^{138}Ba(^{7}Li,4nγ) 2015Li21

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 187,1 (2023)	12-Oct-2022

2015Li21 compiled for XUNDL by J. Chen (NSCL, MSU) and edited by B. Singh (McMaster).

2015Li21: E=38 MeV ^{7}Li beam produced at HI-13 tandem accelerator at China Institute of Atomic Energy (CIAE) in Beijing. Used 3.1 mg/cm^2, 99.8%-enriched $BaCO_3$ target on 1.2 mg/cm^2 carbon backing. γ rays detected with 11 Compton-suppressed HPGe detector array with x rays and low-energy γ rays detected with two planar HPGe detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma\gamma$(ADO). Deduced levels, J, π, band structures. Comparisons with systematics, shell-model calculations (code OXBASH).

^{141}Pr Levels

^{141}Pt has 59 protons and 82 neutrons which gives 9 valence protons above Z=50 closed shell and no valence neutrons above N=82 closed shell.

Possible configurations (2015Li21): $\pi(g_{7/2}d_{5/2})^9$ up to $23/2^+$ and $\pi(g_{7/2}d_{5/2})^7h^2_{11/2}$ up to $45/2^+$ for positive-parity states; $\pi(g_{7/2}d_{5/2})^8h^1_{11/2}$ for negative-parity states.

E(level)[†]	J$^\pi$[#]	T$_{1/2}$[‡]	Comments
0.0	$5/2^+$		
145.41 *25*	$7/2^+$	1.85 ns *3*	
1117.4 *3*	$11/2^-$	4.8 ns *1*	
1457.5 *4*	$(9/2^+)$		
1494.2 *4*	$11/2^+$		
1520.5 *6*	$9/2^+$		
1767.6 *4*	$13/2^+$		
1796.7 *4*	$15/2^+$	1.0 ns *1*	
1986.1 *5*	$(13/2^+)$	>0.42 ps	
2069.0 *5*	$17/2^+$		
2108.3 *5*	$(15/2^+)$		
2626.5 *8*	$(15/2^-)$		
2927.3 *5*	$(19/2^-)$		
2962.8 *5*	$19/2^+$		
3017.0 *5*	$(21/2^+)$		
3018.9 *6*	$(21/2^-)$	0.2 ns *1*	J$^\pi$: $(17/2)^-$ in (α,2nγ).
3396.8 *7*	$21/2^-$		
3471.0 *6*	$23/2^-$		
3526.5 *6*	$(23/2^-)$		J$^\pi$: $(21/2^-)$ in (α,2nγ).
3585.5 *6*	$23/2^+$	0.2 ns *1*	J$^\pi$: maximum alignment of $\pi(g_{7/2}d_{5/2})^9$ configuration.
4187.9 *7*	$(23/2^+)$		Possible configuration=$\pi(g_{7/2}d_{5/2})^9\otimes\nu(f_{7/2}h^{-1}_{11/2})$.
4296.7 *7*	$(25/2^-)$		
4370.5 *6*	$27/2^-$		
4381.7 *7*	$(25/2^-)$		
4430.3 *7*	$(25/2^-)$		
4546.9 *9*	$(27/2^-)$		
4592.0 *8*	$(25/2^-)$		$25/2^-$ in Table II of 2015Li21 is tentative in the level-scheme in Fig. 1.
4740.8 *7*	$(27/2^-)$		
4826.8 *7*	$(25/2^+)$		
4906.9 *9*	$(25/2^-)$		
4988.6 *7*	$(29/2^-)$		
5040.0 *7*	$(29/2^-)$		
5103.7 *8*	$(31/2^-)$		
5142.5 *7*	$(27/2^+)$		
5747.4 *10*	$(29/2^+)$		
6239.7 *11*	$(35/2^-)$		Possible configuration=$\pi(g_{7/2}d_{5/2})^8h^1_{11/2}$ which gives maximum angular momentum of 35/2.

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^{138}Ba(^{7}Li,4nγ) 2015Li21 (continued)

^{141}Pr Levels (continued)

† From a least-squares fit to γ-ray energies.
‡ Adopted values.
# As given in 2015Li21 based on measured $\gamma\gamma$(ADO) combined with theoretical calculations and systematics with tentative configurations sustaining parity assignments.

