

fall. The lining up of the cathode is accomplished by mounting it upon a sort of universal joint which is actuated from without by means of taps. Even then the direction of the cathodic beam changes with the heating current and destroys the alignment necessitating continual adjustment. The energy of the ions is increased by passing them through an accelerating field. With very weak deflecting fields and with an accelerating gradient of about 2,500 volts per centimeter the photographic plates show both the electrons and the negative ions. When the accelerating field is reversed the positive ions are revealed and, of course, the electrons and negative ions in turn are suppressed. The retrograde rays show but very indistinctly even for the largest accelerating fields employed which was about 3,000 volts per centimeter. Their distinctness on the photographic plate depends in a marked way upon the electrical conditions within the discharge vessel, for instance the positive ions show best on the plate when the metallic parts within are grounded while the negative ions are more distinct when the connection within is to the anode. The photographs indicate that the positive rays are more intense than the negative ones.

A number of photographs showing the deflections under the above named conditions accompany the paper.

PHYSICAL LABORATORY, UNIVERSITY OF ILLINOIS.

#### AN EXTENSION OF THE SPECTRUM IN THE EXTREME-VIOLET.<sup>1</sup>

BY THEODORE LYMAN.

THE researches of Schumann led him to extend the spectrum to the neighborhood of wave-length 1,250. His limiting wave-length was determined by the absorption of the fluorite which formed a necessary part of his apparatus. In 1904, I succeeded in pushing the limit to wave-length 1,030 by the use of a concave diffraction grating.

Recently I have renewed the attack on the problem with the result that I have succeeded in photographing the spectrum of hydrogen to wave-length 905. The extension is due not so much to any fundamental change in the nature of the apparatus as to an improvement in technique consequent on an experience of ten years.

It is a characteristic of the region investigated by Schumann between wave-lengths 1,850 and 1,250, that while hydrogen yields a rich secondary spectrum, with the possible exception of one line, no radiation has been discovered belonging to the primary spectrum. On the other hand, in the new region between the limit set by fluorite and wave-length 905, a disruptive discharge in hydrogen produces a primary spectrum of great interest made up of perhaps a dozen lines. These lines are always accompanied in pure hydrogen by members of the secondary spectrum but they may be obtained alone if helium containing a trace of hydrogen is employed.

Results obtained from vacuum tubes when a strong disruptive discharge is used, must always be interpreted with caution since the material torn from the

<sup>1</sup> Abstract of a paper presented at the Washington meeting of the Physical Society, April 24-25, 1914.

tube itself sometimes furnishes impurities. In the present case, it will be some time before the effect of such impurities can be estimated. However, it may be stated with some degree of certainty that the diffuse series predicted in this region by Ritz has been discovered. The first member at 1,216 is found to be greatly intensified by the disruptive discharge and the next line at 1,026 appears also, though very faintly. This diffuse series bears a simple relation to Balmer's formula. Following the same kind of argument, a sharp series corresponding to the Pickering series might be expected. The new region appears to yield two lines belonging to such a relation at positions demanded by calculation.

JEFFERSON PHYSICAL LABORATORY, HARVARD UNIVERSITY,  
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