$^{24}_{11}\mathrm{Na}_{13}$

1 Decay Scheme

Na-24 decays 100% by beta minus emission. The main transition (99.939%) has a maximum energy of 1393 keV and populates the 4123 keV level of Mg-24. This process is followed by two gamma rays in cascade (2754 and 1368 keV) which leads through the 1368 keV level to the ground state of Mg-24. Due to the high transition energies internal pair formation takes place.

Le sodium-24 se désintègre par émission bêta moins (100%). La transition principale a une énergie maximale de 1393 keV et peuple le niveau d'énergie 4123 keV du magnésium-24. Cette désintégration est suivie par deux émissions gamma en cascade vers le niveau fondamental de magnésium-24. Les énergies élevées de ces transitions permettent la création de paires électron-positron.

2 Nuclear Data

$T_{1/2}(^{24}\mathrm{Na})$	:	14,958	(2)	h
$Q^-(^{24}\mathrm{Na})$	:	5515,61	(4)	keV

2.1 β^- Transitions

	Energy (keV)	Probability (%)	Nature	lg ft
$\beta^-_{0,4}$	280,49 (6)	0,066 (3)	Allowed	6,69
$\beta^-_{0,3}$	1277,37 (5)	0,001 (1)	2nd Forbidden	12,3
$\beta^-_{0,2}$	1392,72 (4)	99,930 (3)	Allowed	6,12
$\beta^-_{0,1}$	4146,94 (4)	0,003 (2)	2nd Forbidden	12,7

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy (keV)	$P_{\gamma+ce}$ (%)	Multipolarity	α_K (10^{-5})	α_L (10^{-6})	α_M (10^{-8})	α_T (10^{-5})	α_π (10^{-3})
$\gamma_{4,3}$(Mg)	996,88 (5)	0,00145 (25)	M1+E2	1,92 (4)	1,233 (20)	4,56 (8)	2,05 (4)	
$\gamma_{1,0}$(Mg)	1368,672 (5)	99,9990 (3)	E2	0,929 (13)	0,597 (9)	2,21 (3)	0,991 (13)	0,0463 (7)
$\gamma_{2,1}$(Mg)	2754,217 (13)	99,930 (3)	E2	0,254 (4)	0,1632 (23)	0,605 (9)	0,271 (4)	0,675 (10)
$\gamma_{3,1}$(Mg)	2869,57 (3)	0,00025 (3)	M1+E2	0,238 (4)	0,1528 (22)	0,567 (8)	0,254 (6)	0,727 (11)
$\gamma_{4,1}$(Mg)	3866,45 (4)	0,066 (2)	M1+E2	0,1516 (22)	0,0973 (14)	0,361 (5)	0,162 (2)	1,122 (16)
$\gamma_{3,0}$(Mg)	4238,24 (3)	0,00084 (10)	E2	0,1330 (19)	0,0853 (12)	0,316 (5)	0,142 (2)	1,253 (18)

3 Atomic Data

3.1 Mg

ω_K : 0,0291 (9)
$\bar{\omega}_L$: 0,00030 (12)
n_{KL} : 1,938 (6)

3.1.1 X Radiations

		Energy (keV)	Relative probability
X_K			
	$K\alpha_2$	1,25361	50,31
	$K\alpha_1$	1,25361	100
	$K\beta_1$	1,3022	2,55527

3.1.2 Auger Electrons

	Energy (keV)	Relative probability
Auger K		
KLL	1,102 - 1,182	100
KLX	1,214 - 1,252	3,4
KXY	1,301 - 1,301	0,029

4 Electron Emissions

		Energy (keV)	Electrons (per 100 disint.)
e_{AK}	(Mg)		
	KLL	1,102 - 1,182	0,001148 (14)
	KLX	1,214 - 1,252	
	KXY	1,301 - 1,301	
$ec_{1,0\ \alpha}$	(Mg)	346,669 (5)	0,00463 (7)
$ec_{2,1\ \alpha}$	(Mg)	1732,217 (13)	0,0675 (10)
$ec_{4,1\ \alpha}$	(Mg)	2843,14 (4)	0,0000741 (25)
$ec_{3,0\ \alpha}$	(Mg)	3215,84 (3)	0,00000105 (13)
$\beta^-_{0,4}$	max:	280,49 (6)	0,066 (3)
	avg:	90,00 (2)	
$\beta^-_{0,3}$	max:	1277,37 (5)	0,001 (1)
	avg:	503	
$\beta^-_{0,2}$	max:	1392,72 (4)	99,930 (3)
	avg:	555,05 (2)	
$\beta^-_{0,1}$	max:	4146,94 (4)	0,003 (2)
	avg:	1866,70 (2)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy (keV)	Photons (per 100 disint.)	
$XK\alpha_2$	(Mg)	1,25361	0,0000113 (4)	$K\alpha$
$XK\alpha_1$	(Mg)	1,25361	0,0000225 (8)	
$XK\beta_1$	(Mg)	1,3022	0,00000058 (14)	$K'\beta_1$

