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Marie Curie - Radioactivity

On a New, Strongly Radio-active Substance Contained in Pitchblende

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Translation of “Sur une nouvelle substance fortement radio-active, contenue dans la pechblende,” *Comptes rendus de l'Académie des Sciences,* Paris, 1898 (26 December), vol. 127, pp. 1215-1217.

Two of us have shown that by purely chemical procedures it is possible to extract from pitchblende a strongly radio-active substance. This substance is related to bismuth by its analytical properties. We have expressed the opinion that perhaps the pitchblende contained a new element, for which we have proposed the name of polonium.[1]

The investigations which we are following at present are in agreement with the first results we obtained, but in the course of these investigations we have come upon a second, strongly radioactive substance, entirely different from the first in its chemical properties. Specifically, polonium is precipitated from acid solution by hydrogen sulfide; its salts are soluble in acids and water

precipitates them from solution; polonium is completely precipitated by ammonia.

The new radio-active substance which we have just found has all the chemical appearance of nearly pure barium: it is not precipitated either by hydrogen sulfide or by ammonium sulfide, nor by ammonia; its sulfate is insoluble in water and in acids; its carbonate is insoluble in water; its chloride, very soluble in water, is insoluble in concentrated hydrochloric acid and in alcohol. Finally this substance gives the easily recognized spectrum of barium.

We believe nevertheless that this substance, although constituted in its major part by barium, contains in addition a new element which gives it its radio-activity, and which, in addition, is closely related to barium in its chemical properties.

Here are the reasons which argue for this point of view:

1. Barium and its compounds are not ordinarily radio-active; and one of us has shown that radio-activity appears to be an atomic property, persisting in all the chemical and physical states of the material.[2] From this point of view, the radio-activity of our substance, not being due to barium, must be attributed to another element.

2. The first substances which we obtained had, in the form of a hydrated chloride, a radio-activity 60 times stronger than that of

metallic uranium (the radio-active intensity being evaluated by the magnitude of the conductivity of the air in our parallel-plate apparatus). When these chlorides are dissolved in water and partially precipitated by alcohol, the part precipitated is much more active than the part remaining in solution. Basing a procedure on this, one can carry out a series of fractionations, making it possible to obtain chlorides which are more and more active. We have obtained in this manner chlorides having an activity 900 times greater than that of uranium. We have been stopped by lack of material; and, considering the progress of our operations it is to be predicted that the activity would still have increased if we had been able to continue. These facts can be explained by the presence of a radio-active element whose chloride would be less soluble in alcohol and water than that of barium.

3. M. Demarçay has consented to examine the spectrum of our substance with a kindness which we cannot acknowledge too much. The results of his examinations are given in a special Note at the end of ours. Demarçay has found one line in the spectrum which does not seem due to any known element. This line, hardly visible with the chloride 60 times more active than uranium, has become prominent with the chloride enriched by fractionation to an activity 900 times that of uranium. The intensity of this line increases, then, at the same time as the radio-activity; that, we think, is a very serious reason for attributing it to the radio-active part of our substance.

The various reasons which we have enumerated lead us to believe that the new radio-active substance contains a new element to which we propose to give the name of radium.

We have measured the atomic weight of our active barium, determining the chlorine in its anhydrous chloride. We have found numbers which differ very little from those obtained in parallel measurements on inactive barium chloride; the numbers for the active barium are always a little larger, but the difference is of the order of magnitude of the experimental errors.

The new radio-active substance certainly includes a very large portion of barium; in spite of that, the radio-activity is considerable. The radio-activity of radium then must be enormous.

Uranium, thorium, polonium, radium, and their compounds make the air a conductor of electricity and act photographically on sensitive plates. In these respects, polonium and radium are considerably more active than uranium and thorium. On photographic plates one obtains good impressions with radium and polonium in a half-minute's exposure; several hours are needed to obtain the same result with uranium and thorium.

The rays emitted by the components of polonium and radium make barium platinocyanide fluorescent; their action in this regard is analogous to that of the Röntgen rays, but considerably weaker. To perform the experiment, one lays over the active substance a very

thin aluminum foil on which is spread a thin layer of barium platinocyanide; in the darkness the platinocyanide appears faintly luminous above the active substance.

In this manner a source of light is obtained, which is very feeble to tell the truth, but which operates without a source of energy. Here is at least an apparent contradiction to Carnot's Principle.

Uranium and thorium give no light under these conditions, their action being probably too weak.[3]

1 P. Curie and Mme. P. Curie, *Comptes rendus,* vol. 127, p. 175.
2 Mme. P. Curie, *Comptes rendus,* vol. 126, p. 1101.
3 May we be permitted to thank here M. Suess, Correspondent of the Institute and Professor at the University of Vienna? Thanks to his benevolent intervention, we have obtained from the Austrian government the free gift of 100 kg of a residue from the treatment of the Joachimsthal pitchblende, containing no uranium, but containing polonium and radium. This gift will greatly facilitate our researches.