

cation of the work, a comparison may throw some light on the question of change of form and nature of the surroundings of the Sun during the interval between the observations. In this respect we may have the photographs taken in Chili to further extend this time interval.

The various members of the expeditions have enjoyed good health, and no one seems to have suffered injury from the excessive heat.

The Committee are under great obligations for much assistance given to the expeditions. The work of observation in Africa was made on French territory. The French Government did everything possible in granting a choice of sites, and M. Victor Allys, the French Administrator at Fundium, gave most valuable help.

The Admiralty have given us a gunboat to take the party up the Salum River and attend on them during the time this work lasted, and a cruiser brought the party from Bathurst to Grand Canary. The value of the help afforded by the Admiralty can be appreciated when it is known that without it this expedition could not have been sent.

From many other quarters most valuable aid has been received, and will be more fully acknowledged in the General Report.

II. "On the Bright Bands in the present Spectrum of Nova Aurigæ." By WILLIAM HUGGINS, D.C.L., LL.D., F.R.S., and Mrs. HUGGINS. Received May 29, 1893.

Some few prefatory words are called for in explanation of the partial incompleteness of the present communication.

A considerable brightening, from below the 14th magnitude to above the 10th magnitude, was found to have taken place in the Nova when it was re-observed in the early part of August, 1892, and to be accompanied by a modification of its spectrum, apparently analogous to a similar change in the spectrum of Nova Cygni in 1877, since the observations we made of the star on March 24, 1892, when it had fallen to nearly the 11th magnitude.*

In consequence, however, of the removal of the eye-end of the telescope to the workshops of Messrs. Troughton and Simms for the attachment to it of the mounting for a fine Rowland grating by Mr. Brashear, we were without the means of observing the star and its spectrum during the whole of the autumn and the early winter. It was not until the beginning of the year that the new spectroscope was mounted in our observatory, and then, from some instrumental causes of delay and from a prevalence of bad weather, we were

* 'Roy. Soc. Proc.,' vol. 51, p. 492.

not able to observe the spectrum of the Nova until the night of February 1.

Before this time the altered appearance of the spectrum of the Nova had been observed at several observatories, and its spectrum had been described as consisting mainly, in the visible region, of a bright line in the orange, of the two nebular lines, and of the hydrogen line at F.

As soon as we directed the spectroscope to the star, we saw at once, even with one prism, that the two principal bright bands which had been described as the "nebular lines" were, in strong contrast with these, not single lines but broad bright spaces, diffused at the ends and irregularly bright, which we suspected to be groups of bright lines.

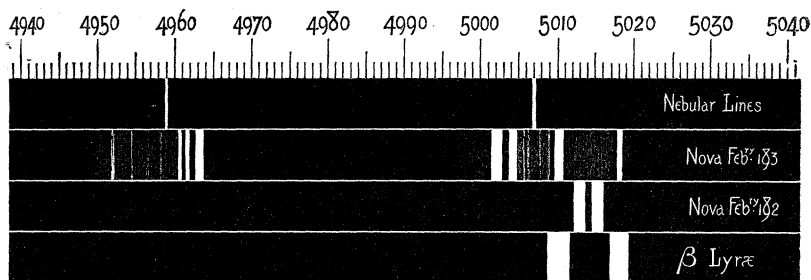
On February 8 we observed these bright spaces with the 4-inch grating of 14,438 lines to the inch, using the spectrum of the second order. The collimator and the telescope have each an aperture of 2 inches, and the spectrum was viewed under a magnifying power of 23 diameters. Our suspicion was then confirmed, the bands being clearly resolved into groups of bright lines upon a feebly luminous background.

On February 26, micrometric measures were begun of the positions of the constituent lines of the groups, when unfortunately we discovered that in consequence of flexure in one part of the instrument, a shifting of the micrometer webs relatively to the lines of the spectrum was liable to take place, and so make the measures uncertain to about as much as 2 tenth-metres when the spectrum of the second order was in use.

The cause of the want of rigidity of the instrument in this respect made it necessary that the spectroscope should go back to Messrs. Troughton and Simms' workshops; and then, from unavoidable delays and the coming in of the Easter holidays, it was not until the second week in April that the spectroscope was again in position for use; but by this time the Nova was too far past the meridian for satisfactory observations to be made upon its spectrum.

Our opportunities of working upon the spectrum of the star were thus absolutely restricted to the few fine nights between February 1 and February 26; and, further, our observations of the positions of the lines are, for the reason we have mentioned, affected with a possibility of error which may be as great as 2 tenth-metres, though it is probable that the positions given in the diagram are not actually in error to as much as half that amount.

For the same reason the resolution of the minor features of the groups has not been worked out with the completeness which was well within our instrumental means, if the number of fine nights had not been so limited, for on some of the nights on which observations



Rowland's Scale

Observed Feb'y 6^h-26^h 1895

were attempted the sky was not clear enough from thin haze for the resolution of the more difficult features of the spectrum of a star of between the 9th and 10th magnitude.

