

Adopted Levels

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh		NDS 177, 1 (2021)	3-Sep-2021

Q(β^-)=5180 SY; S(n)=5100 SY; S(p)=8360 SY; Q(α)=-970 SY [2021Wa16](#)

Estimated uncertainties ([2021Wa16](#)): 200 for Q(β^-) and S(n), 280 for S(p) and Q(α).

S(2n)=11810 210, S(2p)=18740 450 (syst,[2021Wa16](#)).

Other measurements:

[1999Be63](#): ¹⁹⁴Re identified in fragmentation of ¹⁹⁷Au beam in ⁹Be(¹⁹⁷Au,X) reaction at 950 MeV/nucleon.

[2009St16](#) (also [2008StZY](#) thesis), [2009Ku28](#), [2009Al30](#), [2008St20](#): ¹⁹⁴Re nuclide produced in the reaction ⁹Be(²⁰⁸Pb,X) with a beam energy of 1 GeV/nucleon produced by the SIS-18 accelerator at GSI facility. Fragments identified in flight by the Fragment Separator (FRS) based on time of flight, B ρ and energy loss.

[2005Ca02](#), [2000PoZY](#): ⁹Be(²⁰⁸Pb,X) E=1 GeV/nucleon A possible isomer with half-life <75 μ s assigned to ¹⁹⁴Re, energy of the isomer is not known.

[2012Al05](#) (also [2012Be38](#)): ¹⁹⁴Re produced by fragmentation of E=1 GeV/nucleon ²⁰⁸Pb beam from SIS-18 synchrotron at GSI on a ⁹Be target of thickness \approx 2 g/cm². Reaction products were separated and identified by GSI Fragment Separator (FRS) set on ¹⁹⁰Ta, ¹⁹²Ta and ¹⁹⁴Re. The recoils were stopped in RISING active stopper. Measured E γ , I γ , $\gamma\gamma$ coin, (recoil) γ , $\beta\gamma$ and (recoil) β correlations, half-lives using RISING array of 15 seven-element Cluster Ge detectors for γ rays and DSSSD, MUSIC detectors for particle detection. Recoil-decay tagging technique also used. Deduced isomers and levels in ¹⁹⁴Os. Comparison and interpretation with Nilsson model multi-quasiparticle calculations for two quasiparticle states in ¹⁹⁴Re. [2012Al05](#) refer to a “to be published” study: GSI Storage Ring mass measurements reveal two long-lived isomers in ¹⁹⁴Re with excitation energies less than 1 MeV and with half-lives in seconds region (reference #40).

[2012Re19](#) (also [2012ReZZ](#) thesis): Schottky mass spectrometry technique used to measure masses directly and identify high-spin isomers. E=478-492 MeV/nucleon from UNILAC-SIS facility at GSI. Target=⁹Be 1035 mg/cm² with a 221 mg/cm² niobium backing. Mostly bare atoms of the highly-charged reaction products were separated with FRS and injected into storage ring ESR. The ions were stochastically and electron cooled. Deduced masses from Schottky spectra; identified high-spin isomer. ¹⁹⁴Re in 75+ charge state, i.e. bare ion.

[Additional information 1.](#)

¹⁹⁴Re Levels

Cross Reference (XREF) Flags

A ⁹Be(²⁰⁸Pb,X γ)

E(level)	J ^{π}	T _{1/2}	XREF	Comments
0 \ddagger	(0 ⁺ ,1)	5 \ddagger s 1		% β^- =100 The β^- decay is the only decay mode observed. T _{1/2} : from decay curve for 478 γ (2012Al05 , previous value of 7.6 s 23 in 2009ReZW); 6 s 1 is also mentioned in authors’ text, as also referred in 2014Mo15 . Other: 1.0 s 5, deduced from position-time correlations between the implanted fragments and the subsequent β -decay in 2009Ku28 , but half-life retracted by authors in their later analysis in 2014Ku23 . Approximate number of nuclei implanted in the plastic stopper reported to be 101200 300 (2009St16 , 2008StZY).
285 \ddagger 40	(11 ⁻)	25 \ddagger s 8		J ^{π} : from Nilsson multi-quasiparticle (MQP) calculations, 2012Al05 proposed low-lying oblate state of 0 ⁺ , 1 ⁻ and 1 ⁺ with configurations: ν 1/2[660] $\uparrow\otimes\pi$ 1/2[411] \downarrow at 64 keV, ν 1/2[660] $\uparrow\otimes\pi$ 1/2[550] \uparrow at 0, and ν 1/2[660] $\uparrow\otimes\pi$ 3/2[402] \downarrow at 174 keV, respectively, which by β^- decay possibly populates 0 ⁺ g.s. and excited 0 ⁺ at 696.5 keV in ¹⁹⁴ Os. % β^- \approx 100 J ^{π} : from Nilsson multi-quasiparticle (MQP) calculations, 2012Al05 proposed this level as a low-lying prolate state with configuration of ν 13/2[606] $\uparrow\otimes\pi$ 9/2[514] \uparrow , which by β^- decay populates possible high-spin (\approx 10-11) cascade 554 γ \rightarrow 349 γ \rightarrow 194 γ in ¹⁹⁴ Os. Note that theoretical energy for this prolate state is calculated at 46 keV, in disagreement with the

Continued on next page (footnotes at end of table)

Adopted Levels (continued) ^{194}Re Levels (continued)

<u>E(level)</u>	<u>T_{1/2}</u>	<u>XREF</u>	<u>Comments</u>
833 [‡] 33	100 [†] s 10		measured energy of 285 keV in 2012Re19 . T _{1/2} : decay spectra for 194γ, 349γ, 554γ give T _{1/2} =32 s 8, 25 s 8, 25 s 8, respectively. %β ⁻ ≈100
x	45 μs 18	A	This isomer possibly feeds the 6 ⁺ state in ¹⁹⁴ Os. Decay spectra for 218γ, 383γ, 530γ give T _{1/2} =40 s 8, 46 s 8, 100 s 10, respectively. %IT≈100 E(level),T _{1/2} : isomer identified by 2005Ca02 and 2011St21 in ⁹ Be(²⁰⁸ Pb,Xγ) E=1 GeV/nucleon. Half-life is from 2011St21 . Other: 1-75 μs (2005Ca02). It is possible that there are two different isomers, the one reported by 2005Ca02 with T _{1/2} =1-75 μs decaying by γ rays of 128, 148 and 464 keV in a delayed γ-ray spectrum; and the second by 2011St21 decaying by only the 86.3-keV γ ray. As the two half-lives overlap within the uncertainties, evaluators assume only one isomer.

[†] From [2012A105](#) (also [2012Re19](#)) for highly ionized or bare atom. It is not possible to associate the isomers with specific half-lives.

[‡] From mass measurements by [2012Re19](#). In [2012A105](#) as well as in [2012Re19](#) it was not possible to associate the isomers with specific half-lives, meaning that these could be interchanged.