$^{26}_{13}\mathrm{Al}_{13}$

Evaluation of the decay data

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This evaluation was completed including the literature available by end of October 2022. It is an update of the previous DDEP evaluation performed in 1997, which Comments are also given.

Tables of decay data with the decay scheme .... p. 2-6

Comments on the present evaluation .... p. 7

Comments on the 1997 evaluation .... p. 8-10

$^{26}_{13}$Al $_{13}$

1 Decay Scheme

^{26}Al disintegrates by electron capture and beta plus emission to the 2938 keV and to the 1808 keV excited levels of ^{26}Mg.

Le ^{26}Al *se désintègre par capture électronique et par émission bêta plus vers les niveaux excités* 2938 keV *et* 1808 keV *du* ^{26}Mg.

2 Nuclear Data

$T_{1/2}$(^{26}Al)	:	717	(24)	10^3 a
Q^+(^{26}Al)	:	4004,40	(6)	keV

2.1 Electron Capture Transitions

	Energy (keV)	Probability (%)	Nature	lg ft	P_K	P_L	P_M
$\epsilon_{0,2}$	1066,07 (7)	2,74 (2)	Unique 2nd Forbidden	14,577	0,9190 (8)	0,0722 (4)	0,00879 (36)
$\epsilon_{0,1}$	2195,66 (7)	15,23 (18)	Unique 2nd Forbidden	15,726	0,9194 (7)	0,07187 (39)	0,00876 (36)

2.2 β^+ Transitions

	Energy (keV)	Probability (%)	Nature	lg ft
$\beta^+_{0,2}$	44,07 (7)	0,000000570 (41)	Unique 2nd Forbidden	14,577
$\beta^+_{0,1}$	1173,66 (7)	82,01 (18)	Unique 2nd Forbidden	15,726

2.3 Gamma Transitions and Internal Conversion Coefficients

	Energy (keV)	$P_{\gamma+ce}$ (%)	Multipolarity	α_K (10^{-6})	α_L (10^{-7})	α_M (10^{-8})	α_T (10^{-6})	α_π (10^{-6})
$\gamma_{2,1}$(Mg)	1129,72 (10)	2,5 (2)	M1+(1.42%)E2	10,37 (15)	6,66 (10)	2,47 (4)	12,55 (18)	1,492 (22)
$\gamma_{1,0}$(Mg)	1808,72 (7)	99,805 (40)	E2	5,29 (8)	3,40 (5)	1,259 (18)	228 (4)	222 (4)
$\gamma_{2,0}$(Mg)	2938 (1)	0,24 (4)	E2	2,29 (4)	1,473 (21)	0,546 (8)	760 (11)	758 (11)

3 Atomic Data

3.1 Mg

ω_K : 0,0291 (9)
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	
X_L			
	$L\ell$	0,04914	
	$L\eta$	0,0494	

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
Auger L	0,0359 - 0,0359	

4 Electron and Positron Emissions

		Energy (keV)		Electrons (per 100 disint.)
e_{AL}	(Mg)	0,0359 - 0,0359		1,293 (15)
e_{AK}	(Mg)			
	KLL	1,102 - 1,182		16,04 (17)
	KLX	1,214 - 1,252		
	KXY	1,301 - 1,301		
$ec_{1,0\ T}$	(Mg)	1807,42 - 1808,72		0,02275 (40)
$ec_{2,0\ T}$	(Mg)	2936,695 - 2937,998		0,000182 (31)
$\beta^+_{0,1}$	max:	1173,66	(7)	82,01 (18)
	avg:	542,425	(31)	
$\beta^+_{0,2}$	max:	44,07	(7)	0,000000570 (41)
	avg:	24,414	(38)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy (keV)	Photons (per 100 disint.)	
XL	(Mg)	0,04914 - 0,0494		
$XK\alpha_2$	(Mg)	1,25361	0,158 (6)	$K\alpha$
$XK\alpha_1$	(Mg)	1,25361	0,315 (11)	
$XK\beta_1$	(Mg)	1,3022	0,0080 (19)	$K'\beta_1$

5.2 Gamma Emissions

	Energy (keV)	Photons (per 100 disint.)
$\gamma^{\pm}$	511	164,02 (36)
$\gamma_{2,1}$(Mg)	1129,67 (10)	2,5 (2)
$\gamma_{1,0}$(Mg)	1808,65 (7)	99,76 (4)
$\gamma_{2,0}$(Mg)	2938 (1)	0,24 (4)

