

At 18h. Greenwich M.T.

	R.A. h. m.	N.P.D. °	Log. distance from Earth. Sun.
Nov. 2 ...	9 52'7	110 23	0'1700 ... 0'1509
6 ...	9 45'8	111 47	0'1716 ... 0'1749
10 ...	9 38'3	113 9	0'1728 ... 0'1970
14 ...	9 30'1	114 27	0'1739 ... 0'2176
18 ...	9 21'1	115 40	0'1751 ... 0'2368
22 ...	9 11'3	116 47	0'1766 ... 0'2549

At the time we write a sufficient number of observations before perihelion passage to allow of a reliable determination of the orbit prior to the close approach to the sun, is not available.

By the way it strikes us it is about time that M. Crul's name was disassociated from this comet; if personal names are to be attached to naked-eye comets, a practice which to say the least, is inconvenient, Mr. Finlay, so far as is known at present, has the prior claim. The system generally adopted for some years, of assigning letters, *a, b, c,* &c., to comets discovered in a particular year, until their order of perihelion passage is definitely known, was, we think, an advantageous one, and its discontinuance in some quarters is a retrograde step.

COMET 1882 *c* (Barnard, September 10).—From the first observation at Harvard College on September 14, and observations by Prof. Millosevich, at the Collegio Romano in Rome, on September 22 and October 7, Mr. Hind has calculated the following elements of this comet:—

Perihelion passage 1882, November 13'0067 G.M.T.

Longitude of perihelion	354 47'6
„ ascending node	249 8'9
Inclination	83 43'1
Logarithm of perihelion distance ...	9'97998

Motion—retrograde.

From these elements it appears that the comet will be observable in the southern hemisphere for some weeks after it descends below the horizon in Europe. At perihelion passage on November 13, its right ascension will be about 199°'4, with 66½° south declination, which places it near η in the constellation Musca; on December 10 it will be situate between the stars γ and η in Ara, with 58° declination, and an intensity of light one-third greater than at the first Harvard observation, and on January 9 its place will be near ϵ Telescopii, with one-half the intensity of light of September 14.

PONS' COMET OF 1812.—MM. Schulhof and Bossert have published a continuation of their extensive ephemerides to facilitate the search for this comet from October 28 to February 4, and for equal intervals of true anomaly from -97° 30' to +82° 30'. By their new and complete discussion of the observations, including a series by Blanpain at Marseilles, which they discovered in the original, and which they consider the best of all, the most probable elements in 1812 were found to be as follows:—

Perihelion passage, 1812, September 15'33210 Paris M.T.

Longitude of perihelion	92 19 48'2	} Mean
„ ascending node	253 0 43'7	
Inclination	73 57 35'8	} 1812'0
Excentricity	0'9555842	
Logarithm of perihelion distance ...	9'8904903	

The corresponding period is 73'18 years, but the probable error of this period of revolution is $\pm 4\frac{1}{2}$ years. Notwithstanding this large amount of uncertainty, MM. Schulhof and Bossert have calculated the effect of the action of the planets Jupiter, Saturn, Uranus, and Neptune during the actual revolution, and find the most likely epoch of the next perihelion passage to be 1884, September 3'65, M.T. at Paris.

THE TRANSIT OF VENUS.—Mr. Marth, who has charge of the proposed station at Montague Road, Cape Colony, left for Cape Town in Messrs. Currie and Co.'s mail steamship *Conway Castle* on the 13th inst., and Mr. Talmage, of Mr. J. Gurney Barclay's observatory at Leyton, proceeded in the R. M. steamship *Nile* on the 17th for Barbados, with Lieut. Thomson, R.A., as his colleague. Mr. J. Plummer, in charge of Col. Tomline's observatory at Orwell Park, Ipswich, with Lieut. Neate, R.N., have also left for New York, on their way to Bermuda. All the British expeditions are therefore *en route*.

Brazil will furnish four stations, with similar instrumental equipment, including equatorials of 6 inches aperture. M.

