Adopted Levels, Gammas

Туре	Author	History Citation	Literature Cutoff Date		
Full Evaluation	Coral M. Baglin	NDS 114, 1293 (2013)	1-Sep-2013		

 $Q(\beta^{-}) = -9440 SY; S(n) = 11427 4; S(p) = 4803.8 24; Q(\alpha) = -3780 4$ 2012Wa38 $\Delta Q(\beta) = 400 (2012Wa38).$ Q(\varepsylon p)=4644 4 (2012Wa38). Additional information 1.

Other Reactions:

⁹¹Ru ε p decay (1983Ha06): Δ E,E counter telescope, FWHM=65 keV; observed ε -delayed p spectrum; inferred existence of low-spin ⁹¹Ru isomer.

Theory (partial list):

Nuclear structure: 1994He09, 1996Ru02 (shell-model calculations).

⁹¹Ru Levels

Cross Reference (XREF) Flags

 ${}^{58}\text{Ni}({}^{36}\text{Ar},2\text{pn}\gamma)$: E=149 MeV ${}^{58}\text{Ni}({}^{40}\text{Ca},\alpha2\text{pn}\gamma)$ A

В

⁹¹Rh ε decay (1.47 s) С

⁵⁸Ni(³⁶Ar,2pnγ): E=111 MeV D

E(level) [†]	$J^{\pi \ddagger}$	T _{1/2}	XREF	Comments		
0.0 [#]	(9/2+)	8.0 s 4	ABCD	$%ε+%β^+=100$ J ^π : log ft=4.9 to (9/2) ⁺ , 6.5 to (13/2 ⁺) and 6.0 to (7/2) ⁺ In ε decay, but these log ft values May be underestimated; likely dominant configuration=(v g _{9/2}) ⁻¹ (1994He09). T _{1/2} : weighted average of 9 s <i>l</i> from activity (1983Ko43) and 7.85 s 40 from 394γ(t)		
0.0+x	(1/2 ⁻) [@]	7.6 s 8		(2004De40) In ε decay (1.47 s). $\varepsilon + \beta \beta^+ > 0; \ \beta \beta^+ p > 0; \ \beta IT = ?$ $\beta \beta^+ p: \varepsilon + \beta^+$ delayed p spectrum observed by 1983Ha06. E(level): 2012Au07 estimate x=-340 500. Tuo: from delayed-p activity (1983Ha06)		
46	$(7/2^+)$		D	$J_{1/2}^{\pi}$: 46y to (9/2 ⁺) g.s. from (³⁶ Ar.2pny): E=111 MeV.		
436.0 5	$(11/2^+)$		D	J^{π} : 436y to (9/2 ⁺) g.s. from (³⁶ Ar.2pny): E=111 MeV.		
889.8 2	$(11/2^+)$		CD	J^{π} : 890 γ to (9/2 ⁺) g.s., 844 γ to (7/2 ⁺) 46 from (³⁶ Ar,2pn γ): E=111 MeV.		
973.5 ^c	$(13/2^+)$		AB D	J^{π} : M1 $\Delta J=1$ 538 γ to (11/2 ⁺) 436, E2 $\Delta J=2$ 973 γ to (9/2 ⁺) from (³⁶ Ar,2pn γ): E=111 MeV.		
1660	$(11/2^+)$		D	J^{π} : 686 γ to (13/2 ⁺) 974, 686 γ to (9/2 ⁺) 974 from (³⁶ Ar,2pn γ): E=111 MeV.		
1872.0 ^C	$(17/2^+)$		AB D	J^{π} : E2 $\Delta J=2$ 899 γ to (13/2 ⁺) 974 from (³⁶ Ar,2pn γ): E=111 MeV.		
1893.0 ^b	$(13/2^{-})^{a}$		AB D	J ^π : E1 ΔJ=0 920γ to (13/2 ⁺) 974, 1003γ to (11/2 ⁺) 890 from (³⁶ Ar,2pnγ): E=111 MeV.		
2179	$(15/2^+)$		D	J^{π} : 519 γ to (11/2 ⁺) 1660 from (³⁶ Ar,2pn γ): E=111 MeV.		
2200.0 ^b	$(17/2^{-})^{a}$		AB D	J^{π} : E1 ΔJ =0 328 γ to (17/2 ⁺) 1872, Q ΔJ =2 307 γ to (13/2 ⁻) 1893 from (³⁶ Ar,2pn γ): E=111 MeV.		
2253.8 ^b	(15/2 ⁻) ^{<i>a</i>}		AB D	J^{π} : M1 $\Delta J=1$ 361 γ to (13/2 ⁻) 1893, E1 $\Delta J=1$ 1281 γ to (13/2 ⁺) 974 from (³⁶ Ar,2pn γ): E=111 MeV.		
2363	$(17/2^+)$		D	J^{π} : M1 $\Delta J=0.491\gamma$ to (17/2 ⁺) 1872 from (³⁶ Ar,2pn γ): E=111 MeV.		
2369.4 ^C	$(21/2^+)$		AB D	J ^π : E2 ΔJ=2 497γ to (17/2 ⁺) 1872 from (³⁶ Ar,2pnγ): E=111 MeV.		
2409.3 ^b	(17/2 ⁻) ^{&}		AB D	J ^π : D ΔJ=1 155γ to (15/2 ⁻) 2254 <i>1893</i> , E2 ΔJ=2 516γ to (13/2 ⁻) 1893 from (⁴⁰ Ca,α2pnγ).		