$\gamma(^{141}Pr)$

E_γ†	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.@	δ	Comments
(29.1#)		1796.7	$15/2^+$	1767.6	$13/2^+$			
74.2 *7*	<3	3471.0	$23/2^-$	3396.8	$21/2^-$			$J^\pi=23/2^+$ for the initial level in Table II of 2015Li21 seems a misprint.
89.7 *7*	<3	3017.0	$(21/2^+)$	2927.3	$(19/2^-)$	E1		α(exp)=0.35 *8* Mult.: from α(exp) (deduced from intensity balance).
91.6 *5*	18.4 *24*	3018.9	$(21/2^-)$	2927.3	$(19/2^-)$	M1+E2	1.7 *6*	α(exp)=2.60 *32* Mult.: from α(exp) (deduced from intensity balance). ADO=0.38 *13*.
116.6‡ *5*	7.9 *14*	4546.9	$(27/2^-)$	4430.3	$(25/2^-)$			ADO=0.95 *38*. Mult.: D or Q transition based on ADO adopted as M1+E2 by 2015Li21 as based on level scheme placement.
122.2 *7*	4.4 *9*	2108.3	$(15/2^+)$	1986.1	$(13/2^+)$	D(+Q)		ADO=0.66 *19*.
145.4 *3*	100.0 *94*	145.41	$7/2^+$	0.0	$5/2^+$			ADO=1.02 *11*. Mult.: Q transition based on ADO contradicts ΔJ=1 based on level scheme placement.
218.5 *7*	2.3 *5*	1986.1	$(13/2^+)$	1767.6	$13/2^+$			
247.8 *7*	3.8 *7*	4988.6	$(29/2^-)$	4740.8	$(27/2^-)$			
272.3 *3*	99 *17*	2069.0	$17/2^+$	1796.7	$15/2^+$	D+Q		ADO=0.85 *3*.
273.4 *3*	25 *17*	1767.6	$13/2^+$	1494.2	$11/2^+$	D+Q		ADO=0.64 *3*.
299.2 *5*	8.6 *14*	5040.0	$(29/2^-)$	4740.8	$(27/2^-)$	D+Q		ADO=0.74 *18*.
301.4 *7*	4.4 *57*	2069.0	$17/2^+$	1767.6	$13/2^+$			
302.5 *3*	27.6 *57*	1796.7	$15/2^+$	1494.2	$11/2^+$	Q		ADO=1.30 *10*.
310.1 *5*	7.2 *11*	1767.6	$13/2^+$	1457.5	$(9/2^+)$	Q		$J^\pi=13/2^-$ for the initial level in Table II of 2015Li21 seems a misprint; $13/2^+$ in the level scheme (Fig. 1) is in agreement with adopted value (based on different measurements). ADO=1.03 *11*.
311.6 *5*	8.6 *13*	2108.3	$(15/2^+)$	1796.7	$15/2^+$	Q		ADO=1.09 *15*. Mult.: Q transition compatible with ΔJ=0 based on level scheme placement.
315.7 *5*	5.7 *9*	5142.5	$(27/2^+)$	4826.8	$(25/2^+)$	D+Q		ADO=0.64 *12*. Mult.: D+Q transition based on ADO adopted as M1+E2 by 2015Li21 as based on level scheme placement.
340.7 *7*	3.5 *6*	2108.3	$(15/2^+)$	1767.6	$13/2^+$			
362.9 *7*	4.3 *6*	5103.7	$(31/2^-)$	4740.8	$(27/2^-)$	Q		ADO=1.19 *18*.
370.3 *7*	<2	4740.8	$(27/2^-)$	4370.5	$27/2^-$			
377.9& *7*	<2	3396.8	$21/2^-$	3018.9	$(21/2^-)$			
434.0 *5*	8.7 *11*	3396.8	$21/2^-$	2962.8	$19/2^+$	D(+Q)		ADO=0.76 *12*.
454.0 *3*	46.5 *52*	3471.0	$23/2^-$	3017.0	$(21/2^+)$	D		ADO=0.70 *3*.
465.7 *7*	<2	1986.1	$(13/2^+)$	1520.5	$9/2^+$			
507.6 *5*	10.9 *27*	3526.5	$(23/2^-)$	3018.9	$(21/2^-)$	D(+Q)		ADO=0.76 *8*.
509.5 *5*	16.1 *27*	3526.5	$(23/2^-)$	3017.0	$(21/2^+)$	D+Q		ADO=0.60 *5*.