Cruls proceeds to a point in the Straits of Magellan, and Baron de Joffé, of the Brazilian Navy, to St. Thomas. The other stations will be Pernambuco, and the Imperial Observatory at Rio Janeiro. M. Faye, who made a communication to the Paris Academy of Sciences on the 16th inst., in the name of the Emperor of Brazil, who takes a lively personal interest in his observatory, mentions that it is in contemplation to effect a chronometric connection of the station in the Straits of Magellan with Montevideo, an important undertaking, as viewed with reference to the telegraphic determination which the Board of Longitudes is about to execute across the American continent, from Montevideo or Buenos Ayres, to Santiago and Lima.

A SPECTROSCOPIC STUDY OF CHLOROPHYLL¹

THE study of chlorophyll has great fascination; it also has its difficulties. We did not propose adding to the many elaborate attempts to isolate and purify this body; but the beauty and definite character of the spectrum which it gives induced us to try whether some insight into its character and constitution could not be obtained from the study of the spectroscopic changes which it can be made to undergo; and as one of us has already shown that in the case of the cobalt salts, the spectro-scope enables us to follow many chemical changes, we thought that it might be possible to interpret the spectroscopic changes of chlorophyll, and so gain some knowledge of the properties and nature of this body.

The extraction of the green colouring matter from leaves was effected in most cases by breaking up the leaves in a mortar with a mixture of two parts of alcohol and one of ether. The colour of the liquid thus obtained is of a dark green, varying in shade according to the nature of the leaves used, and the solution always has the well-known red fluorescence. This liquid, when examined spectroscopically, gives what is known as the chlorophyll spectrum. According to Krauss, it consists of seven bands; the three at the most refrangible end of the spectrum are difficult, as Krauss says, to observe, and with our source of light, a gas-flame, we could see in an ordinary chlorophyll solution little or nothing of them; but under special circumstances, which will be described further on, the least refrangible of the three becomes very visible. We have confined our observations principally to the four least refrangible bands. Other solvents, such as chloroform, disulphide of carbon, benzene, &c., were used occasionally; they give a similar spectrum, but in most cases they do not dissolve the colouring matter so readily as alcohol and ether do. The ethereal solution appears always to give a clearer and more brilliant spectrum than the alcoholic solution. Fig. 1 shows the spectrum of the solution obtained as above described from the majority of the leaves we have examined.

Among common outdoor plants, the vine and the Virginian creeper may be cited as apparent exceptions, giving a different spectrum. (Fig. 2.) The second band in this case has moved towards the more refrangible end of the spectrum, the band from 589 to 573 has disappeared, and now there is a very marked band from 545 to 532. The cause of this change in the spectrum we shall explain further on.

Fig. 1 then, as far as it goes, represents the spectrum given by the alcohol and ether extract of most leaves. It is important at once to give a definite meaning to the term chlorophyll, and we would therefore state that we mean by it the body or bodies capable of giving this particular spectrum, and of course we found our conclusions on the assumption that a particular absorption-spectrum is a complete identification of a substance.

As is well known, the exact position of these bands alters with the solvent used; in all cases, when no mention is made to the contrary, a mixture of alcohol and ether is the solvent we have used. Apparently the statement that the higher the specific gravity of the solvent, the nearer are the bands to the red end of the spectrum, is not in all cases true, for we find that the chlorophyll bands are nearer to the red in carbon disulphide than in chloroform. All our observations have been made with a Dasaga's spectro-scope having a single heavy glass prism, and the position of the bands is given in millionths of a meter, reduced from the observations by graphical interpolation. Capt. Abney has also been kind enough to take photographs of the different spectra, and these agree with our eye observations. They also prove that there are no bands in the ultra-red.

The first point we would note with regard to chlorophyll is

¹ By W. I. Russell, Ph.D., F.R.S., and W. Lapraik, F.C.S.]

that, as far as our experiments go—and we have now tried a large number of different leaves—although there are apparent exceptions, this particular substance we call chlorophyll exists in all green leaves.

If thinner and thinner strata, or more and more dilute solutions of the same thickness be examined, the fainter bands are seen gradually to fade out, and what is of importance, the dominant band, the last to disappear, thins out to a band from 670 to 660.

