$^{133}_{56}\mathrm{Ba}_{77}$

1 Decay Scheme

Ba-133 disintegrates by electron capture to Cs-133 via the excited states of 437 keV and of 383 keV .
Le baryum 133 se désintègre par capture électronique vers des niveaux excités de 437 et 383 keV du césium 133.

2 Nuclear Data

$T_{1/2}(^{133}\mathrm{Ba}\ )$: 10,540 (6) a
$Q^{+}(^{133}\mathrm{Ba}\ )$: 517,4 (10) keV

2.1 Electron Capture Transitions

	Energy keV	Probability × 100	Nature	lg ft	P_K	P_L	P_M
$\epsilon_{0,4}$	80,4 (10)	86,2 (5)	Allowed	6,68	0,672 (5)	0,252 (4)	0,0612 (13)
$\epsilon_{0,3}$	133,6 (10)	13,7 (4)	Allowed	8,07	0,7734 (21)	0,1761 (15)	0,0408 (8)
$\epsilon_{0,2}$	356,8 (10)	< 0,3	2nd Forbidden	> 10,6	0,79 (3)		
$\epsilon_{0,1}$	436,4 (10)	< 0,7	2nd Forbidden	> 10,6	0,88 (4)		
$\epsilon_{0,0}$	517,4 (10)	< 0,0005	Uniq. 2ndForbidden	> 13,9			

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_{MNO}	α_T
$\gamma_{4,3}$(Cs)	53,1622 (6)	15,0 (4)	M1+2,2(13)%E2	4,93 (10)	0,86 (3)	0,226 (8)	6,02 (18)
$\gamma_{2,1}$(Cs)	79,6142 (12)	7,34 (17)	M1+0,09(9)%E2	1,515 (30)	0,204 (5)	0,0530 (11)	1,77 (4)
$\gamma_{1,0}$(Cs)	80,9979 (11)	90,1 (16)	M1+2,23(4)%E2	1,46 (3)	0,220 (5)	0,0570 (14)	1,74 (4)
$\gamma_{2,0}$(Cs)	160,6121 (16)	0,84 (3)	M1+62(12)%E2	0,24 (3)	0,054 (7)	0,014 (3)	0,31 (4)

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_{MNO}	α_T
$\gamma_{3,2}$(Cs)	223,2370 (13)	0,498 (6)	M1+1,3(2)%E2	0,0853 (20)	0,0113 (3)	0,00292 (6)	0,0995 (30)
$\gamma_{4,2}$(Cs)	276,3992 (12)	7,57 (5)	E2	0,0461 (9)	0,00855 (17)	0,00225 (5)	0,0569 (12)
$\gamma_{3,1}$(Cs)	302,8512 (5)	19,15 (14)	M1+0,05(6)%E2	0,0381 (8)	0,00496 (10)	0,00128 (3)	0,0443 (9)
$\gamma_{4,1}$(Cs)	356,0134 (7)	63,64 (20)	E2	0,0211 (4)	0,00351 (7)	0,00092 (30)	0,0256 (5)
$\gamma_{3,0}$(Cs)	383,8491 (12)	9,12 (6)	E2	0,0169 (3)	0,00273 (5)	0,00071 (2)	0,0203 (4)

3 Atomic Data

3.1 Cs

ω_K : 0,894 (4)
$\bar{\omega}_L$: 0,104 (5)
n_{KL} : 0,895 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	30,625		54,13
	$K\alpha_1$	30,973		100
	$K\beta_3$	34,92	}	
	$K\beta_1$	34,987	}	
	$K\beta_5''$	35,245	}	29
	$K\beta_5'$	35,259	}	
	$K\beta_2$	35,818	}	
	$K\beta_4$	35,907	}	7,33
	$KO_{2,3}$	35,972	}	
X_L				
	$L\ell$	3,8		
	$L\gamma$	– 5,7		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	24,41 – 25,80	100
KLX	29,00 – 30,96	47,2
KXY	33,51 – 35,95	5,56
Auger L	2,5 – 5,6	

