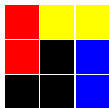


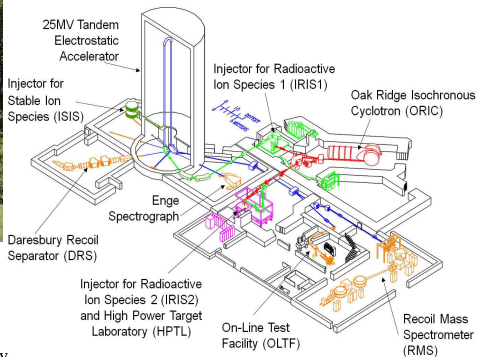
Spektroskopia jąder neutrononadmiarowych od kuchni

Krzysztof Miernik



ZAKŁAD FIZYKI JĄDROWEJ
WYDZIAŁ FIZYKI

Holifield Radioactive Ion Beam Facility



- 1962 - Oak Ridge Isochronous Cyclotron
- 1981 - 25 MV Tandem
- 1982 - Holifield Heavy Ion Research Facility
- 1997 - Holifield Radioactive Ion Beam Facility
- 2006 - High Power Target Laboratory
- 2006 - Injector for Radioactive Ion Species 2
- 2013 - Resonant Ionization Laser Ion Source
- 2012 - Decyzja o zakończeniu działalności
- 2016 - Ostateczna rozbiórka

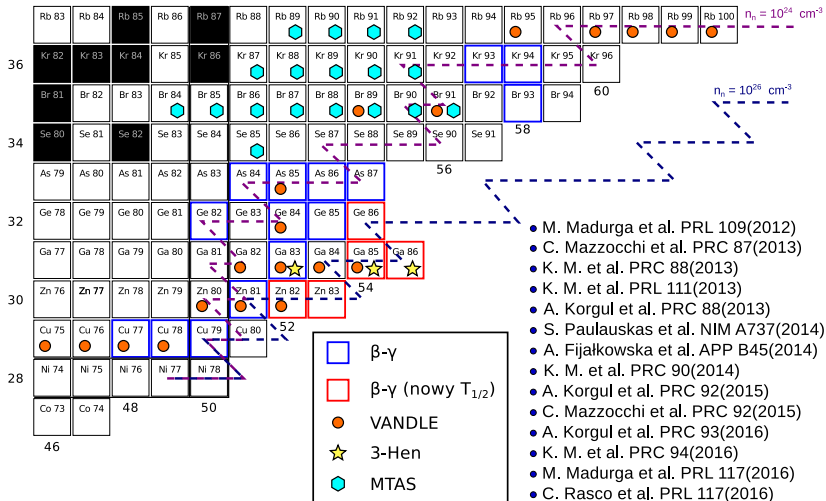


Radioaktywne wiązki w HRIBF

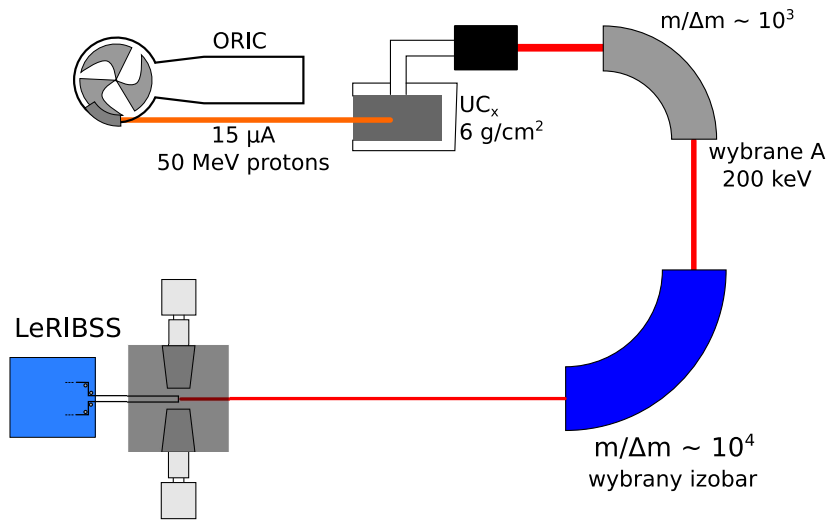
- 175 różnych radioaktywnych wiązek
- co najmniej +30 wiązek bez wtórnego przyspieszania



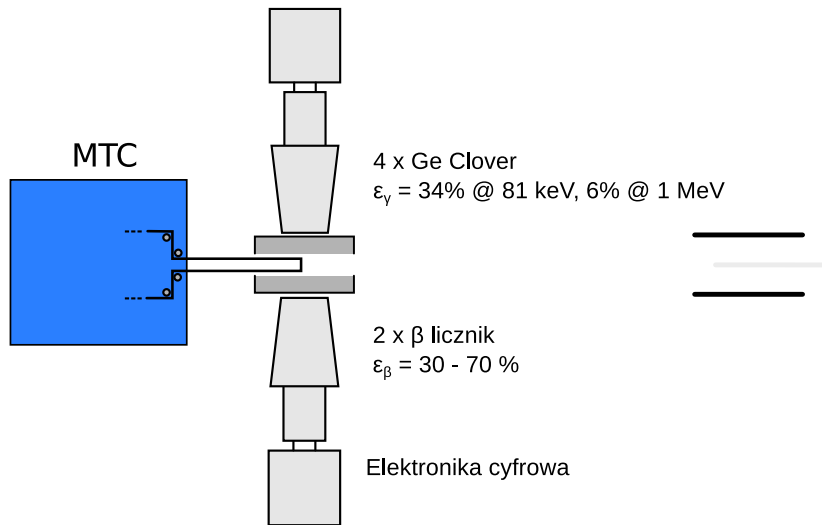
Pomiary spektroskopowe wokół ^{78}Ni



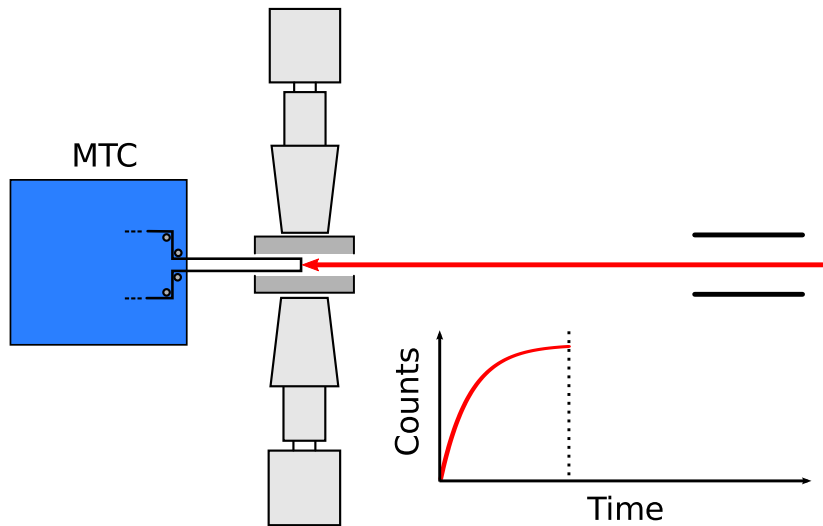
Układ eksperymentalny



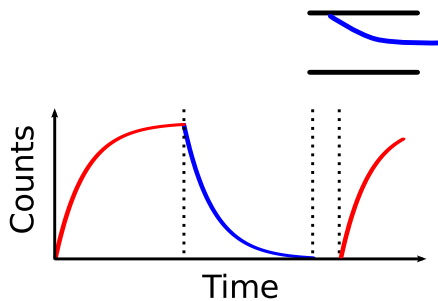
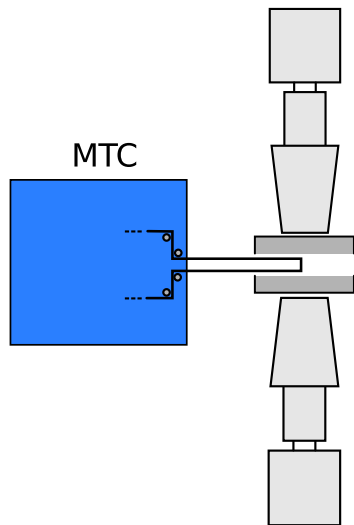
Układ detektorów



