LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twentieth of the preceding month; for the second issue, the fifth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

The Helium Content of Beryls

The late Lord Rayleigh showed in 1908 that many beryls contained large quantities of helium. If this had accumulated in the minerals as a result of atomic disintegrations of beryllium we should expect high helium content only in the older beryls. If, however, the helium was trapped in the mineral when it was formed, (which is unlikely since other siliceous minerals do not absorb helium), or if it is due to a short lived radioactive material initially present, we should expect large helium content in the younger beryls since opportunities for its escape would have been less. Lord Rayleigh's[1] results decidedly support the former alternative. Beryls from the younger rocks have not in any case been found to contain much helium; beryls from the older formations usually contain a relatively large amount. These measurements, which have been confirmed by Paneth and Peters,[2] suggest that the helium found in beryls is due to the disintegration of beryllium.

There is, as yet, no definite evidence of the terrestrial existence of ${}_4Be^8$. It is noteworthy that by extrapolating Aston's mass defect curve it is found that the nuclear binding energy of ${}_4Be^8$ is very small and may indeed be little greater than zero. R. d'E. Atkinson[3] supposed that this isotope has a negative mass defect so that ${}_4Be^8$ is spontaneously radioactive, breaking up into two α-particles. It has, therefore, been suggested that the helium found in beryls may be the disintegration product of ${}_4Be^8$ which was trapped in the minerals when they crystallized out. On general grounds (and by analogy with the other light elements) it would appear more probable that ${}_4Be^8$ is stable, i.e., that it has a positive, though small, mass defect. It is likely, therefore, that ${}_4Be^8$ is not spontaneously radioactive.

In a later communication Lord Rayleigh[4] considered the possibility that ${}_4Be^9$ might be radioactive as suggested by Langer and Raitt;[5] but he has shown that on this assumption the calculated time necessary for the accumulation of the helium is much greater than can be allowed and concludes that the helium in beryls cannot be brought into line with any "existing emission of α-particles," this conclusion being independent of whether beryllium or some other constituent is thought to be the parent element. More recently, moreover, Evans and Henderson,[6] Gans, Harkins and Newson,[7] and Libby[8] have proved conclusively that ${}_4Be^9$ is not radioactive.

In this connection the recent work of Szilard and Chalmers[9] and Gentner[10] is of significance. These investigators have shown that γ-radiation is capable of ejecting neutrons from ${}_4Be^9$, the results of Gentner indicating that ${}_4Be^9$ is stable with a mass defect energy of 0.45×10^6 e.v. It is thus apparent that γ-radiation is capable of disintegrating ${}_4Be^9$ according to one or other of the reactions

$$ {}_4Be^9+\gamma\rightarrow{}_4Be^8+n; \quad {}_4Be^9+\gamma\rightarrow{}_2He^4+{}_2He^4+n. $$

In addition, if ${}_4Be^8$ has a small but positive nuclear binding energy it will not be spontaneously radioactive, though it will probably be easily disintegrated into two α-particles by the nuclear absorption of γ-radiation thus:

$$ {}_4Be^8+\gamma\rightarrow{}_2He^4+{}_2He^4. $$

Hence, since there are widely disseminated radioactive substances in the earth's crust, and since the atmosphere is continually bombarded by the shower producing secondary γ-radiation due to cosmic rays, it is apparent that any stable ${}_4Be^8$ atoms originally present in beryls (or produced from ${}_4Be^9$ as above) may be broken down to form helium as may ${}_4Be^9$ atoms also. In consequence, the helium content of beryls may be due to the disintegration of "stable" (i.e., nonradioactive) beryllium isotopes. Thus ${}_4Be^8$, though stable, may have disappeared from the earth owing to disruption by cosmic radiation. It is to be noted that if the ${}_4Be^8$ mass defect energy is very low the α-particles produced will have such short ranges that no perceptible ionization due to them will be observed, since the nuclear processes discussed above are not sufficiently energetic to give rise to α-particles which could be detected by the normal methods.

In a similar way it would, therefore, appear probable that the just stable ${}_2He^5$ has disappeared from the earth's atmosphere, since this isotope, consisting of an α-particle and a loosely bound neutron, could also be disintegrated into an α-particle and a neutron by the secondary γ-radiation of cosmic rays. Thus both ${}_4Be^8$ and ${}_2He^5$, though stable (in that they have small positive nuclear binding energies), may have disappeared from the earth in the form of helium, i.e., may have died out as if they were "radioactive."

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[2] Paneth and Peters, Zeits. f. physik. Chemie **B1**, 187 (1923).
[3] R. d'E. Atkinson, Astrophys. J. **73**, 250 (1931).
[4] Rayleigh, Nature **131**, 724 (1933).
[5] Langer and Raitt, Phys. Rev. **43**, 585 (1933).
[6] Evans and Henderson, Phys. Rev. **44**, 59 (1933).
[7] Gans, Harkins and Newson, Phys. Rev. **44**, 512 (1933).
[8] Libby, Phys. Rev. **44**, 512 (1933).
[9] Szilard and Chalmers, Nature **134**, 437 (1934).
[10] Gentner, Comptes rendus **199**, 1211 (1934).