AMERICAN GOOSEBERRY MILDEW.

MR. E. S. Salmon, the mycologist to the South-Eastern Agricultural College at Wye, Kent, is the active leader of an agitation against a mildew affecting gooseberries known as *Sphaerotheca mors uvae*. The fungus in question is of American extraction, and somehow it was introduced into Ireland about the year 1900; it has since spread, has already effected much mischief, and will undoubtedly cause more.

In Sweden it has, we believe, been very destructive, and quite recently its presence has been detected in England. Curiously enough, its introduction into Britain has been associated with the yellow-flowering currant *Ribes aureum*. This is a Californian shrub that has long been cultivated for ornamental purposes in this country, and, up to this time, we have not heard of its being subject to the attacks of mildew.

It now appears that Continental growers of gooseberries make use of *Ribes aureum* as a "stock" whereon to graft the common gooseberry. Standard gooseberries are by no means in general cultivation in this country, and we are informed that the use of *Ribes aureum* is being discontinued owing to the circumstance that it produces objectionable suckers. We do not know what object cultivators had in using *Ribes aureum* as a stock, and indeed we were not aware that it was so used until recently, but from the circumstance already mentioned that the golden-flowered currant has long been cultivated here without detriment to neighbouring gooseberry bushes, we may acquit it of anything but indirect participation in the spread of the mildew.

Still, in whatever way the pest may have been introduced, we cannot but look upon it as a serious matter. The trade in ripe gooseberries is no doubt relatively of little importance, but the prices obtained in the market for "green gooseberries" early in the season are often very high, and the market-gardener who was deprived of this source of income would suffer seriously. In face of these facts it is recommended that the importation of all gooseberry bushes, especially of those "worked on" *Ribes aureum*, be prohibited, and that all bushes known to be affected should forthwith be destroyed by fire.

It is evident that such measures could never be efficiently carried out by individuals. If one grower in any district proved negligent, all the careful ones would suffer from his default. No system of Government inspection would be sufficient to keep out the intruder. Not the keenest mycologist in the world could guarantee that no fungus spores were introduced even if the importation of gooseberry bushes were prohibited. Not the most experienced microscopist could guarantee that all the fungus spores in a particular plantation were destroyed by the cremation of the affected bushes. The spread of the Phylloxera throughout the vine-growing countries, despite the most elaborate precautions, shows how ineffective those precautions were. At the same time they caused much inconvenience and loss to the traders and others—a loss which was all the more serious, as, except in the case of vines, it was wholly unnecessary.

It is to be hoped that if legislation on the lines proposed by Mr. Salmon be carried out it will be administered with due discretion, otherwise the remedy may prove more injurious to the interests of the cultivator than the mildew itself. In the meantime the Board of Agriculture has issued a circular giving a description of the fungus and of its mode of life, directing the attention of growers to the imminence of the danger, and recommending that every precaution be taken in the purchase of the bushes, especially those from Ireland and the Continent, that all affected shrubs be forthwith burnt, and that, as a measure of precaution, spraying with Bordeaux mixture be carried out during the winter in the case of plants in any way open to suspicion. The Board states that there is at present no law dealing with the eradication of the pests of fruit trees, and that it depends very largely on the action of the dealers and of the growers whether or not the further development of the pest can be prevented.

Since writing the foregoing remarks we notice in the *Times* of December 8 that Mr. Massee has, at the request of the Board of Agriculture, visited the neighbourhood of Evesham, where he was told that the disease had existed for thirty years, "and had not affected the fruit," so that there is absolutely "no necessity for panic." Panic and discretion are at opposite poles. If we might offer advice to the gooseberry growers it would be that they should practise watchfulness and act with discretion.

RECENT PROGRESS IN MAGNETO-OPTICS.[1]

Rotation of the Plane of Polarisation close to an Absorption Band.[2]

FARADAY'S rotation of the plane of polarisation is extremely small in all gases, also in sodium vapour. Only within a very narrow range close to the sodium lines the rotation is positive and very great, a fact discovered by Macaluso and Corbino.[3] In a recent extremely interesting paper Prof. Wood has given measurements of observed rotation of four complete revolutions.[4] This, however, was in rather dense vapour, at least dense in comparison with the vapour used in the experiments now to be described, in which vapour containing about one-millionth gram of sodium per $cm.^3$ was used.

