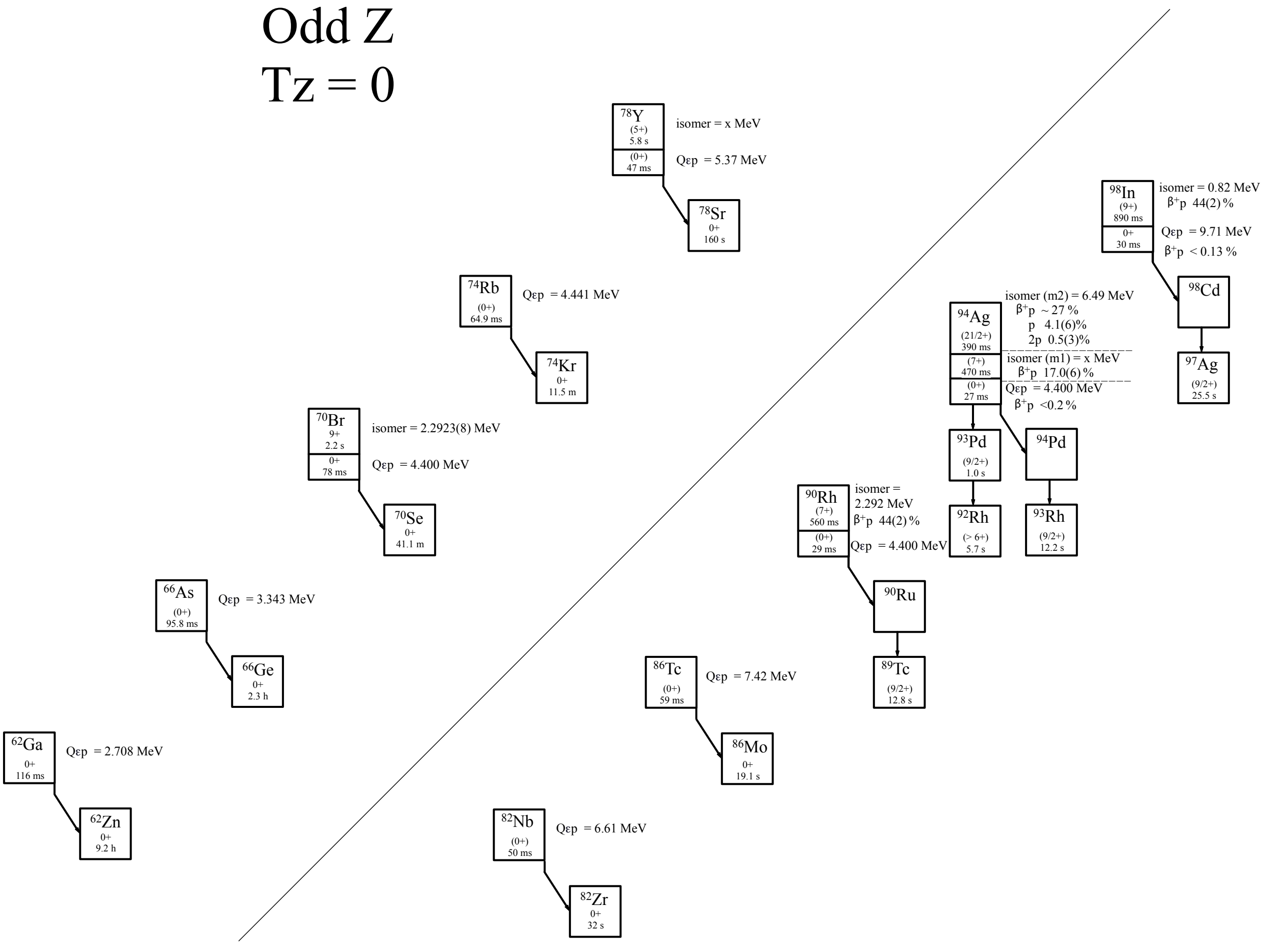

Fig. 1: Known experimental values for heavy particle emission of the odd-Z T_z= 0 nuclei.

last updated 11/23/22

Table 1
Observed and predicted β-delayed particle emission from the odd-Z, T_z = 0 nuclei. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein.

