SOME CONTINUED OBSERVATIONS ON THE VARIABLE STAR η ARGUS, AND THE SURROUNDING NEBULA.

[Read April 14th, by Francis Abbott, F.R.A.S., &c.]

Laid on the table a drawing of the object taken at three different periods, from 1834–7 up to February, 1868, the monographs of Sir John Herschel, taken at the Cape of Good Hope, and a record of the star from the time of Halley in 1677.

It will be remembered by some members of the society, who are interested in astronomical discoveries, that at the monthly meetings held in June, 1863, and March, 1865, some notes were read on the variable star η Argus, and the surrounding nebula. At about the same time information connected with the subject was forwarded to the Royal Astronomical Society, who published it in their proceedings. This communication led to discussions on the subject in many scientific journals, and eventually to notices in standard works on astronomy, in some of which further observations and information have been solicited. It is to answer this enquiry that the original copy of this drawing and description have been prepared. Before proceeding with the notes on the present appearance of η Argus, and its surrounding nebula, I purpose reading one or two paragraphs from recent publications in order to shew the interest which this object has excited among astronomers in Europe, from previous communications which have been sent; and it will appear clear to the present meeting by an inspection of the drawing, that fluctuations to a considerable extent have taken place since those articles were written. There is also reason to believe that other portions of the *via lactea*, as well as the nebula in question, are subject to motions by a system of acting forces calculated to produce them, and such as may offer opportunities for future observations.

Descriptive Astronomy.—Clarendon Press Series.—"The foregoing observations may be said to have relation to objects of a minor character, but we are not without at least one example of an important nebula undergoing peculiar changes. The great nebula in Argus, when observed by Sir J. Herschel in 1838, contained within its area a vacuity of considerable size. The star η, then of the 1st magnitude, was situated in the most dense part of the nebula, and was completely encompassed by nebulous matter. In 1863, we learn from Abbott, of Hobart Town, the star was entirely free from nebulosity, and only of the 6th magnitude. The observer also states that the outline of the vacuity materially different from the representation given by Herschel. Mr. E. B. Powell, of Madras, not only confirms these remarks generally, but also says distinctly that the nebula as a whole has varied much in brilliancy during the time it has

been under his notice. We may evidently expect at some future time to hear of still more interesting discoveries in this department of sidereal astronomy."

The Heavens, Imperial Observatory, Paris.—"We will bring this chapter to a close with a description of the most astonishing of all the phenomena of this kind,—namely, the variations of the star η Argus; a singular star, which can be classed neither among the temporary nor among the variable stars. Towards the end of the seventeenth century this star was only of the 4th magnitude; less than a century after, in 1751, it attained the 2nd. Sixty years later it again descended to its first brightness, increasing anew until the year 1826. From that epoch it has passed through the most astonishing phases, oscillating between the first and second magnitudes, sometimes equal to a Crucis, then to a Centauri, surpassing Canopus, and approaching lastly to Sirius. The rapidity of these changes, their unequal periods, the long duration of this state of variability, the impossibility of finding a law more or less regular, all contribute to make this beautiful star one of the most curious objects of the sky. Our cotemporary astronomer, Mr. F. Abbott, who has followed the variation of η Argus until now, informs us that after having, in 1843, attained the brilliancy of Sirius, it diminished progressively, passing through all the orders of intermediate magnitude between the first and sixth. In 1863 it was no longer visible to the naked eye. We are also informed that the nebulosity which surrounds η Argus, like that of Orion, does not present any symmetry in its form or in its outline. It is situated in the Milky Way, in the midst of a region so rich in stars, that more than 1,200 have been counted in the area occupied by the nebula. The stars, however, do not form part of the nebulosity, but rather appear to be simply projected on it. Towards the centre of the nebula, and close to the star η, an opening of a lengthened and rounded form is noticed, which leaves in view the dark ground of the sky. This has been named by Mr. Abbott, a careful observer, 'the Crooked Billet.' The evidences of change in this nebula are even more decided than in that of Orion. This object indeed may supply a link of the greatest importance, for we read that the objects of which it is composed (not stars) 'are now of a larger character and more refulgent than nebulous matter in general.'"

I may mention here that this object is not seen at all in Europe, at the Cape of Good Hope and Madras it is only partially seen, as in one part of its revolution it dips below the horizon. The only other object of a known similar nature in the heavens at the present time is the great nebula in Orion, which for some years past has been rigidly examined with the most powerful instruments, and discussed by the best observers with a view of investigating some apparent fluctuations. What follows will show that those changes, although now established, bear but a feeble comparison to η Argus and its nebula—the latter, however, will help to confirm what has been long suspected of the former. A paper on the nebula of Orion, read by the late Earl of Rosse before the Royal Society of London at the close of their last session, clearly shows that in the course of the last fifteen years considerable changes have taken place in that object—changes which cannot be attributed either to atmospheric difficulties of vision, or to alterations in the instruments, or in

