

Odd Z
 $T_z = +9/2$

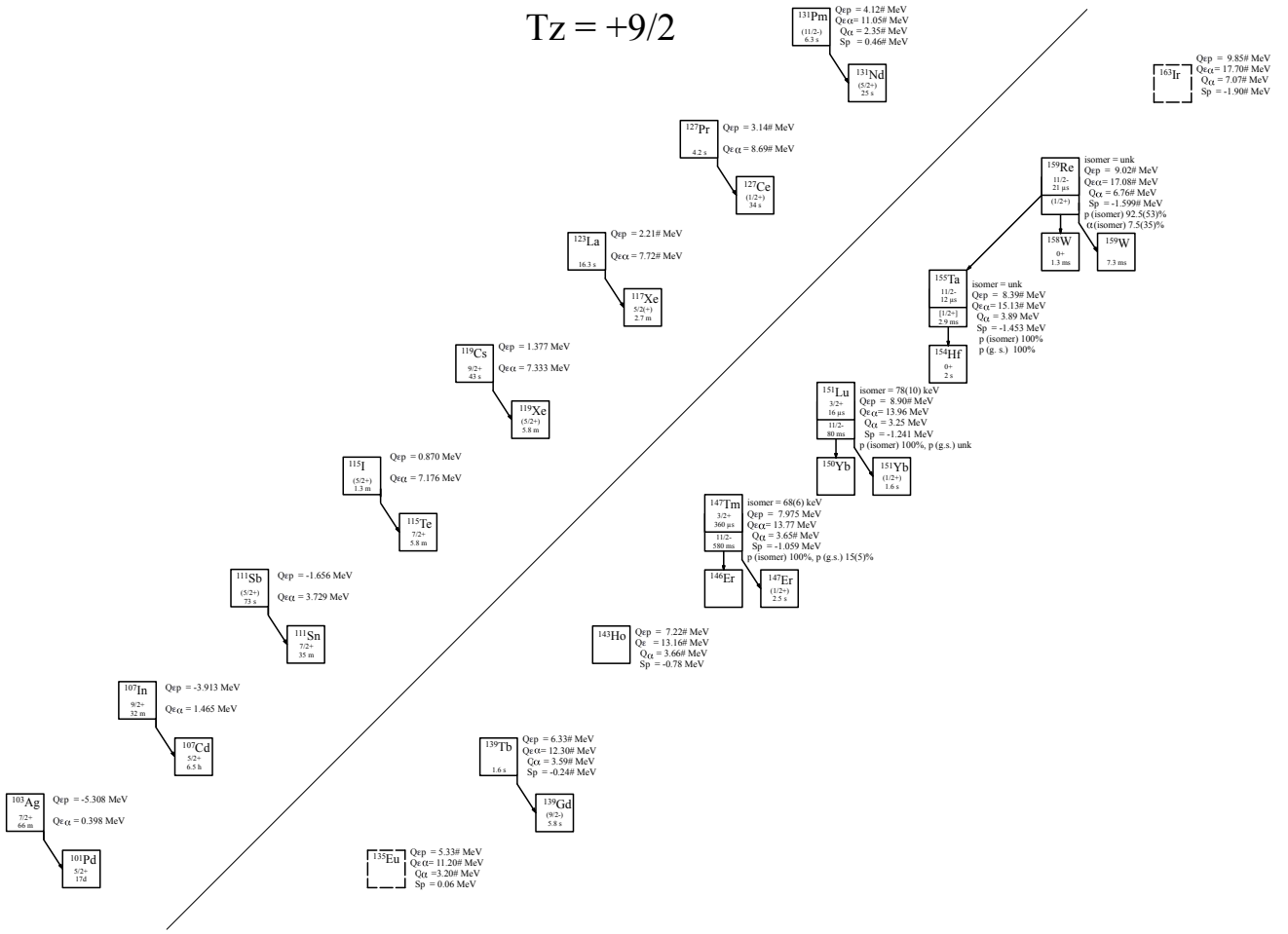


Fig. 1: Known experimental values for heavy particle emission of the odd-Z $T_z = +9/2$ nuclei.

Last updated 3/21/23

Table 1

Observed and predicted β -delayed particle emission from the odd- Z , $T_z = +9/2$ nuclei. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein. J^π values for ^{103}Ag , ^{107}In , ^{111}Sb , ^{115}I , ^{119}Cs , ^{123}La , ^{127}Pr , ^{131}Pm , ^{135}Eu , ^{139}Tb , ^{143}Ho are taken from ENSDF.

