	Histo	ry	
Туре	Author	Citation	Literature Cutoff Date
Full Evaluation	S. K. Basu, E. A. Mccutchan	NDS 165,1 (2020)	1-Mar-2020

Parent: ⁹⁰Nb: E=0.0; $J^{\pi}=8^+$; $T_{1/2}=14.60$ h 5; $Q(\varepsilon)=6111.0$ 30; $\%\varepsilon+\%\beta^+$ decay=100

1990Me15: Measured precision $E\gamma$ and $I\gamma$ with carefully calibrated Ge(Li) detector systems.

1982Wa24: Measured precision E γ , $\gamma(t)$, $\gamma\gamma$ and delayed $\gamma\gamma$ coin with Ge(Li)-NaI escape-suppression spectrometer and Ge(Li).

1968Pe01: Measured γ singles and ce(t) spectra with chemically separated sources.

1987Be12: $\gamma\gamma(\theta)$ with NaI-Ge(Li) detectors.

1964Lo02: Delayed $\beta\gamma$ coin with anthracene and NaI.

Others: 1954On06, 1955Ma31, 1957Sh32, 1958La12, 1959Bj39, 1960Ha06, 1966Pe10, 1970Tu04, 1971Za03, 1975Pa07, 1980Iw03, 2001Ba06.

Decay scheme is based on $\gamma\gamma$ coin and energy sums (1982Wa24).

Total energy release in the decay is 6040 keV 60 as computed by the code Radlist, compared to the Q value of 6111 3. α : Additional information 1.

90Zr Levels

E(level) [†]	$J^{\pi \ddagger}$	T _{1/2}	Comments
0	0+	stable	
1760.74 15	0^{+}		
2186.265 19	2+		
2318.991 19	5-	809.2 ms 20	g=1.250 26 (1987Ed02)
			g: From nuclear magnetic resonance on oriented nuclei.
2739.29 5	(4)-		
2747.867 21	3-		
3076.917 21	4+		
3448.221 21	6+		
3589.409 22	8+	125 ns 6	T _{1/2} : From delayed $\beta\gamma$ coin (1964Lo02).
4232.21 <i>3</i>	6 ⁻ ,7 ⁻		
4319.02? 10			
4375.06 7	7-		
4541.36 4	6+		
4640.94 5			
5059.97 <i>3</i>	7*		
5164.48 3	$(8)^{+}$		
5247.52 5	9+		
5432.78 3	7+,8+,9+		
5589.46? 10			

[†] From a least-squares fit to $E\gamma$, by evaluators.

[‡] From the Adopted Levels.

 ε, β^+ radiations

 $\varepsilon + \beta^+$ branches are obtained from I γ +ce imbalance at each level.

E(decay)	E(level)	$\mathrm{I}\varepsilon^{\dagger}$	Log ft	$\mathrm{I}(\varepsilon + \beta^+)^\dagger$	Comments
$(521.5^{\ddagger} 32)$	5589.46?	0.07 <i>1</i>	7.35 7	0.07 <i>1</i>	ε K=0.8669; ε L=0.10857 4; ε M+=0.024520 9
(678.2 32)	5432.78	1.40 <i>3</i>	6.281 <i>11</i>	1.40 <i>3</i>	ε K=0.8686; ε L=0.10725 2; ε M+=0.024176 5
(863.5 32)	5247.52	0.335 <i>15</i>	7.116 20	0.335 <i>15</i>	ε K=0.8697; ε L=0.10632 2; ε M+=0.023934 3
(946.5 32)	5164.48	1.017 <i>24</i>	6.715 <i>11</i>	1.017 <i>24</i>	ε K=0.8701; ε L=0.1060; ε M+=0.023857 3

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Continued on next page (footnotes at end of table)