Nuclide	Ex	J^{π}	$T_{1/2}$	Q_{ε}	$Q_{\varepsilon p}$	$BR_{\beta p}$	$Q_{\varepsilon 2p}$	$Q_{\varepsilon\alpha}$	Experimental
^{62}Ga		0^+	116.121(21) ms	9.1811(4)	2.7081(11)		-2.0918(7)	5.8169(7)	[**2008Be21**]
^{66}As		(0^+)	95.77(23) ms	9.582(6)	3.343(6)		-0.599(5)	6.718(5)	[**2014Ro14**]
^{70}Br		0^+	78.42(51) ms	10.504(15)	4.400(40)		0.975(25)	7.756(15)	[**2017Mo18**]
^{74}Rb		(0^+)	64.9(5) ms	10.416(3)	4.441(7)		1.374(4)	7.589(3)	[**2013Du14**]
^{78}Y		(0^+)	47(5) ms	11.00(30)#	5.37(30)#		2.27(30)#	7.74(30)#	[**2007Na13**]
^{82}Nb		(0^+)	50(4) ms	11.80(30)#	6.61(30)#		3.92(30)#	8.940(30)#	[**1999Lo07, 1998Lo17**]
^{86}Tc		(0^+)	59^{+8}_{-7} ms	12.54(30)#	7.42(30)#		5.274(300)#	9.619(30)#	[**2002Fa13**]
^{90}Rh		(0^+)	29(3) ms	13.25(20)#	8.47(30)#		6.48(20)#	10.06(20)#	[**2019Pa16**]
^{90m}Rh	x	(7^+)	0.56(2) s	13.25(20)# + x	8.47(30)# + x	9.6(10)%	6.48(20)#+x	10.06(20)#+x	[**2019Pa16**]
^{94}Ag		(0^+)	27(2) ms	13.70(40)#	9.32(40)#	<0.2%	7.32(40)	10.01(40)#	[**2019Pa16**, 2004Mu30, 1994Sc35]
^{94m1}Ag	x	(7^+)	0.47(1) s	13.70(40)# + x	9.32(40)# + x	17.0(6)%	$7.313\#+x$	10.01(40)#+x	[**2019Pa16, 2004Mu30**, 1994Sc35]
^{94m2}Ag	6.49(63)#	$(21/2^+)$	0.39(4) s	20.19(75)#	15.81(75)#	≈27%	13.81(75)#	16.50(75)#	[**2004Mu30, 2005Mu15**, 2007Ro16, 2006Mu03]
^{98}In		0^+	30(1) ms	13.73(30)#	9.71(31)#	<0.13%	7.70(30)#	9.77(30)#	[**2019Pa16**, 2012Lo08]
^{98m}In	0.82(73)	(9^+)	0.89(2) s	14.55(79)#	10.53(79)#	44(2)%	8.52(79)#	9.77(30)#+x	[**2019Pa16**]
^{102}Sb				13.84(41)#	10.16(40)#		8.52(40)#	14.12(40)#	
^{106}I				14.92(41)#	13.43(40)#		13.75(40)#	19.21(41)#	

Table 2
Particle emission from the odd-Z, T_z = 0 nuclei. Unless otherwise stated, all Q-values and separation energies are taken from [2021Wa16] or deduced from values therein.

