^{33}Ar ε+β^+ decay (174.3 ms) 2010Ad03,1993Sc16,1987Bo21

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 199,1 (2025)	30-Sep-2024

Parent: ^{33}Ar: E=0; J$^\pi$=1/2$^+$; $T_{1/2}$=174.3 ms *11*; Q(ε)=11619.0 *6*; %ε+%β^+ decay=100

^{33}Ar-J$^\pi$,$T_{1/2}$: From Adopted Levels of ^{33}Ar.

^{33}Ar-Q(ε): From 2021Wa16.

^{33}Ar-%ε+%β^+ decay: %(ε+β^+)p=38.7% *10* (1987Bo21). Other: 38.8 *13* (2010Ad03).

2010Ad03: ^{33}Ar isotopes were produced by projectile fragmentation of $^{36}Ar^{18+}$ primary beam with intensities between 4 μA and 8 μA provided by the coupled cyclotrons of GANIL. Fragments were identified in the SPIRAL identification station, consisting of a silicon cube detector (6 double-sided silicon strips-DSSSD) for detecting protons and β particles and three HPGe detectors for detecting γ-rays. Measured Eγ, Iγ, E_p, I_p, β^+p coin, pγ-coin. Deduced levels, J, π, β-delayed proton emission probabilities, β-decay branching ratios, log *ft*, B(>). Comparisons with available data and shell-model calculations.

1993Sc16: neutron-deficient argon isotopes were produced in spallation reactions of 600 MeV protons with a CaO-target and subsequently separated at ISOLDE-2. Separated ions were collected on a thin carbon catcher foil (20-50 μg/cm^2) followed by a silicon surface-barrier detector (FWHM=8 *1* keV at 3 MeV). Measured E_p, I_p, β^+p coincidence, $\sigma(E_p)$, I_p. Deduced levels, widths, β-delayed proton emission probabilities. Comparisons with available data.

1987Bo21: neutron-deficient argon isotopes were produced in spallation reactions of 600 MeV protons with a CaO-target and subsequently separated at ISOLDE facility of CERN. Separated ions were finally directed to the measuring station. γ rays were detected with a Ge(Li) detector and β-delayed protons were detected with a silicon surface barrier detector (FWHM=25 *1* keV at 5 MeV). Measured Eγ, Iγ, E_p, I_p, β^+p coincidence. Deduced levels, β-delayed proton emission probabilities.

1996Ho24: neutron-deficient argon isotopes were produced in spallation reactions of 1 GeV protons with a CaO-target and subsequently separated at ISOLDE PS-Booster Facility. Separated ions were implanted into a thin carbon foil. Charged particles were detected with a silicon ΔE-E telescope, a gas-Si combination telescope, and an annular Si; γ rays were detected with a 70% germanium detector. Measured E_p, I_p, β^+p-coin, Eγ, $\beta\gamma$-coin. Deduced levels, absolute proton emission probabilities. Comparisons with shell-model calculations.

1971Ha05: ^{33}Ar ions were produced by ^{32}S(^{3}He,2n) with ^{3}He beam from the Berkeley 88-inch cyclotron and transported to a shielded counting chamber. Charted particles were detected with a silicon ΔE-E telescope and γ rays were detected with a 2-in by 2-in NaI(Tl) crystal and a 45-cc Ge(Li) counter (FWHM=4 keV at E_γ=1 MeV). Measured E_p, I_p, Eγ, Iγ, pγ-coin, $\sigma(E_p)$, βp(t). Deduced levels, J, π, parent $T_{1/2}$, absolute proton-emission probabilities, β-decay branching ratios, log *ft*. Comparisons with available data.

2014Ko17: ^{33}Ar ions were produced and separated at the ISOLDE facility of CERN using the ISOL technique, and collected in a carbon foil in the middle of a silicon cube consisting of six DSSSDs. γ rays were detected with two Miniball Ge cluster detectors. Measured Eγ, Iγ.

Others: 2000Ga61, 1966Ha22.

Additional information 1.

Comparison of proton energies (E_p)

	1987Bo21		1993Sc16		2010Ad03		adopted		E_x	
p1					761	10	761	10	5292	10
p1	1316	3	1320	3	1315	8	1318	3	5867	3
p0	1643	1	1643	1	1643	2	1643	1	3971	1
p2			1665	4	1663	6	1664	4	7771	4
p1	1697	6	1697	2	1689	6	1696	2	6256	2
p1			1750	2	1762	5	1752	2	6314	2
p0	1782	3	1780	2	1779	2	1780	2	4113	2
p1					2022	5	2022	5	6593	5
p0	2100	3	2097	2	2098	3	2098	2	4441	2
p0			2122	2			2122	2	4466	2
p2					2366	6	2366	6	8496	6
p1	2372	6	2366	2	2368	5	2367	2	6949	2
p0	2482	3	2480	2	2479	2	2480	2	4835	2
p1					2708	7	2708	7	7300	7
p0	2744	6	2743	2	2742	3	2743	2	5106	2
p1					2808	10	2808	10	7404	10