		9	90 Nb $arepsilon$ + eta^+ de	cay 1990N	Me15,1982Wa	24 (continued)
				ϵ, β^+ radiatio	ns (continued	<u>)</u>
E(decay)	E(level)	Ιβ ⁺ †	$\mathrm{I}\varepsilon^{\dagger}$	Log ft	$I(\varepsilon + \beta^+)^{\dagger}$	Comments
(1470.1 32)	4640.94	0.00466 23	0.214 9	7.779 18	0.219 9	av Eβ=200.5 13; εK=0.8529 5; εL=0.10271 6; εM+=0.02307 2
(1735.9 32)	4375.06	0.010 1	0.088 9	8.31 5	0.098 10	av Eβ=314.7 13; εK=0.7793 13; εL=0.09353 15; εM+=0.02100 4
(1792.0 [‡] 32)	4319.02?	0.009 1	0.06 1	8.50 7	0.07 1	av Eβ=339.0 13; εK=0.7550 14; εL=0.09057 17; εM+=0.02034 4
(1878.8 32)	4232.21	0.031 4	0.141 20	8.18 6	0.172 24	av E β =376.8 <i>13</i> ; ε K=0.7125 <i>16</i> ; ε L=0.08539 <i>19</i> ; ε M+=0.01917 <i>5</i>
(2521.6 32)	3589.409	51 2	36 1	6.028 16	87 <i>3</i>	av E β =662.2 <i>14</i> ; ε K=0.3600 <i>14</i> ; ε L=0.04296 <i>17</i> ; ε M+=0.00964 <i>4</i>
(2662.8 32)	3448.221	<4	<2	>7.3	<6	av Eβ=726.1 14; εK=0.3014 12; εL=0.03595 14; εM+=0.00807 3

[†] Absolute intensity per 100 decays.
[‡] Existence of this branch is questionable.

$\gamma(^{90}\text{Zr})$

For adjusted $E\gamma$ and $I\gamma$ (based on energy sums and intensity balance) see 1982Wa24. For a search for the 2319 to 1761 E5 transition with mini-orange detectors, see 1985HaZI.