Nuclide	S_p	BR_{1p}	S_{2p}	BR_{2p}	Q_{α}	Experimental
^{62}Ga	2.927(16)	—	8.2197(17)		-2.7441(7)	
^{66}As	2.836(6)	—	7.770(6)		-2.463(6)	
^{70}Br	2.280(15)	—	7.109(15)		-1.825(16)	
^{74}Rb	2.653(7)	—	7.432(3)		-2.915(15)	
^{78}Y	1.66(30)#	—	6.27(30)#		-2.68(30)#	
^{82}Nb	1.57(31)#	—	5.24(30)#		-2.06(42)#	
^{86}Tc	1.35(30)#	—	4.95(30)#		-2.19(42)#	
^{90}Rh	0.55(20)#	—	4.54(20)#		-2.49(36)#	
^{90m}Rh	0.55(20)#-x	—	4.54(20)#-x		-2.49(36)#+x	
^{94}Ag	0.71(55)#	—	3.98(40)#		-3.19(45)#	
^{94m1}Ag	0.71(55)#-x	—	3.98(40)#-x		-3.19(45)#+x	
^{94m2}Ag	-5.78(84)#	4.1(6)%	-2.50(75)#	0.5(3)%	3.00(77)#	[**2006Mu03, 2005Mu15**]
^{98}In	0.46(52)#		3.97(32)#		-3.93(50)#	
^{98m}In	0.46(52)# -x	—	3.97(32)# -x		-3.93(50)# +x	
^{102}Sb	-1.92(50)#		1.50(40)#		0.38(50)#	
^{106}I	-2.22(50)#		-1.42(41)#		5.38(57)#	

Table 3
β-p emission from ^{90m}Rh*, Ex. = unk, $T_{1/2}$ =0.56(2) s, $BR_{\beta p}$ = 9.6(10)%.

E_p(c.m.)	I_p(rel)%	I_p(abs)%	$E_{emitter}$ (^{90}Ru)	$E_{daughter}$(^{89}Tc)	coincident γ-rays
**	37(21)	2.6(15)		0.796	0.796
**	100(56)	7.0(40)		0	—

* All values taken from [2019Pa16].
** Unresolved multiplet (Ep ≈ 1.5-6 MeV) - see Fig 8 in ref. [2019Pa16].

Table 4
β-p emission from ^{94m1,94m2}Ag*, $T_{1/2}$ (^{94m1}Ag)=0.47(1) s[@], $T_{1/2}$(^{94m2}Ag) =390(40) ms

E_p(c.m.)**	I_p(rel)%**	$E_{emitter}$ (^{94}Pd)	$E_{daughter}$(^{89}Tc)	coincident γ-rays
	3.3(7)		0.0	—–
	1.7		0.2401(1)	0.241
	0.4		0.622(1)	0.622
	6.8		0.8529(1)	0.853
	3.0		0.8942(1)	0.894
	0.3		1.4510(7)	0.557, 0.894, 1.451
	0.3		1.4637(8)	0.570, 0.894, 1.464
	0.5		1.7184(5)	1.718
	1.3		1.7189(1)	0.853, 0.866
	0.7		2.1978(5)***	2.198
	0.3		2.5951(2)	0.333, 0.542, 0.853, 0.866
	0.2		2.8905(3)	0.295, 0.333, 0.542, 0.853 0.866
	0.1		3.5430(4)	0.295, 0.333, 0.542, 0.653 0.853, 0.866, 0.948
	0.1		4.0887(3)	0.295, 0.333, 0.542, 0.546 0.653, 0.853, 0.866, 0.948 1.494
	0.3		4.7084(11)	0.159, 0.295, 0.297, 0.333 0.542, 0.853, 0.866, 1.361
	0.1		4.7489(4)	0.138, 0.295, 0.333, 0.497 0.542, 0.522, 0.853, 0.866 1.362, 1.494
	0.8		5.4469(5)	0.138, 0.295, 0.333, 0.497 0.542, 0.522, 0.698, 0.853 0.866, 1.362, 1.494
	0.6		5.6938(5)	0.138, 0.247, 0.295, 0.333 0.497, 0.542, 0.522, 0.698 0.853, 0.866, 1.362, 1.494
	0.4		6.5797(6)	0.138, 0.191, 0.247, 0.295 0.333, 0.497, 0.542, 0.522 0.698, 0.853, 0.866, 1.362 1.494
	0.4		6.7099(7)***	0.130, 0.138, 0.191, 0.247 0.295, 0.333, 0.497, 0.542 0.522, 0.698, 0.853, 0.866 1.362, 1.494

* All values taken from [2004Mu30] and are a combination of the (7^{*}) and (21^{+}) isomers. The ratio of the the two is estimated to be is estimated to be 89% and 11%, respectively.

