^{100}Zr β^- decay (7.1 s) 2007Ri01,2019Gu20,1982VoZP

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 172, 1 (2021)	31-Jan-2021

Parent: ^{100}Zr: E=0.0; $J^\pi=0^+$; $T_{1/2}$=7.1 s *4*; Q(β^-)=3420 *11*; %β^- decay=100.0

^{100}Zr-$T_{1/2}$: From ^{100}Zr Adopted Levels.

^{100}Zr-Q(β^-): From 2017Wa10.

2007Ri01 (also 2007RiZZ): isotopically separated 30-keV beam of ^{100}Zr produced in U(p,F) reaction at E(p)=30 MeV using ion-guide isotope separator on-line (IGISOL) facility at JYFL. The fission fragments were accelerated to 30 keV and mass separated by a 55° dipole magnet. The separated beam was injected into a gas-filled radio frequency quadrupole cooler and buncher (RFQ). Measured Eγ, Iγ, $\gamma\gamma$-, $\beta\gamma$- and xγ-coin, fluorescent production using a planar plastic scintillator for β particles, a large Ge detector and a planar low-energy Ge detector for x rays and low-energy γ rays. Atomic mass measurements of ^{100}Zr and ^{100}Nb were made with a Penning-trap method using JYFLTRAP. Deduced levels, J, π, conversion coefficient, γ-ray multipolarity, β-decay branching ratios, log *ft*. The photon intensities and uncertainties on gamma-ray energies and intensities were supplied as e-mail reply to B. Singh by S. Rinta-Antila on January 30, 2007 (2007RiZZ).

2019Gu20: ^{100}Zr isotope from U(p,F),E=25 MeV at the IGISOL facility and JYFLTRAP double Penning trap system at the university of Jyvaskyla. Measured Eγ, Iγ, Eβ, $\beta\gamma$-coin, total absorption γ spectrum (TAGS) using Decay Total Absorption γ-ray Spectrometer (DTAS) with 18 NaI(Tl) crystals, a plastic β detector and an HPGe detector.

1982VoZP (thesis): measured Eγ, Iγ, $\gamma\gamma$-coin, $\beta\gamma$-coin.

2013RuZX: measured half-life of 400.5 level by $\gamma\gamma$(t) using Lohengrin mass separator of ILL-Grenoble.

Others:

γ: 1989WaZV, 1986LhZX, 1981DeYV, 1979Bo26, 1977Pf01, 1976Ah06.

$\beta\gamma$: 1984Pa19, 1978St02.

$\gamma\gamma$(t): 1989Lh01.

$T_{1/2}$ of ^{100}Zr isotope: 1976Ah06, 1977Pf01, 1972Tr08, 1970Ei02, 1969WiZX.

Total decay energy deposit of 3431 keV *151* calculated by RADLIST code is in agreement with expected value of 3420 keV *11*.

^{100}Nb Levels

A tentative 695 level decaying by uncertain γ rays: 197.0 (Iγ<0.1) (1977Pf01) and 695.0 (Iγ=1.3) (1986LhZX) is not confirmed by 2007Ri01, both γ rays were not seen. This level is omitted here.

E(level)[†]	J^π[‡]	$T_{1/2}$	Comments
0.0	1^+		
400.52 *6*	1^+	90 ps *30*	$T_{1/2}$: from $\gamma\gamma$(t) (2013RuZX). Other: 0.19 ns *23* ($\gamma\gamma$(t), 1989Lh01).
471.39 *7*	(1^+)		
498.05 *25*	(0 to 3^+)[#]		
504.29 *5*	1^+		
653.92 *12*	(0 to 3^+)[#]		
703.72 *11*	(0 to 3^+)[#]		
1240			Level introduced by 2019Gu20 in TAGS data. This level is not included in the Adopted Levels.

[†] From a least-squares fit to Eγ data. Normalized χ^2=0.8.

[‡] From the Adopted Levels.

[#] 2^+,3^+ less likely from log *ft*=6.0-6.8 from 0^+, but β feeding is quite weak which could be affected by weak unobserved γ-ray feeding from higher levels.

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β^- radiations

Calculation of β^- strength function: 1981Al25.

E(decay)	E(level)	Iβ^-[‡][#]	Log *ft*	Comments
(2180 *11*)	1240	1	5.5	av Eβ=880 Iβ^-: from TAGS data (2019Gu20).
(2716 *11*)	703.72	0.59 *8*	6.1	av Eβ=1129.1 *52*
(2766 *11*)	653.92	0.19 *4*	6.6	av Eβ=1152.5 *52*
2841[†] *14*	504.29	33 *4*	4.5 *1*	av Eβ=1223.1 *52*
(2922 *11*)	498.05	0.74 *8*	6.1	av Eβ=1226.0 *52*
(2949 *11*)	471.39	1.7 *6*	5.8	av Eβ=1238.6 *52*
2956[†] *15*	400.52	17.9 *9*	4.8 *1*	av Eβ=1272.1 *52*
(3420 *11*)	0.0	46 *5*	4.6 *1*	av Eβ=1462.1 *53* Iβ^-: 45 *4* in 2007Ri01.

[†] From $\beta\gamma$-coin (1982VoZP). Others: 1984Pa19, 1978St02.
[‡] From transition intensity balance. 2007Ri01 note that some β feeding to higher 1^+ states may be missing, as also found in the TAGS spectroscopy by 2019Gu20 (see Fig. 7 in this paper), that there is a small decay contribution to states at higher energy. However, β feedings for individual levels of level groups are not available from TAGS experiment by 2019Gu20.
[#] Absolute intensity per 100 decays.