Continued on next page (footnotes at end of table)

⁹¹Ru Levels (continued)

E(level) [†]	$J^{\pi \ddagger}$	XREF	Comments			
2709.3 ^b	(19/2 ⁻) ^{<i>a</i>}	AB D	J ^{π} : M1 Δ J=1 300 γ to (17/2 ⁻) 2409 from (⁴⁰ Ca, A2PNG), 509 γ to (17/2 ⁻) 2200 from (³⁶ Ar.2pn γ): E=149 MeV.			
2799	$(21/2^+)$	D	J^{π} : E2 $\Delta J=2$ 436 γ to (17/2 ⁺) 2363 from (³⁶ Ar,2pn γ): E=111 MeV.			
2927.6 <mark>b</mark>	$(19/2^{-})$	A D	J^{π} : D $\Delta J=1$ 728 γ to (17/2 ⁻) 2200, 218 γ to (19/2 ⁻) 2709 from (³⁶ Ar,2pn γ): E=149 MeV.			
2985.3 ^c	$(23/2^+)$	AB D	J^{π} : D ΔJ=1 616γ to (21/2 ⁺) 2369 from (⁴⁰ Ca,α2pnγ).			
3004.9 <mark>b</mark>	(19/2 ⁻)	Α	J^{π} : 296 γ to (19/2 ⁻) 2709, 804 γ to (17/2 ⁻) 2200 from (³⁶ Ar,2pn γ): E=149 MeV.			
3164.3 ^b	$(21/2^{-})^{a}$	AB D	J ^π : Q ΔJ=2 965γ to (17/2 ⁻) 2200, D ΔJ=1 455γ to (19/2 ⁻) 2710 from (³⁶ Ar,2pnγ): E=149 MeV.			
3192.5 ^c	$(25/2^+)$	AB D	J^{π} : D $\Delta J=1$ 207 γ to (23/2 ⁺) 2984, E2 $\Delta J=2$ 823 γ to (21/2 ⁺) 2369 from (³⁶ Ar,2pn γ).			
3258	$(21/2^{-})$	D	J^{π} : M1 ΔJ=1 549γ to (19/2 ⁻) 2709 from (³⁶ Ar,2pnγ): E=111 MeV.			
3554.6 ^b	$(23/2^{-})^{a}$	AB D	J^{π} : M1 $\Delta J=1$ 391 γ to (21/2 ⁻) 3163, E2 $\Delta J=2$ 845 γ to (19/2 ⁻) 2708 from (36 α ,2pn γ): E=111 MeV.			
3633.6 ^c	$(25/2^+)$	AB D	J^{π} : 648 γ to (23/2 ⁺) 2984, E2 ΔJ =2 1264 γ to (21/2 ⁺) 2369 from (³⁶ Ar,2pn γ): E=111 MeV.			
3893.9 <mark>b</mark>	$(23/2^{-})$	Α	J^{π} : 339 γ to (23/2 ⁻) 3555, 889 γ to (19/2 ⁻) 3005 from (³⁶ Ar,2pn γ): E=149 MeV.			
3969.8 ^C	$(27/2^+)$	AB D	J^{π} : 337 γ to (25/2 ⁺) 3632, M1 ΔJ =1 778 γ to (25/2 ⁺) 3191 from (³⁶ Ar,p2n γ): E=111 MeV.			
4035.8 <mark>b</mark>	$(25/2^{-})^{a}$	AB D	J^{π} : 142 γ to (23/2 ⁻) 3894, E2 ΔJ =2 871 γ to (21/2 ⁻) 3163 from (³⁶ Ar,2pn γ): E=111 MeV.			
4151.6 ^c	(29/2 ⁺)	AB D	J^{π} : D $\Delta J=1$ 182 γ to (27/2 ⁺) 3970, E2 $\Delta J=2$ 959 γ to (25/2 ⁺) 3193 from (³⁶ Ar,2pn γ): E=111 MeV.			
4379.7 <mark>b</mark>	$(27/2^{-})^{a}$	AB D	J ^π : M1 ΔJ=1 344γ to (25/2 ⁻) 4036; Q ΔJ=2 825γ to (23/2 ⁻) 3555 from (⁴⁰ Ca, α p2nγ).			
4847	$(27/2^{-})$	D	J ^π : M1 ΔJ=1 812γ to $(25/2^{-})$ 4036 from $({}^{36}$ Ar,2pnγ): E=111 MeV.			
4991.9 <mark>0</mark>	$(29/2^{-})^{a}$	AB D	J ^π : M1 ΔJ=1 612γ to $(27/2^{-})$ 4380; 1022γ to $(27/2^{+})$ 3970 from $({}^{36}$ Ar,2pnγ): E=149 MeV.			
5097	$(31/2^+)$	D	J ^π : Q, Δ J=2 1127γ to (27/2 ⁺) 3970 from (³⁶ Ar,2pnγ):E=111 MeV.			
5100	$(29/2^{-})$	D	J^{π} : M1 $\Delta J=1$ 721 γ to (27/2 ⁻) 4380; 253 γ to (27/2 ⁻) 4847 from (³⁶ Ar,2pn γ):E=111 MeV.			
5108.8 ^c	$(33/2^+)$	AB D	J^{π} : stretched E2 957 γ to (29/2 ⁺) 4152 from (³⁶ Ar,2pn γ):E=111 MeV.			
5961.7 [°]	$(35/2^+)$	AB	J^{π} : D $\Delta J=1$ 853 γ to (33/2 ⁺) 5109 from (³⁶ Ar,2pn γ): E=149 MeV.			
5996.4 ⁰	$(33/2^{-})^{\infty}$	AB D	J^{π} : stretched E2 1005 γ from (³⁶ Ar,2pn γ) to (29/2 ⁻) 4992.			
6085.0 ^C	$(37/2^+)$	AB	J^{π} : 123 γ to (35/2 ⁺) 5960; 976 γ to (33/2 ⁺) 5109 In (⁴⁰ Ca, α 2pn γ).			
6313.8 ⁰	$(35/2^{-})^{a}$	AB	J^{π} : D 317 γ to (35/2 ⁻) 5996 from (⁴⁰ Ca, α 2pn γ).			
6922.3 ⁰	$(37/2^{-})^{a}$	AB	J^{π} : 609 γ to (35/2 ⁻) 6214 from ⁵⁸ Ni(³⁶ Ar,2pn γ): E=149 MeV.			
7515.2 ^c	$(41/2^+)$	AB	J^{π} : stretched Q 1430 γ to (37/2 ⁺) 6085 from (⁴⁰ Ca, α 2pn γ).			
7516.8 <mark>0</mark>	$(39/2^{-})^{a}$	AB	XREF: B(7197).			
			J^{π} : stretched Q 1203 γ to (35/2 ⁻) 6314 In (³⁶ Ar,2pn γ): E=149 MeV.			
L			E(level): 7197 in (40 Ca, $\alpha 2$ pn γ) because 1203 γ was placed feeding 5996 level in that study.			
8149 ⁰	$(41/2^{-})$	AB	J^{π} : 1227 γ to (37/2 ⁻) 6922 from (³⁶ Ar,2pn γ): E=149 MeV.			
9630	(43/2 ⁻ ,45/2 ⁻)	В	J ^{π} : 1481 γ to (41/2 ⁻) 8149 from (⁴⁰ Ca, α 2pn γ). Differs from J proposed in (⁴⁰ Ca, α 2pn γ) because adopted J(8149 level) differs from that in (⁴⁰ Ca, α 2pn γ).			

