

Table 1

Observed and predicted β -delayed particle emission from the even- Z , $T_z = +29$ nuclei. Unless otherwise stated, all Q -values are taken from [2021Wa16] or deduced from values therein.

Nuclide	J^π	$T_{1/2}$	Q_ε	Q_{β^-}	$Q_{\beta^- \alpha}$	Experimental
^{230}Rn	0^+	obs		2.68(20)#	5.27(36)#	[2010Al24]
$^{234}\text{Ra}^*$	0^+	30(10) s		2.089(16)	5.199(10)	[1992Bo44]
$^{238}\text{Th}^*$	0^+	9.4(20) m		1.63(28)#	5.44(28)#	[1999He01]
$^{242}\text{U}^*$	0^+	16.8(5) m		1.20(28)#	5.48(20)#	[1979Ha26]
$^{246}\text{Pu}^*$	0^+	10.85(2) d		0.401(14)#	5.73(20)#	[1956Ho23]
^{250}Cm	0^+	$1.13(5) \times 10^4$ y		0.038(11)	5.751(21)#	[1967Me16]
				$Q_{\varepsilon p}$	$Q_{\varepsilon \alpha}$	
^{254}Cf	0^+	60.2(2) d	-3.05(30)#	—	—	[1968Be21]
^{258}Fm	0^+	360(20) μs	-2.28(45)#	—	—	[1986Hu05]
^{262}No	0^+	≈ 5 ms	-1.57(58)#	—	—	[1989HuZU]
^{266}Rf			-1.53(68)#	—	—	
^{270}Sg			-0.97(74)#	—	—	
^{274}Hs			-0.36(74)#	—	—	
^{278}Ds			0.48(77)#	-2.41(68)#	10.07(77)#	
^{282}Cn	0^+	$880^{+190}_{-130} \mu\text{s}$	1.08(80)#	-1.74(74)#	10.64(80)#	[2024Ga31]
^{286}Fl	0^+	$106^{+17}_{-13} \text{ms}$	1.65(81)#	-0.77(75)#	11.44(81)#	[2024Ga31]
^{290}Lv	0^+	$8.2^{+3.2}_{-1.8} \text{ms}$	2.24(81)#	0.27(75)#	12.65(81)#	[2024Ga31]
^{294}Og	0^+	$580^{+440}_{-180} \mu\text{s}$	2.92(81)#	1.46(76)#	14.10(81)#	[2018Br13]

* 100% β^- -emitter.

Table 2

Particle separation, Q -values, and measured values for direct particle emission of the even- Z , $T_z = +29$ nuclei. Unless otherwise stated, all S and Q -values are taken from [2021Wa16] or deduced from values therein.