** Individual proton energies not measured. Intensities in daughter inferred by gammas and TAS measurements [2004Mu30].

***tentative assignment

@ [2019Pa16]

@@ [2004Mu30]

Table 5
direct proton emission from ^{94m2}Ag*, Ex = 6.49(63)#**, $T_{1/2}$ =390(40) ms***, *BRp* =4.1(6)%.

E_p(c.m.)	E_p(lab)	I_p (rel)%	I_p(abs)%	$E_{daughter}$(^{93}Pd)	coincident γ-rays
0.790(30)	0.781(30)	86 (28)	1.9(5)	4.994	0.167, 0.196, 0.208, 0.275, 0.349, 0.361, 0.887, 0.984, 0.991, 1.096, 1.132
1.010(30)	0.999(30)	100(18)	2.2(4)	4.751	0.167, 0.196, 0.208, 0.275, 0.349, 0.361, 0.403, 0.614, 0.887, 0.984, 0.991, 1.096

* All values from [2005Mu13], except where noted.

** Excitation Energy = 6.49(63)# MeV, based on Q_p = 5.78(30) MeV [2005Mu13] and S_p (^{94}Ag) = 0.71(55) MeV # [2021Wa16].

*** [2004Mu30]

Table 6
direct 2-proton emission from ^{94m2}Ag*, Ex = 6.49(63)#**, $T_{1/2}$ =390(40) ms***, BR_{2p} =0.5(3)%.

E_{2p}(c.m.)	E_{2p}(lab)	I_{2p}(abs)%	$E_{daughter}$(^{92}Rh)	coincident γ-rays
1.90(10)	1.860(10)	0.5(3)	1.549	0.235, 0.278, 0.364, 0.672, 1.036

* All values from [2005Mu13], except where noted.
** Excitation Energy = 6.49(63)# MeV, based on Q_p = 5.78(30) MeV [2005Mu13] and S_p (^{94}Ag) = 0.71(55) MeV # [2021Wa16].
*** [2004Mu30]

Table 7
β-p Emission from ^{98m}In*, Ex = 0.82(73) MeV, $T_{1/2}$ = 30(1) ms, $BR_{\beta p}$ = 44(2)%.

E_p	I_p(rel)%	I_p(abs)%	$E_{emitter}$ (^{98}Cd)	$E_{daughter}$(^{97}Ag)	coincident γ-rays
**	61(14)	9.7(22)		2.343	0.290, 0.763, 1.290
**	100(22)	15.8(36)		2.053	0.763, 1.290
**	78(17)	12.3(27)		2.020	0.602, 0.730, 1.290, 1.470
**	36(31)	5.7(49)		1.290	1.290

* All values taken from [2019Pa16].
** Unresolved multiplet (Ep ≈ 1.5-6 MeV) - see Fig 8 in ref. [2019Pa16].

References used in the Tables

[1] **1994Sc35** K. Schmidt, T. W. Elze, R. Grzywacz, Z. Janas, R. Kirchner, O. Klepper, A. Plochocki, E. Roeckl, K. Rykaczewski, L. D. Skouras, J. Szerypo, Z. Phys. A**350**, 99 (1994). https://doi.org/10.1007/BF01290677

[2] **1998Lo17** C. Longour, J. Garces Narro, B. Blank, M. Lewitowicz, Ch. Miehe, P. H. Regan, D. Applebe, L. Axelsson, A. M. Bruce, W. N. Catford, C. Chandler, R. M. Clark, D. M. Cullen, S. Czajkowski, J. M. Daugas, Ph. Dessagne, A. Fleury, L. Frankland, W. Gelletly, J. Giovinazzo, B. Greenhalgh, R. Grzywacz, M. Harder, K. L. Jones, N. Kelsall, T. Kszczot, R. D. Page, C. J. Pearson, A. T. Reed, O. Sorlin, R. Wadsworth, Phys. Rev. Lett. **81**, 3337 (1998). https://doi.org/10.1103/PhysRevLett.81.3337

[3] **1999Lo07** C. Longour, J. Garces Narro, B. Blank, M. Lewitowicz, Ch. Miehe, P. H. Regan, D. Applebe, L. Axelsson, A. M. Bruce, W. N. Catford, C. Chandler, R. M. Clark, D. M. Cullen, S. Czajkowski, J. M. Daugas, Ph. Dessagne, A. Fleury, L. Frankland, W. Gelletly, J. Giovinazzo, B. Greenhalgh, R. Grzywacz, M. Harder, K. L. Jones, N. Kelsall, T. Kszczot, R. D. Page, C. J. Pearson, A. T. Reed, O. Sorlin, R. Wadsworth, J. Phys. (London) G**25**, 759 (1999).