[†] From least-squares fit to E γ , allowing 1 keV uncertainty (the maximum specified by authors) for data from (⁴⁰Ca, α 2pn γ) and $({}^{36}\text{Ar},2\text{pn}\gamma)$: E=149 MeV.

[‡] Based on γ deexcitation data given in comments and/or on systematics of (HI,xn γ)-type reactions, unless noted otherwise.

[#] From systematics of N=47 isotones, it is concluded that the $1/2^-$ state (rather than the $9/2^+$ state) is the isomeric one (1983Ha06). [@] Although the T_{1/2} observed in ε -delayed p decay is similar to that measured in ($9/2^+$) ⁹¹Ru ε decay, it is presumed that two isomers exist since the spin difference between 91 Ru (9/2⁺) and 90 Mo g.s. (0⁺) is too large to allow sizeable ε -delayed p decay. Also, from systematics for N=47 isotones, $9/2^+$ and $1/2^-$ states are expected at low excitation and, among these J^{π} possibilities, the statistical-model calculations of 1983Ha06 favor $1/2^{-}$ for the delayed p precursor. Dominant configuration= $(\nu p_{1/2})^{-1}$ (1994He09).

& configuration includes major contribution from $((\nu p_{1/2})^{-1}(\nu g_{9/2})^{-2})17/2$ or $((\pi g_{9/2})^2(\nu p_{1/2})^{-1}(\nu g_{9/2})^{-2})$ (see 1994He09).

⁹¹Ru Levels (continued)

^{*a*} Major Configuration= $((\pi p_{1/2})(\pi g_{9/2})^n(\nu g_{9/2})^{-m})$, with seniority=3, 5, 7 and/or 9 components; see 1994He09 for more detailed discussion of likely configurations.

^b Band(A): $\pi = -$, seniority ≥ 3 states.

^{*c*} Band(B): $\pi = +$, seniority ≥ 3 states. Principal Configuration= $((\pi g_{9/2})^n (\nu g_{9/2})^{-m})$, with seniority=3, 5 and/or 7 components; see 1994He09 for more detailed discussion of likely configurations.