$\gamma(^{100}Nb)$

Iγ normalization: Photon intensities are per 100 decays of ^{100}Zr in 2007RiZZ (also 2007Ri01) and 1982VoZP. Others: absolute intensity for 504γ:
The $\gamma\gamma$ and $\beta\gamma$ coincidence information is from 1982VoZP; $\gamma\gamma$-coin information is also from 2007RiZZ.
The following γ rays of energy (intensity) assigned to the decay of ^{100}Zr by 1977Pf01 have been omitted due to lack of confirmation in the works of 1982VoZP and 2007Ri01: 336.0(0.6), 440.9(1.3), 749.4(0.6), 1257.4(1.6), 1654.4(2.2), 2436.0(2.2). Except for 336 and 749 γ rays, all others are possibly from the decay of ^{100}Nb. Further 197.0γ from 1977Pf01 and 695.0γ from 1986LhZX are also omitted as explained below.
A 197.0γ with Iγ(197γ)/Iγ(504γ)=0.01 assigned to ^{100}Zr β^- by 1977Pf01 is probably from an impurity line. From $\gamma\gamma$-coin data, 1982VoZP deduce Iγ(197γ)/Iγ(504γ)<0.003. This γ is not confirmed by 2007Ri01, thus omitted here.
A 695.0γ (Iγ=1.3) (1986LhZX) has not been confirmed by 2007Ri01. With the intensity given by 1986LhZX, it should have been seen by 2007Ri01. This γ ray is also omitted here.

E$_\gamma$	I$_\gamma$[†][#]	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.	α[@]	Comments
33.01[‡] *10*	0.26 *5*	504.29	1^+	471.39	(1^+)	(M1)	5.46 *9*	α(K)exp=3.1 *8* (2007Ri01) Mult.: from α(K)exp, deduced from fluorescent production (2007Ri01). I$_{(\gamma+ce)}$: 1.2 (2007Ri01).
103.72 *10*	0.79 *12*	504.29	1^+	400.52	1^+	[M1]	0.204	E$_\gamma$: weighted average of 103.73 *10* (2007Ri01,2007RiZZ) and 103.7 *1* (1982VoZP). I$_\gamma$: unweighted average of 0.91 *8* (2007RiZZ) and 0.67 *6* (1982VoZP). I$_{(\gamma+ce)}$: 1.10 (2007Ri01).
253.4 *1*	0.19 *4*	653.92	(0 to 3^+)	400.52	1^+			E$_\gamma$: weighted average of 253.3 *5* (2007Ri01,2007RiZZ) and 253.4 *1* (1982VoZP). I$_\gamma$: weighted average of 0.12 *6* (2007RiZZ) and

Continued on next page (footnotes at end of table)

^{100}Zr β^- decay (7.1 s) 2007Ri01,2019Gu20,1982VoZP (continued)

$\gamma(^{100}Nb)$ (continued)

E_γ	I_γ[†][#]	E_i(level)	J_i^π	E_f	J_f^π	Comments
						0.21 *3* (1982VoZP). $I_{(\gamma+ce)}$: 0.12 (2007Ri01).
303.2 *1*	0.21 *3*	703.72	(0 to 3$^+$)	400.52	1$^+$	E_γ: weighted average of 303.8 *8* (2007Ri01,2007RiZZ) and 303.2 *1* (1982VoZP). I_γ: weighted average of 0.16 *6* (2007RiZZ) and 0.22 *3* (1982VoZP). $I_{(\gamma+ce)}$: 0.16 (2007Ri01).
400.50 *6*	19.3 *8*	400.52	1$^+$	0.0	1$^+$	E_γ: weighted average (NRM) of 400.48 *4* (1979Bo26, curved-crystal), 400.81 *8* (2007Ri01,2007RiZZ) and 400.5 *1* (1982VoZP). Uncertainty in 2007RiZZ was doubled in the NRM procedure. I_γ: weighted average of 20.5 *25* (2007RiZZ) and 19.2 *8* (1982VoZP). $I_{(\gamma+ce)}$: 20 (2007Ri01).
471.48[‡] *9*	3.4 *4*	471.39	(1$^+$)	0.0	1$^+$	$I_{(\gamma+ce)}$: 3.4 (2007Ri01).
498.05 *25*	0.74 *8*	498.05	(0 to 3$^+$)	0.0	1$^+$	E_γ: weighted average of 498.08 *25* (2007Ri01,2007RiZZ) and 498.0 *3* (1982VoZP). I_γ: weighted average of 0.80 *15* (2007RiZZ) and 0.72 *8* (1982VoZP). $I_{(\gamma+ce)}$: 0.80 (2007Ri01).
504.27 *5*	30 *4*	504.29	1$^+$	0.0	1$^+$	E_γ: weighted average of 504.25 *4* (1979Bo26, curved-crystal data) and 504.37 *8* (2007Ri01,2007RiZZ). I_γ: from 2007RiZZ. Others: 31 *4* (1982VoZP,1981DeYV), 19 *2* (1989WaZV). $I_{(\gamma+ce)}$: 30.3 (2007Ri01).
703.7 *4*	0.38 *7*	703.72	(0 to 3$^+$)	0.0	1$^+$	E_γ: unweighted average of 704.1 *3* (2007Ri01,2007RiZZ) and 703.3 *2* (1982VoZP). I_γ: weighted average of 0.58 *14* (2007RiZZ) and 0.36 *5* (1982VoZP). $I_{(\gamma+ce)}$: 0.58 (2007Ri01).

[†] Photon intensities per 100 decays of ^{100}Zr.
[‡] From 2007Ri01 (also 2007RiZZ) only.
[#] Absolute intensity per 100 decays.
[@] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

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Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays