

IX. "Results of Examination of Southern Nebulæ with the Spectroscope." By Lieut. J. HERSCHEL. Communicated by Prof. G. G. STOKES, Sec. R.S. Received June 1, 1868.

No. 1179. April 9, 1868. [Great nebula in Orion.] All three lines seen remarkably well, and measured as follows:—

$$\left. \begin{array}{l} 4.63 \\ 4.66 \\ 4.67 \end{array} \right\} \begin{array}{l} 4.65; 4.77 \\ 4.88 \end{array} \left. \right\} 4.82; 5.24; D=2.46.$$

[Note.— $b=D+1.67$, $F=b+1.06$.]

No. 1225. April 9. ["Planetary; pretty bright; very small; very little extended; barely resolvable?"] Not found.

April 4. Seen; faint, but unmistakeable. Not seen in spectroscope, though most carefully placed and intently looked for.

No. 1565. March 30. ["Planetary; pretty bright; pretty small; extremely little extended; barely resolvable; $3^s.75$ diam."] Not seen.

April 18. Seen, but not considered bright enough: some doubt about identity.

April 23. What was seen on the 18th looks more than ever doubtful: a faint haze in a cluster.

No. 1567. April 23. ["Planetary; considerably bright; not very well defined."] Linear spectrum,

$$4.66, D=2.50$$

No. 1783*. ["Remarkable; planetary; pretty bright; =star 9 mag.; very small; round."] Looked for *three times*, but not seen.

No. 1801. ["Remarkable; planetary; pretty bright; pretty large; round."] Looked for *twice*, but not seen.

No. 2008. April 12. ["Very bright; large; very much extended, 45° ."] Well placed, but not seen with spectroscope; focus suspected, but not enough to prevent lines being seen.

April 23. Easily visible in telescope. I am almost certain I must have seen this one if it has a linear spectrum. Continuous spectrum suspected.

No. 2017. March 31. ["Very remarkable; planetary; very bright; very large; little extended; star 9 mag. in the middle; $4^s.0$ diam."] Slight haze and moonlight. Found with difficulty in spectroscope: examination interrupted. A continuous streak with blotch of light $\frac{2}{3}$ from the red end.

No. 2102. April 4. ["Remarkable; planetary; very bright; little ex-

* 1783. May 4. Seen as a monochromatic light—faint, but beyond doubt. Rough measurement, $D+2.0$.

tended; 32^s diam.; blue."'] Found at once, and seen in finder. Not *very* well seen in spectroscope: third line not seen at all.

$$D + \frac{2 \cdot 14}{2 \cdot 16} = D + 2 \cdot 15.$$

No. 2197. March 26. [" η Argus and great nebula."'] Spectrum easily visible; did not, however, succeed in separating the lines (low altitude.) Estimated position $D + 1 \cdot 8 \pm \cdot 3$.

No. 2581. April 2. ["Planetary; remarkable; small; round; blue; equal star 7 mag.; 1^s·5 diam."'] Well seen in spectroscope: eventually a short sharp bright line was seen, with a fainter companion close by. $D + 2 \cdot 1 \pm \cdot 1$.

No. 2917. March 26. ["Very bright; large; round; barely resolvable."'] Not seen in spectroscope.

April 13. Not seen in spectroscope, though every precaution was taken to secure direction and focus. It is almost impossible that this can have a bright line spectrum, or it must have been seen.

April 23. Seen at once; bright; all three lines easily seen, and a fourth suspected, at intervals 1:3:10? from the first by estimation.

$$D + \frac{2 \cdot 10}{2 \cdot 19} = D + 2 \cdot 15.$$

No. 3021. April 13. ["Very bright; large; round."'] Not seen in spectroscope. (See remark of this date for No. 2917.)

No. 3092. April 23. ["Very bright; considerably large; pretty much extended, 63°."'] Not seen in spectroscope.

No. 3128. April 2. ["Cluster; large; extremely rich; very compressed; irregularly round; well resolved; star 12 red."'] Not seen in spectroscope (adjustments suspected).

April 12. Not found in spectroscope. (Remark essentially the same as for 2917.)

No. 3132. April 12. [Remarkable; very bright; very large; extremely extended, 92°."'] No spectrum seen, though carefully placed.

April 26. Continuous spectrum suspected: linear spectrum considered out of the question. (NB. Clear night, and other spectra well seen.)

No. 3525. March 25. ["Very remarkable; very bright; very large; very much extended, 122°; bifid."'] An irregularly shaped nebula with dark space across it. No spectrum seen: faint stellar spectrum seen.

March 26. Looked for again: no result.

April 26. A good instance of the extreme difficulty of finding a continuous spectrum object. I was enabled to find this one by the help of a neighbouring star, whose spectrum was

easily found; but even in the field the faint light could only just be recognized.

No. 3531. March 25. ["Very remarkable; cluster; ω Centauri."] A large cluster visible to the eye: spectrum continuous.

No. 4066. April 29. ["Planetary; very small; round; quite sharp.] (April 5, not seen.) Recognized in telescope as a small round planetary nebula: seen without much difficulty in spectroscope as a small luminous point ill defined on the more refrangible side.

$$D = 2.55; (\pm 1) + \left. \begin{array}{r} 4.60 \\ .70 \\ .63 \end{array} \right\} = D + 2.1 \pm 1.$$

No. 4083. April 5. ["Very remarkable; globular cluster; very bright; large; extremely compressed in the middle."] Seen in telescope as a slightly oval nebulous ball not very bright (? moonshine). Found with difficulty in the spectroscope: a faint continuous spectrum of considerable width: no lines.

