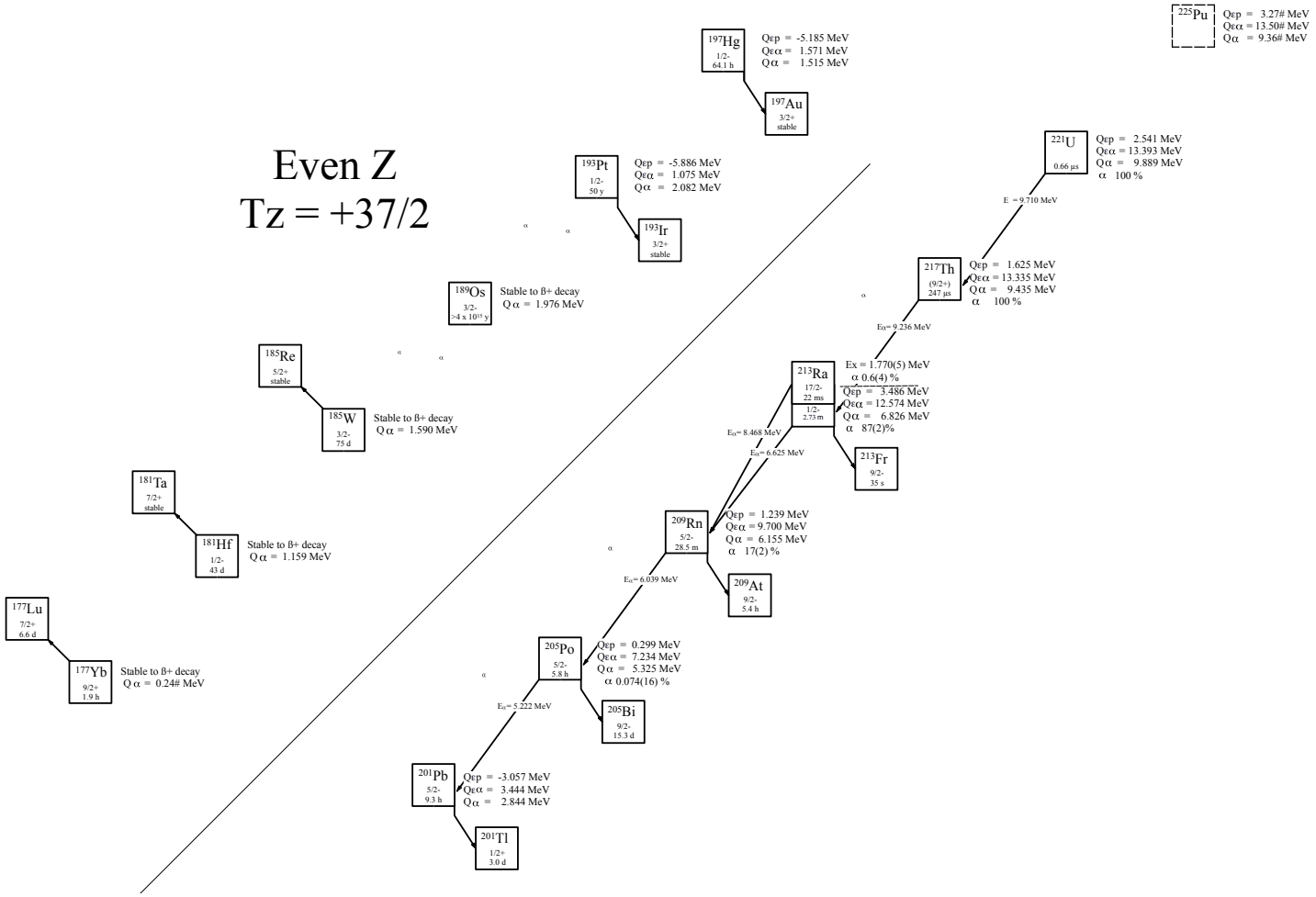

Fig. 1: Known experimental values for heavy particle emission of the even-Z T_z= +37/2 nuclei.

