Similar results are obtained for the other quarter lunations. In all cases that oscillation is the greatest of the two for which the sun is above the horizon, whether the moon be above it or not.

There are still some remarkable facts connected with this variation at the magnetic equator. Limiting our examination of them always to December and January, we find, if we determine the oscillations due to the moon for the day when she is in conjunction and for each of the six following days, that in the first three days of the seven the oscillation is *west-east-west* during the day, that is, from sunrise to sunset; and in the last three days it is *east-west-east*. In the middle day of the seven the lunar action is almost null; the oscillation of the needle is very small, as we might expect, since on that day the change at sunrise from a *west-east* to an *east-west* motion takes place. The lunar hours of the maximum and minimum extremes thus oscillate about two hours on each side of the mean, depending on the position of the moon at sunrise.

The action of the moon, then, is dependent on the sun's position relatively to the equator (or the earth's position in its orbit), and on the position of the moon relatively to sunrise and sunset. But there is no relation between the laws and amplitudes of the solar and lunar diurnal oscillations. In the months from which I have taken my illustrations, the solar diurnal variation is a single oscillation: that for the moon, however taken, for single days, for quarter or for whole lunations, is always double. Through the combination of all the varying modes in which this oscillation is produced from day to day, the mean for a lunation is a regular double oscillation. The amplitude of this mean oscillation is three times as great in January as in June or July; whereas the amplitude of the mean solar diurnal variation is a half greater in June or July than in January.

I shall add another fact, one of the greatest importance in connection with this subject. We have seen that the lunar diurnal variation changes in the relative amplitudes of the two oscillations from day to day; the consequence of this is that when the means for a whole lunation, or even a quarter lunation, are taken, the mean amplitude is much less than that which is shown by each day separately. Thus I have found that the range of the mean lunar diurnal oscillation for the lunation December 16, 1858, to January 15, 1859, at Trevandrum, was 1'25, while the ranges of the mean oscillations for the quarter lunations varied from 1'70 to 2'70, these quarter lunations giving exactly the same laws as have been deduced from eleven years observations for the same lunar epochs.

In order to understand the value of these results we must compare them with the ranges of the solar diurnal oscillations for the same months; those for December, 1858, and January, 1859, were 2'20 and 2'24 respectively. And as on some days the lunar diurnal variation has amounted to nearly 5'0 (which is equivalent to 12' in England with the smaller directive force), it appears that the lunar action is sometimes greater than the solar action at the magnetic equator.

As long as the lunar diurnal action was considered to be of the minute character first discovered, it was always possible for the supporters of the heat thesis to suspect that some small unknown heat action was in question. Such an idea is no longer possible. The lunar is sometimes greater than the solar diurnal action; and the former is dependent for its magnitude on the light and heat vibrations due to the sun shining on the place of the magnetic needle.¹

If the solar light and heat vibrations can increase the magnetic action, there can be no difficulty in believing

¹ Mr. Willoughby Smith's experiments show that the light vibrations of the ether in selenium diminish in a very marked manner the electrical resistance of the crystal; and it does not seem improbable that the increase of the lunar magnetic oscillation in sunlight may be due to some similar action.

that these vibrations may in their turn suffer some modification of intensity. It would be difficult to measure small variations of the sun's light with sufficient accuracy as yet, though Mr. Willoughby Smith has suggested a selenium photometer for this end; we can, however, measure the variations of temperature, and the fact that the direct heating action of the moon is inappreciable is no longer sufficient to disprove the results of Mädler, Kreil, Park Harrison, and Balfour Stewart. We have in fact a mode of lunar action with which M. Faye was unacquainted and could not take into account. The whole basis of his argument is therefore destroyed.

The view now given opens up a wide field of inquiry, and cosmic meteorology appears under another aspect. I hope to be able at another time to present other facts which seem to relate to magnetic and meteorological phenomena.

JOHN ALLAN BROWN

THE NUTRITION OF DROSERA ROTUNDFOLIA

DURING the summer of 1877 I began an experiment, the results of which were given in a paper read before the Linnean Society, January 17, 1878. A number of Drosera Plants were freely supplied with meat, while another set were kept without animal food. At the end of the season the two sets were compared in various ways with the object of deciding whether or not carnivorous plants profit by an animal diet. In the abstract of my paper published in NATURE (vol. xvii. p. 222), it may be seen how numerous were the advantages gained by the fed plants.

The further results of the experiment are not without interest.

