

## PHOTOGRAPHIC STUDIES OF NEBULAE

FOURTH PAPER<sup>1</sup>

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## ABSTRACT

*Studies of the form and structure of diffuse nebulae*, both luminous and obscure, from photographs made with the 100-inch and 60-inch reflectors. *Halftone reproductions* are given of photographs with the Hooker telescope of the dark nebula Barnard 86 and of uncatalogued nebulosities near  $\alpha$  and  $\gamma$  Cygni. The nebulosity between  $\alpha$  Cygni and the America nebula is found to possess a number of interesting features. Two *nebulous stars* are found in the neighborhood of  $\gamma$  Cygni. The *spectra* of one of these and of H.D. 195255 situated at the edge of a dark marking in the nebula east of  $\gamma$  Cygni are of late B type. The spectrum of H.D. 199178, situated on the line dividing a bright nebula from a dark one, is of type G5, and its *spectroscopic parallax*, determined by Mr. Adams, is 0".015.

The study of the forms of the nebulae has been continued, mainly with the 100-inch Hooker telescope, at intervals since the publication of the last paper<sup>2</sup> of this series. Special attention has been given to the diffuse nebulae, both luminous and obscure, in the constellations of Sagittarius and Cygnus.

**The Dark Nebula Barnard 86 Sagittarii**

$$\alpha = 17^{\text{h}}58^{\text{m}}2, \quad \delta = -27^{\circ}52' \quad (1925)$$

Negative  $\Delta$  180, Hooker telescope, 1921, June 6. Seed 30 plate, exposure 2<sup>h</sup>. Seeing poor, images large and elongated by atmospheric dispersion. Illustrated in Hale's *The Depths of the Universe*, page 47

$\Delta$  249, Hooker telescope, 1925, July 19. Eastman Speedway plate, exposure 2<sup>h</sup>30<sup>m</sup>. Seeing fair, images elongated. Illustrated in Plate VI

Discovered in 1883 with a 5-inch refractor by Barnard, who describes it as "like a drop of ink on the bright sky,"<sup>3</sup> this object is probably the most striking in its visual appearance of all the dark nebulae. Especially so is the pocket at the south-preceding end, the edge of which is very sharp and which contains only two tiny stars, both of them too faint to be detected visually. The eastern border of the dark body is much less clearly defined than the western. About 10'