Nuclide	Ex	J^π	$T_{1/2}$	Q_ϵ	$Q_{\epsilon p}$	$BR_{\beta p}$	$Q_{\epsilon 2p}$	$Q_{\epsilon \alpha}$	Experimental
^{103}Ag		$7/2^+$	65.7(7) m	2.654(4)	-5.308(8)	—	-11.423(4)	0.398(4)	[1975Di09]
^{107}In		$9/2^+$	32.4(3) m	3.424(10)	-3.913(10)	—	-9.727(10)	1.465(10)	[1973Ny03]
^{111}Sb		$(5/2^+)$	73(1) s	5.102(10)	-1.656(15)	—	-6.910(9)	3.729(9)	[1976Wi10]
^{115}I		$(5/2^+)$	1.3(2) m	5.72(40)	0.870(35)		-2.588(29)	7.176(29)	[1969Ha03]
^{119}Cs		$9/2^+$	43.0(2) s	6.489(17)	1.377(24)		-1.788(19)	7.333(31)	[1984IcZY]
^{123}La			16.3(3) s	7.00(20)#	2.21(20)#		-0.75(20)#	7.72(20)#	[1992Ic02]
^{127}Pr			4.2(3) s	7.44(20)#	3.14(22)#		0.55(20)#	8.69(20)#	[1995Gi12]
^{131}Pm		$(11/2^-)$	6.3(8) s	8.00(20)#	4.12(21)#		1.94(20)#	9.78(20)#	[1999Ga41]
^{135}Eu				8.71(25)#	5.327(20)#		3.61(20)#	11.20(20)#	
^{139}Tb			1.6(2) s	9.50(36)#	6.33(30)#		5.28(30)#	12.30(34)#	[1999Xi04]
^{143}Ho				10.12(30)#	7.22(76)#		6.60(30)#	13.16(36)#	
^{147}Tm		$11/2^-$	615(45) ms	10.63(40)	7.975(9)		7.690(9)	13.770(15)	[1993Se04, 1993To02]
^{147m}Tm	0.068(6)*	$3/2^+$	375(5) μs	10.70(40)	8.043(11)		7.758(11)	13.838(16)	[2023Au03]
^{151}Lu		$11/2^-$	78(1) ms	11.24(43)#	8.90(36)#		8.86(30)#	13.88(30)	[2015Ta12]
^{151m}Lu	0.078(10)*	$3/2^+$	17(1) μs	11.32(43)#	8.98(36)#		8.894(30)#	13.96(32)	[2015Ta12]
^{155}Ta		$(1/2^+)$	$2.9^{+1.5}_{-1.1}$ ms	10.32(42)#	8.39(36)#		8.59(36)#	15.13(43)	[2007Pa27]
^{155m}Ta	x	$11/2^-$	12^{+4}_{-3} μs	10.32(42)#+x	8.39(36)#+x		8.59(36)#+x	15.13(43)+x	[1999Uu01]
^{159}Re		$(1/2^+)$		10.63(43)#	9.02(37)#		9.47(37)#	17.08(43)#	
^{159m}Re	x	$11/2^-$	21(4) μs	10.63(43)#+x	9.02(37)#+x		9.47(37)#+x	17.08(43)#+x	[2006Jo10]
^{163}Ir				11.03(50)#	9.85(45)#		10.62(45)#	17.70(50)#	

* From difference in Sp.

Table 2

Particle separation and emission from the odd- Z , $T_z = +9/2$ nuclei. Unless otherwise stated, all Q-values and separation energies are taken from [2021Wa16] or deduced from values therein.

