Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	25-Mar-2019

$Q(\beta^-)$=7178 *3*; S(n)=6846 *3*; S(p)=12122.6 *26*; $Q(\alpha)=-994\times10^1$ *23* 2017Wa10

S(p) deduced by evaluator from mass excess for ^{61}Mn from 2017Wa10, and that for ^{61}Cr from 2018Mo14 measurement.

$Q(\beta^-n)$=1600 *4*, S(2n)=12359 *3*, S(2p)=28490 *160* (2017Wa10).

1985Ru05: first identification of ^{61}Mn from fragmentation of ^{82}Se beam at 11.5 MeV/nucleon on tungsten target using on-line mass separator at GSI facility.

1999Ha05: 1-GeV proton-induced spallation of uranium UC_2 target at ISOLDE-CERN facility. The laser ionized Mn isotopes were extracted from the ion source and mass separated. Using tape systems measured β-delayed neutron multiscaling, Eγ and $\gamma\gamma$ coincidence. β-delayed neutron collected by multiscaling measurements using Mainz 4π He neutron counter.

Mass measurements: 2012Na15 (also 2012He13), 1994Se12, 1990Tu01.

Theory references: consult the NSR database (www.nndc.bnl.gov/nsr/) for ten references for structure calculations.

Additional information 1.

^{61}Mn Levels

Cross Reference (XREF) Flags

- A ^{61}Cr β^- decay (234 ms)
- B Coulomb excitation
- C ^{238}U(^{64}Ni,Xγ)
- D ^{238}U(^{70}Zn,Xγ)

E(level)[†]	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0[@]	5/2$^{(-)}$[#]	0.709 s *8*	ABCD	%β^-=100; %β^-n≤0.2 (2013Ra17) μ=+3.535 *2* (2016Ba44) Q=+0.36 *3* (2016Ba44) Other %β^-n=0.6 *1* from 2000HaZL is not adopted, as values for other Mn isotopes in this work are in disagreement with published data. Theoretical T$_{1/2}$=224 ms, %β^-n=0.02 (2003Mo09). Theoretical T$_{1/2}$=5.7 s, %β^-n=0.4 (2016Ma12). J$^\pi$: spin from analysis of hyperfine structure spectrum in 2015Ba49, using collinear laser spectroscopy. Spin of 7/2 gave unrealistically large and negative static quadrupole moment of −5.6 *8*. Parity from probable allowed β feeding of (3/2$^-$) g.s. in ^{61}Fe from ^{61}Mn decay. Large-scale shell-model calculations, and systematics of ground states of odd-A Mn nuclei suggest 5/2$^-$. μ,Q: from collinear laser spectroscopy technique at ISOLDE-CERN (2016Ba44) The moments were measured with reference to μ=+3.46871790 *9* (1974Lu08) and Q=+0.33 *1* (1979De19) for ^{55}Mn. Earlier value: μ=+3.534 *1* (2015Ba49 and 2015He10, from the same group as 2016Ba44). See also 2017Ne04 review article from the same group. δ<r^2>(^{55}Mn,^{61}Mn)=+0.504 fm^2 *15*(stat) *53*(syst) for atomic transitions; +0.504 fm^2 *5*(stat) *54*(syst) for ionic transitions (2016He14, from hyperfine structures using collinear laser spectroscopy at ISOLDE-CERN). Isotope shift: δ<ν>(^{55}Mn,^{61}Mn)=1843 MHz *7*(stat) *25*(syst) for atomic transitions; 1215 MHz *2*(stat) *27*(syst) for ionic transitions (2016He14, from hyperfine structures using collinear laser spectroscopy at ISOLDE-CERN). J$^\pi$: large-scale shell-model predictions and systematics of ground states of odd-A Mn nuclei. Probable allowed β feeding of (3/2$^-$) g.s. in ^{61}Fe from ^{61}Mn decay supports this assignment, and also suggests the same parity for the ground states of ^{61}Mn and ^{61}Fe. T$_{1/2}$: weighted average of 0.708 s *8* (2013Ra17, decay curves for several γ rays) and

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Adopted Levels, Gammas (continued)

^{61}Mn Levels (continued)

E(level)†	Jπ	XREF	Comments
			0.71 s *1* (1985Ru05, from γ timing). Other: 623 ms *10* (1999Ha05, method not given, possibly β-fragment correlations). Low and discrepant value from 1999Ha05 is probably due to mixture of some impurities. Values obtained from γ-ray measurements, being more specific, are preferred here.
157.1@ *2*	(7/2⁻)#	ABCD	$T_{1/2}$: <1.7 ns (minimum flight time between the secondary target and the particle detector (2009Va16).
1034.6@ *3*	(9/2⁻)#	BCD	
1142.3 *4*	(1/2⁻,3/2)	A	Jπ: γ to 5/2$^{(-)}$; probably low spin, as the level is not populated in heavy-ion in-beam studies.
1281.8@ *3*	(11/2⁻)#	BCD	Jπ: ΔJ=(2), (Q) γ to (7/2⁻).
1497.2 *4*	(3/2,5/2,7/2)	A	Jπ: log *ft*=4.9 from (5/2⁻) parent value.
1860.8 *4*	(3/2,5/2,7/2)‡	A	
2031.8? *7*		A	
2201.9? *4*		C	
2378.2 *4*	(3/2,5/2,7/2)‡	A	
2502.2@ *4*	(15/2⁻)	C	Jπ: ΔJ=(2), (Q) γ to (11/2⁻).
2607.5? *5*		C	
2753.1@ *5*		C	
3131.6@ *6*		C	
3572.4@ *7*		C	

† From least-square fit to Eγ data.