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Cs)	2,5 - 5,6	138,0 (15)
e_{AK}	(Cs)		14,2 (6)
	KLL	24,41 - 25,80	}
	KLX	29,00 - 30,96	}
	KXY	33,51 - 35,95	}
$ec_{4,3\ K}$	(Cs)	17,1776 (6)	10,6 (3)
$ec_{2,1\ K}$	(Cs)	43,6296 (12)	4,01 (9)
$ec_{1,0\ K}$	(Cs)	45,0133 (11)	48,1 (11)
$ec_{4,3\ L}$	(Cs)	47,45 - 48,15	1,84 (7)
$ec_{4,3\ MNO}$	(Cs)	51,94 - 53,08	0,484 (18)
$ec_{2,1\ L}$	(Cs)	73,9 - 74,6	0,541 (17)
$ec_{1,0\ L}$	(Cs)	75,29 - 75,79	7,25 (18)
$ec_{2,1\ MNO}$	(Cs)	78,40 - 79,53	0,140 (5)
$ec_{1,0\ MNO}$	(Cs)	79,78 - 80,92	1,88 (5)
$ec_{2,0\ K}$	(Cs)	124,6274 (16)	0,15 (2)
$ec_{4,2\ K}$	(Cs)	240,4143 (12)	0,330 (7)
$ec_{3,1\ K}$	(Cs)	266,8862 (5)	0,70 (2)
$ec_{4,2\ L}$	(Cs)	270,69 - 271,39	0,0612 (13)
$ec_{3,1\ L}$	(Cs)	297,14 - 297,85	0,091 (2)
$ec_{4,1\ K}$	(Cs)	320,0283 (7)	1,31 (3)
$ec_{3,0\ K}$	(Cs)	347,8639 (12)	0,151 (3)
$ec_{4,1\ L}$	(Cs)	350,30 - 351,01	0,218 (4)
$ec_{4,1\ MNO}$	(Cs)	354,80 - 355,93	0,57 (1)

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Cs)	3,8 — 5,7	16,0 (8)	
$XK\alpha_2$	(Cs)	30,625	34,0 (4)	} $K\alpha$
$XK\alpha_1$	(Cs)	30,973	62,8 (7)	}
$XK\beta_3$	(Cs)	34,92 }		
$XK\beta_1$	(Cs)	34,987 }	18,2 (2)	$K'\beta_1$
$XK\beta_5''$	(Cs)	35,245 }		
$XK\beta_5'$	(Cs)	35,259 }		

		Energy keV		Photons per 100 disint.	
$XK\beta_2$	(Cs)	35,818	}		
$XK\beta_4$	(Cs)	35,907	}	4,6 (1)	$K'\beta_2$
$XKO_{2,3}$	(Cs)	35,972	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{4,3}$(Cs)	53,1622 (6)	2,14 (3)
$\gamma_{2,1}$(Cs)	79,6142 (12)	2,65 (5)
$\gamma_{1,0}$(Cs)	80,9979 (11)	32,9 (3)
$\gamma_{2,0}$(Cs)	160,6121 (16)	0,638 (4)
$\gamma_{3,2}$(Cs)	223,2368 (13)	0,453 (3)
$\gamma_{4,2}$(Cs)	276,3989 (12)	7,16 (5)
$\gamma_{3,1}$(Cs)	302,8508 (5)	18,34 (13)
$\gamma_{4,1}$(Cs)	356,0129 (7)	62,05 (19)
$\gamma_{3,0}$(Cs)	383,8485 (12)	8,94 (6)

6 Main Production Modes

$\left\{ \begin{array}{l} \mathrm{Ba-132(n,\gamma)Ba-133} \qquad \sigma : 6{,}5\ (8)\ \text{barns} \\ \text{Possible impurities :}\ \ \mathrm{Ba-131, Ba-140} \end{array} \right.$

$\left\{ \begin{array}{l} \mathrm{Ba-132(n,\gamma)Ba-133m} \qquad \sigma : 0{,}5\ \ \text{barns} \\ \text{Possible impurities :}\ \ \mathrm{Ba-131, Ba-140} \end{array} \right.$

