so nearly equal to that of glass that no appreciable effect is produced by the film of that substance between the face of the prism and the unruled surface of the grating.

On looking through the face of the prism which was perpendicular to that through which the incident light entered, a white image of the slit was seen, together with diffraction spectra on either side of it.

Another experiment was performed, using a grating ruled on glass with 300 lines to the inch. The width of a ruling was very small in comparison with that of a space. The grating was of a cheap kind, and the spacing was probably not very regular; nevertheless phenomena similar to those described above were observed. When the light was incident at an angle of 45° on the grating only a few spectra, of high orders, were seen.

When a strip of a screen such as is used for half-tone process work was used as a grating the number of lines to the inch being equal to 135, no diffraction spectra were seen when the angle of incidence was equal to 45°.

The probable existence of the diffraction phenomena described above was, in the first place, deduced by one of us from theoretical considerations; subsequently the experiments described were devised and executed. The singularity of the results obtained entirely vanishes when the point of view chosen is that of the wave theory of light. On the other hand, the failure of light to penetrate a free surface, combined with the readiness with which it traverses the same surface when parts are rendered opaque, afford sufficient interest, we hope, to merit this short notice. At an earlier date, when the wave theory was in more need of confirmation than at present, the experiments described might possibly have appeared as of a fairly crucial nature. At present they may at least serve to illustrate, in a striking manner, certain important points in the wave theory of light.

XXXIX. *Experiments on Induced-Radioactivity in Air, and on the Electrical Conductivity produced in Gases when they pass through Water.* By J. J. Thomson, *M.A., F.R.S., Cavendish Professor of Experimental Physics, Cambridge**.

IT has been shown by Elster and Geitel † that a wire, if strongly negatively electrified for several hours either in the open air or, as in one of their experiments, in a large

* Communicated by the Author.

† *Physikalische Zeitschr.* ii. p. 563.

cellar becomes radio-active, *i. e.*, it increases the electrical conductivity of the air in its neighbourhood. The most natural explanation of this phenomenon is that, as Elster and Geitel suppose, the atmosphere contains some radio-active constituent which is attracted to the negatively electrified surface; this constituent of the atmosphere behaving like the "emanation" from thorium which has been shown by Rutherford * to induce radio-activity in bodies with which it comes in contact and to be attracted to negatively electrified surfaces. I have, however, as the result of the experiments described below come to the conclusion that though the existence of this radio-active substance in the air is possible it is not necessary for the explanation of the effect observed by Elster and Geitel, and that negatively electrified surfaces may become radio-active without the deposition upon them of substances having specific radio-active properties.

As long as we have to experiment either in the open air or in large rooms, it is exceedingly difficult to alter the conditions sufficiently to afford an adequate test of any proposed explanation; I have therefore been experimenting with air contained in a closed vessel of moderate size, and although under normal conditions I have not been able to get any appreciable amount of induced radio-activity, I have found that a negatively electrified wire placed in the vessel acquired, when the gas in the vessel was exposed to Röntgen rays or had been bubbled through water, properties analogous to those found by Elster and Geitel in wires placed in the open air. The effects with the gas which had bubbled through water were very large.

The method was as follows:—a large cylindrical zinc gas-holder 102 cm. long and 75 cm. in diameter, was supported on insulating feet, and closed by a lid made of millboard; the outer portions of the top and bottom of the lid were put in metallic connexion with the gas-holder by rings of tinfoil which overlapped the lid and were fastened to the cylinder; circular guard-rings of tinfoil connected with the earth were pasted on the upper and under surfaces of the lid, these prevented any leakage of electricity across the lid from the cylinder to a metal rod placed along its axis; this rod, which was connected with the electrometer, passed through a short metal tube in an ebonite disk which occupied the central portion of the lid, a flange on the rod resting on the top of the tube. The current between the rod and the cylinder was measured by an electrometer which was connected with the

* Phil. Mag. [6] i. pp. 1 & 161.

