and the results of their examination prove that it is possible to get large fields sensibly free from optical distortion. This has a most important bearing on the carrying out of the "chart" work, as it is at present necessary to expose for one hour to obtain a region 2° × 2°, whereas the new form of lens would give a much larger region in the same time. For this reason, Prof. Turner has indefinitely postponed the taking of the "chart" plates for the Astrographic Survey.

CAMBRIDGE OBSERVATORY.—Embodied in the *Cambridge University Reporter* for June 16, is the annual report of the Cambridge Observatory from 1898 May 26 to 1899 May 25. With the meridian circle, 2241 observations of 1420 stars have been taken, most of these being repetitions of previous observations for the catalogue.

One hundred and seventy-six observations have been made of the Harrow occultation stars; and, at the request of Dr. Gill, observations of heliometer comparison stars were commenced in March and are still in progress.

In addition, there have been other measurements of standard stars, bringing up the total number of meridian observations to 3616.

The new bent equatorial, to be called the "Sheepshanks equatorial" (see illustrated description in *Monthly Notices*, R.A.S., 1899 January, vol. lix. p. 152) was completed about September 1898, and its adjustment was undertaken by Mr. Hinks. It was soon found that the objective tube had a large flexure, and a new tube is being made. The first trial photographs were unsatisfactory, the disturbing cause being thought to be the air currents in the tube, which is partly open near the joint.

The Newall telescope has been employed on 96 nights during the year, in connection with the Bruce spectroscope, in taking photographs of stellar spectra for determining their velocity in the line of sight; 150 photographs have been obtained, giving material for determining the velocity of 60 stars. Thirty of these are included in the Potsdam list of 51 stars observed from 1888–1891. Preparations are in hand for converting the spectroscope into a powerful 4-prism instrument for detailed examination of a few of the brightest stars. Special series of stellar spectra have been taken to assist in the reduction of the eclipse photographs obtained in India in 1898. For this purpose also attempts have been made to separate scandium salts from the mineral gadolinite.

PICTURES PRODUCED ON PHOTOGRAPHIC PLATES IN THE DARK.[1]

I THINK I may fairly assume that every one in this theatre has had their photograph taken, and consequently must have some idea of the nature of the process employed. I have, therefore, only to add, with regard to what is not visible in the process of taking the picture, that the photographic plate is a piece of glass or such like body, coated on one side by an adhesive paste which is acted on by light, and acted on in a very remarkable manner. No visible change is produced, and the picture might remain latent for years, but place this acted on plate in a solution, of, say pyrogallol, and the picture appears. The subsequent treatment of the plate with sodium hyposulphite is for another purpose, simply to prevent the continuance of the action when the plate is brought into the light. Now, what I purpose demonstrating to you to-night is that there are other ways of producing pictures on photographic plates than by acting on them by light, and that by these other means a latent picture is formed, which is rendered visible in precisely the same way as the light pictures are.

The substances which produce on a photographic plate these results, so strongly resembling those produced by light, are, some of them, metallic, while others are of vegetable origin. At first it seemed very remarkable that bodies so different in character should act in the same way on the photographic plate. The following metals—magnesium, cadmium, zinc, nickel, aluminium, lead, bismuth, tin, cobalt, antimony—are all capable of acting on a photographic plate. Magnesium most strongly, antimony but feebly, and other metals can also act in the same way, but only to a very slight extent. The action in general is much slower than that of light, but under favourable conditions a picture may be produced in two or three seconds.