The magnitude of the rotation close to the sodium lines is illustrated by measurements made by Dr. Hallo in the Amsterdam laboratory. It is clear that on both sides of an absorption line the rotation is in the same direction. We may attenuate the vapour still further so that the doublet in the direction of the lines of force becomes visible. What is the rotation, then, between the components of the doublet?

It is easily deduced from Prof. Voigt's theory that in very diluted vapours the rotation must occur, in a sense, opposite to that outside the components, and therefore negatively, and also that it must be very great. In the case of sodium vapour I had the pleasure to confirm this theoretical result, and to observe rotations of -400°.

In these experiments interference fringes in the spectrum were used, established by means of a system of Fresnel quartz wedges (a method used by Voigt, Corbino, and others in similar cases). I will project these fringes on the screen.

If a plate of quartz, which rotates the plane of polarisation, is held in the ray, you will notice a displacement of the fringes. A plate of glass has no influence, of course. I have here a quartz plate which rotates the plane of polarisation through 90°, and you will notice a displacement of half the distance between two fringes. A displacement of the entire distance between two fringes corresponds to a rotation of half a revolution.

Analysing the light by means of a Rowland grating, we can produce such a system of fringes for all wave-lengths, and can consider the rotation for wave-lengths close to the controlling absorption bands. On the screen I will first project the fringes close to the sodium lines with the field off. The dark vertical lines are the sodium lines. They are broad, because the vapour is rather dense. The horizontal bands are the interference fringes. With the magnetic field on, the image now projected is seen.

You see how fast the rotation increases in the vicinity of the absorption lines, becoming more than 180° closer to the bands. In the interior of the bands only a hazy fringe is seen. A remarkable equation, first deduced by Becquerel,[5] gives the law of the rotation. The phenomenon is more beautiful as soon as the vapour is so thin that the doublet is seen (Fig. 5).

Outside the components of the doublet the fringe rises *upwards*, but inside the components the fringe has moved *downwards*; the rotation is negative there. The rotation is -90° for D_1, nearly -180° for D_2. It is very interesting to watch the movement of the fringes in the spectroscope as the field is increased or the density of the vapour changed.

[1] Discourse delivered at the Royal Institution on Friday, March 30, by Prof. P. Zeeman. Continued from p. 140.

[2] Zeeman, Proc. Ac. Sciences, Amsterdam, May, 1902. Hallo, Thesis, Amsterdam, 1902, Archiv Néerl., ser. 2, T. 10, p. 148, 1905.

[3] Macaluso and Corbino, *Comptes rendus*, cxxvii., p. 548, 1898.

[4] Wood, *Phil. Mag.*, October, 1905.

[5] Becquerel, *C.R.*, cxxv., p. 679, 1897. *Cf.* also Schuster, "The Theory of Optics," pp. 291–294, 1904. Siertsema, Proc. Ak. Amsterdam, xii., p. 499, 1903.

Double Refraction and Resolution of the Absorption Lines.

In the second place, we will now consider the *double refraction* which occurs whenever light traverses a vapour at right angles to the magnetic field. A plane wave with vibrations parallel to the field has a velocity different from that of a wave with vibrations at right angles to the field. It is only close to the absorption band that the difference becomes perceptible. Sodium vapour in a magnetic field behaves as a double refracting crystal for light close to the sodium lines. This result of Voigt's theory was verified by him in conjunction with Wiechert in the case of dense vapours, and commented upon by Becquerel and Cotton.

With great density, and using the same system of interference bands, the phenomenon assumes the appearance now projected. Whereas the rotation of the plane of polarisation was symmetrical on both sides of the absorption band, you see that the double refraction is not. On one side of the absorption line sodium vapour behaves like a positive crystal, on the other side like a negative one. With very dilute sodium vapour, and with a magnetic field strong enough to resolve the sodium lines, the theory must be extended. There is no difficulty here. The observations made by Mr. Geest, as well as by myself, concerning the details of this double refraction, have fully confirmed Voigt's theory.[1]

The slides shown always refer to *one* of the yellow sodium lines, and hence the structure seen is almost entirely confined to the extremely small region between the components of one line. The line D_2 splits up into three components in a moderate field. The theoretical course of double refraction is given in a diagram; next to it the result of observations is given (Figs. 6 and 7). On a somewhat larger scale the appearance is as now shown; with greater density the characteristic sinuous line undergoes transformation. The line D_1 splits up into a quartet. Besides the concave parts, you will now notice a line with a point of inflexion in the theoretical and in the observed curves.

