Adopted Levels

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	NDS 156, 148 (2019)	31-Jan-2019

S(n)=7160 *CA*; S(p)=460 *SY*; Q(α)=11197 *13* 2017Wa10,1997Mo25
Estimated uncertainty (2017Wa10): ΔS(p)=250.
S(n) from 1997Mo25. S(p) and Q(α) from 2017Wa10.
S(2p)=2980 *620*, Q(εp)=4380 *400* (syst,2017Wa10). S(2n)=15630 (1997Mo25,theory).
Other Q(α)=11150 *35* from Eα=10986 keV *35* (2004Mo26, unweighted average of all the events).

1995Ho04: ^{209}Bi(^{64}Ni,n), E=316.1 MeV (no event observed), 318.1 MeV (one event observed) and 320.0 MeV (two events observed) at GSI using SHIP separator. Three position and time correlated chains of α particles were observed, with the α energies and time intervals between successive emissions. These decay chains were assigned to the decay of ^{272}Rg through consistency of α-descendents of the chain whose α-energies and half-lives agreed with the known isotopes of ^{260}Db and ^{256}Lr. 1998Ho13 summarized results from previous experiments and reported production σ<2.9 pb at E=316.1 MeV (no events), 1.7 pb *+33−14* at 318 MeV (one event), and 3.5 pb *+46−23* at E=320 MeV (two events). See also related articles: 1997Ho13, 1997Ho03 and 1999He07.

History of three events in 1995Ho04:
Event #1 (1995Ho04):
$E_{\alpha1}$=533 keV, Δt_1=3.60 ms, assigned to ^{272}Rg; $E_{\alpha1}$: escaped + 155-keV x ray.
$E_{\alpha2}$=10259 keV, Δt_2=71 ms, assigned to ^{268}Mt.
$E_{\alpha3}$=9475 keV, Δt_3=98 ms, assigned to ^{264}Bh.
$E_{\alpha4}$=1969 keV (escaped), Δt_4=1.969 s, assigned to ^{260}Db.

Event #2 (1995Ho04):
$E_{\alpha1}$=4612 keV (escaped), Δt_1=0.696 ms, assigned to ^{272}Rg.
$E_{\alpha2}$=10097 keV, Δt_2=171 ms, assigned to ^{268}Mt.
$E_{\alpha3}$=9618 keV, Δt_3=334 ms, assigned to ^{264}Bh.
$E_{\alpha4}$=9146 keV, Δt_4=953 ms, assigned to ^{260}Db.

Event #3 (1995Ho04):
$E_{\alpha1}$=10820 keV, Δt_1=2.042 ms, assigned to ^{272}Rg.
$E_{\alpha2}$=10221 keV, Δt_2=72 ms, assigned to ^{268}Mt.
$E_{\alpha3}$=9621 keV, Δt_3=1.452 s, assigned to ^{264}Bh.
$E_{\alpha4}$=9200 keV, Δt_4=573 ms, assigned to ^{260}Db.
$E_{\alpha5}$=8463 keV, Δt_5=66.3 s, assigned to ^{256}Lr.

2002Ho11: ^{209}Bi(^{64}Ni,n), E=320 MeV reaction at GSI using UNILAC and SHIP separator with three additional correlated decay chains observed:
History of three events in 2002Ho11:
Event #1: energy of the evaporation residue=41.76 MeV (2002Ho11):
$E_{\alpha1}$=3503 keV (escaped), Δt_1=3.36 ms, assigned to ^{272}Rg.
$E_{\alpha2}$=10294 keV, Δt_2=4.23 ms, assigned to ^{268}Mt.
$E_{\alpha3}$=9385 keV, Δt_3=944 ms, assigned to ^{264}Bh.
$E_{\alpha4}$=9156 keV, Δt_4=364 ms, assigned to ^{260}Db.
$E_{\alpha5}$=8465 keV, Δt_5=55.8 s, assigned to ^{256}Lr.