$\left\{ \begin{array}{l} \mathrm{Cs-133(p,n)Ba-133} \\ \text{Possible impurities :}\ \ \mathrm{Cs-132} \end{array} \right.$

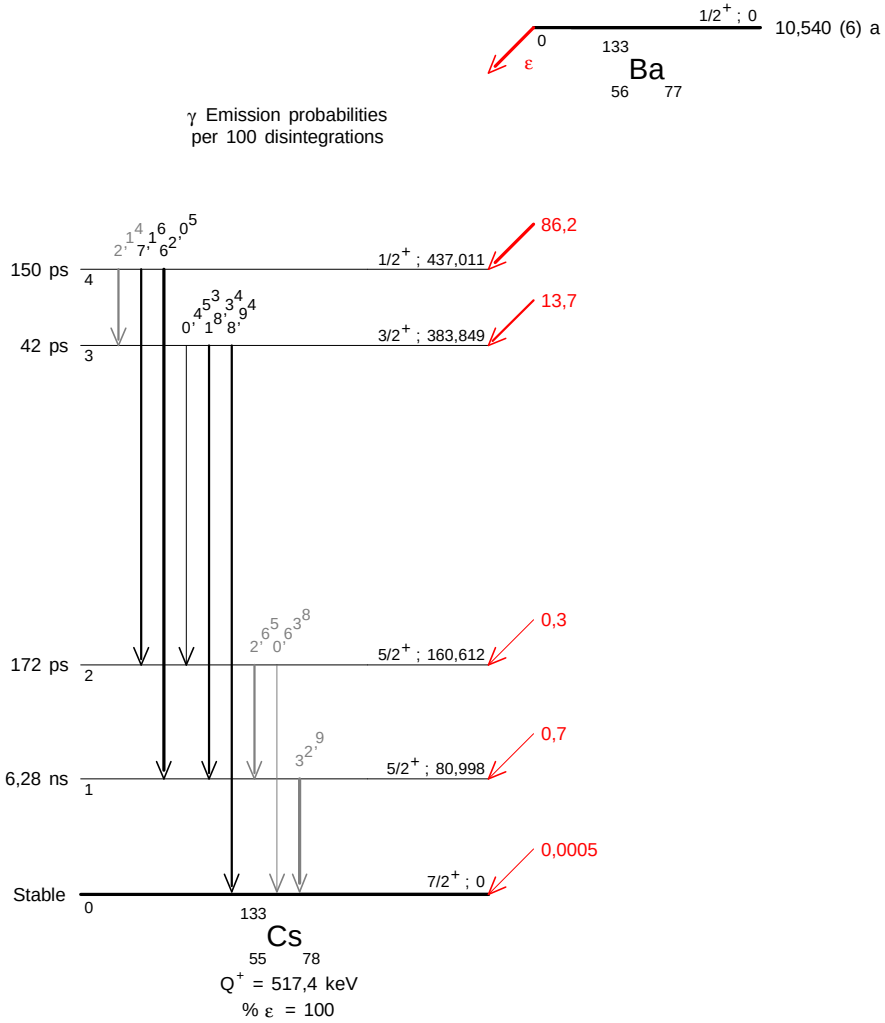
7 References

- 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 intensities)
- J. A. Bearden. Rev. Mod. Phys. 39 (1967) 78
  (X-ray energies)
- F. LAGOUTINE, Y. Le.Gallic, J. Legrand. Int. J. Appl. Radiat. Isotop. 19 (1968) 475
  (Half-life)
- A. NOTEA, Y. Gurfinkel. Nucl. Phys. A107 (1968) 193
  (Gamma-ray emission intensities)