$\gamma(^{91}Ru)$

$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	E _i (level)	\mathbf{J}_i^{π}	E_{γ}^{\dagger}	I_{γ}^{\ddagger}	E_f	\mathbf{J}_f^{π}	Mult. [#]	Comments
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	46	$(7/2^+)$	(46)		0.0	(9/2+)		E_{γ} : from level energy difference. γ shown In fig. 7 of 2013Zh10 but details not yet available.
889.8 (11/2 ⁺) 844 46 (7/2 ⁺) F; from \$\$\$ decay. 973.5 (13/2 ⁺) 538.0 5 <0.40	436.0	$(11/2^+)$	436.0 5	100	0.0	$(9/2^+)$,
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	889.8	$(11/2^+)$	844		46	$(7/2^+)$		
973.5 (13/2 ⁺) 538.0 5 c 0.0 (9/2 ⁺) E2 ^a Mil ^a 1660 (11/2 ⁺) 686 973.5 (13/2 ⁺) E _j : from <i>e</i> decay; 973.5 5 from (³⁶ Ar,2pny): E=111 1660 (11/2 ⁺) 686 973.5 (13/2 ⁺) E _j : 1872.0 (17/2 ⁺) 898.5 5 100 973.5 (13/2 ⁺) E ^a 1893.0 (13/2 ⁻) 234 1660 (11/2 ⁺) Mult: interpreted as $\Delta J=0$ transition in (⁴⁰ Ca, a2pny). 2179 (15/2 ⁺) 519 100 1660 (11/2 ⁺) E1 ^a 2200.0 (17/2 ⁺) 306.8 5 7.6 8 1893.0 (13/2 ⁻) H ^a 2253.8 (15/2 ⁻) 360.6 5 100 3 1893.0 (13/2 ⁻) H ^a 2363 (17/2 ⁺) 491.4 5 100 1872.0 (17/2 ⁺) H ^a 2369.4 (21/2 ⁺) 497.5 5 100.4 2200.0 (17/2 ⁻) H ^a 2409.3 (17/2 ⁻) 155.4 5 67 4 2253.8 (15/2 ⁻) D ^a 2709.3 (19/2 ⁻) 299.4 5 100 4 2403.0 (17/2 ⁻) H ^a 2709.3 (19/2 ⁻) 218 33 37			889.8 2	100	0.0	$(9/2^+)$		E_{γ} : from ε decay.
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	973.5	$(13/2^+)$	538.0 5	< 0.40	436.0	$(11/2^+)$	M1 ^{<i>a</i>}	26
1660 (11/2 ⁺) 686 973.5 (13/2 ⁺) 1614 46 (7/2 ⁺) 898.5 5 100 973.5 (13/2 ⁺) 1873.0 (13/2 ⁺) 898.5 5 100.0 9 973.5 (13/2 ⁺) E2 ^d 1893.0 (13/2 ⁺) 519 100 1660 (1/2 ⁺) Mult: interpreted as ΔJ=0 transition in (⁴⁰ Ca,α2pny). 2179 (15/2 ⁺) 519 100 1660 (1/2 ⁺) E1 ^d 2200.0 (17/2 ⁺) 306.8 5 7.6 8 1893.0 (1/2 ⁺) E1 ^d 2203.3 (15/2 ⁺) 519 100 1660 (1/2 ⁺) E1 ^d 2253.8 (15/2 ⁻) 360.6 5 100.3 1893.0 (13/2 ⁻) M1 ^d 1280.7 5 360.1 4 973.5 (13/2 ⁺) H1 ^d interpreted As D J=0 transition in (³⁶ Ar,2pny): 2369.4 (21/2 ⁺) 491.4 5 100 1872.0 (17/2 ⁺) M1 ^d 2409.3 (17/2 ⁻) 497.2 5 100 1872.0 (17/2 ⁺) E ^d Mct: interpreted As D, Δ1=0 In (³⁶ Ar,2pny): E=149 MeV: not M2 from RUL, based on≤20 ns yy-coi			973.1 <i>1</i>	100	0.0	$(9/2^+)$	E2 ^{<i>a</i>}	E_{γ} : from ε decay; 973.5 5 from (³⁰ Ar,2pnγ): E=111 MeV.
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	1660	$(11/2^+)$	686		973.5	$(13/2^+)$		
1872.0 (17)2 ⁺) 888.5 100.0 9 973.5 (13)2 ⁺) E2 ^d 1893.0 (13)2 ⁻) 234 1660 (11)2 ⁺) E1 ^d Mult.: interpreted as ΔJ=0 transition in (⁴⁰ Ca,α2pny). 2179 (15)2 ⁺) 519 100 1660 (11)2 ⁺) Q ^d L _γ : 11 3 from (⁴⁰ Ca,α2pny), 34 7 from (³⁶ Ar,2pny): 2200.0 (17)2 ⁻) 306.8 5 7.6 8 1893.0 (13)2 ⁻) Q ^d L _γ : 11 3 from (⁴⁰ Ca,α2pny), 34 7 from (³⁶ Ar,2pny): 2253.8 (15/2 ⁻) 306.6 5 100.0 ^d 4 1872.0 (17/2 ⁺) E1 ^d 2363 (17/2 ⁺) 491.4 5 100 1872.0 (17/2 ⁺) E1 ^d interpreted As D ΔJ=0 transition In (³⁶ Ar,2pny): 2369.4 (21/2 ⁺) 497.2 5 100 1872.0 (17/2 ⁺) E2 ^d B(E2)(Wu.)>0.038 Mult.: Of from CO acio in (³⁶ Ar,2pny): E=149 MeV; not M2 from RUL, based on ≤20 ns γγ-coincidence resolving time. 2409.3 (17/2 ⁻) 155.4 5 67.4 2253.8 (15/2 ⁻) E ^d Mult.: interpreted As D ΔJ=0 In (³⁶ Ar,2pny): E=149 MeV; not M2 from RUL, based on ≤20 ns γγ-coincidence resolving time. 2409.3 <			1614		46	$(7/2^+)$		
