

Adopted Levels, Gammas

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh		NDS 199,1 (2025)	30-Sep-2024
<p><math>Q(\beta^-) = -16930</math> syst; <math>S(n) = 15255.3</math> 18; <math>S(p) = 3338.6</math> 7; <math>Q(\alpha) = -8715</math> 13    <a href="#">2021Wa16</a>  <math>\Delta Q(\beta^-) = 200</math> (syst, <a href="#">2021Wa16</a>).  <math>S(2n) = 36850</math> 200 (syst), <math>S(2p) = 4919.7</math> 5, <math>Q(\epsilon) = 11619.0</math> 6, <math>Q(\epsilon p) = 9342.3</math> 4 (<a href="#">2021Wa16</a>).  Identification and production of <math>^{33}\text{Ar}</math>: <a href="#">1966Po12</a> and <a href="#">1964Re08</a>: <math>^{32}\text{S}(^3\text{He}, 2n)</math> reaction at 31.8 MeV, delayed protons; <a href="#">1966Ha22</a>  and <a href="#">1965Ha08</a>: <math>^{33}\text{Cl}(p, X)</math>. Later studies of <math>^{33}\text{Ar}</math> decay: <a href="#">2002Fy01</a>, <a href="#">1999Th09</a>, <a href="#">1996Ho24</a>, <a href="#">1993Sc16</a>, <a href="#">1987Bo21</a>, <a href="#">1971Ha05</a> (also <a href="#">1971EsZR</a> thesis), <a href="#">1970Ce02</a>.  Mass measurements: <a href="#">2003B117</a>, <a href="#">2001He29</a> (also <a href="#">2002He13</a>, <a href="#">2001He37</a>). Mass excess = <math>-9384.08</math> 44 (<a href="#">2003B117</a>).  <a href="#">2023Zh10</a>: re-analyzed mass excess of <math>^{33}\text{Ar}</math> based on mass measurements of certain nuclides.  <a href="#">2012Sh21</a>: <math>^9\text{Be}(^{36}\text{Ca}, X)</math> <math>E = 70</math> MeV/nucleon at NSCL. Measured <math>\sigma</math>.  <a href="#">2002Oz03</a>: <math>\text{C}(^{33}\text{Ar}, X)</math> <math>E = 950</math> MeV/nucleon, measured cross section, deduced effective radius.  <a href="#">2000Ga61</a>: measured positron-neutrino correlations using <math>^{33}\text{Ar}</math> beam at ISOLDE, CERN facility.  <a href="#">2000Ge20</a>: hyperfine structure and charge radii measurements at ISOLDE, CERN facility.  Additional information 1.  Structure calculations:  <a href="#">2022St03</a>: calculated <math>B(E2)</math>.  <a href="#">2004Ge02</a>: calculated binding energy, radius, deformation parameter.</p>				

 $^{33}\text{Ar}$  LevelsCross Reference (XREF) Flags

- A  $^1\text{H}(^{34}\text{Ar}, ^{33}\text{Ar}\gamma)$ ,  
B  $^{36}\text{Ar}(^3\text{He}, ^6\text{He})$   
C Coulomb excitation