rod. This rod before the measurement of the current was connected with the earth, and the cylinder with one terminal of a battery of small storage-cells, the other terminal of which was connected with the earth. The battery contained 500 cells; these were found sufficient in all cases to produce the saturation-current, when the air was in the normal state a very much smaller number of cells was sufficient to do this. As the rod had to be strongly electrified in order to investigate the induced radio-activity, there was some danger that the ebonite disk with which it was connected might get charged with electricity, and this electrification by leaking back to the rod produce effects which were not due to the conductivity of the air. To avoid this two ebonite disks were used, the one used to support the rod whilst it was electrified was removed before the current through the vessel was measured and replaced by the second, which was carefully kept free from electrification.

In the earlier experiments four different rods were used as electrodes, these were pieces of brass tubing of the same length and diameter. The procedure was as follows: in the morning the current through the vessel was measured, using each of the rods as electrode in turn: the deflexion of the electrometer in one minute, which is proportional to the current through the vessel, rarely differed by more than about one part in 75 for the four rods. During the day these rods were subjected to differ nt treatment; one was put aside to serve as a standard, a second was connected with the negative terminal of a Wimshurst machine, and exposed to the air of the room, the Wimshurst machine was giving sparks about 3 cm. long; the third rod was often connected with the positive terminal of the machine and exposed to the air, while the fourth rod was kept in the tank and connected in some experiments with the negative terminal of the machine, in others with the positive. The electrical machine was kept going all day long, and tested from time to time to see that its electrification did not reverse, and at the end of the day the current through the tank was measured, using each of the rods as electrode. If a rod had become radio-active, the current through the tank with this rod as electrode would be greater than it was when the rod was in its normal state, owing to the additional ionization due to the rod. With the air in the tank in its normal state I was never able to detect any change in the rod due to its long negative electrification. The volume of air in the tank, about 440 litres, was too small to produce the radio-active effects observed by Elster and Geitel. As the current coming up to the rod in the tank was much

smaller than if the rod had been electrified in the open air, I tried the effect of increasing the current by ionizing the gas in the tank by means of Röntgen rays: the tube giving out the rays was placed outside the tank, the rays passing into the tank through the millboard cover; this had, of course, the effect of greatly increasing the saturation-current through the tank, and it was found that now prolonged negative electrification of the rod produced an appreciable effect; the saturation-current, when the rod which had been negatively electrified in the tank was used as electrode, was considerably larger than when the electrode was a rod which had not been so treated. The magnitude of the effect is indicated by the numbers given below, which represent the deflexions of the electrometer in one minute; these numbers are proportional to the saturation-current:—

Current at 11 A.M. with rod (1) as electrode . . .	74
Current at 5 P.M. after rod (1), which remained in the tank, had been attached to the negative terminal of a Wimshurst machine while the gas in the tank was ionized by Röntgen rays.	86
Current at 11 A.M. with rod (2) as electrode . . .	74
Current at 5 P.M. with rod (2) as electrode, this rod having been exposed to the air of the room and connected with the negative terminal of a Wimshurst machine.	76
Current at 11 A.M. with rod (3) as electrode . . .	72
Current at 5 P.M. with rod (3) as electrode, this rod having been exposed to the air of the room and connected with the positive terminal of a Wimshurst machine.	71

The above experiments were made on the same day. We see that with the negatively electrified rod in the tank there was an appreciable increase; in the case of the other rods the changes were too small to allow any conclusions to be drawn. A considerable number of experiments of this type were made: it will be sufficient to give one more example:—

Current at 11 A.M. with rod (1) as electrode . . .	77
Current at 5 P.M. with rod (1) as electrode, the rod having been in the tank in the interval, connected with the negative terminal of a Wimshurst machine and the air ionized by Röntgen rays.	88
Current at 11 A.M. with rod (2) as electrode . . .	76
Current at 5 P.M. with rod (2) as electrode, the rod having been kept in the tank but not electrified in the interval.	74

The rods which had been made active by long negative electrification gradually lost this activity, and after the lapse of about one hour the current with these rods as electrodes sank to about its normal value. When the rod in the gas exposed to the Röntgen rays was either positively electrified or not electrified at all, no change took place in the saturation-current sent through the gas before and after the electrification from this wire as electrode, thus in these experiments, as in those of Elster and Geitel, *negative* electrification is required to make the rod active.