[4] **2002Fa13** T. Faestermann, R. Schneider, A. Stolz, K. Summerer, E. Wefers, J. Friese, H. Geissel, M. Hellstrom, P. Kienle, J. J. Korner, M. Mineva, M. Munch, G. Munzenberg, C. Schlegel, K. Schmidt, P. Thirolf, H. Weick, K. Zeitelhack, Eur. Phys. J. A **15**, 185 (2002). https://doi.org/10.1140/epja/i2001-10251-7

[5] **2004Mu30** I. Mukha, L. Batist, E. Roeckl, H. Grawe, J. Doring, A. Blazhev, C. R. Hoffman, Z. Janas, R. Kirchner, M. La Commara, S. Dean, C. Mazzocchi, C. Plettner, S. L. Tabor, M. Wiedeking, Phys. Rev. C **70**, 044311 (2004). https://doi.org/10.1103/PhysRevC.70.044311

[6] **2005Mu15** I. Mukha, E. Roeckl, J. Doring, L. Batist, A. Blazhev, H. Grawe, C. R. Hoffman, M. Huyse, Z. Janas, R. Kirchner, M. La Commara, C. Mazzocchi, C. Plettner, S. L. Tabor, P. Van Duppen, M. Wiedeking, Phys. Rev. Lett. **95**, 022501 (2005). https://doi.org/10.1103/PhysRevLett.95.022501

[7] **2006Mu03** I. Mukha, E. Roeckl, L. Batist, A. Blazhev, J. Doring, H. Grawe, L. Grigorenko, M. Huyse, Z. Janas, R. Kirchner, M. La Commara, C. Mazzocchi, S. L. Tabor, P. Van Duppen, Nature **439**, 298 (2006). https://doi.org/10.1038/nature04453

[8] **2007Na13** B. S. Nara Singh, A. N. Steer, D. G. Jenkins, R. Wadsworth, M. A. Bentley, P. J. Davies, R. Glover, N. S. Pattabiraman, C. J. Lister, T. Grahn, P. T. Greenlees, P. Jones, R. Julin, S. Juutinen, M. Leino, M. Nyman, J. Pakarinen, P. Rahkila, J. Saren, C. Scholey, J. Sorri, J. Uusitalo, P. A. Butler, M. Dimmock, D. T. Joss, J. Thomson, B. Cederwall, B. Hadinia, M. Sandzelius, Phys. Rev. C **75**, 061301 (2007). https://doi.org/10.1103/PhysRevC.75.061301

[9] **2007Ro16** E. Roeckl, I. Mukha, L. Batist, A. Blazhev, J. Doring, H. Grawe, L. Grigorenkof, M. Huyse, Z. Janas, R. Kirchner, M. La Commara, C. Mazzocchi, S. L. Tabor, P. Van Duppen, Acta Phys. Pol. B**38**, 1121 (2007).

[10] **2008Be21** A. Bey, B. Blank, G. Canchel, C. Dossat, J. Giovinazzo, I. Matea, V. -V. Elomaa, T. Eronen, U. Hager, J. Hakala, A. Jokinen, A. Kankainen, I. Moore, H. Penttila, S. Rinta-Antila, A. Saastamoinen, T. Sonoda, J. Aysto, N. Adimi, G. de France, J. -C. Thomas, G. Voltolini, T. Chaventre, Eur. Phys. J. A **36**, 121 (2008). https://doi.org/10.1140/epja/i2008-10578-5