Nuclide	S_p	Q_α	BR_α	BR_{SF}	Experimental
^{230}Rn	10.01(45)#	2.20(45)#			
^{234}Ra	9.278(21)	2.34(20)#			
^{238}Th	8.78(49)#	3.17(28)#			
^{242}U	8.41(36)#	3.67(200)#			
^{246}Pu	7.744(201)#	4.350(20)#			
^{250}Cm	7.40(30)#	5.170(18)		100%*	[1967Me16, 1973Ho02, 1971Or03, 1966Rg01, 1957Hu76]
^{254}Cf	6.88(36)#	5.927(5)	0.310(16)%	99.690(16)%	[1968Be21, 2019De11, 1991So16, 1990SoZY, 1981SeZW, 1980ChZM, 1980Ho01, 1979SeZY, 1974UnZU, 1974UnZX, 1971Or03, 1968BeZY, 1966Rg01, 1965Me02, 1963Br35, 1963Fr15, 1963Ph01, 1962Br45, 1956Fi11]
^{258}Fm	6.27(46)#	6.66(20)#		100%*	[1989Hu09, 1986Hu05, 1986Hu01, 1980Ho04, 1971Hu03, 1971HuZX, 1971Jo13]
^{262}No	5.77(62)#	7.25(30)#		100%*	[1989HuZU, 1989LoZW, 1988LOZV]
^{266}Rf	5.39(69)#	7.61(20)#			
^{270}Sg	5.01(77)#	8.87(20)#			
^{274}Hs	4.57(81)#	9.55(10)#			
^{278}Ds	4.05(84)#	10.420(20)#			
^{282}Cn	3.80(95)#	10.15(20)#		100%*	[2024Ga31, 2018Br13, 2023Sa03, 2021Sa01, 2012Og06, 2011Og07, 2010El06, 2007Og05, 2006Og05, 2005Og03, 2005OgZZ, 2004Og10, 2004Og12, 2004OgZZ, 2002OgZX]
^{286}Fl	3.45(95)#	10.355(41)	57(5)%	43(5)%	[2024Ga31, 2023Sa03, 2021Sa01, 2018Br13, 2012Og06, 2011Og07, 2010El06, 2007Og05, 2006Og05, 2005Og03, 2005OgZZ, 2004Og10, 2004Og12, 2004OgZZ, 2002OgZX]
^{290}Lv	2.94(95)#	10.997(58)	100%**		[2024Ga31, 2018Br13, 2012Og06, 2011Og07, 2007Og05, 2006Og05, 2005Og03, 2005OgZZ, 2004Og10, 2004Og12, 2004OgZZ, 2002OgZX]
^{294}Og	2.40(96)#	11.867(31)	100%**		[2018Br13, 2012Og06, 2011Og07, 2007Og05, 2006Og05, 2005Og03, 2005OgZZ, 2002OgZX]

* Only SF has been observed.

** Only α -decay has been observed.

Table 3direct α emission from $^{254}\text{Cf}^*$, $J^\pi = 0^+$, $T_{1/2} = 60.2(2)$ d, $BR_\alpha = 8.66(43)\%$.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_α (abs)	J_f^π	$E_{daughter}(^{250}\text{Cm})$	coincident γ -rays (keV)	HF
5.884(5)	5.791(5)	20.5(24)%	0.053(7)%	2^+	0.042(7)		1.517(24)
5.926(5)	5.833(5)	100%	0.26(1)%	0^+	0.0	—	$2.9^{+0.6}_{-0.5}$
							0.99(5)

* All values from [1968Be21], E_α values are adjusted by -0.6 keV as recommended in [1991Ry01].**Table 4**direct α emission from $^{286}\text{Fl}^*$, $J^\pi = 0^+$, $T_{1/2} = 106^{+17}_{-13}$ ms, $BR_\alpha = 57(5)\%$.

$E_{\alpha}(\text{c.m.})$	$E_{\alpha}(\text{lab})$	$I_{\alpha}(\text{rel})$	$I_{\alpha}(\text{abs})$	J_f^{π}	$E_{daughter}(^{282}\text{Cn})$	coincident γ -rays (keV)	HF	
9.71(3)	9.57(3)	3%	1.8%	0^{+**}	0.620**	***	1.441(15)	$0.31^{+0.24}_{-0.21}$
10.32(2)	10.18(2)	100%	55%	0^{+}	0.0	—	1.441(15)	0.51(9)

* All values from [2024Ga31], which contains all previously measured data.

** Decay scenario from [2021Sa01], [2023Sa03] offer three additional possibilities.

*** α in coincidence with a 0.36(1) MeV electron**Table 5**direct α emission from $^{290}\text{Lv}^*$, $J^\pi = 0^+$, $T_{1/2} = 8.2^{+3.2}_{-1.8}$ ms, $BR_\alpha = 100\%^{**}$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{286}\text{Fl})$	coincident γ -rays (keV)	HF
10.99(7)	10.84(7)	100%**	0^+	—	1.486(28)	0.935(10)

* All values from [2024Ga31], which contains all measured data.

