.317**
1969Ar16	-	-	-	-	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	1.88 (15)	0.26 (6)	0.33 (7)	1.06 (12)	0.248 (50)	1.27 (14)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	-	-	-
Adopted	**1.88 (15)**	**0.26 (6)**	**0.33 (7)**	**1.06 (12)**	**0.25 (5)**	**1.27 (14)**
Normalised	0.084 (7)	0.012 (3)	0.015 (3)	0.047 (5)	0.0111 (22)	0.057 (6)
Comments	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	***649.02***	**651.526**	**660.14**	**663.88**	***666.451***	**671.95**
1969Ar16	-	-	-	-	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	*0.94 (10)*	2.12 (21)	0.121 (6)	0.66 (14)	*1.45 (14)*	0.61 (18)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	-	-	-
Adopted	***0.94 (10)***	**2.12 (21)**	**0.121 (6)**	**0.66 (14)**	***1.45 (14)***	**0.61 (18)**
Normalised	*0.042 (5)*	0.094 (10)	0.0054 (3)	0.029 (6)	*0.065 (6)*	0.027 (8)
Comments	*1987Da28*	1987Da28	1987Da28	1987Da28	*1987Da28*	1987Da28

Nominal Energy /keV	**674.625**	**677.08**	***688.117***	**698.99**	**701.742**	**707.421**
1969Ar16	~3	-	-	-	~2.7	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	2.36 (22)	1.45 (14)	*1.58 (14)*	0.86 (13)	4.06 (31)	3.64 (40)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	-	-	-
Adopted	**2.36 (22)**	**1.45 (14)**	***1.58 (14)***	**0.86 (13)**	**4.1 (3)**	**3.6 (4)**
Normalised	0.105 (10)	0.065 (6)	*0.070 (7)*	0.038 (6)	0.181 (15)	0.162 (18)
Comments	1987Da28	1987Da28	*1987Da28*	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**718.303**	**727.317**	**737.736**	**755.313**	**772.291**	**774.07**
1969Ar16	-	18 (4)	-	22 (3)	40 (4)	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	23.8 (26)	38.1 (30)	-
1983Sc13	-	-	-	23.6 (15)	32.2 (16)	-
1987Da28	0.44 (9)	14.5 (20)	0.87 (9)	21.8 (16)	33.9 (25)	1.39 (7)
1992Li05	-	-	-	23.4 (11)	34.0 (12)	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	15.2 (18)	-	23.1 (7)	34.1 (10)	-
Adopted	**0.44 (9)**	**15.2 (20)**	**0.87 (9)**	**23.1 (11)**	**34.1 (12)**	**1.39 (7)**
Normalised	0.019 (4)	0.68 (8)	0.039 (5)	1.03 (4)	1.52 (6)	0.062 (4)
Comments	1987Da28	wtd mean	1987Da28	wtd mean	wtd mean	1987Da28

Nominal Energy /keV	**776.514**	**782.14**	***791.43***	**792.69**	**794.942**	**813.88**
1969Ar16	-	17 (3)	-	-	105 (10)	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	100 (7)	-
1983Sc13	-	10.7 (14)	-	-	96.4 (35)	-
1987Da28	0.44 (14)	11.3 (8)	*0.54 (17)*	1.82 (9)	98 (7)	0.164 (37)
1992Li05	-	10.8 (13)	-	-	95.2 (34)	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	11.3 (7)	-	-	96.9 (22)	-
Adopted	**0.44 (14)**	**11.3 (8)**	***0.54 (17)***	**1.82 (9)**	**97 (4)**	**0.16 (4)**
Normalised	0.020 (6)	0.50 (4)	*0.024 (7)*	0.081 (5)	4.31 (14)	0.0073 (17)
Comments	1987Da28	1987Da28	*1987Da28*	1987Da28	wtd mean	wtd mean