Last updated 12/22/2023

Table 1
Observed and predicted β-delayed particle emission from the even-Z, T_z = +37/2 nuclei. J^π values for ^{177}Yb, ^{181}Hf, ^{185}W, ^{189}Os, ^{193}Pt, ^{197}Hg, and ^{201}Pb are taken from ENSDF. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein.

Nuclide	J^π	Ex.	$T_{1/2}$	Q$_\varepsilon$	$Q_{\varepsilon p}$	$Q_{\varepsilon\alpha}$	Experimental
^{177}Yb*		$9/2^+$	1.911(3) h	-3.42(20)#	——	——	[**1989Ab18**]
^{181}Hf*		$1/2^-$	43.39(8) d**	-2.61(13)	——	——	[**1966Br20, 1960Li14**
^{185}W*		$3/2^-$	75.1(3) d	-1.994(14)	——	——	[**1972Em01**
^{189}Os		$3/2^-$	$\geq 3.5 \times 10^{15}$ y	-1.008(8)	——	——	[**2020Be23**
^{193}Pt		$1/2^-$	50(9) y	0.0566(3)	-5.886(2)	1.075(8)	[**1971Ra18**
^{197}Hg		$1/2^-$	64.14(5) h	0.600(3)	-5.185(3)	1.571(3)	[**1966El09**
^{201}Pb		$5/2^-$	9.33(3) h	1.910(19)	-3.057(14)	3.444(14)	[**1981An11**
^{205}Po		$5/2^-$	5.79(2) h	3.544(11)	0.299(10)	7.234(17)	[**1983He09**]
^{209}Rn		$5/2^-$	28.5(10) m	3.943(11)	1.239(10)	9.700(11)	[**1971Go35**]
^{213}Ra		$1/2^-$	2.73(5) m	3.900(11)	1.716(10)	10.804(11)	[**2017Lo13**]
^{213m}Ra	1.770(5)	$17/2^-$	2.20(5) ms	5.670(12)	3.486(11)	12.574(12)	[**2006Ku26**]
^{217}Th		$(9/2^+)$	247(2) μs***	3.503(15)	1.625(13)	13.335(12)	[**2005Ku31, 2002He29, 2009QiZZ**]
^{221}U			0.66(14) μs	4.150(0)	2.541(73)	13.393(73)	[**2015Kh09**]
^{225}Pu				4.68(31)#	3.27(30)#	13.50(31)#	

* 100 β^- emitter
** Weighted average of 42.29(10) d [1966Br20] and 42.45(8) d [1960Li14].
*** Weighted average of 257(2) μs [2005Ku31], 237(2) μs [2002He29] and 247(3) μs [2009QiZZ].

Table 2
Particle separation, Q-values, and measured values for direct particle emission of the even-Z, T_z = +37/2 nuclei. Unless otherwise stated, all S and Q-values are taken from [2021Wa16] or deduced from values therein.

Nuclide	S$_p$	S$_{2p}$	Q$_\alpha$	BR$_\alpha$	Experimental
^{177}Yb	8.90(10)	16.91(40)#	0.24(20)#		
^{181}Hf	8.015(71)	15.34(20)#	1.159(1)		
^{185}W	7.837(26)	14.682(30)	1.590(2)		
^{189}Os	7.259	13.661(1)	1.976(1)		
^{193}Pt	6.933	12.662(1)	2.082(1)		
^{197}Hg	6.690(3)	12.324(3)	1.515(3)		
^{201}Pb	5.513(15)	10.303(14)	2.844(14)		
^{205}Po	4.164(14)	7.313(12)	5.325(10)	0.074(16)%	[**1970Jo26, 1967Ti01, 1951Ha83**, 1970DaZM, 1951Ka37]
^{209}Rn	3.760(13)	6.373(12)	6.155(2)	17(2)%	[**1971Go35**, 2017Lo13, 1993Wa04, 1971Jo19, 1955Mo68, 1955Mo69, 1952Mo23]
^{213}Ra	3.427(13)	5.477(12)	6.862(2)	87(2)%	[**2017Lo13, 2006Ku26**, 2005KuZV, 1976Ra37, 1970TaZS, 1968Lo15, 1967Va22, 1961Gr42, 1955Mo68]
^{213m}Ra	1.657(14)	3.707(13)	8.632(5)	0.6(4)%	[**2006Ku26**, 1976Ra37]
^{217}Th	3.233(14)	4.904(13)	9.435(4)	100%	[**2005Ku31, 2002He29**, 2019Zh54, 2009QiZZ, 2005Li17, 2005YeZZ, 2000He17, 2000Ni02, 2000NiZY, 1973Ha32, 1973HaZO, 1969MaZT, 1968Va10, 1968Va18]
^{221}U	3.047(74)	4.521(92)	9.889(71)	100%	[**2015Kh09**
^{225}Pu	3.02(30)#	4.32(31)#	9.36(31)#		

