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On the Invisible Radiations Emitted by Phosphorescent Substance

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At the last session I sketched briefly the experiments I had been led to perform in order to demonstrate the invisible radiations emitted by certain phosphorescent substances, radiations which penetrate various substances which are opaque to light.

I have been able to extend these observations, and although I propose to continue and develop the study of these phenomena, their present interest [actualite] leads me to set forth as early as today the first results I have obtained.

The experiments I shell report were made with the radiations emitted by crystalline lamellas of the double sulfate of potassium and uranium.

$$[K(UO)SO_4 + H_2O],$$

a substance whose phosphorescence is very lively and whose persistence of luminosity is less than $^1/_{100}$ of a second.The characteristics of the luminous radiations emitted by this substance have formerly been studied by my father, and I have since had occasion to point out a few interesting peculiarities which these luminous radiations show.

It is very simple to verify that the radiations emitted by this substance when exposed to the sun or to diffuse daylight will penetrate not only sheets of black paper but even some metals, for example, an aluminium plate and a thin copper foil. In particular, I have performed the following experiment:

A Lumiere plate of silver bromide in gelatine was enclosed in an opaque plate–holder of black fabric, closed on one side by a plate of aluminium; if the plate–holder was exposed to full sunlight, even for an entire day, the plate would not be fogged; but if a lamella of the uranium salt is fastened

to the outside of the aluminium plate, held down, for example, by strips of paper, and if the whole is exposed to the sun for several hours, it can be seen, after the plate has been developed in the ordinary fashion, that the silhouette of the crystalline lamella appears in black on the sensitive plate and that the silver salt has been reduced opposite the phosphorescent lamella. If the sheet of aluminium is rather thick, the intensity of the action is less than that through two sheets of black paper.

If between the lamella of the uranium salt and the aluminium sheet or the black paper we place a screen formed by a sheet of copper about 0.10 mm thick, in the shape of a cross, for example, the silhouette of this cross can be seen in the image, more transparently, but with a shading which nevertheless shows that the radiation has penetrated the sheet of copper. In another experiment, a thinner sheet of copper (0.04 mm) weakened the active radiations much less. The phosphorescence excited no longer by the direct rays of the sun but by the solar radiations reflected on the metallic mirror of a heliostat, then refracted by a prism and lens of quartz, gave rise to the same.

I shall particularly insist on the following fact, which appears to me very important and quite outside the range of the phenomena one might expect to observe. The same crystalline lamellas, placed opposite photographic plates, under the same conditions, separated by the same screens, but shielded from excitation by incident radiation and kept in darkness, still produce the same photographic impressions. Here is the way I was led to make this observation. Among the preceding experiments, some were prepared on Wednesday the 26 and Thursday the 27 of February, and, as on those days the sun appeared only intermittently, I held black the experiments that had been prepared, and returned the plate– holders to darkness in a drawer, leaving the lamellas of the uranium salt in place. As the sun still did not appear during the following days, I developed the photographic plates on the first of March, expecting to find very weak images. To the contrary, the silhouettes appeared with great intensity. I thought at once that the action must have been going on in darkness, and I arranged the following experiment.

At the bottom of a box of opaque cardboard I placed a photographic plate; then, on the sensitive side, I placed a lamella of the uranium salt, a convex lamella, which touched the gelatine–bromide at only a few points; then nearby I arranged on the same plate another lamella of the same salt, separated from the gelatine-bromide surface by a thin slip of glass; this operation having been carried out in the dark–room, the box was closed, then shut inside another card–board box, and then inside a drawer.

I did the same with a plate–holder closed by a sheet of aluminium, into which I put a photographic plate, and, on the outside, a lamella of the uranium salt. The whole was shut inside a cardboard box, then in a drawer. At the end of five hours I developed the plates, and the silhouettes of the crystalline lamellas appeared in black, as in the preceding experiments, and as through they had been rendered phosphorescent by light. As for the lamella laid directly on the gelatine, there was hardly any difference in action between the points of contact and the parts of the lamella which were separated by about a millimeter from the gelatine; the difference can be attributed to the differing distance of the sources of the active radiations. The action of the lamella placed on a slip of glass was very slightly weakened, but the shape of the lamella was very well reproduced. Finally, through the aluminium sheet, the action was considerably weaker but nevertheless very distinct.

It is important to notice that this phenomenon does not seem to have to be attributed to luminous radiations emitted in phosphorescence, since at the end of $^1/_{100}$ of a second these radiations have become so weak that they are hardly perceptible.

A hypothesis which presents itself rather naturally to the mind would be to suppose that these radiations, whose effects possess a strong analogy with the effects produced by the radiations studied by Lenard and Röntgen, might be invisible radiations emitted by phosphorescence, whose duration of persistence might be infinitely greater than that of the luminous radiations emitted by these substances. Nevertheless, the present experiments, without being contrary to this hypothesis, do not warrant our formulating it. The experiments I am prosecuting at the moment may, I hope, contribute some clarification of this new order of phenomena.