			1660	100	0.0	$(9/2^+)$	Ta (1	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	1872.0 1893.0	$(1^{7}/2^{+})$ $(1^{3}/2^{-})$	898.5 5 234	100	973.5 1660	$(13/2^+)$ $(11/2^+)$	E2 ^{cr}	
2179 (15/2 ⁺) 519 100 1660 (11/2 ⁺) 2200.0 (17/2 ⁻) 306.8 5 7.6 8 1893.0 (13/2 ⁺) Q ^a I;: 11 3 from (⁴⁰ Ca,a ² 2pny), 34 7 from (³⁶ Ar,2pny): 2253.8 (15/2 ⁻) 360.6 5 100 3 1893.0 (13/2 ⁺) H1 ^a 2253.8 (15/2 ⁺) 360.6 5 100 3 1893.0 (13/2 ⁺) H1 ^a 2363 (17/2 ⁺) 491.4 5 100 1872.0 (17/2 ⁺) H1 ^a 2369.4 (21/2 ⁺) 497.2 5 100 1872.0 (17/2 ⁺) H2 ^a 2409.3 (17/2 ⁻) 155.4 5 67 4 2253.8 (15/2 ⁻) D ^a 2409.3 (17/2 ⁻) 155.4 5 67 4 2253.8 (15/2 ⁻) D ^a 2709.3 (19/2 ⁻) 299.9 5 100 4 2200.0 (17/2 ⁻) M1 ^a 2799 (21/2 ⁺) 436.0 5 100 2363 (17/2 ⁻) M1 ^a 2927.6 (19/2 ⁻) 218 33 17 2709.3 (19/2 ⁻) E149 MeV. 2927.5 100 77<			919.8 <i>5</i> 1003	100.0 9	973.5 889.8	$(13/2^+)$ $(11/2^+)$	E1 ^{<i>a</i>}	Mult.: interpreted as $\Delta J=0$ transition in (⁴⁰ Ca, $\alpha 2pn\gamma$).
2200.0 (17/2 ⁻) 306.8 5 7.6 8 1893.0 (13/2 ⁻) Q ⁴ I _y : 11 3 from (⁴⁰ Ca, a 2pny), 34 7 from (³⁶ Ar, 2pny): E=149 MeV. 2253.8 (15/2 ⁻) 360.6 5 100.0 4 1872.0 (17/2 ⁺) E14 2363 (17/2 ⁺) 491.4 5 100 1872.0 (17/2 ⁺) H1 ⁴ 2363 (17/2 ⁺) 491.4 5 100 1872.0 (17/2 ⁺) H1 ⁴ 2369.4 (21/2 ⁺) 497.2 5 100 1872.0 (17/2 ⁺) E1 ⁴ interpreted As D ΔJ=0 transition In (³⁶ Ar,2pny): E=149 MeV. E=111 MeV. E=111 MeV. 2409.3 (17/2 ⁻) 155.4 5 67 4 2253.8 (15/2 ⁻) D ⁴ 2409.3 (17/2 ⁻) 155.4 5 67 4 2253.8 (15/2 ⁻) D ⁴ 2409.3 (17/2 ⁻) 156.4 5 24.4 22 1893.0 (13/2 ⁻) D ⁴ 2409.3 (17/2 ⁻) 100 4 2200.0 (17/2 ⁻) M ¹⁴ Mult: Of rom COC ratio in (³⁶ Ar,2pny): E=149 MeV. 2709.3 (19/2 ⁻) 299.9 5 100 1/4 2409.3 (2179	$(15/2^+)$	519	100	1660	$(11/2^+)$		
328.0 5100.0 [@] 41872.0(17/2 ⁺)E1 ^a M1 ^a interpreted as ΔJ=0 transition in (36 Ar,2pny):2253.8(17/2 ⁺)491.4 51001872.0(17/2 ⁺)M1 ^a 2363(17/2 ⁺)491.4 51001872.0(17/2 ⁺)M1 ^a 2364.4(21/2 ⁺)497.2 51001872.0(17/2 ⁺)E2 ^a 2409.3(17/2 ⁻)155.4 567 42253.8(15/2 ⁻)D ^a 2409.3(17/2 ⁻)155.4 567 42253.8(15/2 ⁻)D ^a 2709.3(19/2 ⁻)299.9 5100 142409.3(17/2 ⁻)M1 ^a 2709.3(19/2 ⁻)299.9 5100 142409.3(17/2 ⁻)M1 ^a 2799(21/2 ⁺)436.0 51002363(17/2 ⁺)E2 ^a 2927.6(19/2 ⁻)21833 172709.3(19/2 ⁻)E149 MeV; unobserved At E=111 MeV.2927.6(19/2 ⁻)236.8 516.8 172920.0(17/2 ⁻)M1 ^a 3164.3(21/2 ⁺)80467 332200.0(17/2 ⁻)M1 ^a 3164.3(21/2 ⁻)236.8 516.8 172927.6(19/2 ⁻)E149 MeV.3164.3(21/2 ⁻)236.8 516.8 172927.6(19/2 ⁻)11/2 ⁻ 3192.5(25/2 ⁺)206.9 5100.0 252985.3(23/2 ⁺)D ^a 3192.5(25/2 ⁺)206.9 5100.0 252985.3(23/2 ⁺)D ^a 3192.5(25/2 ⁺)206.9 5100.0	2200.0	(17/2 ⁻)	306.8 5	7.6 8	1893.0	(13/2 ⁻)	Q ^a	I_{γ} : 11 3 from (⁴⁰ Ca,α2pnγ), 34 7 from (³⁶ Ar,2pnγ): E=149 MeV.
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			328.0 5	$100.0^{\textcircled{0}}4$	1872.0	$(17/2^+)$	E1 ^a	interpreted as $\Delta J=0$ transition in (³⁶ Ar,2pn γ).
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	2253.8	$(15/2^{-})$	360.6 5	100 3	1893.0	$(13/2^{-})$	M1 ^{<i>a</i>}	