Nuclide	S_p	BR_p	S_{2p}	Q_α	BR_α	Experimental
^{103}Ag	4.189(4)	—	11.968(7)	-1.643(20)	—	
^{107}In	3.723(10)	—	11.074(11)	-1.189(10)	—	
^{111}Sb	2.284(16)	—	8.925(10)	0.305(13)		
^{115}I	1.737(38)	—	6.499(34)	2.074(30)		
^{119}Cs	1.515(17)	—	6.444(29)	1.608(32)		
^{123}La	1.33(20)#	—	6.13(13)#	1.23(20)#		
^{127}Pr	1.01(20)#	—	5.36(20)#	1.68(28)#		
^{131}Pm	0.46(20)#	—	4.58(20)#	2.35(28)#		
^{135}Eu	0.06(28)#		3.32(20)#	3.20(28)#		
^{139}Tb	-0.24(36)#		2.56(30)#	3.59(36)#		
^{143}Ho	-0.78(79)#		2.09(32)#	3.66(42)#		
^{147}Tm	-1.059(3)	15(5)%	1.432(10)	3.65(30)		[1993Se04, 1993To02, 2023Au03, 2008Ra03, 2007Ra37, 2007HeZV, 2007RaZZ, 2004SeZW, 1997Se03, 1995Ho26, 1995PeZY, 1993WoZY, 1988ToZW, 1984HoZN, 1983La27, 1982KI03]
^{147m}Tm	-1.127(7)	100%	1.500(12)	3.72(31)		[1993Se04, 2023Au03, 1993To02, 1997Se03, 1995PeZY, 1995Ho26, 1995PeZY, 1993WoZY]
^{151}Lu	-1.232(4)*	**	0.94(36)	3.25(30)		[2015Ta12, 1999Bi14, 1997Mo25, 1993Se04, 1982Ho04, 2017Wa18, 2017Wa47, 2013Pr05, 2007LiZR, 2003Pr05, 2003YuZW, 1999BaZR, 1998BaZU, 1982Ho04]
^{151m}Lu	-1.319(10)	100%	1.02(37)	3.33(32)		[2015Ta12, 2017Wa18, 2017Wa47, 1999Bi14, 1997Mo25, 1993Se04, 2013Pr05, 2007LiZR, 2003YuZW, 1999BaZR, 1999BaZZ]
^{155}Ta	-1.453(15)	100%	0.19(334)	3.89(42)		[2007Pa27]
^{155m}Ta	-1.453(15)-x	100%	0.19(33)-x	3.89(42)+x		[1999Uu01]
^{159}Re	-1.599(53)#		-0.21(34)#	6.76(55)#		
^{159m}Re	-1.599(53)#-x	92.5(35)%	-0.21(34)#-x	6.76(55)#+x	7.5(35)%	[2007Pa27, 2006Jo10, 2007JoZX, 2007PaZT]
^{163}Ir	-1.90(50)#		-0.95(43)#	7.07(50)#		

* Deduced from proton energy, -1.241(2) MeV in [2021Wa16].

** β -decay branch not measured.

Table 3
direct p emission from $^{147}\text{Tm}^*$, $J^\pi = 11/2^-$, $T_{1/2} = 615(45)$ ms**, $BR_p = 15(5)\%$.

$E_p(\text{c.m.})$	$E_p(\text{lab})$	$I_p(\text{rel})$	$I_p(\text{absb})$	J_f^π	$E_{\text{daughter}}(^{146}\text{Er})$	coincident γ -rays
1.071(33)	1.0510(33)***	100%	15(5)%	0^+	0.0	—

* All values from [1993To02], except where noted.

** Weighted average of 580(70) ms [1993Se04], and 640(60) ms [1993To02].

*** [1993Se04].

Table 4
direct p emission from $^{147m}\text{Tm}^*$, $E_x = 68(6)$ keV, $J^\pi = 3/2^+$, $T_{1/2} = 360(40)$ ms, $BR_p = 100\%$.

$E_p(\text{c.m.})$	$E_p(\text{lab})$	$I_p(\text{rel})$	$I_p(\text{absb})$	J_f^π	$E_{\text{daughter}}(^{146}\text{Er})$	coincident γ -rays
1.1315(39)	1.1108(39)	100%	100%	0^+	0.0	—

* All values from [1993Se04].

Table 5
direct p emission from $^{151}\text{Lu}^*$, $J^\pi = 11/2^-$, $T_{1/2} = 78(1)$ ms.

$E_p(\text{c.m.})$	$E_p(\text{lab})$	$I_p(\text{rel})$	$I_p(\text{absb})$	J_f^π	$E_{\text{daughter}}(^{150}\text{Yb})$	coincident γ -rays
1.240(4)	1.232(4)			0^+	0.0	—

* All values from [2015Ta12].

Table 6
direct p emission from $^{151m}\text{Lu}^*$, $E_x = 78(10)$ keV, $J^\pi = 3/2^+$, $T_{1/2} = 17(1)$ μs , $BR_p = 100\%$.

$E_p(\text{c.m.})$	$E_p(\text{lab})$	$I_p(\text{rel})$	$I_p(\text{absb})$	J_f^π	$E_{\text{daughter}}(^{150}\text{Yb})$	coincident γ -rays
1.294(4)	1.285(4)	100%	100%	0^+	0.0	—

* All values from [2015Ta12].

Table 7
direct p emission from $^{155}\text{Ta}^*$, $J^\pi = (1/2^+)$, $T_{1/2} = 2.9^{+15}_{-11}$ ms, $BR_p = 100\%$.

$E_p(\text{c.m.})$	$E_p(\text{lab})$	$I_p(\text{rel})$	$I_p(\text{absb})$	J_f^π	$E_{\text{daughter}}(^{154}\text{Hf})$	coincident γ -rays
1.453(15)	1.444(15)	100%	100%	0^+	0.0	—

* All values from [2007Pa27].