‡ γ to 5/2$^{(-)}$ suggests 1/2⁻ to 9/2⁻; 1/2 or 9/2 less likely from apparent β feeding from (5/2⁻) parent state. Parity would be negative if the β transition is allowed, as suggested by apparent log *ft* value.

Systematics of J^π of ground states of odd Mn nuclei and shell-model calculations (2009Cr02,2008Va08). See also shell-model calculations by 2013Ji04, level spectrum shown in figure 3.

@ Seq.(A): γ cascade based on (5/2⁻).

γ(^{61}Mn)

E_i(level)	J_i^π	Eγ†	Iγ†	E_f	J_f^π	Mult.‡	α#	Comments
157.1	(7/2⁻)	157.1 *2*	100	0.0	5/2$^{(-)}$	(M1+E2)	0.044 *35*	B(E2)(W.u.)=30 *4* (2009Va16) Eγ: unweighted average of 157.2 *5* (β⁻ data), 157.3 *2* ((^{64}Ni,Xγ) data), 156.7 *1* ((^{70}Zn,Xγ) data). Weighted average is 156.8 *2* but with reduced χ^2=3.9. α: value overlaps M1 and E2. B(E2)(W.u.) is obtained by 2009Va16 with constrained B(M1)=0.008 based on $T_{1/2}$(157 level)<1.7 ns (minimum flight time between the secondary target and the particle detector) since mixing ratio of the 157-keV transition could not be obtained from their γ(θ) data.
1034.6	(9/2⁻)	877.6 *3*	100	157.1	(7/2⁻)	[M1(+E2)]		B(E2)(W.u.)=0 (2009Va16) B(E2)(W.u.) from Coulomb excitation.
		(1035)		0.0	5/2$^{(-)}$	[E2]		B(E2)(W.u.)=7.5 *15* (2009Va16) B(E2)(W.u.) from Coulomb excitation.
1142.3	(1/2⁻,3/2)	1142.2 *4*	100	0.0	5/2$^{(-)}$			

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Adopted Levels, Gammas (continued)

$\gamma(^{61}Mn)$ (continued)