Układ detektorów

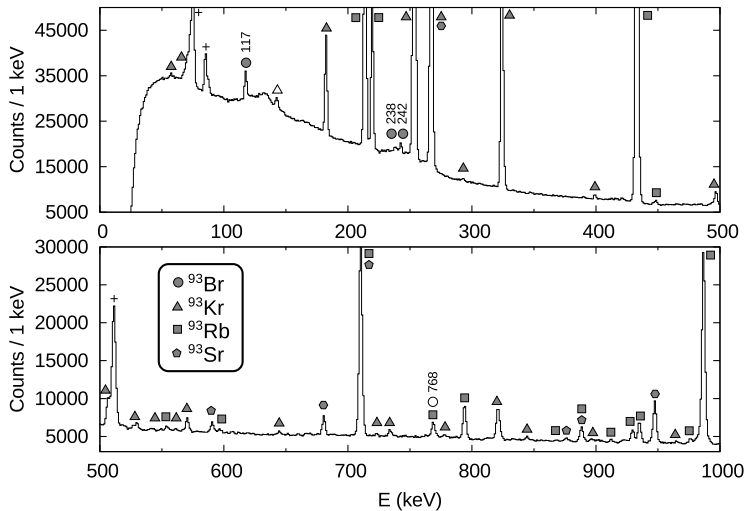


Układ detektorów



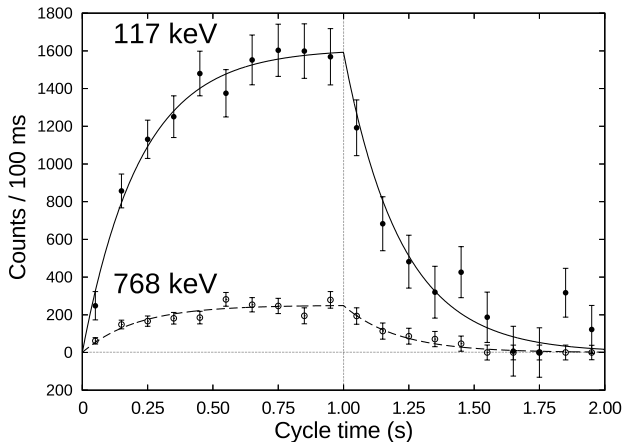
Izomery

Pomiar rozpadu ^{93}Br



12-godzinny pomiar, cykl 1–1–0.425 oraz 1–4–0.425 s

Okres połowicznego zaniku



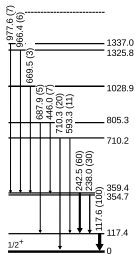
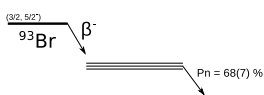
- $T_{1/2} = 152(8)$ ms
- Dane w tablicach $T_{1/2} = 102(10)$ ms
- Nie przechodzi testu 3σ

- Okres połowicznego zaniku:
K.-L. Kratz et al., Z. Phys. A **330**(1988) (short note)

Isotope	Experiment		RPA Shell Model		
	$T_{1/2}$ [ms]	P_n [%]	$T_{1/2}$ [ms]	P_n [%]	Def. ϵ_2
$^{91}_{35}\text{Br}_{56}$	510 ± 20	25.5 ± 3.5	892	26.8	0
			628	21.8	0.05
			202	8.0	0.10
			43	3.2	0.20
$^{92}_{35}\text{Br}_{57}$	310 ± 10	32 ± 4.5	1830	100	0
			439	23.6	0.025
			41	4.2	0.10
			78	13.7	0.20
$^{93}_{35}\text{Br}_{58}$	102 ± 10	$10 \pm \frac{5}{3}$	19	2.9	0
			92	10.7	0.10
			41	5.4	0.20
$^{94}_{35}\text{Br}_{59}$	70 ± 20	30 ± 10	19	8.9	0
			35	7.8	0.25
			93	34.9	0.275
			107	25.3	0.30

- Schemat rozpadu: G. Lhersonneau et al., Phys. Rev. C **63**(2001)
Brak podanego $T_{1/2}$, ale nowy $P_n = 68(7)\%$
- Brak widm γ , krzywych zaniku itd.

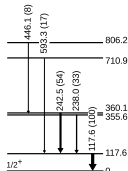
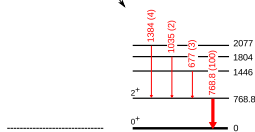
Schemat rozpadu ^{93}Br



G. Lhersonneau et al. (2001)

$Q\beta = 11\,170$ keV

$S_n = 3438$ keV



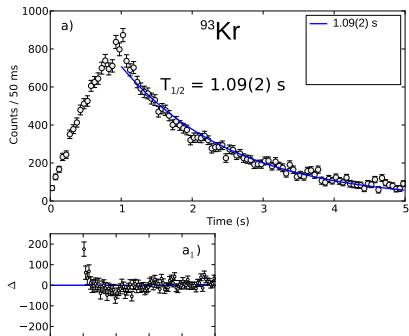
This work

Poprzednie pomiary czasu połowicznego zaniku ^{93}Kr

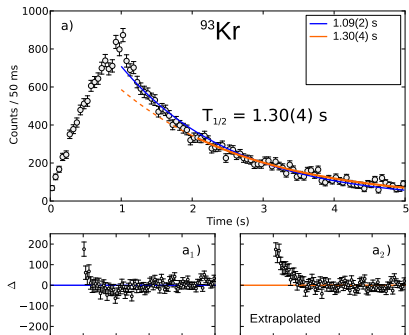
	$T_{1/2}$ (s)	Comment
P. Patzelt (1965)	1.17(4)	Metoda przepływu gazu
J. Talbert (1969)	1.29(1)	Linia transportująca gaz
G. Carslon (1969)	1.289(12)	Linia transportująca gaz (12 s)
S. Amiel (1972)	1.20(10)	Separator masowy, gazy szlachetne
M. Ashgar (1975)	1.27(2)	Separator masowy, taśma transportująca
G. Rudstam (1976)	1.33(5)	Separator masowy, taśma transportująca
M. Quinn (2012)	1.04(6)	fragmentacja

Adopted value $T_{1/2} = 1.286(12)$ s

Okres połowicznego zaniku ^{93}Kr

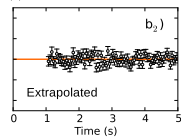
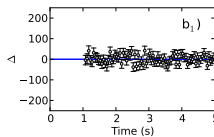
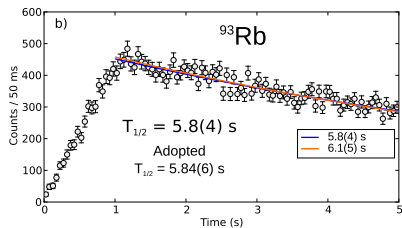
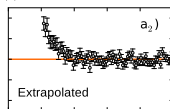
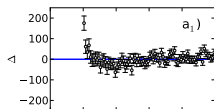
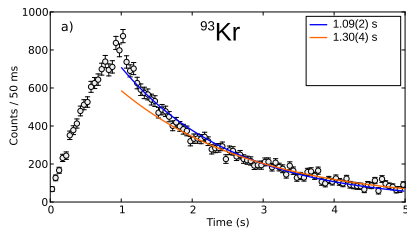