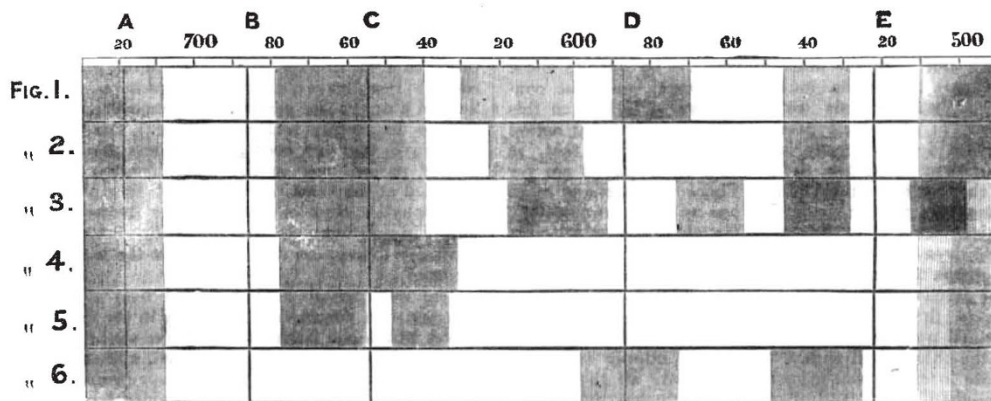
Passing over a large number of experiments on other points, we shall limit our present communication as far as possible to an account of the action of acids and alkalis on this so-called chlorophyll.

It is a body exceedingly sensitive to the action of acids. If for instance a mere trace of hydrochloric acid gas be introduced into the air of a test-tube containing a chlorophyll-solution, on shaking the tube, the 628 band will be found to have moved slightly towards the blue, and the next band to have become fainter. This action of the acid, specially with regard to the 628 band, is very remarkable; the addition of acid gradually causes this band to move bodily towards the blue, till it reaches 611—599. So constant and complete is this action, that the position of the band is an indication up to a certain amount of the quantity of acid present. On adding a little more hydrochloric acid gas to the air of the test-tube, and again shaking, this second band will be found to have moved from 615 to 596, the 589—573 band will have disappeared, and the other band at 545—532 will remain unmoved, but will have become much

darker. On still further increasing the amount of acid, the second band comes to 611—589, and now a new band appears from 573—558, and the band at 545—532 has also again increased in intensity. Further, the blue end of the spectrum has considerably opened. This spectrum, Fig. 3, is permanent, for on adding more acid, even a large amount of liquid acid, no further alteration takes place. The action of hydrochloric acid on chlorophyll appears then to be very definite, and is well shown by the two drawings, Figs. 2 and 3, which represent two well-marked stages; in the first the movement of the 628 band and the disappearance of the 589 band, the other two bands remaining unaltered in position; in the second (Fig. 3) the 628 band has moved to its furthest extent, and a new band has appeared at 573—558, the most and least refrangible of the four bands remaining still unaltered in position.

We have described in detail these spectra, for they have great interest and importance, owing to the fact that these changes do not arise from the formation of any chlorine-compound, but are produced by the action of the hydrochloric acid simply as an acid. Substitute any strong acid, sulphuric, nitric, &c., for the hydrochloric acid, and exactly the same changes will occur. Use a weak acid, an organic acid, such as tartaric, citric, oxalic, &c., and the action does not go beyond the first stage (Fig. 2). Carbonic acid is without action on the chlorophyll.

There is also another way in which the same changes may be brought about without the presence of acid, namely, by the application of heat. If, for instance, the solution of chlorophyll be evaporated to dryness on a water-bath at a temperature of 80°



or above, then on redissolution it will be found to have changed and to give no longer the original, but the second spectrum. Let the evaporation take place at ordinary temperatures in a current of air, or under the air-pump, then, on at once redissolving the residue, no change will have occurred; if, however, after the evaporation, the dry mass be kept for a short time, it will change even at ordinary temperatures. Further, if the alcoholic solution be diluted with water, and then boiled, the body giving spectrum No. 2 is formed; and the addition of certain salts, such as mercuric chloride, ferric chloride, &c., causes a similar change. Alum precipitates the colouring matter, and if the precipitate be collected, washed, and dried at ordinary temperatures, and again dissolved, it will give the second spectrum. On the other hand, basic acetate of lead precipitates the chlorophyll unchanged.