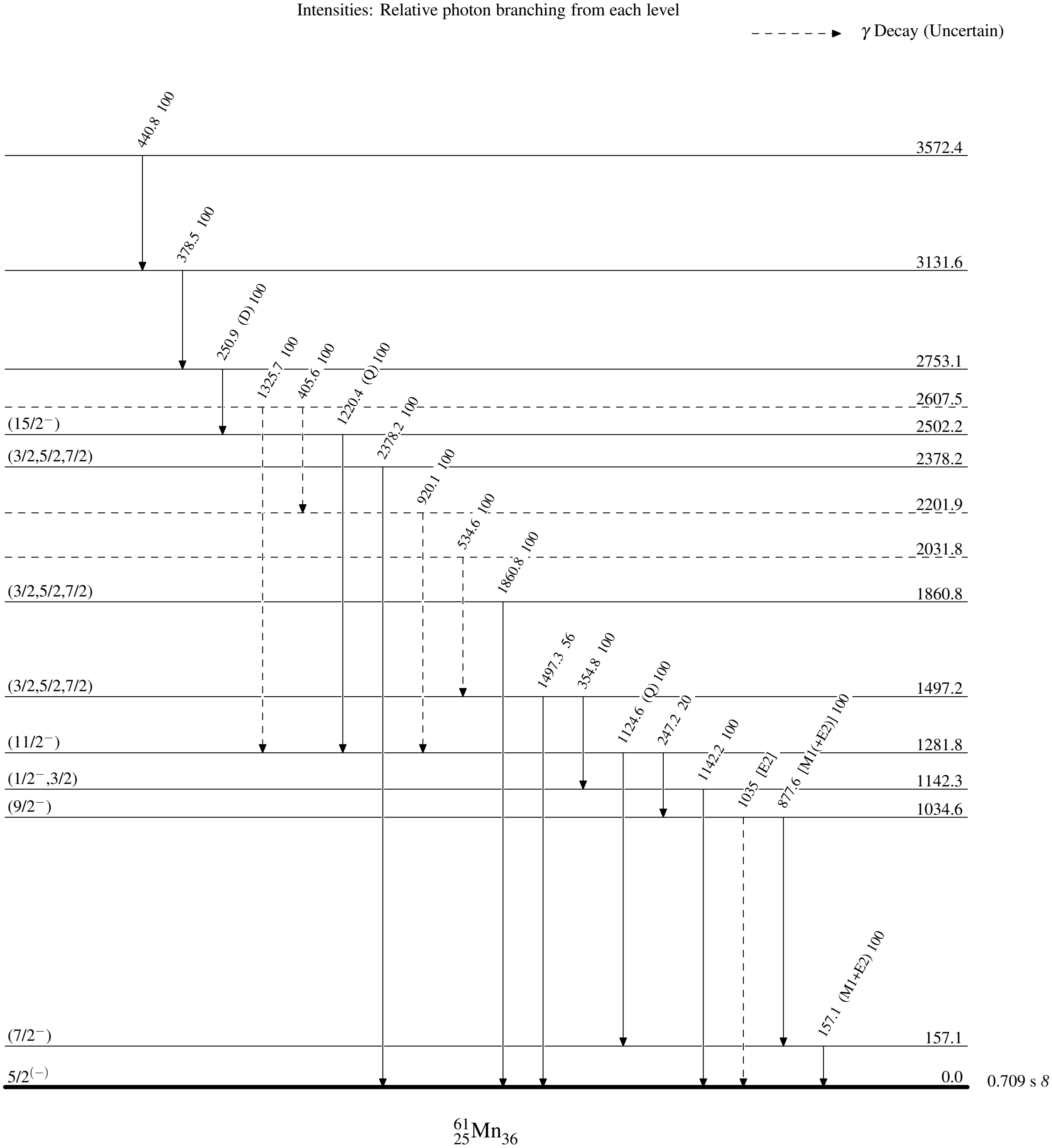
E_i(level)	J_i^π	E_γ †	I_γ †	E_f	J_f^π	Mult. ‡	Comments
1281.8	(11/2⁻)	247.2 *2*	20 *8*	1034.6	(9/2⁻)		
		1124.6 *2*	100 *20*	157.1	(7/2⁻)	(Q)	
1497.2	(3/2,5/2,7/2)	354.8 *4*	100 *13*	1142.3	(1/2⁻,3/2)		
		1497.3 *5*	56 *13*	0.0	$5/2^{(-)}$		
1860.8	(3/2,5/2,7/2)	1860.8 *4*	100	0.0	$5/2^{(-)}$		
2031.8?		534.6@ *5*	100	1497.2	(3/2,5/2,7/2)		
2201.9?		920.1@ *2*	100	1281.8	(11/2⁻)		
2378.2	(3/2,5/2,7/2)	2378.2 *4*	100	0.0	$5/2^{(-)}$		
2502.2	(15/2⁻)	1220.4 *2*	100	1281.8	(11/2⁻)	(Q)	
2607.5?		405.6@ *3*	100 *50*	2201.9?			
		1325.7@ *10*	100 *50*	1281.8	(11/2⁻)		
2753.1		250.9 *3*	100	2502.2	(15/2⁻)	(D)	Mult.: ΔJ=(0).
3131.6		378.5 *3*	100	2753.1			
3572.4		440.8 *3*	100	3131.6			

† Weighted averages from all available data, unless noted otherwise.
‡ Tentative assignment from $\gamma\gamma(\theta)$ data in $^{238}U(^{64}Ni,X\gamma)$.
\# Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.
@ Placement of transition in the level scheme is uncertain.

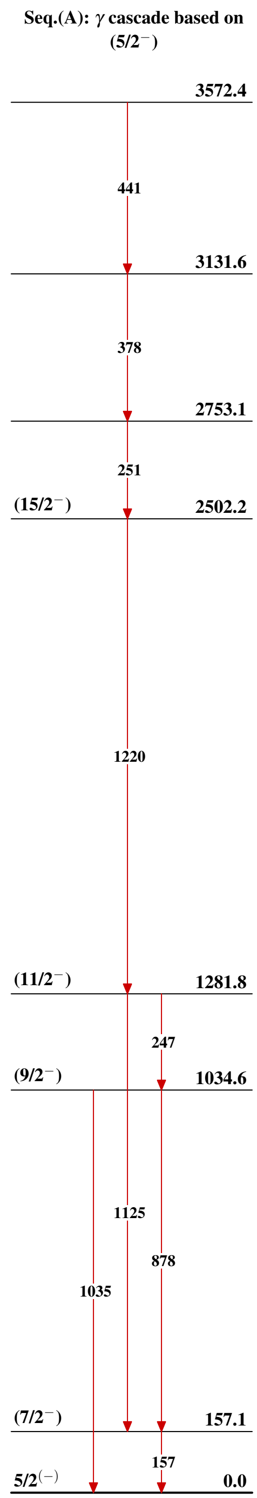
Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level



Adopted Levels, Gammas



$^{61}_{25}Mn_{36}$