Event #2: energy of the evaporation residue=36.55 MeV (2002Ho11):
$E_{\alpha1}$=11008 keV, Δt_1=1.38 ms, assigned to ^{272}Rg.
$E_{\alpha2}$=6953 keV, Δt_2=7.32 ms, assigned to ^{268}Mt.
$E_{\alpha3}$=9514 keV, Δt_3=2.99 s, assigned to ^{264}Bh.
$E_{\alpha4}$=1706 keV (escaped), Δt_4=14.98 s, assigned to ^{260}Db.
$E_{\alpha5}$=877 keV (escaped), Δt_5=47.0 s, assigned to ^{256}Lr.

Adopted Levels (continued)

Event #3: energy of the evaporation residue=39.19 MeV (2002Ho11):
$E_{\alpha 1}$=11046 keV, Δt_1=2.70 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=765 keV (escaped), Δt_2=37.14 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9113 keV, Δt_3=3.01 s, assigned to ^{264}Bh.
$E_{\alpha 4}$=9129 keV, Δt_4=4.06 s, assigned to ^{260}Db.
$E_{\alpha 5}$=8423 keV, Δt_5=20.6 s, assigned to ^{256}Lr.
5 event average (including data points from 1995Ho04) for t_1=2.3 ms. Two event average (two data points indicating redundancy within current experiment) for Eα=11027 keV. At a beam energy of 320 MeV, a total of 3.3×10^{18} projectiles were delivered over 5 events from both experiments corresponding to an average cross-section of 2.9 pb *+19−13*.

2004Fo08: cold fusion experiment done at LBNL-Berkeley using the ^{208}Pb(^{65}Cu,n),E=326.9 MeV (E*=13.2 MeV) reaction, $^{65}Cu^{15+}$ beam provided by the 88-inch cyclotron, and reaction products separated using Berkeley gas-filled separator (BGS). One EVR-α1−α2−α3−α4−α5 correlated decay chain was observed and attributed to the decay of ^{272}Rg. The cross-section was estimated to be 1.7 pb *+39−14*.
Energy of evaporation residue=28.58 MeV (2004Fo08):
$E_{\alpha 1}$=11042 keV, Δt_1=0.263 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10114 keV, Δt_2=12.6 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=993 keV (escaped), Δt_3=1.16 s, assigned to ^{264}Bh.
$E_{\alpha 4}$=9416 keV, Δt_4=1.45 s, assigned to ^{260}Db.
$E_{\alpha 5}$=8613 keV, Δt_5=3.16 s, assigned to ^{256}Lr.

2004Mo26: ^{209}Bi(^{64}Ni,n),E=320,323,326 MeV using the RIKEN linear accelerator (RILAC) and the gas filled recoil ion separator GARIS. The detector system consisted of two foil detectors with micro-channel plates (MCP′s) and a Si semi-conductor (SSD) box. The detectors were used for purpose of time-of-flight and, in anti-coincidence mode, as a veto for signals coming from the MCP′s. A total of 11 correlated decay chains were observed at 323 MeV, three at 320 MeV, and none at 326 MeV. The cross-sections were measured as: 2.6 pb *+23−15* for 320 MeV, 2.5 pb *+12−9* for 323 MeV, and <1.1 pb at 326 MeV. Probability for accidental signals was determined to be 2.3×10^{-8}, with estimates given for different types of events. See also related article 2004Mo14.
History of 14 events in 2004Mo26, projectile energies given in parentheses, when uncertain due to target deterioration:
Event #1: E=(323 MeV); tof=48.3 ns; E(EVR)=33.1 MeV (2004Mo26):
$E_{\alpha 1}$=11.08 MeV, Δt_1=11.0 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.36 MeV, Δt_2=9.20 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.81 MeV, Δt_3=1.38 s, assigned to ^{264}Bh.
$E_{\alpha 4}$=9.17 MeV, Δt_4=1.93 s, assigned to ^{260}Db.
$E_{\alpha 5}$=8.39 MeV, Δt_5=11.9 s, assigned to ^{256}Lr.

