A NEW METHOD FOR PRODUCTION OF RADIOACTIVE HYDROGEN OF ATOMIC WEIGHT THREE

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In the course of an investigation in which we attempted to confirm a report that Be^{10} is formed when B^{10} is disintegrated by slow neutrons, and which was unsuccessful, we became interested in the soft radiation emitted from a beryllium target after bombardment with deuterons. This soft radiation which had been ascribed to Be^{10} had been investigated by Libby and Lee[1] and reported to have an energy of 13 ± 5 k.e.v. We had at our disposal for investigation a metallic beryllium target which had been used for the production of neutrons and had been bombarded with 1 M.E.V. deuterons for some time in our cyclotron. It had been removed from the cyclotron for over six months and was therefore well "aged." In order to determine the range of electrons emitted we placed the target on the inner wall of an outer cylinder containing a screen wall Geiger counter so that the electrons had to pass through only two centimeters of the counter filling gas in order to be counted. The pressure of this gas could be varied. The counter filling gas was a mixture of argon and alcohol in the ratio 9 to 1 as recommended by Trost.

Fig. 1 shows the range of the electrons emitted from the Be target. The range was translated into range in Al by considering the stopping powers of argon and alcohol relative to Al. By studying this logarithmic plot and also the plot of actual numbers of counts against thickness of absorber the upper energy of these electrons was deduced from the range energy relation to be 15 ± 3 k.e.v. This value is in essential agreement with Libby and Lee's value. It is also seen from this curve that these are not monochromatic electrons, but must have a spectrum somewhat similar to ordinary β-spectra. No gamma rays were observed.

As no activity was found by bombarding boron with slow neutrons an attempt was made to identify chemically the radioactive isotope emitting the soft radiation observed. A thin surface layer of the active Be target was dissolved in sulphuric acid. No activity was found in the Be precipitate. However, the beryllium target had lost some of its activity. Since the energy of these electrons agreed with the rough value of the energy of the electrons from H^3 as determined by Alvarez and Cornog,[2] we thought that H^3 might have been formed by the reaction.

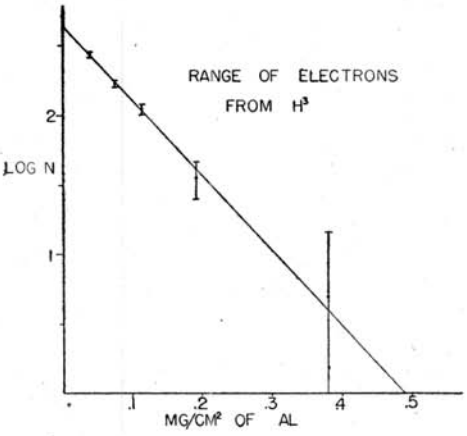

Fig. 1

$$Be^9 + H^2 \rightarrow Be^8 + H^3 \ldots\ldots (1)$$

and that some of the gas escaping in the chemical reaction was H^3. Therefore, in a second experiment the gas from the reaction was collected and introduced into a Geiger counter. Considerable activity—approximately 3000 counts per minute—was observed and no noticeable decay of this activity occurred. The half-life of H^3 as deduced from the half-life relation of Wigner[3] should be approximately 50 years. Other experiments which we have performed indicate a lower limit of 5 years.

A similar radioactive gas could also be obtained by heating the beryllium to a few hundred degrees, showing that this gas was occluded in the beryllium. The gas was shown chemically to be hydrogen by heating to red heat some lithium in the presence of the radioactive gas and noting that the activity was reduced. This indicated lithium-hydride had been formed.

The conclusions that we have H^3 and therefore that reaction (1) occurs is in agreement with work reported by Oliphant, Kempton, and Rutherford[4] in which they determined the ranges of particles given off during the bombardment of beryllium by deuterons. Reaction (1) was tentatively suggested by them to explain one of the groups. The range of this group was 8 cms. while the range of the H^3 particles from

$$H^2 + H^2 \rightarrow H^3 + H^1 \ldots\ldots (2)$$

is 1.6 cms.

This latter value excludes the possibility that H^3 was formed by bombarding deuterium adsorbed on to the target, since this range is equivalent to approximately 1 mg/cm.^{2} of beryllium while sufficient sulphuric acid to take off 3.7 mg/cm.^{2} was used. Therefore, if reaction (2) occurred all the activity of the beryllium target should have been removed. However, approximately one half still remained. This would be expected if H^3 were formed by reaction (1).

Therefore, it seems H^3 must be formed by the transmutation of Be^9 by deuterons. Since many laboratories already have beryllium which has been bombarded by deuterons for the production of neutrons, this seems to be a very convenient method of obtaining large quantities of H^3 in a concentrated form.

REFERENCES

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