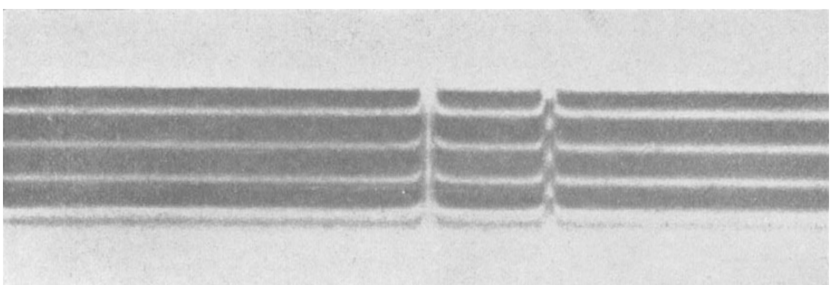

FIG. 5.

The same phenomenon is again illustrated by the next slide, where also the change which occurs with greater density is manifest. In a very strong field the line D_2 is resolved into a sextet. The inverse sextet can be readily seen with the means at our disposal, but the phenomena occurring between these narrow-spaced components could only be seen with difficulty. Only in very favourable circumstances Mr. Geest observed the image now projected.

All the described phenomena are qualitatively in excellent accordance with Voigt's theory. It is certainly very interesting that the theory is able to explain the complicated course of double refraction by the difference between the velocities of propagation of vibrations at right angles and parallel to the field.

Magnetic Resolution and Intensity of Field.

Let me again refer to our first subject, the magnetic separation of the lines. The magnitude of this separation is proportional to the intensity of the field in which the source is placed. We may, therefore, deduce the intensity of the field from the magnitude of the magnetic separation. We have only to measure the distance of the components of a suitable line. It is not generally known that

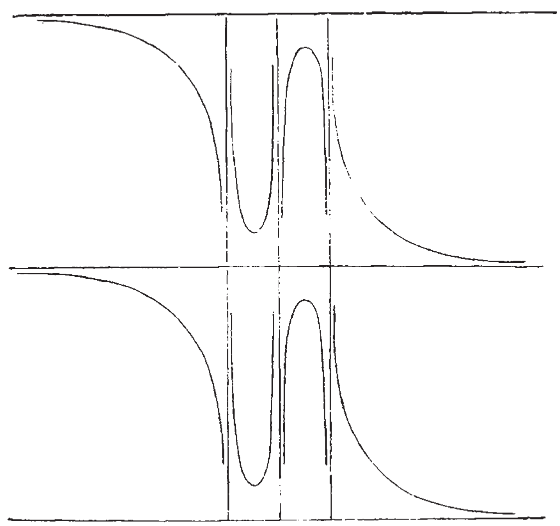

FIG. 6.

this distance can be measured with great accuracy (with an error of considerably less than 1 per cent.). It is, therefore, far easier, if a relatively high degree of accuracy is necessary, to compare the intensities of field by measurements of the distance between the components than by direct magnetic measurements.

All methods used for the measurement of magnetic fields give us the intensity in a point. On the other hand, the magnetic resolution of spectroscopic lines can give us the intensity *in all points belonging to a line.* Moreover, in this manner we make direct use of a property of the atom.

You see here a vacuum tube with some mercury. We heat the tube and excite it with the coil. You notice the brilliant light, which is, however, greatly increased when the tube is placed in a magnetic field.[1] For a given density of the vapour there is a definite intensity of field for which the luminosity is a maximum. You can see this when we put on the current in the electromagnet; the intensity of the field then rises gradually.

FIG. 7.

We project an image of the tube on the slit of a spectroscope. This spectroscope must be so arranged that to every point of the slit there corresponds a point of the image. The blue line of mercury (4359) resolves into a sextet. Using this line, the field of a du Bois electromagnet with a pole distance of 4 mm. is mapped out in the spindle-shaped optical magnetograms now shown (Fig. 8). We may, of course, extinguish the light of the inner components. In some cases a triplet will give more accurate results. The method sketched will, of course, only be applied in difficult cases. So long as our spectroscopes of great resolving power are rather cumbersome there is no practical application for the method. By means of this method we may also study some questions as to the way in which certain phenomena which accompany the resolution depend on intensity of field.

[1] Zeeman and Geest, Proc. Acad. of Sciences, Amsterdam, May, 1903, December, 1904. Geest, Thesis, Amsterdam, 1904, Archiv Néerl, sér. 2, T. 10, p. 291, 1905.