the observer's eye. If, therefore, it has taken so long a time, and been so difficult to trace the fluctuations in the nebula of Orion with the late Earl of Rosse's six feet speculum, and the fine refractor with 15 inches aparture of the late Professor Bond, how much greater and more apparent must be the alterations which are taking place in the nebula around η Argus to be discovered with a five feet refractor with only four inches clear aperture. These singular and newly-discovered motions in nebulous masses at so remote a distance, are well calculated to open up new inquiries into the physical and dynamical laws which determine the conditions and relations of the forces which produce them. The singularity of the nebulous portion of this region has but recently been made a subject of systematic examination, and but for the observations and beautiful monograph of Sir John Herschel the pecularities attached to it might have remained unknown for a long time to come. In 1677 the star η was recorded by Halley as of the 4th magnitude. Its maximum was first noted by Burchell in 1827, it being then of the 1st magnitude, and on the 30th March, 1863, it was found for the first time reduced to the 6th magnitude. Independent, however, of the variability of the star itself, there is a much more singular property belonging to the surrounding nebula, the particular features of which I now purpose to describe. The mutability of the nebula will be best made apparent by the accompanying drawing, which will at once shew the different forms of the dark space, and the relative position of η Argus to it, from 1834-7 to 1868. It must not be considered, however, that the positions and characters here given are the only ones in which the object has appeared; a system of photographs only would be the means of assisting materially the recognition of a principle of irregularity pervading the whole structure. The missing portion of the nebulous matter, as compared with the Cape Monograph, may be thought by some to be owing to the want of a larger optical power, but when the same instruments have been used throughout this objection as to variability must fail to have any weight. The principal instrument used is a 5ft. equatorial by Dallmeyer. The building being situated in a garden the view of a small portion of the circumpolar stars is intercepted by fruit trees—to make good this want a five feet portable refractor by Varley is used in the open air, so that the object has been watched and noted throughout its entire revolution round the pole. The eye-pieces in general use, and found most suitable for this purpose, are a comet one of 28, and orthoscopic of 45, and an annular micrometer of about the same power. A more powerful instrument, would, no doubt, at any one observation, alter the

apparent features of the nebula, and render manifest changes of a somewhat different character to those here described. To witness these effects I wait the arrival of the Melbourne telescope, when I hope to have the opportunity of more correctly verifying these statements. The investigation of the fluctuations connected with the object η Argus and surrounding nebula appears not to require such refined and delicate observations as were bestowed upon Herchel's subnebulous region near the trapezone in Orion, by the late Professor Bond, and Earl of Rosse, nor are such powerful instruments necessary. Take, for instance, the position of the star η, as given by Sir J. Herschel, at the Cape of Good Hope, and note its position again, when in the dark space as confirmed by E. P. Powell, Esq., at Madras—and now for the third time compare its situation removed from the dark space altogether to quite a different portion of the nebula, and it will appear clear that the optical means employed have been ample, notwithstanding Mr. Powell was at first inclined to think that the fluctuations were only apparent, and owing to the inferiority of his instrument. The beautiful soft white light given out by the nebulous matter about η Argus appears to be produced, either from the increased magnitude of the stars, or the displacement of some of the nebulous mass, or probably from both, for in the former case it is difficult to say (only from its position) which is η Argus and which is not, there being so great a similarity in its size and that of some of the accompanying stars. On a clear fine night the object gives out fully twice as much light as that of the great nebula—nebicula major,—and about three times as much as nebicula minor, irrespective of size. In the twilight it appears as soon as a star of the second or third magnitude the light being white and more diffused—very like a small white woolly cloud on a blue sky, seen in sunlight. It is also seen in full moonlight, when all other nebulous matter is obscured. At present there appears to be no further diminution in the magnitude of the star below the 6th. Being in Melbourne on the night of the 25th March, 1865, which was a very fine one, and happening to look towards η Argus I fancied that the star appeared as a distinct point in the nebula. I immediately proceeded to the observatory, Mr. Ellery with his accustomed kindness allowing me to take possession of the equatorial, and on examining the object found the colour of the accompanying stars to be the same as before described to the society, and, with the comparative eye-piece, considered the star η to be 5·5. It was about this time that Mr. Tebbutt, of New South Wales, forwarded the result of his observations to the society, giving the star as 5·5. This appearance, how-

ever, must be considered only transitory, for many times since that period the star has not reached more than the 6th magnitude, and may be so estimated at present. The accompanying drawing was made with an inverting eye-piece, and taken 75° east of the meridian to prevent the unpleasantness of taking it near the zenith. If, therefore, the line of sight is brought to correspond with the south of the Cape Monograph the position of both drawings will be made approximately to agree at the time they were taken. In conclusion, I would observe that the particular interest taken in this object is owing to the star's inequality of motion, as to magnitude, and fluctuations in the nebulous mass. There are on record very many variable, as well as binary stars, whose change in magnitude and periods are correctly known. If we take the star α Centauri, not far from η Argus, the binary period is 78 years, or a little more than $4\frac{1}{2}°$ annually. R Leporis is Hinds' celebrated intense crimson star, max. 7, period 400 days. R Leonis is a ruby star, max. 5, min. 10, period 324 day. μ Cephei, fine deep garnet star, max. 3, min. 6, period $5\frac{1}{2}$ years, β Persei moves from max. 2 to min. 4, period 2.86727 days. α Hydrae has a period of 55 days, &c. The period that has been given to η Argus is 46 years, and its variability from 1 to 4. This we have seen, however, is not correct, since the time of Halley in 1677 we have passed over 191 years, and not arrived at either the variability or period of η Argus, and for anything known it may disappear altogether: there are stars of that class on record. In 1604 a new star appeared in the east foot of Ophiuchus, but disappeared again in 1605, it was as bright as Venus and lasted but 15 months. In 1600 Kepler discovered a new star η in Cygnus, which he observed for 19 years, it faded away and then blazed out again several times before its final disappearance in 1621. With respect to the fluctuations that are taking place in the nebulous matter, it scarcely requires to be premised, that on a subject of this nature, the highest evidence that can be attained is a degree greater or less of probability. The only speculation to unfold it, which has hitherto thrown any light upon what is so legitimate and urgent a physical inquiry, constitutes the remarkable Nebular Hypothesis of Laplace.