** Only α -decay has been observed.**Table 6**direct α emission from $^{294}\text{Og}^*$, $J^\pi = 0^+$, $T_{1/2} = 580^{+440}_{-180}$ μ s, $BR_\alpha = 100\%^{**}$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{290}\text{Lv})$	coincident γ -rays (keV)	HF
11.86(3)	11.70(3)	100%**	0^+	—	1.461(24)	1.01

* All values from [2018Br13], which contains all measured data.

** Only α -decay has been observed.**References used in the Tables**

- [1] **1956Fi11** P. R. Fields, M. H. Studier, H. Diamond, J. F. Mech, M. G. Inghram, G. L. Pyle, C. M. Stevens, S. Fried, W. M. Manning, A. Ghiorso, S. G. Thompson, G. H. Higgins, G. T. Seaborg, Phys. Rev. **102**, 180 (1956). <https://doi.org/10.1103/PhysRev.102.180>
- [2] **1956Ho23** D. C. Hoffman, C. J. Browne, J. Inorg. Nuclear Chem. **2**, 209 (1956). [https://doi.org/10.1016/0022-1902\(56\).80046-8](https://doi.org/10.1016/0022-1902(56).80046-8)
- [3] **1957Hu76** J. R. Huizenga, H. Diamond, Phys. Rev. **107**, 1087 (1957). <https://doi.org/10.1103/PhysRev.107.1087>
- [4] **1962Br45** R. Brandt, UCRL-10481 (1962).
- [5] **1963Br35** R. Brandt, S. G. Thompson, R. C. Gatti, L. Phillips, Phys. Rev. **131**, 2617 (1963). <https://doi.org/10.1103/PhysRev.131.2617>
- [6] **1963Fr15** A. M. Friedman, J. W. Meadows, A. B. Smith, P. R. Fields, J. Milsted, J. F. Whalen, Phys. Rev. **131**, 1203 (1963). <https://doi.org/10.1103/PhysRev.131.1203>
- [7] **1963Ph01** L. Phillips, R. C. Gatti, R. Brandt, S. G. Thompson, J. Inorg. Nucl. Chem. **25**, 1085 (1963). [https://doi.org/10.1016/0022-1902\(63\).80125-6](https://doi.org/10.1016/0022-1902(63).80125-6)
- [8] **1965Me02** D. Metta, H. Diamond, R. F. Barnes, J. Milsted, J. Gray, Jr., D. J. Henderson, C. M. Stevens, J. Inorg. Nucl. Chem. **27**, 33 (1965). [https://doi.org/10.1016/0022-1902\(65\).80187-7](https://doi.org/10.1016/0022-1902(65).80187-7)