Nominal Energy /keV	**816.82**	**824.931**	**830.481**	**835.481**	**840.372**	***853.57***
1969Ar16	-	-	16.5 (10)	39.5 (10)	23.0 (10)	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	15.0 (20)	42.9 (31)	22.1 (20)	-
1983Sc13	-	-	11.1 (12)	34.0 (22)	21.6 (13)	-
1987Da28	0.70 (8)	1.18 (13)	12.7 (9)	37.6 (26)	20.0 (16)	*0.279 (45)*
1992Li05	-	-	-	35.4 (20)	18.6 (24)	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	13.7 (12)	38.3 (12)	21.7 (7)	-
Adopted	**0.70 (8)**	**1.18 (13)**	**13.7 (12)**	**38.3 (12)**	**21.7 (10)**	***0.28 (5)***
Normalised	0.031 (4)	0.053 (6)	0.61 (6)	1.70 (7)	0.97 (4)	*0.0124 (20)*
Comments	1987Da28	1987Da28	wtd mean	wtd mean	wtd mean	*wtd mean*

Nominal Energy /keV	**870.47**	**872.99**	**874.45**	**877.38**	**880.76**	**887.26**
1969Ar16	-	-	-	-	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	1.03 (11)	0.73 (15)	1.12 (25)	0.32 (6)	0.145 (43)	0.64 (7)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	-	-	-
Adopted	**1.03 (11)**	**0.73 (15)**	**1.12 (25)**	**0.32 (6)**	**0.15 (5)**	**0.64 (7)**
Normalised	0.046 (5)	0.032 (7)	0.050 (11)	0.014 (3)	0.0065 (19)	0.029 (3)
Comments	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**901.383**	**904.2**	**911.196**	**919.03**	***921.87***	***930.99***
1969Ar16	-	-	590 (30)	-	-	-
1971He23	-	-	580 (20)	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	19.0 (25)	605 (42)	-	-	-
1983Sc13	-	17.6 (10)	591 (22)	-	-	-
1987Da28	0.38 (8)	17.0 (15)	606 (29)	0.64 (7)	*0.345 (51)*	*0.291 (45)*
1992Li05	-	-	573 (20)	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	17.5 (8)	588 (12)	-	-	-
Adopted	**0.38 (8)**	**17.5 (10)**	**588 (20)**	**0.64 (7)**	***0.35 (5)***	***0.29 (5)***
Normalised	0.017 (4)	0.78 (4)	26.2 (8)	0.028 (3)	*0.0154 (23)*	*0.0129 (20)*
Comments	1987Da28	wtd mean	wtd mean	wtd mean	*1987Da28*	*1987Da28*

Nominal Energy /keV	**939.89**	**944.191**	**947.976**	**958.591**	**964.786**	**968.96**
1969Ar16	-	-	-	-	100 (10)	360 (20)
1971He23	-	-	-	-	100 (10)	350 (10)
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	3.8 (14)	124 (9)	360 (26)
1983Sc13	-	-	-	-	112.2 (43)	361 (13)
1987Da28	0.21 (6)	2.24 (21)	2.49 (22)	6.8 (6)	118 (8)	372 (26)
1992Li05	-	-	-	-	110.4 (42)	349 (13)
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	6.4 (11)	112.1 (26)	357 (7)
Adopted	**0.21 (6)**	**2.24 (21)**	**2.49 (22)**	**6.4 (11)**	**112 (5)**	**357 (10)**
Normalised	0.009 (3)	0.100 (10)	0.111 (10)	0.29 (5)	4.99 (17)	15.9 (5)
Comments	1987Da28	1987Da28	1987Da28	wtd mean	wtd mean	wtd mean