5.2 Gamma Emissions

	Energy (keV)	Photons (per 100 disint.)
$\gamma_{(-1,1)}$(Mg)	511	0,144 (2)
$\gamma_{4,3}$(Mg)	996,86 (5)	0,00145 (25)
$\gamma_{1,0}$(Mg)	1368,630 (5)	99,9934 (5)
$\gamma_{2,1}$(Mg)	2754,049 (13)	99,862 (3)
$\gamma_{3,1}$(Mg)	2869,38 (3)	0,00025 (3)
$\gamma_{4,1}$(Mg)	3866,12 (4)	0,066 (2)
$\gamma_{3,0}$(Mg)	4237,84 (3)	0,00084 (10)

6 Main Production Modes

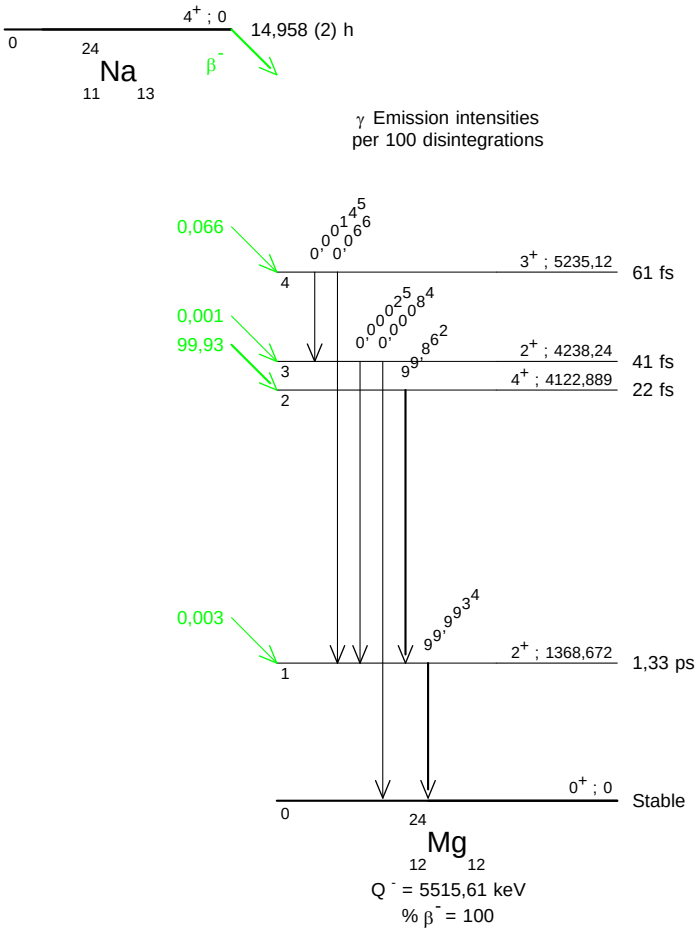
$\mathrm{Na-23(n,\gamma)Na-24}$

7 References

- R. Wilson, G. R. Bishop. Proc. Phys. Soc. (London) 62 (1949) 457
  (Half-life)
- E. R. Rae. Phil. Mag. 40 (1949) 1155
  (Internal-pair formation coefficient)
- J. W. Cobble, R. W. Atteberry. Phys. Rev. 80 (1950) 917
  (Half-life)
- P. Grant. Proc. Phys. Soc. (London) 63 (1950) 1298
  (Beta minus emission probability)
- W. Mims, H. Halban, R. Wilson. Nature 166 (1950) 1571
  (Internal-pair formation coefficient)
- M. R. Cleland, J. Townsend, A. L. Hughes. Phys. Rev. 84 (1951) 298
  (Internal-pair formation coefficient)
- J. F. Turner, P. E. Cavanagh. Phil. Mag. 42 (1951) 636
  (Beta minus emission probability)
- S. D. Bloom. Phys. Rev. 88 (1952) 312
  (Internal-pair formation coefficient)
- H. Slätis, K. Siegbahn. Ark. Fysik 4 (1952) 485
  (Internal-pair formation coefficient)
- E. E. Lockett, R. H. Thomas. Nucleonics 11 (1953) 14
  (Half-life)
- J. Tobailem. J. Phys. Radium 16 (1955) 48
  (Half-life)