[11] **2012Lo08** G. Lorusso, A. Becerril, A. Amthor, T. Baumann, D. Bazin, J. S. Berryman, B. A. Brown, R. H. Cyburt, H. L. Crawford, A. Estrade, A. Gade, T. Ginter, C. J. Guess, M. Hausmann, G. W. Hitt, P. F. Mantica, M. Matos, R. Meharchand, K. Minamisono, F. Montes, G. Perdikakis, J. Pereira, M. Portillo, H. Schatz, K. Smith, J. Stoker, A. Stolz, R. G. T. Zegers, Phys. Rev. C **86**, 014313 (2012). https://doi.org/10.1103/PhysRevC.86.014313

[12] **2013Du14** R. Dunlop, G. C. Ball, J. R. Leslie, C. E. Svensson, I. S. Towner, C. Andreoiu, S. Chagnon-Lessard, A. Chester, D. S. Cross, P. Finlay, A. B. Garnsworthy, P. E. Garrett, J. Glister, G. Hackman, B. Hadinia, K. G. Leach, E. T. Rand, K. Starosta, E. R. Tardiff, S. Triambak, S. J. Williams, J. Wong, S. W. Yates, E. F. Zganjar, Phys. Rev. C **88**, 045501 (2013). https://doi.org/10.1103/PhysRevC.88.045501

[13] **2014Ro14** A. M. Rogers, J. Giovinazzo, C. J. Lister, B. Blank, G. Canchel, J. A. Clark, G. de France, S. Grevy, S. Gros, E. A. McCutchan, F. de Oliveira Santos, G. Savard, D. Seweryniak, I. Stefan, J. -C. Thomas, Nucl. Data Sheets **120**, 41 (2014). https://doi.org/10.1016/j.nds.2014.07.001

[14] **2017Mo18** A. I. Morales, A. Algora, B. Rubio, K. Kaneko, S. Nishimura, P. Aguilera, S. E. A. Orrigo, F. Molina, G. de Angelis, F. Recchia, G. Kiss, V. H. Phong, J. Wu, D. Nishimura, H. Oikawa, T. Goigoux, J. Giovinazzo, P. Ascher, J. Agramunt, D. S. Ahn, H. Baba, B. Blank, C. Borcea, A. Boso, P. Davies, F. Diel, Zs. Dombradi, P. Doornenbal, J. Eberth, G. de France, Y. Fujita, N. Fukuda, E. Ganioglu, W. Gelletly, M. Gerbaux, S. Grevy, V. Guadilla, N. Inabe, T. Isobe, I. Kojouharov, W. Korten, T. Kubo, S. Kubono, T. Kurtukian Nieto, N. Kurz, J. Lee, S. Lenzi, J. Liu, T. Lokotko, D. Lubos, C. Magron, A. Montaner-Piza, D. R. Napoli, H. Sakurai, H. Schaffner, Y. Shimizu, C. Sidong, P. -A. Soderstrom, T. Sumikama, H. Suzuki, H. Takeda, Y. Takei, M. Tanaka, S. Yagi, Phys. Rev. C **95**, 064327 (2017). https://doi.org/10.1103/PhysRevC.95.064327

[15] **2019Pa16** J. Park, R. Krucken, D. Lubos, R. Gernhauser, M. Lewitowicz, S. Nishimura, D. S. Ahn, H. Baba, B. Blank, A. Blazhev, P. Boutachkov, F. Browne, I. Celikovic, G. de France, P. Doornenbal, T. Faestermann, Y. Fang, N. Fukuda, J. Giovinazzo, N. Goel, M. Gorska, H. Grawe, S. Ilieva, N. Inabe, T. Isobe, A. Jungclaus, D. Kameda, G. D. Kim, Y. -K. Kim, I. Kojouharov, T. Kubo, N. Kurz, Y. K. Kwon, G. Lorusso, K. Moschner, D. Murai, I. Nishizuka, Z. Patel, M. M. Rajabali, S. Rice, H. Sakurai, H. Schaffner, Y. Shimizu, L. Sinclair, P. -A. Soderstrom, K. Steiger, T. Sumikama, H. Suzuki, H. Takeda, Z. Wang, H. Watanabe, J. Wu, Z. Y. Xu, Phys. Rev. C **99**, 034313 (2019). https://doi.org/10.1103/PhysRevC.99.034313

[16] **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