Event #2: E=(323 MeV); tof=45.8 ns; E(EVR)=33.0 MeV (2004Mo26):
$E_{\alpha 1}$=11.04 MeV, Δt_1=4.42 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.68 MeV, Δt_2=13.0 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.60 MeV, Δt_3=1.45 s, assigned to ^{264}Bh.
$E_{\alpha 4}$=9.05 MeV, Δt_4=10.9 s, assigned to ^{260}Db.
$E_{\alpha 5}$=8.37 MeV, Δt_5=21.9 s, assigned to ^{256}Lr.

Event #3: E=(323 MeV); tof=46.5 ns; E(EVR)=33.2 MeV (2004Mo26):
$E_{\alpha 1}$=11.56 MeV, Δt_1=14.9 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=1.12 MeV (escaped), Δt_2=122 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.85 MeV, Δt_3=21.8 ms, assigned to ^{264}Bh.
$E_{\alpha 4}$=9.34 MeV, Δt_4=0.505 s, assigned to ^{260}Db.
$E_{\alpha 5}$=8.65 MeV, Δt_5=33.5 s, assigned to ^{256}Lr.

Event #4: E=323 MeV; tof=47.3 ns; E(EVR)=30.5 MeV (2004Mo26):
$E_{\alpha 1}$=11.25 MeV, Δt_1=1.42 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.43 MeV, Δt_2=36.6 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.66 MeV, Δt_3=1.87 s, assigned to ^{264}Bh.

Adopted Levels (continued)

$E_{\alpha 4}$=9.40 MeV, Δt_4=1.52 s, assigned to ^{260}Db.
$E_{\alpha 5}$=3.12 MeV (escaped), Δt_5=46.8 s, assigned to ^{256}Lr.

Event #5: E=323 MeV; tof=46.3 ns; E(EVR)=31.6 MeV (2004Mo26):
$E_{\alpha 1}$=10.82 MeV, Δt_1=7.11 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.29 MeV, Δt_2=0.715 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.57 MeV, Δt_3=0.543 s, assigned to ^{264}Bh.
E_{SF}=231 MeV, Δt_4=1.71 s, assigned to ^{260}Db.

Event #6: E=323 MeV; tof=47.5 ns; E(EVR)=32.7 MeV (2004Mo26):
$E_{\alpha 1}$=11.31 MeV, Δt_1=2.82 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.78 MeV, Δt_2=44.0 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.58 MeV, Δt_3=0.442 s, assigned to ^{264}Bh.
$E_{\alpha 4}$=8.81 MeV, Δt_4=48.5 s, assigned to ^{260}Db.

Event #7: E=323 MeV; tof=47.5 ns; E(EVR)=32.7 MeV (2004Mo26):
$E_{\alpha 1}$=10.58 MeV, Δt_1=1.17 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.35 MeV, Δt_2=38.3 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.31 MeV, Δt_3=3.6 ms, assigned to ^{264}Bh.
$E_{\alpha 4}$=9.01 MeV, Δt_4=4.87 s, assigned to ^{260}Db.
$E_{\alpha 5}$=8.50 MeV, Δt_5=45.8 s, assigned to ^{256}Lr.

Event #8: E=323 MeV; tof=46.0 ns; E(EVR)=31.1 MeV (2004Mo26):
$E_{\alpha 1}$=10.96 MeV, Δt_1=8.89 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=2.76 MeV (escaped), Δt_2=26.2 ms, assigned to ^{268}Mt.
E_{SF}=208 MeV, Δt_3=0.967 s, assigned to ^{264}Bh.

