^{159}Gd - Comments on evaluation of decay data
by R. G. Helmer

This evaluation was completed in 2004. The literature available by March 2005 was included.

1 Decay Scheme

^{159}Gd decays by β- emission to levels in ^{159}Tb.

2 Nuclear Data

Q value is 970.5(7) from Audi et al. 2003 mass evaluation (2003Au03).

For the adopted decay scheme, the total radiation energy per decay is calculated to be 970(12) keV which agrees well with the decay energy of 970.5(7) keV from the 2003 mass evaluation (2003Au03), which confirms the internal consistency of this scheme.

The half-life values available are, in hours:

18.0	1948Kr03
18.0(2)	1949Bu01
18.0(3)	1960Wi10
18.56(8)	1966Da19
18.479(4)	1989Ab05

18.479(7) Adopted value

The weighted average of the last four values in the Limitation of Relative Statistical method, as implemented in the LWEIGHT code, is completely dominated by the value of 1989Ab05 which has 99.7% of the relative weight. The data of 1949Bu01 and 1960Wi10 contribute 2.8 to the reduced-χ^2 value of 3.1, but since this value is less than the critical reduced-χ^2 value of 3.8 used in LWEIGHT for four input values, the relative weight of the dominate input value is not reduced. The internal uncertainty for this average is 0.004 and the external uncertainty is 0.007, which is adopted.

2.1 b$^-$ Transitions

The probabilities for the β$^-$ branches are from the probability balances from the γ-ray transitions for the excited levels and from the measurement of 1975BaXG for the ground state. These values are:

Level (keV)	Value (%)
0	57.8(12)
58	29.6(12)
137	0.012(9)
348	0.315(4)
363	12.19(6)
580	0.0626(8)
617	0.0300(9)
674	0.00388(10)
854	0.0162(5)
891	0.0009(4)

The other measured values from 1975BaXG are 24(4) for the level at 58 keV and 13(2) for the levels at

348 and 363 keV.

2.2 g Transitions

The multipolarities are from the Adopted γ data in the Nuclear Data Sheets (2003He11). See sect. 4.2 for comments on the γ-ray and level energies and the normalization of relative photon emission probabilities to absolute values. The multipolarities are as follows:
( ) indicates a tentative assignment, based on experimental data;
[ ] indicates an assignment based on the spins and parities of the associated levels:

Levels and Jπ's		γ energy (keV)	multipolarity	mixing ratio	%E2
58 5/2+	0 3/2+	58	M1+E2	+0.119(2)	1.40(6)
137 7/2+	58 5/2+	79	M1+E2	+0.126(8)	1.56(20)
	0 3/2+	137	[E2]		
348 5/2+	137 7/2+	210	[M1,E2]		
	58 5/2+	290	[M1,E2]		
	0 3/2+	348	M1+E2	+0.43(+10, -9)	16(6)
363 5/2-	137 7/2+	226	E1		
	58 5/2+	305	E1		
	0 3/2+	363	E1		
580 1/2+	0 3/2+	580	[M1,E2]		
617 3/2+	58 5/2+	559	M1+E2	0.67(+58, -1)	31(+30, -1)
	0 3/2+	617	(M1)		
674 5/2+	137 7/2+	536	(M1)		
	58 5/2+	616	(M1)		
	0 3/2+	674	(M1)		
854 (1/2-)	617 3/2+	237	[E1]		
	580 1/2+	274	[E1]		
	0 3/2+	854	[E1]		
891 (5/2-)	617 3/2+	273	[E1]		
	137 7/2+	753	[E1]		

See section 4.2 for the γ-ray energies and emission probabilities.

3 Atomic Data

3.1 X rays and Auger electrons

The fluorescence yield data are from Schönfeld and Janßen (1996Sc06) and the EMISSION code. These give ω_K = 0.935(4), the average ω_L = 0.186(8), and η_{KL} = 0.847(4).

The Auger electron emission intensities are from the EMISSION code and based on the adopted γ-ray emission probabilities and conversion coefficients. These values are KLL 0.94(7)%, KLX 0.49(4)%, and KXY 0.063(5)%.

4 Emissions

4.1 K x-rays

The K x-ray electron emission probabilities are from the EMISSIONS code and based on the adopted γ-ray emission probabilities and conversion coefficients.

4.2 Photon Emission

Values for the γ-ray energies are available from 1968Hi03, 1969Br05, and 1995Mo08. Any weighted average would be dominated by the values of 1995Mo08, so the values from the latter reference are adopted.