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E_{γ}^{\ddagger}	$I_{\gamma}^{\ddagger@}$	E _i (level)	\mathbf{J}_i^π	\mathbf{E}_{f}	\mathbf{J}_f^{π}	Mult. [#]	$\delta^{\#}$	α	Comments
132.716 18	50.4 5	2318.991	5-	2186.265	2+	E3(+M4)	< 0.07	2.97 11	α (K)=2.20 8; α (L)=0.644 23; α (M)=0.115 5; α (N)=0.0146 6; α (O)=0.000359 24
									Mult.: α (K)exp=2.11 <i>15</i> ; K/L=3.22 <i>16</i> (1968Pe01). Mult.: $(132.7\gamma)(2186.3\gamma)(\theta)$: A ₂ =+0.187 <i>38</i> , A ₄ =-0.063 <i>36</i>
									(1978Be12). δ : +0.06 10 from $\gamma\gamma(\theta)$; 0.00 7 from ce measurements.
141.178 15	814 8	3589.409	8+	3448.221	6+	E2		0.316	$\alpha(K)=0.268 \ 4; \ \alpha(L)=0.0402 \ 6; \ \alpha(M)=0.00701 \ 10; \ \alpha(N)=0.000940$ 14: $\alpha(Q)=4.52\times10^{-5} \ 7$
									Mult.: α (K)exp=0.268 <i>19</i> ; K/L=6.25 <i>33</i> (1968Pe01).
									Mult.: $(141.3\gamma)(1129.2\gamma)(\theta)$: A ₂ =-0.070 <i>12</i> , A ₄ =-0.003 <i>10</i> (1978Be12).
									$ δ: -0.02 + 11-5 $ from $\gamma\gamma(\theta)$; 0.05 4 from ce measurements; both consistent with no M3 admixture.
222 ^a	< 0.08	4541.36	6+	4319.02?					
268 ^{<i>a</i>}	< 0.05	5432.78	7+,8+,9+	5164.48	(8)+				
309 ^{<i>a</i>}	< 0.11	4541.36	6+	4232.21	6-,7-				
329.058 16	1.50 5	3076.917	4+	2747.867	3-				
337.50 15	0.3 1	3076.917	4^+	2739.29	$(4)^{-}$	50		0.01064	
3/1.30/ 8	22.0 8	3448.221	6'	30/6.91/	4'	E2		0.01064	$\alpha(\mathbf{K})=0.00929\ 13;\ \alpha(\mathbf{L})=0.001119\ 10;\ \alpha(\mathbf{M})=0.000194\ 3;$ $\alpha(\mathbf{N})=2\ 71\times10^{-5}\ 4;\ \alpha(\mathbf{O})=1\ 712\times10^{-6}\ 24$
									Mult.: $\alpha(K)$ exp=0.088 6.
409 ^{<i>a</i>}	< 0.11	4640.94		4232.21	$6^{-},7^{-}$				
420.28 5	0.33 3	2739.29	(4) ⁻	2318.991	5-				
425.5 2	0.06 1	2186.265	2+	1760.74	0^{+}	E2		0.00688	α (K)=0.00602 9; α (L)=0.000713 10; α (M)=0.0001239 18; α (N)=1.732×10 ⁻⁵ 25
									$\alpha(O)=1.117\times10^{-6}$ 16
429 ^{<i>a</i>}	< 0.06	2747.867	3-	2318.991	5-				
518.60 6	8.4 6	5059.97	7+	4541.36	6+				α (K)exp=0.00195 <i>17</i> .
524 ^a	< 0.23	5164.48	$(8)^+$	4640.94	2+				
561.604 11	1.46 4	2747.867	3	2186.265	21				
623 ^{<i>u</i>}	< 0.23	5164.48	(8)+	4541.36	6+				
643 ^u	< 0.23	4232.21	$6^{-},7^{-}$	3589.409	8+ 5-				
151.95 5	0.49 5	50/0.91/	4	2318.991	5				
/84 ^{••}	<0.08	4232.21	6,7	3448.221	0'				