Event #9: E=323 MeV; tof=47.0 ns; E(EVR)=31.1 MeV (2004Mo26):
$E_{\alpha 1}$=11.06 MeV, Δt_1=5.11 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.43 MeV, Δt_2=19.1 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.50 MeV, Δt_3=1.34 s, assigned to ^{264}Bh.
$E_{\alpha 4}$=9.10 MeV, Δt_4=3.69 s, assigned to ^{260}Db.
$E_{\alpha 5}$=8.41 MeV, Δt_5=48.5 s, assigned to ^{256}Lr.

Event #10: E=320 MeV; tof=47.5 ns; E(EVR)=31.0 MeV (2004Mo26):
$E_{\alpha 1}$=10.21 MeV, Δt_1=1.00 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.03 MeV, Δt_2=8.81 ms, assigned to ^{268}Mt.
E_{SF}=206 MeV, Δt_3=4.93 s, assigned to ^{264}Bh.

Event #11: E=320 MeV; tof=47.8 ns; E(EVR)=32.2 MeV (2004Mo26):
$E_{\alpha 1}$=10.85 MeV, Δt_1=0.773 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.34 MeV, Δt_2=32.4 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=8.87 MeV, Δt_3=1.91 s, assigned to ^{264}Bh.
$E_{\alpha 4}$=8.50 MeV, Δt_4=21.0 s, assigned to ^{260}Db.

Event #12: E=320 MeV; tof=47.0 ns; E(EVR)=32.4 MeV (2004Mo26):
$E_{\alpha 1}$=11.00 MeV, Δt_1=6.92 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.58 MeV, Δt_2=35.5 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.34 MeV, Δt_3=1.00 s, assigned to ^{264}Bh.
$E_{\alpha 4}$=9.14 MeV, Δt_4=1.14 s, assigned to ^{260}Db.
$E_{\alpha 5}$=8.47 MeV, Δt_5=38.6 s, assigned to ^{256}Lr.

Event #13: E=323 MeV; tof=44.8 ns; E(EVR)=28.9 MeV (2004Mo26):

Adopted Levels (continued)

$E_{\alpha 1}$=11.01 MeV Δt_1=6.84 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=9.40 MeV Δt_2=37.2 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.56 MeV Δt_3=1.23 s, assigned to ^{264}Bh.
$E_{\alpha 4}$=8.29 MeV Δt_4=0.334 s, assigned to ^{260}Db.

Event #14: E=323 MeV; tof=47.8 ns; E(EVR)=33.0 MeV (2004Mo26):
$E_{\alpha 1}$=11.08 MeV, Δt_1=4.46 ms, assigned to ^{272}Rg.
$E_{\alpha 2}$=10.28 MeV, Δt_2=3.35 ms, assigned to ^{268}Mt.
$E_{\alpha 3}$=9.63 MeV, Δt_3=0.81 s, assigned to ^{264}Bh.
$E_{\alpha 4}$=9.13 MeV, Δt_4=2.42 s, assigned to ^{260}Db.
$E_{\alpha 5}$=8.63 MeV, Δt_5=6.85 s, assigned to ^{256}Lr.

For theoretical studies, consult Nuclear Science References (NSR) database at NNDC, BNL for 58 primary references dealing with the half-lives and other aspects of nuclear structure in this mass region.

^{272}Rg Levels

E(level)	$T_{1/2}$	Comments
0	3.8 ms *+14−8*	%α≈100 Only the α-decay mode observed in 21 decay chains from three different laboratories. E(level): the observed activity is assumed to correspond to the ground state of ^{272}Rg, although assignment to an isomeric activity cannot be excluded. J^{π}: 3^-,6^- from Ω(proton)=9/2$^-$; Ω(neutron)=3/2$^+$ from 1997Mo25 (theory). $T_{1/2}$: from 14 events in 2004Mo26. Other: 1.6 ms *+11−5* (from six events in 2002Ho11). Average Eα=11045 keV *35* (2004Mo26) in agreement with the average 11027 keV *20* from 2002Ho11 for two redundant events.