## Adopted Levels

History

| Type | Author | Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | Balraj Singh, M. S. Basunia, Jun Chen et al. , | NDS 192,315 (2023) | 25-Sep-2023 |

Q($\beta^-$)=−221×10$^1$ *10*; S(n)=638×10$^1$ *11*; S(p)=2160 *90*; Q($\alpha$)=8790 *60* 2021Wa16
Q($\varepsilon$)=4860 *90*, S(2n)=14360 *90*, S(2p)=6260 *90* (2021Wa16).

Production and identification of $^{222}$Pa:

1970Bo13: $^{209}$Bi($^{16}$O,3n), $^{206}$Pb($^{19}$F,3n), excitation function; parent of $^{218}$Ac from 9210$\alpha$.

1979Sc09: $^{184}$W($^{40}$Ar,pn),E=165-202 MeV, excitation function; parent of $^{218}$Ac from 9210$\alpha$; and parent of $^{214}$Fr from 8430$\alpha$.
Additional information 1.

2019Mi08: $^{222}$Pa produced in $^{181}$Ta($^{48}$Ca,X),E=212,217,226 MeV fusion-evaporation reactions at the UNILAC accelerator of GSI, followed by separation of evaporation residues (ERs) using the SHIP velocity filter and implanted into the COMPAct Spectroscopy Set-up (COMPASS). Measured E$\alpha$ and half-life of $^{222}$Pa decay from time correlations between ERs and $\alpha$ particles.

2021Hu18: $^{222}$Pa produced in $^{186}$W($^{40}$Ar,p3n),E=198.7 MeV. The evaporation residues (ERs) were separated in-flight by the gas-filled recoil separator SHANS and implanted in three 16-strip position-sensitive silicon detectors (PSSDs) at the IMP-Lanzhou facility. $^{222}$Pa identified by ERs-$\alpha$-$\alpha$-$\alpha$ time and position correlations. Measured E$\alpha$, I$\alpha$, and $T_{1/2}$ of g.s. of $^{222}$Pa.

Theoretical calculations for $\alpha$ decay:

2023Za01: calculated $T_{1/2}$ for $\alpha$ decay using the generalized liquid-drop model with a 1977 nuclear proximity potential.

2022He18: calculated $\alpha$-decay $T_{1/2}$, $\alpha$-preformation factor using density-dependent cluster model with RMF NN interactions, M3Y NN interactions and universal decay law (UDL) formula.

2021Sa52: calculated Q(2$\alpha$), $T_{1/2}$ for 2$\alpha$-decay with and without the deformation effects using the modified generalized liquid drop model, and Coulomb and proximity potential model with different preformation factors for double $\alpha$ decay.

2018De17: calculated $\alpha$-decay preformation factors using cluster-formation model (CFM) and $T_{1/2}(\alpha)$ using a 1977 proximity potential (Prox. 1977).

2017Se19: calculated difference between proton and neutron skin thicknesses, Q($\alpha$) using Hartree-Fock-Bogoliubov (HFB) method, based on the Skyrme-like effective interactions.

### $^{222}$Pa Levels

Cross Reference (XREF) Flags

A $^{226}$Np $\alpha$ decay (44 ms)

| E(level) | $T_{1/2}$ | XREF | Comments |
|---|---|---|---|
| 0 | 3.8 ms *6* | A | %$\alpha$=100<br>Only the $\alpha$ decay has been observed for the decay of $^{222}$Pa. Theoretical partial $T_{1/2}$=21.3 s for $^{222}$Pa $\varepsilon$ decay (2019Mo01) gives %$\varepsilon$+%$\beta^+$=0.02. Other: %$\varepsilon$+%$\beta^+\approx 4\times10^{-4}$ from gross $\beta^-$ decay calculations (1973Ta30).<br>Additional information 2.<br>E(level): observed activity is assumed to correspond to the g.s. of $^{222}$Pa.<br>$T_{1/2}$: unweighted average of 2.76 ms *+43−33* (2021Hu18, $^{222}$Pa fragments and $\alpha$ decay correlated decay curve); 4.5 ms *3* (2019Mi08, time correlations between $^{222}$Pa fragments and subsequent $\alpha$ decays); 3.3 ms *3* (1995AnZY); 2.9 ms *+6−4* (1979Sc09); 5.7 ms *5* (1970Bo13). Weighted average is 3.85 ms *47*, but with large reduced $\chi^2$ of 7.7 versus 2.4 at 95% confidence level. |
| 107 *30* | | A | |
| 188 *30* | | A | |