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^{138}Ba(^{7}Li,4nγ) 2015Li21 (continued)

$\gamma(^{141}Pr)$ (continued)

E_γ [†]	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult. [@]	Comments
568.5 *5*	16.6 *18*	3585.5	$23/2^+$	3017.0	$(21/2^+)$	D(+Q)	ADO=0.65 *7*.
604.9 *7*	3.8 *5*	5747.4	$(29/2^+)$	5142.5	$(27/2^+)$	D+Q	ADO=0.30 *7*. Mult.: D+Q transition based on ADO adopted as M1+E2 by 2015Li21 as based on level scheme placement.
606.9 *7*	3.6 *5*	4988.6	$(29/2^-)$	4381.7	$(25/2^-)$		
618.1 *7*	4.3 *6*	4988.6	$(29/2^-)$	4370.5	$27/2^-$	D+Q	ADO=0.54 *13*.
622.7 *7*	4.9 *6*	3585.5	$23/2^+$	2962.8	$19/2^+$	Q	ADO=1.10 *25*. Mult.: Q transition based on ADO adopted as E2 by 2015Li21 as based on level scheme placement.
650.2 *3*	95.7 *98*	1767.6	$13/2^+$	1117.4	$11/2^-$	D(+Q)	ADO=0.69 *4*.
669.5 *5*	8.6 *10*	5040.0	$(29/2^-)$	4370.5	$27/2^-$	D+Q	ADO=0.77 *10*.
691.9 *7*	2.6 *4*	4988.6	$(29/2^-)$	4296.7	$(25/2^-)$		
711.2 *7*	4.2 *5*	4296.7	$(25/2^-)$	3585.5	$23/2^+$	D(+Q)	ADO=0.69 *10*.
733.2 *7*	4.8 *6*	5103.7	$(31/2^-)$	4370.5	$27/2^-$	Q	ADO=1.22 *25*.
772.0 *7*	2.9 *5*	5142.5	$(27/2^+)$	4370.5	$27/2^-$		
796.2 *7*	2.5 *5*	4381.7	$(25/2^-)$	3585.5	$23/2^+$		
825.7 *7*	2.1 *4*	4296.7	$(25/2^-)$	3471.0	$23/2^-$		
844.0 *5*	5.8 *7*	4370.5	$27/2^-$	3526.5	$(23/2^-)$	Q	ADO=1.07 *18*.
854.5 *5*	10.2 *12*	2962.8	$19/2^+$	2108.3	$(15/2^+)$	Q	ADO=1.06 *17*.
858.3 *3*	55.4 *61*	2927.3	$(19/2^-)$	2069.0	$17/2^+$	D	ADO=0.74 *4*.
868.7 *5*	5.2 *9*	1986.1	$(13/2^+)$	1117.4	$11/2^-$	D(+Q)	ADO=0.71 *10*.
893.8 *5*	11.1 *13*	2962.8	$19/2^+$	2069.0	$17/2^+$	(D+Q)	ADO=0.40 *5*.
899.5 *3*	23.9 *28*	4370.5	$27/2^-$	3471.0	$23/2^-$	Q	ADO=1.15 *9*.
903.8 *5*	6.2 *8*	4430.3	$(25/2^-)$	3526.5	$(23/2^-)$	(D+Q)	ADO=0.84 *17*.
910.7 *7*	2.1 *4*	4381.7	$(25/2^-)$	3471.0	$23/2^-$		
948.0 *3*	75.5 *86*	3017.0	$(21/2^+)$	2069.0	$17/2^+$	Q	ADO=1.15 *6*.
959.3 *7*	3.6 *5*	4430.3	$(25/2^-)$	3471.0	$23/2^-$	D+Q	ADO=0.65 *12*.
972.0 *3*	92 *11*	1117.4	$11/2^-$	145.41	$7/2^+$	(Q)	ADO=1.00 *36*. Mult.: tentative Q transition; D not excluded.
1117.4 *5*	10.8 *15*	1117.4	$11/2^-$	0.0	$5/2^+$		ADO=1.14 *10*. Mult.: Q transition based on ADO contradicts ΔJ=3 based on level scheme placement.
1121.0 *7*	4.2 *6*	4592.0	$(25/2^-)$	3471.0	$23/2^-$		
1136.0 *7*	2.5 *4*	6239.7	$(35/2^-)$	5103.7	$(31/2^-)$		
1166.1 *7*	4.8 *7*	2962.8	$19/2^+$	1796.7	$15/2^+$	Q	ADO=1.31 *26*. Mult.: Q transition based on ADO adopted as E2 by 2015Li21 as based on level scheme placement.
1170.9 *5*	5.2 *9*	4187.9	$(23/2^+)$	3017.0	$(21/2^+)$	D+Q	ADO=0.66 *12*. Mult.: D+Q transition based on ADO adopted as M1+E2 by 2015Li21 as based on level scheme placement.
1241.3 *5*	5.3 *8*	4826.8	$(25/2^+)$	3585.5	$23/2^+$	D+Q	ADO=0.68 *10*. Mult.: D+Q transition based on ADO adopted as M1+E2 by 2015Li21 as based on level scheme placement.
1269.8 *5*	12.0 *17*	4740.8	$(27/2^-)$	3471.0	$23/2^-$	Q	ADO=1.13 *14*.
1277.8 *7*	3.7 *6*	4296.7	$(25/2^-)$	3018.9	$(21/2^-)$	Q	ADO=1.13 *24*.
1312.1 *5*	5.9 *9*	1457.5	$(9/2^+)$	145.41	$7/2^+$	D(+Q)	ADO=0.69 *12*.
1348.8 *3*	55.3 *78*	1494.2	$11/2^+$	145.41	$7/2^+$	Q	ADO=0.89 *7*.
1355.8 *7*	2.7 *5*	4826.8	$(25/2^+)$	3471.0	$23/2^-$		
1362.8 *7*	3.9 *7*	4381.7	$(25/2^-)$	3018.9	$(21/2^-)$	Q	ADO=1.17 *21*.
1380.4 *7*	3.8 *6*	4906.9	$(25/2^-)$	3526.5	$(23/2^-)$		ADO=0.99 *19*. Mult.: Q transition based on ADO adopted as M1+E2 by 2015Li21 as based on level scheme placement.
1457.5 *7*	<2	1457.5	$(9/2^+)$	0.0	$5/2^+$		

