Lick's deed required that it should be, "the most powerful in the world." We have but just begun to use it regularly. In many details it is as yet incomplete, but its performance up to this time has proved to us that, if it is rightly used under suitable conditions, it will produce superb results. The chief object of this note is, as I have said, not so much to add any fact of scientific value to what is known, as to enable a judgment to be made of the power of this latest addition to the family of great telescopes.

_Lick Observatory, University of California, Mount Hamilton: 1888, July 15._


In the intervals of other work the great equatorial has been turned upon some of the more interesting nebulae. Our observations of the annular nebula in Lyra have already been communicated to the Royal Astronomical Society. We beg to communicate herewith further observations upon nebulae of the planetary class, one of which (37 H. iv., *Draconis*) has proved to be a highly complex and interesting object of a new class.


This nebula (of which a drawing is given) was first viewed here on July 27, 1888.

Its bright blue colour and elliptic shape make it one of the most interesting of the class of planetary nebulae with central stars. It was examined with powers from 270 to 2000 and even higher, and bears magnifying well, losing only its characteristic and remarkable colour with the higher powers.

The nebula is apparently composed of rings overlying each other, and it is difficult to resist the conviction that these are arranged in space in the form of a true helix. The following diagram will illustrate this.

[Diagram of a helical nebula with labels A, B, C, and a note indicating 'North' and 'Bright']
At the first glance the nebula appears to consist of two circles, C and B, which intersect so as to form the space A which surrounds the central star. At the south point of intersection the brightness is approximately twice the average brightness of the circumference; at the north point it is less bright relatively than this. A little attention, however, seems to show that these rings are so arranged that the complete ring C (360°) lies on the hither side (nearer the eye) of the complete ring B (360°); or, if we consider the helix to be generated by the motion of a luminous point in the direction of the arrow, the circumference B is last described.

A then appears to be a part of both B and C. This appearance is perfectly well seen with the central star in exact focus, and it is entirely unmistakable under these conditions with all the eyepieces. It is, however, much better seen with the eyepieces outside of the best focus for the central star. The aspect of the nebula is not changed in this way, but the brighter portions become relatively brighter, narrower, and more sharply defined.

With an eyepiece magnifying 700 diameters one of the observers (E. S. H.) focussed carefully on Mars, δ = -15°, and the focussing scale read 2.77 inches; on Jupiter, δ = -19°, the reading was 2.75 inches; on the central star of the nebula δ = +67°, 2.76 inches. The nebula itself was well seen with the setting 2.76, but was much better seen when the focus was lengthened by 4 4 of an inch (reading of scale 3.20 inches): 4 4 of an inch is about 1 200 of the focal length of the objective. A suggestion of Mr. Keeler's that the longer focal adjustment on the nebula was necessary because the central star was essentially red or yellow, while the nebula was unmistakably blue, was tested on August 6, and found to be correct by means of a small pocket spectroscope by Browning. The light of the nebula with a wide slit was monochromatic and blue. The image of the nebula, under these circumstances, was crossed by the continuous spectrum of the central star in which the colours, red and yellow, were plainly visible. With a narrow slit the spectrum of the nebula was seen to consist of three lines.

The places of these lines were first determined by Dr.
Huggins, in his celebrated paper on the "Spectra of Some of the Nebula" (Philosophical Transactions, 1864, p. 438).

After viewing this object under the circumstances in which it is seen blue here, it is difficult to escape the conviction that in this instance we have the first example of a nebula whose brighter parts are arranged in a true helix. The disposition of the fainter parts has nothing to discredit this conception. In fact it is perfectly easy to conceive the true form of the whole nebula to be that of a cylinder, with the helix of the brighter portions wound upon its outer surface.

We have, therefore, ventured to designate this object as a helical nebula—the first of its class—because its brighter portions unquestionably appear to the eye in a helical and not simply in a spiral form; and also because it seems to us at least probable that the real disposition of the brighter parts in space may be in the form of a helix.

The accompanying figure (Plate 4, fig. 1) is the best representation which we could make. It is highly unsatisfactory at the best; and in order to present more data, extracts from our observing book of July 31, 1888, are given below.

"With power 270, focussed on a star. The central star of the nebula is also in good focus, and the helical shapes are perfectly well seen. They are also seen with the eyepiece inside of focus, and best of all with the eyepiece slightly outside.

"With power 670; the same.

"With other (higher) powers; the same. The higher the power the greater the advantage gained by viewing the nebula slightly out of focus.

"Near the west end of the minor axis of A is the darkest part of A; the south half of A is the next darkest. The north half of A is pretty well filled up with nebulosity.

"The whole of the interior of B is pretty dark; it is darkest towards the north-west edge.