p1	2886	6	2885	2	2884	7	2885	2	7483	2
p0	2939	12	2930	2	2939	4	2932	2	5301	2
p1			2951	2	2955	7	2951	2	7551	2
p2					3014	10	3014	10	9166	10
p1	3074	12			3064	6	3066	6	7670	6
p0	3171	1	3171	12	3171	3	3171	1	5548	1
p0	3334	20	3351	3	3348	4	3350	3	5732	3
p1	3465	30			3467	6	3467	6	8083	6
p1			3512	3	3513	6	3512	3	8130	3
p1	3565	6			3574	5	3570	5	8190	5
p1	3695	6					3695	6	8318	6
p0	3856	3	3855	3	3855	3	3855	3	6253	3
p1	3924	6			3924	5	3924	5	8555	5
p1	4223	12			4207	5	4209	5	8849	5
p1	4325	12			4328	8	4327	8	8970	8
p1					4472	5	4472	5	9120	5
p1	4516	10			4503	6	4506	6	9155	6
p0					4717	5	4717	5	7142	5
p0	4856	10	4853	4	4858	4	4856	4	7286	4
p1					4921	6	4921	6	9583	6
p0	5043	6	5041	5	5037	4	5040	4	7476	4
p0	5106	7	5106	5	5099	4	5102	4	7540	4
p0	5225	7	5227	5	5223	4	5225	4	7666	4
p0	5320	9	5320	5	5315	3	5317	3	7761	3
p0	5626	11	5622	6	5621	3	5621	3	8075	3
p0	5727	11	5728	6	5721	3	5723	3	8180	3
p0	5849	12			5853	9	5852	9	8313	9
p0					6009	10	6009	10	8475	10
p0	6103	17			6098	10	6099	10	8568	10
p0	6315	18			6341	8	6337	8	8813	8
p0					6386	10	6386	10	8864	10
p0	6466	15			6477	10	6474	10	8955	10
p0	6611	15			6625	10	6621	10	9106	10
p0					6654	9	6654	9	9140	9
p0	6686	15			6712	9	6705	9	9193	9
p0					6850		6850		9343	
p0					6950		6950		9446	
p0					7050		7050		9549	
p0					7150		7150		9652	
p0					7250		7250		9755	
p0					7350		7350		9858	
p0					7450		7450		9962	
p0					7750		7750		10271	
p0					8500		8500		11045	

Notes:
1. $E_x=E_p*1.031522+2276.8$ for decay to ^{32}S ground state.
   $E_x(1st)(^{32}S)=2230.6$, $E_x(2nd)=3778.4$
2. In 1987Bo21, E_p after 3690 were corrected for pulse height effect by $E_p(new)=E_p*1.01611-52.3618$. The correction formula was obtained from the comparison of the 1987Bo21 data with 1993Sc16 data.
3. In 1993Sc16, E_p=1665 and 1750 from p0 decay but have been changed to p2 and p1 decay, respectively, as in 2010Ad03
4. In 1987Bo21, E_p=2372, 3074, 3465, 3565, 3695, 3924, 4223, 4325, 4516 from p0 decay but changed to p1 decay as in 2010Ad03
5. Adopted proton energy is from weighted average if applicable.
6. Adopted decay mode is taken from 2010Ad03 because it has better pγ coincidence data.
7. All proton energies have been corrected for the internal calibration using the new values of the calibration peaks in 2010Ad03 (1643.4 (13) keV and 3171.1 (10) keV). Values are also available in 1971Ha05 but less precise

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Comparison of proton intensities(I_p)

E_p	1987Bo21		1993Sc16		2010Ad03		adopted	
761					0.0202	17	0.0202	17
1318	0.191	8	0.180	3	0.168	9	0.18	3
1643	0.343	10	0.391	6	0.411	20	0.382	20
1664			0.0099	16	0.0060	11	0.0073	11
1696	0.046	6	0.0319	16	0.0332	32	0.0329	16
1752			0.022	3	0.0081	13	0.015	7
1780	0.434	10	0.459	6	0.471	22	0.453	6
2022					0.0043	7	0.0043	7
2098	2.373	20	2.368	20	2.73	12	2.375	20
2122			0.347	6			0.347	6
2366					0.0012	3	0.0012	3
2367	0.019	3	0.0158	31	0.0153	12	0.0158	12
2480	0.333	10	0.353	6	0.362	17	0.349	6
2708					0.0069	12	0.0069	12
2743	0.0454	50	0.0403	31	0.0483	44	0.0435	31
2808					0.00141	14	0.00141	14
2885	0.065	6	0.0341	31	0.0376	35	0.046	10
2932	0.122	8	0.0713	31	0.0748	55	0.089	16
2951			0.0434	31	0.0359	32	0.0398	31
3014					0.0007	2	0.0007	2
3066	0.071	20			0.00440	61	0.0044	6
3171	31.0	14	31.0	14	31.0	14	31.0	14
3350	0.757	40	0.031	6	0.0918	48	0.061	31
3467	0.414	40			0.0531	40	0.0531	40
3512			0.0065	16	0.0150	25	0.011	4
3570	0.101	10			0.0085	16	0.0085	10
3695	0.013	4					0.013	4
3855	0.808	20	0.716	6	0.735	34	0.753	28
3924	0.0192	40			0.0082	13	0.0137	55
4209	0.0172	30			0.00645	83	0.0118	54
4327	0.0081	20			0.00142	40	0.0048	33
4472					0.00367	55	0.00367	55
4506	0.0182	50			0.00467	62	0.00467	62
4717					0.00079	10	0.00079	10
4856	0.0232	30	0.0152	31	0.0097	8	0.016	4
4921					0.00066	16	0.00066	16
5040	0.333	10	0.217	6	0.224	12	0.258	38
5102	0.111	10	0.0589	31	0.0470	50	0.072	20
5225	0.0545	40	0.0288	16	0.0234	24	0.036	10
5317	0.0182	30	0.0133	12	0.0083	12	0.0133	29
5621	0.222	10	0.118	25	0.124	7	0.155	34
5723	0.172	10	0.062	15	0.092	5	0.109	33
5852	0.0121	20			0.00284	40	0.0075	46
6009					0.00100	15	0.00100	15
6099	0.0212	40			0.0138	15	0.0147	14
6337	0.005	2			0.00053	9	0.00053	9
6386					0.00027	8	0.00027	8
6474	0.0162	20			0.0103	11	0.0133	30
6621	0.004	2			0.00170	23	0.00173	23
6654					0.00049	10	0.00049	10
6705	0.0036	16			0.00100	12	0.00101	12
6850					0.00023	9	0.00023	9
6950					0.00007	3	0.00007	3
7050					0.00032	4	0.00032	4
7250					0.00012	3	0.00012	3
7350					0.00010	3	0.00010	3
7450					0.00008	3	0.00008	3
7750					0.00006	3	0.00006	3
8500					0.00004	3	0.00004	3