[1] Paschen, "Physik. Zeitschr.," I. S., 478, 1900.

We have no time, however, to discuss this further, because I should like to refer to the important subject of the

Behaviour of the Different Lines in the Magnetic Field.

In many metallic spectra a number of lines occur which are closely related, and form so-called series of lines. The important discoveries of Hartley, Liveing, and Dewar were followed by the discovery of series, owing to the indefatigable efforts of Balmer, Kayser and Runge, Rydberg and Schuster.

The plate shows diagrammatically the arrangement of the three connected series which are found in the spectra of the alkalies and other elements, and which are distinguished by Prof. Schuster[1] as the trunk series (Kayser and Runge's "Hauptserie"), the main branch series (Kayser and Runge's "Zweite Nebenserie"), and the side branch series (Kayser and Runge's "Erste Nebenserie").

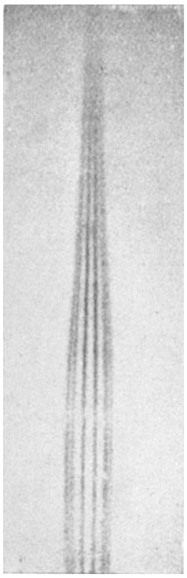

FIG. 8.

The laws of these series are simpler than those governing acoustical vibrations. They are of an entirely different character; for instance, the members of each series approach some definite limit of frequency, whereas the number of acoustical vibrations may increase indefinitely.

My first measurements already made it evident that lines of different series behaved entirely unlike each other.[2] Hence the ratio of charge to mass could not be the same for all vibrating electrons.

Runge and Paschen have proved in a most beautiful and systematic investigation[3] that all the lines of a trunk or of a branch behave in the same manner. This result was first announced by Thomas Preston,[4] but it is not stated to what degree of accuracy and for how many lines he investigated the subject.

All lines of the same series are split up in the same manner, *e.g.* all lines are resolved into triplets or all into nonets. Moreover, not only the general type of subdivision is the same, but even the amount of separation when measured in oscillation frequency.

The second law discovered by these physicists is this: That corresponding series of *different* elements show the same type of resolution, and the amount of separation is the same when measured on the frequency scale.

In the alkalies each line of the trunk series is double, and we may speak of a twin trunk. The yellow sodium lines are a typical example. The type of resolution of the two lines is shown in the diagram (Fig. 9). Here we have again our old sodium lines in the field. The same division occurs in all cases when twin trunks exist. Substances so different in chemical behaviour as sodium, copper, silver, and calcium (*e.g.* the well-known lines H and K), split up in the same manner; and I think that even Sir William Crookes will be surprised to hear that his thallium lines are in the magnetic field only counterfeit sodium lines. I can show you the splitting up of these beautiful thallium lines in the slide.

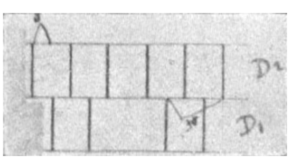

FIG. 9.

[1] Schuster, "The Theory of Optics," p. 282, 1904.
[2] "Zeeman, Verslagen Ak. v. Wetenschappen, Amsterdam, December, 1897. *Phil. Mag.*, February, 1898.
[3] Runge and Paschen, Berl. Akad. Abhandlungen, Anhang, 1902. Sitzberichte, Berlin, p. 380, p. 720, 1902. Runge, "Physik. Zeitschr.," 3. Jahrgang, S. 441. Kayser, Spektroscopie, Band 2, Kapitel ix., 1902.
[4] Preston, Dublin Trans. (2) 7, pp. 7–22, 1899.

With zinc, cadmium, mercury, and calcium, there are *three* main branches associated with each other. The amount of separation is the same in each of these branches. The type of resolution is shown in the diagram (Fig. 10). I can show you further lines of mercury, the triplet, the sextet, the nonet. Another example of the same sextet is given by a zinc line. The next slide refers to some beautiful magnesium lines exhibiting the same three types of resolution (Fig. 11).

We see that in these cases the simple image of an oscillating electron does not apply. I regret to say that the electronic theory cannot yet give us the explanation of the more complicated resolutions; even for the quartet we are yet in want of a model.

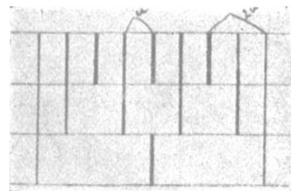

FIG. 10.