- [9] **1966Rg01** Combined Radiochemistry Group LRL, LASL, UCRL, ANL, Phys. Rev. **148**, 1192 (1966). <https://doi.org/10.1103/PhysRev.148.1192>
- [10] **1967Me16** D. N. Metta, P. E. Moreland, J. Inorg. Nucl. Chem. **29**, 2822 (1967). [https://doi.org/10.1016/0022-1902\(67\).80023-X](https://doi.org/10.1016/0022-1902(67).80023-X)
- [11] **1968Be21** C. E. Bemis, Jr., J. Halperin, Nucl. Phys. A**121**, 433 (1968). [https://doi.org/10.1016/0375-9474\(68\).90431-4](https://doi.org/10.1016/0375-9474(68).90431-4)
- [12] **1968BeZY** C. E. Bemis, Jr., J. Halperin, ORNL-4306, p. 28(1968).
- [13] **1971Hu03** E. K. Hulet, J. F. Wild, R. W. Lougheed, J. E. Evans, B. J. Qualheim, M. Nurmia, A. Ghiorso, Phys. Rev. Lett. **26**, 523 (1971). <https://doi.org/10.1103/PhysRevLett.26.523>
- [14] **1971HuZX** E K Hulet, REPT UCRL-20426,P33, 9/14/71
- [15] **1971Or03** C. J. Orth, Nucl. Sci. Eng. **43**, 54(1971). <https://doi.org/10.13182/NSE71-A21245>
- [16] **1971Jo13** W. John, E. K. Hulet, R. W. Lougheed, J. J. Wesolowski, Phys. Rev. Lett. **27**, 45 (1971). <https://doi.org/10.1103/PhysRevLett.27.45>
- [17] **1973Ho02** D. C. Hoffman, G. P. Ford, J. P. Balagna, Phys. Rev. C**7**, 276 (1973). <https://doi.org/10.1103/PhysRevC.7.276>
- [18] **1974UnZU** J. P. Unik, J. E. Gindler, L. E. Glendenin, K. F. Flynn, A. Gorski, R. K. Sjoblom, Proc. Symp. Phys. Chem. Fission, 3rd, Rochester, N. Y. (1973)., Int. At. En. Agency, Vienna, Vol. II p. 19 (1974).
- [19] **1974UnZX** J. P. Unik, J. E. Gindler, L. E. Glendenin, K. F. Flynn, A. Gorski, R. K. Sjoblom, Proc. Symp. Phys. Chem. Fission, 3rd, Rochester, N. Y. (1973)., Int. At. En. Agency, Vienna, Vol. 2, p. 19 (1974).
- [20] **1979Ha26** P. E. Haustein, H-C. Hseuh, R. L. Klobuchar, E-M. Franz, S. Katcoff, L. K. Peker, Phys. Rev. C**19**, 2332 (1979). <https://doi.org/10.1103/PhysRevC.19.2332>
- [21] **1979SeZV** H. A. Selic, E. Cheifetz, A. Wolf, J. B. Wilhelmy, Contrib. Conf. Nucl. Spectrosc. Fission Products, Grenoble, p. 316 (1979).
- [22] **1980ChZM** E. Cheifetz, H. A. Selic, A. Wolf, R. Chechik, J. B. Wilhelmy, Proc. Conf. Nucl. Spectr. Fission Products, Grenoble, 1979, p. 193 (1980).
- [23] **1980Ho01** D. C. Hoffman, G. P. Ford, J. P. Balagna, L. R. Veaser, Phys. Rev. C**21**, 637 (1980). <https://doi.org/10.1103/PhysRevC.21.637>