2363(17/2 ⁺)491.4 51001872.0(17/2 ⁺)M1 ^d interpreted As D ΔJ=0 transition In (36 Ar,2pnγ): E=111 MeV.2369.4(21/2 ⁺)497.2 51001872.0(17/2 ⁺)E2 ^d B(E2)(W.u.)>0.038 Mult: Q from DCO ratio in (36 Ar,2pnγ): E=149 MeV; not M2 from RUL, based on≤20 ns γγ-coincidence resolving time.2409.3(17/2 ⁻)155.4 567 42253.8(15/2 ⁻)D ^d 2409.3(17/2 ⁻)155.4 567 42253.8(15/2 ⁻)D ^d 2709.3(19/2 ⁻)299.9 5100 42200.0(17/2 ⁻)M1 ^d 509.457 292200.0(17/2 ⁻)M1 ^d Iy: from (36 Ar,p2ny): E=149 MeV. Iy: from (36 Ar,p2ny): E=149 MeV. Iy: from (36 Ar,p2ny): E=149 MeV. Iy: from (36 Ar,p2ny): E=149 MeV. E=111 MeV.2799(21/2 ⁺)436.0 51002363(17/2 ⁻)M1 ^d Iy: from (36 Ar,p2ny): E=149 MeV. Iy: from (36 Ar,p2ny): E=149 MeV. E=111 MeV.2985.3(23/2 ⁺)615.8 51002369.4(17/2 ⁻)M1 ^d Iy: from (36 Ar,p2ny): E=149 MeV.2985.3(23/2 ⁺)296.3100 332709.3(19/2 ⁻) Iy: from (36 Ar,p2ny): E=149 MeV.3164.3(21/2 ⁻)236.8 516.8 172927.6(19/2 ⁻) IS5.59.8 122409.3(17/2 ⁻) Iy: from (36 Sr,p2ny): E=149 MeV.3192.5(25/2 ⁺)206.9 5100.0 252985.3(23/2 ⁺) ID ^a As3.0 542.5 132369.4(21/2 ⁺)3192.5(25/2 ⁺			1280.7 5	36 14	973.5	$(13/2^+)$	E1 ^a	
2369.4(21/2 ⁺)497.2 51001872.0(17/2 ⁺)E2 ^{al} B(E2)(W.u.)>0.038 Mult.: Q from DCO ratio in (36 Ar,2pny): E=149 MeV; not M2 from RUL, based on≤20 ns γγ-coincidence resolving time.2409.3(17/2 ⁻)155.4 567 42253.8(15/2 ⁻)D ^a 2409.3(17/2 ⁻)155.4 567 42253.8(15/2 ⁻)D ^a 209.4 5100 42200.0(17/2 ⁻)M1 ^a Mult.: interpreted As D, ΔJ=0 In (36 Ar,2pny): E=149 MeV.2709.3(19/2 ⁻)299.9 5100 142409.3(17/2 ⁻)M1 ^a 509.457 292200.0(17/2 ⁻)M1 ^a Iy: from (36 Ar,p2ny): E=149 MeV.2799(21/2 ⁺)436.0 51002363(17/2 ⁺)E2 ^a 2927.6(19/2 ⁻)21833 172709.3(19/2 ⁻)M1 ^a 727.5 5100 172200.0(17/2 ⁻)M1 ^a Iy: from (36 Ar,p2ny): E=149 MeV.2985.3(23/2 ⁺)615.8 51002363.4(19/2 ⁻)Iy: from (36 Ar,p2ny): E=149 MeV.2985.3(23/2 ⁺)296.3100 332709.3(19/2 ⁻)Iy: from (36 Ar,p2ny): E=149 MeV.3164.3(21/2 ⁻)286.516.8 172927.6(19/2 ⁻)Iy: from (36 Sr,p2ny): E=149 MeV.3192.5(25/2 ⁺)206.9 5100.0 252985.3(23/2 ⁺)D3192.5(25/2 ⁺)206.9 5100.0 252985.3(23/2 ⁺)E ^a 3192.5(25/2 ⁺)206.9 5100.0 25<	2363	(17/2 ⁺)	491.4 5	100	1872.0	(17/2 ⁺)	M1 ^{<i>a</i>}	interpreted As D $\Delta J=0$ transition In (³⁶ Ar,2pn γ): E=111 MeV.
2409.3(17/2 ⁻)155.4 567.42253.8(15/2 ⁻)D ^a 2409.3(17/2 ⁻)155.4 567.42253.8(15/2 ⁻)D ^a 209.4 5100.42200.0(17/2 ⁻)D ^a 2709.3(19/2 ⁻)299.9 5100.142409.3(17/2 ⁻)M1 ^a 2709.3(19/2 ⁻)299.9 5100.142409.3(17/2 ⁻)M1 ^a 270921/2 ⁺)436.0 51002363(17/2 ⁺)E2 ^a 2799(21/2 ⁺)21833.172709.3(19/2 ⁻)E149 MeV.2799(21/2 ⁺)436.0 51002363(17/2 ⁺)E2 ^a 2927.6(19/2 ⁻)21833.172709.3(19/2 ⁻)E149 MeV.2985.3(23/2 ⁺)615.8 51002369.4(21/2 ⁺)M1 ^a 3004.9(19/2 ⁻)296.3100.332709.3(19/2 ⁻)H ^a 3164.3(21/2 ⁻)236.8 5168.172927.6(19/2 ⁻)H ^a 3164.3(21/2 ⁻)236.8 5168.172927.6(19/2 ⁻)H ^a 3164.3(21/2 ⁻)236.8 5168.172927.6(19/2 ⁻)H ^a 3192.5(25/2 ⁺)206.9 5100.0 252985.3(23/2 ⁺)D3192.5(25/2 ⁺)206.9 5100.0 252985.3(23/2 ⁺)D3192.5(25/2 ⁺)206.9 5100.0 252985.3(23/2 ⁺)D ^a 3192.5(25/2 ⁺)206.9 5100.0 25	2369.4	$(21/2^+)$	497.2 5	100	1872.0	$(17/2^+)$	E2 ^a	B(E2)(W.u.)>0.038