Acids, heat, metallic solutions, all action the chlorophyll, and all give rise to an identical spectrum, and therefore, we conclude, to the same body. Further, it is of interest to note the identity of these processes with those used to coagulate albumin, and consequently the probability that the change in both cases is of a similar character.

Since these changes are produced by processes and reagents which differ so materially, we are bound to conclude that the change is a molecular, not a chemical one. In these cases the least refrangible band does not alter, for if the solution be diluted, it always thins down to a band from 670 to 660; the other three bands, on the contrary, all change, the 628—607 moving towards the blue, the 589—573 band disappearing, and the 544—531 band becoming very much darker. In fact, although a shadowy indication of this last band is constantly visible in the normal solution, it is often so small in amount that

it should be regarded rather as an accidental impurity than as a necessary part of the normal spectrum. Again, the essential and characteristic distinction between the two spectra, Figs. 2 and 3, is the presence in the latter of the band at 573—558. This band, as far as we know, is produced solely by the presence of a strong acid in considerable excess, and all specimens of chlorophyll, either normal or not, yield it on the addition of hydrochloric, nitric, or sulphuric acid.

There is obviously a considerable resemblance between these three spectra, but at present, notwithstanding the beautiful work of Abney and Festing, we can hardly deduce from these indications alone the nature and relationship between these bodies; but from the processes used for obtaining them, there can, we think, be little or no doubt that they are simply molecular modifications of the original chlorophyll, and we propose at present to designate them as α - and β -chlorophyll.

With regard to the different purifying processes that have been used for obtaining chlorophyll from leaves, &c., in some cases the normal chlorophyll has been extracted; in others the leaves have first been dried at steam-heat, or the alcoholic solution has been boiled, and it is the α -chlorophyll that has been obtained. We have tried several of these processes, and, efficacious as they undoubtedly are in removing many, if not all, of the numerous bodies existing in more or less intimate connection with the chlorophyll, still they appear to produce really no change in the spectrum. With regard to general absorption, no doubt they do produce marked effects, specially at the blue end of the spectrum; this is well seen in the methods of purification recommended by Conrad. He obtained, as he believed, a separation of chlorophyll into a green and a yellow body by means of benzene. Observation shows, however, that the band-giving

body, the chlorophyll, remains quite unchanged by the benzene, but that certain bodies which absorb in the blue are insoluble in this menstruum: hence the change in colour.

Hydrochloric acid has apparently considerable power of destroying certain of these blue-absorbing bodies, for on adding this acid to an ordinary chlorophyll solution, blue rays come through, where before the addition it was quite dark. This fact has also this application: by means of it chlorophyll can be obtained more free from blue-absorbing matter than in any other way we are acquainted with. If to an alcoholic chlorophyll solution dilute hydrochloric acid be added, a precipitate is obtained, and if this be washed, dried, and dissolved in ether or in a mixture of alcohol and ether, it gives a solution which shows, not only the bands of the α -modification, but also a band at the blue end of the spectrum, which was before alluded to, quite dark and distinct from 513 to 499. In all probability this band is present in other cases, but is masked by general absorption.