Okres połowicznego zaniku ^{93}Kr



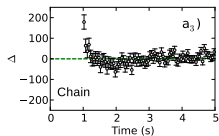
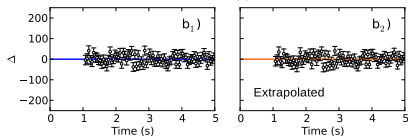
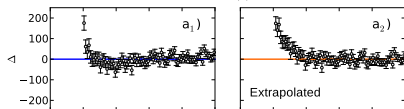
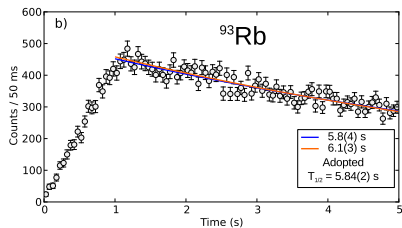
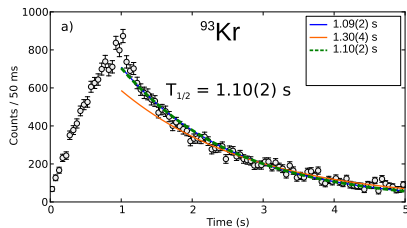
- Problemy z synchronizacją taśma–wiązka?
- Problem z systemem akwizycji danych? Czas martwy?

Okres połowicznego zaniku ^{93}Kr



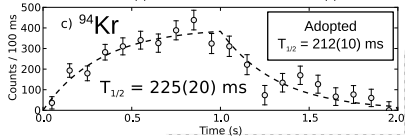
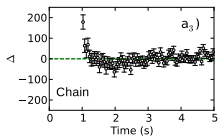
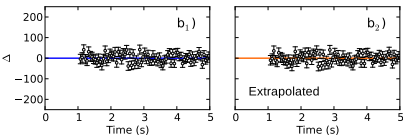
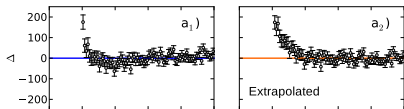
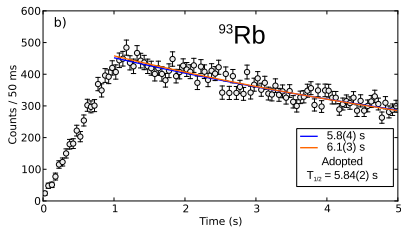
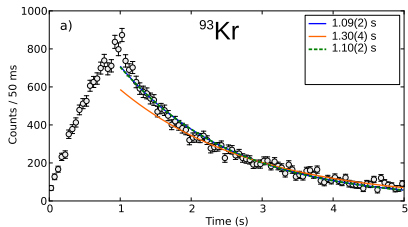
- Wpływ krótkożyciowego ^{93}Br ?

Okres połowicznego zaniku ^{93}Kr



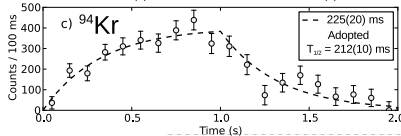
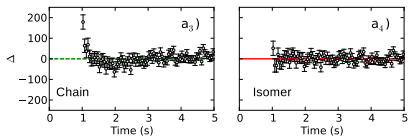
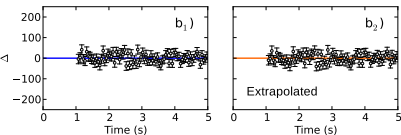
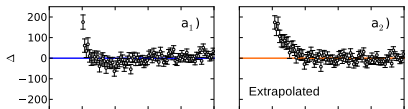
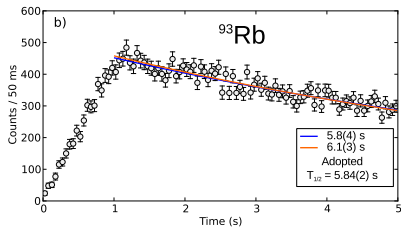
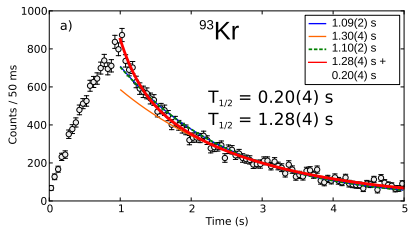
- Dyfuzja kryptonu z taśmy?

Okres połowicznego zaniku ^{93}Kr



- Izomer ulegający rozpadowi beta?

Okres połowicznego zaniku ^{93}Kr

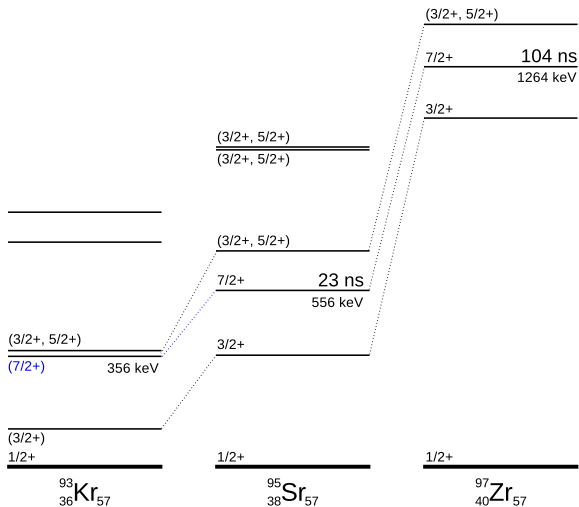


Poprzednie pomiary czasu połowicznego zaniku ^{93}Kr

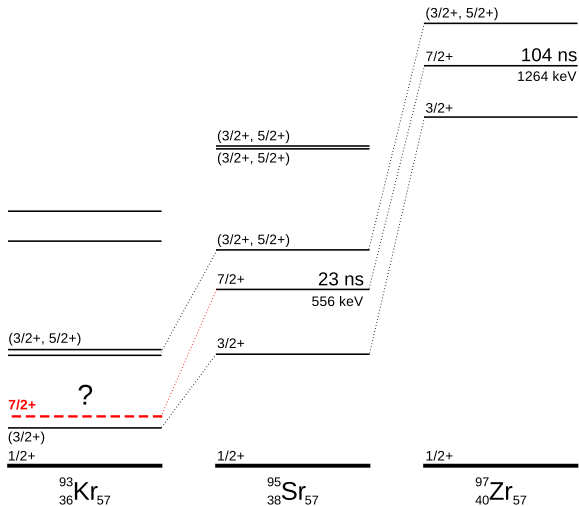
	$T_{1/2}$ (s)	Comment
P. Patzelt (1965)	1.17(4)	Metoda przepływu gazu
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G. Rudstam (1976)	1.33(5)	Separator masowy, taśma transportująca
M. Quinn (2012)	1.04(6)	fragmentacja
K. M.	1.28(4)	$^{93}\text{Kr}^{\text{g.s}}$
K. M.	0.20(4)	$^{93}\text{Kr}^{\text{m}}$

Adopted value $T_{1/2} = 1.286(12)$ s

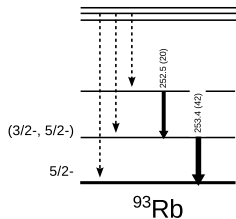
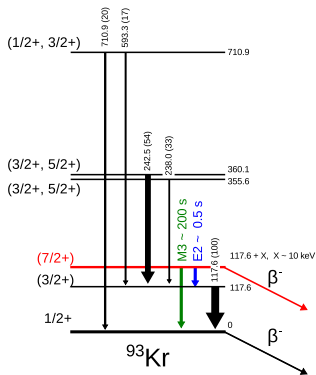
Możliwe położenie izomeru



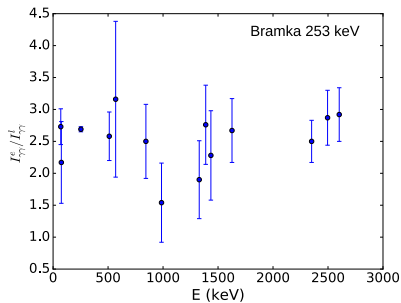
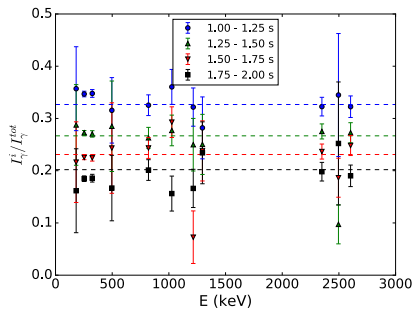
Możliwe położenie izomeru



Możliwe położenie izomeru



Weryfikacja



Rozwiązanie zagadki?