Table 8
direct p emission from $^{155m}\text{Ta}^*$, $E_x = \text{unk.}$, $J^\pi = 11/2^-$, $T_{1/2} = 12^{+4}_{-3}$ μs , $BR_p = 100\%$.

$E_p(\text{c.m.})$	$E_p(\text{lab})$	$I_p(\text{absb})$	J_f^π	$E_{\text{daughter}}(^{154}\text{Hf})$	coincident γ -rays
1.776(10)	1.765(10)	100%			

* All values from [1999Uu01].

Table 9
direct p emission from $^{159m}\text{Re}^*$, $E_x = \text{unk.}$, $J^\pi = 11/2^-$, $T_{1/2} = 21(4)$ μs , $BR_p = 92.5(35)\%$.

$E_p(\text{c.m.})$	$E_p(\text{lab})$	$I_p(\text{rel})$	$I_p(\text{absb})$	J_f^π	$E_{\text{daughter}}(^{158}\text{W})$	coincident γ -rays
1.816(20)	1.805(20)	100%	92.5(35)%	0^+	0.0	—

* All values from [2006Jo10].

Table 10
direct α emission from $^{159m}\text{Re}^*$, Ex = unk., $J^\pi = 11/2^-$, $T_{1/2} = 21(4) \mu\text{s}^{**}$, $BR_\alpha = 7.5(35)\%$.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_p (absb)	J_f^π	$E_{\text{daughter}}(^{155}\text{Ta})$	coincident γ -rays
6.950(26)	6.776(26)	100%	7.5(35)%	0 ⁺	0.0	—

* All values from [2007Pa27], except where noted.

** [2006Jo10]

References used in the Tables

- [1] **1969Ha03** P. G. Hansen, P. Hornshoj, H. L. Nielsen, K. Wilsky, H. Kugler, G. Astner, E. Hagebo, J. Hudis, A. Kjelberg, F. Munnich, P. Patzelt, M. Alpsten, G. Andersson, A. Appelqvist, B. Bengtsson, R. A. Naumann, O. B. Nielsen, E. Beck, R. Foucher, J. P. Husson, J. Jastrzebski, A. Johnson, J. Alstad, T. Jahnsen, A. C. Pappas, T. Tunaal, R. Henck, P. Siffert, G. Rudstam, Phys. Lett. **28B**, 415 (1969); Erratum Phys. Lett. **28B**, 663 (1969). [https://doi.org/10.1016/0370-2693\(69\)90337-2](https://doi.org/10.1016/0370-2693(69)90337-2)
- [2] **1973Ny03** B. Nyman, A. Johansson, W. Dietrich, A. Backlin, H. Pettersson, B. Svahn, C. O. Lannergard, Phys. Scr. **7**, 265 (1973). <https://doi.org/10.1088/0031-8949/7/6/004>
- [3] **1975Di09** W. Dietrich, B. Nyman, A. Johansson, A. Backlin, Phys. Scr. **12**, 80 (1975). <https://doi.org/10.1088/0031-8949/12/1-2/009>
- [4] **1976Wi10** M. E. J. Wigmans, R. J. Heynis, P. M. A. van der Kam, H. Verheul, Phys. Rev. **C14**, 229 (1976). <https://doi.org/10.1103/PhysRevC.14.229>
- [5] **1982Ho04** S. Hofmann, W. Reisdorf, G. Munzenberg, F. P. Hessberger, J. R. H. Schneider, P. Armbruster, Z. Phys. **A305**, 111 (1982). <https://doi.org/10.1007/BF01415018>
- [6] **1982Kl03** O. Klepper, T. Batsch, S. Hofmann, R. Kirchner, W. Kurcewicz, W. Reisdorf, E. Roeckl, D. Schardt, G. Nyman, Z. Phys. **A305**, 125 (1982). <https://doi.org/10.1007/BF01415019>
