^{71}Co β^- decay (80 ms) 2012Ra10,2019Ly02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 188,1 (2023)	17-Jan-2023

Parent: ^{71}Co: E=0.0; J$^\pi$=(7/2$^-$); $T_{1/2}$=80 ms *3*; Q(β^-)=11.04×10^3 *47*; %β^- decay=100

^{71}Co-J$^\pi$,$T_{1/2}$: From ^{71}Co Adopted Levels.

^{71}Co-Q(β^-): From 2021Wa16.

^{71}Co-%β^- decay: %β^-n≈16 *2* (2020MoZS) for ^{71}Co decay, estimated from the decay of ^{72}Co decay (2016Mo07).

2012Ra10 (also 2005Ma95,2010RaZY)): ^{71}Co produced in fragmentation of 140 MeV/nucleon ^{86}Kr beam with a ^{9}Be target at NSCL-MSU facility, followed by separation of fragments using A1900 fragment separator. The ions were implanted in double-sided silicon strip (DSSD) detectors for detection of (fragment)β correlated events. SeGA γ-detector array containing 16 HPGe detectors was used for Eγ, Iγ, $\gamma\gamma$- and $\beta\gamma$-coin and isotopic half-life measurements. Detailed shell-model calculations using NR78 residual interaction.

Additional information 1.

2019Ly02: ^{71}Co from ^{86}Kr beam at 140 MeV/nucleon impinging on a ^{9}Be target at the NSCL-MSU facility. ^{71}Co, was identified using energy loss and time-of-flight information from a plastic scintillator detector in the focal plane of the A1900 and two silicon PIN detectors, followed by implantation in a 1-mm thick double-sided silicon strip detector (DSSD) which was placed in the geometric center of the Summing NaI(Tl) (SuN) detector. Measured total absorption γ spectrum (TAGS), β-decay branching ratios, B(GT), parent half life. Comparison with theoretical calculations using different models.

2012Ra10 mentioned an additional experiment at NSCL (reference 36 in 2012Ra10) dealing with on-line spectroscopy for ^{71}Ni in a knockout reaction on ^{73}Cu beam and probably ^{9}Be target, where 281-, 567- and 813-keV γ rays were seen, none of these in coincidence mode. This observation confirms the placement of these γ rays in ^{71}Co.

Others:

2009St07: ^{71}Co beam produced in ^{238}U(p,X) reaction with E(p)=30 MeV at the LISOL facility. The γ rays were detected using three HPGe detectors. The β particles were detected with four plastic ΔE detectors. The decay scheme for ^{71}Co to ^{71}Ni was taken by 2009St07 from November 2007 Sanibel Island conference report and by Priv. Comm. (references 9 and 22 in 2009St07).

2005GaZR: Measured Eγ, half-life. Five γ rays reported at 251, 280, 568, 736 and 772 keV. No level scheme was proposed.

2004Sa59: ^{71}Co produced from fragmentation of ^{86}Kr beam in charge state 36$^+$. The reaction products analyzed by LISE2000 spectrometer. Measured Eβ, Eγ, $\beta\gamma$ coin, isotopic half-life. See also 2002MaZN thesis. Four γ rays were reported at 253, 281, 566 and 774 keV; and levels were proposed at 281 (or 253), 489 (or 461), 1055 (or 1027) and 1308 with J^π=(7/2$^+$), (1/2$^-$), (5/2$^-$) and (5/2$^-$), respectively, based on shell-model considerations and comparisons with ^{69}Ni level scheme.

2009St07 list five γ rays at 252, 281, 566, 774 and 813 with levels at 281, (7/2$^+$); 499, (1/2$^-$); 813, (5/2$^+$); 1065, (5/2$^-$); and 1273, (5/2$^-$) from a Priv. Comm. (reference 22 in 2009St07). The 281, 566 and 774 γ rays were also seen by 2009St07, depicted in authors′ spectral Fig. 5.