The plants on which I worked were cultivated in six soup-plates, and after all the flower stems had been cut, the plants in three of the plates were removed from the moss in which they grew, and were counted and weighed. The plants in the other plates were left undisturbed with the object of comparing the new plants which should spring up from the winter buds of the two sets in the following year. They were removed to the hothouse in the course of the autumn, in order that they might rapidly send up the next year's leaves. By the middle of January, 1878, it became quite clear that far more leaves were springing up from the winter buds of the plants which had been fed than from the others. Both sets of plants were now kept without food, and on April 3 they were removed from the plates, and carefully counted, dried, and weighed. The following numbers give the result of the examination:—

	Actual numbers and weights.		Proportion between two first columns.	
	Not fed.	Fed.	Not fed.	Fed.
Number of plants ...	89	105	100	118.0
Total weight ...	grams. 206	grams. 518	100	251.6
Average weight per plant	.0023	.0049	100	213.0

It will be seen that there is only comparatively a small difference (18 per cent.) between the number of not-fed and fed plants. Numerous minute offsets were found among both sets, and were all counted as separate plants. But, judging either by the total or average weights, no doubt can be entertained of the great advantage gained by the fed plants. It is a striking fact that, in spite of the far larger yield of flower stalks, seeds, &c., produced during the previous summer by the fed plants, they were nevertheless enabled to lay by a far greater store of reserve-material than their not-fed competitors.

It is a curious coincidence that while I was at work on *Drosera*, an almost identical research was being conducted in Germany. The experiment of Drs. Kellermann and von Raumer were described before the Phys. Med. Society of Erlangen in July, 1877, and the final results were communicated by Rees, of Erlangen, to the *Botanische Zeitung*, April 5, 1878.

The research was evidently conducted with extreme care, and it is very satisfactory to me to find that my results agree (speaking generally) with those of Kellermann and von Raumer. The plants used in their experiments were fed on aphides, and do not seem to have thriven quite so heartily as mine did on a meat diet. This appears from the following figures:—

	Kellermann and von Raumer's results.	Mine.
Number of flower stems ...	100 : 152	100 : 165
Number of capsules ...	100 : 174	100 : 194
Weight of seeds ...	100 : 205	100 : 380

In testing the relative powers of the fed and not fed plants in laying by reserve-material in the winter buds, the Erlangen observers adopted a more accurate method than mine, namely, that of weighing the winter buds, instead of waiting until the new leaves had grown. They found that the weights of winter buds for the fed and not fed plants were as 173 : 100.

FRANCIS DARWIN

PHYSICAL SCIENCE FOR ARTISTS¹ V.

THE simple and forcible language employed by Prof. Stokes in the extract I gave in my last paper, should have made it quite clear that in nine cases out of ten, when bodies reflect light to us, they have really absorbed a part of it in the process, and that to this absorption of light bodies by their colours are chiefly to be ascribed.

Those bodies which give back to us light in the middle of the spectrum—light, in other words, containing green and yellow—are those which are most liable to change with different intensities of light. I shall endeavour, if I have space, to return to this point in the sequel, but I feel that my first duty, now that the phenomena of absorption have, I trust, been clearly explained, is to pass on to the application of this knowledge to the various colours of the sky.

Having, then, this idea of absorption, a very important consideration comes in: the absorption of a substance generally increases with its thickness, and when we deal with those substances that for a given thickness absorb either the red or the blue, we often find that when the thickness is considerably increased the absorption spreads over the whole spectrum from the blue or the red end respectively. This can be shown graphically as follows:—

¹ Continued from p. 126.

Here, then, we have an absorption beginning at the blue end and gradually closing everything except the red. I may remark *en passant* that we here have the physics of sunrise and sunset colours; similarly we might begin at the red end and then we should get

V I B C Y O R
V I B C Y O R
V I B C Y O R
V I B G Y O R, and so on.

These effects may be experimentally observed by either using different thicknesses of the absorbing materials or by putting them into a V-shaped vessel, and observing the change which takes place when the light passes through the greatest and least thicknesses of the absorbing material. It is of importance also for the artist to observe the effect of the residual light independently of the spectral phenomena. For instance: if we take a chlorine tube of such a length that it begins to cut off the

FIG. 1.—Showing phenomena of absorption produced by great and small thicknesses of the same substance in a wedge-shaped cell.

blue the residual light will be a delicate green; a tube twice the length will give us a colour in which the rich golden yellow predominates.

Although we have been compelled to leave out several steps in the argument, we are in a position now to approach the cause of the various colours of the sky.

Let us assume that our complex atmosphere—complex because it consists of a mixture of two pure gases and aqueous vapour—absorbs the light which passes through it, and that the absorptive effect depends upon the thickness of the atmosphere through which the light has to pass before it reaches the eye.

Now there are many grounds for supposing that the

FIG. 2.—Arrangement for observing the absorption of a great thickness of gas or liquid. L, lamp; N, tube; S, spectroscope; G, Bunsen burner when used.

general absorptive effect both of the pure gases and of