Rozwiązanie zagadki?

- Problem dyfuzji gazów szlachetnych z materiałów, w których są implantowane jest znany

Rozwiązanie zagadki?

- Problem dyfuzji gazów szlachetnych z materiałów, w których są implantowane jest znany
- Część atomów zostaje uwięziona, podczas gdy pozostałe ulegają dyfuzji

Rozwiązanie zagadki?

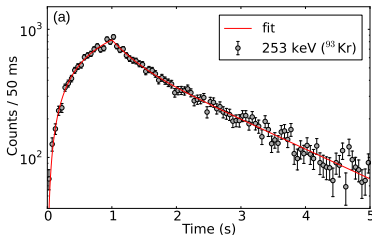
- Problem dyfuzji gazów szlachetnych z materiałów, w których są implantowane jest znany
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- Pomiary czasów życia $^{94-96}\text{Kr}$ z ISOLDE (U.C. Bergman et al., NPA 714 (2003)) podają czas połowicznej dyfuzji 50-110 ms i 13-22% uciekających atomów

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-

$$\tau_{\text{eff}} = \frac{\tau_{\beta}\tau_d}{\tau_{\beta} + \tau_d},$$

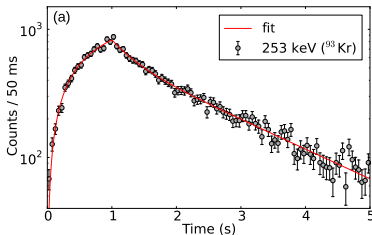
$$f(t) = \begin{cases} PR(1 - e^{(-t/\tau_{\text{eff}})}) + P(1 - R)(1 - e^{(-t/\tau_{\beta})}) \\ PR(1 - e^{(-t_1/\tau_{\text{eff}})})e^{(-t/\tau_{\text{eff}})} + P(1 - R)(1 - e^{(-t_1/\tau_{\beta})})e^{(-t/\tau_{\beta})} \end{cases},$$



Rozwiązanie zagadki?

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- $T_{1/2} = 1.298(54)$ s, $T_{1/2}^d = 0.295(68)$ s, $R = 16\%$
- W przypadku ^{94}Kr efekt był zamaskowany bardzo podobnym czasem życia!

G. Audi NUBASE 2012

Table I. The NUBASE2012 table (continued, Explanation of Table on page 1176)

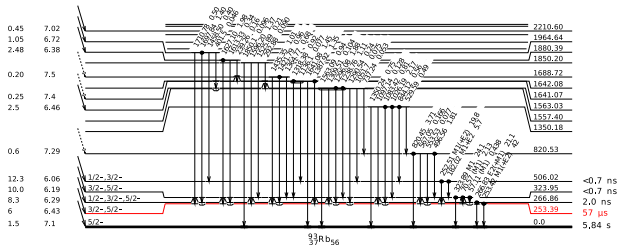
Nuclide	Mass excess (keV)	Excitation energy (keV)	Half-life	J^π	Ens	Reference	Year of discovery	Decay modes and intensities (%)
^{93}Kr	-64136,0	2,5	1,286 s	0,010	1/2 ⁺	11	1951	β^- =100; β^- _n =1,95 11
^{93}Rb	-72620	8	5,84 s	0,02	5/2 ⁻	11	1960	β^- =100; β^- _n =1,39 7
$^{93}\text{Rb}^m$	-72367	8 253,39	0,03	57 μs	15	3/2 ⁻	11 FGK126 J	1970 Γ =100

*

ENSDF Data File (93RB)

93RB L 253.39 3 3/2-, 5/2- 57 US 15
 93RB CL T from Adopted Levels. Other: <0.5 NS (1986Si20).

C.M. Baglin Nuc. Data Sheets 112(2011)



J.W. Grüter CERN Conf. Proc. (1970)

Table I : Isomeric x- and γ -rays measured for light fission products

nuclide assignment by separator from eq.(1)	isomeric x-rays			isomeric γ -rays					most probable isomers	
	element	$t_{1/2}$ [μs]	rel. yield	this work		ref. 9)				
				E_{γ} + 0.5 [keV]	$t_{1/2}$ [μs]	rel. yield	E_{γ} [keV]	$t_{1/2}$ [μs]	mass	
$^{88}\text{Se}; ^{88}\text{Br}_j$ $^{88,89}\text{Kr}; ^{89}\text{Rb}$	Br	6.8 ± 1.0	-	111.0 159.0	6.2 ± 0.6 6.5 ± 0.6	45 57	111.2	3.0 *	89 ± 0	^{88}Br
$^{91}\text{Br}_j; ^{92}\text{Kr}; ^{93}\text{Rb}_j$ $^{93,94}\text{Sr}_j; ^{95}\text{Y}_j; ^{96}\text{Zr}$	Rb	> 10	-	257.0	57 ± 15	-	-	-	-	^{93}Rb
$^{94}\text{Kr}_j; ^{95,96}\text{Rb}_j$ $^{96,97}\text{Sr}_j; ^{97,98}\text{Y}_j$ $^{99}\text{Zr}_j; ^{100}\text{Nb}_j$ $^{101,102}\text{Mo}$	Rb	0.51 ± 0.18	38	140.5 167.2	0.48 ± 0.1 0.50 ± 0.1	41 40	140.9 167.1	0.36 0.24	$96 \pm 1, -0$	^{96}Rb
	Sr	0.44 ± 0.08	105	-	-	-	-	-	-	$^{96,97}\text{Sr}$
	Y	} 0.6 ± 0.1 8.2 ± 0.9	248	130.0	0.44 ± 0.1	72	129.8	0.34	$99 \pm 1, -0$	$^{97,98}\text{Y}$
				101.0	0.84 ± 0.15	15	100.7	0.53	$98 \pm 0, -1$	^{98}Y
				110.7	0.90 ± 0.15	7	111.0	0.76	98 ± 0	
				158.9	0.75 ± 0.2	9	158.0	1.50	97 ± 1	
				169.8	0.62 ± 0.15	35	170.5	1.1	98 ± 0	
				185.3	0.85 ± 0.1	8	186.4	0.65	98 ± 1	
	Zr	} 0.32 ± 0.08	550 *	120.1	7.9 ± 0.3	100			98 ± 1	$^{97,98}\text{Y}$
				169.8	8.1 ± 0.3	64				
203.7				8.1 ± 0.3	69	204.0	3.0 *	98 ± 1		
Nb	0.32 ± 0.08	345 *	-	-	-	-	-	-	^{99}Zr ^{100}Nb	

* estimated value

J.W. Grüter Phys. Lett B (1970)

Table 1
Table of results.