The level scheme is from 2012Ra10, based on a $\gamma\gamma$ cascade observed in coincidence and two γ rays from (5/2$^-$) levels feeding the 1/2$^-$ isomer in analogy with the decay scheme of ^{69}Co to ^{69}Ni proposed in 1999Mu17. Other scenarios for the placement of 566 and 774 γ rays were considered in 2012Ra10 but ruled out on the basis of unacceptable transition rates and/or lack of $\gamma\gamma$-coincidence correlations.

The decay scheme for γ-ray data is incomplete thus no γ-normalization factor can be deduced.

^{71}Ni Levels

E(level)[†]	J$^\pi$[#]	$T_{1/2}$	Comments
0.0	(9/2$^+$)	2.56 s *3*	$T_{1/2}$: from the Adopted Levels.
280.8 *2*	(7/2$^+$)		
498.5 *6*	(1/2$^-$)	2.3 s *3*	%β^-=100 E(level): from 1065.4 *6* − 566.9 *2*. Other: 499 (2012Ra10,2009St07). $T_{1/2}$: isomer identified by 2009St07, $T_{1/2}$ measured from decay curve for 454γ.
812.8? *5*	(5/2$^+$)		E(level): from 2012Ra10. A possible 532γ from this level to 281 level was not observed either due to large hindrance factor for M1 transition in competition with E2 transition or that it is obscured by a strong 534-keV γ ray from ^{71}Ni decay to ^{71}Cu.
1065.4 *6*	(5/2$^-$)		E(level): from 812.8 *5* + 252.6 *4*.

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^{71}Co β^- decay (80 ms) 2012Ra10,2019Ly02 (continued)

^{71}Ni Levels (continued)

E(level)[†]	J$^\pi$[#]	Comments
1272.9 *7*	(5/2$^-$)	E(level): from 774.4 *3* + 498.5 *6*.
1290[‡] *15*		
1320[‡] *15*		
1350[‡] *15*		
1390[‡] *20*		
1430[‡] *20*		
1480[‡] *25*		
1530[‡] *25*		
1580[‡] *30*		
1640[‡] *30*		
1700[‡] *35*		
1770[‡] *35*		
1840[‡] *40*		
1920[‡] *45*		
2010[‡] *45*		
2100[‡] *50*		
2200[‡] *50*		
2300[‡] *50*		
2400[‡] *50*		
2500[‡] *50*		
2600[‡] *50*		
2700[‡] *50*		
2800[‡] *50*		
2900[‡] *50*		
3000[‡] *50*		
3150[‡] *75*		
3300[‡] *75*		
3450[‡] *75*		
365×10^1[‡] *10*		
385×10^1[‡] *10*		
405×10^1[‡] *10*		
425×10^1[‡] *10*		
445×10^1[‡] *10*		
465×10^1[‡] *10*		
485×10^1[‡] *10*		
505×10^1[‡] *10*		
525×10^1[‡] *10*		
550×10^1[‡] *10*		
570×10^1[‡] *10*		
590×10^1[‡] *10*		
630×10^1[‡] *10*		
650×10^1[‡] *10*		
670×10^1[‡] *10*		

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^{71}Co β^- decay (80 ms) 2012Ra10,2019Ly02 (continued)

^{71}Ni Levels (continued)

E(level)†
690×10[1]‡ *10*
710×10[1]‡ *10*
750×10[1]‡ *10*
770×10[1]‡ *10*
800×10[1]‡ *20*

† From Eγ data.

‡ Pseudo-levels constructed using the statistical model code DICEBOX to fit the measured total absorption spectrum (TAGS). The quoted level energies represent energy bins equivalent to the energy resolution of the SuN detector (2019Ly02). The data are from Priv. Comm. in October 2019 between the XUNDL compiler Jun Chen (NSCL-MSU) and S. Lyon, the first author of 2019Ly02. This level is not included in the Adopted Levels.

Assignments from 2012Ra10, based on shell-model predictions.