The action of alkalis on chlorophyll is quite as marked and as characteristic as the action of acids. On adding either an alcoholic or an aqueous solution of potash or soda to a chlorophyll solution, two effects are produced: one is the fading out of all except the least refrangible, the dominant band, and the other is the spread of this band towards the blue, extending from 674 to 628. The action of alkali does not, however, stop here, for if a considerable excess be present, another, and an exceedingly interesting change sets in the dominant band now from 674 to 628 dividing into two distinct bands, one from 674 to 660, and the other from 646 to 632; then if sufficient alkali be present, the 674 to 628 band gradually becomes fainter and fainter, and ultimately the one from 674 to 628 alone remains. The same changes can be brought about with the α - and β -chlorophyll, but with far more difficulty. To change these varieties the potash or soda must be stronger, and the contact longer. With ammonia we believe we have broken this band up, but in almost all cases ammonia is without action on these modified chlorophylls, and it is quite clear that, as regards the action of alkalis, the α - and β -chlorophylls are far more stable than normal chlorophyll. There are other and more convenient methods for preparing this one-banded modification of chlorophyll. One is to evaporate an alcoholic solution of chlorophyll to dryness over a water-bath; then treat the residue with water, which washes out a soluble yellow substance, varying very much in amount with different samples of chlorophyll; and then evaporate the residue several times to dryness with a mixture of equal parts of ammonia and water. Another method is to act on the chlorophyll with a solution of copper sulphate; the precipitate formed is washed with water until all the copper is removed, then dried, and dissolved in alcohol and ether. It gives a spectrum identical with that obtained by the ammonia process, and like it the band is capable of being split up into two bands. In the filtrate from the above precipitate there is always much chlorophyll remaining, but this, curiously enough, has also been modified, and now gives only the one-band spectrum. When we first obtained this one-banded substance, the position of this band appeared so nearly to correspond with that of the dominant band in a strong solution, that we were inclined to believe that we had really separated the bodies giving the more refrangible bands, from those which give the less refrangible; but evidently this is not the case; neither does it now seem at all probable that such a separation would be possible.

We have used the term one-banded modification of the chlorophyll, and are aware of the possible ambiguity that this band can be split into two; but this change is really brought about only by the continued action of alkalis, for on simply diluting the solution down even to the vanishing point of the band, there is no indication of two bands being present.

The solution of this one-banded substance is still of a beautiful green colour, and is very remarkable for its stability; neither a trace nor an excess of acid of any kind produces any change in its spectrum, and it may even be dissolved in strong sulphuric acid and reprecipitated by water without alteration.

If the action of caustic potash or soda be pushed to an extreme, for instance if chlorophyll be heated with solid potash, then it is apparently completely decomposed, the dominant band disappearing, and two bands different in position from any of the former ones being produced; these are shown in Fig. 6.

To return now to the fact of different leaves giving different

spectra; for instance, when vine-leaves are treated with alcohol and ether, the liquid gives strongly the α -not the normal spectrum. As is well known, the juices of the vine-leaf are very acid; consequently during the extraction of the colouring-matter, the acid has time and opportunity for action, and hence the cause of what appears at first to be an anomaly. In the leaf itself the chlorophyll is in the normal condition, for if to the bruised leaf precipitated calcium carbonate or carbonate of soda be added, together with the alcohol and ether, the filtered liquid then gives, not the α - but the normal spectrum; and even without the addition of the calcium carbonate, on rapidly extracting the colouring-matter from the leaf and examining it immediately, the spectrum is normal. It is therefore evident that although both chlorophyll and acid are present in the leaf, they are not under such conditions that they can act on one another; but bring them into solution, and the change commences immediately.

Virginia creeper, *Bigonia*, and other leaves, act exactly like the vine. The acid in the *Bigonia* can be entirely removed by water, and if the colouring-matter be then extracted, it gives the normal spectrum.

The way we now generally adopt in extracting the chlorophyll from leaves is to add with the alcohol and ether precipitated calcium carbonate; then, whether the juice of the leaf be very acid or not, is a matter of indifference. We have already stated that in all the different leaves which we have examined, the chlorophyll has been found to be in the normal condition. This applies of course only to freshly-gathered leaves; the chlorophyll in gathered leaves gradually changes, and passes over to the α -modification, the time required for this change varying with the leaf and with external circumstances; whether the leaf be exposed to light, or kept in the dark, does not appear to affect the result. Pear leaves, after being gathered for three weeks and kept in a dry room, yielded both normal and α -chlorophyll; the change apparently had just begun. The chlorophyll in some vine leaves that had been gathered less than ten days had completely passed over to the α modification; but similar leaves, gathered at the same time and kept in water, gave only normal chlorophyll. Remembering how easily the solid normal chlorophyll passes over to the α -modification, it is evidently not necessary to suppose that the acid in the leaf is the cause of this change.

The chlorophyll having passed over to the α -modification, remains with wonderful pertinacity in the dead leaf. Dead pear leaves which had fallen from the tree seven months ago still gave a brilliant spectrum of α -chlorophyll, and even an alcoholic and ether extract of tobacco gives this spectrum.

