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Contract No. W-7405-eng-48

ALPHA-DECAY IN ISOTOPES OF ATOMIC NUMBER LESS THAN 83

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September 5, 1949

Berkeley, California

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ALPHA-DECAY IN ISOTOPES OF ATOMIC NUMBER LESS THAN 83

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Some time ago we started work in an attempt to observe alpha-particle decay in isotopes of atomic number less than 83. In the first experiments, thin targets of gold leaf were bombarded with 190-Mev deuterons in the 184-inch cyclotron. Two alpha-decay periods were observed in these targets; one of 0.7 minutes half-life and another of 4.3 minutes half-life. The alpha-particle energies were 5.7 and 5.2 Mev, respectively. Chemical separations proved that the 4.3-minute period is due to a gold isotope and suggested that the 0.7-minute period is due to a mercury isotope. The mass numbers of these new isotopes have not been determined. However, the results of excitation-functions in the production of the gold isotope by bombarding gold and platinum with protons suggest that its mass number lies in the range 185 to 188. The work on this isotope indicates that the alpha to electron capture branching ratio is of the order of magnitude of 10^{-4}, and that positron activity accompanies the 4.3-minute alpha-period.

Very recently Sm_2O_3, Gd_2O_3 and Dy_2O_3 targets were bombarded similarly with 200-Mev protons. Several new alpha-decay periods were observed in the gadolinium and dysprosium targets, but significant alpha-activity was absent in the samarium target.

In the gadolinium bombardment there was present an alpha-decay period of approximately 7 minutes half-life and another of about 4 hours half-life, the alpha-particle energies being approximately 4.2 and 4.0 Mev, respectively, as determined with a pulse analyzer apparatus.

In the dysprosium bombardment, three alpha-decay periods were observed, namely $\sim$7 minutes, $\sim$20 minutes, and $\sim$4 hours with alpha-particle energies of 4.2, 4.1,

and 4.0 Mev, respectively. Present also was some electromagnetic radiation and a smaller amount of positron activity. With rough assumptions as to counting efficiency and geometry in the counting of the electromagnetic radiation with a Geiger counter, it appears that a minimum value for the ratio of alpha to electron capture is approximately 1% for the 4-hour activity.

The relationship between the alpha-particle energies and the half-lives of these new isotopes places them in a new class. The energies are approximately the same as the alpha-particle energy of Th^{232} which has a half-life of 1.4×10^{10} years. These facts in themselves are proof that these new periods could not have been due to heavy isotope contamination.

Chemical identification of these rare earths has not been completed as yet. However, since the 4.0-hour and 7-minute activities were produced in gadolinium and dysprosium targets and not in samarium, they would appear to be associated with gadolinium or terbium isotopes. Since the 20-minute period was produced only in the dysprosium target it would appear to be an isotope of dysprosium or holmium.

Although it is probably premature to attempt now to interpret these rather limited data, it is tempting to suggest a difference between the alpha-emitting isotopes of the gold region and those of the rare earths. As has been pointed out on numerous occasions(1) it should be possible to observe artificial alpha-activity in sufficiently neutron deficient isotopes in the region between the rare earths and lead. The alpha-emitting isotopes of the gold region might be "normal" examples of this since they are observed to decay with short electron capture half-lives, and with small alpha to electron capture branching ratios. In this case alpha-particle decay would be largely the consequence of considerable neutron deficiency. The higher alpha to electron capture branching ratio of the new rare earth isotopes is probably due to (a) a more moderate degree of neutron deficiency giving rise to longer electron capture half-lives, and (b) exceptionally high alpha-particle energies giving rise to shorter alpha half-lives. These new rare earth periods might, therefore, be correlated with

the stable configuration of 82 neutrons[2] in such a way as to acquire the necessary extra alpha-disintegration energy. Just as the isotopes having neutron numbers in the range 127-130 of the region above lead (for example $_{84}Po^{211}$, $_{84}Po^{212}$, $_{84}Po^{213}$, or $_{85}At^{215}$) decay by unusually high energy alpha-particle emission as a consequence of their decay to or near the stable configuration of 126 neutrons[3], so might isotopes such as $_{65}Tb^{149}$ or $_{66}Dy^{150}$ and those differing by a few neutrons (such as $_{65}Tb^{148}$, $_{65}Tb^{150}$, $_{66}Dy^{151}$, or $_{67}Ho^{153}$, etc.) decay by relatively high energy alpha-particle emission as a consequence of their decay to or near the stable configuration of 82 neutrons. Such isotopes would, therefore, be attractive possibilities for the assignment of these new rare earth periods. It would be more consistent with this view to assign the long-known natural radioactivity of samarium to $_{62}Sm^{147}$(and/or $_{62}Sm^{148}$) rather than to $_{62}Sm^{152}$(present best tentative assignment[4]), but, on the other hand, other stable configurations with a larger number of neutrons[5] may also be important.

In view of these new data it can be seen that alpha-decay in the lighter elements is more prevalent than hitherto recognized, and therefore these investigations are being continued. This letter is intended only as a very preliminary report and more complete results will be reported at some future date.

We wish to thank James Vale and the crew of the 184-inch cyclotron for their assistance in carrying out the work.

This work was performed under the auspices of the U.S. Atomic Energy Commission

References

(1) See, e.g., T. P. Kohman, Phys. Rev. 76, 448 (1949). This contains a rather complete list of references to other publications on this subject.

(2) See, e.g., Maria G. Mayer, Phys. Rev. 74, 235 (1948).

(3) I. Perlman, A. Ghiorso, and G. T. Seaborg, Phys. Rev. 74, 1730 (1948).

(4) A. J. Dempster, Phys. Rev. 73, 1125 (1948).

(5) N. Feather, Nature 162, 412 (1948).

August 31, 1949