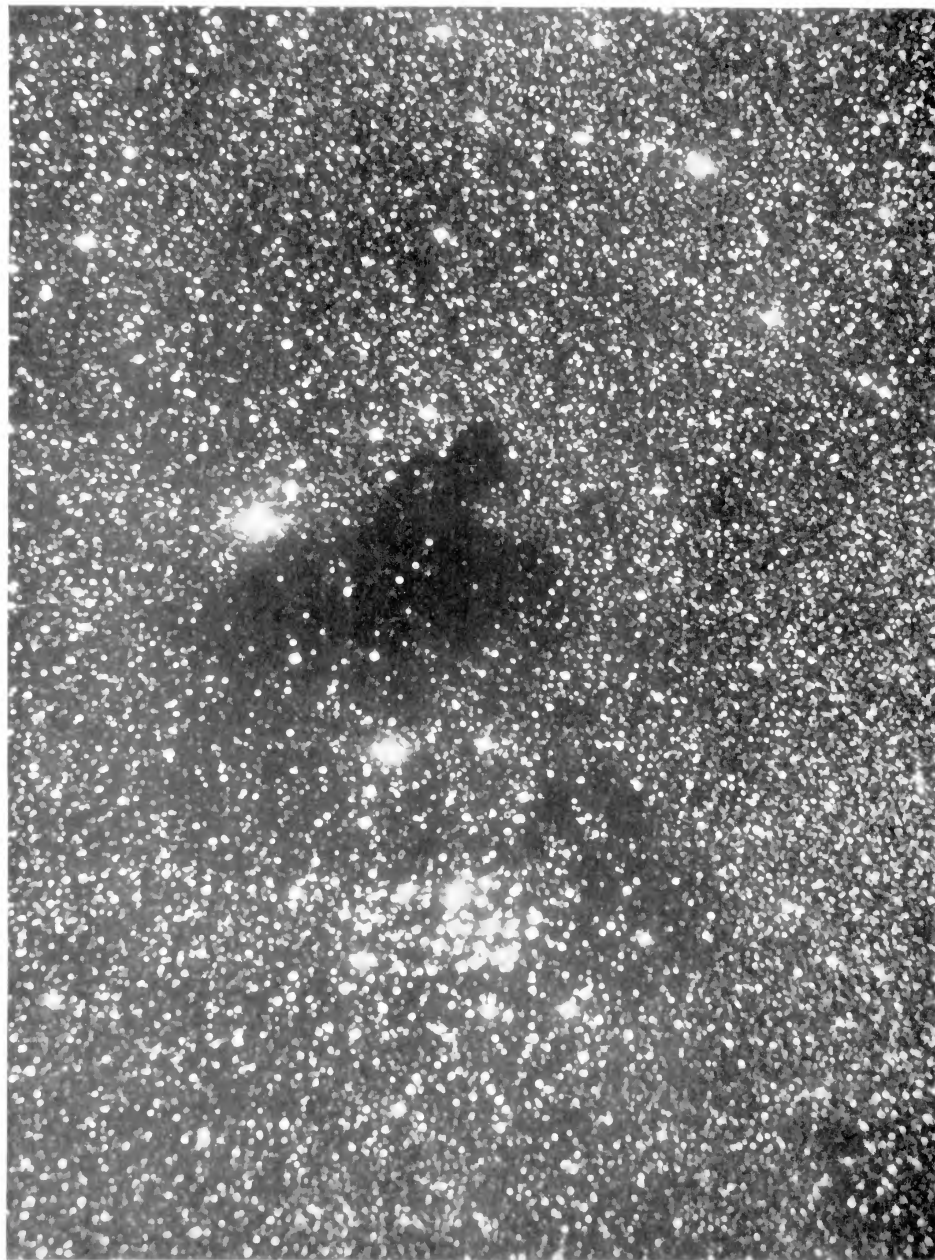
<sup>1</sup> *Contributions from Mount Wilson Observatory*, No. 303

<sup>2</sup> *Mt. Wilson Contr.*, No. 256; *Astrophysical Journal*, 57, 137, 1923.

<sup>3</sup> *Publications of the Lick Observatory*, 11, Plate 50, 1913.