- [7] **1983La27** P. O. Larsson, T. Batsch, R. Kirchner, O. Klepper, W. Kurcewicz, E. Roeckl, D. Schardt, W. F. Feix, G. Nyman, P. Tidemand-Petersson, Z. Phys. **A314**, 9 (1983).
- [8] **1984HoZN** S. Hofmann, Y. K. Agarwal, P. Armbruster, F. P. Hessberger, P. O. Larsson, G. Munzenberg, K. Poppensieker, W. Reisdorf, J. R. H. Schneider, H. J. Schott, Proc. Intern. Conf. Atomic Masses and Fundamental Constants, 7th, Darmstadt-Seeheim, p. 184 (1984).
- [9] **1984IcZY** S. -C. Ichikawa, T. Sekine, K. Hata, T. Tamura, E. Minehara, N. Takahashi, I. Fujiwara, N. Imanishi, Japan Atomic Energy Res. Int. Tandem, Ann. Rept. , 1983, p. 60 (1984).
- [10] **1988ToZW** K. S. Toth, J. M. Nitschke, P. A. Wilmarth, Y. A. Ellis-Akovali, D. C. Sousa, K. Vierinen, D. M. Moltz, J. Gilat, N. M. Rao, Proc. 5th Int. Conf. Nuclei Far from Stability, Rosseau Lake, Canada 1987, Ed. , I. S. Towner, p. 718 (1988).
- [11] **1992Ic02** S. -I. Ichikawa, T. Sekine, M. Oshima, H. Iimura, Y. Nakahara, Nucl. Instrum. Methods Phys. Res. **B70**, 93 (1992). [https://doi.org/10.1016/0168-583X\(92\)95915-E](https://doi.org/10.1016/0168-583X(92)95915-E)
- [12] **1993Se04** P. J. Sellin, P. J. Woods, T. Davinson, N. J. Davis, K. Livingston, R. D. Page, A. C. Shotter, S. Hofmann, A. N. James, Phys. Rev. **C47**, 1933 (1993). <https://doi.org/10.1103/PhysRevC.47.1933>
- [13] **1993To02** K. S. Toth, D. C. Sousa, P. A. Wilmarth, J. M. Nitschke, K. S. Vierinen, Phys. Rev. **C47**, 1804 (1993). <https://doi.org/10.1103/PhysRevC.47.1804>
- [14] **1993WoZY** P. J. Woods, T. Davinson, N. J. Davis, S. Hofmann, A. James, K. Livingston, R. D. Page, P. J. Sellin, A. C. Shotter, Proc. 6th Intern. Conf. on Nuclei Far from Stability + 9th Intern. Conf. on Atomic Masses and Fundamental Constants, Bernkastel-Kues, Germany, 19-24 July, 1992, R. Neugart, A. Woehr, Eds. , p. 323 (1993)
- [15] **1995Gi12** A. Gizon, J. Genevey, D. Barneoud, A. Astier, R. Beraud, Gh. Cata-Danil, A. Emsallem, J. Gizon, Y. Le Coz, C. F. Liang, P. Paris, Z. Phys. **A351**, 361 (1995). <https://doi.org/10.1007/BF01291139>
- [16] **1995Ho26** S. Hofmann, Radiochim. Acta **70/71**, 93 (1995).
- [17] **1995PeZY** H. Penttila, C. N. Davids, P. J. Woods, J. C. Batchelder, C. R. Bingham, D. J. Blumenthal, L. T. Brown, B. C. Busse, L. F. Conticchio, S. J. Freeman, M. Freer, D. J. Henderson, R. D. Page, A. V. Ramayya, K. S. Toth, W. B. Walters, A. H.

