

Decay properties of ^{269}Hs and evidence for the new nuclide ^{270}Hs

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Three decays of the nuclide ^{269}Hs were observed by Hofmann et al. [1,2] as grand daughter of $^{277}112$. The deduced relatively long half-life of about 10 s makes ^{269}Hs an ideal candidate for first chemical experiments with hassium (element 108). ^{269}Hs can be produced directly in the reaction $^{248}\text{Cm}(^{26}\text{Mg}, 5n)$. In the $4n$ de-excitation channel, the new nuclide ^{270}Hs is produced, which was predicted to be the next heavier “doubly-magic” nucleus after ^{208}Pb [3]. Its decay properties are of great interest to nuclear physics.

In order to investigate the chemical properties of Hs, the gas chromatographic separation system IVO (In situ Volatilization and On-line detection) [4] and the cryo on-line detector (COLD) [5] were set up at the rotating target- and window irradiation facility of the UNILAC at GSI Darmstadt. Hs is expected to belong to group 8 of the periodic table of the elements and should thus form very volatile HsO_4 molecules. Test experiments with short-lived Os isotopes, the lighter homologue element of Hs, showed that OsO_4 molecules were formed when the recoiling Os nuclei were stopped in a mixture of He and O_2 .

In the course of the experiment, data was collected during 64.2 h and a beam integral of 1.0×10^{18} ^{26}Mg ions was accumulated. The count rate in all detectors was very low. Only the nuclides ^{219}Rn , ^{220}Rn , ^{211}At and their decay products were identified after chemical separation. While ^{211}At (and its decay product ^{211}Po) was deposited mainly in the first two detectors, ^{219}Rn and ^{220}Rn and their decay products accumulated in the last three detectors, where the temperature was low enough to condense Rn. Due to a defect, one side of detector sandwich 1 was not operating and was therefore excluded from the data analysis. The average count rate per detector pair was 0.6 h^{-1} in the relevant α -decay energy window $E_{\alpha}=8.0\text{-}9.5 \text{ MeV}$ in detectors 2 through 9.

The data analysis revealed one four-member- and 4 three-member decay chains (Fig. 1) which all occurred within a time period of less than 70 s and which all have random probabilities of less than 7×10^{-5} . Since only about 77% of the inner surface of the COLD channel consisted of active detector surface, detection of a few incomplete decay sequences is expected. Two α -SF correlations were observed in detectors 3 and 4 that still have a rather low random probability, but could not be assigned with certainty to ^{269}Hs or ^{270}Hs . Also, 4 uncorrelated SF decays with fragment energies $>50 \text{ MeV}$ were registered in detectors 2, 3, and 4. Only for one SF both fragments were observed. All other detectors 5 through 12 registered zero SF events. The 4-member and the 3-member α -decay chains were attributed to the decay of the nuclide ^{269}Hs , since these almost perfectly match the decay properties observed previously by Hoffman et al. [1] (except for the low α -decay energy of ^{269}Hs in the three member decay chain). Three decay chains were

terminated by spontaneous fission. From the previously known decay data such a signature would be expected only for the decay of the new nuclide ^{270}Hs . But, one of the terminating SF events had a rather long life-time of 7.9 s, which is not very likely for ^{262}Rf with a half-life of 2.1 s. A similar decay sequence has also been observed in one of the decay chains assigned to $^{277}112$ [2]. Therefore, this chain was attributed to ^{269}Hs . Noteworthy are the very unusual decay properties of ^{261}Rf [6]. We tentatively assigned the remaining two decay chains to the new nuclide ^{270}Hs . From the measured $E_{\alpha}=9.16 \pm 0.03 \text{ MeV}$ an α -decay half-life of 2-7 s was estimated.

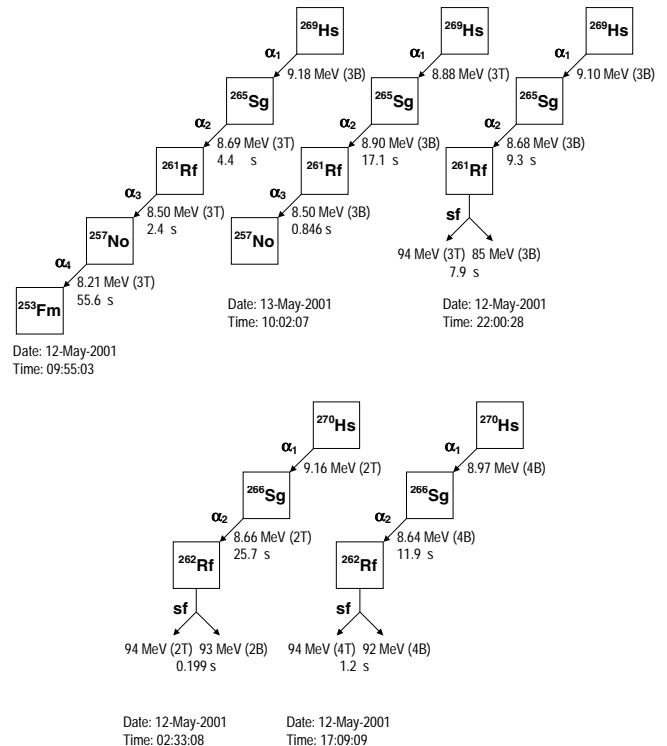


Fig. 1: Decay chains attributed to the decay of Hs-nuclides.

References

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