Zinc is nearly as active as magnesium or cadmium, and is the most convenient metal to experiment with. In its ordinary dull state it is entirely without the power of acting on a photographic plate, but scratch it or scrape it, and it is easy to prove that the bright metal is active. I would say that all the pictures which I have to show you, by means of the lantern, are produced by the direct action of the metal, or whatever the active body may be, on the photographic plate, and that they have not been intensified or touched up in any way. This first slide is the picture given by a piece of ordinary zinc which has been rubbed with some coarse sand paper, and you see the picture of every scratch. Here is a piece of dull zinc on which some circles have been turned. It was exposed to the photographic plate for four hours at a temperature of 55° C. In the other cases, which are on a larger scale, a zinc stencil was polished and laid upon a photographic plate, and you see where the zinc was in contact with the plate much action has occurred. In the other case a bright zinc plate was used, and a Japanese stencil interposed between it and the photographic plate, and a very strong and sharp picture is the result. The time required to produce these zinc pictures varies very much with the temperature. At ordinary temperature the exposure would have to be for about two days, but if the temperature was, say, 55° C., then half to three-quarters of an hour might be sufficient. Temperatures higher than this cannot be used except for very short times, as the photographic plate would be damaged. Contact between the zinc and photographic plate is not necessary, as the action readily takes place through considerable distances. Obviously, however, as you increase the distance between object and plate, so you decrease the sharpness of the picture, as is shown by the following pictures, which were taken respectively at a distance of 1 mm. and 3 mm. from the scratched zinc surface. The appearance of the surfaces of different metals varies, and the following slides show the surface of a plate of bismuth, a plate of lead, and one of aluminium. On the next slide are the pictures produced by similar pieces of pure nickel and cobalt, and it clearly shows how much more active in this way nickel is than cobalt. Many alloys, such as pewter, fusible metal, brass, &c., are active bodies, and in the case of brass the amount of action which occurs is determined by the amount of zinc present. Thus you will see that a brass with 30 per cent. of zinc produces hardly any action on the photographic plate, but when 50 per cent. of zinc is present there is a fairly dark picture, and when as much as 70 per cent. is present a still darker picture is produced. The second class of bodies which act in the same way on a photographic plate are organic substances, and belong essentially to the groups of bodies known as terpenes. In trying to stop the action of metallic zinc, which I thought at the time might arise from vapour given off by the metal, copal varnish was used, but in place of stopping the action it was found to increase it, and this increase of activity was traced to the turpentine contained in the varnish. In experimenting with liquids it is convenient to use small shallow circular glass vessels such as are made for bacteriological experiments, the plate resting on the top of the vessel, and the amount of liquid in the vessel determining the distance through which the action shall take place. The following slide, produced in this way, shows how dark a picture ordinary turpentine produces. All the terpenes are active bodies. Dipentine is remarkably so; in a very short time it gives a black picture, and if the action be continued, the dark picture passes away, and you then have a phenomenon corresponding to what photographers call reversal. The strong smelling bodies known as essential oils, such as oil of bergamot, oil of lavender, oil of peppermint, oil of lemons, &c., are all active bodies, and all are known to contain in varying quantities different terpenes; therefore ordinary scents are active bodies, and this is shown by the following pictures produced by eau de Cologne, by cinnamon, by coffee, and by tea. Certain wines also act in the same way, Sauterne gives a tolerably dark picture, but brandy only a faint one. Other oils than these essential ones are also active bodies; linseed oil is especially so; olive oil is active, but not nearly as much so as linseed oil; and mineral oils, such as paraffin oil, are without action on the photographic plate.

Interesting results are obtained with bodies which contain some of these active substances; for instance, wood will give its own picture, as is shown by the following slides: the first is a section of a young spruce tree, the next a piece of ordinary deal, and the third of an old piece of mahogany. Again, the

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[1] A lecture delivered at the Royal Institution on Friday, May 5, by Dr. W. J. Russell, V.P.R.S.

next slide you will recognise as the picture of a peacock's feather. There is much interest in these pictures of feathers, as they distinguish the brilliant interference colours from those produced by certain pigments; the beautiful blue in the eye of the peacock's feather is without action on the photographic plate. Butterflies' wings, at least some of them, will draw, as you see, their own pictures. Linseed oil, which is a constituent of all printing ink, makes it an active body, and it can, like the zinc and other active bodies, act through considerable distances. In the picture before you the ink was at a distance of one inch from the plate, and the next slide shows what a remarkably clear and dark picture ordinary printing can produce. As the composition of printing ink varies so does its activity, and here are pieces of three different newspapers which have acted under the same conditions on the same plate, and you see how different the pictures are in intensity. Printed pictures, of course, act in the same way; here is a likeness of Sir H. Tate taken from "The Year's Art." The pictures and printing in *Punch* always print well, so does the yellow ticket for the Friday evening lectures at the Royal Institution; also the rude trade-mark on Wills's tobacco, and it is of interest because the red pigment produces a very clear picture, but the blue printing is without action on the plate.