Notes:
I_p renormalization: values from 1993Sc16, 1987Bo21 and 1971Ha05
have been renormalized by the evaluators relative to the strongest

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  %I(p)=31.0 14 of the IAS proton line, as determined by 2010Ad03
  using statistical rate function. Values from 1971Ha05 are not listed
  here but given under comments in E(level) table
 Evaluators' criteria for determining the adopted value:
 1.If the data from different references are consistent within errors
  (reduced χ2≤5), weighted average is taken.
 2.If the discrepancy between data from different references is smaller
  than factor of 3, unweighted average is taken.
 3.If any data are larger than others by more than factor of 3 and not
  consistent within error (reduced χ2>5), omit it and weighted or
  unweighted average is taken from the rest data depending on reduced
  χ2.
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^{33}Cl Levels

E_p(lab) in 1987Bo21 are corrected for the pulse height effect due to the use of alpha calibration for high proton energies. Formula used for correction: E(final)=E*1.01611-52.3618.

E(level)[†]	Jπ[#]	Γ[&]	S	Comments
0.0	3/2+[@]			
810.63 *19*	1/2+[@]			
2352.30 *40*	3/2+[@]			
3971 *1*	3/2+[@]	<2 keV		E(level): from E_{p0}=1643 *1*. Other: E_{p0}=1640 *19* (1971Ha05).
4113 *2*	3/2+	<3 keV		E(level): from E_{p0}=1780 *2*. Other: E_{p0}=1781 *19* (1971Ha05).
4441 *2*	1/2+[@]	2 keV *1*		E(level): from E_{p0}=2098 *2*. Other: E_{p0}=2108 *19* (1971Ha05).
4466 *2*	3/2+[@]	<2 keV		E(level): from E_{p0}=2122 *2* in 1993Sc16 only.
4835 *2*	3/2+[@]	<2 keV		E(level): from E_{p0}=2480 *2*. Other: E_{p0}=2488 *15* (1971Ha05).
5106 *2*	3/2+[@]	<10 keV		E(level): from E_{p0}=2743 *2*. Other: E_{p0}=2748 *24* (1971Ha05).
5300 *2*	(3/2)+	<10 keV		E(level): weighted average of 5301 *2* from E_{p0}=2932 *2* and 5292 *10* from E_{p1}=761 *10*. Others: E_{p1}=768 *5* and E_{p0}=2927 *4* (1996Ho24).
5548 *1*	1/2+[@]	<0.8 keV		E(level): from E_{p0}=3171 *1*. Other: E_{p0}=3169 *4* (1971Ha05). IAS of 1/2+ g.s. in ^{33}Ar.
5669? *20*				E(level): from E_{p0}=3299 *19* and E_{p1}=1092 *34* in 1971Ha05. But those proton groups are not observed in later studies and considered questionable by the evaluator.
5732 *3*	1/2+[@]	30 keV *10*		E(level): from E_{p0}=3350 *3*. Other: E_p=3363 *29* (1971Ha05); E_{p1}=1225 *34* from 1971Ha05, but this p1 proton decay is not seen in other studies.
5867 *3*	1/2+,3/2+[@]	1.4 keV *5*		E(level): from E_{p1}=1318 *3*. Others: E_{p1}=1322 *29* and a weak peak of E_{p0}=3482 *34* probably for several groups (1971Ha05); E_{p1}=1322 *3* and E_{p0}=3485 (1996Ho24).
6027? *35*				E(level): from E_{p0}=3636 *34* and E_{p1}=1473 *34* in 1971Ha05. But those proton groups are not observed in later studies and considered questionable by the evaluators.
6118? *35*				E(level): from E_{p0}=3741 *34* and E_{p1}=1539 *39* in 1971Ha05. But those proton groups are not observed in later studies and considered questionable by the evaluators.
6255 *2*	1/2+[@]	2 keV *1*		E(level): weighted average of 6253 *3* from E_{p0}=3855 *3* and 6256 *2* from E_{p1}=1696 *2*. Other: E_{p0}=3852 *19* (1971Ha05).
6314 *2*	1/2,3/2[@]			E(level): from E_{p1}=1752 *2*.
6593 *5*	1/2,3/2		0.0008	E(level): from E_{p1}=2022 *5*.
6949 *2*	1/2(+),3/2(+)			E(level): from E_{p1}=2367 *2*. Other: E_p=2364 *34* p0 decay to a level at 4720 *35*, but changed to p1 by the evaluators, as assigned in 1993Sc16 and 2010Ad03.
7142 *5*	1/2,3/2		0.0003	E(level): from E_{p0}=4717 *5*.