Table 3
direct α emission from ^{205}Po, $J_i^\pi = 5/2^-$, T$_{1/2}$ = 5.79(2) h*, BR_α = 0.074(16)%**.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{201}Pb)	coincident γ-rays	R$_0$ (fm)	HF
5.326(7)	5.222(7)***	0.074(16)%**	$5/2^-$	0.0	——	1.4586(16)	$2.1^{+0.6}_{-0.4}$

* [1983He09].
** [1951Ha83].
*** Weighted average of 5.224(10) MeV [1970Jo26] and 5.220(10) MeV [1967Ti04].

Table 4
direct α emission from ^{209}Rn*, $J_i^\pi = 5/2^-$, $T_{1/2}$ = 28.5(10) m, BR_α = 17(2)%.

E_α(c.m.)	E_α(lab)	I_α(rel)	I_α(abs)	J_f^π	$E_{daughter}$(^{205}Po)**	coincident γ-rays**	R_0 (fm)	HF
5.770(3)	5.660(3)	0.024(2)%	0.0041(6)%		0.384	0.154, 0.230, 0.384	1.4662(37)	87^{+20}_{-15}
6.002(3)	5.887(3)	0.22(2)%	0.037(6)%		0.154	0.154	1.4662(37)	117^{+27}_{-21}
6.013(3)	5.898(3)	0.14(2)%	0.024(4)%		0.143	0.143	1.4662(37)	210^{+60}_{-40}
6.157(3)	6.039(3)	100	16.9(20)%		0.0	——	1.4662(37)	$1.3^{+0.3}_{-0.2}$

* All values from [1971Go35], except where noted.
** [2020Ko17].

Table 5
direct α emission from ^{213}Ra, $J_i^\pi = 1/2^-$, $T_{1/2}$ = 2.83(5) m*, BR_α = 89(2)%*.

E_α(c.m.)	E_α(lab)**	I_α(rel)*	I_α(abs)	J_f^π	$E_{daughter}$(^{209}Rn)	coincident γ-rays	R_0 (fm)	HF
6.349(6)	6.230(6)	0.7(3)%	0.44(17)%	$(3/2^-)$***	0.5113	0.1106(2), 0.1830(2), 0.2152(2), 0.2181(2), 0.2964(2), 0.3283(1), 0.5113(3)	1.4638(22)	$4.5^{+3.2}_{-1.4}$
6.536(4)	6.413(4)	0.7(3)%	0.44(17)%	$(5/2^-)$***	0.3283	0.1106(2), 0.2181(2), 0.3283(1)	1.4638(22)	27^{+19}_{-8}
6.647(3)	6.522(3)	13.9(22)%	8.3(13)%	$3/2^-$	0.2149	0.106(1), 0.1106(2), 0.2152(2)	1.4638(22)	$4.1^{+0.9}_{-0.7}$
6.752(3)	6.625(3)	100(4)%	59.6(22)%	$1/2^-$	0.1103	0.1103	1.4638(22)	1.49(10)
6.862(3)	6.733(3)	30.7(31)%	18.3(18)%	$5/2^-$	0.0	——	1.4638(22)	13.0(15)

* [2017Lo13].
** [2006Ku26].
*** Reported as $(5/2^-)$ for the 511 keV state and $3/2^-$ for the 328 keV state in [2017Lo17].