- 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 intensities)
- H. E. BOSCH, A. J. Haverfield, E. Szichman, S. M. Abecasis. Nucl. Phys. A108 (1968) 209
  (Gamma-ray emission intensities)
- D. P. DONNELLY, J. J. Reidy, M. L. Wiedenbeck. Phys.Rev. 173 (1968) 1192
  (Gamma-ray emission intensities)
- V. NARAND, H. Houtermans. Phys. Soc., Budapest (1968) 97
  (L/K-capture ratio)
- R. GUNNINK, J. B. Niday, R. P. Anderson, R. A. Meyer. Priv. Comm. UCID-15439 (1969)
  (Gamma-ray emission intensities)
- K. F. WALZ, J. L. Campbell. 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. Phys. 249 (1972) 286
  (K-capture probability, absolute XKemission probability, g-ray emission])
- H. INOUE, Y. Yoshizawa, T. Morii. J. Phys. Soc. Jap. 34 (1973) 1437
  (Gamma-ray emission intensities)
- L. A. MCNELLES, J. L. Campbell. Nucl. Instrum. Methods 109 (1973) 241
  (Gamma-ray emission intensities)
- R. D. LLOYD, C. W. Mays. Int. J. Appl. Radiat. Isotop. 24 (1973) 189
  (Half-life)
- J. LEGRAND, K. Debertin, K. F. Walz. Nucl. Instrum. Methods 112 (1973) 229
  (Gamma-ray emission intensities)
- Das. B. K. MAHAPATRA, P. Mukherjee. J. Phys. (London) A7 (1974) 388
  (K-capture probabilities)
- W. F. NICAISE, A. W. Waltner. Nucl. Instrum. Methods 131 (1975) 477
  (K-capture probability)
- U. SCHÖTZIG, K. Debertin, K. F. Walz. Int. J. Appl. Radiat. Isotop. 28 (1977) 503
  (XK-ray and g-ray emission probabilities)
- R. J. GEHRKE, R. G. Helmer, R. C. Greenwood. Nucl. Instrum. Methods 147 (1977) 405
  (K-capture probability)
- K. S. KRANE. At. Data Nucl. Data Tables 19 (1977) 363
  (E2/M1 mixing ratio)
- F. P. LARKINS. At. Data Nucl. Data Tables 20 (1977) 313
  (Auger electron energies)
- F. Rösel, H. M. Friess, K. Alder, H. C. Pauli. At. Data Nuc. Data Tables 21 (1978) 92
  (Internal conversion coefficients)
- R. G. HELMER, R. C. Greenwood, R. J. Gehrke. Nucl. Instrum. Methods 155 (1978) 189
  (Gamma-ray emission intensities)
- C. VYLOV, B. P. Osipenko, V. G. Chumin. Particles and Nuclei 6 (1978) 1350
  (Gamma-ray emission intensities)
- H. H. HANSEN, J. Morel, J. Legrand. Report NEANDC v.3 (1979) 28
  (Half-life)
- 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. Meth. 171 (1980) 389
  (Gamma-ray emission intensities)
- A. R. RUTLEDGE, L. V. Smith, J. S. Merritt. Report AECL 6692 (1980)
  (Half-life)
- K. S. KRANE. At. Data Nuc. Data Tables 25 (1980) 29
  (E2/M1 mixing ratio)
- B. CHAUVENET, J. Morel, J. Legrand. Report ICRM-S-6 (1980)
  (Absolut gamma-ray emission intensities)
- D. D. HOPPES, J. M. R. Hutchinson, F. J. Schima, M. P. Unterweger. Report NBS-SP 626 (1982) 85
  (half-life)
- J. KITS, F. Latal, M. Choc. Int. J. Appl. Radiat. Isotop. 34 (1983) 935
  (Half-life)