Continued on next page (footnotes at end of table)

^{33}Ar $\varepsilon+\beta^+$ decay (174.3 ms) 2010Ad03,1993Sc16,1987Bo21 (continued)

^{33}Cl Levels (continued)

E(level)[†]	Jπ[#]	Γ[&]	S	Comments
7289 *6*	(3/2)+[@]	10 keV *5*		E(level): weighted average of 7286 *4* from E_{p0}=4856 *4* and 7300 *7* from E_{p1}=2708 *7*. Other: E_{p0}=4832 *39* and E_{p1}=2605 *29* from 1971Ha05 give a level at 7219 *32*.
7404 *10*	1/2,3/2		0.0007	E(level): from E_p1=2808 *10*.
7482 *3*	1/2+	6.5 keV *20*		E(level): weighted average of 7476 *4* from E_{p0}=5040 *4* and 7483 *2* from E_{p1}=2885 *2*. Others: E_{p0}=5030 *19* and 2884 *39* (1971Ha05); E_{p0}=5036 *4* (1996Ho24).
7540 *4*	1/2+,3/2+[@]	<4 keV		E(level): from E_{p0}=5102 *4*. Other: E_{p0}=5100 *4* (p0) (1996Ho24).
7551 *2*	1/2+,3/2+[@]	<10 keV		E(level): from E_{p1}=2951 *2*. Other: E_{p1}=2950 *5* (1996Ho24); E_{p1}=2955 *29* and E_{p0}=5179 *29* from 1971Ha05 give a level at 7588 *32*.
7667 *4*	1/2+,3/2+[@]	8 keV *4*		E(level): weighted average of 7666 *4* from E_{p0}=5225 *4* and 7670 *6* from E_{p1}=3066 *2*. Other: E_p=3068 *29* p0 proton from a level at 5442 *30* in 1971Ha05, but changed to p1 decay by the evaluator.
7766 *5*	(1/2)+[@]	10 keV *6*		E(level): unweighted average of 7761 *3* from E_{p0}=5317 *3* and 7771 *4* E_{p2}=1664 *4*. Other: E_{p0}=5318 *39* (1971Ha05).
8077 *3*	1/2+,3/2+[@]	34 keV *6*		E(level): weighted average of 8075 *3* from E_{p0}=5621 *3* and 8083 *6* E_{p1}=3467 *6*. Others: E_{p0}=5626 *19*, E_{p1}=3482 *34* and E_{p2}=1960 *29* (p2) (1971Ha05), with p2 proton not seen in other studies.
8130 *3*	1/2+,3/2+[@]			E(level): from E_{p1}=3512 *3*. Others: E_{p1}=3502 *7* and E_{p0}=5658 *10* (1996Ho24).
8183 *5*	(1/2)+[@]	22 keV *6*		E(level): weighted average of 8180 *3* from E_{p0}=5723 *3* and 8190 *5* from E_{p1}=3570 *5*. Other: E_{p0}=5722 *24* (1971Ha05).
8316 *6*	1/2+,3/2+[@]			E(level): weighted average of 8318 *6* from E_{p1}=3695 *6* and 8313 *9* from E_{p0}=5852 *9*. Other: E_{p0}=5845 *29* (1971Ha05).
8490 *6*	(1/2)+		0.0071	E(level): weighted average of 8475 *10* from E_{p0}=6009 *10* and 8496 *6* E_{p2}=2366 *6*.
8558 *5*	(3/2)+[@]			E(level): weighted average of 8568 *10* from E_{p0}=6099 *10* and 8555 *5* E_{p1}=3924 *5*. Other: E_{p0}=6117 *39*, E_{p1}=3981 *34* (1971Ha05).
8813 *8*	1/2,3/2[@]			E(level): from E_{p0}=6337 *8*.
8849 *5*	1/2+,3/2+[@]			E(level): from E_{p1}=4209 *5*.
8864 *10*	1/2,3/2		0.0021	E(level): from E_{p0}=6386 *10*.
8964 *8*	(1/2)+[@]			E(level): weighted average of 8955 *10* from E_{p0}=6474 *10* and 8970 *8* from E_{p1}=4327 *8*. Other: E_{p0}=6484 *29* (1971Ha05).
9117 *6*	(3/2)+[@]			E(level): weighted average of 9106 *10* from E_{p0}=6621 *10* and 9120 *5* E_{p1}=4472 *5*.
9154 *6*	(3/2)+		0.0988	E(level): weighted average of 9140 *9* from E_{p0}=6654 *9*, 9155 *6* from E_{p1}=4506 *6* and 9166 *10* from E_{p2}=3014 *10*.
9193 *9*	1/2+,3/2+[@]			E(level): from E_{p0}=6705 *9*.
9350[‡] *50*			0.0068	E(level): energy range: 9300-9400 keV.
9450[‡] *50*			0.0030	E(level): energy range: 9400-9500 keV.
9550[‡] *50*			0.0194	E(level): energy range: 9500-9600 keV.
9583 *6*	1/2+,3/2+		0.0459	
9650[‡] *50*				E(level): energy range: 9600-9700 keV.
9750[‡] *50*			0.0175	E(level): energy range: 9700-9800 keV.
9850[‡] *50*			0.0221	E(level): energy range: 9800-9900 keV.
9950[‡] *50*			0.0315	E(level): energy range: 9900-10000 keV.
1025×10^1[‡] *25*			0.1042	E(level): energy range: 10000-10500 keV.
1100×10^1[‡] *50*			0.4966	E(level): energy range: 10500-11500 keV.

Continued on next page (footnotes at end of table)

^{33}Ar $\varepsilon+\beta^+$ decay (174.3 ms) 2010Ad03,1993Sc16,1987Bo21 (continued)

^{33}Cl Levels (continued)

† From Eγ data for proton-bound levels (below S(p)=2276.8) and from measured E_p of β-delayed protons for proton-unbound levels as given in the table of comparison of proton energies above, unless otherwise noted. Original E_p values in 1971Ha05 are given in c.m. and have been converted to E_p(lab) by the evaluators as quoted.

‡ Pseudo level from 2010Ad03. Quoted value is the central value of the energy range given under comments.

\# From Adopted Levels, unless otherwise noted.

@ From log *ft* value from $1/2^+$ parent state, which is typical of allowed β-decay transition; the quoted single value is favored in barrier-penetration calculations (2010Ad03). Assignments are adopted in Adopted Levels.

& Half-life taken from Adopted Levels and level width deduced from the measured peak shape and the calculated recoil broadening in 1993Sc16, unless otherwise noted.