β^- radiations

E(decay)	E(level)	Iβ$^-$†‡	Comments
(3.0×10^3 *5*)	8000	≈1.2×10^{-5}	Iβ=0.000012 ± 7.8.
(3.3×10^3 *5*)	7700	≈4.8×10^{-6}	Iβ=0.0000048 ± 7.8.
(3.5×10^3 *5*)	7500	≈1.0×10^{-5}	Iβ=0.000010 ± 7.8.
(3.9×10^3 *5*)	7100	≈4.9×10^{-6}	Iβ=0.0000049 ± 7.8.
(4.1×10^3 *5*)	6900	≈6.7×10^{-6}	Iβ=0.0000067 ± 7.8.
(4.3×10^3 *5*)	6700	≈6.5×10^{-5}	Iβ=0.000065 ± 7.8.
(4.5×10^3 *5*)	6500	≈3.5×10^{-6}	Iβ=0.0000035 ± 7.8.
(4.7×10^3 *5*)	6300	≈1.6×10^{-4}	Iβ=0.00016 ± 7.8.
(5.1×10^3 *5*)	5900	≈1.6×10^{-8}	Iβ=0.000000016 ± 7.8.
(5.3×10^3 *5*)	5700	≈1.3×10^{-4}	Iβ=0.00013 ± 7.8.
(5.5×10^3 *5*)	5500	≈6.7×10^{-5}	Iβ=0.000067 ± 7.8.
(5.8×10^3 *5*)	5250	≈2.0×10^{-4}	Iβ=0.00020 ± 7.8.
(6.0×10^3 *5*)	5050	≈1.1×10^{-4}	Iβ=0.00011 ± 7.8.
(6.2×10^3 *5*)	4850	≈0.036	Iβ=0.036 ± 7.8.
(6.4×10^3 *5*)	4650	≈0.19	Iβ=0.19 ± 7.8.
(6.6×10^3 *5*)	4450	≈0.75	Iβ=0.75 ± 7.8.
(6.8×10^3 *5*)	4250	≈1.8	Iβ=1.8 ± 7.7.
(7.0×10^3 *5*)	4050	≈3.6	Iβ=3.6 ± 7.7.
(7.2×10^3 *5*)	3850	≈0.90	Iβ=0.90 ± 7.6.
(7.4×10^3 *5*)	3650	≈1.5×10^{-6}	Iβ=0.0000015 ± 7.6.
(7.6×10^3 *5*)	3450	≈3.9	Iβ=3.9 ± 7.6.
(7.7×10^3 *5*)	3300	≈3.1	Iβ=3.1 ± 7.5.
(7.9×10^3 *5*)	3150	≈0.0011	Iβ=0.0011 ± 7.4.
(8.0×10^3 *5*)	3000	≈3.0	Iβ=3.0 ± 7.4.
(8.1×10^3 *5*)	2900	≈0.32	Iβ=0.32 ± 7.3.
(8.2×10^3 *5*)	2800	≈0.23	Iβ=0.23 ± 7.3.
(8.3×10^3 *5*)	2700	≈0.0021	Iβ=0.0021 ± 7.0.
(8.4×10^3 *5*)	2600	≈1.0	Iβ=1.0 ± 7.0.
(8.5×10^3 *5*)	2500	≈5.6	Iβ=5.6 ± 7.0.
(8.6×10^3 *5*)	2400	≈0.0031	Iβ=0.0031 ± 6.7.
(8.7×10^3 *5*)	2300	≈4.6	Iβ=4.6 ± 6.7.
(8.8×10^3 *5*)	2200	≈2.9×10^{-4}	Iβ=0.00029 ± 6.5.
(8.9×10^3 *5*)	2100	≈1.1	Iβ=1.1 ± 6.5.