- F. T. Porter, F. Wagner, Jr., M. S. Freedman. Phys. Rev. 107 (1957) 135
  (Beta emission energies)
- P. J. Campion, J. S. Merritt. Can. J. Phys. 36 (1958) 983
  (Half-life)
- H. Daniel. Nucl. Phys. 8 (1958) 191
  (Beta emission energies)
- G. Wolf. Nukleonik 2 (1960) 255
  (Half-life)
- K. P. Artamonova, L. V. Gustova, Y. N. Podkapaev, O. V. Chubinskii. Soviet Phys. JETP 12 (1960) 1109
  (Gamma-ray emission probabilities)
- E. I. Wyatt, S. A. Reynolds, T. H. Handley, W. S. Lyon, H. A. Parker. Nucl. Sci. Eng. 11 (1961) 74
  (Half-life)
- G. Demortier, P.C. Macq. J. Phys. Radium 22 (1961) 597
  (Beta emission energies)
- P. Depommier, M. Chabre. J. Phys. Radium 22 (1961) 656
  (Beta emission energies)
- J. E. Monahan, S. Raboy, C. C. Trail. Nucl. Instrum. Methods 17 (1962) 225
  (Half-life, Gamma-ray emission probabilities)
- H. Paul, F. P. Viehböck, P. Skarek, H. Baier, I. Hofmann, H. Wotke. Acta Phys. Austr. 16 (1963) 278
  (Beta emission energies)
- J. Lehmann. J. Phys. 25 (1964) 326
  (Beta emission energies)
- H. Beekhuis, H. De Waard. Nucl. Phys. 74 (1965) 459
  (Beta emission energies)
- P. M. Endt, C. van der Leun. Nucl. Phys. A105 (1967) 1
  (Gamma-ray emission probabilities)
- F. Lagoutine, Y. le Gallic, J. Legrand. Int. J. Appl. Radiat. Isotop. 19 (1968) 475
  (Half-life)
- J. van Klinken, F. Pleiter, H. T. Dijkstra. Nucl. Phys. A112 (1968) 372
  (Gamma-ray emission probabilities)

