

## DIFFUSED NEBULOSITIES IN THE HEAVENS.

By E. E. BARNARD.

IN the present number of this JOURNAL there is a paper by Dr. Isaac Roberts containing an account of a photographic investigation of certain regions of the sky supposed by Herschel to be affected with diffused nebulosity. This investigation was made simultaneously with Dr. Roberts' 20-inch (51 cm) reflector and 5-inch (12.7 cm) Cooke portrait lens. The exposures given by Dr. Roberts to test the existence of these diffused nebulosities was ninety minutes, which, it is stated, showed stars of the sixteenth and seventeenth magnitudes. Out of these fifty-two regions he found only four that showed any traces of nebulosity. These four regions, however, had already been shown by numerous photographs to be nebulous. One of these, the great nebula north of *a Cygni*, was first photographed by Dr. Max Wolf some twelve years ago and has lately been called by him the "America Nebula"<sup>1</sup> from its striking resemblance to North America as shown on maps and globes.

The curious nebulous ribbon extending southward from  $\zeta$  *Orionis* seems to have been first photographed by Professor W. H. Pickering and others as far back as 1889.

This question of large areas of diffused nebulosity in the sky is a very important one, not yet fully appreciated, but which must sooner or later have the highest bearing on a proper understanding of the physical condition of the universe. Dr. Roberts' negative results are so sweeping in character that it is highly important that anything tending to prove the existence of any of these questioned regions of nebulosity should be brought forward at once.

First, I do not think 90 minutes a sufficient exposure to test the existence of some of these nebulosities with Dr. Roberts'

<sup>1</sup>The "North America Nebula" would perhaps be more definite, for it is North America to which Dr. Max Wolf intends the compliment.

outfit. The photographing of sixteenth or seventeenth magnitude stars does not necessarily prove that the same exposure ought to show diffused nebulosities, for photographing faint stars often stands on an entirely different footing from photographing faint nebulosities.

Second, it is a little unreasonable to suppose that Herschel, who made so few blunders compared with the wonderful and varied work that he accomplished, should be so palpably mistaken in forty-eight out of fifty-two observations of this kind.

I have myself been very much interested in the diffused nebulosities of the sky and have independently come across some of these very regions of Herschel, besides others not noted by him. It has been a long-cherished desire of mine to investigate them further photographically, and I now hope to be able to put this desire into a practical reality within the next twelve months. Some of these regions I have already shown to be extraordinary features of the sky—as instances, the nebulous regions of  $\gamma$  *Monocerotis*, of  $\rho$  *Ophiuchi*, the region surrounding the *Pleiades*, etc. All of these were known to me previous to their really being proved by the photographic plate and the portrait lens to be true nebulosities.

As far back as January 1892, in *Knowledge*, **15**, 14–16, I called special attention to these nebulous regions of Herschel and gave the table contained in Dr. Roberts' present article. Attention was called to these objects as being suitable for photographic investigation in these words:

It would appear that this table of diffused nebulosities will just now be of extremely great value, as it at once points out to those interested in photographing such objects, the proper pointings of their exposures. I have taken the liberty to copy the foregoing table in full for the benefit of those not familiar with it and who may wish to try exposures on these objects.

What leads me to hope that more of these regions given by Herschel may yet be shown to be nebulous with photographic plates, is that one of these very objects, which the photographs of Dr. Roberts show to be free from nebulosity, is really the brightest portion of one of the most extraordinary nebulæ in the sky, as shown by photographs made by two independent observers with

three different photographic telescopes on several different occasions. I refer to region 27 of the list. This is described by Herschel as being "affected with milky nebulosity" and its position given for 1800.0 as  $\alpha = 5^{\text{h}} 38^{\text{m}} 5^{\text{s}}$ ; P. D.  $88^{\circ} 55'$ .

The right ascension and declination for 1900.0 would be closely

$$\alpha = 5^{\text{h}} 43^{\text{m}} 13^{\text{s}}; \delta = +1^{\circ} 8'$$

Dr. Roberts' note on this is: "Sky clear; stars very few in number; large areas void of stars; no nebulosity."

In *Popular Astronomy*, 2, 151-154, December 1894, the writer has given some experiments with a very small magic lantern lens in photographing diffused nebulosities. In this account is given of the finding of a great nebula extending in a curved form over the entire body of *Orion*. The brightest portion of the nebula is near 56 and 60 *Orionis*. From the photographs, the position of this brightest portion is in

$$1900.0 \alpha = 5^{\text{h}} 43.7^{\text{m}}; \delta = +1^{\circ} 0'$$

This would make it identical with Herschel's No. 27. These pictures were made with an ordinary child's magic lantern lens, of 1.5 inches diameter and 4.9 inches equivalent focus. The exposures were 1894, October 3, for  $2^{\text{h}} 0^{\text{m}}$ , and October 24, for  $1^{\text{h}} 15^{\text{m}}$ . The shortest exposure,  $1^{\text{h}} 15^{\text{m}}$ , showed it best. I suppose a half-hour's exposure would have shown traces of it. Unknown to me at the time, this nebula had already been photographed in 1889 by Professor W. H. Pickering on Mount Wilson (altitude 6,250 feet) in southern California, with a Voigtlander portrait lens of 2.6 inches aperture and 8.6 inches equivalent focus, with an exposure of three hours.<sup>1</sup>

Besides the photographs made with the magic-lantern lens, I have two made with the six-inch Willard portrait lens that show portions of the nebula distinctly. They were made 1893, October 17, with  $3^{\text{h}} 0^{\text{m}}$  exposure; and 1894, October 3, with  $2^{\text{h}} 0^{\text{m}}$  exposure. In both the photographs with the Willard lens, the region of the nebulosity falls near the edge of the plate and hence the stars are deformed. At the time of making these

<sup>1</sup>See *Sidereal Messenger*, 9, 1, 1889.

1903ApJ...17

pictures I knew nothing of the existence of this object and therefore had no choice as to its location on the plate. One of these photographs has been selected for reproduction, though it will necessarily be unsatisfactory because of the position of the object close to the edge of the plate.

[Through the courtesy of the editor of *Popular Astronomy*, the map of *Orion* showing the location of the nebula is here reproduced. (Plate VI, A).]

To further show the reality of the nebulous region No. 27 of Herschel's list, I made an exposure of 2<sup>h</sup> 10<sup>m</sup> on the night of January 17, 1903, on the region with a small, cheap lantern lens belonging to Professor Hale. This lens is 1.6 inches in diameter and has an equivalent focus of 6.3 inches or  $\frac{a}{f} = \frac{1}{4}$ .

The sky was clear and the conditions fair. The resulting negative showed a fairly good field of nearly 25°.

Most of the great curved nebula is clearly shown, especially the region described by Herschel, which is now in question and which, as I have said, is the brightest portion of the nebula.

This plate does not show the nebula as strongly as those made with the lantern lens used by me at the Lick Observatory, because, for one reason, the present lens is relatively of smaller angular aperture,  $\frac{1}{4}$  as compared with  $\frac{1}{3.2}$ ; and for another reason the sky was not perhaps as pure; but the main portion of the nebula is conspicuous. There is therefore no question but that this nebulosity exists where Herschel saw it.

Just what the faintest stars are that appear on this plate I am not prepared to say, not having had any chance to make a comparison with the sky; but they are certainly several magnitudes brighter than the fifteenth or sixteenth magnitude.

It was with the same instruments described in his present paper that Dr. Roberts failed to get any traces of the exterior nebulosities of the *Pleiades*, which have been shown by four observers with four different instruments not only to exist, but to be not at all difficult objects.

YERKES OBSERVATORY,  
January 1903.