- K. SINGH, H. S. Sahota. J. Phys. (London) G9 (1983) 1565
  (K-capture probabilities)
- K. SINGH, H. S. Sahota. J. Phys. Soc. Jap. 52 (1983) 2336
  (K-capture probability)
- B. CHAUVENET, J. Morel, J. Legrand. Int. J. Appl. Radiat. Isotop. 34 (1983) 479
  (Absolute g-ray emission probabilities)
- 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 intensities)
- LAKSHN, S. B. Reddy, K. B. Reddy. Curr. Sci. V.50 (1987) 407
  (Gamma-ray emission intensities)
- R. B. BEGZHANOV, Sh. K. Azimov, R. D. Magrupov, Sh. A. Mirakhmedov, A. Mukhammadiev, M. Narzikulov, S. Kh. Salimov. Proc. 38th Ann. Conf. Spectros. Struc. At. Nuclei, Baku (1988) 93
  (K-capture 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. Rad. Isotopes 40 (1989) 707
  (Gamma-ray emission intensities)
- M. C. MARTINS, M. I. Marques, F. Parente, J. G. Ferreira. J. Phys. (London) B.22 (1989) 3167
  (KB'2/K'B1 ratio)
- A. G. EGOROV, Yu. S. Egorov, V. G. Nedovesov, G. E. Shchukin, K. P. Yakovlev. Proc. 39th Ann. Conf.Nucl. Spectrosc. Struct. At Nuclei, Leningrad (1989) 505
  (K X-ray emission intensities)
- R. A. MEYER. Fizika (Zagreb) 22 (1990) 153
  (Gamma-ray emission intensities)
- B. DASMAHAPATRA, S. Bhattacharya, S. Sen, M. Saha, A. Goswami. J. Phys. (London) G.67 (1990) 1227
  (K-capture probability)
- R. B. FIRESTONE. Nucl. Instrum. Methods A286 (1990) 584
  (Decay scheme)
- K. RAO, Bhaskara, S. S. Rao, V. S. Rao, H. C. Padhi. Nuovo Cim. 103A (1990) 683
  (K-capture probability)
- C. WESSELBORG, D. E. Alburger. Nucl. Instrum. Methods A302 (1991) 89
  (Gamma ray energies)
- F. E. CHUKREEV. Yadern. Konstanti v.2 (1992) 92
  (Decay scheme)
- G. PS. SAHOTA, H. Singh, H. S. Binarh, B. S. Pallan, H. S. Sahota. J. Phys. Soc. Jap. 61 (1992) 3518
  (K-capture probability)
- M. P. Unterwerger, D. D. Hoppes, F. J. Schima. Nucl. Instrum. Methods A312 (1992) 349
  (Half-life)
- A. L. Nichols. AEA Technology Report AEA-RS 5449 (1993)
  (Decay Scheme)
- S. Rab. Nucl. Data Sheets 75 (1995) 491
  (Decay Scheme)
- G. Audi, A. H. Wapstra. Nucl. Phys. A 595 (1995) 409
  (Q-value)
- H. Miyahara, K. Usami, C. Mori. Nucl. Instrum. Methods A374 (1996) 193
  (gamma-ray emission probabilities)
- E. Schönfeld, H. Janssen. Nucl. Instrum. Methods A369 (1996) 527
  (Atomic Data)
- R. H. Martin, K. I. W. Burns, J. G. V. Taylor. Nucl. Instrum. Methods A390 (1997) 267
  (Half-life)
- H. Y. Hwang, C. B. Lee, T. S. Park. Appl. Rad. Isotopes 49 (1998) 1201
  (gamma-ray emission probabilities)
- E. Schönfeld. Appl. Rad. Isotopes 49 (1998) 1353
  (Pk, Pl, Pm electron capture probabilities)
- B. Singh, J. L. Rodriguez, S. S. Wong, J. K. Tuli. Nucl. Data Sheets 84 (1998) 487
  (lg ft)
- R. G. Helmer, C. van der Leun. Nucl. Instrum. Meth. Phys. Res. A450 (2000) 35
  (Gamma-ray energies)

- V. P. Chechev, A. G. Egorov. Appl. Rad. Isotopes 52 (2000) 601
(Evaluation technique)
- M. P. Unterwerger. Appl. Rad. Isotopes 56 (2002) 125
(Half-life)
- H. Schrader. Appl. Rad. Isotopes 60 (2004) 317
(Half-life)


1/2+ ; 0
10,540 (6) a
0
ε
133
Ba
56
77
γ Emission probabilities
per 100 disintegrations
150 ps
4
42 ps
3
172 ps
2
6,28 ns
1
Stable
0
1/2+ ; 437,011
3/2+ ; 383,849
5/2+ ; 160,612
5/2+ ; 80,998
7/2+ ; 0
86,2
13,7
0,3
0,7
0,0005
133
Cs
55
78
Q+ = 517,4 keV
% ε = 100