ε,β^+ radiations

E(decay)	E(level)	$I\beta^+$ ‡	$I\varepsilon$‡	Log *ft*	$I(\varepsilon+\beta^+)$†‡	Comments
(6×10^2 *5*)	11000		4×10^{-5} *3*	4.0 *+11−16*		εK=0.9037 *36*; εL=0.0839 *30*; εM=0.0124 *6*
(1.37×10^3 *25*)	10250	1.40×10^{-5}	4.6×10^{-5} *30*	4.7 *+8−5*	6×10^{-5} *3*	av Eβ=1.4×10^2 *10*; εK=1.E1 2; εL=0.1 *18*; εM=0.01 *27*
(1.67×10^3 *5*)	9950	5.8×10^{-5} *28*	2.2×10^{-5} *10*	5.15 *+31−25*	8×10^{-5} *3*	av Eβ=266 *21*; εK=0.25 *6*; εL=0.023 *5*; εM=0.0034 *8*
(1.77×10^3 *5*)	9850	8.1×10^{-5} *29*	1.9×10^{-5} *7*	5.26 *+26−22*	1.0×10^{-4} *3*	av Eβ=308 *21*; εK=0.175 *38*; εL=0.0162 *35*; εM=0.0024 *5*
(1.87×10^3 *5*)	9750	1.0×10^{-4} *3*	1.7×10^{-5} *5*	5.38 *+22−20*	1.2×10^{-4} *3*	av Eβ=351 *22*; εK=0.125 *25*; εL=0.0115 *23*; εM=0.00170 *34*
(2036 *6*)	9583	6.1×10^{-4} *16*	5.4×10^{-5} *13*	4.94 *+13−11*	6.6×10^{-4} *16*	av Eβ=422.3 *26*; εK=0.0745 *21*; εL=0.00687 *19*; εM=0.001017 *31*
(2.07×10^3 *5*)	9550	3.0×10^{-4} *4*	2.4×10^{-5} *5*	5.31 *14*	3.2×10^{-4} *4*	av Eβ=438 *22*; εK=0.068 *11*; εL=0.0063 *10*; εM=9.3×10^{-4} *15*
(2.17×10^3 *5*)	9450	6.6×10^{-5} *30*	4.0×10^{-6} *18*	6.13 *+32−24*	7.×10^{-5} *3*	av Eβ=482 *22*; εK=0.052 *8*; εL=0.0048 *7*; εM=7.1×10^{-4} *11*
(2.27×10^3 *5*)	9350	2.2×10^{-4} *9*	1.0×10^{-5} *4*	5.76 *+29−22*	2.3×10^{-4} *9*	av Eβ=527 *22*; εK=0.040 *6*; εL=0.0037 *5*; εM=5.5×10^{-4} *8*
(2426 *9*)	9193	9.8×10^{-4} *12*	3.2×10^{-5} *4*	5.32 *+7−6*	0.00101 *12*	av Eβ=595.5 *41*; εK=0.0283 *9*; εL=0.00261 *8*; εM=3.86×10^{-4} *13*
(2465 *6*)	9154	0.0057 *7*	1.70×10^{-4} *21*	4.61 *+7−6*	0.0059 *7*	av Eβ=613.1 *27*; εK=0.0261 *6*; εL=0.00240 *6*; εM=3.56×10^{-4} *9* I(ε+β$^+$): deduced from: Iβ(p0)=0.00049 *10*, Iβ(p1)=0.00467 *62* and Iβ(p2)=0.0007 *2*.
(2502 *6*)	9117	0.0053 *6*	1.44×10^{-4} *16*	4.69 *6*	0.0054 *6*	av Eβ=629.8 *27*; εK=0.0242 *6*; εL=0.00223 *5*; εM=3.30×10^{-4} *9* I(ε+β$^+$): deduced from two contributions: Iβ(p0)=0.00173 *23* and Iβ(p1)=0.00367 *55*.
(2655 *8*)	8964	0.0177 *45*	3.6×10^{-4} *9*	4.35 *+14−11*	0.0181 *45*	av Eβ=699.3 *36*; εK=0.01798 *46*; εL=0.001658 *43*; εM=2.45×10^{-4} *7* I(ε+β$^+$): deduced from two contributions: Iβ(p0)=0.0133 *30* and Iβ(p1)=0.0048 *33*. Others: 0.0030 *15* (p0) (1971Ha05).
(2755 *10*)	8864	2.7×10^{-4} *8*	4.5×10^{-6} *13*	6.28 *+17−13*	2.7×10^{-4} *8*	av Eβ=745.0 *46*; εK=0.01504 *43*; εL=0.001387 *40*; εM=2.05×10^{-4} *6*
(2770 *5*)	8849	0.012 *5*	1.9×10^{-4} *8*	4.65 *+24−16*	0.012 *5*	av Eβ=751.9 *23*; εK=0.01466 *29*; εL=0.001351 *27*; εM=1.999×10^{-4} *46*
(2806 *8*)	8813	5.2×10^{-4} *9*	8.1×10^{-6} *14*	6.04 *+9−8*	5.3×10^{-4} *9*	av Eβ=768.4 *37*; εK=0.01378 *34*;

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^{33}Ar $\varepsilon+\beta^+$ decay (174.3 ms) 2010Ad03,1993Sc16,1987Bo21 (continued)

ϵ,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ ‡	Iε‡	Log *ft*	I($\varepsilon+\beta^+$)†‡	Comments
						εL=0.001271 *32*; εM=1.88×10^{-4} *5*
(3061 *5*)	8558	0.028 *6*	2.9×10^{-4} *6*	4.57 *+11−9*	0.028 *6*	av Eβ=886.0 *23*; εK=0.00923 *17*; εL=8.51×10^{-4} *16*; εM=1.259×10^{-4} *28* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.0147 *14* and Iβ(p1)=0.0137 *55*. Other: 0.017 *4* (p0+p1) (1971Ha05).
(3129 *6*)	8490	0.00218 *30*	2.0×10^{-5} *3*	5.74 *+7−6*	0.0022 *3*	av Eβ=917.6 *28*; εK=0.00837 *16*; εL=7.72×10^{-4} *15*; εM=1.141×10^{-4} *26* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.00100 *15* and Iβ(p2)=0.0012 *3*.
(3303 *6*)	8316	0.021 *6*	1.5×10^{-4} *5*	4.91 *+15−12*	0.021 *6*	av Eβ=998.7 *28*; εK=0.00660 *12*; εL=6.09×10^{-4} *12*; εM=9.0×10^{-5} *2* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.0075 *46* and Iβ(p1)=0.013 *4*. Other: 0.017 *4* (p0) (1971Ha05).
(3436 *5*)	8183	0.117 *33*	7.3×10^{-4} *20*	4.27 *+15−11*	0.118 *33*	av Eβ=1061.0 *23*; εK=0.00558 *10*; εL=5.14×10^{-4} *9*; εM=7.60×10^{-5} *16* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.109 *33* and Iβ(p1)=0.0085 *10*. Other: 0.14 *+13−7* (p0) (1971Ha05).
(3489.0 *32*)	8130	0.011 *4*	6.4×10^{-5} *23*	5.34 *+20−14*	0.011 *4*	av Eβ=1085.9 *15*; εK=0.00523 *8*; εL=4.82×10^{-4} *7*; εM=7.13×10^{-5} *14* I($\varepsilon+\beta^+$): Others: 0.037 *11* (p1) and <0.005 (p0) (1996Ho24). Additional information 2.
(3542.0 *32*)	8077	0.207 *34*	0.0011 *2*	4.10 *+8−7*	0.208 *34*	av Eβ=1110.8 *15*; εK=0.00491 *7*; εL=4.52×10^{-4} *7*; εM=6.69×10^{-5} *13* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.155 *34* and Iβ(p1)=0.0531 *40*. Others: 0.23 *+13−7* (p0+p1+p2) (1971Ha05); 0.122 *11* (p0) and 0.036 *11* (p1) (1996Ho24). Additional information 3.
(3853 *5*)	7766	0.0209 *30*	8.1×10^{-5} *12*	5.32 *+7−6*	0.021 *3*	av Eβ=1257.6 *24*; εK=0.00347 *6*; εL=3.20×10^{-4} *5*; εM=4.73×10^{-5} *10* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.0133 *29* and Iβ(p2)=0.0073 *11*. Other: 0.010 *3* for E_{p0}=5318 *29* (1971Ha05).
(3952 *4*)	7667	0.041 *10*	1.4×10^{-4} *4*	5.10 *+13−10*	0.041 *10*	av Eβ=1304.5 *19*; εK=0.003135 *47*; εL=2.890×10^{-4} *45*; εM=4.27×10^{-5} *8* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.036 *10* and Iβ(p1)=0.0044 *6*. Other: 0.57 *6* for E_p=3068 *29* (1971Ha05) is discrepant.
(4068.0 *23*)	7551	0.0397 *31*	1.23×10^{-4} *10*	5.187 *+39−37*	0.0398 *31*	av Eβ=1359.7 *10*; εK=0.002795 *36*; εL=2.576×10^{-4} *35*; εM=3.81×10^{-5} *7* I($\varepsilon+\beta^+$): others: 0.037 *15* (p1) (1996Ho24); 0.25 *3* (p0+p1) for a level at 7588 *32*.
(4079 *4*)	7540	0.072 *20*	2.2×10^{-4} *6*	4.94 *+15−11*	0.072 *20*	av Eβ=1364.9 *19*; εK=0.002765 *41*; εL=2.548×10^{-4} *39*; εM=3.77×10^{-5} *7* I($\varepsilon+\beta^+$): other: 0.079 *9* (p0) (1996Ho24). Additional information 4.
(4137.0 *32*)	7482	0.303 *39*	8.8×10^{-4} *11*	4.35 *6*	0.304 *39*	av Eβ=1392.5 *15*; εK=0.002616 *36*;

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^{33}Ar $\varepsilon+\beta^+$ decay (174.3 ms) 2010Ad03,1993Sc16,1987Bo21 (continued)