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^{71}Co β^- decay (80 ms) 2012Ra10,2019Ly02 (continued)

β^- radiations (continued)

E(decay)	E(level)	Iβ^- [†‡]	Comments
(9.0×10^3 *5*)	2010	≈0.077	Iβ=0.077 ± 6.4.
(9.1×10^3 *5*)	1920	≈0.0042	Iβ=0.0042 ± 6.4.
(9.2×10^3 *5*)	1840	≈4.8	Iβ=4.8 ± 6.4.
(9.3×10^3 *5*)	1770	≈0.0044	Iβ=0.0044 ± 6.3.
(9.3×10^3 *5*)	1700	≈0.0030	Iβ=0.0030 ± 6.3.
(9.4×10^3 *5*)	1640	≈0.24	Iβ=0.24 ± 6.2.
(9.5×10^3 *5*)	1580	≈4.5	Iβ=4.5 ± 6.1.
(9.5×10^3 *5*)	1530	≈4.2×10^{-6}	Iβ=0.0000042 ± 5.9.
(9.6×10^3 *5*)	1480	≈0.31	Iβ=0.31 ± 5.9.
(9.6×10^3 *5*)	1430	7.6 *58*	
(9.7×10^3 *5*)	1390	≈0.022	Iβ=0.022 ± 5.4.
(9.7×10^3 *5*)	1350	≈0.0015	Iβ=0.0015 ± 5.4.
(9.7×10^3 *5*)	1320	≈0.005	Iβ=0.0048 ± 5.3.
(9.8×10^3 *5*)	1290	13 *5*	
(9.8×10^3 *5*)	1272.9	4 *4*	Iβ=4.2 *44* (2019Ly02). Other %Iβ=22 (2012Ra10).
(1.00×10^4 *5*)	1065.4	33 *4*	Other %Iβ=64 (2012Ra10).
(1.08×10^4 *5*)	280.8	1.7 *11*	Other Iβ=11% (2012Ra10).

† From a fit to measured total absorption spectrum (TAGS) data in 2019Ly02. Values were obtained as a Priv. Comm. in Oct 2019 by one of the evaluators from S. Lyon, the first author of 2019Ly02. For pseudo-levels, the quoted β feedings are for energy bins of 30-200 keV around the quoted level energies, with the bin equivalent to the energy resolution of the SuN detector (2019Ly02). For values that are listed as approximate, the uncertainties given by the authors are much larger than the listed β feedings.
‡ Absolute intensity per 100 decays.

γ(^{71}Ni)