"The interior of C is darkest on the east and south sides."

Circumferences.

"The brightest part of the nebula is about 20° at the south extremity of A. The next brightest is about 40° in the north-west edge of B. The third brightest part of the circumference begins at the north point of A, and extends about 70° towards the north-east (in C). Beyond that point the circumference of C is rapidly fainter."

"Starting from the point where C and A join, at the south, the first 30° of the circumference is faint; the next 40° fairly bright; then comes a fainter portion; and then the circumference is bright till it joins A at the north, where C seems to overlie A."

"The east half of the circumference of A is pretty bright as far north as the central star, and the rest of the way it is very
faint. The west half of the circumference of A is pretty faint for the first 30° or more, commencing at the north point; and then pretty bright down to the south point of A."

"The circumference of B is faint and diffused from the south point of A to the west end of the major axis of the nebula; from the latter point for 70° or so it is quite bright, and fainter again before it re-joins A at the north."

The outlying nebulosity is about as drawn, only that it is relatively too bright in the sketch.

The only thing specially noteworthy with regard to this outlying nebulosity is the dark space lying on the north-east side of the whole nebula which separates two spires of nebulous matter.

A star 14 magnitude, north of the nebula in the direction of the minor axis, has a nebulous appendage on its west side. The central star is 11 magnitude. Another star is shown in the sketch close south-following the circumference of B. A node of nebulosity or a faint star is obvious in the brightest part (the north-west part) of the circumference of B.

"The longest diameter of A makes an angle of about 25° with the minor axis of the whole nebula, and is inclined towards the west at its north extremity."

The foregoing notes, together with the sketch, will probably serve as a sufficient description of this most remarkable of Sir William Herschel's planetary nebulae, which seems to be the first known example of an entirely new class of objects.

Ring Nebula, r H. iv., Aquarii, G. C. 4628.

The accompanying drawing (Plate 4, fig. 2) gives a fair idea of the shape of this truly wonderful object. One of the best general representations of this nebula may be found in Mr. Lassell's paper, Memoirs of the Royal Astronomical Society, vol. xxxvi., plate x., figure 37.

The colour is a pale blue. The form of the object is perfectly well seen with the central star in focus. It is a little better seen by moving the eyepiece outside of focus until the central star almost disappears.

None of the shapes are changed by this process, but the bright central ring becomes narrower, relatively brighter and better defined, and the circular mass in which the central ring seems to lie does not lose any of its characteristics.

The central oval is not bounded by a smooth curve. It looks like an elastic link which has been warped, so that the preceding one-quarter appears beyond the median plane (further away from the eye); the central one-half appears on the hither side of the median plane (nearer the eye); and the following one-quarter again appears to be beyond the median plane.

To use a very homely comparison, the appearance of this central ring is similar to that of a footprint left in the wet sand of a sea-beach.
The central ring lies upon an oval of much fainter nebulosity, somewhat as drawn. This outer nebulosity is fairly uniform in brightness, except that there is a defalcation of light at its south-preceding edge, and one at its north-following edge, as drawn. The latter is very remarkable as seen, but it is very imperfectly depicted in the sketch. A dark band lies just north of the bright central ring, and one not quite so dark lies just south of the same ring.

The two satellites preceding and following nearly in the major axis of the nebula appear to be faintly connected with the main nebula. They are nebulous patches with a faint central nucleus, which is probably not stellar.

The central ring is brightest in the s.p. quadrant, in the s.f. quadrant, and in the n.f. quadrant, somewhat as drawn. Just following the south end of the minor axis the bright circumference becomes suddenly much fainter, as drawn. This defect of light materially aids to give the warped appearance to the surface of the interior oval, and suggests a helical arrangement of the parts.

The interior of the central oval is filled with pretty bright nebulosity at its following end, with diffused nebulosity at its preceding end, and a dark circular space surrounds the central star (by contrast?). This circular space is prolonged in a triangular shape towards the west. The preceding end of the major axis of the central ring is open, somewhat as in the ring nebula in Lyra. Besides the central star (or nebulous nucleus?) there is a fainter star (or node of nebulosity?) near the north end of the minor axis of the whole nebula, and two nebulous nodes in the north portion of the brighter central ring. These two nodes form a nearly equilateral triangle with the central star. It is noteworthy that Mr. Lassell, one of the most scrupulously accurate observers, places the central star south of the major axis of the inner oval. We think there is no doubt that this nucleus is now slightly north of this line.

Careful inspection fails to show a decided helical form to the nebulous mass as a whole, yet the analogy of this nebula to 37 H. iv., Draconis, is sufficiently striking to deserve mention.

Lick Observatory, Mount Hamilton, 1888.