An interesting and important peculiarity of all these actions is that it is able to pass through certain media; for instance, through a thin sheet of gelatin. Here are two plates of zinc; both have been scratched by sand-paper; one is laid directly on the photographic plate, and the other one has a sheet of gelatin, its colour is of no note, laid between it and the sensitive plate; the picture in this case is, of course, not so sharp as when no gelatin is present, but it is a good and clear likeness of the scratches.

Celluloid is also a body which allows the action to pass through it, as is seen in this picture of a piece of perforated zinc, a picture which was produced at ordinary temperatures. Gold-beaters' skin, albumen, collodion, gutta-percha, are also bodies which are transparent to the action of the zinc and the other active bodies. On the other hand, many bodies do not allow the transmission of the action through them; for instance, paraffin does not, and among common substances writing ink does not, as is easily shown by placing ordinary paper with writing on it between the active body and the photographic plate. The active body may conveniently be either a plate of zinc or a card painted with copal varnish and allowed to dry, or a dish of drying oil. The picture of an ordinarily directed envelope shows this opacity of ink well. It is a property long retained by the ink, as this picture of the direction of a letter, written in 1801, shows; also this letter of Dr. Priestley's, dated 1795, and here is also some very faded writing of 1810, which still gives a very good and clear picture. Even if the writing be on parchment, the action passes through the parchment, but not through the ink, and hence a picture is formed.

With bodies which are porous, such as most papers, for instance, the action passes gradually through the interstices, and impresses the plate with a picture of the general structure of the intervening substance. For instance, the following pictures show the structure and the water-mark of certain old and modern writing papers. Some modern writing papers are, however, quite opaque; but usually paper allows the action to take place through it, and combining this fact with the fact of the strong activity of the printing ink, the apparently confused appearance produced on obtaining a picture from paper with printing on both sides is accounted for, as the printing on the side away from the photographic plate, as well as that next to it, prints through the paper, and is, of course, reversed.

I hope I have now given you a clear idea how a picture can be produced on a photographic plate in the dark, and the general character and appearance of such pictures. I now pass on to the important question of how they are produced. Moser suggested fifty years ago that there was "dark light," which gave rise to pictures on polished metallic plates, and lately it was suggested that pictures were produced by vapour given off by the metals themselves; the explanation, however, which I have to offer you is, I think, simpler than either of these views, for I believe that the action on the photographic plate is due to the formation of a well-known chemical compound, hydrogen peroxide, which undergoing decomposition acts upon the plate and is the immediate cause of the pictures formed. The complicated changes which take place on the sensitive plate I have nothing to say about on the present occasion, but I desire to convince you that this body, hydrogen peroxide, is the direct cause of these pictures produced in the dark. Indirect proof has to be resorted to. Water cannot be entirely excluded, for an absolutely dry photographic plate would probably be perfectly inactive, and as long as water is present peroxide of hydrogen may be there also. But what are the conditions under which these pictures are formed? Only certain metals are capable of producing them. This list of active metals which I have mentioned to you was determined solely by experiment, and when completed it was not evident what common property bound them together. Now, however, the explanation has come, for these are the very metals which most readily cause, when exposed to air and moisture, the formation of this body, peroxide of hydrogen. Schönbein showed as long ago as 1860 that when zinc turnings were shaken up in a bottle with a little water hydrogen peroxide was formed, and the delicate tests which we now know for this body show that all the metals I named to you not only can in the presence of moisture produce it, but that their power of doing so follows the same order as their power of acting on a photographic plate. Again, what happened with regard to the organic bodies which act on the photographic plates? I have already mentioned that in experimenting with the metals it was accidentally observed that copal varnish was an active substance producing a picture like that produced by zinc, and that the action was traced to the turpentine present; again, a process very much like groping in the dark had to be carried on in order to determine which were active and which inactive organic bodies, and the result obtained was that the active substances essentially belonged to the class of bodies known to chemists as terpenes. Now a most characteristic property of this class of bodies is that in presence of moisture and air they cause the formation of hydrogen peroxide, so that whether a metal or an organic body be used to produce a picture, it is in both cases a body capable, under the circumstances, of causing the formation of hydrogen peroxide. Passing now to experimental facts, which confirm this view of the action on sensitive plates, I may at once say that every result obtained by a metal or by an organic body can be exactly imitated by using the peroxide itself. It is a body now made in considerably quantity, and sold in solution in water. Even when in a very dilute condition it is extremely active. One part of the peroxide diluted with a million parts of water is capable of giving a picture. It can, of course, be used in the glass dishes like any other liquid, but it is often convenient not to have so much water present; and then it is best to take white blotting-paper, wet it in the solution of the peroxide, and let it dry in the air. The paper remains active for about twenty-four hours; or, what is still better, take ordinary plaster of Paris, wet it with the peroxide solution, and let it set "in a mould" so as to get a slab of it. This slab increases in activity for the first day or two after making, and retains its activity for a fortnight or more. Such a slab will give a good and dark picture in three or four seconds.