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^{138}Ba(^{7}Li,4nγ) 2015Li21 (continued)

$\gamma(^{141}Pr)$ (continued)

E_γ [†]	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult. [@]	Comments
1509.1 *7*	2.4 *6*	2626.5	$(15/2^-)$	1117.4	$11/2^-$		
1520.6 *7*	2.2 *4*	1520.5	$9/2^+$	0.0	$5/2^+$		
1573.1 *7*	3.6 *7*	4592.0	$(25/2^-)$	3018.9	$(21/2^-)$	(Q)	ADO=1.12 *32*.

† Uncertainties of γ-ray energies are $\Delta E\gamma$=0.3 keV for $I\gamma \geq 20$, 0.5 keV for $5 < I\gamma \leq 20$, and 0.7 keV for $I\gamma < 5$ (figures established by priv. comm. of xundl compilers with first author of 2015Li21).

‡ Transition replaced from 3643.5 in ^{139}La(α,2nγ) dataset.

From Fig. 1 but not listed in Table II of 2015Li21. This transition may not have been observed by 2015Li21 but included in the level scheme from literature, with energy deduced from level-energy difference.

@ Adopted by evaluator based on 2015Li21 measured ADO ratios. ADO ratio is defined as $I\gamma(\approx 40°)/I\gamma(\approx 90°)$ with typical values ≈1 for stretched quadrupole (or ΔJ=0 dipole) and ≈0.7 for stretched pure dipole. The quadrupole transitions are likely E2 while it is more difficult to assign the electric or magnetic character for dipole transitions without extra parity-sensitive measurements.