The laws discovered, however, seem to point to the conclusion that all the lines of a series are emitted by one oscillating system, that there are, therefore, as many series in the spectrum of a substance as oscillating systems in its atom; moreover, that the oscillating mechanism is the same in different elements. We are reminded here of the view advocated by Sir Norman Lockyer that the different elements have something in common. The relation between these spectral series and resolution in the magnetic field is so close that we may expect that the solution of the problem of the series will give at the same time the solution of the magnetic separation problem.

That Lorentz's theory is on the right track even in the case of the more complicated magnetic effects appears from the polarisation of the nonet shown in the slide. Three groups of vibrating lines here correspond to the three lines of the triplet. The circular polarisation corresponds also to that of the doublet, indicating that it is always the negative electron which executes the vibrations. There is yet room enough for experimental work in extending these investigations in different directions and to other elements.

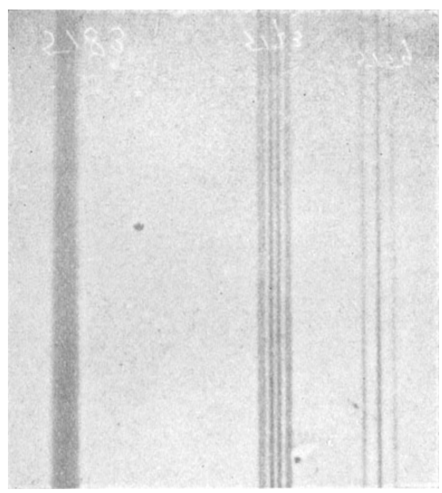

FIG. 11.

Much light on our present subject will be thrown undoubtedly by the activity in adjacent chapters of physics. I can only mention in this relation the extremely interesting experiments by Lenard and Stark on the centres of emission of different spectral series, and the important theoretical work by Drude[1] on the optical properties and electronic theory. Maxwell has said, "an intelligent student armed with the calculus and the spectroscope can

[1] Drude, *Annalen der Physik*, pp. 677, 936. Bd. 14, 1904.

hardly fail to discover some important fact about the interior structure of a molecule." I think this statement remains as true now as it was thirty-two years ago. There can be no doubt, I think, that spectrum analysis, and especially the magnetisation of the spectral lines, will give us a clue to the inner structure of the atom. I hope that I have succeeded in imparting to you this, my conviction.

THE ERUPTION OF VESUVIUS IN APRIL, 1906.

THE most complete published account of the eruption of Vesuvius in April last is due to the enlightened liberality of the French Government, which commissioned Prof. Lacroix to study and report upon the eruption, and it is gratifying to find that this, as all other detailed accounts by qualified scientific observers of the eruption of Vesuvius, confirms in every respect the description which we were able to disentangle from contemporary newspaper reports and publish in our issues of April 12 and 19. As a result of Prof. Lacroix's researches he has, in addition to more detailed memoirs published or to come, communicated to the *Revue générale des Sciences* of October 30 and November 15 an interesting account of the result of his observations and deductions, some of which are sufficiently interesting to deserve notice, in extension of what we have already published.

The earlier stage of the eruption was of the Strombolian type, that is to say, the material ejected from the crater was formed by the breaking up of molten lava; it was consequently red hot, and Prof. Mercalli, who was watching the eruption from Torre Annunziata, noticed that the mountain became covered, for from 200 metres to 300 metres from its summit, with a continuous sheet of glowing material, from which blocks incessantly rolled down to lower levels. At 0h. 31m. and again at 2h. 40m. a.m. on April 8 violent earthquakes were felt, corresponding to the most violent paroxysms of the eruption, accompanied by a lowering of the height of the cone and a change from the Strombolian to the Vulcanian type of eruption. From this time onward the ejected material was less and less composed of fresh lava, and less and less incandescent, being composed, in increasing degree, of the old solidified lavas and tuffs of the cone.

