CLXXVI.—*Experiments on Transmutation.*

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In 1907 Ramsay (*Nature*, 1907, **76**, 269; Ramsay and Cameron, J., 1907, **91**, 1606; Ramsay, J., 1909, **95**, 624) observed the presence of spectroscopic amounts of lithium in solutions of copper nitrate and sulphate after exposure to radium, whereas parallel experiments with lead nitrate solution did not lead to any conclusive result. Ramsay suggested that the copper had been transmuted to the lowest member of its series, *i.e.*, lithium, although the possibility was not excluded that the chief product in the degradation of copper was sodium.

Repetition of the experiments by Curie and Gleditsch (*Compt. rend.*, 1908, **147**, 345; see also Ramsay and Cameron, *ibid.*, 1908, **146**, 456), in which containing vessels of platinum instead of glass were employed, failed to yield a similar result and the authors concluded that Ramsay's results were due to dissolution of lithium already present in the glass of his apparatus. Perman (J., 1908, **93**, 1775) exposed solid copper sulphate and nitrate, a solution of gold chloride, and some precipitated gold to the action of radium bromide for several months, but obtained no evidence of transmutation to lithium.

These experiments do not definitely disprove Ramsay's theory, but they certainly offer no support. In more recent experiments, attention has in the main been directed to methods involving electronic bombardment only, although Rutherford (*Proc. Roy. Soc.*, 1920, *A*, **97**, 374; J., 1922, **121**, 400; *Brit. Assoc. Rep.*, 1923, 16), employing an exceedingly delicate physical method, has proved that rapidly moving α-particles are capable of effecting the disruption of stable atoms.

It seemed desirable, therefore, that further experiments on the effect of exposure to radium " rays " should be carried out, and the spectra of the exposed substances examined over their whole range, and not merely for the presence of lithium.

EXPERIMENTAL.

Expt. 1. A small flat crystal of pure barium sulphate was exposed in air to bombardment for 3 years from a feeble source of radium-*D*, -*E*, and -*F*. The optical spark spectrum was photographed by Messrs. Adam Hilger, but no lines appeared that did not also appear on the blank.*

Expt. 2. A crystal of barium sulphate, a small piece of pure silver foil, and one of pure gold foil (A) were laid horizontally in a glass tube separated by pure cotton wool. The tube was evacuated and, at intervals, varying quantities of emanation were admitted, *viz.*, 28 millicuries at the first filling on Dec. 20th, 1926, and 32, 20, and 23 millicuries, respectively, at intervals of 5 or 6 weeks. The

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* Condensed spark spectra both with and without the introduction of a Hemsalech coil into the circuit.

spark spectra of the barium sulphate and silver coincided exactly with those of the blanks, but the gold spectrum showed calcium lines λ 3934, 3968, not present in the blank, and stronger copper lines than occurred in the blank, λ 3274 and 3247.

Expt. 3. As the glass containing-tube had been strongly discoloured, it appeared possible that the calcium found in the gold had come from this source, although in that event one might have expected to find traces in the silver and barium sulphate, which was not the case.

The experiment was therefore repeated with fresh pieces from the same sheet of gold foil (A), and with foil obtained from a different source (B). The specimens were laid in a silica test-tube enclosed in a wider glass tube, no cotton wool being employed. The glass tube was drawn out, evacuated and finally sealed after admission of 250 millicuries of emanation.

After 2 months the specimens were removed and dispatched with blanks to Professor A. Fowler, who had generously consented to examine their spectra. Calcium lines * appeared, not only in both exposed specimens, but also in both blanks. They were short, confined to the region near the poles, and of low intensity. In specimen A the lines appeared to be stronger in the exposed sample than in the unexposed, but the reverse was the case with specimen B.

It would appear, therefore, that the lines in both Expts. 2 and 3 were due to traces of calcium present in the original specimens, though somewhat irregularly distributed. If any kind of transmutation had taken place, its quantity was too minute to admit of detection spectroscopically

The silica tube used in Expt. 3 assumed a uniform violet-purple colour. This agrees with the statement by Lawson (*Nature*, 1919, **104**, 335) that the silica vessels used by Hönigschmid in his researches on the atomic weight of radium became dark violet, although in this case the colouring was streaky. In Doelter's experiments (quoted by Clarke, *Trans. Soc. Glass. Tech.*, 1921, **5**, 155) pure quartz was coloured uniformly brownish-red by radium salts, and Clarke appears to regard brown as the normal coloration for quartz. Unfortunately, neither author gives the wave-lengths of the transmitted light, and verbal descriptions of colour effects may be misleading. The silica used in the tests here described showed absorption at both the red and the violet end of the spectrum. Absorption did not begin sharply, but gradually increased in intensity with the distance from the middle of the visible spectrum. Speaking generally, light of λ 5000 to 7000 Å.U. was transmitted quite well, the remainder of the spectrum being comparatively feeble.

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* Spark spectra, with inductance. Lines of λ 3934 and 3968 Å.U.

In conclusion, the author desires to thank Professor Fowler for examining the spectra of the gold specimens used in Expt. 3, and the Radium Institute for assistance in exposing the specimens in Expts. 2 and 3.

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