- [24] **1981SeZW** H. A. Selic, E. Cheifetz, J. B. Wilhelmy, JUL-Spez-99, p. 69 (1981).
- [25] **1986Hu01** E. K. Hulet, J. F. Wild, R. J. Dougan, R. W. Lougheed, J. H. Landrum, A. D. Dougan, M. Schadel, R. L. Hahn, P. A. Baisden, C. M. Henderson, R. J. Dupzyk, K. Summerer, G. R. Bethune, Phys. Rev. Lett. **56**, 313 (1986). <https://doi.org/10.1103/PhysRevLett.56.313>
- [26] **1986Hu05** E. K. Hulet, R. W. Lougheed, J. F. Wild, R. J. Dougan, K. J. Moody, R. L. Hahn, C. M. Henderson, R. J. Dupzyk, G. R. Bethune, Phys. Rev. C**34**, 1394 (1986). <https://doi.org/10.1103/PhysRevC.34.1394>
- [27] **1988LoZV** R. W. Lougheed, E. K. Hulet, J. F. Wild, K. J. Moody, R. J. Dougan, C. M. Gannett, R. A. Henderson, D. C. Hoffman, D. M. Lee, UCAR-10062-88, p. 135 (1988).
- [28] **1989Hu09** E. K. Hulet, J. F. Wild, R. J. Dougan, R. W. Lougheed, J. H. Landrum, A. D. Dougan, P. A. Baisden, C. M. Henderson, R. J. Dupzyk, R. L. Hahn, M. Schadel, K. Summerer, G. R. Bethune, Phys. Rev. C**40**, 770 (1989). <https://doi.org/10.1103/PhysRevC.40.770>
- [29] **1989HuZU** E. K. Hulet, UCRL-100763 (1989).
- [30] **1989LoZW** R. W. Lougheed, E. K. Hulet, J. F. Wild, K. J. Moody, R. J. Dougan, C. M. Gannett, R. A. Henderson, D. C. Hoffman, D. M. Lee, Proc. 50 Years with Nuclear Fission Vol. 2, Gaithersburg, Maryland, April 25-28 1989 , p. 694 (1989).
- [31] **1990SoZY** E. A. Sokol, G. M. Ter-Akopyan, A. I. Krupman, V. P. Katkov, L. F. Nikonova, N. V. Eremin, JINR-P7-90-238 (1990).
- [32] **1991So16** E. A. Sokol, G. M. Ter-Akopyan, A. I. Krupman, V. P. Katkov, L. F. Nikonova, N. V. Eremin, At. Energ. **71**, 422 (1991).; Sov. At. Energy **71**, 906 (1992).
- [33] **1992Bo44** V. A. Bolshakov, A. G. Dernyatin, K. A. Mezilev, Yu. N. Novikov, A. G. Polyakov, A. V. Popov, Yu. Ya. Sergeev, V. I. Tikhonov, Nucl. Instrum. Methods Phys. Res. B**70**, 69 (1992). [https://doi.org/10.1016/0168-583X\(92\).95911-A](https://doi.org/10.1016/0168-583X(92).95911-A)
- [34] **1999He01** J. He, W. Yang, S. Yuan, Y. Xu, Z. Li, T. Ma, B. Xiong, Z. Qin, W. Mou, Z. Gan, L. Shi, T. Guo, Z. Chen, J. Guo, Phys. Rev. C**59**, 520 (1999). <https://doi.org/10.1103/PhysRevC.59.520>
- [35] **2002OgZX** Yu. Ts. Oganessian, V. K. Utyonkov, Yu. V. Lobanov, F. Sh. Abdullin, A. N. Polyakov, I. V. Shirokovsky, Yu. S.

