



1 Decay Scheme

¹³³Ba disintegrates by electron capture mainly to two ¹³³Cs excited levels of 437 keV (85.4%) and of 383 keV (14.5%) with three very minor branches to the 160 keV, 81 keV excited levels and the ground state.

Le baryum 133 se désintègre par capture électronique principalement vers deux niveaux excités de 437 keV et 383 keV du césium 133.

2 Nuclear Data

$$T_{1/2}({}^{133}\text{Ba}) : 10,539 \quad (6) \quad \text{a}$$

$$Q^+({}^{133}\text{Ba}) : 517,3 \quad (10) \quad \text{keV}$$

2.1 Electron Capture Transitions

	Energy (keV)	Probability (%)	Nature	lg <i>ft</i>	<i>P_K</i>	<i>P_L</i>	<i>P_M</i>
ε _{0,4}	80,3 (10)	85,41 (53)	Allowed	6,63	0,671 (5)	0,251 (4)	0,0777 (11)
ε _{0,3}	133,5 (10)	14,46 (51)	Allowed	8,03	0,7727 (9)	0,1755 (7)	0,05174 (23)
ε _{0,2}	356,7 (10)	<0,3	2nd Forbidden	>10,6	0,83	0,13	0,037
ε _{0,1}	436,3 (10)	<0,7	2nd Forbidden	>10,9	0,84	0,13	0,037
ε _{0,0}	517,3 (10)	<0,0005	Unique 2nd Forbidden	>13,9	0,77	0,18	0,05

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy (keV)	P _{γ+ce} (%)	Multipolarity	α _K	α _L	α _M	α _T
γ _{4,3} (Cs)	53,1622 (18)	14,25 (46)	M1+E2	4,78 (7)	0,70 (5)	0,144 (12)	5,66 (11)
γ _{2,1} (Cs)	79,6142 (19)	7,3 (5)	M1+E2	1,495 (22)	0,217 (6)	0,0447 (13)	1,77 (3)
γ _{1,0} (Cs)	80,9979 (11)	90,05 (6)	M1+E2	1,431 (20)	0,216 (4)	0,0447 (8)	1,703 (24)
γ _{2,0} (Cs)	160,6121 (16)	0,826 (9)	M1+E2	0,234 (4)	0,0471 (13)	0,0099 (3)	0,294 (6)
γ _{3,2} (Cs)	223,237 (2)	0,494 (6)	M1+E2	0,0836 (12)	0,01103 (16)	0,00226 (4)	0,0975 (14)
γ _{4,2} (Cs)	276,3992 (21)	7,53 (6)	E2	0,0460 (7)	0,00842 (12)	0,001763 (25)	0,0566 (8)
γ _{3,1} (Cs)	302,8512 (16)	19,10 (12)	M1+E2	0,0373 (6)	0,00484 (7)	0,000988 (14)	0,0434 (6)
γ _{4,1} (Cs)	356,0134 (17)	63,63 (20)	E2	0,0211 (3)	0,00346 (5)	0,000721 (10)	0,0254 (4)
γ _{3,0} (Cs)	383,8491 (12)	9,12 (6)	E2	0,01684 (24)	0,00270 (4)	0,000560 (8)	0,0202 (3)

3 Atomic Data

3.1 Cs

ω _K	:	0,894 (4)
ω _L	:	0,104 (5)
n _{KL}	:	0,895 (4)

3.1.1 X Radiations

	Energy (keV)	Relative probability
X _K		
Kα ₂	30,6254	54,13
Kα ₁	30,9731	100
Kβ ₃	34,9197	} 29,21532
Kβ ₁	34,9873	
Kβ'' ₅	35,252	
Kβ ₂	35,822	} 7,12854
Kβ ₄	35,907	
KO _{2,3}	35,972	
X _L		
Lℓ	3,7946	
Lα	4,2729 - 4,2866	
Lη	4,1418	
Lβ	4,62 - 4,9333	
Lγ	5,1308 - 5,5525	

3.1.2 Auger Electrons

	Energy (keV)	Relative probability
Auger K		
KLL	24,411 - 25,804	100
KLX	28,991 - 30,961	47,2
KXY	33,55 - 35,96	5,56
Auger L		
	2,5777 - 5,5590	