& Placement of transition in the level scheme is uncertain.

^{138}Ba(^{7}Li,4nγ) 2015Li21

Level Scheme

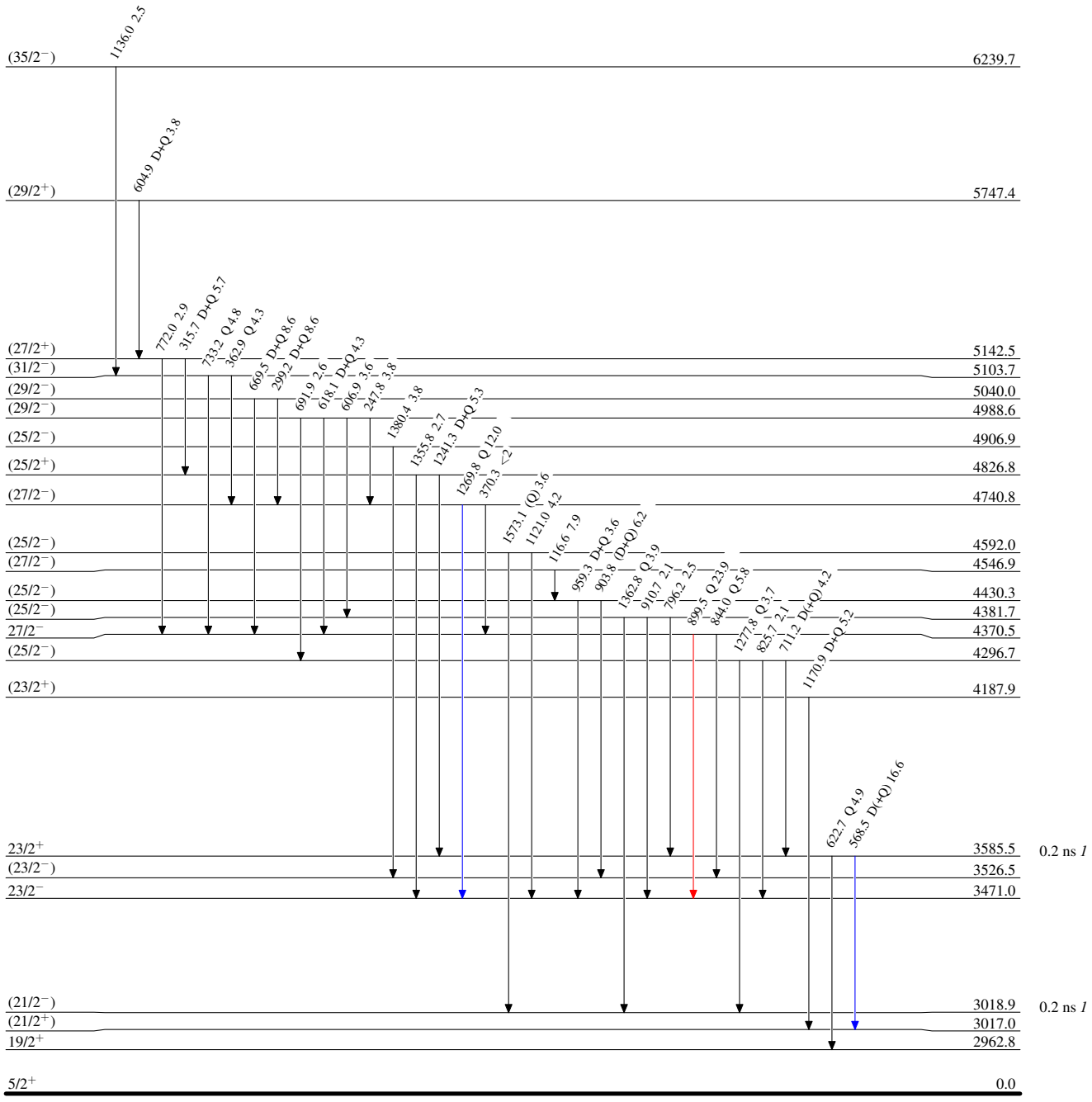
Intensities: Relative I_γ

Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$