- Tsyganov, A. N. Mezentssev, S. Iliev, V. G. Subbotin, A. M. Sukhov, O. V. Ivanov, A. A. Voinov, K. Subotic, V. I. Zagrebaev, M. G. Itkis, K. J. Moody, J. F. Wild, M. A. Stoyer, N. J. Stoyer, C. A. Laue, D. A. Shaughnessy, J. B. Patin, R. W. Loughheed, JINR-D7-2002-287 (2002).
- [36] **2004Og10** Yu. Ts. Oganessian, V. K. Utyonkov, Yu. V. Lobanov, F. Sh. Abdullin, A. N. Polyakov, I. V. Shirokovsky, Yu. S. Tsyganov, G. G. Gulbekian, S. L. Bogomolov, B. N. Gikal, A. N. Mezentssev, S. Iliev, V. G. Subbotin, A. M. Sukhov, A. A. Voinov, G. V. Buklanov, K. Subotic, V. I. Zagrebaev, M. G. Itkis, K. J. Moody, J. F. Wild, M. A. Stoyer, N. J. Stoyer, D. A. Shaughnessy, J. M. Kenneally, J. B. Patin, R. W. Loughheed, Prog. Theor. Phys. (Kyoto). , Suppl. **154**, 406 (2004). <https://doi.org/10.1143/PTPS.154.406>
- [37] **2004Og12** Yu. Ts. Oganessian, V. K. Utyonkov, Yu. V. Lobanov, F. Sh. Abdullin, A. N. Polyakov, I. V. Shirokovsky, Yu. S. Tsyganov, G. G. Gulbekian, S. L. Bogomolov, B. N. Gikal, A. N. Mezentssev, S. Iliev, V. G. Subbotin, A. M. Sukhov, A. A. Voinov, G. V. Buklanov, K. Subotic, V. I. Zagrebaev, M. G. Itkis, J. B. Patin, K. J. Moody, J. F. Wild, M. A. Stoyer, N. J. Stoyer, D. A. Shaughnessy, J. M. Kenneally, P. A. Wilk, R. W. Loughheed, R. I. Ilkaev, S. P. Vesnovskii, Phys. Rev. C **70**, 064609 (2004).; Erratum Phys. Rev. C **71**, 029902 (2005). <https://doi.org/10.1103/PhysRevC.70.064609>
- [38] **2004OgZZ** Yu. Ts. Oganessian, V. K. Utyonkov, Yu. V. Lobanov, F. Sh. Abdullin, A. N. Polyakov, I. V. Shirokovsky, Yu. S. Tsyganov, G. G. Gulbekian, S. L. Bogomolov, B. N. Gikal, A. N. Mezentssev, S. Iliev, V. G. Subbotin, A. M. Sukhov, A. A. Voinov, G. V. Buklanov, K. Subotic, V. I. Zagrebaev, M. G. Itkis, J. B. Patin, K. J. Moody, J. F. Wild, M. A. Stoyer, N. J. Stoyer, D. A. Shaughnessy, J. M. Kenneally, P. A. Wilk, R. W. Loughheed, R. I. Ilkaev, S. P. Vesnovskii, JINR-E7-2004-160 (2004).
- [39] **2005Og03** Yu. Ts. Oganessian, V. K. Utyonkov, Yu. V. Lobanov, F. Sh. Abdullin, A. N. Polyakov, I. V. Shirokovsky, Yu. S. Tsyganov, G. G. Gulbekian, S. L. Bogomolov, B. N. Gikal, A. N. Mezentssev, S. Iliev, V. G. Subbotin, A. M. Sukhov, A. A. Voinov, G. V. Buklanov, K. Subotic, V. I. Zagrebaev, M. G. Itkis, J. B. Patin, K. J. Moody, J. F. Wild, M. A. Stoyer, N. J. Stoyer, D. A. Shaughnessy, J. M. Kenneally, P. A. Wilk, R. W. Loughheed, Eur. Phys. J. A **25**, Supplement 1, 589 (2005). <https://doi.org/10.1140/epjad/i2005-06-134-9>
- [40] **2005OgZZ** Yu. Ts. Oganessian, V. K. Utyonkov, Yu. V. Lobanov, F. Sh. Abdullin, A. N. Polyakov, I. V. Shirokovsky, Yu. S. Tsyganov, G. G. Gulbekian, S. L. Bogomolov, B. N. Gikal, A. N. Mezentssev, S. Iliev, V. G. Subbotin, A. M. Sukhov, A. A. Voinov, G. V. Buklanov, K. Subotic, V. I. Zagrebaev, M. G. Itkis, J. B. Patin, K. J. Moody, J. F. Wild, M. A. Stoyer, N. J. Stoyer, D. A. Shaughnessy, J. M. Kenneally, P. A. Wilk, R. W. Loughheed, Proc. Intern. Symposium Exotic Nuclei, Peterhof, Russia, July 5-12, 2004, Yu. E. Penionzhkevich, E. A. Cherepanov, Eds. , World Scientific, Singapore, p. 168 (2005).