When a rod is in the active state, the current in the direction corresponding to a flow of positive electricity from the rod is slightly greater than the current in the opposite direction. When the rod is in the normal state the two currents are equal. The effects produced on the rods in the preceding experiments are not very great; but the method described below gives very large effects, exceeding even those produced by electrification in the open air.

Properties of Air Bubbled through Water.

I made further experiments to see whether the induced radio-activity on negatively electrified bodies could be detected in the space of an ordinary-sized room without artificial ionization of the air. I endeavoured to produce throughout the air in the room an electric field of greater average intensity than that produced by a negatively-electrified wire. With this object very finely-divided water-spray strongly negatively electrified was projected into the room; the spray was produced by forcing a jet of water under high pressure through a small hole in a negatively-electrified plate; the spray as it fell was collected on filter-paper which, when drenched by the spray, was placed in the tank through which the saturation-current was measured. Very large effects were obtained in this way, so large, indeed, that it seemed unlikely that they were due to induced radio-activity on the negatively-electrified spray. A series of experiments were accordingly made to see whether wet paper produced any effect when the water had not previously been electrified. Strips of wet filter-paper were wrapped round the rods used as electrodes in the preceding experiments, and much larger saturation-currents were obtained with these electrodes than with bare rods. The current was found to vary much with the nature of the paper—filter, blotting, tissue, cartridge, and foolscap papers were tried—and also with the nature of the solution; the results obtained were complex and irregular, and this method of

investigating the action of water was for the time abandoned in favour of the following, which gave quite regular effects.

The air in the large tank, previously described, was made to circulate through water. To effect this two tubes were fastened into the tank, through one of these the air was sucked by a water-pump into a closed vessel, from which it found its way back into the tank through the other tube; the air got thoroughly mixed up with water during the process of pumping. A plug of glass wool was placed in the return-tube to stop water-spray.

The air which had thus been forced through water was found to be a very much better conductor of electricity than air in the normal state, the increase in the conductivity is surprisingly large; thus, after the circulation of the air through water had continued for about two hours, the saturation-current was more than twenty times the value before the circulation commenced. The air, when once it has been modified in this way, retains its new properties for a very long time: thus, if the tank is kept closed so that the air cannot diffuse out, it takes several days after the stoppage of the circulation for the conductivity of the air to fall to its normal value. The following numbers give an idea of the rate at which the modified gas returns to its normal condition. At 5.20 P.M. on Saturday afternoon the current through the tank with the central wire positively charged was 600, with the central wire negatively charged it was 330; at 10 A.M. on Monday, *i. e.*, after more than 40 hours, the current with the central wire + was 143, with the central wire − 115. The saturation-current through air in the normal state was 30 whichever way the wire was electrified.

The properties of the modified air cannot be explained by the negative electrification which Lord Kelvin has shown to be present in air which has bubbled through distilled water, nor could they be explained by supposing that the bubbling of the air through the water filled it once for all with a supply of positive as well as of negative ions. In the air modified by passing through water there must be a continuous production of ions. A gas which contains a mixture of positive and negative ions, but in which no fresh ions are being produced, though it will conduct electricity, will exhibit peculiarities which will distinguish it from a gas in which spontaneous ionization is taking place; the current through a gas in which no fresh ionization is taking place will increase with the electromotive force acting on the gas; each increase in the electromotive force producing an increase in the current. There will be no approach to the state of

saturation, indeed in many such cases the tendency is for the current to increase more rapidly than the electromotive force. In the gas in which continuous ionization is taking place the current gets saturated, the maximum current being the one which takes out of the gas in one second all the ions which are produced in the gas in that time; the current will not increase beyond this, however much the electromotive force is increased, provided that the electric field does not become so strong that it gives rise to spark or brush discharge.