Table 6
direct α emission from ^{213m}Ra, Ex. = 1.770(5) MeV, $J_i^\pi = 17/2^-$, $T_{1/2}$ = 2.20(5) ms*, BR_α = 0.6(4)%*.

E_α(c.m.)	E_α(lab)**	I_α(rel)*	I_α(abs)	J_f^π	$E_{daughter}$(^{209}Rn)	coincident γ-rays	R_0 (fm)	HF
8.426(9)	8.268(9)**	5.2(21)%**	0.021(16)%	$3/2^-$	0.2149	0.106(1), 0.1106(2), 0.2152(2)	1.4638(22)	$1.7^{+6.2}_{-0.8} \times 10^4$
8.517(7)	8.357(7)***	43(29)%***	0.17(12)%	$1/2^-$	0.1103	0.1103	1.4638(22)	$4^{+10}_{-2} \times 10^3$
8.630(4)	8.468(4)[@]	100%	0.41(27)%	$5/2^-$	0.0	——	1.4638(22)	$3^{+7}_{-2} \times 10^3$

* [2006Ku26].
** Weighted average of 8.270(20) MeV; 4(2)% [2006Ku26] and 8.266(10) MeV (adjusted to 8.267(10) in [1991Ry01]); 3(2)% [2006Ku26].
*** Weighted average of 8.355(9) MeV; 33(13)% [2006Ku26] and 8.358(10) MeV (adjusted to 8.359(10) in [1991Ry01]); 28(6)% [2006Ku26].
[@] Weighted average of 8.469(6)(6) MeV; 63(13)% [2006Ku26] and 8.467(5) MeV (adjusted to 8.468(5) in [1991Ry01]); 69(7)% [2006Ku26].

Table 7
direct α emission from ^{217}Th, $J_i^\pi = (9/2+)$, $T_{1/2}$ = 247(2) μs*, BR_α = 100%.

E_α(c.m.)	E_α(lab)	I_α(rel)	I_α(abs)	J_f^π	$E_{daughter}$(^{213}Ra)	coincident γ-rays	R_0 (fm)	HF
8.616(5)	8.457(5)**	3.8(2)%**	3.5(1)%	$(3/2^-)$	0.8221	0.8221(1)	1.5091(22)	24.3(14)
8.890(5)	8.726(5)***	1.7(1)%***	1.6(1)%	$(5/2^-)$	0.5461	0.5461(1)	1.5091(22)	286(23)
9.437(5)	9.263(5)[@]	100%	95.0(3)%	$1/2^-$	0.0	——	1.5091(22)	106(6)

*** Weighted average of 257(2) μs [2005Ku31], 237(2) μs [2002He29] and 247(3) μs [2009QiZZ].
** Weighted average of 8.460(7) MeV, I_α(rel) = 3.1(2)% [2005Ku31] and 8.455(5) MeV, I_α(rel) = 3.9(1)% [2002He29].
*** Weighted average of 8.727(8) MeV, I_α(rel) = 1.6(1)% [2005Ku31] and 8.725(5) MeV, I_α(rel) = 1.9(1)% [2002He29].
[@] Weighted average of 9.269(9) MeV, [2005Ku31] and 9.261(5) MeV [2002He29].

Table 8
direct α emission from ^{221}U*, $T_{1/2}$ = 0.66(14) μs, BR_α = 100%.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{217}Th)	coincident γ-rays	R_0 (fm)	HF
9.889(50)	9.710(50)	100%	$(9/2^+)$	0.0	—-	1.525(15)	$1.1^{+0.5}_{-0.4}$

* All values from [2015Kh09].

References used in the Tables

[1] **1951Ha83** K. L. Hall, UCRL-1460 (1951).

