

because they form, substantially, complete photographs of the red end of the solar spectrum such as have not hitherto been produced.

This paper is illustrated by a very faithful drawing by Mr. Wesley of the A group of lines, taken from the photographs. The photographs themselves have been placed in the Library.

1888, *December* 13.

Note on Observations of Nebulæ Spectra at Hurstside Observatory.
By Albert Taylor.

The observations of nebulæ spectra recorded in this paper have been made at Sir Henry Thompson's Observatory (recently erected at Hurstside, West Molesey, Surrey) with a 12-inch refractor by Cooke, and a new star spectroscope by Hilger, specially adapted for observations of spectra of faint stars and nebulæ. The dispersive apparatus consists of a train of one 60° prism and two half-prisms, the half-prisms being attached to the lenses of the collimator and observing-telescope of the spectroscope. The micrometer is constructed so that one turn of the screw moves the cross-wires $\frac{1}{100}$ th of an inch, and the drum being divided into 100 parts, readings can be made with accuracy to $\frac{1}{10000}$ th of an inch, and by estimation to a smaller fraction than that.

The cross-wires of the micrometer can be illuminated at will by means of a small electric lamp. The eyepiece usually used for measurements has a power of 15, but a power of 10 was used for the nebula in *Lyra*.

The nebulæ examined were the Great Nebulæ in *Orion* and *Andromeda* and the Ring Nebula in *Lyra*.

The Great Nebula in Orion.

The spectrum of this nebula has been observed on every possible occasion during the last four months of 1888, and the results, while fully confirming Dr. Copeland's 'Observations' at Dun Echt, communicated to the Society in June 1888, also add several other lines which have not previously been recorded.

Previous to Dr. Copeland's observations, the visible spectrum of the Great Nebula was usually given as consisting of four bright lines and a faint continuous spectrum, the wave-lengths of the lines being given as 500, 495, 486, and 434. To these Dr. Copeland added 5874 (D_3), the position of which he had obtained from no less than 33 measurements, and a brightening at 447·6, seen only on one occasion. He found the continuous spectrum extending from 568 to 459·5, and showing "some indications of resolvability into lines or bands."

In September 1888, although the nebula was badly placed for observation, and daybreak interfered, measurements were made at

Hurstmide Observatory of four bright lines in the green and blue, the positions being found to agree with those usually assigned. The continuous spectrum was easily seen on widening the slit. On October 13 the sky was exceptionally clear, and the spectrum of the nebula showed six bright lines, five of which had been previously seen by Dr. Copeland, viz. 500, 495, 486, 434, and D_3 (5873), the new line being at 470. The line 5873 was visible with a rather wide slit, and its position was fixed by micrometer readings and by comparison with the sodium (D) lines.

The 470 line was exceedingly faint, and measures were very difficult. The continuous spectrum extended from 460 to 570, and although there were evident irregularities in its intensity no positions of maximum brightness could be fixed. Later observations confirmed this appearance, and on October 27 a decided maximum was noted in the green above the 500 line. This was seen several times afterwards, but not until November 26 could its position be fixed as 520. November 26 and 27 were magnificently clear, especially the latter date, when all the bright lines previously observed were again measured, and in addition a line at 4470, and a maximum brightness of the continuous spectrum near the red end, the position of which was found to be 5592.

The bright lines observed in the nebula in *Orion* were therefore nine in number, their wave-lengths being 5872.6, 5592, 5200, 5001, 4953, 4863, 4703, 4470, 4340.5.

Since the end of November all the lines except 4470 and 5592 have been re-observed, but, considering the exceptional circumstances of November 27, it is not at all surprising that the excessively faint lines have not been visible since that date.

The 5001 line is by far the brightest in the spectrum, and is quite unlike any of the other lines in appearance. It is never seen sharp, but with the narrowest slit always has a fluffy appearance, this being much more marked on the blue than on the red edge. This was most carefully examined for evidence of structure, but the line was always found to be single, and no decided evidence of fluting structure could be made out. It may be that greater dispersion will show structure, but with the dispersion used here no structure could be seen. The F line was a little brighter than the 4953, and these two lines and the fainter hydrogen G (434) were always sharp and comparatively easy to measure. The 5872 is faint, but, being beyond the continuous spectrum, it is not so difficult to see as the 520. A rather wide slit is necessary to see these, but I have frequently seen them both with the slit sufficiently narrow to clearly separate the 5001 and 4953. Of the other lines 4706 has been most frequently seen, but the continuous spectrum and the faintness of the line render the measurements of position difficult. The 4470 and the 5592 were very faint indeed, and have not been seen since November 27, but then their positions were ascertained from four measurements of each.