Air which has been modified by passing through water shows all the peculiarities of a gas in which continuous ionization is taking place; the current gets saturated; although, as is natural, from the much greater conductivity of the gas the electromotive force required to saturate it is much greater than when the gas is in the normal state.

Many experiments on the relation between the current through the modified gas and the electromotive force acting upon it were made. The following tables embody the results of two such experiments.

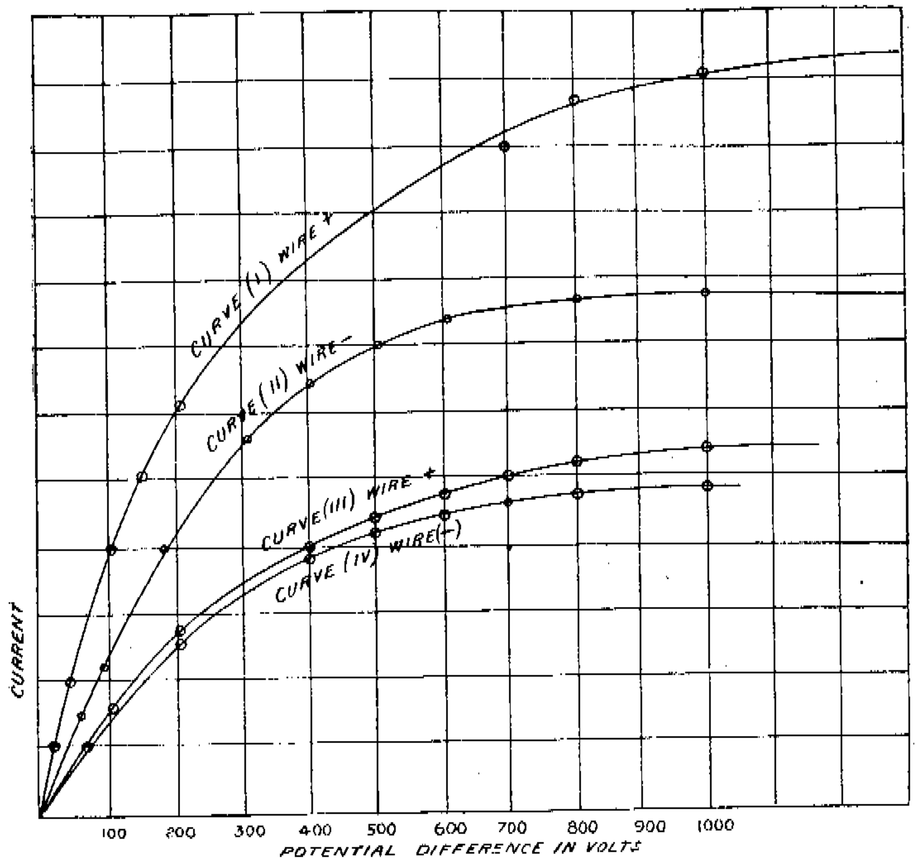
Potential-difference in volts between the central wire and the cylinder.	Current. wire +.	wire −.
40	40	30
80	66	45
120	80	70
160	107	80
200	122	97
400	150	126
600	200	139
800	220	138
1000	230	150

These results are represented graphically in the curves in fig. 1. These curves clearly show the approach to saturation. The following observations were taken with air of considerably smaller conductivity than that used in the preceding experiments:—

Potential-difference in volts between the central wire and the cylinder.	Current. wire +.	wire −.
40	18	17
80	29	28
120	36	36
200	58	55
400	80	78
600	92	85
800	105	95
1000	110	95

Curves representing the results of these experiments are shown in fig. 1.

Fig. 1.



In these experiments the central electrode was not supported by the ebonite plate at the centre of the lid of the vessel containing the modified gas, but was supported above the vessel and passed into the vessel through a hole in the lid which it did not touch.

