## Adopted Levels:unobserved

History

| Type | Author | Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | Balraj Singh | ENSDF | 30-Nov-2021 |

S(n)=16860 *SY*; S(p)=−1400 *SY*; Q(α)=−2230 *SY* 2021Wa16
Estimated uncertainties (2021Wa16): 540 for S(n), 200 for S(p), 540 for Q(α).
Q(ε)=12720 *360*, Q(εp)=8730 *360*, S(2p)=2540 *360* (syst,2021Wa16). S(2n)=30740 (theory, 2019Mo01).
The $^{89}$Rh isotope is expected to be unbound towards proton emission. Laboratory identification of $^{89}$Rh remains uncertain, as also in the most recent study by 2016Ce02.
1995Ry03 (also 1995Le14): $^{89}$Rh isotope reported by analyzing fragments by time-of-flight (≈1.5 μs) method in Ni($^{112}$Sn,X) at E=58 MeV/nucleon, GANIL facility using LISE3 spectrometer. The $^{89}$Rh fragments were observed 1.5 μs after a time-of-flight. It was not known whether these events were from the ground state or an isomer.
2007WeZX, 2000WeZZ (also E. Wefers et al., GSI annual (2000) report 2001-1,p10): no evidence was found for the formation of $^{89}$Rh isotope in $^{9}$Be($^{112}$Sn,X) at E($^{112}$Sn)=1 GeV/nucleon, FRS at GSI, with the implication that it may be unbound towards proton emission.
2016Ce02: $^{89}$Rh nuclide searched at RIBF-RIKEN facility in $^{9}$Be($^{124}$Xe,X) reaction at E=345 MeV/nucleon with an average beam intensity of 30 pnA. Identification of residues was made by determining atomic Z and mass-to-charge ratio A/Q, where Q=charge state of the ions. The selectivity of ions was based on magnetic rigidity, time-of-flight and energy loss using BigRIPS separator and zero degree spectrometer ZDS. The separated nuclei were implanted in a wide range silicon-strip stopper array for ion and β particle detection WAS3ABi, consisting of three highly-segmented 1 mm thick double-sided silicon detectors, a stack of ten segmented 1 mm thick single-sided silicon strip detectors. The γ rays were detected by EURICA array of 84 HPGe detectors surrounding the WAS3ABi system. In addition an array of 18 $LaBr_3$(Ce) detectors was used for γ detection in fast-timing measurements. An upper limit of one event was assigned by authors to the $^{89}$Rh nuclide.
Theoretical calculations: consult NSR database at www.nndc.bnl.gov/nsr/ or additional document records in this dataset for ten primary references, seven for structure and three for half-life and decay mode of $^{89}$Rh.
Additional information 1.

### $^{89}$Rh Levels

| E(level) | $T_{1/2}$ | Comments |
|---|---|---|
| 0? | <120 ns | %p=?; %ε+%$\beta^+$=?; %εp=?<br>E(level): the $^{89}$Rh fragments claimed to have been observed by 1995Ry03 may be from the g.s. or an isomer of $^{89}$Rh. However no events due to $^{89}$Rh were either observed in the GSI experiment (2007WeZX, 2000WeZZ, E. Wefers et al., 2000 GSI annual report 2001-1, p10); or in the RIBF-RIKEN study by 2016Ce02, where an upper limit of one event was assigned to $^{89}$Rh, thus the laboratory identification of this nuclide remains unconfirmed.<br>$J^\pi$: $9/2^+$ proposed from systematics (2021Ko07); $3/2^+$ (2019Mo01, theoretical calculations); $7/2^+$ in 1995Ry03,<br>$T_{1/2}$: from 2016Ce02, based on upper limit of one event assigned to $^{89}$Rh, with the assumption that the ratio of number of identified events associated with nuclei of the same $T_z$ is the same as that for the neighboring $T_z$ nuclei. One event assigned to $^{89}$Rh was assumed for ground-state activity, although, the authors mentioned that the proton decay could occur from either the ground state or from an isomeric activity. Other: ≈1.5 μs (1995Ry03) from time-of-flight.<br>$T_{1/2}$: Theoretical proton decay $T_{1/2}$=7 μs (2007Me28), using Q value of 708 keV; 201 ns (for l=0), 214 ns (for l=2) and 4 μs (for l=5) (2015Sh03), using Q value of 700 keV.<br>$T_{1/2}$: theoretical β decay $T_{1/2}$=90 ms (2019Mo01). |