ϵ,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ ‡	Iε‡	Log *ft*	I($\varepsilon+\beta^+$)†‡	Comments
						εL=2.411×10^{-4} *35*; εM=3.56×10^{-5} *7* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.258 *38* and Iβ(p1)=0.046 *10*. Others: 0.037 *3* (p1) and 0.223 *15* (p0) (1996Ho24); 0.29 *3* (p0+p1) (1971Ha05). Additional information 5.
(4215 *10*)	7404	0.00141 *14*	3.8×10^{-6} *4*	6.73 *5*	0.00141 *14*	av Eβ=1429.7 *48*; εK=0.002431 *49*; εL=2.240×10^{-4} *46*; εM=3.31×10^{-5} *8*
(4330 *6*)	7289	0.023 *4*	5.6×10^{-5} *10*	5.59 *+9−8*	0.023 *4*	av Eβ=1484.5 *29*; εK=0.002190 *36*; εL=2.018×10^{-4} *34*; εM=2.98×10^{-5} *6* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.016 *4* and Iβ(p1)=0.0069 *12*. Other: 0.041 *8* (p0+p1) for a level at 7219 *32*.
(4477 *5*)	7142	7.9×10^{-4} *10*	1.7×10^{-6} *2*	7.14 *6*	7.9×10^{-4} *10*	av Eβ=1554.8 *24*; εK=0.001926 *29*; εL=1.775×10^{-4} *28*; εM=2.62×10^{-5} *5*
(4670.0 *23*)	6949	0.0158 *12*	2.87×10^{-5} *22*	5.941 *+38−36*	0.0158 *12*	av Eβ=1647.3 *10*; εK=0.001641 *21*; εL=1.512×10^{-4} *20*; εM=2.236×10^{-5} *39*
(5026 *5*)	6593	0.0043 *7*	5.9×10^{-6} *10*	6.69 *+8−7*	0.0043 *7*	av Eβ=1818.5 *24*; εK=0.001248 *18*; εL=1.150×10^{-4} *18*; εM=1.700×10^{-5} *32*
(5305.0 *23*)	6314	0.015 *7*	1.7×10^{-5} *8*	6.28 *+28−17*	0.015 *7*	av Eβ=1953.1 *10*; εK=0.001024 *13*; εL=9.43×10^{-5} *12*; εM=1.395×10^{-5} *24*
(5364.0 *23*)	6255	0.785 *28*	8.6×10^{-4} *3*	4.589 *19*	0.786 *28*	av Eβ=1981.6 *10*; εK=9.84×10^{-4} *12*; εL=9.06×10^{-5} *12*; εM=1.340×10^{-5} *23* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.753 *28* and Iβ(p1)=0.0329 *16*. Other: 0.58 *6* (1971Ha05).
(5.50×10^3# *4*)	6118?	0.017 *7*	1.7×10^{-5} *7*	6.32 *+25−17*	0.017 *7*	av Eβ=2048 *17*; εK=8.98×10^{-4} *31*; εL=8.28×10^{-5} *29*; εM=1.224×10^{-5} *44* I($\varepsilon+\beta^+$): from 1971Ha05.
(5.59×10^3# *4*)	6027?	0.027 *7*	2.5×10^{-5} *7*	6.15 *+15−12*	0.027 *7*	av Eβ=2092 *17*; εK=8.47×10^{-4} *29*; εL=7.80×10^{-5} *27*; εM=1.154×10^{-5} *41* I($\varepsilon+\beta^+$): from 1971Ha05.
(5752.0 *32*)	5867	0.18 *3*	1.52×10^{-4} *25*	5.40 *+8−7*	0.18 *3*	av Eβ=2169.4 *15*; εK=7.66×10^{-4} *10*; εL=7.05×10^{-5} *10*; εM=1.043×10^{-5} *18* I($\varepsilon+\beta^+$): Others: 0.23 *+13−7* (p0+p1) (1971Ha05); 0.192 *14* (p1) and <0.015 (p0) (1996Ho24). Additional information 6.
(5887.0 *32*)	5732	0.061 *31*	4.8×10^{-5} *24*	5.93 *+31−18*	0.061 *31*	av Eβ=2234.9 *15*; εK=7.05×10^{-4} *9*; εL=6.50×10^{-5} *9*; εM=9.61×10^{-6} *17* I($\varepsilon+\beta^+$): Other: 0.37 *4* from 1971Ha05 is discrepant.
(5950# *20*)	5669?	0.55 *6*	4.1×10^{-4} *5*	5.00 *6*	0.55 *6*	av Eβ=2265 *10*; εK=6.79×10^{-4} *16*; εL=6.26×10^{-5} *15*; εM=9.25×10^{-6} *24* I($\varepsilon+\beta^+$): from 1971Ha05.
(6071.0 *16*)	5548	31.0 *14*	0.0217 *10*	3.294 *+23−22*	31.0 *14*	av Eβ=2324.2 *6*; εK=6.33×10^{-4} *7*; εL=5.83×10^{-5} *7*; εM=8.62×10^{-6} *14* I($\varepsilon+\beta^+$): determined by 2010Ad03 using statistical rate function. Other: 30.7 calculated from *ft* value 1981.4 by 1987Bo21; 26.7 *27* from 1971Ha05 is discrepant.
(6319.0 *23*)	5300	0.109 *16*	6.6×10^{-5} *10*	5.84 *+7−6*	0.109 *16*	av Eβ=2444.7 *10*; εK=5.50×10^{-4} *7*;

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^{33}Ar ε+β^+ decay (174.3 ms) 2010Ad03,1993Sc16,1987Bo21 (continued)

