^{91}Rh ε decay (1.47 s) 2004De40

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Coral M. Baglin	NDS 114, 1293 (2013)	1-Sep-2013

Parent: ^{91}Rh: E=0.0; J$^\pi$=(9/2$^+$); $T_{1/2}$=1.47 s *22*; Q(ε)=9440 *SY*; %ε+%β^+ decay=100.0

^{91}Rh-Q(ε): 9440 *400* from systematics (2012Wa38).

^{91}Rh-J$^\pi$: A g.s. J$^\pi$=9/2$^+$ is favored by systematics and is tentatively adopted by 2004De40. Such an assignment is consistent with β feedings to levels in ^{91}Ru.

^{91}Rh-$T_{1/2}$: measured using a macrocycle of beam-on followed by a beam-off period with on/off times chosen to suit the expected half-life of the isotope studied. A time-to-digital converter was started at the beginning of each macrocycle, recording the time of each triggered event relative to the start. Except for the 533γ, half-lives based on the time behavior of each γ were determined. The half-life assigned to ^{91}Rh ground-state decay is the weighted average of the values for the 890γ and 973γ, 1.40 s *33* and 1.52 s *29*, respectively.

^{91}Rh source produced in the ^{58}Ni(^{36}Ar^{10+},p2n) reaction; E=235 MeV beam degraded to≈121 MeV near target center using a set of Ta degraders of varying thicknesses in the beam line in order to capitalize on the maximum cross-section of 11 μb for this reaction channel as calculated by HIVAP code. Nuclei recoiling out of the target were stopped and neutralized by 500 mbar of purified Ar gas inside a cell. Reaction products were ionized selectively, according to Z, using two dye lasers tuned to the resonant atomic transitions of Rh or Ru, thereby enhancing strongly the ionization and subsequent extraction of those nuclei and improving the statistical quality of γ spectra resulting from their decay. The laser-ionized nuclei were guided toward the LISOL mass separator by a sextupole ion guide. Measured Eγ, Iγ, $\gamma\gamma$ coin, $\beta\gamma$ (coin), I(ε+β), isotope $T_{1/2}$ with two HPGe detectors arranged in a compact configuration around β-sensitive plastic ΔE detectors that enclosed a tape station. shell-model calculations (for J$^\pi$≤15/2$^+$ and E<1500).

^{91}Ru Levels

E(level)	J$^\pi$ †	$T_{1/2}$	Comments
0.0	(9/2$^+$)	8.0 s *4*	$T_{1/2}$: weighted average of 9 s *1* from activity (1983Ko43) and 7.85 s *40* from 394γ(t) (2004De40).
889.80 *20*	(11/2$^+$)		
973.11 *10*	(13/2$^+$)		

† From Adopted Levels.

ε,β^+ radiations

E(decay)	E(level)	Iβ^+ #	Iε #	Log *ft* ‡	I(ε+β^+) †#	Comments
(8466 *SY*)	973.11	5 *1*	0.04 *1*	5.63 *16*	5 *1*	av Eβ=3.50×10^3 *20*; εK=0.0073 *13*; εL=0.00089 *16*; εM+=0.00021 *4* I(ε+β^+): consistent with 4.9 *14* from intensity balance. Log *ft*: the value is unrealistically lower than expectation for a ΔJ=2, Δπ=no transition.
(8550 *SY*)	889.80	4 *1*	0.03 *1*	5.74 *17*	4 *1*	av Eβ=3.54×10^3 *20*; εK=0.0070 *13*; εL=0.00086 *15*; εM+=0.00020 *4* I(ε+β^+): consistent with 4.2 *13* from intensity balance.
(9440 *SY*)	0.0	85 *8*	0.50 *9*	4.64 *13*	86 *8*	av Eβ=3.98×10^3 *20*; εK=0.0051 *8*; εL=0.00062 *10*; εM+=0.000145 *23* Iβ^+: from Iε=78 to 94 (2004De40); 91 *2* from intensity balance,.

† 2004De40 calculated β-feeding to ^{91}Rh g.s. and excited states using the 511 keV annihilation line. Since all I(511γ) that could not be associated with γ events visible in the γ-ray spectra were attributed to g.s. β feeding, branching to weakly populated states and to levels emitting γ-rays outside the 4 MeV γ-energy range may have been wrongly included in the g.s. branch, resulting in an underestimate of branching to some excited states.

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^{91}Rh ε decay (1.47 s) 2004De40 (continued)

ε,β^+ radiations (continued)

‡ Values should probably be regarded as lower limits; the large Q value suggests the possibility of significant unobserved feeding to highly excited states whose deexcitation may reduce the intensity imbalance at lower-lying levels; the possible presence of γ-rays with Eγ outside the 4-MeV experimental energy window further increases the uncertainty in deduced intensity imbalances. See also the comment on I(γ+ce). log *ft* values assume an uncertainty of 400 In Q from systematics.

Absolute intensity per 100 decays.

γ(^{91}Ru)

Iγ normalization: from Ti(890γ+973γ)=9.0 *14*; consistent with 0.12 *7* assuming Σ (I(γ+ce) to g.s.)=100−Iε(g.s.)=14 *8*.

E_γ	I_γ†	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α‡	Comments
x387.4 *2*	351 *39*							Eγ: This transition, with half-life of 1.46 s *11*, is not seen in the β-gated spectra of 2004De40, with or without lasers. It is, however, a strong line in the singles spectra, but only when the lasers are tuned to Rh. The authors conclude that this is evidence of an isomeric transition in either ^{91}Rh or ^{91}Ru, the former being fed directly in the heavy-ion reaction or the latter being populated through the decay of ^{91}Rh.
x437.7 *1*	100							
x533.3 *1*	21 *10*							
x821.1 *1*	63 *9*							
889.8 *2*	52 *11*	889.80	(11/2$^+$)	0.0	(9/2$^+$)			Eγ: placement from 'to be published' work of C. Rusu et al. (reference 26 in 2004De40); that work is still unpublished, but placement is confirmed In (^{36}Ar,2pnγ): E=111 MeV (2013Zh10).
973.1 *1*	61 *11*	973.11	(13/2$^+$)	0.0	(9/2$^+$)	E2	0.000941 *14*	α=0.000941 *14*; α(K)=0.000825 *12*; α(L)=9.55×10^{-5} *14*; α(M)=1.750×10^{-5} *25*; α(N+..)=2.97×10^{-6} α(N)=2.82×10^{-6} *4*; α(O)=1.467×10^{-7} *21* Eγ: placement taken by 2004De40 from the literature. Mult.: from Adopted Gammas.

† For absolute intensity per 100 decays, multiply by 0.080 *17*.

‡ 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.

x γ ray not placed in level scheme.

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Decay Scheme