[2] **1951Ka37** D. G. Karraker, A. Ghiorso, D. H. Templeton, Phys. Rev. **83**, 390 (1951). https://doi.org/10.1103/PhysRev.83.390

[3] **952Mo23** F. F. Momyer, E. K. Hyde, A. Ghiorso, W. E. Glenn, Phys. Rev. **86**, 805 (1952). https://doi.org/10.1103/PhysRev.86.805

[4] **1955Mo68** F. F. Momyer, Jr. , E. K. Hyde, J. Inorg. Nucl. Chem. **1**, 274 (1955). https://doi.org/10.1016/0022-1902(55)80033-4

[5] **1955Mo69** F. F. Momyer, Jr. , F. Asaro, E. K. Hyde, J. Inorg. Nucl. Chem. **1**, 267 (1955). https://doi.org/10.1016/0022-1902(55)80032-2

[6] **1960Li14** M. Lindner, K. V. Marsh, J. A. Miskel, R. J. Nagle, J. Inorg. Nuclear Chem. **15**, 194 (1960). https://doi.org/10.1016/0022-1902(60)80034-6

[7] **1961Gr42** R. D. Griffioen, R. D. Macfarlane, UCRL-10023, p. 47 (1961).

[8] **1966Br20** L. Broman, K. Karlsson, Nucl. Instr. Methods **44**, 174 (1966). https://doi.org/10.1016/0029-554X(66)90463-0

[9] **1966El09** J. S. Eldridge, W. S. Lyon, ORNL-3889, p. 49 (1966).

[10] **1967Ti04** E. Tielsch-Cassel, Nucl. Phys. A**100**, 425 (1967). https://doi.org/10.1016/0375-9474(67)90419-8

[11] **1967Va22** K. Valli, W. Treytl, E. K. Hyde, Phys. Rev. **161**, 1284 (1967). https://doi.org/10.1103/PhysRev.161.1284

[12] **1968Lo15** Y. V. Lobanov, V. A. Durin, Yadern. Fiz. **8**, 849 (1968); Soviet J. Nucl. Phys. **8**, 493 (1969).

[13] **1968Va10** K. Valli, E. K. Hyde, UCRL-17989, p. 17 (1968)

[14] **1968Va18** K. Valli, E. K. Hyde, Phys. Rev. **176**, 1377 (1968). https://doi.org/10.1103/PhysRev.176.1377

[15] **1969MaZT** R. D. Macfarlane, ORO-3820-1 (1969).

[16] **1970DaZM** J. M. Dairiki, Thesis, Univ. California (1970); UCRL-20412 (1970).

[17] **1970Jo26** A. G. Jones, A. H. W. Aten, Jr., Radiochim. Acta **13**, 176 (1970).

[18] **1970TaZS** N. I. Tarantin, A. P. Kabachenko, A. V. Demyanov, N. S. Ivanov, Proc. Int. Conf. Mass Spectrosc. , Kyoto (1969), K. Ogata, T. Hayakawa, Eds. , University Park Press, Baltimore, p. 548 (1970).

[19] **1971Go35** N. A. Golovkov, R. B. Ivanov, A. Kolaczkowski, Y. V. Norseev, V. G. Chumin, Izv. Akad. Nauk SSSR, Ser. Fiz. **35**, 2272 (1971); Bull. Acad. Sci. USSR, Phys. Ser. **35**, 2063 (1972).

[20] **1971Jo19** B. Jonson, M. Alpsten, A. Appelqvist, G. Astner, Nucl. Phys. A**174**, 225 (1971). https://doi.org/10.1016/0375-9474(71)90660-9

[21] **1971Ra18** H. L. Ravn, P. Bogeholt, Phys. Rev. C**4**, 601 (1971). https://doi.org/10.1103/PhysRevC.4.601

[22] **1972Em01** J. F. Emery, S. A. Reynolds, E. I. Wyatt, G. I. Gleason, Nucl. Sci. Eng. **48**, 319 (1972). https://doi.org/10.13182/NSE72-A22489

[23] **1973Ha32** O. Hausser, W. Witthuhn, T. K. Alexander, A. B. McDonald, J. C. D.Milton, A. Olin, Phys. Rev. Lett. **31**, 323 (1973). https://doi.org/10.1103/PhysRevLett.31.323

[24] **1973HaZO** O. Hausser, W. Witthuhn, T. K. Alexander, A. B. McDonald, J. C. D. Milton, A. Olin, S. J. Skorka, AECL-4595, p. 19 (1973).

[25] **1976Ra37** D. G. Raich, H. R. Bowman, R. E. Eppley, J. O. Rasmussen, I. Rezanka, Z. Phys. A**279**, 301 (1976); Erratum Z. Phys. A**282**, 124 (1977). https://doi.org/10.1007/BF01408303

[26] **1981An11** O. Ando, K. Miyano, Int. J. Appl. Radiat. Isotop. **32**, 381 (1981). https://doi.org/10.1016/S0020-708X(81)81004-6

[27] **1983He09** P. Herzog, H. Walitzki, K. Freitag, H. Hildebrand, K. Schlosser, Z. Phys. A**311**, 351 (1983). https://doi.org/10.1007/BF01415691

[28] **1989Ab18** A. Abzouzi, M. S. Antony, V. B. Ndocko Ndongue, J. Radioanal. Nucl. Chem. **137**, 381 (1989). https://doi.org/10.1007/BF02162466

[29] **1993Wa04** J. Wauters, P. Dendooven, M. Huyse, G. Reusen, P. Van Duppen, P. Lievens, and the ISOLDE Collaboration, Phys. Rev. C**47**, 1447 (1993). https://doi.org/10.1103/PhysRevC.47.1447

[30] **2000He17** F. P. Hessberger, S. Hofmann, D. Ackermann, V. Ninov, M. Leino, S. Saro, A. Andreyev, A. Lavrentev, A. G. Popeko, A. V. Yeremin, Eur. Phys. J. A **8**, 521 (2000); Erratum Eur. Phys. J. A **9**, 433 (2000). https://doi.org/10.1007/s100500070075

[31] **2000Ni02** K. Nishio, H. Ikezoe, S. Mitsuoka, J. Lu, Phys. Rev. C**61**, 034309 (2000). https://doi.org/10.1103/PhysRevC.61.034309

[32] **2002He29** F. P. Hessberger, S. Hofmann, I. Kojouharov, D. Ackermann, S. Antalic, P. Cagarda, B. Kindler, B. Lommel, R. Mann, A. G. Popeko, S. Saro, J. Uusitalo, A. V. Yeremin, Eur. Phys. J. A **15**, 335 (2002). https://doi.org/10.1140/epja/i2002-10038-4

[33] **2005Ku31** P. Kuusiniemi, F. P. Hessberger, D. Ackermann, S. Hofmann, B. Sulignano, I. Kojouharov, R. Mann, Eur. Phys. J. A **25**, 397 (2005). https://doi.org/10.1140/epja/i2005-10117-0

[34] **2005KuZV** P. Kuusiniemi, F. P. Hessberger, D. Ackermann, S. Hofmann, K. Nishio, B. Sulignano, I. Kojouharov, R. Mann, GSI 2005-1, p. 76 (2005).

[35] **2005Li17** Z. Liu, J. Kurcewicz, P. J. Woods, C. Mazzocchi, F. Attallah, E. Badura, C. N. Davids, T. Davinson, J. Doring, H. Geissel, M. Gorska, R. Grzywacz, M. Hellstrom, Z. Janas, M. Karny, A. Korgul, I. Mukha, M. Pfutzner, C. Plettner, A. Robinson, E. Roeckl, K. Rykaczewski, K. Schmidt, D. Seweryniak, H. Weick, Nucl. Instrum. Methods Phys. Res. A**543**, 591 (2005). https://doi.org/10.1016/j.nima.2004.12.023

[36] **2005YeZZ** A. V. Yeremin, A. V. Belozerov, M. L. Chelnokov, V. I. Chepigin, V. A. Gorshkov, A. P. Kabachenko, O. N. Malyshev, Yu. Ts. Oganessian, A. G. Popeko, R. N. Sagaidak, A. V. Shutov, A. I. Svirikhin, Ch. Briancon, K. Hauschild, A. Korichi, A. Lopez-Martens, O. Dorvaux, Proc. Intern. Symposium Exotic Nuclei, Peterhof, Russia, July 5-12, 2004, Yu. E. Penionzhkevich, E. A. Cherepanov, Eds. , World Scientific, Singapore, p. 206 (2005).

[37] **2006Ku26** P. Kuusiniemi, F. P. Hessberger, D. Ackermann, S. Antalic, S. Hofmann, K. Nishio, B. Sulignano, I. Kojouharov, R. Mann, Eur. Phys. J. A **30**, 551 (2006). https://doi.org/10.1140/epja/i2006-10148-y

[38] **2009QiZZ** J. Qian, Thesis, Yale University, New Haven CT (2009).

[39] **2015Kh09** J. Khuyagbaatar, A. Yakushev, Ch. E. Dullmann, D. Ackermann, L. L-. Andersson, M. Block, H. Brand, D. M. Cox, J. Even, U. Forsberg, P. Golubev, W. Hartmann, R. -D. Herzberg, F. P. Hessberger, J. Hoffmann, A. Hubner, E. Jager, J. Jeppsson, b. Kindler, J. V. Kratz, J. Krier, N. Kurz, B. Lommel, M. Maiti, S. Minami, A. K. Mistry, C. M. Mrosek, I. Pysmenetska, D. Rudolph, L. G. Sarmiento, H. Schaffner, M. Schadel, B. Schausten, J. Steiner, T. Torres De Heidenreich, J. Uusitalo, M. Wegrzecki, N. Wiehl, V. Yakusheva, Phys. Rev. Lett. **115**, 242502 (2015). https://doi.org/10.1103/PhysRevLett.115.242502

[40] **2017Lo13** Ch. Lorenz, L. G. Sarmiento, D. Rudolph, D. E. Ward, M. Block, F. P. Hessberger, D. Ackermann, L. -L. Andersson, M. L. Cortes, C. Droese, M. Dworschak, M. Eibach, U. Forsberg, P. Golubev, R. Hoischen, I. Kojouharov, J. Khuyagbaatar, D. Nesterenko, I. Ragnarsson, H. Schaffner, L. Schweikhard, S. Stolze, J. Wenzl, Phys. Rev. C **96**, 034315 (2017). https://doi.org/10.1103/PhysRevC.96.034315

[41] **2019Zh54** M. M. Zhang, Y. L. Tian, Y. S. Wang, X. H. Zhou, Z. Y. Zhang, H. B. Yang, M. H. Huang, L. Ma, C. L. Yang, Z. G. Gan, J. G. Wang, H. B. Zhou, S. Huang, X. T. He, S. Y. Wang, W. Z. Xu, H. W. Li, X. X. Xu, L. M. Duan, Z. Z. Ren, S. G. Zhou, H. S. Xu, Phys. Rev. C **100**, 064317 (2019). https://doi.org/10.1103/PhysRevC.100.064317

[42] **2020Be23** P. Belli, R. Bernabei, F. Cappella, V. Caracciolo, R. Cerulli, F. A. Danevich, A. Incicchitti, D. V. Kasperovych, V. V. Kobychev, G. P. Kovtun, N. G. Kovtun, M. Laubenstein, D. V. Poda, O. G. Polischuk, A. P. Shcherban, S. Tessalina, V. I. Tretyak, Phys. Rev. C **102**, 024605 (2020). https://doi.org/10.1103/PhysRevC.102.024605

[43] **2020Ko17** F. G. Kondev, Nucl. Data Sheets **166**, 1 (2020). https://doi.org/10.1016/j.nds.2020.05.001

[44] **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