4 Electron Emissions

		Energy (keV)	Electrons (per 100 disint.)
e _{AL}	(Cs)	2,5777 - 5,5590	136,8 (8)
e _{AK}	(Cs)		
	KLL	24,411 - 25,804	} 14,1 (6)
	KLX	28,991 - 30,961	
	KXY	33,55 - 35,96	
ec _{4,3} T	(Cs)	17,1776 - 53,1508	12,11 (41)
ec _{4,3} K	(Cs)	17,1776 (18)	10,23 (32)
ec _{2,1} T	(Cs)	43,6296 - 79,6028	4,66 (35)
ec _{2,1} K	(Cs)	43,6296 (19)	3,93 (29)
ec _{1,0} K	(Cs)	45,0133 (11)	47,7 (8)
ec _{1,0} T	(Cs)	45,0133 - 80,9865	56,7 (9)
ec _{4,3} L	(Cs)	47,4479 - 48,1503	1,50 (11)
ec _{4,3} M	(Cs)	51,9451 - 52,4367	0,308 (27)
ec _{4,3} N	(Cs)	52,9314 - 53,0857	0,065 (5)
ec _{2,1} L	(Cs)	73,8999 - 74,6023	0,571 (44)
ec _{1,0} L	(Cs)	75,2836 - 75,9860	7,19 (15)
ec _{2,1} M	(Cs)	78,3971 - 78,8887	0,118 (9)
ec _{2,1} N	(Cs)	79,3834 - 79,5377	0,0247 (19)
ec _{1,0} M	(Cs)	79,7808 - 80,2724	1,489 (30)
ec _{1,0} N	(Cs)	80,7671 - 80,9214	0,313 (6)
ec _{2,0} K	(Cs)	124,6275 (16)	0,1493 (29)
ec _{2,0} L	(Cs)	154,8978 - 155,6002	0,0300 (9)
ec _{3,2} K	(Cs)	187,252 (2)	0,0376 (7)
ec _{4,2} K	(Cs)	240,4146 (21)	0,328 (6)
ec _{3,1} T	(Cs)	266,8666 - 302,8398	0,795 (12)
ec _{3,1} K	(Cs)	266,8666 (16)	0,683 (12)
ec _{4,2} L	(Cs)	270,6849 - 271,3873	0,060 (1)
ec _{4,2} M	(Cs)	275,1821 - 275,6737	0,01257 (21)
ec _{3,1} L	(Cs)	297,1369 - 297,8393	0,0886 (14)
ec _{3,1} M	(Cs)	301,6341 - 302,1257	0,01809 (28)
ec _{4,1} T	(Cs)	320,0288 - 356,0020	1,576 (25)

		Energy (keV)	Electrons (per 100 disint.)
ec _{4,1} K	(Cs)	320,0288 (17)	1,309 (19)
ec _{3,0} K	(Cs)	347,8645 (12)	0,1505 (24)
ec _{4,1} L	(Cs)	350,2991 - 351,0015	0,2147 (32)
ec _{4,1} M	(Cs)	354,7963 - 355,2879	0,0447 (6)
ec _{3,0} L	(Cs)	378,1348 - 378,8372	0,02414 (39)

5 Photon Emissions

5.1 X-Ray Emissions

		Energy (keV)	Photons (per 100 disint.)	
XL	(Cs)	3,7946 - 5,5525	15,87 (26)	
XK α_2	(Cs)	30,6254	33,8 (4)	} K α
XK α_1	(Cs)	30,9731	62,4 (7)	
XK β_3	(Cs)	34,9197	} 18,24 (29)	} K' β_1
XK β_1	(Cs)	34,9873		
XK β_5''	(Cs)	35,252		
XK β_2	(Cs)	35,822	} 4,45 (12)	} K' β_2
XK β_4	(Cs)	35,907		
XKO _{2,3}	(Cs)	35,972		