- Wuosmaa, B. E. Zimmerman, Proc. Intern. Conf on Exotic Nuclei and Atomic Masses, Arles, France, June 19-23, 1995, p. 313 (1995).
- [18] **1997Mo25** P. Moller, J. R. Nix, K. -L. Kratz, At. Data Nucl. Data Tables **66**, 131 (1997). <https://doi.org/10.1006/adnd.1997.0746>
- [19] **1997Se03** D. Seweryniak, C. N. Davids, W. B. Walters, P. J. Woods, I. Ahmad, H. Amro, D. J. Blumenthal, L. T. Brown, M. P. Carpenter, T. Davinson, S. M. Fischer, D. J. Henderson, R. V. F. Janssens, T. L. Khoo, I. Hibbert, R. J. Irvine, C. J. Lister, J. A. Mackenzie, D. Nisius, C. Parry, R. Wadsworth, Phys. Rev. C55, **R2137** (1997). <https://doi.org/10.1103/PhysRevC.55.R2137>
- [20] **1999BaZR** J. C. Batchelder, C. R. Bingham, C. J. Gross, R. Grzywacz, K. Rykaczewski, K. S. Toth, E. F. Zganjar, Y. Akaoli, T. Davinson, T. N. Ginter, J. H. Hamilton, Z. Janas, M. Karny, S. H. Kim, B. D. MacDonald, J. F. Mas, J. W. McConnell, A. Piechaczek, J. J. Ressler, R. C. Slinger, J. Szerypo, W. Weintraub, P. J. Woods, C. -H. Yu, Proc. Nuclear Structure 98, Gatlinburg, Tenn. , C. Baktash, Ed. , p. 216 (1999); AIP Conf. Proc. **481** (1999).
- [21] **1998BaZU** J. C. Batchelder, C. R. Bingham, K. Rykaczewski, K. S. Toth, T. Davinson, T. N. Ginter, C. J. Gross, R. Grzywacz, M. Karny, S. H. Kim, J. F. Mas, J. W. McConnell, B. D. MacDonald, A. Piechaczek, J. J. Ressler, R. C. Slinger, J. Szerypo, W. Weintraub, P. J. Woods, C. -H. Yu, E. F. Zganjar, Contrib. Nuclear Structure '98, Gatlinburg, p. 8 (1998).
- [22] **1999BaZR** J. C. Batchelder, C. R. Bingham, C. J. Gross, R. Grzywacz, K. Rykaczewski, K. S. Toth, E. F. Zganjar, Y. Akaoli, T. Davinson, T. N. Ginter, J. H. Hamilton, Z. Janas, M. Karny, S. H. Kim, B. D. MacDonald, J. F. Mas, J. W. McConnell, A. Piechaczek, J. J. Ressler, R. C. Slinger, J. Szerypo, W. Weintraub, P. J. Woods, C. -H. Yu, Proc. Nuclear Structure 98, Gatlinburg, Tenn. , C. Baktash, Ed. , p. 216 (1999); AIP Conf. Proc. **481** (1999).
- [23] **1999Bi14** C. R. Bingham, J. C. Batchelder, K. Rykaczewski, K. S. Toth, C. -H. Yu, T. N. Ginter, C. J. Gross, R. Grzywacz, M. Karny, S. H. Kim, B. D. MacDonald, J. Mas, J. W. McConnell, P. B. Semmes, J. Szerypo, W. Weintraub, E. F. Zganjar, Phys. Rev. C59, **R2984** (1999). <https://doi.org/10.1103/PhysRevC.59.R2984>
- [24] **1999Ga41** Z. G. Gan, Z. Qin, J. S. Guo, L. J. Shi, H. Y. Liu, T. R. Guo, X. G. Lei, R. C. Ma, W. X. Huang, S. G. Yuan, X. Q. Zhang, G. M. Jin, Eur. Phys. J. A **6**, 59 (1999). <https://doi.org/10.1007/s100500050317>
- [25] **1999Uu01** J. Uusitalo, C. N. Davids, P. J. Woods, D. Seweryniak, A. A. Sonzogni, J. C. Batchelder, C. R. Bingham, T. Davinson, J. deBoer, D. J. Henderson, H. J. Maier, J. J. Ressler, R. Slinger, W. B. Walters, Phys. Rev. C59, **R2975** (1999). <https://doi.org/10.1103/PhysRevC.59.R2975>