When the 520 and 5592 were first measured it was thought that they and the 4706 were due to carbon in the nebula. Comparisons were made with the carbon flutings from a spirit-lamp and from a Bunsen's burner. The brightest carbon (517) does not agree with the 520 of the nebula, and the measurements of 520 are so decisive that it is impossible to believe that that brightness is due to the 517 carbon. A more probable explanation of the origin of the 5200 line or brightening is that it is due to magnesium, the 5001 and the 4706 being also due to that metal. It is interesting to note that the 470 line has been observed by Dr. Copeland in a planetary nebula which also contained 500, 495, and F (*Copernicus*, vol. i. p. 2). The 520 has been observed in comet *d* 1880 by Christie, and in comet *c* 1881 by Hasselberg, this line thus furnishing another spectroscopic connection between the comets and nebulæ. The D_3 line has not yet been definitely assigned to any substance, but it and the 559 may be due to manganese radiation; comparisons were tried, using manganese chloride heated in a Bunsen's burner, but, owing to the wide slit and the faintness of the lines in the nebula spectrum, no decisive results could be obtained. The 4863 and 4340 lines are undoubtedly the hydrogen F and G lines. C was searched for with the spectroscope specially adjusted for that line, but no trace of it could be found.

The results of the measurements on those dates when more measures than one were obtained are given in the wave-length table, the figures in brackets indicating the number of measurements made on each occasion. The numbers over the separate columns indicate the relative brightness of the lines; although 8 and 9 are so faint that it is almost impossible to say which is seen with least difficulty.

Table of Measurements of Lines in the Great Nebula in Orion.

Date. 1888.	5	9	6	1	3	2	7	8	4
Sept. 9	...	...	...	5002 (3)	4951 (3)	4863 (3)	...	...	4340 (1)
Oct. 13	5873 (6)	...	...	5000 (8)	4953 (8)	4863 (8)	4695 (3)	...	4240 (7)
Nov. 26	seen (0)	...	5200 (4)	5001 (4)	4954 (4)	4863 (4)	4703 (3)	...	4340 (4)
27	5872 (4)	5592 (4)	5200 (4)	5001 (4)	4952 (4)	4863 (4)	4706 (4)	4470 (4)	4342 (4)
Mean Values	5872.6	5592	5200	5001	4953	4863	4703	4470	4340.5

The continuous spectrum ends between 4703 and 4470 in the blue, and at about 570 in the citron.

The Great Nebula in Andromeda.

The spectrum of this nebula is usually recorded as perfectly continuous, but on October 5 and 9 I noticed in it a decided maximum in the green. Subsequent observations did not confirm this until November 30, when two maxima were visible, and five measures of their positions gave them as 5175 and 548; three measures on December 1 gave 5180 and 5467, and one on December 7 and 9 and two on the 12th gave 5170 and 547 as

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the positions. The means, therefore, of the twelve measurements of each maximum show positions of 517.4 and 547.3. No other maximum has been measured, but on one occasion another was suspected down in the blue, although its position could not be fixed.

The Ring Nebula in Lyra.

This nebula has a monochromatic spectrum, and eight measurements at different times give a mean of 5002 as the position of the line. One other line has been suspected but not definitely measured.

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*Spectroscopic Results for the Motions of Stars in the Line of Sight,
obtained at the Royal Observatory, Greenwich, in the year 1888.
No. XII.*

(Communicated by the Astronomer Royal.)

The results here given are in continuation of those printed in the *Monthly Notices*, vol. xxxvi. p. 318, vol. xxxvii. p. 32, vol. xxxviii. p. 493, vol. xli. p. 109, vol. xlii. p. 230, vol. xliii. p. 81, vol. xliv. p. 89, vol. xlv. p. 330, vol. xlvi. p. 126, vol. xlvii. p. 101, and vol. xlviii. p. 116. The observations were made with the 'half-prism' spectroscope, one 'half-prism,' with a dispersion of about $18\frac{1}{2}^\circ$ from A to H, being used throughout. A magnifying power of 14 was employed.

The cylindrical lens has always been used in front of the slit as in the observations made previously to 1881 and since 1882, March 14. The observations of the Sun, Moon, and planets have been made as a check on the general accuracy of the results.

The day specified in the first column is the civil day, and the hour is that of Greenwich civil time, commencing at Greenwich mean midnight, and reckoning from 0 to 24 hours.

The observations were made by Mr. Maunder throughout.

*Motions of Stars in the Line of Sight in Miles per Second, observed with the
Half-prism Spectroscope.*

(+ denotes Recession; —, Approach).

Date. 1888.	No of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Meas. Estimd.	Remarks.
<i>γ Cassiopeiæ.</i>					
Dec. 13 20 ^h	2	F	+ 8.0	+ 7.1 + 10.2	Spectrum faint and very tremulous.
<i>Algol.</i>					
Feb. 1 20	2	F	+ 17.1	— 49.8 — 52.0	Spectrum faint but steady,
Dec. 7 20	2	F	+ 6.4	— 101.8 — 120.0	Spectrum rather faint and tremulous; definition poor.