 $^{90}_{40}$ Zr₅₀-3

 $^{90}_{40}{
m Zr}_{50}$ -3

				⁹⁰ N	b ε + β ⁺	decay 1	1990Me15,1982V	Va24 (continued)
						γ (⁹⁰	Zr) (continued)	
E_{γ}^{\ddagger}	$I_{\gamma}^{\ddagger @}$	E _i (level)	\mathbf{J}_i^{π}	E_f	\mathbf{J}_{f}^{π}	Mult. [#]	α	Comments
792.05 19	0.13 4	5432.78	$7^+, 8^+, 9^+$	4640.94	<- - -	-	4.10 10-4	
821.14 4	13.5 2	5059.97	7*	4232.21	6 ,7	EI	4.19×10 ⁺	$\alpha(K)=0.0003716; \alpha(L)=4.04\times10^{-5}6; \alpha(M)=6.99\times10^{-6}70; \alpha(N)=9.93\times10^{-7}14; \alpha(O)=7.02\times10^{-8}10$ Mult.: $\alpha(K)\exp=0.000334.$ Mult.: $(827.7\gamma)(1913.2\gamma)(\theta)$: A ₂ =+0.16440, A ₄ =+0.06235 (1978Be12).
890.64 5	22.0 5	3076.917	4+	2186.265	2+	(E2)	8.82×10 ⁻⁴	$\begin{aligned} \alpha(K) &= 0.000777 \ 11; \ \alpha(L) = 8.69 \times 10^{-5} \ 13; \ \alpha(M) = 1.507 \times 10^{-5} \ 22; \\ \alpha(N) &= 2.13 \times 10^{-6} \ 3 \\ \alpha(O) &= 1.479 \times 10^{-7} \ 21 \\ \text{Mult.:} \ \alpha(K) &= 0.00076 \ 6. \\ \text{Mult.:} \ (890.6\gamma)(2186.3\gamma)(\theta): \ A_2 &= +0.132 \ 51, \ A_4 &= -0.023 \ 48 \\ (1978Be12). \\ \delta: \ +0.05 \ 7 \ \text{from } \gamma\gamma(\theta); \ 0.0 \ 1 \ \text{from ce measurements; both consistent} \\ \text{with no M3 admixture.} \end{aligned}$
891 ^a	< 0.70	5432.78	7 ⁺ ,8 ⁺ ,9 ⁺	4541.36	6+			
932 ^a	<1.4	5164.48	$(8)^{+}$	4232.21	$6^{-}, 7^{-}$			
952 ^a	< 0.11	4541.36	6+	3589.409	8+			
1051.53 4	2.6 1	4640.94		3589.409	$\frac{8^{+}}{7^{-}}$			
1057.8 1	0.21 6	5432.78	7 ⁺ ,8 ⁺ ,9 ⁺	43/5.06	6 ⁺			
1129.224 15	1130 5	3448.221	6 ⁺	2318.991	5-	E1	2.41×10 ⁻⁴	$\alpha(K)=0.000203 \ 3; \ \alpha(L)=2.20\times10^{-5} \ 3; \ \alpha(M)=3.81\times10^{-6} \ 6; \ \alpha(N)=5.42\times10^{-7} \ 8; \ \alpha(O)=3.85\times10^{-8} \ 6$ Mult.: $\alpha(K)\exp=0.000197 \ 11.$ Mult.: $(141.3\gamma)(1129.2\gamma)(\theta): \ A_2=-0.070 \ 12, \ A_4=-0.003 \ 10 \ (1978Be12).$ $\delta: \ -0.02 \ 7 \ from \ \gamma\gamma(\theta): \ 0.000 \ 14 \ from \ ce \ measurements: \ both$
								consistent with no M2 admixture.
1155 ^a	< 0.06	4232.21	6 ⁻ ,7 ⁻	3076.917	4+			
1192.7 <i>1</i>	0.20 2	4640.94		3448.221	6+			
1201 ^{<i>a</i>}	< 0.23	5432.78	7 ⁺ ,8 ⁺ ,9 ⁺	4232.21	6 ⁻ ,7 ⁻			5
1270.396 18	15.8 3	3589.409	8+	2318.991	5-	(E3)	7.63×10 ⁻⁴	$\begin{aligned} &\alpha(\mathbf{K}) = 0.000667 \ I0; \ \alpha(\mathbf{L}) = 7.56 \times 10^{-3} \ II; \ \alpha(\mathbf{M}) = 1.313 \times 10^{-3} \ I9; \\ &\alpha(\mathbf{N}) = 1.86 \times 10^{-6} \ 3 \\ &\alpha(\mathbf{O}) = 1.285 \times 10^{-7} \ I8 \\ &\text{Mult.:} \ \alpha(\mathbf{K}) \exp = 0.00068 \ 7. \end{aligned}$
1464 ^{<i>a</i>}	< 0.28	4541.36	6+	3076.917	4+			
1470.528 24	5.6 2	5059.97	7*	3589.409	8*			
1493 ⁴⁴ 1575.035 <i>23</i>	<0.11	4232.21 5164.48	$6^{-}, 7^{-}$ (8) ⁺	2739.29 3589.409	$(4)^{-}$ 8 ⁺	M1,E2	3.64×10 ⁻⁴ 8	$\alpha(K)=0.000230\ 5;\ \alpha(L)=2.50\times10^{-5}\ 5;\ \alpha(M)=4.34\times10^{-6}\ 9;$