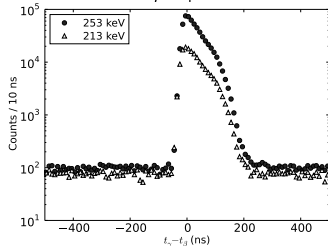
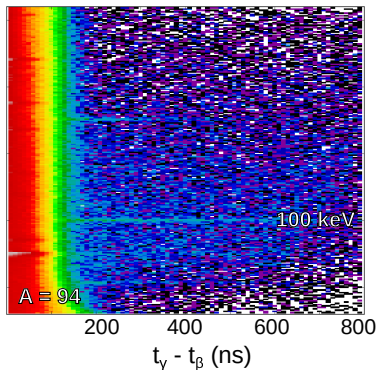
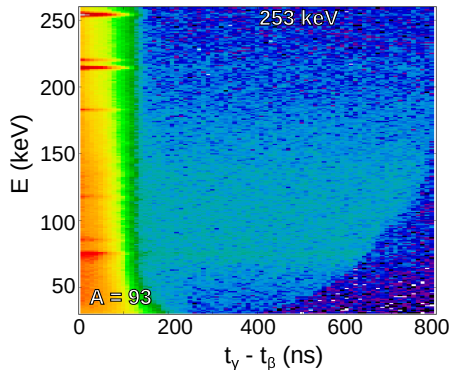
Emitter	$t_{1/2}$ (μs)	E_γ
		(keV) $\Delta E_\gamma = \pm 0.5 \text{ keV}$
$^{88}_{35}\text{Br}_{53}$	6.3 ± 0.5	111.0
		159.0
$^{93}_{37}\text{Rb}_{56}$	57.0 ± 15.0	257.0
$^{96}_{37}\text{Rb}_{59}$	0.49 ± 0.08	140.5
		167.2
$^{96}_{38}\text{Sr}_{58}$ or $^{97}_{38}\text{Sr}_{59}$	0.47 ± 0.08	*
		101.0
$^{98}_{39}\text{Y}_{59}$	0.83 ± 0.10	110.7
		130.0
		158.9
		185.3
		120.1
$^{97}_{39}\text{Y}_{58}$ or $^{98}_{39}\text{Y}_{59}$	8.0 ± 0.2	120.1
		169.8
		203.7
		121.4
$^{99}_{40}\text{Zr}_{59}$	0.40 ± 0.08	130.0
		*
$^{100}_{41}\text{Nb}_{59}$	0.32 ± 0.08	*
$^{132}_{50}\text{Sn}_{82}$ or $^{133}_{50}\text{Sn}_{83}$	0.53 ± 0.2	*
		324.0
$^{135}_{51}\text{Sb}_{84}$ or $^{135}_{52}\text{Te}_{83}$	0.58 ± 0.04	1181.0
		**
$^{134}_{51}\text{Sb}_{83}$ or $^{135}_{51}\text{Sb}_{84}$	0.58 ± 0.12	**
		**
$^{134}_{52}\text{Te}_{82}$ or $^{135}_{52}\text{Te}_{83}$	0.69 ± 0.15	115.0
		297.0
$^{134}_{52}\text{Te}_{82}$	0.20 ± 0.05	1280.0
		391.0
$^{134}_{53}\text{J}_{81}$, $^{135}_{53}\text{J}_{82}$ or $^{136}_{53}\text{J}_{83}$	1.4 ± 0.3	197.0
		381.0
$^{136}_{54}\text{Xe}_{82}$	3.10 ± 0.25	1313.0

S. Amiel Phys. Rev C (1972)

TABLE II. γ -ray energies and relative intensities for nuclides of mass 93.

Isotope	This work		Previous measurements	
	E_γ (keV)	Relative intensity	E_γ (keV)	Relative intensity
Kr	182 ± 2	0.10		
	253 ± 2	1.00	257^a	
	267 ± 2	0.29		
	323 ± 2	0.49		
Rb	215 ± 2	0.30		
	431 ± 2	1.00		
Sr	169 ± 2	0.29	178^b	0.17^b
	260 ± 2	0.15	255	0.13
	590 ± 2	1.00	600	1.00
	710 ± 3	0.58	710	0.35
	876 ± 3	0.55	880	0.76
	889 ± 3	0.39		

Nasze wyniki



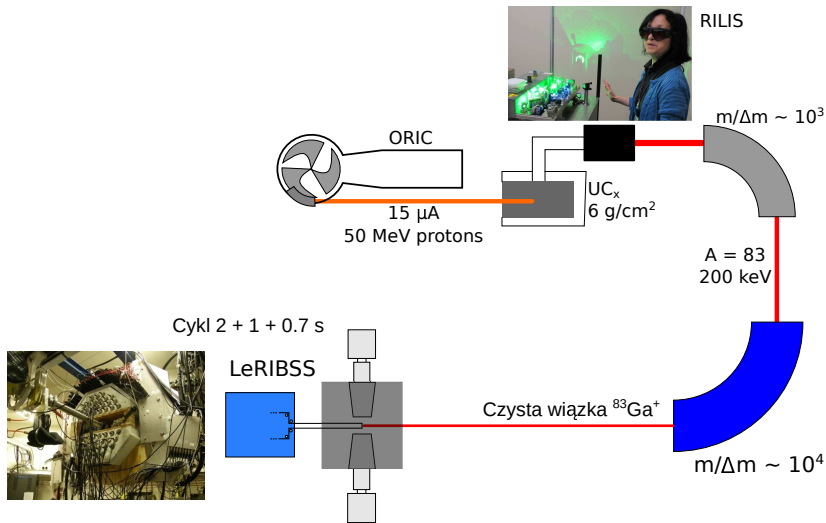
- E. Achterberg PRC 10(1974)

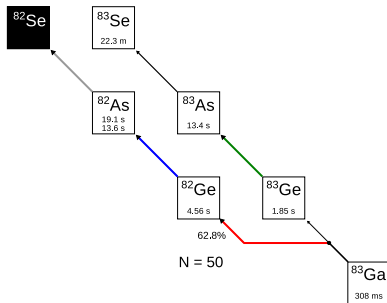
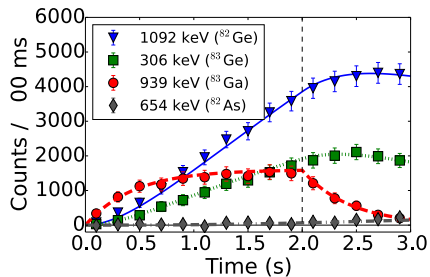
We were able to propose tentative parities for eight excited levels and to show that if the isomeric state reported in Ref. 7 is populated in the β decay of ^{93}Kr , it does so only very weakly.