The γ-ray energies from these references are:

1968Hi03	**1969Br05**	**1995Mo08**
58.00(1)	58.00(5)	58.0000(22)
79.45(2)	79.52(2)	79.5132(27)
137.7(3)	137.4(2)	137.515(5)
210.8(3)	210.9(5)	210.783(3)
226.00(4)	226.2(2)	226.0406(18)
236.9(4)	237.5(2)	237.341(5)
		273.62(12)
274.2(6)	274.2(2)	274.163(19)
290.2(3)	290.3(2)	290.2865(25)
305.6(2)	305.5(2)	305.5492(20)
348.17(8)	348.1(2)	348.2807(18)
363.56(3)	363.3(2)	363.5430(18)
		479.84(6)
536.7(4)	536.8(2)	536.730(12)
559.9(3)	559.56(15)	559.623(6)
581.1(3)	580.84(15)	580.808(6)
	616.5(3)	616.233(18)
617.7(3)	617.7(2)	617.615(18)
	674.3(5)	674.26(5)
		753.74(6)
854.5(4)	854.9(2)	854.947(20)

For the relative γ-ray emission probabilities, the following data were used. All the values of 1965Fu14 are omitted since the normalization value of 100 has a 30% uncertainty.

g ray (keV)	1964Pe07	1965Fu14	1968Hi03	1969Br05	1985Da31	1994St05	1995Mo08	2001Ma01	Adopted	Reduced c^2
58			18.0(30)	21(2)	19.1(8)	22.7(4)	18.9(9)	20.7(3)[ae]	21.1(6)	6.2
79		0.44(8)	0.38(7)	0.38(4)	0.37(6)	0.36(2)	0.417(11)	0.388(14)	0.397(9)	1.52
137		0.10(3)	0.042(26)	0.06(1)	0.05(1)	0.05(1)	0.0550(13)[f]		0.0549(13)	0.25
210			0.090(35)	0.165(25)	0.16(3)	0.192(23)	0.178(4)[e]		0.170(12)	1.66
226			1.8(1)	1.96(10)	1.80(4)	1.92(10)	1.89(4)	1.83(1)	1.842(18)	0.99
237			0.055(36)	0.072(11)	0.059(12)	0.064(12)	0.0652(14)[f]		0.0653(14)	0.33
246					0.012(7)		< 0.0008			
269					0.013(9)		< 0.0004			
273		0.065(3)[b]	0.065(40)[b]	0.054(13)[b]	0.056(11)[b]	0.055(12)[b]	0.0065(25)		0.006(3)	
274							0.0478(25)		0.048(3)	
290			0.24(3)	0.28	0.23(5)	0.27(3)	0.275(5)	0.274(8)	0.274(4)	0.43
305			0.54(4)	0.55(4)	0.51(2)	0.52(2)	0.527(10)	0.527(9)	0.526(6)	0.25
348	2.0(3)		2.0(1)	2.00(15)	1.99(8)	2.04(10)	2.05(4)	1.99(1)[ce]	2.031(21)	1.86
363	≡ 100(5)	100(30)	100	100(5)	100	100	100	100	100	
371					0.006(4)		< 0.0003			
429					0.005(4)		< 0.0003			
536	0.07 (4)	< 0.02	0.018(12)	0.010(3)	0.018(9)	0.013(3)	0.0137(4)[f]		0.0136(4)	0.48
559	0.25(10)	0.23(4)	0.17(3)	0.20(2)	0.19(2)	0.19(1)	0.187(6)		0.188(5)	0.20
581	0.70(15)	0.5(2)	0.55(4)	0.57(4)	0.60(4)	0.57(2)	0.578(19)	0.581(5)[f]	0.588(5)	0.24
616	0.20(8)[d]	0.02(1)	0.009(6)	0.020(5)	0.016(6)	0.026(8)	0.0159(7)[f]		0.0160(7)	0.90
617		0.15(5)	0.13(4)	0.13(2)	0.15(3)	0.14(1)	0.134(5)[f]		0.135(4)	0.15
674				0.0034(10)	< 0.008	0.0034(13)	0.00263(20)[f]		0.00268(19)	0.044
753							0.00153(17)		0.00153(17)	
854		0.015(7)	0.014(8)	0.021(3)	0.020(6)	0.021(2)	0.0212(18)		0.0209(12)	0.20

[a] Authors also give value of 20.1(8). The most precise value is adopted.
[b] Value is for sum of 273 and 274 lines.
[c] Authors also give value of 2.11(3), both values are included in the calculation of the average.
[d] Value is for sum of 616 and 617 lines.
[e] This uncertainty was increased in the averaging process to reduce the relative weight to 50%.
[f] Value contributes over 70% of the relative weight in the calculation of the average, but since the input values are consistent this weight is not reduced.

These relative γ-ray emission probabilities have been scaled by 0.1178(5) to obtain absolute values based on the measured emission probability of 11.78(5)% from 2001Ma01.

5. Electron emissions

The internal-conversion electron emission probabilities are from the adopted γ-ray emission probabilities and the associated conversion coefficients. These values for the stronger lines are:

g-ray energy (keV)	shell, energy	emission probability (%)
58	K, 6.004	22.8(9)
	L, 49.292	3.86(16)
	M, 56.032	0.85(4)
	N+, 57.602	0.235(10)
79	K, 27.518	0.17(7)
	L, 70.805	0.0273(11)
	M, 77.546	0.00604(23)
	N+, 70.115	0.00167(5)
137	K, 85.519	0.00307(12)
	L, 128.807	0.00179(7)
210	K, 158.787	0.0036(11)
226	K, 174.045	0.00629(19)
290	K, 238.291	0.0024(8)
348	K, 296.285	0.0134(5)
	L, 339.573	0.00201(6)
363	K, 311.547	0.104(3)
	L, 354.835	0.0145(4)
	M, 361.576	0.00313(9)
581	K, 528.812	0.00084(25)

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