- [26] **1999Xi04** Y. Xie, S. Xu, Z. Li, Y. Yu, Q. Pan, C. Wang, T. Zhang, Eur. Phys. J. A **6**, 239 (1999). <https://doi.org/10.1007/s100500050340>
- [27] **2003Pr05** J. Praena, E. Buendia, F. J. Galvez, A. Sarsa, Phys. Rev. C **67**, 044301 (2003). <https://doi.org/10.1103/PhysRevC.67.044301>
- [28] **2003YuZW** C. -H. Yu, J. C. Batchelder, C. R. Bingham, C. J. Gross, R. Grzywacz, K. Rykaczewski, Proc. 2nd Inter. Sym. Proton Emitting Nuclei (PROCON 2003), Legnaro, Italy, 112-15 February 2003, E. Maglione, F. Soramel Ed. p. 172 (2003); AIP Conf. Proc. 681 (2003).
- [29] **2004SeZW** D. Seweryniak, C. N. Davids, M. P. Carpenter, N. Hammond, R. V. F. Janssens, T. -L. Khoo, G. Mukherjee, S. Sinha, A. Robinson, P. J. Woods, B. Blank, T. Davinson, S. J. Freeman, N. Hoteling, Z. Liu, J. Shergur, A. A. Sonzogni, W. B. Walters, A. Woehr, ANL-04/22 (Physics Division Ann. Rept., 2003), p. 27 (2004).
- [30] **2006Jo10** D. T. Joss, I. G. Darby, R. D. Page, J. Uusitalo, S. Eeckhaudt, T. Grahn, P. T. Greenlees, P. M. Jones, R. Julin, S. Juutinen, S. Ketelhut, M. Leino, A. -P. Leppanen, M. Nyman, J. Pakarinen, P. Rahkila, J. Saren, C. Scholey, A. Steer, A. J. Cannon, P. D. Stevenson, J. S. Al-Khalili, S. Erturk, M. Venhart, B. Gall, B. Hadinia, J. Simpson, Phys. Lett. B **641**, 34 (2006). <https://doi.org/10.1016/j.physletb.2006.08.014>
- [31] **2007HeZV** F. Herfurth, D. Ackermann, K. Blaum, M. Block, A. Chaudhuri, M. Dworschak, S. Eliseev, R. Ferrer, F. Hessberger, S. Hofmann, H. -J. Kluge, G. Maero, A. Martin, G. Marx, M. Mazzocco, D. Neidherr, J. Nuemayr, W. Plass, S. Rahaman, C. Rauth, D. Rodriguez, L. Schweikhard, P. Thirolf, G. Vorobjev, C. Weber, Proc. Inter. Conf. Proton Emitting Nuclei and Related Topics (PROCON 2007), Lisbon, Portugal, 17-23 June 2007, L. S. Ferreira Ed. p. 319 (2007); AIP Conf. Proc. 961 (2007).
- [32] **2007JoZX** D. T. Joss, I. G. Darby, R. D. Page, J. Uusitalo, S. Eeckhaudt, T. Grahn, P. T. Greenlees, P. M. Jones, R. Julin, S. Juutinen, S. Ketelhut, M. Leino, A. -P. Leppanen, M. Nyman, J. Pakarinen, P. Rahkila, J. Saren, C. Scholey, A. N. Steer, J. S. Al-Khalili, A. J. Cannon, P. D. Stevenson, S. Erturk, B. Gall, B. Hadinia, M. Venhart, J. Simpson, Proc. Inter. Conf. Proton Emitting Nuclei and Related Topics (PROCON 2007), Lisbon, Portugal, 17-23 June 2007, L. S. Ferreira Ed. p. 28 (2007); AIP Conf. Proc. —bf961 (2007).
- [33] **2007LiZR** Z. Liu, D. Seweryniak, P. J. Woods, C. N. Davids, M. P. Carpenter, T. Davinson, R. V. F. Janssens, R. Page, A. P. Robinson, J. Shergur, S. Sinhab, X. D. Tang, S. Zhu, Proc. Inter. Conf. Proton Emitting Nuclei and Related Topics (PROCON

