

Adopted Levels

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	12-Feb-2023

S(n)=7230 *calc*; S(p)=2180 *syst*; Q(α)=9430 *syst* [2021Wa16,2019Mo01](#)

S(p) and Q(α) from [2021Wa16](#). S(n) from theory ([2019Mo01](#)).

Estimated uncertainties ([2021Wa16](#)): 450 for S(p), 300 for Q(α).

Q(ε)=5120 *440*, Q(εp)=3480 *410*, S(2p)=3790 *450* (*syst*, [2021Wa16](#)). S(2n)=16110 (theory,[2019Mo01](#)).

[1976FIZN](#): review article on the production of superheavy elements at JINR-Dubna, including ²⁵³Rf (labeled as ²⁵³Ku in the paper), produced in ²⁰⁶Pb(⁵⁰Ti,3n) reaction, with measured T_{1/2}=1.8 s, and 50% SF decay branching. This activity is likely different as the measured half-life is in sharp disagreement with 9.9 ms *I2* in [2022Lo03](#).

[1997He29](#): ²⁵³Rf produced in ²⁰⁴Pb(⁵⁰Ti,n),E=4.68 MeV/nucleon at GSI facility. A total of 14 correlated events with T_{1/2}=48 μs and eight correlated events with T_{1/2}=11 ms were observed.

[2021Kh07](#): ²⁵³Rf produced in ²⁰⁴Pb(⁵⁰Ti,n),E=234.3 MeV, followed by separation of evaporation residues (ERs) using gas-filled TransActinide Separator and Chemistry Apparatus (TASCA) at UNILAC, GSI. Measured (ER)(fission)-correlated events, half-lives of the two fission activities of ²⁵³Rf.

[2022Lo03](#): ²⁵³Rf produced in ²⁰⁴Pb(⁵⁰Ti,n),E=244 MeV. Measured Eα, (recoil)αα-correlated decays, and T_{1/2} of the g.s. and two isomers in ²⁵³Rf using SHELS fragment separator and implanted into the GABRIELA setup at FLNR-JINR-Dubna.

Theoretical structure calculations:

[2018Ma38](#): calculated single-particle energy spectra, J^π, deformation of odd isotones with N=149, 153 using Two-Center Shell Model (TCSM) with K-mixing of the basis wave functions and inclusion of the Coriolis correction.

[2015As05](#): calculated energy levels, J^π, Nilsson single-particle energies, deformation parameters.

[2006Sh19](#): calculated levels, J^π, rotational bands, transition dipole and quadrupole moments using cluster model.

[2005Pa73](#): calculated following single-particle level sequence: g.s., 9/2[734]; 0.01 MeV, 7/2[624]; 0.07 MeV, 5/2[622]; 0.33 MeV, 1/2[633]; 0.38 MeV, 1/2[501].

[1994Cw02](#): calculated following single-particle level sequence: g.s., 7/2[624]; 0.02 MeV, 9/2[734]; 0.21 MeV, 5/2[622].

[1985Cw01](#): calculated deformation energy along fission barrier versus β₂, fission barrier versus neutron number using Strutinsky method.

[Additional information 1.](#)

²⁵³Rf Levels

E(level)	J ^π	T _{1/2}	Comments
0	(1/2 ⁺)	9.9 ms <i>I2</i>	%SF=83 <i>6</i> ; %α=17 <i>6</i> (2022Lo03) %α: from ratio of α to SF activities (2022Lo03). Other %α: ≈12.5 (2021Kh07). SF decay observed by 1997He29 ; SF and α decay observed by 2021Kh07 and 2022Lo03 . E(level): it is assumed that longer-lived and slow-fissioning activity is the ground state. Experimentally, however, the ordering of the energies of the two activities is unknown. Possibility exists for the reversal of the ordering in energy of the two activities. J ^π : configuration=ν1/2[631] (2022Lo03). 2021Kh07 suggested 7/2 ⁺ for the g.s. with configuration=ν7/2[724]. Note that 2022Lo03 reversed the J ^π assignments for the g.s. and the 52.8-μs isomer from those proposed by 2021Kh07 , based on systematics of fission hindrances and half-lives of the two activities. T _{1/2} : from SF decay curve (2022Lo03). Others: 5.7 ms +31-15 from ER-α-correlated decay curve (2022Lo03); 12.8 ms +70-34 (2021Kh07 , ER-α decay); 11 ms +6-3 (1997He29).
0+x	(7/2 ⁺)	52.8 μs <i>44</i>	%SF≈100; %α=? %SF: there is evidence for only the α decay from 1997He29 and 2022Lo03 . E(level): x≤15 keV from the decoupling parameter of the ν1/2[631] configuration known from lighter isotopes, but x≈-105 keV from trend of the energies of the 1/2 ⁺ state in N=149 isotones as Z increases (2022Lo03). Based on discussion in 2022Lo03 , it is assumed that the shorter-lived and fast-fissioning activity is the isomeric activity. Experimentally, however, the ordering of the energies of the two activities is unknown. Possibility exists for the reversal of the ordering in energy of the two activities.

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Adopted Levels (continued) ^{253}Rf Levels (continued)

<u>E(level)</u>	<u>T_{1/2}</u>	<u>Comments</u>
$\geq 1020+x$	0.66 ms +40-18	<p>J^π: configuration=$\nu 7/2[724]$ (2022Lo03). 2021Kh07 suggested $1/2^+$ for the g.s. with configuration=$\nu 1/2[631]$. Note that 2022Lo03 reversed the J^π assignments for the g.s. and the 52.8-μs isomer from those proposed by 2021Kh07, based on systematics of fission hindrances and half-lives of the two activities.</p> <p>T_{1/2}: from SF decay curve (2022Lo03). Others: 44 μs +17-10 (2021Kh07), 48 μs +17-10 (1997He29,1999He11).</p> <p>%IT\approx100; %α=?</p> <p>Level identified from observation of seven isomeric decays followed by the fast fission of ^{253}Rf (2022Lo03). From evidence of decay by isomeric transitions only, \approx100% IT decay is assigned by inference, while there is no experimental information for the branching ratio.</p> <p>J^π: possible high-K isomer (2022Lo03).</p> <p>T_{1/2}: from 2022Lo03. Other: \approx0.6 μs (2021Kh07).</p> <p>E(level): energy removed by the isomeric cascades obtained from summing all the signals in the GABRIELA detectors (2022Lo03).</p>