2409.3 $(17/2^{-})$ 155.4 5 67 4 2253.8 $(15/2^{-})$ D ^{<i>a</i>} 209.4 5 100 4 2200.0 $(17/2^{-})$ Mult.: interpreted As D, $\Delta J=0$ In $({}^{36}Ar,2pny)$: E=111 MeV. 2709.3 $(19/2^{-})$ 299.9 5 100 14 2409.3 $(17/2^{-})$ M1 ^{<i>a</i>} 509.4 57 29 2200.0 $(17/2^{-})$ M1 ^{<i>a</i>} 2799 $(21/2^{+})$ 436.0 5 100 2363 $(17/2^{+})$ E2 ^{<i>a</i>} 2927.6 $(19/2^{-})$ 218 33 17 2709.3 $(19/2^{-})$ $m1a 2985.3 (23/2^{+}) 615.8 5 100 2369.4 (21/2^{+}) M1a3004.9 (19/2^{-}) 296.3 100 33 2709.3 (19/2^{-}) m1a 3164.3 (21/2^{-}) 236.8 5 16.8 17 2927.6 (19/2^{-}) 455.0 5 5.8.6 2709.3 (19/2^{-}) m1a 3164.3 (21/2^{-}) 236.5 100.17 2200.0 (17/2^{-}) M23192.5 (25/2^{+}) 206.9 5 100.0 25 2985.3 (23/2^{+}) D^{a}802 (25/2^{+}) 206.9 5 100.0 25 2985.3 (23/2^{+}) D^{a}812 2409.3 (17/2^{-}) E2^{a}3192.5 (25/2^{+}) 206.9 5 100.0 25 2985.3 (23/2^{+}) D^{a}823.0 5 42.5 13 2369.4 (21/2^{+}) D^{a}10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} 10^{-1} $								Mult.: Q from DCO ratio in $({}^{36}\text{Ar},2\text{pn}\gamma)$: E=149 MeV; not M2 from RUL, based on≤20 ns $\gamma\gamma$ -coincidence resolving time.
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	2409.3	$(17/2^{-})$	155.4 5	67 4	2253.8	$(15/2^{-})$	D ^a	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			209.4 5	100 4	2200.0	(17/2 ⁻)		Mult.: interpreted As D, $\Delta J=0$ In (³⁶ Ar,2pn γ): E=111 MeV.
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			516.4 5	24.4 22	1893.0	$(13/2^{-})$	E2 ^a	other I γ : 100 25 from (³⁶ Ar,p2n γ): E=149 MeV.
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	2709.3	$(19/2^{-})$	299.9 5	100 14	2409.3	$(17/2^{-})$	M1 ^{<i>a</i>}	I_{γ} : from (³⁶ Ar,p2n γ): E=149 MeV.
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			509.4	57 29	2200.0	(17/2 ⁻)		I _y : from $({}^{36}\text{Ar}, p2n\gamma)$: E=149 MeV; unobserved At E=111 MeV.
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2799	$(21/2^+)$	436.0 5	100	2363	$(17/2^+)$	E2 ^a	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2927.6	$(19/2^{-})$	218	33 17	2709.3	$(19/2^{-})$		I_{γ} : from (³⁶ Ar,p2n γ): E=149 MeV only.
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			727.5 5	100 17	2200.0	$(17/2^{-})$	M1 ^{<i>a</i>}	I_{γ} : from (³⁶ Ar,p2n γ): E=149 MeV.
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2985.3	$(23/2^+)$	615.8 5	100	2369.4	$(21/2^+)$	M1 ^{<i>a</i>}	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	3004.9	$(19/2^{-})$	296.3	100 33	2709.3	$(19/2^{-})$		I_{γ} : from (³⁶ Sr,p2n γ): E=149 MeV.
3164.3 $(21/2^{-})$ 236.8 5 16.8 17 2927.6 $(19/2^{-})$ 455.0 5 5.8 6 2709.3 $(19/2^{-})$ D 754.5 5 9.8 12 2409.3 $(17/2^{-})$ 964.5 5 100.0 17 2200.0 $(17/2^{-})$ E2 ^{<i>a</i>} 3192.5 $(25/2^{+})$ 206.9 5 100.0 25 2985.3 $(23/2^{+})$ D ^{<i>a</i>} 823.0 5 42.5 13 2369.4 $(21/2^{+})$ E2 ^{<i>a</i>} other Iy: 75 10 from $(^{36}\text{Ar,p2ny})$: E=149 MeV.			804	67 <i>33</i>	2200.0	$(17/2^{-})$		I_{γ} : from (³⁶ Sr,p2n γ): E=149 MeV.
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	3164.3	$(21/2^{-})$	236.8 5	16.8 17	2927.6	$(19/2^{-})$		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			455.0 5	5.8 6	2709.3	$(19/2^{-})$	D	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			754.5 5	9.8 12	2409.3	$(17/2^{-})$		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2102.5	(25/2+)	904.3 J	100.0 17	2200.0	(17/2)	$E2^{\bullet}$	
625.05 42.515 2509.4 $(21/2^{+})$ $E2^{-10}$ other 1 γ : 7510 from (10 Ar,p2n γ): E=149 MeV.	5192.5	(23/21)	200.9 3	100.0 23	2985.3	$(23/2^{+})$	D	other Ly 75 10 from $(36 \text{ Arr}) = 140 \text{ MeV}$
			023.0 3	42.3 13	2509.4	(21/2)	EZ .	outer 1γ . 75 10 from (Ar,p2li γ): E=149 MeV.