Nominal Energy /keV	**975.983**	**979.49**	**987.87**	**988.65**	**1000.68**	**1013.55**
1969Ar16	-	-	4.3 (3)	-	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	1.16 (13)	0.62 (7)	1.82 (32)	1.82 (32)	0.121 (6)	0.109 (31)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	3.1 (12)	-	-	-
Adopted	**1.16 (13)**	**0.62 (7)**	**3.1 (12)**	**1.8 (4)**	**0.121 (6)**	**0.11 (3)**
Normalised	0.052 (6)	0.028 (3)	0.14 (6)	0.081 (14)	0.0054 (3)	0.0049 (14)
Comments	1987Da28	1987Da28	wtd mean	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**1016.44**	**1017.94**	**1019.88**	**1033.244**	**1039.83**	**1040.94**
1969Ar16	-	1.3 (3)	-	4.5 (3)	2.0 (4)	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.44 (6)	0.133 (31)	0.49 (10)	4.73 (38)	1.05 (22)	1.05 (22)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	-	1.27 (40)	-
Adopted	**0.44 (6)**	**0.7 (6)**	**0.49 (10)**	**4.59 (24)**	**1.3 (4)**	**1.05 (22)**
Normalised	0.019 (3)	0.03 (3)	0.022 (5)	0.204 (12)	0.056 (18)	0.047 (10)
Comments	1987Da28	wtd mean	1987Da28	wtd mean	wtd mean	1987Da28

Nominal Energy /keV	**1053.11**	**1054.13**	**1062.57**	**1065.168**	**1074.73**	**1088.20**
1969Ar16	~1	-	-	3.0 (2)	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.32 (9)	0.42 (13)	0.24 (7)	3.09 (29)	0.24 (7)	0.139 (31)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	3.03 (16)	-	-
Adopted	**0.32 (9)**	**0.42 (13)**	**0.24 (7)**	**3.03 (20)**	**0.24 (7)**	**0.14 (3)**
Normalised	0.014 (4)	0.019 (6)	0.011 (4)	0.135 (8)	0.011 (4)	0.0062 (14)
Comments	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**1095.671**	**1103.43**	**1110.604**	**1117.65**	**1135.26**	**1142.87**
1969Ar16	2.6 (3)	-	6.5 (10)	1.6 (3)	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	3.03 (28)	0.35 (6)	7.2 (6)	1.27 (19)	0.230 (38)	0.242 (50)
1992Li05	-	-	-	-	-	-
1995Ba42	-	0.224 (11)	-	-	-	-
LWEIGHT4	2.83 (22)	0.228 (24)	6.98 (51)	1.37 (16)	-	-
Adopted	**2.8 (3)**	**0.228 (24)**	**7.0 (6)**	**1.37 (19)**	**0.23 (4)**	**0.24 (5)**
Normalised	0.126 (10)	0.0102 (11)	0.311 (24)	0.061 (7)	0.0102 (17)	0.0108 (22)
Comments	wtd mean	wtd mean	wtd mean	wtd mean	1987Da28	1987Da28

Nominal Energy /keV	**1148.17**	**1153.266**	**1157.16**	**1164.55**	**1175.33**	**1190.83**
1969Ar16	-	4.0 (10)	-	~1.5	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.139 (31)	3.27 (29)	0.164 (31)	1.52 (14)	0.56 (8)	0.146 (37)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	3.33 (28)	-	-	-	-
Adopted	**0.14 (3)**	**3.3 (3)**	**0.16 (3)**	**1.52 (14)**	**0.56 (8)**	**0.15 (4)**
Normalised	0.0062 (14)	0.148 (13)	0.0073 (14)	0.067 (7)	0.025 (4)	0.0065 (17)
Comments	1987Da28	wtd mean	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**1217.03**	**1229.42**	**1245.15**	**1247.10**	**1250.062**	**1276.72**
1969Ar16	-	-	-	-	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.50 (8)	0.176 (55)	2.24 (44)	11.21 (55)	1.46 (14)	0.33 (7)
1992Li05	-	-	-	11.5 (14)	-	-
1995Ba42	-	-	2.50 (18)	-	-	-
LWEIGHT4	-	-	2.46 (17)	11.78 (46)	-	-
Adopted	**0.50 (8)**	**0.18 (6)**	**2.46 (18)**	**11.8 (5)**	**1.46 (14)**	**0.33 (7)**
Normalised	0.022 (4)	0.0078 (25)	0.110 (8)	0.524 (24)	0.065 (6)	0.015 (3)
Comments	1987Da28	1987Da28	wtd mean	wtd mean	1987Da28	1987Da28