Still, notwithstanding the comparatively incomplete state of our observations, which we greatly regret, we do not hesitate to consider them of sufficient importance, bearing as they do upon so remarkable a phenomenon as would be the change of a star into a nebula, to justify us in communicating them to the Royal Society.

The spectroscope is provided with a 4-inch Rowland grating by Brashear, and a prism of dense flint of 27°, silvered on one face, which can take the place of the grating in the grating box.

As we have already stated, the observation of the Nova with this prism showed the bright "lines" broad and irregularly bright, and raised the suspicion in our minds that they were probably groups. They were observed more or less successfully with the grating, usually with an eye-piece magnifying 23 diameters, on February 8, 10, 11, 16, 17, and 26.

1. *Brighter Group near the Position of the Principal Nebular Line.*

The separate results of our more favourable observations of this group on the different nights are put together in the accompanying diagram. In addition, however, to the details drawn in the diagram, at several very favourable moments of seeing, we had distinct and undoubted glimpses of finer lines in the spaces between the brighter ones, of which some only are given in the diagram. For this reason the diagram must be regarded as an incomplete representation of the group, though showing accurately its main features and general character.

The group, as shown in the diagram, extends through a little more than 15 tenth-metres, and consists of lines more or less bright upon a feebly luminous background, which can be traced to some distance beyond the lines at both ends of the group. The more prominent features are: two lines, the brightest in the group and about equally bright—but the more refrangible one rather the

brighter—which form the termination of the group towards the blue; a line nearly as bright about the middle of the group; and a third prominent line at the end of the group towards the red.

We have little doubt, though we hesitate to state it positively, that the space between the two brightest lines, that on the blue side of the bright line in the middle of the group, and the spaces on the blue sides of some others of the lines, were darker than the faint luminous background, in which case we should have to do possibly with lines of absorption of the same substances shifted towards the blue. A few only of the finer bright lines which were occasionally glimpsed between the more brilliant lines have been put into the diagram.

The pair of bright lines at the termination of the group towards the blue makes this the brighter end of the group, which does not, however, as a whole possess any of the usual features of a fluting.

On February 10, the micrometer webs were placed so as just to include the bright lines of the group, but not the faint background which at the clearest moments could be traced for some distance, especially at the blue end of the group. The instrument remained untouched, and the position given in the diagram is that found from the places of the micrometer webs upon the solar spectrum, on Rowland's scale, as observed on the following morning.

On the 26th measures of this group were made relatively to the position of the principal line in the nebula of Orion; these gave also almost exactly the same position in the spectrum for the group, but, as we have already stated, all these measures are unfortunately liable to a small error from the possible flexure, at that time, of a part of the instrument.

The mean of Mr. Campbell's measures at the Lick Observatory, during the period of our observations, from February 10 to February 27, gives $\lambda 5006$ for the middle of the band. He remarks: "In any discussion of these observations it is necessary to take into account the difficulty of accurately locating the centre of a line so broad and diffuse as this one is."*

In another place Mr. Campbell says: "The line is at least 8 tenths-metres broad and the edges very diffuse."†

These observations would be brought into accordance with our own, so far as relates to the length and the position of the band, if we suppose Mr. Campbell to have observed only the more refrangible and much brighter half of the whole group.‡

* 'Astronomy and Astro-Physics,' May, 1893, pp. 418, 419.

† 'Publ. Ast. Soc. Pacific,' vol. 4, p. 246.

‡ Professor Campbell also says: "On August 30 the line was suspected to be double, and the grating measures of that night refer to a point midway between the two condensations. On September 7 the measures refer to a point of maximum brightness slightly less refrangible than the centre of the line."—'Astronomy and Astro-Physics,' Oct., 1892, p. 718.

The probable analogy between the Nova and the remarkable variable star β Lyræ, in the spectrum of which also we have to do apparently with bright and dark lines of the same substances, though not in all cases identical with those of the Nova, in motion relatively to each other, which we ventured to point out in our former communication on the Nova,* has been recently greatly strengthened by the photographic observations of β Lyræ at different stages of its periodic variations by Dr. Bépolsky at the Observatory of Pulkova.

In some of his photographs, especially in one taken shortly after the star's second maximum, bright lines come out near the positions of the bright groups of the Nova which are now under discussion. As the scale of Dr. Bépolsky's photographs is much smaller than that of our diagram, we felt some hesitation in attempting any identification of his lines with those of the Nova. At our request, Dr. Bépolsky has been so kind as to put into our diagram the two brightest of the lines of β Lyræ, as they appeared shortly after a second maximum, which fall within the brightest group of the Nova, and which, indeed, may be identical with two of the lines in the Nova. It may, however, be thought that the lines of β Lyræ suggest that they are independent bright lines rather than members of a group such as that of the Nova.

Whatever may ultimately be found to be the truth, there can be no question as to the probable high significance of the remarkable analogy which exists between the changes which take place in β Lyræ and those which have been observed in Nova Aurigæ.