- R. Brissot et al. Nuc. Phys. A238(1975)
Wyklucza możliwość populacji izomerów w rozpadzie ^{93}Kr .
- C.J. Bischof and W.L. Talbert Jr. PRC 15(1977)
Nie widzą izomeru, zgadzają się z Achterbergiem z przypisaniem przejścia M1.
- K. Sistemich et al. ZPA 325(1986)
Zmierzony limit czasu połowicznego zaniku poziomu 253 keV: < 0.5 ns
- Izomer o $T_{1/2} = 53\mu\text{s}$ i energii 260 keV został znaleziony w ^{95}Y (obecny w wiązce Grütera)
- Po publikacji K. M. et al. Nucl. Data Sheets (2014) izomer wreszcie się rozpadł

Nocna zmiana

Rozpad ^{83}Ga





Dzienna zmiana



Nocna zmiana



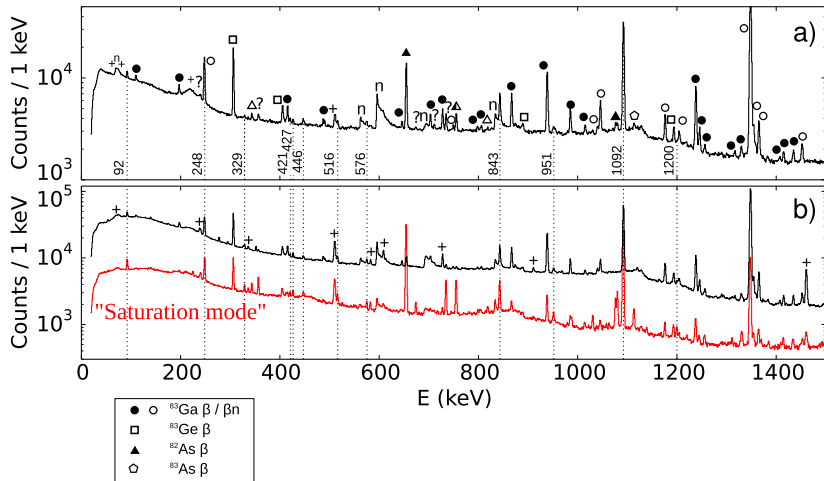
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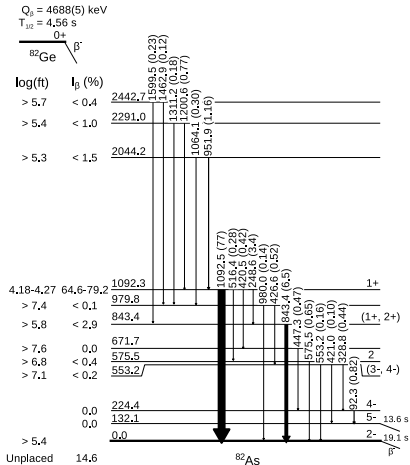
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STOP	FILES	COMMENTS
6:46	a86-03.24 01.43	At about 6:30 we noticed an increase in SSS Ab line. Checked files, but made some file.
	a86-04.04 01.43	TAPE Break (-7:10) looks like we have some PDS creeping in changed deceleration from 6200 to 7750 values from 100 to 400 acceleration 150 to 160 deceleration 150 to 160
	a86-05.04 a86-06.04	(Time is changing) hope this not interfering w/ signal connected
16:25	a86-06 a86-06	20:00 A(17) 200-100 A(17) 200-100 20:05 150 17 0.32(10) 20:10 200 31 0.25(10) 20:15 250 41 0.19(14) 20:20 300 45 21.022 (11) 21.022 20:25 350 49 21.022 (11) 21.022 20:30 400 53 21.022 (11) 21.022 20:35 450 57 0.19(10) 20:40 500 61 0.19(10) 20:45 550 65 0.19(10) 20:50 600 69 0.19(10) 20:55 650 73 0.19(10) 21:00 700 77 0.19(10) 21:05 750 81 0.19(10) 21:10 800 85 0.19(10) 21:15 850 89 0.19(10) 21:20 900 93 0.19(10) 21:25 950 97 0.19(10) 21:30 1000 101 0.19(10) 21:35 1050 105 0.19(10) 21:40 1100 109 0.19(10) 21:45 1150 113 0.19(10) 21:50 1200 117 0.19(10) 21:55 1250 121 0.19(10) 22:00 1300 125 0.19(10) 22:05 1350 129 0.19(10) 22:10 1400 133 0.19(10) 22:15 1450 137 0.19(10) 22:20 1500 141 0.19(10) 22:25 1550 145 0.19(10) 22:30 1600 149 0.19(10) 22:35 1650 153 0.19(10) 22:40 1700 157 0.19(10) 22:45 1750 161 0.19(10) 22:50 1800 165 0.19(10) 22:55 1850 169 0.19(10) 23:00 1900 173 0.19(10) 23:05 1950 177 0.19(10) 23:10 2000 181 0.19(10) 23:15 2050 185 0.19(10) 23:20 2100 189 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4200 357 0.19(10) 02:55 4250 361 0.19(10) 03:00 4300 365 0.19(10) 03:05 4350 369 0.19(10) 03:10 4400 373 0.19(10) 03:15 4450 377 0.19(10) 03:20 4500 381 0.19(10) 03:25 4550 385 0.19(10) 03:30 4600 389 0.19(10) 03:35 4650 393 0.19(10) 03:40 4700 397 0.19(10) 03:45 4750 401 0.19(10) 03:50 4800 405 0.19(10) 03:55 4850 409 0.19(10) 04:00 4900 413 0.19(10) 04:05 4950 417 0.19(10) 04:10 5000 421 0.19(10) 04:15 5050 425 0.19(10) 04:20 5100 429 0.19(10) 04:25 5150 433 0.19(10) 04:30 5200 437 0.19(10) 04:35 5250 441 0.19(10) 04:40 5300 445 0.19(10) 04:45 5350 449 0.19(10) 04:50 5400 453 0.19(10) 04:55 5450 457 0.19(10) 05:00 5500 461 0.19(10) 05:05 5550 465 0.19(10) 05:10 5600 469 0.19(10) 05:15 5650 473 0.19(10) 05:20 5700 477 0.19(10) 05:25 5750 481 0.19(10) 05:30 5800 485 0.19(10) 05:35 5850 489 0.19(10) 05:40 5900 493 0.19(10) 05:45 5950 497 0.19(10) 05:50 6000 501 0.19(10) 05:55 6050 505 0.19(10) 06:00 6100 509 0.19(10) 06:05 6150 513 0.19(10) 06:10 6200 517 0.19(10) 06:15 6250 521 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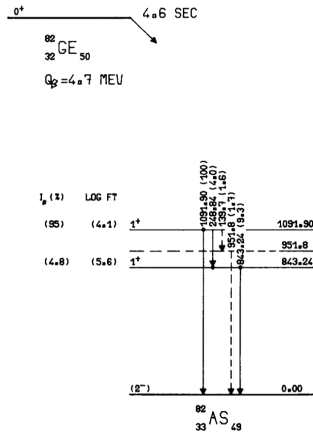
Zerwana taśma



Schemat rozpadu ^{82}Ge

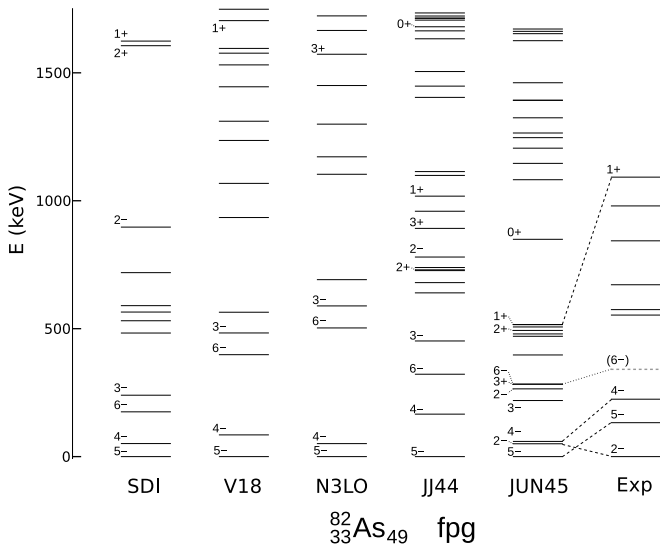


K. M. et al. PRC 90 (2014)



P. Hoff and B. Fogelberg
 NPA 368 (1981)

Porównanie z modelem powłokowym



Rozpad ^{94}Br

Co wiadomo o rozpadzie ^{94}Br ?

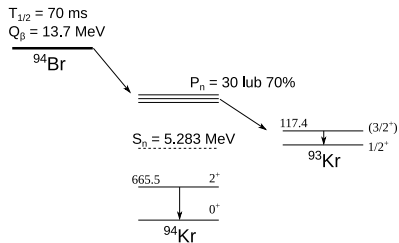
38	Sr 94 75.3 s	Sr 95 23.90 s	Sr 96 1.07 s	Sr 97 429 ms	Sr 98 653 ms	Sr 99 269 ms	Sr 100 202 ms	Sr 101 118 ms	Sr 102 69 ms
	Rb 93 5.84 s	Rb 94 2.702 s	Rb 95 377.5 ms	Rb 96 203 ms	Rb 97 169.9 ms	Rb 98 114 ms	Rb 99 50.3 ms	Rb 100 51 ms	Rb 101 32 ms
36	Kr 92 1.840 s	Kr 93 1.286 s	Kr 94 210 ms	Kr 95 114 ms	Kr 96 80 ms	Kr 97 63 ms	Kr 98 46 ms	Kr 99 40 ms	
	Br 91 541 ms	Br 92 343 ms	Br 93 102 ms	Br 94 70 ms	60	62	64		
34	Se 90	Se 91 270 ms	58						
			56						

- K.-L. Kratz et al., Z. Phys. A **330**(1988) (short note) $T_{1/2} = 70$ ms, $P_n = 30(10)\%$

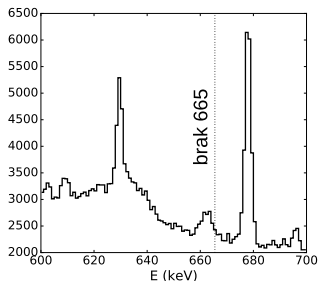
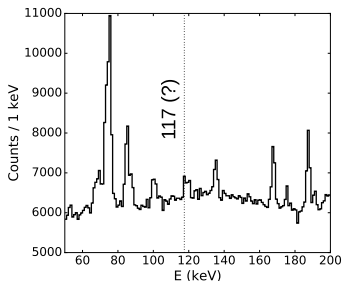
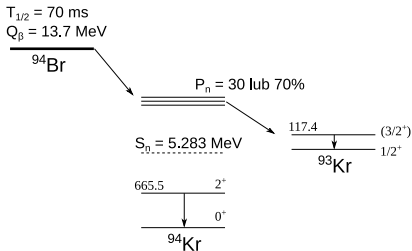
Isotope	Experiment		RPA Shell Model		
	$T_{1/2}$ [ms]	P_n [%]	$T_{1/2}$ [ms]	P_n [%]	Def. ϵ_2
$^{91}_{35}\text{Br}_{56}$	510 ± 20	25.5 ± 3.5	892	26.8	0
			628	21.8	0.05
			202	8.0	0.10
			43	3.2	0.20
$^{92}_{36}\text{Br}_{57}$	310 ± 10	32 ± 4.5	1830	100	0
			439	23.6	0.025
			41	4.2	0.10
			78	13.7	0.20
$^{93}_{37}\text{Br}_{58}$	102 ± 10	$10 \pm \frac{5}{3}$	19	2.9	0
			92	10.7	0.10
			41	5.4	0.20
$^{94}_{38}\text{Br}_{59}$	70 ± 20	30 ± 10	19	8.9	0
			35	7.8	0.25
			93	34.9	0.275
			107	25.3	0.30

- B. Pfeiffer and K.-L. Kratz Prog. Nucl. Energy 41 (2002) $P_n = 70(20)\%$ (?)

Co spodziewamy się znaleźć?

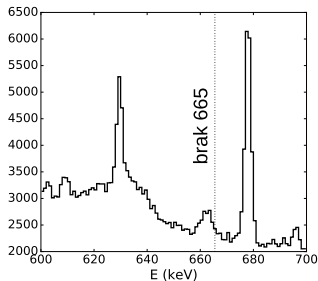
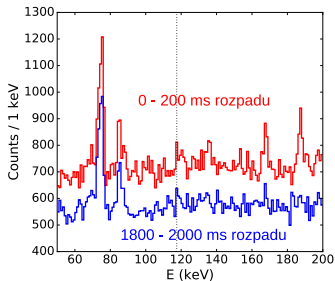
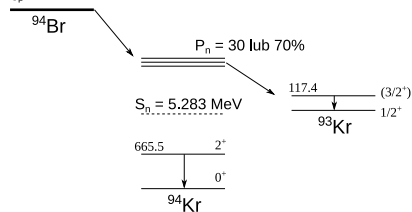


Co spodziewamy się znaleźć?

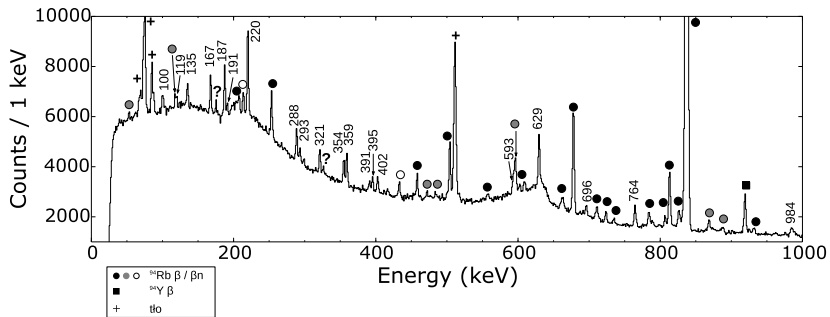


Co spodziewamy się znaleźć?

$T_{1/2} = 70$ ms
 $Q_{\beta} = 13.7$ MeV

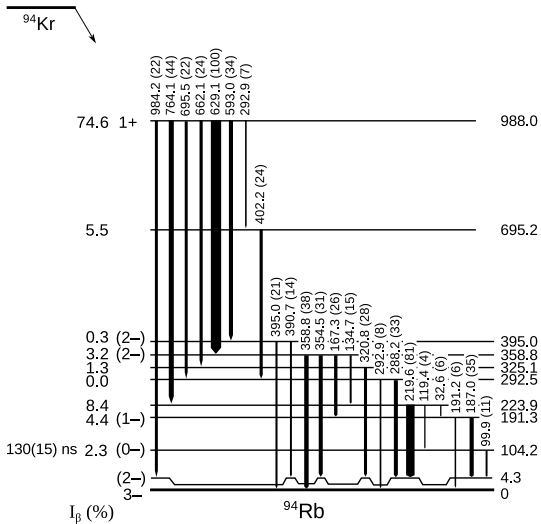


Widmo promieniowania γ - β



Schemat rozpadu ^{94}Kr

$T_{1/2} = 227(14)$ ms
 $Q_{\beta} = 7214$ keV

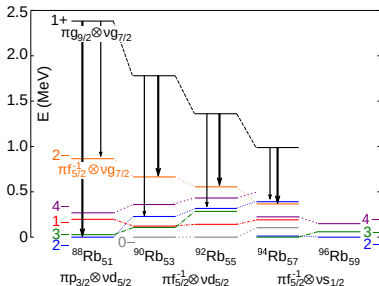


Systematyka stanów w izotopach Rb

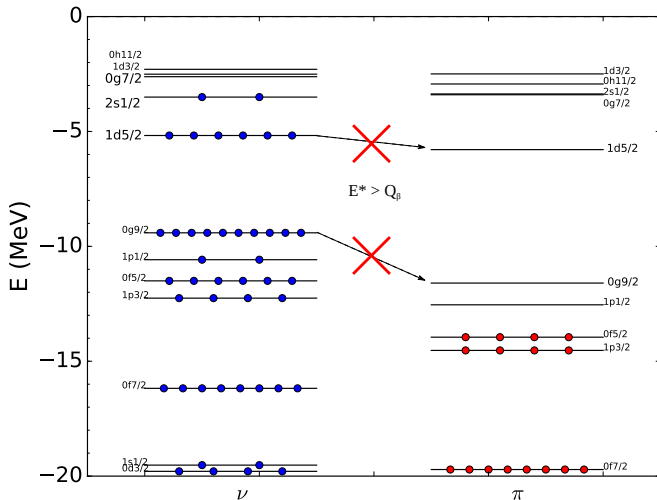
$\pi p_{1/2}$	40	Zr 90	Zr 91	Zr 92	Zr 93	Zr 94	Zr 95	Zr 96	Zr 97	Zr 98	Zr 99	
			5/2+		5/2+		5/2+		1/2+			
$\pi p_{3/2}$	38	Y 89	Y 90	Y 91	Y 92	Y 93	Y 94	Y 95	Y 96	Y 97	Y 98	
		1/2-	2-	1/2-	2-	1/2-	2-	1/2-	0-			
$\pi f_{5/2}$	36	Sr 88	Sr 89	Sr 90	Sr 91	Sr 92	Sr 93	Sr 94	Sr 95	Sr 96	Sr 97	
		5/2+		5/2+		5/2+		1/2+		1/2+		
		Rb 87	Rb 88	Rb 89	Rb 90	Rb 91	Rb 92	Rb 93	Rb 94	Rb 95	Rb 96	
		3/2-	2-	3/2-	0-	3/2-	0-	5/2-	3-	5/2-	2-	
		Kr 86	Kr 87	Kr 88	Kr 89	Kr 90	Kr 91	Kr 92	Kr 93	Kr 94	Kr 95	
		5/2+		3/2+		5/2+		1/2+		1/2+		
		Br 85	Br 86	Br 87	Br 88	Br 89	Br 90	Br 91	Br 92	Br 93	Br 94	
		3/2-		3/2-								
		50	52	54	56	58						
		$vd_{5/2}$				$vs_{1/2}$						

Systematyka stanów w izotopach Rb

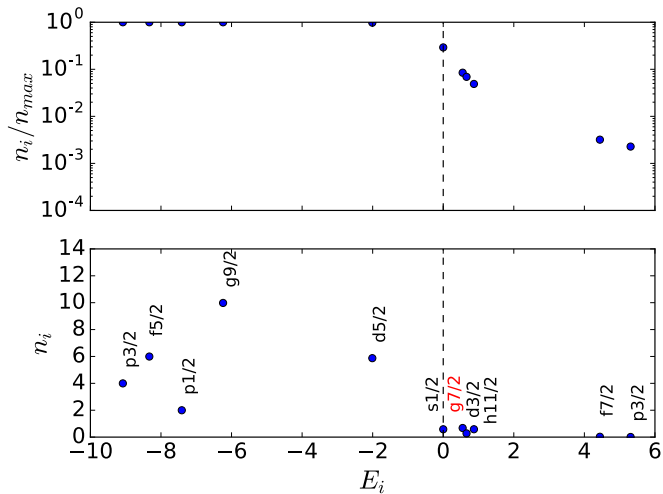
$\pi p_{1/2}$	40	Zr 90	Zr 91	Zr 92	Zr 93	Zr 94	Zr 95	Zr 96	Zr 97	Zr 98	Zr 99
			5/2+		5/2+		5/2+		1/2+		
$\pi p_{3/2}$	38	Y 89	Y 90	Y 91	Y 92	Y 93	Y 94	Y 95	Y 96	Y 97	Y 98
		1/2-	2-	1/2-	2-	1/2-	2-	1/2-	0-		
$\pi f_{5/2}$	36	Sr 88	Sr 89	Sr 90	Sr 91	Sr 92	Sr 93	Sr 94	Sr 95	Sr 96	Sr 97
		5/2+		5/2+		5/2+		1/2+		1/2+	
		Rb 87	Rb 88	Rb 89	Rb 90	Rb 91	Rb 92	Rb 93	Rb 94	Rb 95	Rb 96
		3/2-	2-	3/2-	0-	3/2-	0-	5/2-	3-	5/2-	2-
		Kr 86	Kr 87	Kr 88	Kr 89	Kr 90	Kr 91	Kr 92	Kr 93	Kr 94	Kr 95
		5/2+		3/2+		5/2+		1/2+		1/2+	
		Br 85	Br 86	Br 87	Br 88	Br 89	Br 90	Br 91	Br 92	Br 93	Br 94
		3/2-		3/2-							
		50	vd _{5/2}				vs _{1/2}				



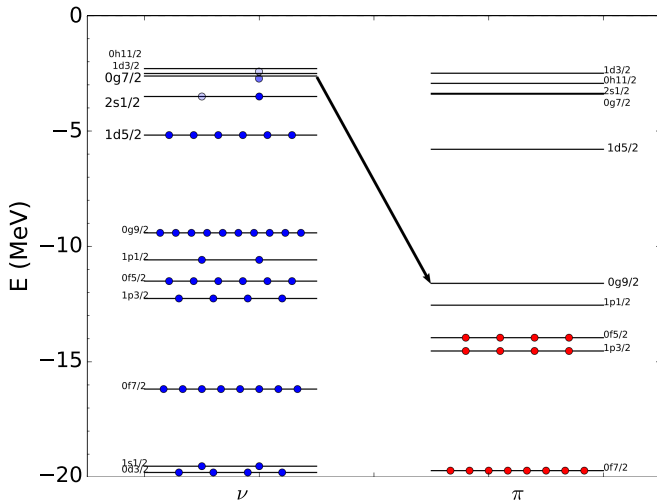
Poziomy jednocząstkowe ^{94}Kr



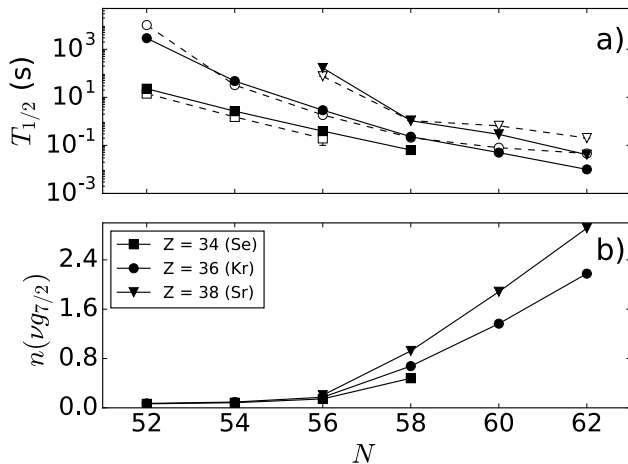
Poziomy jednocząstkowe ^{94}Kr






Poziomy jednocząstkowe ^{94}Kr



Czasy życia sąsiednich jąder



- W ^{93}Kr nie ma izomeru i krypton jednak ucieka z taśmy...
- ale czas połowicznego zaniku ^{93}Br został lepiej zmierzony,
- a stan 253 keV w ^{93}Rb nie jest izomerem.
- Dzięki drzemce na nocnej zmianie udało się zmierzyć nadprogramowe rozpady (^{82}Ge , ...)
- Wprawdzie nie udało się wyprodukować dostatecznie dużo ^{94}Br , ale uzyskaliśmy nowe, ciekawe wyniki i ich interpretację dla ^{94}Kr .

-  K. Miernik et al., Phys. Rev. C **88**(2013)014309
-  K. Miernik et al., Phys. Rev. C **90**(2014)034311
-  K. Miernik et al., Phys. Rev. C **94**(2016)024305