

from that of young persons; for in the former the diurnal fall occurs at any hour, and not, as is the case with young persons, during the hours of night.

Concerning the influence of food on the temperature of the body the authors have concluded that none of the diurnal variations is in any way caused by the food we eat.

The experiments to prove this conclusion are very numerous. Some were made with the breakfast, others with the dinner and tea; but all point to the conclusion just stated.

This important question is very fully discussed in the section devoted to it.

By cold baths both the surface of the body and the deep parts were lowered in temperature. The temperature of the surface was in some instances reduced to 88° Fahr.; but the heat so soon returned to all parts as to show that the cold bath is of very little use as a refrigerator of the body.

The cold bath produced no alteration in the time or amount of the diurnal variation. This began at the same hour, and reached the same amount as on those days when no bath was taken.

By hot-water or vapour baths the heat of the body could be raised very considerably. Thus, on some occasions, when using the general hot bath, the temperature under the tongue was noted to be between 103° and 104° Fahr., a fever temperature.

The body being heated considerably above the point at which combustion could maintain it, it was then shown with what rapidity heat may be lost, simply by radiation and evaporation. The particulars of these results are given in the paper.

The experiments tend to prove that hot baths in no way affect the diurnal variation of the temperature.

V. "Preliminary Note of Researches on Gaseous Spectra in relation to the Physical Constitution of the Sun." By EDWARD FRANKLAND, F.R.S., and J. NORMAN LOCKYER, F.R.A.S.
Received February 11, 1869.

1. For some time past we have been engaged in a careful examination of the spectra of several gases and vapours under varying conditions of pressure and temperature, with a view to throw light upon the discoveries recently made bearing upon the physical constitution of the sun.

Although the investigations are by no means yet completed, we consider it desirable to lay at once before the Royal Society several broad conclusions at which we have already arrived.

It will be recollected that one of us in a recent communication to the Royal Society pointed out the following facts:—

- i. That there is a continuous envelope round the sun, and that in the

spectrum of this envelope (which has been named for accuracy of description the "chromosphere") the hydrogen line in the green corresponding with Fraunhofer's line F takes the form of an arrowhead, and widens from the upper to the lower surface of the chromosphere.

ii. That ordinarily in a prominence the F line is nearly of the same thickness as the C line.

iii. That sometimes in a prominence the F line is exceedingly brilliant, and widens out so as to present a bulbous appearance above the chromosphere.

iv. That the F line in the chromosphere, and also the C line, extend on to the spectrum of the subjacent regions and re-reverse the Fraunhofer lines.

v. That there is a line near D visible in the spectrum of the chromosphere to which there is no corresponding Fraunhofer line.

vi. That there are many bright lines visible in the ordinary solar spectrum near the sun's edge.

vii. That a new line sometimes makes its appearance in the chromosphere.

2. It became obviously, then, of primary importance—

i. To study the hydrogen spectrum very carefully under varying conditions, with the view of detecting whether or not there existed a line in the orange, and

ii. To determine the cause to which the thickening of the F line is due.

We have altogether failed to detect any line in the hydrogen spectrum in the place indicated, *i. e.* near the line D; but we have not yet completed all the experiments we had proposed to ourselves.

With regard to the thickening of the F line, we may remark that, in the paper by MM. Plücker and Hittorf, to which reference was made in the communication before alluded to, the phenomena of the expansion of the spectral lines of hydrogen are fully stated, but the cause of the phenomena is left undetermined.

We have convinced ourselves that this widening out is due to pressure, and not appreciably, if at all, to temperature *per se*.

3. Having determined, then, that the phenomena presented by the F line were phenomena depending upon and indicating varying pressures, we were in a position to determine the atmospheric pressure operating in a prominence, in which the red and green lines are nearly of equal width, and in the chromosphere, through which the green line gradually expands as the sun is approached*.

With regard to the higher prominences, we have ample evidence that the gaseous medium of which they are composed exists in a condition of *excessive* tenuity, and that at the lower surface of the chromosphere itself the pressure is very far below the pressure of the earth's atmosphere.

* Will not this enable us ultimately to determine the temperature?

The bulbous appearance of the F line before referred to may be taken to indicate violent convective currents or local generations of heat, the condition of the chromosphere being doubtless one of the most intense action.