Nominal Energy /keV	**1286.29**	**1287.77**	**1309.76**	**1315.33**	**1337.33**	**1344.62**
1969Ar16	-	3.0 (2)	-	-	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	1.17 (24)	1.88 (38)	0.44 (15)	0.35 (7)	0.115 (37)	0.212 (44)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	2.44 (56)	-	-	-	-
Adopted	**1.17 (24)**	**2.4 (6)**	**0.44 (15)**	**0.35 (7)**	**0.12 (4)**	**0.21 (5)**
Normalised	0.052 (11)	0.109 (25)	0.020 (7)	0.015 (3)	0.0051 (16)	0.0094 (20)
Comments	1987Da28	wtd mean	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**1347.50**	**1357.81**	**1365.71**	**1374.24**	**1378.23**	**1385.39**
1969Ar16	-	-	-	-	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.36 (8)	0.48 (10)	0.32 (7)	0.32 (9)	0.139 (43)	0.248 (50)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	0.447 (22)	-	-
LWEIGHT4	-	-	-	0.440 (29)	-	-
Adopted	**0.36 (8)**	**0.48 (10)**	**0.32 (7)**	**0.44 (3)**	**0.14 (5)**	**0.25 (5)**
Normalised	0.016 (4)	0.021 (5)	0.014 (3)	0.0196 (14)	0.0062 (19)	0.0111 (22)
Comments	1987Da28	1987Da28	1987Da28	wtd mean	1987Da28	1987Da28

Nominal Energy /keV	**1401.52**	**1415.55**	**1430.99**	**1434.22**	**1438.01**	**1451.43**
1969Ar16	-	-	-	-	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.29 (6)	0.50 (10)	0.82 (17)	0.188 (55)	0.139 (37)	0.248 (50)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	-	-	-
Adopted	**0.29 (6)**	**0.50 (10)**	**0.82 (17)**	**0.19 (6)**	**0.14 (4)**	**0.25 (5)**
Normalised	0.013 (3)	0.022 (5)	0.037 (8)	0.0084 (25)	0.0062 (17)	0.0111 (22)
Comments	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**1459.131**	**1469.74**	**1480.38**	**1495.904**	**1501.59**	**1529.01**
1969Ar16	20.0 (5)	-	-	21.0 (4)	11.6 (2)	~1
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	17.3 (10)	-	-	18.7 (16)	9.6 (11)	-
1987Da28	18.8 (15)	0.47 (9)	0.38 (8)	21.2 (16)	11.2 (10)	1.33 (14)
1992Li05	24.3 (17)	-	-	18.9 (13)	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	19.5 (11)	-	-	20.73 (43)	11.53 (25)	-
Adopted	**19.5 (11)**	**0.47 (9)**	**0.38 (8)**	**20.7 (5)**	**11.53 (25)**	**1.33 (14)**
Normalised	0.87 (5)	0.021 (5)	0.017 (4)	0.92 (3)	0.513 (17)	0.059 (6)
Comments	wtd mean	1987Da28	1987Da28	wtd mean	wtd mean	1987Da28