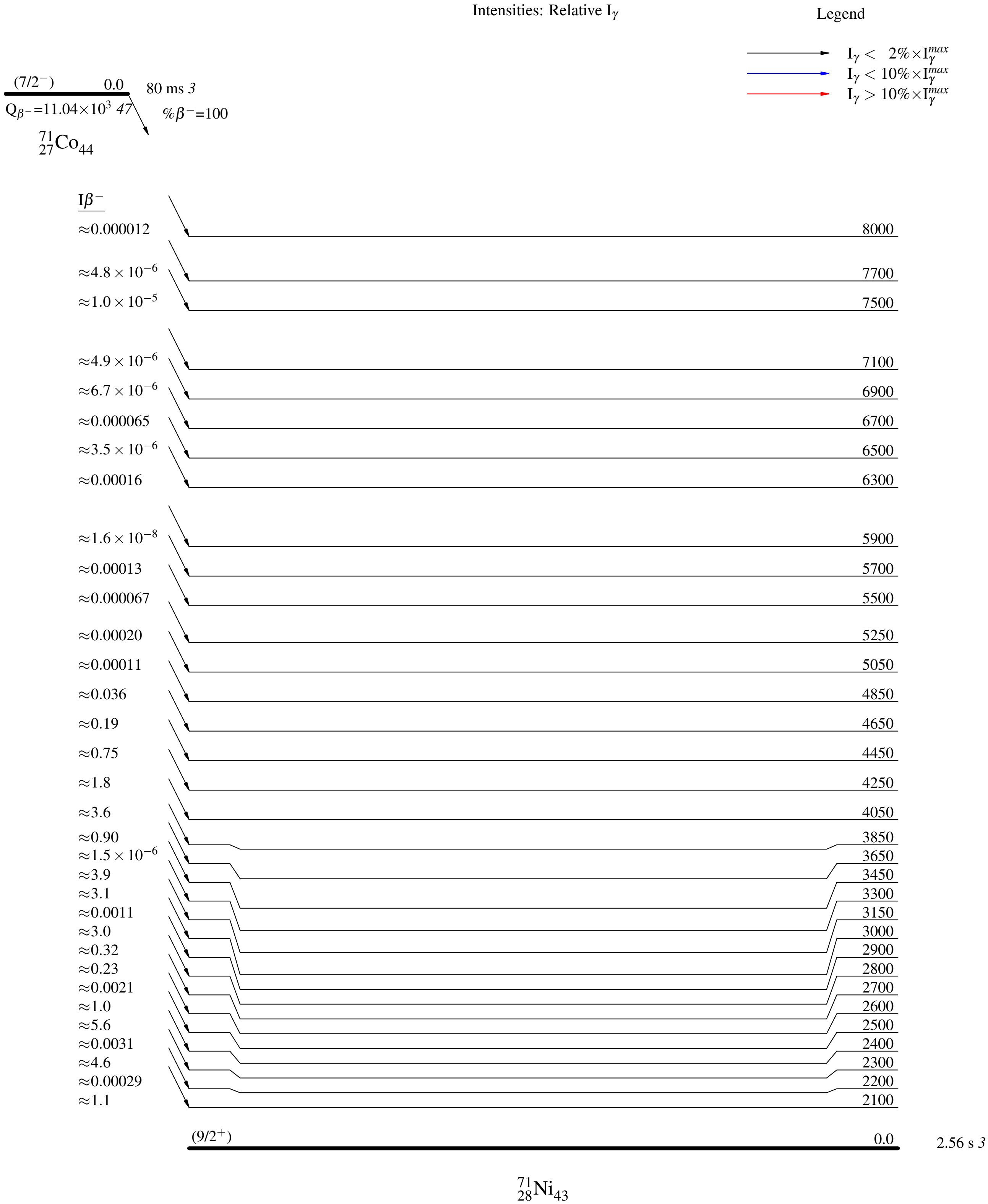
E_γ [†]	I_γ [†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	Comments
252.6[#] *4*	9 *2*	1065.4	(5/2⁻)	812.8?	(5/2⁺)	[E1]	I_γ: 54 *10* (2004Sa59). E_γ: placement proposed from 253 or 1308 level in 2004Sa59, which is inconsistent with placement from 1065 level in more recent study by 2012Ra10, based on observed γ-ray intensities of the 252.6γ and 812.8γ.
280.8[‡] *2*	19 *4*	280.8	(7/2⁺)	0.0	(9/2⁺)		I_γ: 40 *30* (2004Sa59).
566.9[‡@] *2*	100	1065.4	(5/2⁻)	498.5	(1/2⁻)		I_γ: 100 (2004Sa59). E_γ: placement proposed from 1027 or 1055 level in 2004Sa59, which is inconsistent with placement from 1065 level in more recent study by 2012Ra10, based on observed γ-ray intensities of the 252.6γ and 812.8γ.
[x]736							E_γ: from 2005GaZR only.
774.4[‡@] *3*	38 *7*	1272.9	(5/2⁻)	498.5	(1/2⁻)		I_γ: 85 *20* (2004Sa59). E_γ: placement proposed from 1027 or 1055 level in 2004Sa59.
812.8[#] *5*	16 *3*	812.8?	(5/2⁺)	0.0	(9/2⁺)	[E2]	E_γ: γ not reported in 2004Sa59.

† From 2012Ra10, unless otherwise stated.
‡ Not observed in $\gamma\gamma$-coincidences.
# Ordering of the 252-813 γ cascade is from 2012Ra10, based on observed γ-ray intensities of the 252.6γ and 812.8γ.
@ Placement proposed in 2012Ra10 in analogy with the decay scheme of ^{69}Co to ^{69}Ni as proposed in 1999Mu17.
x γ ray not placed in level scheme.

^{71}Co β^- decay (80 ms) 2012Ra10,2019Ly02

Decay Scheme

Intensities: Relative I_γ



^{71}Co β^- decay (80 ms) 2012Ra10,2019Ly02

Decay Scheme (continued)

Intensities: Relative I_γ