The solutions of chlorophyll obtained by the direct treatment of leaves with alcohol and ether, contain a large number of substances, and the chlorophyll, as well as the other bodies, undergoes change on keeping. The length of time during which these solutions retain their green colour varies very much; expose them to light, and the rapidity of the change is enormously increased. If acid be present in the solution, the chlorophyll quickly passes over to the α -modification, and even if the extract has been made with calcium carbonate present, the same change occurs, only more slowly. These changes take place even in the dark. Besides this change of the chlorophyll, other and more complicated changes occur. Solutions from some leaves can be kept in the dark apparently without change for months, whereas others rapidly alter, and the chlorophyll disappears from them. The extract from rhubarb, for instance, very soon changes, the solution becoming of a tolerably bright red colour, and the chlorophyll bands disappearing. This red substance and the other products of decomposition from their solutions do not give visible spectra, and the same remark applies to at least the majority of the colouring matters in flowers. If these green solutions be exposed to light, they are, without exception, rapidly decomposed, and lose entirely their green colour, becoming either red, yellow, or of some intermediate shade. Brilliant sunshine in an hour or two will completely decompose all the chlorophyll in a dark green solution, not even a vestige of the dominant band remaining. If a solution of the α -chlorophyll, dissolved in alcohol and ether, be exposed to light, it is far more difficult of decomposition, and will withstand its action for a few days. That this stability is not due to the absence of certain substances in the solution of the α -modification, is shown by dissolving some of this modified chlorophyll in a normal and readily decomposable solution, when it will be found that, although there will be a change of colour

¹ Chautard, as long ago as 1836, mentions this; he naturally concludes that it is the original dominant band split up (*Compt. rend.*, lxxvi. 570).

owing to the decomposition taking place in such a solution, still the green colour from the modified chlorophyll will long remain. A single drop of hydrochloric acid added to the green extract, although it at once changes the bright green to a darker and browner green, enables the solution to resist this action of light to a much greater extent than it could have done if no acid had been added.

In the one-banded modification of chlorophyll we appear to have a body on which light has no action; solutions of this body have been, for the last three months, exposed continuously to all the light and sunshine we could get, and they are unchanged in colour and constitution; another proof of the really wonderful stability of this substance. Again, as a confirmation of the properties and formation of this form of chlorophyll, a single drop of sulphate of copper added to an ordinary chlorophyll extract renders the green colour of the solution permanent.

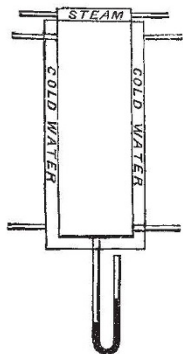
The very striking change of tint which occurs when a strong chlorophyll solution is very considerably diluted, whereupon it changes from a dark to a light yellowish-green, forcibly suggests to us the probability that the difference in shade of old leaves as compared with young ones, is due to the same cause, namely, the greater or smaller amount of chlorophyll in a given area.

ON A METHOD OF INVESTIGATING EXPERIMENTALLY THE ABSORPTION OF RADIANT HEAT BY GASES¹

THERE are grave objections, which have been only partially overcome, to almost all the processes hitherto employed for testing the diathermancy of vapours. These arise chiefly from condensation on some part of the apparatus. Thus when rock-salt is used, an absorbent surface-layer may be formed; and, when the pile is used without a plate of salt, the effect of radiant heat may be to cool it (the pile) by the evaporation of such a surface film. The use of intermittent radiation is liable to the same objection.

Some time ago it occurred to me that *this* part of the difficulty might be got rid of by dispensing with the pile, and measuring the amount of absorption by its continued effects on the volume and pressure of the gas or vapour itself.

Only preliminary trials have, as yet, been made. They were carried out for me by Prof. Mac-Gregor and Mr. Lindsay.



Their object was *first* to find whether the method would work well, *second* (when this was satisfactorily proved) to find the best form and dimensions for the apparatus.