5.2 Gamma Emissions

	Energy (keV)	Photons (per 100 disint.)
$\gamma_{4,3}$ (Cs)	53,1622 (18)	2,14 (6)
$\gamma_{2,1}$ (Cs)	79,6142 (19)	2,63 (19)
$\gamma_{1,0}$ (Cs)	80,9979 (11)	33,31 (30)
$\gamma_{2,0}$ (Cs)	160,6121 (16)	0,638 (6)
$\gamma_{3,2}$ (Cs)	223,2368 (13)	0,450 (5)
$\gamma_{4,2}$ (Cs)	276,3989 (12)	7,13 (6)
$\gamma_{3,1}$ (Cs)	302,8508 (5)	18,31 (11)
$\gamma_{4,1}$ (Cs)	356,0129 (7)	62,05 (19)
$\gamma_{3,0}$ (Cs)	383,8485 (12)	8,94 (6)

6 Main Production Modes

- { Ba – 132(n,γ)Ba – 133 σ : 6,5 (8) barns
- { Possible impurities: Ba – 131, Ba – 140
- Ba – 132(n,γ)Ba – 133m σ : 0,5 barns
- { Cs – 133(p,n)Ba – 133
- { Possible impurities: Cs – 132

7 References

- E.I. WYATT, S.A. REYNOLDS, T.H. HANDLEY, W.S. LYON, H.A. PARKER. Nucl. Sci. Eng. 11 (1961) 74 (Half-life)
- P. BLASI, M. BOCCIOLINI, P.R. MAURENZIG, P. SONA, N. TACCETTI. Nuovo Cim. 50B (1967) 298 (Gamma-ray emission probabilities)
- J.A. BEARDEN. Rev. Mod. Phys. 39 (1967) 78 (X-ray energies)
- D.P. DONNELLY, J.J. REIDY, M.L. WIEDENBECK. Phys. Rev. 173 (1968) 1192 (Gamma-ray emission probabilities)
- S.A. REYNOLDS, J.F. EMERY, E.I. WYATT. Nucl. Sci. Eng. 32 (1968) 46 (Half-life)
- P. ALEXANDER, J. P. LAU. Nucl. Phys. A121 (1968) 612 (Gamma-ray emission probabilities, ICC)
- V. NARANG, H. HOUTERMANS. In: Proc. Conf. Electron Capture and Higher Order Processes in Nucl. Decays, Debrecen, Hungary, D. Berenyi, Ed. Eotvos Lorand Phys Soc, Budapest, (1968) 97 (L/K-capture ratio)
- A. NOTEA, Y. GURFINKEL. Nucl. Phys. A107 (1968) 193 (Gamma-ray emission probabilities)
- F. LAGOUTINE, Y. LE GALLIC, J. LEGRAND. Int. J. Appl. Radiat. Isotop. 19 (1968) 475 (Half-life)
- H.E. BOSCH, A.J. HAVERFIELD, E. SZICHMAN, S.M. ABECASIS. Nucl. Phys. A108 (1968) 209 (ICC 81 keV)
- R. GUNNINK, J.B. NIDAY, R.P. ANDERSON, R.A. MEYER. In: UCID-15439 (1969); Gunnink, R.; Nethaway, D. - Priv. Comm. (1969) (Gamma-ray emission probabilities)
- K.F. WALZ, H.M. WEISS. Z. Naturforsch. 25a (1970) 921 (Half-life)
- J.F. EMERY, S.A. REYNOLDS, E.I. WYATT, G.I. GLEASON. Nucl. Sci. Eng. 48 (1972) 319 (Half-life)
- W.D. SCHMIDT-OTT, R.M. FINK. Z. Physik 249 (1972) 286 (K-capture probability, absolute XK emission probability, gamma-ray emission probabilities, ICC)
- H. INOUE, Y. YOSHIKAWA, T. MORII. J. Phys. Soc. Jpn 34 (1973) 1437 (Gamma-ray emission probabilities)
- J. LEGRAND. Nucl. Instrum. Methods 112 (1973) 229 (Gamma-ray emission probabilities)
- R.D. LLOYD, C.W. MAYS. Int. J. Appl. Radiat. Isotop. 24 (1973) 189 (Half-life)
- L.A. MCNELLES, J.L. CAMPBELL. Nucl. Instrum. Methods 109 (1973) 241 (Gamma-ray emission probabilities)
- B.K. DAS MAHAPATRA, P. MUKHERJEE. J. Phys. (London) A7 (1974) 388 (K-capture probability)
- W.F. NICAISE, A.W. WALTNER. Nucl. Instrum. Methods 131 (1975) 477 (K-capture probability)
- R.J. GEHRKE, R.G. HELMER, R.C. GREENWOOD. Nucl. Instrum. Methods 147 (1977) 405 (Gamma-ray emission probabilities)
- U. SCHÖTZIG, K. DEBERTIN, K.F. WALZ. Int. J. Appl. Radiat. Isotop. 28 (1977) 503 (X-ray emission probabilities, Gamma-ray emission probabilities)