6 Main Production Modes

$^{26}Mg(p,n)^{26}Al$

$^{25}Mg(d,n)^{26}Al$

$^{25}Mg(p,\gamma)^{26}Al$

$^{25}Mg(^{3}He,d)^{26}Al$

$^{25}Mg(\alpha,t)^{26}Al$

$^{27}Al(p,d)^{26}Al$

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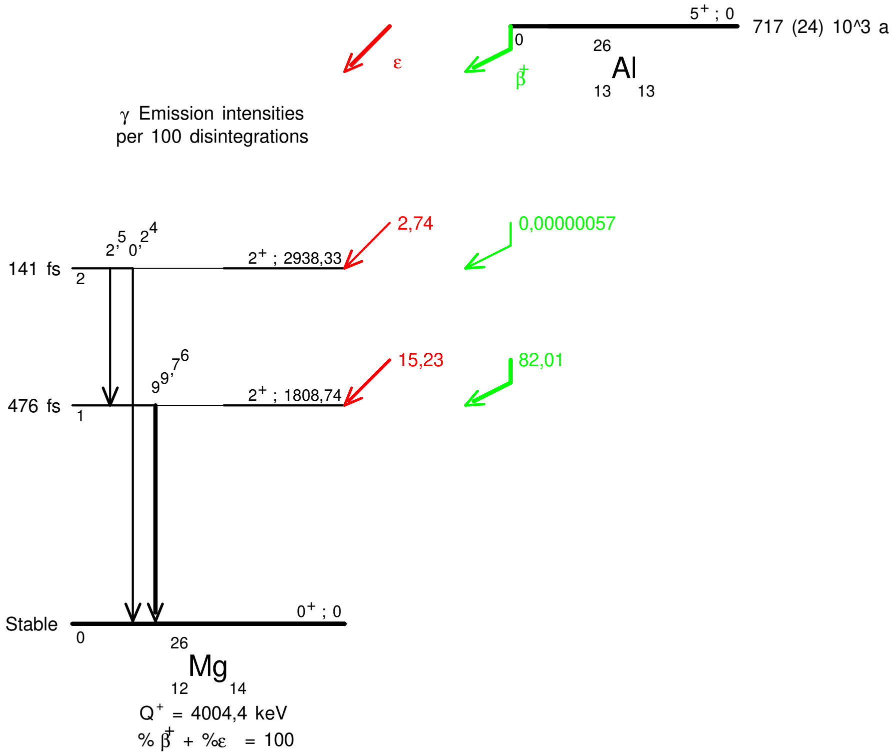
5+ ; 0
717 (24) 10^3 a
ε
β+
0
26 Al 13 13
γ Emission intensities
per 100 disintegrations
2,74
0,00000057
15,23
82,01
141 fs
2
2,5
0,24
2+ ; 2938,33
476 fs
1
99,76
2+ ; 1808,74
Stable
0
0+ ; 0
26 Mg 12 14
Q+ = 4004,4 keV
% β+ + %ε = 100

^{26}Al - Comments on evaluation of decay data

by X. Mougeot
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This evaluation is an update of a former evaluation done in 1997, which Comments are given on the next pages. Available literature by October 2022 does not add any new useful measurement.

1 Nuclear data

The available energy has been updated with the latest recommended value from the Atomic Mass Evaluation (AME) 2020 [2021WA16]. Excited levels (energies, half-lives) have been updated from the Adopted Levels in [2016BA18].

The BetaShape code [2019MO35] has been applied on the EC and β^+ transitions to determine average energies of the continuous spectra, fractional atomic shell electron-capture probabilities, EC/β^+ ratios and log *ft* values. Conversion coefficients and conversion electron emissions have been recalculated with the BrIcc code [2008KI07]. The emission probability of annihilation radiation has been recalculated by Saisinuc [2008DUZX] from the related decay data.

2 Atomic data

The fluorescence yield data, the relative K X-ray emission probabilities and the ratios P(KLX)/P(KLL) and P(KXY)/P(KLL) have been taken from Schönfeld et al. [1996Sc06].

The Auger electron and X-ray absolute probabilities have been determined with the EMISSION program [2000Sc47] from the related decay data.

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^{26}Al - Comments on evaluation of Electron-Capture and Positron Decay Data

by Shiu-Chin Wu [1] and E. Browne [2]

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The *Limitation of Relative Statistical Weight* [2] (LWM) method, used for averaging numbers throughout this evaluation, provided a uniform approach for the analysis of discrepant data. The uncertainty assigned to the recommended values was always greater than or equal to the smallest uncertainty of the values used to calculate the average.