The air when in the modified state produced by bubbling through water can be transferred from one vessel to another and still retain some, at least, of its conductivity. To show this a second vessel was prepared. This was a large galvanized iron cistern supported on insulating feet, a central wire placed along its axis was kept connected with the electrometer, and the current between this wire and the case of the cistern measured. This vessel, which we shall call B, was connected by a metal pipe about 150 cm. long and 1 cm. in diameter with the vessel A, in which the modified gas was stored. When air was blown from A to B the saturation-current through A diminished, while that through B increased.

The gas, while passing through the tube between A and B, could easily be subjected to various physical processes, and

by observing the rate at which the conductivity in B increased—the rate of flow of air through the tube being kept constant—the effect of these processes on the conductivity of the modified gas could be determined. Thus a plug of glass-wool was placed in the tube, and it was found that the modified gas could pass through this without losing its conductivity.

If the conductivity of the modified gas did not arise from some process of continuous ionization, but was due to the presence of ions placed once for all in a gas in which there was no further creation of ions, it should be destroyed like that of gases sucked from flames by passing the gas through a strong electric field. To test this point a long metal tube, about 1 metre long and 1 cm. in diameter, with an insulated wire along its axis, was inserted between the vessels A and B. The modified gas could pass through this tube when there was a potential-difference of 1000 volts between the wire and the tube without losing its conductivity. Thus, in this respect, the modified gas resembles a gas mixed with the "emanation" from thorium. Rutherford has shown that in this case the conductivity is not destroyed by a strong electric field.

The modified gas passed through a tube filled with wire gauze heated to a dull red heat without losing its conductivity: when, however, the gauze was at a bright red heat the conductivity was destroyed.

The conductivity was also destroyed when the gas passed slowly through a spiral tube immersed in a freezing-mixture of ether and solid carbonic acid.

The conductivity can be taken out of the gas by passing it slowly through a tube filled with glass beads moistened with sulphuric acid; if the gas is merely allowed to bubble through sulphuric acid it escapes with a considerable amount of conductivity.

Experiments with a Gouy Sprayer.

The water-pump arrangement, although very convenient for testing the effects of water and air, was not suitable for use with other liquids and gases. To test the effect of different liquids air was forced through a Gouy spray. The air, after passing through the sprayer, was found to have a high conductivity, and when it passed into either of the testing vessels A or B, the saturation-current through this vessel was increased. By measuring the increase produced after the current of air from the sprayer had passed into the testing vessel for a given time an estimate could be formed of the

conductivity given to the gas by passing through the liquid in the sprayer; by changing this liquid the effect of the nature of the liquid on the conductivity communicated to a gas passing through it could easily be determined.

The following is an example of some experiments of this kind:—

Vessel B, normal saturation-current before spraying	wire +16, wire −16
Pure distilled water in the sprayer, the air after passing through the sprayer went into B, duration of experiment 15 minutes, saturation-current . .	wire +33, wire −30
Air blown out of B, saturation-current .	wire +15, wire −15
Strong solution of NaCl in the sprayer, air passed through sprayer as before for 15 minutes, saturation-current .	wire +30, wire −28

Thus there is no clearly-marked difference between the effects of pure water and brine. Solutions of rosaniline, phenol, hydrogen peroxide, and sulphuric acid were tried, and all gave much the same effects as pure water: the amount of electrification given to the air by bubbling through these solutions is very different, so that these experiments afford another proof of the difference between the conductivity communicated to a gas and the amount of electric charge. Another illustration of this is that though when air is first bubbled through distilled water it is strongly negatively electrified, it loses its charge much more rapidly than its conductivity, and after the lapse of an hour or so the charge will be unappreciable while the conductivity will be almost as large as it was at first.

Ether, alcohol, and turpentine were placed in the sprayer and air forced through them, but with these liquids no appreciable conductivity was produced.

When coal-gas was forced through distilled water in the sprayer the conductivity was much less than when the same volume of air was passed through.

Induced Radio-Activity produced on a Negatively-Electrified Surface immersed in Modified Gas.