- C. VYLOV, B.P. OSIPENKO, V.G. CHUMIN. In: *Elementarnie chastitsi and atomnie yadra (Particles and Nuclei)* 9 (1978) 1350
(Gamma-ray emission probabilities)
- R.G. HELMER, R.C. GREENWOOD, R.J. GEHRKE. *Nucl. Instrum. Methods* 155 (1978) 189
(Gamma-ray emission probabilities)
- H.H. HANSEN, D. MOUCHEL. In: *NEANDC(E) 202U; Vol III* (1979) 28
(Half-life)
- B. CHAUVENET, J. MOREL, J. LEGRAND. *Report ICRM-S-6(December 1980)* (1980)
(Absolute gamma-ray emission probabilities)
- H. HOUTERMANS, O. MILOSEVIC, F. REICHEL. *Int. J. Appl. Radiat. Isotop.* 31 (1980) 153
(Half-life)
- W.M. RONEY JR., W.A. SEALE. *Nucl. Instrum. Methods* 171 (1980) 389
(Gamma-ray emission probabilities)
- A.R. RUTLEDGE, L.V. SMITH, J.S. MERRITT. In: *AECL 6692* (1980)
(Half-life)
- D.D. HOPPE, J.M.R. HUTCHINSON, F.J. SCHIMA, M.P. UNTERWEGER. In: *NBS-SP-626* (1982) 85
(Half-life)
- K. SINGH, H.S. SAHOTA. *J. Phys. (London)* G9 (1983) 1565
(K-capture probability)
- K. SINGH, H.S. SAHOTA. *J. Phys. Soc. Jpn* 52 (1983) 2336
(K-capture probability)
- B. CHAUVENET, J. MOREL, J. LEGRAND. *Int. J. Appl. Radiat. Isotop.* 34 (1983) 479
(Absolute gamma-ray emission probabilities)
- J. KITS, F. LATAL, M. CHOC. *Int. J. Appl. Radiat. Isotop.* 34 (1983) 935
(Half-life)
- K.F. WALZ, K. DEBERTIN, H. SCHRADER. *Int. J. Appl. Radiat. Isotop.* 34 (1983) 1191
(Half-life)
- Y. YOSHIZAWA, Y. IWATA, T. KATOH, J.Z. RUAN, Y. KAWADA. *Nucl. Instrum. Methods* 212 (1983) 249
(Gamma-ray emission probabilities)
- A.S.V. SUBBA LAKSHMI, S. VENKATARATNAM, S.B. REDDY, K.V. REDDY. *Curr. Sci.* 56 (1987) 407
(Gamma-ray relative emission probabilities)
- R.B. BEGZHANOV, SH.K. AZIMOV, R.D. MAGRUPOV, SH.A. MIRAKHMEDOV, A. MUKHAMMADIEV, M. NARZIKULOV, S.KH. SALIMOV. In: *Program and Theses, Proc. 38th Ann. Conf. Nucl. Spectrosc. Struct. At Nuclei, Baku* (1988) 93
(K-capture probabilities)
- M.C. MARTINS, M.I. MARQUES, F. PARENTE, J.G. FERREIRA. *J. Phys. (London)* B22 (1989) 3167
(X-ray emission probabilities)
- A.G. EGOROV, YU.S. EGOROV, V.G. NEDOVESOV, G.E. SHCHUKIN, K.P. YAKOVLEV. In: *Program and Thesis, Proc. 39th Ann. Conf. Nucl. Spectrosc. Struct. At Nuclei, Leningrad* (1989) 505
(X-ray emission probabilities)
- V.N. DANILENKO, A.A. KONSTANTINOV, N.V. KURENKOV, L.N. KURCHATOVA, A.B. MALININ, A.V. MAMELIN, S.V. MATVEEV, T.E. SAZONOVA, E.K. STEPANOV, S.V. SERMAN, YU.G. TOPOROV. *Appl. Radiat. Isot.* 40 (1989) 707
(Gamma-ray emission probabilities)
- B. DASMAHAPATRA, S. BHATTACHARYA, S. SEN, M. SAHA, A. GOSWAMI. *J. Phys. (London)* G16 (1990) 1227
(K-capture probability)
- R.B. FIRESTONE. *Nucl. Instrum. Methods Phys. Res.* A286 (1990) 584
(Gamma-ray emission probabilities)
- K. BHASKARA RAO, S.S. RAO, V.S. RAO, H.C. PADHI. *Nuovo Cim.* 103A (1990) 683
(K-capture probability)
- R.A. MEYER. *Fizika (Zagreb)* 22 (1990) 153
(Gamma-ray emission probabilities)
- C. WESSELBORG, D.E. ALBURGER. *Nucl. Instrum. Methods Phys. Res.* A302 (1991) 89
(Gamma ray energies)
- G.P.S. SAHOTA, H. SINGH, H.S. BINARH, B.S. PALLAN, H.S. SAHOTA. *J. Phys. Soc. Jpn* 61 (1992) 3518
(K-capture probability)
- M.P. UNTERWERGER, D.D. HOPPE, F.J. SCHIMA. *Nucl. Instrum. Methods Phys. Res.* A312 (1992) 349
(Half-life)
- F.E. CHUKREEV. In: *Voprosi Atomnoi Nauki i Tekhniki, Ser.: Yadernie konstanti, 1992 2* (1992) 92
(Decay scheme)

