disruptible by α-particles with the emission of neutrons, and while the structure $2\alpha + n$ for $_4Be^9$ will explain why no protons are emitted from this isotope under α-particle bombardment, it is difficult to see why no proton emission has been observed from lithium when bombarded with α-particles.

In addition, it has been found that all elements which emit protons under α-particle bombardment also emit neutrons, and, moreover, that many nuclei emit both protons and neutrons. It is significant that neutron emission followed by positron radioactivity has been observed by Miss Meitner[1] when lithium is bombarded by α-particles, and this suggests that proton emission from this element should also be observed. The reaction detected by Miss Meitner is :—

$$_3Li^6 + \alpha \rightarrow {}_5B^9 + n\uparrow\,;\quad {}_5B^9 \rightarrow {}_4Be^9 + \overset{+}{e}\uparrow\,;$$

and we should therefore expect to observe

$$_3Li^6 + \alpha \rightarrow {}_4Be^9 + p\uparrow\,.$$

In addition, the neutron and proton emission from boron, namely,

$$_5B^{10} + \alpha \rightarrow {}_7N^{13} + n\uparrow\,;\quad {}_7N^{13} \rightarrow {}_6C^{13} + \overset{+}{e}\uparrow\,;$$

$$_5B^{10} + \alpha \rightarrow {}_6C^{13} + p\uparrow \text{ and } {}_5B^{11} + \alpha \rightarrow {}_7N^{14} + n\uparrow\,,$$

as well as the emission of both protons and neutrons from $_7N^{14}$ and $_9F^{19}$, $_{11}Na^{23}$, $_{13}Al^{27}$ and $_{15}P^{31}$ suggest, therefore, that the following reactions from the structurally similar nuclei $_3Li^7$ and $_5B^{11}$ should be possible :

$$_3Li^7 + \alpha \rightarrow {}_4Be^{10} + p\uparrow$$
$$_3Li^7 + \alpha \rightarrow {}_5B^{10} + n\uparrow$$
$$_5B^{11} + \alpha \rightarrow {}_6C^{14} + p\uparrow$$

It is significant that $_4Be^{10}$ and $_6C^{14}$ are β-radioactive, so that these actions indicate that the delayed emission of 'negative' electrons should be observed from lithium and boron when these elements are bombarded by α-particles of suitable energy. The detection of such β-radioactivity with lithium would be evidence in favour of proton emission from this element.

In a similar way, the production of β-radioactive isotopes by proton emission from isotopes such as $_8O^{17}$, $_{10}Ne^{21}$, etc., for example,

$$_8O^{17} + \alpha \rightarrow {}_9F^{20} + p\uparrow\,;\quad {}_{10}Ne^{21} + \alpha \rightarrow {}_{11}Na^{24} + p\uparrow\,,$$

is possible. The abundance of these isotopes is, however, too small for such reactions to be detected experimentally. As, however, $_3Li^7$ and $_5B^{11}$ are the more abundant isotopes of lithium and boron, we anticipate that the induced β-radioactivity due to $_4Be^{10}$ and $_6C^{14}$ should be experimentally detectable.

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[1] Meitner, *Naturwiss.*, **22**, 420 ; 1934.

A Completely Supraconducting Galvanometer

SINCE it was thought that interesting experiments might be performed if it were possible to measure quantitatively persistent currents in a supraconducting circuit much smaller than have so far been detected with a magnetometer, there has been constructed in this laboratory a completely supraconducting moving-coil galvanometer. The coil consists of 100 turns of fine lead wire, connected by leads of lead to the experimental circuit. The coil is suspended in the liquid helium by a rigid wire connected above the cryostat to an ordinary galvanometer suspension and mirror. With this arrangement the suspension remains nearly at room temperature. The coil is completely shielded from moderate external magnetic fields by placing it inside a supraconducting cylinder of sheet lead, and thus is subjected only to the controlling magnetic field from a pair of copper coils within the cylinder.

Mathematical investigation of the characteristics of a resistanceless galvanometer showed that its behaviour would be interesting, apart from its possible applications. Assuming that, when the external circuit is also supraconducting, the whole can be treated as a circuit having zero resistance and self-inductance L, it was found :

(1) With a persistent current i_0, such that the deflection when there is resistance in the circuit would be $d_0 = Ki_0$, the coil should oscillate, undamped except mechanically, about a point

$$d' = d_0\left(1 + \frac{n^2A^2H^2}{kL}\right)^{-1}$$

where nAH is the flux linked with the moving coil in its control field, and k is the torsion constant of the suspension.

(2) For a given current i_0 the deflection should be a maximum, $d' = \frac{1}{2}d_0$, when $H = \sqrt{kL}/nA$.

The galvanometer has been tested by connecting it to a supraconducting tin coil in which a persistent current could be induced by means of an external magnetic field. As first constructed, the coil oscillated as expected, damped only by the small viscosity of the liquid helium, but proved to be unsteady. When artificial oil damping was introduced, the practical behaviour of the instrument was entirely satisfactory. The deflections were found to depend in the manner expected upon the control field H, and can be used to give quantitative measurements of the current. The sensitivity of the present instrument at the optimum field is about 5×10^{-5} ampere per mm.

This confirmation of the predicted behaviour shows definitely that true persistent currents throughout the circuit were induced, agreeing quantitatively with the law of induction, when the field was applied to the tin coil. In view of recent experiments upon the effects of magnetic fields upon supraconductors, it is interesting to note that the same deflection is obtained whether the control field is altered before or after the tin portion of the circuit becomes supraconducting, or before or after the persistent current is induced.

Some of the experiments in which an instrument of this kind may be of use are :

(1) Further investigations of the thermoelectric effect between two supraconductors around their transition points.

(2) An attempt to settle the still doubtful question of the Hall effect in a supraconductor.

(3) Experiments on the distribution of persistent currents.

(4) Studies of persistent currents which may throw some light on the recently discovered anomalous magnetic behaviour of certain supraconducting alloys.

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