Nominal Energy /keV	**1537.89**	**1548.65**	**1557.13**	**1559.88**	**1571.55**	**1573.23**
1969Ar16	~0.8	~0.7	3.8 (2)	-	-	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	1.10 (12)	0.89 (10)	4.18 (37)	0.48 (10)	0.133 (37)	0.77 (9)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	3.89 (18)	-	-	-
Adopted	**1.10 (12)**	**0.89 (10)**	**3.89 (20)**	**0.48 (10)**	**0.13 (4)**	**0.77 (9)**
Normalised	0.049 (6)	0.040 (5)	0.173 (9)	0.021 (5)	0.0059 (17)	0.034 (4)
Comments	1987Da28	1987Da28	wtd mean	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**1580.531**	**1588.20**	**1609.44**	**1625.092**	**1630.618**	**1638.272**
1969Ar16	17 (3)	71 (3)	-	7.0 (20)	33.0 (20)	10.0 (10)
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	11.6 (20)	72.4 (29)	-	-	34.0 (22)	10.2 (9)
1987Da28	14.5 (14)	76.4 (52)	0.182 (37)	6.00 (51)	38.8 (31)	11.0 (10)
1992Li05	13.7 (14)	66.0 (17)	-	-	33.8 (12)	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	13.9 (9)	68.8 (20)	-	6.06 (50)	34.1 (9)	10.43 (55)
Adopted	**13.9 (14)**	**68.8 (20)**	**0.182 (37)**	**6.1 (5)**	**34.1 (12)**	**10.4 (9)**
Normalised	0.62 (4)	3.06 (12)	0.0081 (17)	0.270 (23)	1.52 (6)	0.46 (3)
Comments	wtd mean	1987Da28	1987Da28	wtd mean	wtd mean	wtd mean

Nominal Energy /keV	**1666.514**	**1671.67**	**1677.66**	**1684.04**	**1686.22**	**1700.62**
1969Ar16	3.8 (2)	-	~1.2	-	2.0 (2)	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	4.18 (37)	0.091 (31)	1.27 (14)	0.35 (11)	2.24 (21)	0.236 (56)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	3.89 (18)	-	-	-	2.11 (15)	-
Adopted	**3.89 (20)**	**0.9 (3)**	**1.27 (14)**	**0.35 (11)**	**2.11 (20)**	**0.24 (6)**
Normalised	0.173 (9)	0.0043 (14)	0.057 (6)	0.015 (5)	0.094 (7)	0.0105 (25)
Comments	wtd mean	1987Da28	1987Da28	1987Da28	wtd mean	1987Da28

Nominal Energy /keV	**1702.40**	**1706.17**	**1713.49**	**1721.49**	**1724.188**	**1738.46**
1969Ar16	1.5 (2)	-	-	-	~0.5	~0.6
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	1.13 (12)	0.200 (26)	0.127 (25)	0.133 (43)	0.68 (8)	0.41 (9)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	1.23 (17)	-	-	-	-	-
Adopted	**1.23 (17)**	**0.20 (3)**	**0.127 (25)**	**0.13 (5)**	**0.68 (8)**	**0.41 (9)**
Normalised	0.055 (7)	0.0089 (12)	0.0057 (11)	0.0059 (19)	0.030 (4)	0.018 (4)
Comments	wtd mean	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**1740.46**	**1742.09**	**1745.32**	**1750.58**	**1758.11**	**1772.22**
1969Ar16	-	~0.5	-	-	~0.8	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.26 (8)	0.188 (55)	0.152 (20)	0.188 (20)	0.81 (9)	0.042 (12)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	-	-	-
Adopted	**0.26 (8)**	**0.19 (6)**	**0.152 (20)**	**0.188 (20)**	**0.81 (9)**	**0.042 (12)**
Normalised	0.011 (4)	0.0084 (25)	0.0067 (9)	0.0084 (9)	0.036 (4)	0.0019 (5)
Comments	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**1784.40**	**1787.20**	**1795.13**	**1797.50**	**1800.90**	**1823.22**
1969Ar16	-	-	-	-	-	1.00 (10)
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.139 (25)	0.030 (12)	0.048 (18)	0.048 (18)	0.103 (19)	1.03 (12)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	-	-	-	1.01 (8)
Adopted	**0.139 (25)**	**0.030 (12)**	**0.048 (18)**	**0.048 (18)**	**0.103 (19)**	**1.01 (10)**
Normalised	0.0062 (11)	0.0013 (5)	0.0022 (8)	0.0022 (8)	0.0046 (8)	0.046 (5)
Comments	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28	wtd mean