The rough apparatus is merely a double cylinder, placed vertically. Cold water circulates in the jacket, and steam can be blown into the double top. The changes in the pressure of the gas are shown by a manometer U tube at the bottom, which contains a liquid which will not absorb the contents. This apparatus was 4 feet long, with 2 inches internal radius. The results of a number of experiments show that it should be shorter and much wider. The former idea I was not quite prepared for, the latter is obvious.

The effects on the manometer are due to five chief causes:—

1. Heating of the upper layer of gas by contact with lid.
2. Cooling " " " " sides.
3. Heating of more or less of the column by absorption.

¹ Letter from Prof. Tait, read by Sir W. Thomson at the Southampton meeting of the British Association.

4. Cooling of do. by radiation.

5. " " " " contact.

(1) and (2) only are present in a perfectly diathermanous gas, and in a perfectly adiathermanous gas or vapour.

All five are present in a partially diathermanous gas or vapour.

The preliminary experiments show that the manometer effect is only *very slightly less* for dry olefiant gas than for dry air, while moist air shows a markedly smaller effect than either of the others.

This is conclusive as to the absorption of low radiant heat by aqueous vapour, but it shows also that the absorption is so small as to take place throughout the whole column.

Even with the present rude apparatus I hope soon to get a very accurate determination of the absorbing power of aqueous vapour, by finding in what proportions olefiant gas must be mixed with air to form an absorbing medium equivalent to saturated air at different temperatures.

I have to acknowledge valuable hints from Prof. Stokes, who, before I told him the results I had obtained (thus knowing merely the *nature* of the experiments) made something much higher than a guess) though somewhat short of a prediction, of the truth.

In these preliminary trials no precaution was taken to exclude *dust*. The results, therefore, are still liable to a certain amount of doubt, as Mr. Aitken's beautiful experiments have shown.

The *point* of the method is that there can be no question of surface-layers.

[Since the above was written, Messrs. Mac-Gregor and Lindsay have made an extended series of experiments with dry and moist air, and with mixtures of dry air and olefiant gas in different proportions. The cylinder employed was 9 inches in radius. The results will soon be communicated to the Royal Society of Edinburgh.—P. G. T.]

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—In addition to the courses in Natural Science described in last week's NATURE, the following will be given during the present Michaelmas term:—Prof. Pritchard will give a course of six lectures on the Theory of the Transit Instrument, Equatorial, and Sextant, to be followed by six lectures on the Lunar Theory. There will be eight lectures on Instrumental Practice, and eight "Evenings with the Telescope," the latter being of a popular and untechnical character.

Prof. Lawson has announced the following courses of lectures for the ensuing year at the Botanical Gardens:—

Course I. Vegetable Histology; Michaelmas Term, 1882.

Course II. Special Morphology; Lent Term, 1883, and Trinity Term, 1883 (continued).

Course III. Descriptive Botany; every Saturday in Lent and Trinity Terms, 1882.

Prof. Prestwich gives a course on Theoretical Geology at the University Museum, and Prof. Westwood on Certain Groups of Anthropoda.

The Regius Professor of Medicine gives notice that an examination for certificates in Preventive Medicine and Public Health will be held this term, and secondly that Bachelors of Medicine may proceed to the degree of Doctor in any term, on due notice being given.

Natural Science Scholarships are offered this term at Palliol and at Christ Church.

The notice issued by Balliol College states there will be an election to a scholarship on the foundation of Miss Hannah Brackenbury, "for the encouragement of the study of Natural Science," worth 80*l.* a year (55*l.* and tuition free), tenable during residence for four years: open to all such candidates as shall not have exceeded eight terms from Matriculation. This examination will begin on Thursday, November 16, at ten o'clock. Papers will be set in the following subjects:—(1) Mechanical Philosophy and Physics; (2) Chemistry; (3) Biology. But candidates will not be expected to offer themselves in more than two of these. There will be a practical examination in one or more of the above subjects, if the examiners think it expedient. There will also be an optional paper in Mathematics; and the literary qualifications of the candidates will be tested by an English essay, or by a paper of general questions.

At Christ Church *at least* one scholar will be elected in Natural Science. Papers will be set in Biology, Chemistry, and Physics, but no candidate will be allowed to offer more than two of these subjects. An optional paper will be set in Elementary