The experiments already described have shown that when air is in its normal state the volume of air in the closed vessel A is too small to give the induced radio-activity observed in a negatively electrified wire placed in the open air. We have seen too that when the current of electricity through the vessel is increased by exposing the gas in it to Röntgen rays,

a negatively electrified wire acquires the property of ionizing the air around it; this effect is, however, shown to a very much greater extent by the gas when it is in the modified state produced by bubbling it through water.

To show this the tank A was filled with the modified conducting gas, while the air in B was kept in its normal condition, a clean wire electrode was taken and the saturation-current through B with this wire as electrode measured; the wire was then placed in A and kept negatively electrified by a Wimshurst machine for periods ranging from 30 minutes to 7 hours; the wire was then taken out of A and replaced in B, and the current through B again measured with this wire as electrode: the current was found to be considerably greater than before the electrification of the wire. The following numbers show the magnitude of this effect:—

Current through B with a potential-difference of 1000 volts before wire was electrified	wire +24, wire −17
Current after wire had been negatively electrified in the vessel A for 7 hours	wire +54, wire −54

The conductivity of the air in the tank A was about 10 times normal.

In another experiment when the conductivity in A was about 12 times normal, the results were:—

Current through B before wire was electrified	wire +22, wire −17
After 7 hours' negative electrification of the wire in A the current through B was	wire +74, wire −67

Larger effects were obtained with electrodes having larger surfaces than that of the straight wire. Thus, when a cylinder of copper wire-gauze was used as the electrode, the current through B before the gauze was electrified was: gauze +22, −21. After 7 hours' electrification in A the current through B was: gauze +400, −200.

The amount of ionization produced by a wire after negative electrification does not seem to depend to any great extent on the material of which the wire is made. Wires of the same diameter and length made of zinc, lead, iron, copper, amalgamated copper, copper covered with a layer of water and glycerine, copper wet with alcohol, which all gave when used as electrodes equal currents through B before electrification, gave approximately equal currents (much larger than the previous ones) after negative electrification in A. To ensure that the wires were exposed to similar influences in the vessel A they were usually tested in pairs, which were connected together and placed in symmetrical positions with respect to the axis of A.

The amount of induced radio-activity on negatively electrified surfaces exposed to the emanation from thorium, or placed in the open air, seems also to be independent of the nature of the surface.

The ionizing power of the wire is only produced by negative electrification. If the wire when placed in the modified conducting gas in A is positively electrified, or if it is not electrified at all, then no change in the current through B with this wire as electrode is produced by the immersion of the wire in the vessel A.

To show the ionization produced by a wire after negative electrification in A, it is not necessary to use the wire itself as the electrode in measuring the current through B, an independent wire may be used as electrode, and the ionization due to the wire can be detected by the increase in the saturation-current which takes place when the wire is put into B after its negative electrification in A: the effect, although very distinct, is not so large as when the electrified body is itself used as the electrode; it is desirable to use a piece of metal of considerable area for the body which is negatively electrified.

The ionizing power possessed by the active metal is very easily cut off by thin layers of solids. I have, however, been able to detect that an appreciable effect is produced by the negatively electrified metal even when surrounded by thin aluminium foil or paper. In this connexion it may be mentioned that if the conductivity of air when in the modified state is due to rays given out from centres of ionization, these rays must have very little penetrating power, as I have drawn modified air possessing high conductivity over a photographic plate in the dark for more than four hours without producing an impression on the plate.

The active state in which a metal rod is put after being negatively electrified in the modified air is not a permanent one. As soon as the negative electrification stops, the activity of the metal begins to diminish, and after a few hours it entirely disappears: measurements of the rate at which this activity disappeared showed that it fell off rapidly at first and then much more slowly: the time taken for the activity to fall to half its initial value was about 45 minutes. It varied a little in the different experiments.

When once a wire has been put into the active state it can stand very rough treatment without losing its ionizing power.