Nominal Energy /keV	**1826.78**	**1835.29**	**1842.15**	**1850.17**	**1870.82**	**1879.60**
1969Ar16	-	0.80 (10)	0.70 (10)	-	0.60 (10)	-
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.048 (18)	0.89 (10)	0.98 (11)	0.103 (19)	0.57 (6)	0.030 (12)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	0.84 (7)	0.83 (14)	-	0.578 (52)	-
Adopted	**0.048 (18)**	**0.84 (10)**	**0.83 (14)**	**0.103 (19)**	**0.58 (5)**	**0.030 (12)**
Normalised	0.0022 (8)	0.038 (4)	0.037 (6)	0.0046 (8)	0.0257 (24)	0.0013 (5)
Comments	1987Da28	wtd mean	wtd mean	wtd mean	wtd mean	1987Da28

Nominal Energy /keV	**1887.13**	**1900.16**	**1907.14**	**1916.34**	**1919.54**	**1929.78**
1969Ar16	2.1 (2)	-	~0.3	-	-	~0.4
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	2.12 (21)	0.067 (13)	0.279 (28)	0.018 (6)	0.048 (12)	0.467 (54)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	2.11 (14)	-	-	-	-	-
Adopted	**2.11 (20)**	**0.067 (13)**	**0.28 (3)**	**0.018 (6)**	**0.048(12)**	**0.47 (6)**
Normalised	0.094 (7)	0.0030 (6)	0.0124 (13)	0.008 (3)	0.0022 (6)	0.0208 (24)
Comments	wtd mean	1987Da28	1987Da28	1987Da28	1987Da28	1987Da28

Nominal Energy /keV	**1936.34**	**1944.24**	**1952.37**	**1955.90**	**1958.41**	**1965.22**
1969Ar16	-	-	1.4 (2)	-	-	0.60 (10)
1971He23	-	-	-	-	-	-
1982Ma52	-	-	-	-	-	-
1982Sa36	-	-	-	-	-	-
1983Sc13	-	-	-	-	-	-
1987Da28	0.048 (12)	0.048 (12)	1.39 (14)	0.018 (6)	0.036 (12)	0.478 (48)
1992Li05	-	-	-	-	-	-
1995Ba42	-	-	-	-	-	-
LWEIGHT4	-	-	1.40 (11)	-	-	0.502 (48)
Adopted	**0.048 (12)**	**0.048 (12)**	**1.40 (14)**	**0.018 (6)**	**0.036 (12)**	**0.50 (5)**
Normalised	0.0022 (6)	0.0022 (6)	0.062 (5)	0.008 (3)	0.0016 (5)	0.0223 (22)
Comments	1987Da28	1987Da28	wtd mean	1987Da28	1987Da28	wtd mean

Nominal Energy /keV	**1971.96**	**1979.32**	**2001.0**	**2029.4**
1969Ar16	-	-	-	-
1971He23	-	-	-	-
1982Ma52	-	-	-	-
1982Sa36	-	-	-	-
1983Sc13	-	-	-	-
1987Da28	0.085 (19)	0.042 (12)	0.024 (6)	0.042 (12)
1992Li05	-	-	-	-
1995Ba42	-	-	-	-
LWEIGHT4	-	-	-	-
Adopted	**0.085 (19)**	**0.042 (12)**	**0.024 (6)**	**0.042 (12)**
Normalised	0.0038 (8)	0.0019 (5)	0.0011 (3)	0.0019 (5)
Comments	1987Da28	1987Da28	1987Da28	1987Da28