- P. Kemeny. Radiochem. Radioanal. Lett. 2 (1969) 119
  (Half-life)
- H. M. W. Booij, E. A. Van Hoek, J. Blok. Nucl. Instrum. Methods 72 (1969) 40
  (Beta emission energies)
- J. Lebowitz, A. R. Sayres, C. C. Trail, B. Weber, P. L. Zirkind. Nuovo Cim. 65A (1970) 675
  (Gamma-ray energies, Gamma-ray emission probabilities)
- S. Raman, N. B. Gove, J. K. Dicken, T. A. Walkiewicz. Phys. Lett. 40B (1972) 89
  (Gamma-ray energies, Gamma-ray emission probabilities, Beta emission probabilities)
- H. J. Gils, D. Flothmann, R. Löhken, W. Wiesner. Nucl. Instrum. Methods 105 (1972) 179
  (Beta emission energies)
- J. F. Emery, S. A. Reynolds, E. I. Wyatt, G. I. Gleason. Nucl. Sci. Eng. 48 (1972) 319
  (Half-life)
- M. A. Meyer, J. P. L. Reinecke, D. Reitmann. Nucl. Phys. A185 (1972) 625
  (Gamma-ray energies, Gamma-ray emission probabilities)
- D. Branford. Austral. J. Phys. 26 (1973) 1995
  (Gamma-ray emission probabilities)
- F. Leccia, M. M. Alconard, D. Castera, P. Hubert, P. Mennrath. J. Phys. 34 (1973) 147
  (Gamma-ray emission probabilities, Multipolarities)
- S. Chakraborty. Radiochem. Radioanal. Lett. 17 (1974) 61
  (Half-life)
- S. G. Boydell, D. G. Sargood. Austral. J. Phys. 28 (1975) 369
  (Gamma-ray emission probabilities)
- H. Genz, J. Reisberg, A. Richter, B. M. Schmitz, G. Schrieder, K. Werner, H. Behrens. Nucl. Instrum. Methods 134 (1976) 309
  (Half-life, Beta emission energies)
- M. C. Davis, W. C. Bowman, J. C. Robertson. Int. J. Appl. Radiat. Isotop. 29 (1978) 331
  (Half-life)
- H. Houtermans, O. Milosevic, F. Reichel. Int. J. Appl. Radiat. Isotop. 31 (1980) 153
  (Half-life)
- W. Muckenheim, P. Rullhusen, F. Smend, M. Schumacher. Nucl. Instrum. Methods 173 (1980) 403
  (Half-life)
- A. R. Rutledge, L. V. Smith, J. S. Merritt. AECL-6692 (1980)
  (Half-life)
- E. K. Warburton, C. J. Lister, D. E. Alburger, J. W. Olness. Phys. Rev. C23 (1981) 1242
  (Gamma-ray emission probabilities)
- D. D. Hoppes, J. M. R. Hutchinson, F. J. Schima, M. P. Unterweger. NBS-SP- 626 (1982) 85
  (Half-life)
- F. Lagoutine, J. Legrand. Int. J. Appl. Radiat. Isotop. 33 (1982) 711
  (Half-life)
- A. R. Rutledge, L. V. Smith, J. S. Merritt. NBS-SP- 626 (1982) 5
  (Half-life)
- K. F. Walz, K. Debertin, H. Schrader. Int. J. Appl. Radiat. Isotop. 34 (1983) 1191
  (Half-life)
- A. Abzouzi, M. S. Antony, V. B. Ndocko Ndonguc. J. Radioanal. Nucl. Chem. 135 (1989) 1
  (Half-life)
- P. M. Endt, C. Alderliesten, F. Zijderhand, A. A. Wolters, A. G. M. van Hees. Nucl. Phys. A510 (1990) 209
  (Gamma-ray emission probabilities)
- P. M. Endt. Nucl. Phys. A521 (1990) 1
  (Spin and Parity)
- P. Bode, M. J. J. Ammerlaan, M. Koese. Appl. Radiat. Isot. 42 (1991) 692
  (Half-life)
- M. P. Unterweger, D. D. Hoppes, F. J. Schima. Nucl. Instrum. Methods A312 (1992) 349
  (Half-life)
- E. P. Mignonsin. Appl. Radiat. Isot. 45 (1994) 17
  (Half-life)
- B. Singh, J. L. Rodriguez, S. S. M. Wong, J. K. Tuli. Nucl. Data Sheets 84 (1998) 487
  (log ft systematics)

- I. M. Band, M. B. Trzhaskovskaya, C. W. Nestor Jr., P. O. Tikkanen, S. Raman. At. Data Nucl. Data Tables 81 (2002) 1
(Theoretical ICC)
- M. P. Unterweger. Appl. Radiat. Isot. 56 (2002) 125
(Half-life)
- E. M. Epp, H. C. Griffin. Nucl. Instrum. Methods Phys. Res. A505 (2003) 9
(Gamma-ray emission probabilities)
- M. P. Unterweger, R. M. Lindstrom. Appl. Radiat. Isot. 60 (2004) 325
(Half-life)
- M.-M. Bé, V. Chisté, C. Dulieu, E. Browne, V. Chechev, N. Kuzmenko, R. Helmer, A. Nichols, E. Schönfeld, R. Dersch. Table of Radionuclides (Vol. 1 - A =1 to 150). Bureau International des Poids et Mesures, (2004) 27
(Decay data evaluation)
- R. M. Lindstrom, M. Blaauw, M. P. Unterweger. J. Radioanal. Nucl. Chem. 263 (2005) 311
(Half-life)
- R. B. Firestone. Nucl. Data Sheets 108 (2007) 2319
(Decay Scheme, adopted levels and gammas)
- 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)
- 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)
- M. P. Unterweger, R. Fitzgerald. Appl. Radiat. Isot. 87 (2014) 92
(Half-life)


4+ ; 0
14,958 (2) h
0
24
Na
11
13
β-
γ Emission intensities
per 100 disintegrations
0,066
0,001
99,93
0,003
3+ ; 5235,12
61 fs
2+ ; 4238,24
41 fs
4+ ; 4122,889
22 fs
2+ ; 1368,672
1,33 ps
0+ ; 0
Stable
4
3
2
1
0
24
Mg
12
12
Q - = 5515,61 keV
% β- = 100