Adopted Levels

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	09-Sep-2022

History

$Q(\beta^-)$=14054 *30*; S(n)=2908 *30*; S(p)=15090 *SY*; $Q(\alpha)$=−98404 *SY* 2021Wa16

Estimated uncertainties (2021Wa16): 300 for S(p) and $Q(\alpha)$.

$Q(\beta^-n)$=8811 *30*, S(2n)=7306 *30*, S(2p)=32940 *400* (syst) (2021Wa16). $Q(\beta^-2n)$=5180 *30* (deduced by evaluator from mass excesses in 2021Wa16).

1991Kr15: ^{84}Ga produced and identified in ^{238}U(p,F),E=600 MeV, followed by mass separation of fission products. Measured β-delayed neutrons, $T_{1/2}$ and $\%\beta^-n$ from the decay of ^{84}Ga at CERN-ISOLDE facility.

2003Pe18, 2006Pe20: ^{238}U(n,f), measured Eγ, Iγ, γ(t), $\gamma\gamma$-coin, $\beta\gamma$-coin following mass separation by ISOL method at the PARRNe facility in Orsay.

2009Le26 (also 2009Ve11): ^{84}Ga isotope produced in U(γ,F),E=50 MeV reaction at PARRNe on-line mass separator within the ALTO facility. Bremsstrahlung beam was produced by 50-MeV electron beam hitting a UC_x target, followed by mass separation of fission fragments. Measured Eγ, Iγ, $\beta\gamma$-coin. The authors propose an isomer based on the gamma intensities from ^{84}Ge β^- decay and ^{84}Ga β-delayed neutron decay.

Additional information 1.

2010Wi03 (also 2009Gr06): ^{84}Ga produced in ^{238}U(p,F),E(p)=54 MeV reaction. Reaction products were accelerated to 225 MeV in the ORNL Tandem van de Graaff generator. Measured Eγ, Iγ, $\gamma\gamma$-coin, (fragment)γ-coin, (ion-tagged γ-ray spectra), $\beta\gamma$(ion)-coin, $\beta n\gamma$-coin using an array composed of four Ge clover and two plastic scintillator detectors. Comparison with spherical HFB calculations. No evidence was found for the existence of two isomers in ^{84}Ga, as was proposed in 2009Le26. 2010Wi03 state that 1046γ is in ^{83}Ge, not in ^{84}Ge as was suggested by 2009Le26.

2013Ko32: ^{84}Ga produced in U(γ,F),E=50 MeV, the bremsstrahlung beam was produced in 50 MeV (10 μA) electron beam incident on a thick UC_x target. It was followed by selective photoionization using the ALTO resonant laser ion source. ^{84}Ga was then mass separated at the PARRNe online mass separator at IPN, Orsay facility, and implanted on Al-coated mylar tape. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\beta\gamma$-coin and $T_{1/2}$ of ^{84}Ga isotope using two HPGe detectors and a plastic scintillator.

2016Ma50: ^{84}Ga isotope produced in the reaction U(p,F),E(p)=50 MeV, at the RIB-HRIBF-ORNL facility, where the ^{84}Ga radioactive ion beam was extracted, mass separated and transmitted to the Low Energy Radioactive Ion Beam Spectroscopy Station. Measured Eγ, Iγ, E(n), I(n), E(β), nβ-coin using two HPGe detectors, the VANDLE array of 48 plastic scintillators for neutron time-of-flight measurements, and two plastic scintillators surrounding the implantation point for β particles. Deduced β-delayed neutron emission probability or P_n.

2017Ve01: radioactive ion beam of ^{84}Ga at 30 keV was produced in photofission of ^{238}U using UC_x pellets containing about 60 g of ^{238}U. The photons were created by 50-MeV primary electron beam bombarding a Ta target heated up to ≈2000°C. The Ga atoms were ionized with the Resonant Ionization Laser Ion source (RILIS) using a two-step ionization system. Extracted 30 keV ion beam was delivered to PARRNe on-line separator at ALTO ISOL facility. Mass-separated ^{84}Ga beam was then sent to β-decay counting station BEDO where it was collected on mylar tape at the center of the detection system of 4π ^{3}He neutron counter TETRA, an HPGe detector for γ radiation and plastic 4$\pi\beta$ array for electrons. Measured Eγ, Iγ, β spectrum, β-gated γ and β(neutron)-gated γ spectra, delayed neutrons, $\%\beta^-n$ of ^{84}Ga decay for 17971 counting cycles in beam-off and beam-on collection/counting steps. The measurements reported in this work were a test case for the ^{3}He neutron-counter TETRA installed behind the PARRNe mass separator at the electron-driven ALTO-ISOL facility. Experimental details are given in 2016Te09.

2019Yo03: ^{84}Ga produced in ^{9}Be(^{238}U,F),E(^{238}U)=345 MeV/nucleon on a 4-mm thick ^{9}Be target at the RIBF-RIKEN facility. Fragments separated and identified using the BigRIPS separator, then implanted into active stoppers consisting of double-sided silicon strip detectors. Measured Eγ, Iγ, E(n), I(n), nβ-coin, $T_{1/2}$, $\%\beta^-n$ using two HPGe detectors for γ rays and the BRIKEN detector consisting of 140 ^{3}He counters for neutrons.

Mass measurement: 2020Re04.

No evidence for an isomer with $T_{1/2}$<0.085 s and J^π=(3^-,4^-) as proposed in 2009Le26.

In literature, there are no studies of decay of ^{84}Zn to ^{84}Ga, with an exception that 2014XuZZ report $T_{1/2}$ of decay of ^{84}Zn by β(108.5γ)-coin method, implying that 108.5-keV γ ray possibly deexcites a level in ^{84}Ga.

Adopted Levels (continued)

^{84}Ga Levels

E(level)	J^{π}	$T_{1/2}$	Comments
0	(0^-)	95.2 ms *24*	$\%\beta^-$=100; $\%\beta^-$n=46 *5*; $\%\beta^-$2n=1.6 *2* (2019Yo03) $\%\beta^-$n: weighted average of 44 *4* (2019Yo03, from sum of neutron intensity distribution normalized to the total number of decays observed, systematic uncertainty included); 53 *20* (2017Ve01, from neutron and β activity measurement, also 51 *28* in 2014TeZY); 40 *7* (2016Ma50, from sum of the neutron intensity distribution normalized to the total number of decays observed); 74 *14* (2010Wi03, from $\beta\gamma$-coin data, 80 *15* in 2009Gr06, 47 *10* in 2008WiZZ); 70 *15* (1991Kr15, from neutron measurement). $\%\beta^-$2n: from 2019Yo03, sum of the two-neutron intensity distribution normalized to the total number of decays observed. $T_{1/2}$: unweighted average of 97.6 ms *12* (2019Yo03, from binned maximum likelihood fitting of βn(t) as 1n spectra including contributions from parent, daughter, β1n, and β2n daughter and a linear background); and 92.7 ms *7* (2014XuZZ, $\beta\gamma$-coin, also 91.2 ms *83* from analysis of β-decay curve). Others: 84 ms *7* (2013Ko32, from evaluator′s weighted average of measured half-lives for eight γ rays) 76 ms *48* (2009Le26, from decay curve for 247.8γ, 75 ms *33* in 2009Ve11); 70 ms *35* (2006Pe20, from decay curve for γ rays); 85 ms *10* (1991Kr15, neutron-decay curve). J^{π}: 0^- assigned by 2009Le26 based on configuration of $\pi 1f^3_{5/2} \otimes \nu 2d^3_{5/2}$ and Paar model.