4

From ENSDF

 $^{90}_{40}{
m Zr}_{50}{
m -4}$

				⁹⁰ Nb a	ε + β ⁺	decay	1990Me15,1982V	Wa24 (contin	nued)
						$\gamma(9)$	⁰⁰ Zr) (continued)		
E_{γ}^{\ddagger}	$I_{\gamma}^{\ddagger@}$	E _i (level)	J^{π}_i	E_f	\mathbf{J}_f^{π}	Mult. [#]	α	$I_{(\gamma+ce)}$	Comments
1611.76 3	29.0 8	5059.97	7+	3448.221	6+	M1,E2	3.67×10 ⁻⁴ 9		$\alpha(N)=6.17\times10^{-7} \ 13; \ \alpha(O)=4.41\times10^{-8} \ 11$ Mult.: $\alpha(K)\exp=0.00023 \ 6.$ $\alpha(K)=0.000220 \ 5; \ \alpha(L)=2.39\times10^{-5} \ 5; \ \alpha(M)=4.14\times10^{-6}$ $9; \ \alpha(N)=5.90\times10^{-7} \ 13; \ \alpha(O)=4.21\times10^{-8} \ 11$ Mult.: $\alpha(K)\exp=0.000240 \ 22.$ Mult: $(1611 \ 8\gamma)(1129 \ 2\gamma)(\theta): \ A_{2}=-0.088 \ 20$
1659 10 4	1 09 19	5247 52	0+	2580 400	o+				A_4 =+0.013 <i>18</i> (1978Be12). δ : +0.35 7 or +2.4 5 from $\gamma\gamma$ correlation.
1036.10 <i>4</i> 1716.27 <i>3</i>	6.1 2	5164.48	9 (8) ⁺	3448.221	о 6 ⁺	(E2)	3.91×10 ⁻⁴		$\alpha(K)=0.000191 \ 3; \ \alpha(L)=2.08\times10^{-5} \ 3; \ \alpha(M)=3.61\times10^{-6} \ 5; \ \alpha(N)=5.14\times10^{-7} \ 8; \ \alpha(O)=3.66\times10^{-8} \ 6$ Mult.: $\alpha(K)exp=0.00021 \ 7.$ Mult.: $(1716.2\gamma)(1129.2\gamma)(\theta): \ A_2=-0.011 \ 75,$ $\Delta_{i=1}=0.041 \ 60 \ (1978p+12)$
1760.70 20		1760.74	0+	0	0+	E0		0.060 10	$A_4 = +0.041$ bb (1976be12). E_{γ} : Conversion electrons observed by 1968Pe01. $I_{(\gamma+ce)}$: From intensity balance, assuming no ε feeding. Mult : $\alpha(K) \exp > 4.8$
1843.342 22	8.4 2	5432.78	7+,8+,9+	3589.409	8+	M1,E2	4.08×10 ⁻⁴ 14		$\alpha(\mathbf{K})=0.000170 \ 4; \ \alpha(\mathbf{L})=1.84 \times 10^{-5} \ 4; \ \alpha(\mathbf{M})=3.19 \times 10^{-6} \ 6; \ \alpha(\mathbf{N})=4.54 \times 10^{-7} \ 9; \ \alpha(\mathbf{O})=3.25 \times 10^{-8} \ 8 \ \text{Mult:} \ \alpha(\mathbf{K})=0.000166 \ 23 \ \text{Mult:} \ \alpha(\mathbf{K})=0.000166 \ 23 \ \text{Mult:} \ \alpha(\mathbf{K})=0.000166 \ 23 \ \text{Mult:} \ \alpha(\mathbf{K})=0.000166 \ \text{Mult:} \ \alpha(\mathbf{K})=0.00016$
1913.194 25	15.6 2	4232.21	6 ⁻ ,7 ⁻	2318.991	5-	M1,E2	4.27×10 ⁻⁴ 16		$\alpha(\mathbf{K}) = 0.000158 \ 3; \ \alpha(\mathbf{L}) = 1.71 \times 10^{-5} \ 4; \ \alpha(\mathbf{M}) = 2.97 \times 10^{-6} \ 6; \ \alpha(\mathbf{N}) = 4.23 \times 10^{-7} \ 8; \ \alpha(\mathbf{O}) = 3.03 \times 10^{-8} \ 7 \ \text{Mult:} \ \alpha(\mathbf{K}) = 0.000144 \ 17 \ \text{Mult:} \ 17 \ \text{Mult:} \ \alpha(\mathbf{K}) = 0.000144 \ 17 \ 17 \ 17 \ 17 \ 17 \ 17 \ 17 \$