- 2007), Lisbon, Portugal, 17-23 June 2007, L. S. Ferreira Ed. p. 34 (2007); AIP Conf. Proc. **961** (2007).
- [34] **2007Pa27** R. D. Page, L. Bianco, I. G. Darby, J. Uusitalo, D. T. Joss, T. Grahn, R. -D. Herzberg, J. Pakarinen, J. Thomson, S. Eeckhaudt, P. T. Greenlees, P. M. Jones, R. Julin, S. Juutinen, S. Ketelhut, M. Leino, A. -P. Leppanen, M. Nyman, P. Rahkila, J. Saren, C. Scholey, A. Steer, M. B. Gomez Hornillos, J. S. Al-Khalili, A. J. Cannon, P. D. Stevenson, S. Erturk, B. Gall, B. Hadinia, M. Venhart, J. Simpson, Phys. Rev. C **75**, 061302 (2007). <https://doi.org/10.1103/PhysRevC.75.061302>
- [35] **2007PaZT** R. D. Page, L. Bianco, I. G. Darby, D. T. Joss, T. Grahn, R. -D. Herzberg, J. Pakarinen, J. Thomson, J. Uusitalo, S. Eeckhaudt, P. T. Greenlees, P. M. Jones, R. Julin, S. Juutinen, S. Ketelhut, M. leino, A. -P. Leppanen, M. Nyman, P. Rahkila, J. Saren, C. Scholey, A. Steer, M. Venhart, J. Simpson, J. S. Al-Khalili, A. J. Cannon, P. D. Stevenson, S. Erturk, B. Gall, B. Hadinia, Proc. Inter. Conf. Proton Emitting Nuclei and Related Topics (PROCON 2007), Lisbon, Portugal, 17-23 June 2007, L. S. Ferreira Ed. p. 137 (2007); AIP Conf. Proc. 961 (2007)
- [36] **2007Ra37** C. Rauth, D. Ackermann, G. Audi, M. Block, A. Chaudhuri, S. Eliseev, F. Herfurth, F. P. Hessberger, S. Hofmann, H. -J. Kluge, A. Martin, G. Marx, M. Mukherjee, J. B. Neumayr, W. R. Plass, S. Rahaman, D. Rodriguez, L. Schweikhard, P. G. Thirolf, G. Vorobjev, C. Weber, Eur. Phys. J. Special Topics **150**, 329 (2007). <https://doi.org/10.1140/epjst/e2007-00339-8>
- [37] **2007RaZZ** C. Rauth, D. Ackermann, K. Blaum, M. Block, A. Chaudhuri, S. Eliseev, R. Ferrer, D. Habs, F. Herfurth, F. P. Hessberger, S. Hofmann, H. -J. Kluge, G. Maero, A. Martin, G. Marx, M. Mukherjee, J. B. Neumayr, W. R. Plass, W. Quint, S. Rahaman, D. Rodriguez, C. Scheidenberger, L. Schweikhard, P. G. Thirolf, G. Vorobjev, C. Weber, Z. Di, nucl-ex/0701030, 01/22/2007 (2007).
- [38] **2008Ra03** C. Rauth, D. Ackermann, K. Blaum, M. Block, A. Chaudhuri, Z. Di, S. Eliseev, R. Ferrer, D. Habs, F. Herfurth, F. P. Hessberger, S. Hofmann, H. -J. Kluge, G. Maero, A. Martin, G. Marx, M. Mukherjee, J. B. Neumayr, W. R. Plass, S. Rahaman, D. Rodriguez, C. Scheidenberger, L. Schweikhard, P. G. Thirolf, G. Vorobjev, C. Weber, Phys. Rev. Lett. **100**, 012501 (2008). <https://doi.org/10.1103/PhysRevLett.100.012501>
- [39] **2013Pr05** M. G. Procter, D. M. Cullen, M. J. Taylor, G. A. Alharshan, L. S. Ferreira, E. Maglione, K. Auranen, T. Grahn, P. T. Greenlees, U. Jakobsson, R. Julin, A. Herzan, J. Konki, M. Leino, J. Pakarinen, J. Partanen, P. Peura, P. Rahkila, P. Ruotsalainen, M. Sandzelius, J. Saren, S. Stolze, C. Scholey, J. Sorri, J. Uusitalo, T. Braunroth, E. Ellinger, A. Dewald, D. T. Joss, C. McPeake, B. Saygi, Phys. Lett. B **725**, 79 (2013). <https://doi.org/10.1016/j.physletb.2013.06.045>
- [40] **2015Ta12** M. J. Taylor, D. M. Cullen, M. G. Procter, A. J. Smith, A. McFarlane, V. Twist, G. A. Alharshan, L. S. Ferreira, E. Maglione, K. Auranen, T. Grahn, P. T. Greenlees, K. Hauschild, A. Herzan, U. Jakobsson, R. Julin, S. Juutinen, S. Ketelhut, J. Konki, M. Leino, A. Lopez-Martens, J. Pakarinen, J. Partanen, P. Peura, P. Rahkila, S. Rinta-Antila, P. Ruotsalainen, M. Sandzelius, J. Saren, C. Scholey, J. Sorri, S. Stolze, J. Uusitalo, M. Doncel, Phys. Rev. C **91**, 044322 (2015). <https://doi.org/10.1103/PhysRevC.91.044322>
- [41] **2017Wa18** F. Wang, B. H. Sun, Z. Liu, R. D. Page, C. Qi, C. Scholey, S. F. Ashley, L. Bianco, I. J. Cullen, I. G. Darby, S. Eeckhaudt, A. B. Garnsworthy, W. Gelletly, M. B. Gomez Hornillos, T. Grahn, P. T. Greenlees, D. G. Jenkins, G. A. Jones, P. Jones, D. T. Joss, R. Julin, S. Juutinen, S. Ketelhut, S. Khan, A. Kishada, M. Leino, M. Niikura, M. Nyman, J. Pakarinen, S. Pietri, Z. Podolyak, P. Rahkila, S. Rigby, J. Saren, T. Shizuma, J. Sorri, S. Steer, J. Thomson, N. J. Thompson, J. Uusitalo, P. M. Walker, S. Williams, H. F. Zhang, W. Q. Zhang, L. H. Zhu, Phys. Lett. B **770**, 83 (2017). <https://doi.org/10.1016/j.physletb.2017.04.034>
- [42] **2017Wa47** Z. Wang, C. Xu, Z. Ren, C. Gao, Phys. Rev. C **96**, 054603 (2017). <https://doi.org/10.1103/PhysRevC.96.054603>
- [43] **2021Wa16** M. Wang, W. J. Huang, F. G. Kondev, G. Audi, S. Naimi, Chin. Phys. C **45**, 030003 (2021). <https://doi.org/10.1088/1674-1137/abddaf>
- [44] **2023Au03** K. Auranen, P. Siwach, P. Arumugam, A. D. Briscoe, L. S. Ferreira, T. Grahn, P. T. Greenlees, A. Herzan, A. Illana, D.T. Joss, H. Joukainen, R. Julin, H. Jutila, M. Leino, J. Louko, M. Luoma, E. Maglione, J. Ojala, R. D. Page, J. Pakarinen, P. Rahkila, J. Romero, P. Ruotsalainen, M. Sandzelius, J. Saren, A. Tolosa-Delgado, J. Uusitalo, G. Zimba, Phys. Rev. C **108**, L011303 (2023).