III. RADIOCHEMISTRY.

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(Abstract.)

While radiochemistry as a distinct branch of science has developed almost exclusively during the last decade, the beginnings which led to this development go back more than a century.

Toward the close of the 18th century Cavendish, by mixing air with oxygen, and subjecting the mixture to the action of electric sparks from a friction machine found, after a tedious experiment, that 1/120 of the volume of nitrogen, which he used, could not be converted by this method into oxides of nitrogen. He had in reality discovered argon, though it was a century later before the discovery was recognized. In 1868 Lockyer discovered helium by the spectroscope in the sun. Both discoveries foreshadow the discovery of the noble gases by Rayleigh and Ramsay, and these in turn prepared the way for the recognition of helium as one of the disintegration products of radium. During the seventies Crookes devised a large number of extremely interesting experiments with electrical discharges through rarefied gases, and laid the basis for the discovery of the Röntgen rays and many of the phenomena connected with electrons and radioactivity.

In 1889 Hillebrand in Washington discovered nitrogen in uraninite and missed by only a hair's breadth the discovery of argon and helium. In 1894 Rayleigh and Ramsay discovered argon and shortly afterward Ramsay completed the discovery of helium from terrestial materials. In 1895 Röntgen of Würtzburg discovered the penetrating radiations from Crookes tubes. The following year Becquerel in Paris discovered the Becquerel rays emanated by compounds of uranium and noted the effect upon photographic plates, the ionization of gases through which they pass and the effect upon a screen of zinc sulphide. This led in the hands of the Curies two years later to the discovery of radium.

During the four years following Rutherford worked at McGill University, partly upon radio-active thorium, which led to the proposal of his disintegration theory of chemical elements, a theory which has since been established on a very firm foundation. Rutherford discovered in the course of his work that a gas with the properties of one of the noble gases results from the breaking down of radium. Shortly after this, in 1903, Soddy who had been at work with Rutherford, and who went to the laboratory of Ramsay in London to secure his aid in working out the difficult problem of identifying the disintegration products, succeeded in conjunction with Ramsay in establishing the fact that helium results from the spontaneous decomposition of radium.

Rutherford and others have also shown that radium as it decomposes evolves a large amount of heat, one gram of radium giving 118 gram calories of heat per hour. In this way chemists have become acquainted with a source of energy which is enormously greater than any form of chemical action hitherto known. For instance, a given amount of radium emanation evolves during its decomposition two million times as much heat as would be evolved by the same quantity of electrolytic gas.

From this time on there have been very many workers in the field of radiochemistry, and it has been established that the phenomena of disintegration is much more common than was at first supposed. The rate of disintegration is measured in the period required for one-half of a given element to disappear. This period varies very greatly for different elements. For uranium it is estimated at 6,000,000,000 years, for radium 1,760 years, for radium emanation 3.86 days, while for the actinium emanation it is only 3.9 seconds.

Recognizing that in radium emanation we have a source of energy of an entirely new order, Ramsay conceived the bold idea that it might be made use of to bring about the disintegration of other elements, and in 1907 he announced that potassium and lithium may be formed by the action of radium emanation on copper. A repetition of his experiments by Madame Curie has, however, thrown some doubt upon this conclusion.

The discovery of radioactivity has opened up to the vision of chemists a whole new field of work and has introduced many new points of view in the science. It has also given very strong support for the much older notion that there is some sort of genetic relationship among the chemical elements. It has compelled us to revise our definition of elements and compounds, and to recognize that what we have called an atom is in some cases, and probably always, composite. The last ten years have brought such varied and startling discoveries, in bewildering rapidity, that it seems certain that we are only at the threshold of a new epoch in the physical sciences.