To show how similar the pictures produced by the peroxide and those by zinc are, pictures of a Japanese paper stencil, which had been paraffined to make it quite opaque, have been made by both processes, and are shown with other instances in which turpentine was used in the following slides. It is also very easy to obtain good pictures with the peroxide alone of the structure of paper, &c.; see, for instance, this one of a five-pound note and these of lace. Again, the strict similarity between the action of the peroxide and that of the metals and organic bodies is further shown by the fact that its action passes through the same media as theirs does; and here are good pictures formed by the action of the peroxide after passing through a sheet of these substances. How this singular transmission can be explained, I have treated of elsewhere, and time does not allow of my discussing the matter to-night.

There are many ways in which the bright, active zinc surface can be modified. Draw your finger across it, press your thumb upon it, and you stop its activity, as is shown by the picture it will give. Lay a printed paper on the zinc, and let the contact continue for three-quarters of an hour, at a temperature of 55°, then bring the zinc in contact with a sensitive plate, a picture of the printing is formed, but allow the contact between the zinc and printing to continue for eighteen hours at the same temperature, and the picture then given by the zinc is the reverse of the former one. Where the ink has been is now less active than the rest of the plate. Here are slides which show these positive and negative pictures. Another way of modifying the zinc surface is interesting. You have seen that the ordinary zinc surface which has been exposed to air and moisture is quite inactive, but if a bright piece of zinc be immersed in water for about twelve hours, the surface is acted on; oxide of zinc is formed, showing generally a curious pattern. Now, if the plate be dried, it will be found that this oxide is strongly active, and gives a good picture of the markings on the zinc. The oxide evidently holds, feebly combined or entangled in it, a considerable quantity of the hydrogen peroxide, and it requires long drying or heating to a high temperature to get rid of it. Also, if a zinc plate be attacked by the hydrogen peroxide, the attacked parts become more active than the bright metal. Thus, place a stencil on a piece of bright zinc, and expose the plate to the action of an active plaster of Paris slab, or to active blotting-paper for a short time, then, on removing the stencil, the zinc plate will give a very good picture of the stencil. Any inactive body—for instance, a piece of Bristol board or any ordinary soft paper—can be made active by exposing it above a solution of peroxide, or, more slowly, by exposing it to a bright zinc surface. If, for instance, a copper stencil be laid on a piece of Bristol board, and a slab of active plaster of Paris be placed on the stencil for a short time, the Bristol board will even, after it has been removed from the stencil for some time, give a good picture of the stencil. Drying oil and other organic bodies may be used in the same way to change the paper. A curious case of this occurred in printing a coloured advertisement cut out of a magazine, for there appeared printing in the picture which was not in the original. This printing was ultimately traced to an advertisement on the opposite page, which had been in contact with the one which was used; thus this ghostly effect was produced.

I believe, then, that it is this active body, hydrogen peroxide, which enables us to produce pictures on a photographic plate in the dark. There are many other curious and interesting effects which it can produce, and which I should like to have shown you, had time permitted.

I would only add that this investigation has been carried on in the Davy-Faraday laboratory of this institution.

WILLIAM J. RUSSELL.

THE ROYAL SOCIETY'S CONVERSAZIONE.

THE second of the two annual conversazioni of the Royal Society was held on Wednesday, June 21, and was attended by a large and brilliant company. Many of the objects of scientific interest exhibited in the various rooms of the Society were the same as were shown at the first (or gentlemen's) conversazione held on May 3, the most important of which were described in NATURE of May 11 (p. 44). In addition to the objects already referred to, the following were among the exhibits.

Mr. C. V. Boys, F.R.S., exhibited for Mr. R. W. Wood, of the University of Wisconsin:—(1) Silvered photographic grating. The grating of 2,000 lines to the inch is a contact print on albumen. It is then silvered and polished while wet. The brilliancy of the spectrum is very great. (2) Diffraction colour photograph (see p. 199). Mr. J. E. Petavel exhibited the molten platinum standard of light.