4 Decay Scheme

^{26}Al decays 100% by (EC + β^+) to ^{26}Mg 2+ states at 1808.72 and 2938.41 keV. A measured relative emission probability for the positron annihilation radiation (511 keV) produced a total β^+ branching of 82 (2) % (72Sa02). This branching agrees well with a value of 81.7% predicted by theory [1].

5 Nuclear data

The recommended half-life of ^{26}Al, **7.17 (24) × 10^5 a**, is a weighted average (χ^2/N-1=0.64, LWM) of 7.16 (32) $\times$ 10^5 a, from partial $T_{1/2}$ (β^+) = 8.73 (30) $\times$ 10^5 a, β^+ counting and mass spectrometric analysis [3], combined with β^+(%) = 82 (2) from measurement of positron annihilation radiation [72Sa02]; 7.05 (24) $\times$ 10^5 a, by specific activity and mass spectrometric analysis [4]; 7.8 (5) $\times$ 10^5 a, by specific activity from a source produced by ^{26}Mg(p,n)^{26}Al (the number of ^{26}Al atoms in the source were estimated by using the reaction cross section) [5]; and 7.02 (56) $\times$ 10^5 a, by counting the atoms of ^{26}Al that did not disintegrate in the source (Accelerator Mass Spectrometry) [6]. The internal uncertainty in the weighted average is 0.17 $\times$ 10^5 a. However, we adopted a conservative value of 0.24 $\times$ 10^5 a (the lowest uncertainty in the input experimental half-life results), because of possible correlations between the measured values.

6 Gamma-rays

Gamma-ray energies and relative emission probabilities are from measurements with Ge(Li) detectors [72Sa02]. Since (EC + β^+) feeding to the ground state of ^{26}Mg is not expected (ΔJ = 5), the sum of the relative emission probabilities of the 1808.65 (0.9976) and 2938 keV (0.025 (2)) gamma rays to the ground state of ^{26}Mg was used to normalize the decay scheme (see Table 1). A conservative estimate based on data reported by [73Ra10] gives log *ft* > 24 for a fourth forbidden unique transition. This value corresponds to I_{EC} < 0.0005% for a possible (but yet unobserved) EC transition to ^{26}Mg ground state. In this calculation, we assumed a fractional uncertainty of 2% for the relative emission probability of the 1808.65 keV gamma ray. This value, which is based on the fractional uncertainty of the annihilation radiation (1.641 (32)) quoted by [72Sa02], has a negligible effect on the uncertainty of its absolute gamma-ray emission probability.

Gamma-ray multipolarities and mixing ratios are from [78En08]. Conversion coefficients, are insignificant, however, theoretical interpolated values between Z = 10 and Z = 14 from [76Ba63] have been included in this evaluation.

Table 1 : Gamma-ray Energies and Relative Emission Probabilities from ^{26}Al (EC + β^+) Decay

Energy (keV)	Relative Emission Probability (per disint.)
annihil. rad.	1.641 (32)*
1129.67 (10)	0.025 (2)
1808.65 (7)	0.9976
2938	0.0024 (4)

* Corrected for annihilation of positrons in flight

7 Electron Capture and Positron Emission (β^+)

Electron-capture and β^+ end-point energies are equal to Q_{EC} = 4004.19 (6) keV [95Au04] minus the individual level energies, and to the electron-capture energies minus $2m_0c^2$ (1022 keV), respectively. (EC + β^+) feedings to the 1808.72 keV and 2938.41 keV levels are from gamma-ray emission probability balances. The individual electron-capture and positron emission probabilities are based on theoretical [1] β^+/EC ratios. The total measured positron absolute emission probability (82 (2) %) agrees well with a value of 81.7%, calculated for a second forbidden unique transition using a theoretical β^+/(EC + β^+) ratio of 0.840. β^+ ($P_{\beta+}$) and EC (P_{EC}) are given in percent (%) on the decay scheme. Fractional atomic shell electron-capture probabilities are theoretical values [7], calculated with the LOGFT computer program [8].

8 Atomic data

The X-ray and Auger electron emission probabilities are values calculated by using the computer program RADLST [9], the electron capture probabilities and atomic data from [96Sc06].

9 Acknowledgment

The authors are grateful to E.B. Norman and R.W. Kavanagh for enlightening discussions regarding the half-life of ^{26}Al.

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