The two other spectra in the diagram represent respectively the position and character of the two nebular lines, and the position of the bright double or multiple band which was so brilliant in this region of the Nova in the beginning of last year.

2. Bright Group near the Position of the Second Nebular Line.

Not anticipating that our opportunities of observing were to be so soon cut off, we gave our attention chiefly to the brighter group, intending, after we had completed our observations and measures of it, to attack seriously the second group.

However, on nearly all the nights we observed we gave some attention to this group, which, from being fainter, is more difficult to resolve, though on the clearer nights it was fairly well seen with the grating.

Generally, the group may be described as of the same order as the brighter one, consisting of bright lines and possibly of some absorption lines upon a feebly illuminated background.

* 'Roy. Soc. Proc.,' vol. 51, p. 494.

We have endeavoured to represent in the diagram as truthfully as we can the best views we obtained of this group; but during one or two exceptional moments of good seeing we thought that we glimpsed finer, bright lines in the spaces between. Indeed, the group may consist of a close grouping of bright lines.

For the same reasons, fewer measures were attempted of this group, and its position was less accurately determined, but neither the constitution of the group as represented in the diagram nor its position can, we think, be much in error.

We were also unable to work upon the bright line in the orange, and to do more than satisfy ourselves, by a direct comparison, that the line about F was really the hydrogen line in that region.

General Conclusions.

It need scarcely be said that no contrast could well be more striking than that which these extended groups of lines form with the two narrow and defined lines in the spectrum of the Great Nebula in Orion.

It is difficult to suppose that we have to do with the same substance or substances, whatever they may be, which produce the nebular lines, even if we imagine very different conditions of temperature, or even allotropic conditions.

In the laboratory, allotropic changes are not usually accompanied by new groups, or lines at the positions of the characteristic lines of the substances in their original state.

We wish to speak at present with great reserve, as our knowledge of the Nova is very incomplete, but we do not regard the circumstance that the two groups of lines above described fall near the positions of the two principal nebular lines as sufficient to show any connexion between the present physical state of the Nova and that of a nebula of the class which gives these lines.

Influenced by the analogy between some of the changes in the spectrum of the Nova and those which are associated in the spectrum of β Lyrae with the variation of its light, and also by other reasons which we pointed out in our former communication, we are still strongly inclined to take the same view which we there ventured to suggest, namely, that in the outburst of the Nova we have not to do mainly with cold matter raised suddenly to a high temperature by a collision of any form but rather, for the most part, as was suggested by Dr. Miller and myself in 1866 in the case of the first temporary star examined with the spectroscope, with an outburst of existing hot matter from the interior of the star or stars; indeed, with phenomena broadly similar to, but on an immensely grander scale than those with which we are familiar in the periodic greater and lesser disturbances of the Sun's surface.

Such grand eruptions may well be expected to take place as stars cool, and if in two or more dull and comparatively cool stars such a state of things were imminent, then the tidal action due to their near approach might be amply adequate to determine, as by a trigger action, such eruptions.

Under such conditions, fluctuations of brightness and subsequent partial renewals of the eruptive disturbances might well take place.

III. "The Process of Secretion in the Skin of the Common Eel."

By E. WAYMOUTH REID, Professor of Physiology in University College, Dundee. Communicated by Professor M. FOSTER, Sec. R.S. Received April 18, 1893.

(Abstract.)

Leydig, more than forty years ago, demonstrated the possibility of a secretory process in the skins of Fish by the discovery in the epidermis of some twelve genera, of specialised cells to which the name of "schleimzellen" was given. Since then Kölliker, Max Schultze, F. E. Schulze, Foettinger, List, Leydig himself, and others have extended our knowledge of the anatomical secreting elements of the epidermis, and shown that in many instances it is extremely probable that several varieties of such structures exist. Of the several forms of glandular elements, the goblet cell is the most widely spread, and its epidermic origin and development has been most carefully investigated by F. E. Schulze and List. Considerable difference of opinion has, however, arisen regarding the function of another form of specialised epidermic cell, viz., the club cell ("kolben" of Max Schultze), which was originally described by Kölliker for *Myxine* and *Petromyzon*, though F. E. Schulze found that such cells also occurred in *Tinca*, *Leuciscus*, *Cobitis*, *Esox*, *Silurus*, and *Anguilla*, and Fritsch in *Malapterurus*. Kölliker himself, in *Myxine*, recognised the relationship of these cells to the thread cells of the mucous sacs, first clearly described by Johannes Müller. Max Schultze, however, deemed them to be of the nature of nervous end organs, possibly contractile, on account of certain appearances in polarised light recalling those of striated muscle fibre. H. Müller, F. E. Schulze, Foettinger, Leydig, and Fritsch, finding that these club cells are not constantly found in contact with the corium, as Max Schultze thought, have all inclined towards considering a secretory function probable for these structures, but have given no very definite information as to its details. Quite recently Pogojeff has again upheld Max Schultze's nerve end organ theory in the case of *Petromyzon*.