Mr. W. A. Shenstone, F.R.S., and Mr. W. T. Evans showed experiments on the making of tubes from rock crystal in the oxyhydrogen blowpipe flame.

The Parsons Marine Steam Turbine Co., Ltd., had on view: (1) model of the *Turbinia*, the first vessel propelled by steam turbine engines; (2) model of torpedo boat destroyer of 35 knots guaranteed speed and 10,000 I.H.P.; (3) model of Atlantic liner of 38,000 I.H.P. and 27 knots speed.

Mr. A. A. Campbell Swinton showed experiments with electrolytic contact breakers. Mr. J. W. Swan, F.R.S., exhibited experiments showing effects produced by the action of modifications of the Wehnelt-Caldwell interrupter. Mr. W. R. Pidgeon showed a new influence machine. Mr. Mackenzie Davidson exhibited an apparatus to enable Röntgen ray shadows upon a fluorescent screen to be seen in stereoscopic relief.

Prof. Ray Lankester, F.R.S., exhibited (1) collections of mosquitoes recently received at the Natural History Museum for study in reference to the connection of malaria with mosquitoes; (2) drawings of mosquitoes, by Mr. Ernest E. Austen.

Dr. Patrick Manson showed microscopic specimens showing the development of the parasite of malaria.

Dr. Allan Macfadyen, for the Jenner Institute of Preventive Medicine, exhibited cultures and microscopical specimens of certain pathogenic bacteria.

Dr. Gladstone, F.R.S., showed ancient metals from Egypt, Babylon, and Britain.

The Victoria and Albert Museum for the Seismological Committee of the British Association exhibited a Milne horizontal-pendulum seismograph, with specimen of the seismograms yielded by it.

Prof. Haddon, F.R.S., showed a small collection of polished stone implements from the Baram District, Sarawak, Borneo.

Prof. T. G. Bonney, F.R.S., exhibited diamonds in eclogite. Boulders of eclogite, &c., occur in the "Blue Ground" at the Newlands Diamond Mines, West Griqua Land. Two of these contain diamonds. Thus the diamond cannot have its genesis in the "Blue Ground," nor can the latter, containing true boulders, be an igneous rock.

Mr. Walter Gardiner, F.R.S., and Mr. A. W. Hill showed histological preparations of plant tissues demonstrating the "connecting threads" which traverse the cell walls and establish a means of communication between the several cells.

Dr. F. W. Oliver exhibited a collection of Cingalese Podostemaceæ. The specimens included the majority of the Cingalese representatives of this remarkable family of flowering plants.

THE RED SPOT ON JUPITER.

I HAVE frequently observed this object during the present apparition of the planet, but always found it exceedingly faint and only visible under good definition. Its aspect is that of a faint dusky stain attached to the northern side of the south temperate belt, and partially filling up the hollow formed in the great southern equatorial belt. With my 10-inch reflector—power 312—the following estimated times of transit were obtained, and I have added the corresponding longitude of the object:—

Date.	Transit time.	Long.
	h. m.	°
1898 November 29	19 55	31·9
1899 February 2	18 39	29·5
7	17 46	29·0
24	16 49	30·0
26	18 27	29·9
April 19	11 20	32·0
26	12 3	30·8
May 6	10 19	31·7
8	11 58	32·3
June 4	9 18	34·4
6	10 57	34·8
9	8 26	34·4
11	10 4	34·0
14	7 32	32·9
16	9 13	34·4
21	8 20	33·5
23	9 58	33·1
26	7 29	33·7

This feature has shown a remarkable variation of motion during the last twelve months. In the winter there was a very decided acceleration of speed, but during the past three months the motion has been again retarded. The acceleration was first noticed here on the morning of February 3, when the marking came to the central meridian seven or eight minutes before its computed time. In the first half of 1898, and again during the last few months, the rotation period of the spot was nearly 9h. 55m. 42s., but for several months in the past winter the rate corresponded very nearly with 9h. 55m. 40·6s., the period employed by Mr. Crommelin in System II. of his ephemerides (*Monthly Notices*, November 1898). But, unfortunately, the precise character of the recent irregularity of motion cannot be determined, Jupiter having been too near the sun for effective observation during several months (August to November 1898).