It is well known among physiologists that when a nerve is stimulated by an electric current, the sensation is more intense at the cathode than at the anode. However in my experiments with a large electrode in contact with the palms of the hands practically no sensation was produced at either electrode while at a distance from the electrode, namely in the wrist and forearm the sensation, when it become intense, depended upon the direction of the current, being more painful in the cathode wrist.

This fact which the physiologists seem not to know about may be harmonized with the greater sensitiveness at the cathode by making use in our explanation of what are called physiological cathodes. Wherever current flows from nerve tissue across a surface of separation into another kind of tissue such as muscle or tendon we have a change of material in the path of the current and physiologists call this a physiological cathode. Now I am told that in the wrist there are a great many sensory nerve endings which terminate in tendons. If these are called physiological cathodes when the corresponding hand is the cathode, the greater pain in the cathode wrist is brought into line with the greater sensitiveness of the cathode in nerve stimulation.

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PHOTOGRAPHS OF RETROGRADE RAYS, (a) FROM THE COLD CATHODE,
(b) FROM THE HOT LIME CATHODE.¹

By O. H. SMITH.

AT the Thanksgiving, 1912, meeting of the American Physical Society several photographs were exhibited by Knipp showing retrograde rays. Thomson had photographed them, however with limited detail, a few months before. The present paper deals with a more extended photographic study of these rays using both the cold and the hot lime cathodes. The apparatus employed is essentially that described by Knipp.²

(a) The photographs, in the case of the cold cathode, with very weak deflecting fields, show in a very striking manner the three kinds of carriers—the electron, the carriers atomic in size with a negative charge, and carriers atomic in size with a positive charge. For a given magnetic field these heavy ions show a deflection that is 2 or 3 per cent. of that of the electron. For strong deflecting fields the electrons are blown off the plate and in place of the single line representing each the heavy positively and negatively charged ions there appear a number of parabolic lines characteristic of the gas in the discharge vessel. Under favorable conditions some of the negative lines are duplicated on the positive side, *i. e.*, a negative line having a corresponding positive component.

(b) For the case of the hot lime the problem presents additional difficulty. First, in lining up the cathode, and second, apparently the heavy carriers do not possess sufficient energy to affect the photographic plate upon which they

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

² Phil. Mag., December, 1911; PHYS. REV., XXXIV., March, 1912.

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.

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AN EXTENSION OF THE SPECTRUM IN THE EXTREME-VIOLET.¹

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

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