For several days after April 8 the summit was hidden by a thick cloud of ashes, and when this cleared away the mountain was found to have changed its form, from a pointed to a truncated cone, like that left after the eruption of 1822, though not so low or with so large a crater. When it became possible to ascend the cone it was found that the new crater was a true caldera, almost circular, of 640 metres to 650 metres in diameter, surrounded by walls almost vertical, except at the top, where a steep talus reached up to the crest, and at the bottom, where a funnel-shaped talus sloped down into a cloud of vapour escaping from the fumeroles. The rim was irregular in height and generally sharp-crested, but cut by a deep gap on the north-east, where, for some 80 metres, the crest was not only lower, but comparatively flat-topped; this gap faces the crest of Somma in the direction of Ottajano, where scoriæ and ashes fell in quantity sufficient to crush in the roofs of houses, while the observatory, less than half as far from the crater in the opposite direction, received but a very small quantity of these same ejections. Prof. Lacroix rejects the explanation that this difference was solely due to wind, and considers that he has established a case of oblique eruption, the average direction of projection being, not vertical, but inclined at a considerable angle towards the north-east.

The greater part of the material blown out from the crater fell on the slopes of the cone, which was covered many yards deep with a loose deposit of fine dust, ashes, and blocks of all sizes. Even before the eruption ceased the surface of this deposit began to be broken by dry avalanches, which crashed down on every side, leaving the cone deeply scored by a series of radiating valleys, separated by steep-sided, sharp-crested ridges. Later on, rain-water sinking into and saturating these loose deposits set them in motion as the well-known mud lavas, the mode of flow of which resembles closely that of the molten lava, and still later the rain-water, flowing off the surface, formed torrents of more liquid mud, which cut through the earlier accumulations of the dry avalanches and mud lavas.

The eruption was accompanied by a change in level of the land, but this was confined to the immediate neighbourhood of the volcano, for the tide-gauge shows that there was no alteration in the relative level of land and sea at Naples, while Prof. Mercalli found an elevation of from 30 cm. to 48 cm. between Portici and Vico Equense. Of mineralogical interest is the new mineral, of which the first published description appeared in NATURE of May 31, and the discovery of galena as an addition to the list of Vesuvian minerals.

RUSSIAN OBSERVATIONS OF THE SOLAR ECLIPSE, AUGUST 30, 1905.

CONSIDERING the unfavourable weather conditions experienced by many of the eclipse parties last year, the members of the Russian expedition, in charge of M. A. Hansky, are to be congratulated on the results they obtained, which have been recently circulated as a publication of the Pulkowa Observatory. The observers were stationed at Alcocebre, on the Mediterranean coast near Valencia. The central line of totality passed almost exactly through the station, and various local conveniences combined to render the choice of site favourable to efficient observation. On August 15 all the instruments were received in good condition, and after observations had been made for determining the azimuth of the sun's rising point, the various pillars and stands for the apparatus were erected.

Photographs of the corona were taken on two scales:—small pictures with the Bredikhine double photographic telescope, furnished with a Zeiss objective of 170 mm. aperture and 800 mm. focal length, giving a field of 12°·4 in R.A. and 8°·8 in declination; large pictures, for the delineation of fine detail in the coronal streamers, with an objective of 5 inches aperture and 13·28 m. focal length, the light being supplied from a cœlostat 30 cm. in diameter. Spectroscopic observations of the corona and prominences were made with a direct-vision spectroscope without slit, and the polariscopic phenomena examined by the aid of a Savart polariscope. Measurements of the solar radiation were taken with an actinometer and actinograph of Crova's pattern.

Near the time of eclipse the sky became clouded over, but about a minute before totality the sun was seen in clear sky. The corona was seen five or six seconds before totality, and the last ray of sunlight was visible for some two seconds, probably through a deep valley in the moon's limb. This feature is also shown very clearly in the photograph of the chromosphere accompanying the report, which is divided up into a series of bead-like masses at that particular place. Visually the corona was seen of a brilliant, silver-white colour, its brightness increasing rapidly towards the moon's limb. The longest rays seen extended about one and a half lunar diameters, and were situated near the poles of the sun, one at the north and two very fine ones at the south pole. The sky had a green colour, similar to that often seen about half an hour before sunrise. Careful examination of the spectrum of the corona during one of the forty-seconds' exposures showed that the continuous spectrum was especially strong in the green, yellow, and red, the latter region being so brilliant that it suggested the possibility of photographing the corona in ordinary daylight by means of suitably prepared colour screens.

With the polariscope the coronal light was seen to be strongly polarised, and the conditions were such that the dark bands were not visible on the sky surrounding the corona. The bands were much stronger when tangential to the sun's limb than when radial. There appeared to be a rotation of about $2\frac{1}{2}°$ of the plane of polarisation, which may possibly be ascribed to the action of a magnetic field round the sun.

Eight photographs of the corona were obtained with the long-focus telescope, the exposures varying from 40–45