- [41] **2006Og05** Yu. Ts. Oganessian, V. K. Utyonkov, Yu. V. Lobanov, F. Sh. Abdullin, A. N. Polyakov, R. N. Sagaidak, I. V. Shirokovsky, Yu. S. Tsyganov, A. A. Voinov, G. G. Gulbekian, S. L. Bogomolov, B. N. Gikal, A. N. Mezentssev, S. Iliev, V. G. Subbotin, A. M. Sukhov, K. Subotic, V. I. Zagrebaev, G. K. Vostokin, M. G. Itkis, K. J. Moody, J. B. Patin, D. A. Shaughnessy, M. A. Stoyer, N. J. Stoyer, P. A. Wilk, J. M. Kenneally, J. H. Landrum, J. F. Wild, R. W. Loughheed, Phys. Rev. C **74**, 044602 (2006). <https://doi.org/10.1103/PhysRevC.74.044602>
- [42] **2007Og05** Yu. Ts. Oganessian, Nucl. Phys. A **787**, 343c (2007). <https://doi.org/10.1016/j.nuclphysa.2006.12.055>
- [43] **2010Al24** H. Alvarez-Pol, J. Benlliure, E. Casarejos, L. Audouin, D. Cortina-Gil, T. Enqvist, B. Fernandez-Dominguez, A. R. Junghans, B. Jurado, P. Napolitani, J. Pereira, F. Rejmund, K. -H. Schmidt, O. Yordanov, Phys. Rev. C **82**, 041602 (2010). <https://doi.org/10.1103/PhysRevC.82.041602>
- [44] **2010El06** P. A. Ellison, K. E. Gregorich, J. S. Berryman, D. L. Bleuel, R. M. Clark, I. Dragojevic, J. Dvorak, P. Fallon, C. Fineman-Sotomayor, J. M. Gates, O. R. Gothe, I. Y. Lee, W. D. Loveland, J. P. McLaughlin, S. Paschalis, M. Petri, J. Qian, L. Stavsetra, M. Wiedeking, H. Nitsche, Phys. Rev. Lett. **105**, 182701 (2010). <https://doi.org/10.1103/PhysRevLett.105.182701>
- [45] **2011Og07** Yu. Ts. Oganessian, Radiochim. Acta **99**, 429 (2011). <https://doi.org/10.1524/ract.2011.1860>
- [46] **2012Og06** Yu. Ts. Oganessian, F. Sh. Abdullin, C. Alexander, J. Binder, R. A. Boll, S. N. Dmitriev, J. Ezold, K. Felker, J. M. Gostic, R. K. Grzywacz, J. H. Hamilton, R. A. Henderson, M. G. Itkis, K. Miernik, D. Miller, K. J. Moody, A. N. Polyakov, A. V. Ramayya, J. B. Roberto, M. A. Ryabinin, K. P. Rykaczewski, R. N. Sagaidak, D. A. Shaughnessy, I. V. Shirokovsky, M. V. Shumeiko, M. A. Stoyer, N. J. Stoyer, V. G. Subbotin, A. M. Sukhov, Yu. S. Tsyganov, V. K. Utyonkov, A. A. Voinov, G. K. Vostokin, Phys. Rev. Lett. **109**, 162501 (2012). <https://doi.org/10.1103/PhysRevLett.109.162501>
- [47] **2018Br13** N. T. Brewer, V. K. Utyonkov, K. P. Rykaczewski, Yu. Ts. Oganessian, F. Sh. Abdullin, R. A. Boll, D. J. Dean, S. N. Dmitriev, J. G. Ezold, L. K. Felker, R. K. Grzywacz, M. G. Itkis, N. D. Kovrizhnykh, D. C. McInturff, K. Miernik, G. D. Owen, A. N. Polyakov, A. G. Popeko, J. B. Roberto, A. V. Sabelnikov, R. N. Sagaidak, I. V. Shirokovsky, M. V. Shumeiko, N. J. Sims, E. H. Smith, V. G. Subbotin, A. M. Sukhov, A. I. Svirikhin, Yu. S. Tsyganov, S. M. Van Cleve, A. A. Voinov, G. K. Vostokin, C. S. White, J. H. Hamilton, M. A. Stoyer, Phys. Rev. C **98**, 024317 (2018). <https://doi.org/10.1103/PhysRevC.98.024317>
- [48] **2019De11** H. M. Devaraja, S. Heinz, O. Beliuskina, S. Hofmann, C. Hornung, G. Munzenberg, D. Ackermann, M. Gupta, Y. K. Gambhir, R. A. Henderson, F. P. Hessberger, A. V. Yeremin, B. Kindler, B. Lommel, J. Maurer, K. J. Moody, K. Nishio, A.