4. We will now return for one moment to the hydrogen spectrum. We have already stated that certain proposed experiments have not been carried out. We have postponed them in consequence of a further consideration of the fact that the bright line near D has apparently no representative among the Fraunhofer lines. This fact implies that, assuming the line to be a hydrogen line, the selective absorption of the chromosphere is insufficient to reverse the spectrum.

It is to be remembered that the stratum of incandescent gas which is pierced by the line of sight along the sun's limb, the radiation from which stratum gives us the spectrum of the chromosphere, is very great compared with the radial thickness of the chromosphere itself; it would amount to something under 200,000 miles close to the limb.

Although there is another possible explanation of the non-reversal of the D line, we reserve our remarks on the subject (with which the visibility of the prominences on the sun's disk is connected) until further experiments and observations have been made.

5. We believe that the determination of the above-mentioned facts leads us necessarily to several important modifications of the received theory of the physical constitution of our central luminary—the theory we owe to Kirchhoff, who based it upon his examination of the solar spectrum. According to this hypothesis, the photosphere itself is either solid or liquid, and it is surrounded by an atmosphere composed of gases and the vapours of the substances incandescent in the photosphere.

We find, however, instead of this compound atmosphere, one which gives us nearly, or at all events mainly the spectrum of hydrogen; (it is not, however, composed necessarily of hydrogen alone; and this point is engaging our special attention;) and the tenuity of this incandescent atmosphere is such that it is extremely improbable that any considerable atmosphere, such as the corona has been imagined to indicate, lies outside it,—a view strengthened by the fact that the chromosphere bright lines present no appearance of absorption, and that its physical conditions are not statical.

With regard to the photosphere itself, so far from being either a solid surface or a liquid ocean, that it is cloudy or gaseous or both follows both from our observations and experiments. The separate prior observations of both of us have shown:—

i. That a gaseous condition of the photosphere is quite consistent with its continuous spectrum. The possibility of this condition has also been suggested by Messrs. De La Rue, Stewart, and Loewy.

ii. That the spectrum of the photosphere contains bright lines when the

limb is observed, these bright lines indicating probably an outer shell of the photosphere of a gaseous nature.

iii. That a sun-spot is a region of greater absorption.

iv. That occasionally photospheric matter appears to be injected into the chromosphere.

May not these facts indicate that the absorption to which the reversal of the spectrum and the Fraunhofer lines are due takes place in the photosphere itself or extremely near to it, instead of in an extensive outer absorbing atmosphere? And is not this conclusion strengthened by the consideration that otherwise the newly discovered bright lines in the solar spectrum itself should be themselves reversed on Kirchhoff's theory? this, however, is not the case. We do not forget that the selective radiation of the chromosphere does not necessarily indicate the whole of its possible selective absorption; but our experiments lead us to believe that, were any considerable quantity of metallic vapours present, their bright spectra would not be entirely invisible in all strata of the chromosphere.

February 18, 1869.

Lieut.-General SABINE, President, in the Chair.

The Most Noble the Marquis of Salisbury and the Right Hon. Lord Houghton were admitted into the Society.

The following communications were read:—

- I. "On the Structure of Rubies, Sapphires, Diamonds, and some other Minerals." By H. C. SORBY, F.R.S., and P. J. BUTLER.
Received December 8, 1868.

[Plate VII.]

For many years Mr. Butler has had the opportunity of examining very many rubies, sapphires, and diamonds, and has taken advantage of it in forming a most interesting collection, cut and mounted as microscopical objects. He had very carefully studied the included fluid-cavities, and ascertained many curious facts. Mr. Sorby had for some time paid much attention to the microscopical structure of crystals, and published a paper* in which he showed that their microscopical characters often serve to throw much light on the origin of rocks. Mr. Butler therefore placed the whole of his collection in Mr. Sorby's hands for careful examination, and it was decided that a paper should be written by the two conjointly; and since Mr. Sorby had previously made many experiments in connexion with the expansion of liquids, as already described in a paper published in the *Philosophical Magazine*†, he took advantage of the opportunity to investi-

* Quarterly Journal of Geol. Soc., 1858, vol. xiv. p. 453.

† "On the Expansion of Water and Saline Solutions at High Temperatures," August 1859, vol. xviii. p. 81.