- A.L. NICHOLS. AEA Technology Report AEA- RS-5449 (1993)
(Decay scheme)
- S. RAB. Nucl. Data Sheets 75 (1995) 491
(Decay scheme)
- H. MIYAHARA, K. USAMI, C. MORI. Nucl. Instrum. Methods Phys. Res. A374 (1996) 193
(Gamma-ray emission probabilities)
- E. SCHÖNFELD, H. JANSSEN. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
(Atomic Data)
- R.H. MARTIN, K.I.W. BURNS, J.G.V. TAYLOR. Nucl. Instrum. Methods Phys. Res. A390 (1997) 267
(Half-life)
- H.Y. HWANG, C.B. LEE, T.S. PARK. Appl. Radiat. Isot. 49 (1998) 1201
(Gamma-ray emission probabilities)
- R.G. HELMER, C. VAN DER LEUN. Nucl. Instrum. Methods Phys. Res. A450 (2000) 35
(Gamma ray energies)
- M.P. UNTERWEGER. Appl. Radiat. Isot. 56 (2002) 125
(Half-life)
- H. SCHRADER. Appl. Radiat. Isot. 60 (2004) 17
(Half-life)
- M.M. BÉ, V. CHISTÉ, C. DULIEU, E. BROWNE, V. CHECHEV, N. KUZMENKO, R. HELMER, A. NICHOLS, E. SCHÖNFELD, R. DERSCH. Monographie BIPM-5 1 (2004) 263
(Decay data evaluation)
- T. KIBÉDI, T.W. BURROWS, M.B. TRZHASKOVSKAYA, P.M. DAVIDSON, C.W. NESTOR JR. Nucl. Instrum. Methods Phys. Res. A589 (2008) 202
(BrIcc computer program)
- H. SCHRADER. Appl. Radiat. Isot. 68 (2010) 1583
(Half-life)
- YU. KHAZOV, A. RODIONOV, F.G. KONDEV. Nucl. Data Sheets 112 (2011) 855
(Decay scheme)
- M. WANG, G. AUDI, A.H. WAPSTRA, F.G. KONDEV, M. MACCORMICK, X. XU, B. PFEIFFER. Chin. Phys. C36 (2012) 1603
(Q)
- R. FITZGERALD. J. Res. Natl. Inst. Stand. Technol. 117 (2012) 80
(Half-life)
- G.V. SAI MANOHAR, K.S. YADAV, K.V. SAI, R. GOWRISHANKAR, K. VENKATARAMANIAN, S. DEEPA, D. RAO. Proceedings of the DAE Symp. on Nucl. Phys. 59 (2014) 286
(Gamma-ray and electron relative emission probabilities)
- M.P. UNTERWEGER, R. FITZGERALD. Appl. Radiat. Isot. 87 (2014) 92
(Half-life)

