# An EC-branch in the decay of 27-s $^{263}$Db: Evidence for the new isotope $^{263}$Rf

J.V. Kratz[1], A. Nähler[1], U. Rieth[1], A. Kronenberg[1], B. Kuczewski[1], E. Strub[1], W. Brüchle[2], M. Schädel[2], B. Schausten[2], A. Türler[3], H. Gäggeler[3], C. Laue[4], R. Sudowe[4], P.A. Wilk[4]
[1]Institut für Kernchemie, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany
[2]Gesellschaft für Schwerionenforschung, 64291 Darmstadt, Germany
[3]Paul Scherrer Institut, 5232 Villigen, Switzerland
[4]Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

The first hint for $^{263}$Rf was reported by Czerwinski et al. who detected 7 spontaneous fission (SF) events with a half life of $500^{+300}_{-200}$ s in rutherfordium fractions separated by manual TTA extractions from the $^{248}$Cm($^{18}$O, 3n) reaction at 92.5 MeV [1]. No α events could be attributed to $^{263}$Rf.

In 1990, we discovered the new isotope 27-s $^{263}$Db in the $^{249}$Bk($^{18}$O, 4n) reaction at 93 MeV by eluting element 105 from cation exchange columns in unbuffered 0.05 M α-HiB [2].

In 1993, a rutherfordium fraction was milked from $^{263}$Db, and 22 SF events were registered in that fraction. Of these, 8.8 events had to be assigned to a contamination by $^{256}$Fm. A two-component decay curve with the $^{256}$Fm fixed gave a half life of $10^{+5}_{-3}$ min for the isotope $^{263}$Rf [3]. Based on the effective production cross section, an EC-branch in $^{263}$Db on the order of 5% was deduced [3]. Two α particles at 7.9 MeV were discussed as possibly being associated with the decay of $^{263}$Rf giving an upper limit for the α-decay branch of 30%.

A search for $^{263}$Rf in the $^{248}$Cm($^{22}$Ne, α3n) reaction at 122 MeV by Dressler et al. [4] involving a chemical separation of Rf as the volatile tetrachloride yielded two α particles at 7.8 and 7.9 MeV and four SF events with very long life times. Another search using the same reaction and aqueous chemistry with fluoride complexes of Rf [5] yielded two α events near 7.9 MeV with unusually long life times. This was not considered to present conclusive evidence for $^{263}$Rf [4],[5].

We have attempted to add further evidence for an EC-branch in the decay of $^{263}$Db and for $^{263}$Rf in an experiment at the Paul Scherrer Institute (PSI), Switzerland, producing again $^{263}$Db in the $^{249}$Bk($^{18}$O, 4n) reaction at 93 MeV. The activity was transported by a He/KCl jet and collected for 15 min on a Ta disc. It was dissolved in 2 x 20 µl of unbuffered 0.5 M α-HiB and added on top of a 3 x 50 mm cation-exchange column (AG 50Wx8). The α-HiB solution contained $^{88}$Zr tracer for the determination of the chemical yield for group-4 elements. These were eluted from the column with 1 ml 0.5 M α-HiB. The eluate was mixed with 3 ml 12 M HCl yielding a solution being 9 M in HCl. This was subject to liquid-liquid extraction with 200 µl of 20 vol% TBP/Cyclohexane which, after phase separation, was evaporated to dryness on a Ta disc. The Ta discs were assayed for α and SF activity starting about 8 min after the end of collection. The He/KCl jet efficiency was about 50%, the chemical yields were 70% on the average. The decontamination factor for Fm was on the order of $10^4$.

In some 200 experiments, a total of 9 SF events was registered of which 2 have to be considered a long-lived background. The life times are consistent with a half life of $^{263}$Rf of about 22 min with an uncertainty of ±5 min. Relative to the measured cross section for production of $^{263}$Db in the $^{249}$Bk($^{18}$O, 4n) reaction at 93 MeV, 10±6 nb [2], the new experiments give an EC-branch in the decay of $^{263}$Db of

$$3^{+4}_{-1}\%$$

and provide additional evidence for the new isotope $^{263}$Rf. The latter decays predominantly by spontaneous fission with a long half life of tens of minutes. In principle, the observation of α particles from the α-decay daugther of $^{263}$Rf, $^{259}$No (7.472 – 7.689 MeV), could help to fix the α-decay branch in the decay of $^{263}$Rf. However, this part of the spectrum is masked by a contamination with the naturally occuring $^{214}$Po (7.687 MeV). The picture that consistently emerges from [3] and the present work is shown in Fig.1.

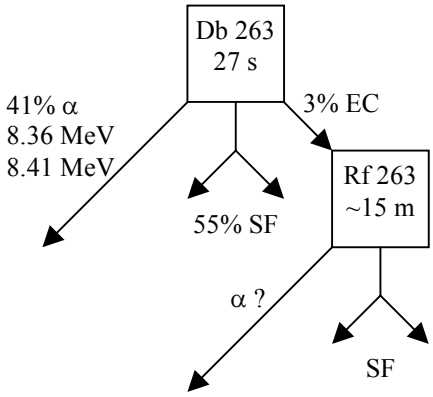


Fig.1 Decay scheme for $^{263}$Db and $^{263}$Rf

## References

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