- G. Popeko, M. A. Stoyer, D. A. Shaughnessy, *Eur. Phys. J. A* **55**, 25 (2019). <https://doi.org/10.1140/epja/i2019-12696-3>
- [49] **2021Sa01** A. Samark-Roth, D. M. Cox, D. Rudolph, L. G. Sarmiento, B. G. Carlsson, J. L. Egido, P. Golubev, J. Heery, A. Yakushev, S. Aberg, H. M. Albers, M. Albertsson, M. Block, H. Brand, T. Calverley, R. Cantemir, R. M. Clark, C. E. Dullmann, J. Eberth, C. Fahlander, U. Forsberg, J. M. Gates, F. Giacoppo, M. Gotz, S. Gotz, R. -D. Herzberg, Y. Hrabar, E. Jager, D. Judson, J. Khuyagbaatar, B. Kindler, I. Kojouharov, J. V. Kratz, J. Krier, N. Kurz, L. Lens, J. Ljungberg, B. Lommel, J. Louko, C. -C. Meyer, A. Mistry, C. Mokry, P. Papadakis, E. Parr, J. L. Pore, I. Ragnarsson, J. Runke, M. Schadel, H. Schaffner, B. Schausten, D. A. Shaughnessy, P. Thorle-Pospiech, N. Trautmann, J. Uusitalo, *Phys. Rev. Lett.* **126**, 032503 (2021). <https://doi.org/10.1103/PhysRevLett.126.032503>
- [50] **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>
- [51] **2023Sa03** A. Saamark-Roth, D. M. Cox, D. Rudolph, L. G. Sarmiento, M. Albertsson, B. G. Carlsson, J. L. Egido, P. Golubev, J. Heery, A. Yakushev, S. Aberg, H. M. Albers, M. Block, H. Brand, T. Calverley, R. Cantemir, R. M. Clark, Ch. E. Dullmann, J. Eberth, C. Fahlander, U. Forsberg, J. M. Gates, F. Giacoppo, M. Gotz, S. Gotz, R. -D. Herzberg, Y. Hrabar, E. Jager, D. Judson, J. Khuyagbaatar, B. Kindler, I. Kojouharov, J. V. Kratz, J. Krier, N. Kurz, L. Lens, J. Ljungberg, B. Lommel, J. Louko, C. -C. Meyer, A. Mistry, C. Mokry, P. Papadakis, E. Parr, J. L. Pore, I. Ragnarsson, J. Runke, M. Schadel, H. Schaffner, B. Schausten, D. A. Shaughnessy, P. Thorle-Pospiech, N. Trautmann, J. Uusitalo, *Phys. Rev. C* **107**, 024301 (2023). <https://doi.org/10.1103/PhysRevC.107.024301>
- [52] **2024Ga31** J. M. Gates, R. Orford, D. Rudolph, C. Appleton, B. M. Barrios, J. Y. Benitez, M. Bordeau, W. Botha, C. M. Campbell, J. Chadderton, A. T. Chemey, R. M. Clark, H. L. Crawford, J. D. Despotopoulos, O. Dorvaux, N. E. Esker, P. Fallon, C. M. Folden, B. J. P. Gall, F. H. Garcia, P. Golubev, J. A. Gooding, M. Grebo, K. E. Gregorich, M. Guerrero, R. A. Henderson, R. -D. Herzberg, Y. Hrabar, T. T. King, M. Kireeff Covo, A. S. Kirkland, R. Krucken, E. Leistenschneider, E. M. Lykiardopoulou, M. McCarthy, J. A. Mildon, C. Muller-Gatermann, L. Phair, J. L. Pore, E. Rice, K. P. Rykaczewski, B. N. Sammis, L. G. Sarmiento, D. Seweryniak, D. K. Sharp, A. Sinjari, P. Steinegger, M. A. Stoyer, J. M. Szornel, K. Thomas, D. S. Todd, P. Vo, V. Watson, P. T. Wooddy, *Phys. Rev. Lett.* **133**, 172502 (2024). <https://doi.org/10.1103/PhysRevLett.133.172502>