ϵ,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ ‡	Iε‡	Log *ft*	I($\varepsilon+\beta^+$)†‡	Comments
						εL=5.07×10^{-5} *7*; εM=7.50×10^{-6} *13* I($\varepsilon+\beta^+$): deduced from two contributions: Iβ(p0)=0.089 *16* and Iβ(p1)=0.0202 *17*. Others: Iβ(p1)/Iβ(p0)=39 *9*/93 *19* (1996Ho24).
(6513.0 *23*)	5106	0.0435 *31*	2.38×10^{-5} *17*	6.316 *+36−33*	0.0435 *31*	av Eβ=2539.2 *10*; εK=4.96×10^{-4} *6*; εL=4.57×10^{-5} *6*; εM=6.75×10^{-6} *12* I($\varepsilon+\beta^+$): Others: 0.081 *13* (1971Ha05) is discrepant.
(6784.0 *23*)	4835	0.349 *6*	1.66×10^{-4} *4*	5.509 *11*	0.349 *6*	av Eβ=2671.2 *10*; εK=4.31×10^{-4} *5*; εL=3.97×10^{-5} *5*; εM=5.87×10^{-6} *10* I($\varepsilon+\beta^+$): Other: 0.31 *4* (1971Ha05).
(7153.0 *23*)	4466	0.347 *6*	1.38×10^{-4} *3*	5.638 *11*	0.347 *6*	av Eβ=2851.3 *10*; εK=3.598×10^{-4} *43*; εL=3.315×10^{-5} *42*; εM=4.90×10^{-6} *8*
(7178.0 *23*)	4441	2.374 *20*	9.34×10^{-4} *14*	4.810 *7*	2.375 *20*	av Eβ=2863.5 *10*; εK=3.556×10^{-4} *42*; εL=3.276×10^{-5} *42*; εM=4.84×10^{-6} *8* I($\varepsilon+\beta^+$): Other: 2.50 *26* (1971Ha05).
(7506.0 *23*)	4113	0.453 *6*	1.53×10^{-4} *3*	5.636 *9*	0.453 *6*	av Eβ=3023.8 *10*; εK=3.060×10^{-4} *36*; εL=2.819×10^{-5} *36*; εM=4.17×10^{-6} *7* I($\varepsilon+\beta^+$): Other: 0.43 *5* (1971Ha05).
(7648.0 *16*)	3971	0.382 *20*	1.21×10^{-4} *7*	5.754 *+26−25*	0.382 *20*	av Eβ=3093.2 *6*; εK=2.874×10^{-4} *33*; εL=2.648×10^{-5} *32*; εM=3.92×10^{-6} *7* I($\varepsilon+\beta^+$): Other: 0.40 *4* (1971Ha05).
(9266.7 *12*)	2352.30	1.93 *15*	3.3×10^{-4} *3*	5.498 *+38−35*	1.93 *15*	av Eβ=3886.95 *34*; εK=1.534×10^{-4} *17*; εL=1.413×10^{-5} *17*; εM=2.089×10^{-6} *34* I($\varepsilon+\beta^+$): others: 1.7 *3* (1987Bo21), 2.0 *3* (2010Ad03). No ε+β^+ feeding is reported by 1971Ha05.
(10808.4 *12*)	810.63	40.5 *11*	0.00422 *12*	4.530 *15*	40.5 *11*	av Eβ=4645.34 *30*; εK=9.42×10^{-5} *11*; εL=8.68×10^{-6} *10*; εM=1.284×10^{-6} *21* I($\varepsilon+\beta^+$): others: 41.1 *8* (1987Bo21), 40.5 *16* (2010Ad03); 48.1 *36* from 1971Ha05 is discrepant.
(11619.0 *16*)	0.0	18.7 *4*	0.00156 *4*	5.031 *12*	18.7 *4*	av Eβ=5044.76 *30*; εK=7.53×10^{-5} *8*; εL=6.94×10^{-6} *8*; εM=1.026×10^{-6} *17* I($\varepsilon+\beta^+$): estimate based on log *ft*=5.03 *1*, as in mirror 1/2$^+$ to 3/2$^+$ (^{33}P) decay (2010Ad03). Others: 18.5 (1987Bo21) and 18.1 *19*, estimated using the same method.

† From %I$_p$ for proton-unbound levels (above S(p)=2276.8) as given in the table of comparison of proton intensities above, for γ intensity balance for bound levels, unless otherwise noted. Absolute proton intensities %I$_p$ are deduced by normalizing relative intensities to %I$_p$=31.0 *14* of the IAS proton line (E$_p$=3171 to g.s. of ^{32}S), as determined by 2010Ad03 using statistical rate function.

‡ Absolute intensity per 100 decays.

Existence of this branch is questionable.

^{33}Ar $\varepsilon+\beta^+$ decay (174.3 ms) 2010Ad03,1993Sc16,1987Bo21 (continued)

$\gamma(^{33}Cl)$

Iγ normalization: From Σ%Iγ(γ to g.s.)=42.6 *11*, deduced from 100−Σ%I_p-%I($\varepsilon+\beta^+$)(g.s.)=100, where Σ%I_p=%($\varepsilon+\beta^+$)=38.7 *10* (1987Bo21), %I($\varepsilon+\beta^+$)(g.s.)=18.7 *4* (2010Ad03).

E_γ	I_γ[†‡]	E_i(level)	J^π_i	E_f	J^π_f	Comments
810.6 *2*	100 *1*	810.63	1/2$^+$	0.0	3/2$^+$	%Iγ=42.1 *11* E_γ: weighted average of 810.3 *5* (1987Bo21) and 810.6 *2* (2010Ad03). Others: 811.2 *10* (2014Ko17), 810 *2* (1971Ha05). I_γ: from 2010Ad03. Other: 100 *3* (1987Bo21), deduced from their %Iγ=42.1 *8*; 100 *10* (2014Ko17).
1541.5 *5*	3.4 *3*	2352.30	3/2$^+$	810.63	1/2$^+$	%Iγ=1.43 *13* E_γ: weighted average of 1541.5 *5* (1987Bo21), 1541.6 *6* (2010Ad03), and 1541.0 *10* (2014Ko17). I_γ: weighted average of 3.2 *3* (2014Ko17), 3.6 *2* (2010Ad03) and 2.4 *5* (1987Bo21). 1987Bo21 give %Iγ=1.0 *2*. Additional information 7.
2352.4 *6*	1.18 *13*	2352.30	3/2$^+$	0.0	3/2$^+$	%Iγ=0.50 *6* E_γ: weighted average of 2352.2 *9* (1987Bo21), 2352.5 *6* (2010Ad03), and 2352.3 *11* (2014Ko17). Additional information 8. I_γ: weighted average of 1.10 *13* (2014Ko17), 1.3 *2* (2010Ad03) and 1.7 *5* (1987Bo21). 1987Bo21 give %Iγ=0.7 *2*.
4734 *3*	0.46 *9*	5548	1/2$^+$	810.63	1/2$^+$	%Iγ=0.19 *4* E_γ,I_γ: from 2014Ko17 only.

† Relative to Iγ(810.6γ)=100. Values quoted from 1987Bo21 are deduced from the original %Iγ values.
‡ For absolute intensity per 100 decays, multiply by 0.421 *12*.