Thus, for example, washing the wire with water and drying it by heating with a bunsen does not destroy its activity, nor does heating it in a bunsen to a red heat seem to have much effect upon it ; an amalgamated copper wire was made active and then heated until the mercury was given off, even after this treatment it retained some activity.

Theory of the preceding Phenomena.

These experiments show, I think, that induced radio-activity caused by negative electrification is not necessarily due to the deposition of a radio-active substance. This hypothesis does not seem admissible in the case of the preceding experiments ; for when the air is put in the modified state by means of the water-pump, only a limited supply of air is used, the volume of which, as we have seen, is too small to give rise to radio-activity when the air is in its normal condition, hence if in these experiments the effects produced by negative electrification are due to the deposition of a radio-active substance, such a substance must have come from the water. In the experiments with the Gouy sprayer, however, the amount of water used was very small : to see whether there was any radio-active substance in it which could produce the observed effects, the water in the sprayer was evaporated to dryness on a metal plate ; the plate, however, after this treatment did not show any ionizing power. Again, the amount of air passed through the sprayer was not large enough to produce a supply of radio-active substance large enough to produce the observed effects, for a larger volume of air than that passed through the sprayer was drawn past a negatively-electrified wire without imparting to it any ionizing power. The experiments have led me to the conclusion that the ionizing power imparted to the wire in the preceding experiments arises in the following way :—In consequence of the negative electrification of the wire positive ions move up to it when it is placed in the modified gas ; some of these ions do not discharge to the wire, but stick close to it, forming a coating of positive electricity around it. Between this coating and the wire there will be a strong electric field tending to draw negative electricity from the wire. Now there are many phenomena which lead us to the conclusion that a wire, even at ordinary temperatures, contains rapidly-moving negatively-electrified corpuscles which, under ordinary circumstances, remain in the wire because their kinetic energy is not sufficient to carry them beyond the attraction of the metal. When, however, there is a layer of positive electricity just outside the metal, the attraction of this on the negative

corpuscles drags the latter from the wire ; as the corpuscles move across the space between the coating and the wire they acquire additional kinetic energy, and if the difference of potential between the coating and the wire exceeds a certain value they will emerge from the positive coating with sufficient kinetic energy to enable them to ionize the molecules of the gas with which they come into collision ; for this to be the case the potential-difference between the positive coating and the wire must exceed 2 volts, as Mr. H. A. Wilson has shown that the energy required to ionize a molecule of a gas is of the order of that given to a charge equal to that on a corpuscle when it moves through a potential-difference of about two volts.

Thus, on this view, the ionizing power of the wire is due to a kind of polarization, which produces an electric field which makes the wire into a cathode emitting cathode-rays of feeble penetrating power which ionize the gas in the neighbourhood of the wire.

If the wire, when in the conducting gas, had been positively electrified the electric field due to the polarization would have tended to force back the corpuscles into the wire rather than pull them out ; there would therefore in this case be no emission of cathode-rays and no ionization of the gas.

The amount of polarization seems to depend upon the way the gas in which the negatively-electrified wire is placed is ionized. Thus we have seen that when the gas is made a conductor by bubbling through water the effect on the negatively electrified wire is much greater than when the gas is made a conductor by Röntgen rays, although the conductivity of the gas is greater in the latter case than in the former. Again, I made the gas in the vessel a very good conductor by keeping a Bunsen burner burning in the vessel, but in this case I could not detect any ionizing power in a negatively-electrified wire which had been kept in the vessel. Air which has been passed over phosphorus is a conductor of electricity, but I could not detect any ionizing power in a negatively-electrified wire immersed in it.