1984.54 <i>3</i>	8.3 <i>3</i>	5432.78	7 ⁺ ,8 ⁺ ,9 ⁺	3448.221	6+				(1984.5 γ)(1129.2 γ)(θ): A ₂ =-0.006 54, A ₄ =-0.036 50 (1978Be12).
2000.2 ^{&a} 3	$0.8^{\&}$ 1	4319.02?		2318.991	5-				
$2000 2^{\&a}$	$0.8^{\&}$ 1	5589 46?		3589 409	8+				
2056.10 8	1.4 1	4375.06	7-	2318.991	5-				
2186.242 25	219 2	2186.265	2+	0	0+	E2	5.36×10 ⁻⁴		$\begin{aligned} &\alpha(\mathbf{K}) = 0.0001223 \ 18; \ \alpha(\mathbf{L}) = 1.325 \times 10^{-5} \ 19; \\ &\alpha(\mathbf{M}) = 2.29 \times 10^{-6} \ 4; \ \alpha(\mathbf{N}) = 3.27 \times 10^{-7} \ 5; \\ &\alpha(\mathbf{O}) = 2.34 \times 10^{-8} \ 4 \end{aligned}$
		1511.06	C +	2210.001					Mult.: $\alpha(K) \exp[=0.000123 \ 10.$
2222.34 3	/.6 <i>3</i>	4541.30	0' 5-	2518.991	С О+	E5	4.64×10^{-4}		$\alpha(\mathbf{K}) = 0.00010.5$.
2316.939 23	1000 2	2318.991	3	U	0.	ЕJ	4.04×10		$a(K) = 0.000408 \text{ o}; \alpha(L) = 4.05 \times 10^{-7} \text{; } \alpha(M) = 8.04 \times 10^{-7} 12; \alpha(N) = 1.141 \times 10^{-6} 16; \alpha(O) = 7.97 \times 10^{-8} 12$ Mult.: $\alpha(K) \exp = 0.000385 30 (1984\text{HaZC}).$
^x 2321.9 2	92								
2322 ^a	< 0.10 [†]	4640.94		2318.991	5^{-}				
2741.0 3	0.09 3	5059.97	7+	2318.991	5^{-}	E3	5.86×10^{-4}		α (K)=0.0001277 18; α (L)=1.391×10 ⁻⁵ 20;

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From ENSDF

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$\gamma(^{90}$ Zr) (continued)

Eγ‡	$I_{\gamma}^{\ddagger @}$	E _i (level)	\mathbf{J}_i^{π}	E_f	\mathbf{J}_f^{π}	Comments
						$\alpha(M)=2.41\times10^{-6} 4; \ \alpha(N)=3.43\times10^{-7} 5; \ \alpha(O)=2.46\times10^{-8} 4$
2747.8 <i>3</i>	0.06 2	2747.867	3-	0	0^+	
2845 ^a	< 0.02	5164.48	$(8)^{+}$	2318.991	5-	
3114 ^a	< 0.02	5432.78	7+,8+,9+	2318.991	5-	

[†] Upper limits from 1982Wa24 renormalized to current normalization.

[‡] From 1990Me15, except as noted.

[#] From the Adopted Gammas. For cases where values originate from this dataset, supported evidence is included in the comments. [@] For absolute intensity per 100 decays, multiply by 0.08203 *20*.

[&] Multiply placed with undivided intensity.

^{*a*} Placement of transition in the level scheme is uncertain.

 $x \gamma$ ray not placed in level scheme.



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