E(level) <sup>†</sup>	$J^\pi$ <sup>‡</sup>	$T_{1/2}$	XREF	Comments
0.0	$1/2^+$	174.3 ms 11	ABC	$\% \epsilon + \% \beta^+ = 100$ ; $\% \epsilon p = 38.7$ 10 ( <a href="#">1987Bo21</a> ) $\mu = -0.723$ 6 ( <a href="#">1996K104</a> , <a href="#">2019StZV</a> ) Nuclear rms charge radius = $3.3438$ fm 58 ( <a href="#">2013An02</a> evaluation). Evaluated $\delta \langle r^2 \rangle (^{33}\text{Ar} - ^{38}\text{Ar}) = -0.395$ fm <sup>2</sup> 21 ( <a href="#">2013An02</a> ). $J^\pi$ : $\text{L}(^1\text{H}(^{34}\text{Ar}, d))$ or $\text{L}(p, d) = 0$ from $0^+$ ; mirror analog of $1/2^+$ g.s. in $^{33}\text{P}$ . $T_{1/2}$ : weighted average of 174.1 ms 11 ( <a href="#">1987Bo21</a> ), 173.0 ms 20 ( <a href="#">1971Ha05</a> ), 171 ms 15 ( <a href="#">1999Tr04</a> ), 178 ms 10 ( <a href="#">1966Ha22</a> , <a href="#">1965Ha08</a> ), 178 ms 5 ( <a href="#">1966Po12</a> ), and 182 ms 5 ( <a href="#">1964Re08</a> ). $\mu$ : Collinear fast-beam laser spectroscopy and $\beta$ -NMR ( <a href="#">1996K104</a> ). $B(E2)\uparrow = 0.0081$ 19 XREF: B(1340). $B(E2)\uparrow$ : from Coulomb excitation. $J^\pi$ : mirror analog state at 1431.7, $3/2^+$ in $^{33}\text{P}$ Adopted Levels; positive parity expected from Coulomb excitation from $1/2^+$ g.s.
1358.9 17	$(3/2^+)$		ABC	$B(E2)\uparrow = 0.0109$ 30 $J^\pi$ : mirror analog state at 1847.7, $5/2^+$ in $^{33}\text{P}$ Adopted Levels; positive parity expected from Coulomb excitation $1/2^+$ g.s.
1799.2 17	$(5/2^+)$	0.81 ps +32-18	ABC	$T_{1/2}$ : deduced by evaluators from measured $B(E2)$ (W.u.) for 1799 $\gamma$ ( <a href="#">2014We13</a> ) and $\gamma$ branching ratio of 1799 $\gamma$ . $B(E2)\uparrow$ : from Coulomb excitation.
2439.2? 24	$(3/2^+)$		A	XREF: A(?). $J^\pi$ : mirror analog state at 2538.6, $3/2^+$ in $^{33}\text{P}$ Adopted Levels.
3155 8	$(3/2^+)$		A	$J^\pi$ : mirror analog state at 3276.2, $3/2^+$ in $^{33}\text{P}$ Adopted Levels.
3362 5	$(5/2^+)$		A	$J^\pi$ : mirror analog state at 3490.6, $5/2^+$ in $^{33}\text{P}$ Adopted Levels.

Continued on next page (footnotes at end of table)

**Adopted Levels, Gammas (continued)** $^{33}\text{Ar}$  Levels (continued)

<u>E(level)<sup>†</sup></u>	<u>J<sup>π</sup><sup>‡</sup></u>	<u>XREF</u>	<u>Comments</u>
3454 4	(7/2 <sup>+</sup> )	A	J <sup>π</sup> : mirror analog state at 3627.9, 7/2 <sup>+</sup> in $^{33}\text{P}$ Adopted Levels.
3819.0 26	(5/2 <sup>+</sup> )	A	J <sup>π</sup> : mirror analog state at 4048.3, 5/2 <sup>+</sup> in $^{33}\text{P}$ Adopted Levels.

<sup>†</sup> From a least-squares fit to  $\gamma$ -ray energies.

<sup>‡</sup> Assignments for excited levels are proposed by 2004CI02 in ( $^{34}\text{Ar}, ^{33}\text{Ar}\gamma$ ) based on their identification as mirror analog states of  $^{33}\text{P}$ , with the parentheses added by the evaluators. Exceptions are noted.