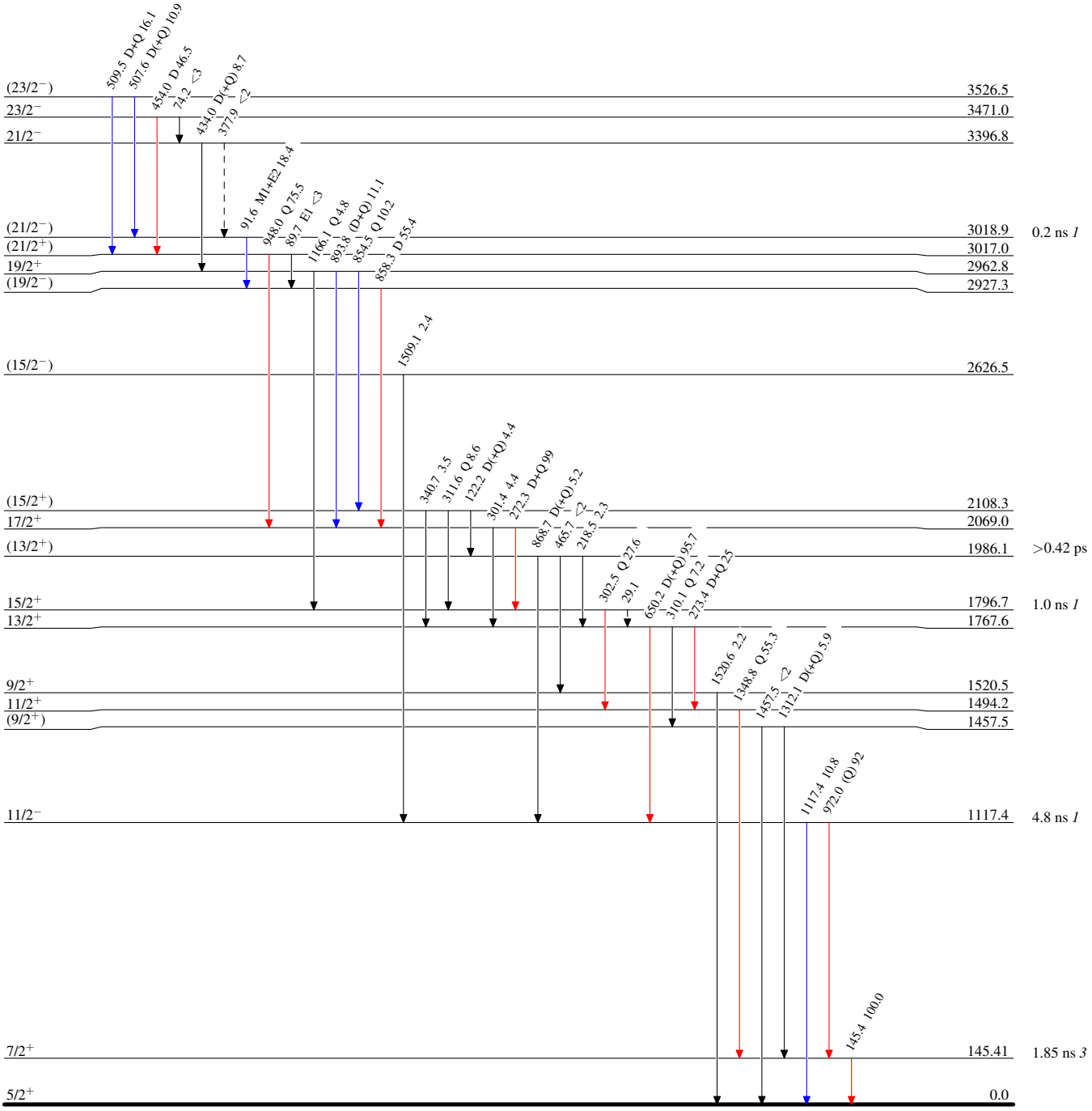
$^{141}_{59}Pr_{82}$

^{138}Ba(^{7}Li,4nγ) **2015Li21**

Level Scheme (continued)

Intensities: Relative I_γ

Legend
- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- γ Decay (Uncertain)



$^{141}_{59}Pr_{82}$