No. 4173. April 5. ["Very remarkable; globular cluster; very bright; large; well resolved."] Seen easily in telescope: looked for two hours in vain with spectroscope.

April 13. Spectrum continuous; compared its appearance with that of a small star close by to make sure; difference quite marked.

No. 4183. April 13. ["Cluster; well resolved."] Spectrum clearly continuous.

No. 4238. April 13. ["Remarkable; globular cluster; very bright; very large; irregularly round; well resolved."] A faint continuous spectrum certainly seen, but too faint for more than recognition; stellar spectrum seen involved.

No. 4284. April 5. ["Very remarkable; planetary; pretty bright; very small; round."] Not seen in telescope.

April 17. Not seen in spectroscope, though pretty certainly placed.

April 24. Linear spectrum seen, though too faint for measurement, even for absolute *certainty* of its character. The light seen, however, was too strictly *LOCAL* to belong to a continuous spectrum of so faint an object, but that is the whole of the evidence.

No. 4302. April 17. ["Remarkable; annular nebula; pretty bright; small; round."] (April 6, not seen in telescope.) Not seen in spectroscope, though pretty certainly placed.

April 24. No result. A faint object in telescope (200), but of some size. No spectrum, though satisfactorily placed.

No. 4355. April 24. ["Very remarkable; very bright; very large; trifid; double star involved."] A very large object with a double

star in the central patch (sketched). This star was frequently in the spectroscopic field, but no lines were seen: a haziness suspected.

April 26. Continuous spectrum: readily found owing to the central star.

No. 4361. April 17. ["Very remarkable; very bright; extremely large; extremely irregular figure; with large cluster."] A large nebulous area visible in finder; not examined with telescope; spectrum linear, but feeble. $D + 1.98$. Some doubt about the reading of D .

No. 4390. April 16. ["Planetary; very bright; very small; round; little hazy."] Seen in spectroscope as a short bright line with a second fainter one; a third suspected. Measurement $D + 2.34$.

No. 4403. April 26. ["Very remarkable; bright; extremely large; extremely irregular figure."] I should say this is as bright an object as any of the larger nebulae I have seen. It is a striking object (detailed account of appearance and sketch), and the various parts could be recognized as they were brought on the slit. Measurements, D being read by reflected light from soda-flame:—

$$\left. \begin{array}{l} 4.53 \\ 4.58 \end{array} \right\} 4.56 \quad D = 2.48 \quad \left. \begin{array}{l} \\ \\ 4.59 \end{array} \right\} D + 2.10. \\ \quad \quad \quad 4.59 \quad \quad = 2.44$$

No. 4628. April 26. ["Remarkable; planetary; very bright; small; elliptic."] Easily seen in telescope, and *confidently* looked for in spectroscope. Spectrum as bright and distinct as any yet seen; lines measured *by obliteration* with cross-wires in a dark field, D being obtained from a reflected soda-flame.

$$\begin{array}{ccccccc} 4.61. & 4.81, & 5.16, & D = 2.41, \\ \text{or} & D + 2.20, & + 2.40, & + 2.75. \end{array}$$

No. 4510. May 3. ["Planetary; bright; very small; round."] I am rather surprised to find this described as "bright, very small;" I should have expected very bright, pretty large. Its spectrum is the first in which I have suspected a new character. In the first place, there is no trace of a third line, and the second is more uncertain, as though there were more than one fainter companion. The brightness of the principal line is considerable, making measurements by estimation behind the wires in a dark field not very difficult. The following measures are, I believe,

$$\text{trustworthy: } D = \left\{ \begin{array}{l} 3.32 \\ .32 \end{array} \right\} 2.32, \quad \text{Neb. line} = \left\{ \begin{array}{l} 4.62 \\ .66 \end{array} \right\} 4.64.$$

In the second place, therefore, here is a reliable measurement, differing widely from the rest (too widely, as I think,

for an accident), but agreeing closely with one other (4390), in which the third line is only "suspected." Both must of course be remeasured. This is the first planetary nebula I have seen in the "finder." Can it have changed its character since?

[*Note*.—With four exceptions, Nos. 1843, 2076, 1565, 1801 (all between 7^h & 11^h R.A.), the *whole* of the bright planetary nebulæ between 80° and 150° N.P.D. have now been examined.

Abstract of Measurements.

No. 1179	D+2.19+2.36+2.78		
1567	+2.16		
2102	+2.15		
2197	+1.8		
2581	+2.1		
2917	+2.14		
4066	+2.1		
4361	+1.98		
4390	+2.34 (!)		
4403	+2.10		
4407	+2.08		
4628	+2.20+2.40+2.75		
4510	+2.32 (!)		
General mean	2.10	2.29	2.67
b=D+	1.67	1.67	1.67
	b +.43	.62	1.00
F=b+	1.06		

Supplementary List.

- No. 4450. May 4. ["Globular cluster; very large; very little extended; well resolved."] A faint continuous spectrum barely visible.
- No. 4543. May 4. ["Globular cluster; bright; pretty large; round; partially resolved."] A decided continuous spectrum brighter in the middle. No trace of lines.
- No. 4678. May 4. ["Globular cluster; very remarkable; bright; very large; well resolved."] A decided continuous spectrum of visible width, No trace of lines.

May 5, 1868.

The above were observed this morning half an hour before despatch.

[The spectra of the following nebulæ have been described by Mr. Huggins. See Phil. Trans. 1864, p. 439, and 1866, p. 383, and Proceedings of the Royal Society, vol. xiv. p. 40.

No. 2102	No. 4628
No. 4238	No. 4510
No. 4403	No. 4678.—G. G. S.]
No. 4390	