 $\gamma(^{33}\text{Ar})$ 

## Additional information 2.

<u>E<sub>i</sub>(level)</u>	<u>J<sub>i</sub><sup>π</sup></u>	<u>E<sub>γ</sub><sup>†</sup></u>	<u>I<sub>γ</sub><sup>†</sup></u>	<u>E<sub>f</sub></u>	<u>J<sub>f</sub><sup>π</sup></u>	<u>Mult.</u>	<u>Comments</u>
1358.9	(3/2 <sup>+</sup> )	1359 2	100	0.0	1/2 <sup>+</sup>	[M1+E2]	B(E2)(W.u.)=6.4 15 (2014We13) E <sub>γ</sub> : other: 1360 3 from Coulomb excitation.
1799.2	(5/2 <sup>+</sup> )	437 3	2.4 4	1358.9	(3/2 <sup>+</sup> )	[M1+E2]	B(M1)(W.u.)=0.0076 +29-26 if M1.
		1799 2	100 15	0.0	1/2 <sup>+</sup>	[E2]	B(E2)(W.u.)=1.6×10 <sup>2</sup> 6 exceeds RUL=100 if E2. B(E2)(W.u.)=5.8 16 (2014We13) E <sub>γ</sub> : weighted average of 1798 2 from ( $^{34}\text{Ar}, ^{33}\text{Ar}\gamma$ ) and 1804 6 from Coulomb excitation.
2439.2?	(3/2 <sup>+</sup> )	639 <sup>‡</sup> 2	100 29	1799.2	(5/2 <sup>+</sup> )		
		1084 <sup>‡</sup> 4	100 57	1358.9	(3/2 <sup>+</sup> )		
3155	(3/2 <sup>+</sup> )	1356 8	100	1799.2	(5/2 <sup>+</sup> )		
3362	(5/2 <sup>+</sup> )	1556 8	100 14	1799.2	(5/2 <sup>+</sup> )		
		2005 5	60 40	1358.9	(3/2 <sup>+</sup> )		
3454	(7/2 <sup>+</sup> )	1651 <sup>‡</sup> 6	30 20	1799.2	(5/2 <sup>+</sup> )		
		2097 5	100 50	1358.9	(3/2 <sup>+</sup> )		
3819.0	(5/2 <sup>+</sup> )	2460 2	100	1358.9	(3/2 <sup>+</sup> )		

<sup>†</sup> From ( $^{34}\text{Ar}, ^{33}\text{Ar}\gamma$ ), unless otherwise noted.

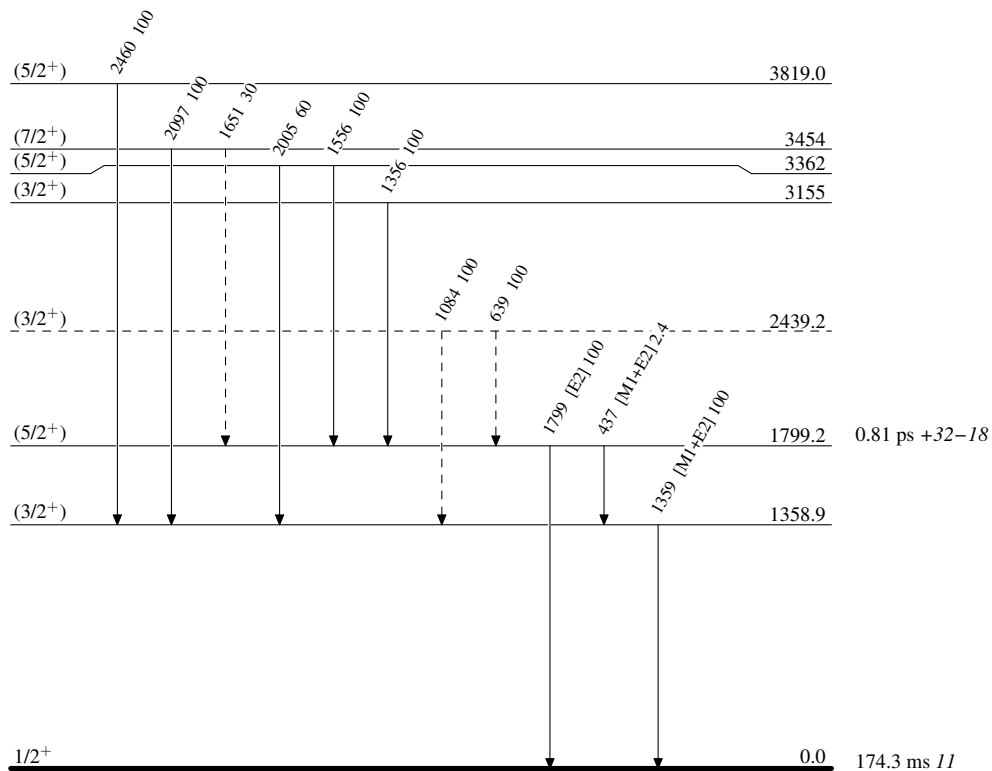
<sup>‡</sup> Placement of transition in the level scheme is uncertain.

**Adopted Levels, Gammas**

Legend

Level Scheme

Intensities: Relative photon branching from each level

-----▶  $\gamma$  Decay (Uncertain) $^{33}_{18}\text{Ar}_{15}$