$\gamma(^{91}\text{Ru})$ (continued)

E _i (level)	\mathbf{J}_i^π	$\mathrm{E}_{\gamma}^{\dagger}$	I_{γ}^{\ddagger}	E_f	\mathbf{J}_f^{π}	Mult. [#]	Comments
3258	$(21/2^{-})$	549.3 5	100	2709.3	$(19/2^{-})$	M1 ^{aa}	
3554.6	$(23/2^{-})$	296.0 5	59 7	3258	$(21/2^{-})$		
		390.5 5	100 7	3164.3	$(21/2^{-})$	M1 ^a	
		549.3 5	25 8	3004.9	$(19/2^{-})$		from $({}^{36}\text{Ar}, p2n\gamma)$: E=149 MeV only.
		845.3 5	74 4	2709.3	(19/2 ⁻)	E2 ^a	other Iγ: 67 8 from (³⁶ Ar,p2nγ): E=149 MeV, 87 <i>18</i> from (⁴⁰ Ca,α2pnγ).
3633.6	$(25/2^+)$	648.0 <i>5</i>	57 4	2985.3	$(23/2^+)$		Additional information 2.
		1263.9 5	100 21	2369.4	$(21/2^+)$	$E2^{a}$	
3893.9	$(23/2^{-})$	339	29 14	3554.6	$(23/2^{-})$		from $({}^{36}\text{Ar}, p2n\gamma)$: E=149 MeV.
		889.4	100 14	3004.9	$(19/2^{-})$		from $({}^{36}\text{Ar},p2n\gamma)$: E=149 MeV.
3969.8	$(27/2^+)$	336.5 5	67 4	3633.6	$(25/2^+)$		I _{γ} : weighted average of 60 <i>10</i> from (³⁶ Ar,2pn γ): E=149 MeV and 63 <i>18</i> from (⁴⁰ Ca, α 2pn γ).
		777.5 5	100.0 21	3192.5	$(25/2^+)$	M1 ^a	
4035.8	$(25/2^{-})$	142	11 6	3893.9	$(23/2^{-})$		from $({}^{36}\text{Ar},p2n\gamma)$: E=149 MeV only.
		871.2 5	100 11	3164.3	$(21/2^{-})$	E2 ^a	from $({}^{36}\text{Ar}, p2n\gamma)$: E=149 MeV.
4151.6	(29/2 ⁺)	181.6 5	28.1 10	3969.8	(27/2 ⁺)	D ^a	I _γ : other I _γ : 43 4 from (⁴⁰ Ca, α 2pnγ); 20 6 in (³⁶ Ar,2pnγ): E=149 MeV.
		959.4 5	100 3	3192.5	$(25/2^+)$	E2 ^{<i>a</i>}	
4379.7	$(27/2^{-})$	343.8 5	100.0 19	4035.8	$(25/2^{-})$	M1 ^a	
		824.7 5	69 4	3554.6	(23/2 ⁻)	Q ^{&}	other I γ : 80 7 from (³⁶ Ar,2pn γ): E=149 MeV, 106 8 from (⁴⁰ Ca, α 2pn γ).
4847	$(27/2^{-})$	811.6 5	100	4035.8	$(25/2^{-})$	M1 ^a	
4991.9	(29/2 ⁻)	612.3 5	100 9	4379.7	(27/2 ⁻)	M1 ^a	Mult.: DCO ratio in $({}^{36}\text{Ar},2pn\gamma)$ not consistent with pure Q (as proposed based on γ anisotropy data in $({}^{40}\text{Ca},\alpha2pn\gamma)$).
		1022	94	3969.8	$(27/2^+)$		from $({}^{36}\text{Ar},p2n\gamma)$: E=149 MeV.
5097	$(31/2^+)$	1126.9 5	$100^{@}$	3969.8	$(27/2^+)$	Q ^a	
5100	$(29/2^{-})$	252.9 5	<86 [@]	4847	$(27/2^{-})$		
		720.7.5	$100^{@}$ 14	4379.7	$(27/2^{-})$	M1 ^a	
5108.8	$(33/2^+)$	957.4 5	100	4151.6	$(29/2^+)$	E2 ^a	
5961.7	$(35/2^+)$	852.9	100	5108.8	$(33/2^+)$	D&	E_{γ} : from (³⁶ Ar.2pn γ): E=149 MeV.
5996.4	$(33/2^{-})$	1004.7 5	100	4991.9	$(29/2^{-})$	E2 ^{<i>a</i>}	-y
6085.0	$(37/2^+)$	123.3	75 11	5961.7	(35/2+)		I_{γ} : from (⁴⁰ Ca,α2pnγ); 44 22 from (³⁶ Ar,2pnγ): E=149 MeV.
		976.2	100 16	5108.8	$(33/2^+)$		
6313.8	$(35/2^{-})$	317.4	100	5996.4	$(33/2^{-})$	D <mark>&</mark>	
6922.3	(37/2 ⁻)	608.5	100	6313.8	(35/2 ⁻)		Mult.: Q from γ -anisotropy ratio in (⁴⁰ Ca, α 2pn γ); however, E γ is atypically low for a crossover transition, and γ is placed as a Δ J=1, $\Delta\pi$ =no transition in (³⁶ Ar,2pn γ): E=149 MeV.
7515.2	$(41/2^+)$	1430.2	100	6085.0	$(37/2^+)$	Q ^{&}	E_{γ} : from (⁴⁰ Ca, α 2pn γ).
7516.8	$(39/2^{-})$	1203.0	100	6313.8	$(35/2^{-})$	0&	E_{γ} : from (⁴⁰ Ca, $\alpha 2 pn \gamma$).
8149	$(41/2^{-})$	1226.7	100	6922.3	$(37/2^{-})$		E_{γ} : from (⁴⁰ Ca, $\alpha 2$ pn γ).
9630	(43/2 ⁻ ,45/2 ⁻)	1481.2	100	8149	(41/2 ⁻)		E_{γ} : from (⁴⁰ Ca, α 2pn γ).

[†] From (³⁶Ar,2pn γ): E=111 MeV, unless noted otherwise. These data are In excellent agreement with those from (³⁶Ar,2pn γ): E=149 MeV, for which ΔE_{γ} =0.1-1.0 keV, depending on energy and I γ , and with those from (⁴⁰Ca, α 2pn γ) for which the stated precision is 0.2-1.0 keV.

[‡] From (³⁶Ar,2pnγ): E=111 MeV, unless noted otherwise.
 [#] From measured DCO ratio in (³⁶Ar,2pnγ): E=149 MeV, except As noted.

 $\gamma(^{91}\text{Ru})$ (continued)

[@] From ⁵⁸Ni(³⁶Ar,2pn γ): E=149 MeV. [&] Based on measured γ anisotropy ratio in (⁴⁰Ca, α 2pn γ). ^{*a*} From DCO and/or polarization In (³⁶Ar,2pn γ): E=111 MeV.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level



 $^{91}_{44}{
m Ru}_{47}$

6



Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

 $--- \blacktriangleright \gamma$ Decay (Uncertain)



Adopted Levels, Gammas



 $^{91}_{44}$ Ru $_{47}$