The principle by which we have explained the ionizing power of the negatively electrified wire—the emission of cathode-rays from the wire under the influence of a coating of positive electricity close to the surface of the wire—will also, I think, explain the conductivity produced in air when it bubbles through water. We may suppose that by this process very minute drops of water get mixed with the air, these drops must be exceedingly small, otherwise they would not be able to pass through a plug of glass-wool ; the very slow rate

at which the conductivity dies away also shows that the drops must settle down exceedingly slowly, so slowly that they take some days to fall through 1 metre; from this we may conclude that the diameter of the drop cannot greatly exceed 10^{-5} cm. If each little drop gets surrounded by a layer of positive electricity then, just as in the case of the wire, the drop might emit cathode-rays which would ionize the air in its immediate neighbourhood; thus each little drop would act as a centre of ionization, and thus make the air a conductor. The formation of a layer of positive electricity outside the drop is what we should expect if any chemical combination went on between the water of the drop and the oxygen of the air leading to the formation of such a compound as H_2O_2, for, in forming this compound, the water would combine with a negative oxygen ion and not with a positive one; thus from the layer of oxygen outside the drop the water would pick out the negative and leave the positive ions, this would lead to the production of the coating of positive electricity round the drop required to make it act as an ionizing agent.

The drops of water as well as acting as producers of ions would also act as traps to catch ions moving through the air in which they are suspended; they thus tend to reduce the conductivity, because when an ion gets attached to one of these drops, it is as it were anchored to it, and only moves with great difficulty; in some cases the presence of drops of water diminishes the conductivity of the gas instead of increasing it: thus I found that squirting a steam-jet into either of the tanks A or B materially diminished the saturation-current through the tank.

The ordinary polarization of the electrodes in the electrolysis of liquids is usually explained by the existence of a layer of electrification close to the surface of the electrode, thus the polarized electrode resembles in this respect the electrified wire and the small drop of water on the preceding theory. I therefore thought it of interest to see whether a polarized electrode, when taken out of the electrolytic cell, would ionize the gas. Two platinum plates or wires were immersed in a solution of sulphuric acid of about the maximum conductivity, and a current of from 1 to 5 amperes sent from one electrode to the other for about an hour; the electrodes were then taken out, washed with distilled water, and dried with filter-paper; they were then placed in tank B and the saturation-current through the tank when these were used as electrodes measured. It was found that the one which had been used as the negative electrode (*i. e.* the one against which the hydrogen was liberated) now gave considerably higher currents than before the electrolysis, in some cases twice the current, while the positive electrode gave the same current as before. On first charging up the negative electrode positively, there was frequently a very large current for a short time, which was not repeated on the second charging, as if there were some positive ions loosely attached to the electrode which got driven away; the smaller increase to which I have alluded lasted for about half-an-hour. The amount of the increase varied a good deal; in one or two experiments there was no change in the current. The experiments with liquid electrolytes are more ambiguous than those with gases, as there is the possibility of some acid adhering to the plate and not getting entirely removed by the washing and drying, and then setting up some chemical action. Against this explanation we have the fact that the increase only occurs with one electrode—the negative, not with the positive—so that if it is due to the chemical action it must be caused by something produced at the negative terminal and not at the positive. Hydrogen peroxide seemed to me the most likely substance, so I immersed a platinum plate in a strong solution of H_2O_2, and washed and dried it in the same way as the electrodes. I found, however, in this case no change in the current through the tank B.

I have much pleasure in thanking my assistant, Mr. E. Everett, for the help he has given me in these experiments.

June 1902.

XL. *On the Influence of Convection on Optical Rotatory Polarization.* *By* J. Larmor *.

THE postscript (this volume, p. 220) to Lord Rayleigh's account of his decisive determination that the orbital motion of the Earth is without influence on the rotatory polarization produced by quartz, has brought to my notice the recent paper by Prof. H. A. Lorentz there quoted.

The fundamental character of Lord Rayleigh's negative result may be illustrated by reference to Prof. Lorentz's *Versuch einer Theorie* . . ., p. 119 (1895), where the opposite conclusion is considered as not unlikely in view of the formal possibilities that are open. But the main object of this note is to entirely admit the demur made by Prof. Lorentz, that my criticism ('Æther and Matter,' p. 214) of his calculation of rotational effect, there given, is not well founded. The conclusion which I had reached was in fact that for light *of given absolute wave-length* the optical rotation would be

* Communicated by the Author.