A Search for ^{259}Ha

C. A. McGrath, K. E. Gregorich, V. Ninov, D. M. Lee, M. R. Lane, E. R. Sylwester, D. A. Shaughnessy, P. A. Wilk, D. A. Strellis, J. L. Adams, C. A Laue, D. C. Hoffman

A search was undertaken at the 88-Inch Cyclotron at Lawrence Berkeley National Laboratory for the new isotope ^{259}Ha. The systematics in the region indicate that this nucleus should decay by spontaneous fission (SF) and by alpha emission with $E_\alpha \approx 9$ MeV and with a half life between .5 and 2 seconds. The ^{255}Lr daughter of this alpha decay undergoes alpha decay with $E_\alpha = 8.37/8.42$ with a reported half life of 22 seconds. We tried to produce ^{259}Ha via the ^{249}Cf(^{14}N,4n)^{259}Ha reaction at 88 MeV and to correlate parent and daughter decays using our MG rotating-wheel system in parent-daughter mode. In parent-daughter mode the wheel has foils alternating with holes. When a parent event is detected in the bottom detector the wheel is stepped so that the recoiled daughter nucleus on the top detector can be counted in a lower background environment.

As is usually the case, compound nucleus reactions with target contaminants produced high background levels in the region of interest for ^{259}Ha α events. Using SPIT to calculate the cross section for the reaction yields a value of 750 pb. With a cross section this high, it would not be unusual to detect 15 parent events per day. For the full run, lasting almost 2 days, we detected nearly 650 possible parent events.

It was obvious that most, if not all, of these parent events were the result of some process other than the α decay of ^{259}Ha. In analyzing the data it became apparent that about half the parent events were not single α events at all. In fact, they had not even been recorded with the data. They had only caused the initiation of daughter mode. This is almost certainly the result of pile-ups of ^{8}Be a-decays in the first detector. Because four or five of these α particles must pile-up to reach 9 MeV, they do not always trigger the fast constant-fraction discriminator, but can still trigger the slower single-channel analyzers.

All false parent events were filtered out and the remaining daughter modes were searched. Under these constraints, only 6 α events with energy between 8.3 and 8.5 MeV were recorded in daughter mode. In every case the second α particle was in a different detector pair than the parent event. Thus, we recorded no valid parent-daughter correlations over more than 35 hours of experimental time. The data was also analyzed for the presence of a short SF activity that might be attributed to ^{259}Ha. However, none was found.

With the detection of zero events, it is possible to calculate a 95% confidence limit on the cross-section by assuming three events. With this assumption, the cross section curve shown in figure 1 is produced. For half lives between .5 and 2 seconds, the cross section is less than half the calculated value. This also assumes an α-decay branch of 100%. Reducing the branch would raise the calculated cross-section limit.

While this reaction provided the best hope of producing ^{259}Ha using our regular methods, it may be possible to produce it in the future using BGS. Previous gas separator experiments at GSI have given us some hope.

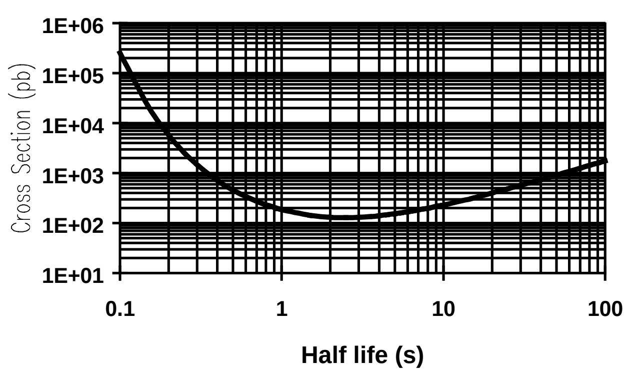

Fig. 1. Cross section upper limit plotted versus assumed ^{259}Ha half life for the ^{249}Cf(^{14}N,4n)^{259}Ha reaction at 88 MeV. An α-decay branch of 100% was assumed