PLATE VI

N



E

W

Negative  $\Delta$  249

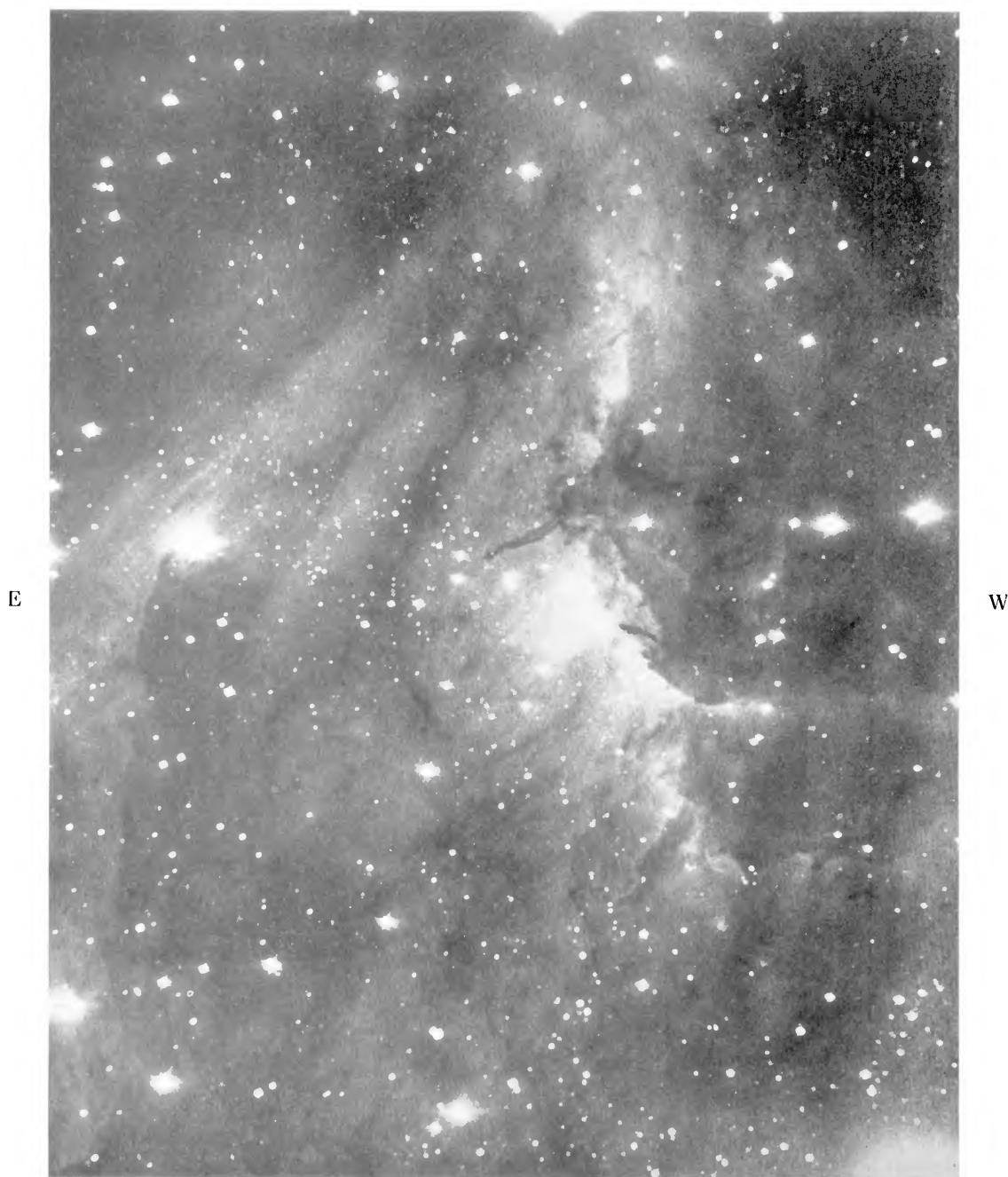
THE DARK NEBULA BARNARD 86

Photographed with the 100-inch Hooker telescope, 1925, July 19  
Exposure, 2<sup>h</sup> 30<sup>m</sup>

Scale: 1 mm = 8".6 (1.84 times that of original negative)

PLATE VII

N



Negative  $\Delta 252$

NEBULOSITY PRECEDING THE AMERICA NEBULA IN CYGNUS

Photographed with the 100-inch Hooker telescope, 1925, July 20

Exposure,  $4^{\text{h}}45^{\text{m}}$

Scale: 1 mm =  $14''.2$  (1.11 times that of original negative)

east of the center of the dark nebula is the bright open cluster N.G.C. 6520, and south of this, as shown in the illustration, is a dark marking that is less pronounced than the main nebula, and is not noticeable visually. The brightest star in the immediate neighborhood is H.D. 164562, visual magnitude 6.68, spectrum K0, situated on the north-preceding border of Barnard 86. It is of a deep orange-red color that is very striking when seen in the great reflector. In the bright star-cluster also are a number of orange-colored stars. The background against which the dark nebula is seen seems to be composed of faint stars, and there is no evidence on the negatives of any bright nebulosity.

At the latitude of Mount Wilson ( $+34^{\circ}13'$ ), objects having so great a south declination as this are always so near the horizon that the star-images, drawn out into short spectra by atmospheric dispersion, appear elongated on all plates made with the Hooker telescope.

A photograph made by H. D. Curtis with the Crossley reflector is reproduced in *Publications of the Lick Observatory*, 13, Plate VII, 1918.

**Portion of the Faint Nebulosity Preceding the North  
America Nebula (N.G.C. 7000 Cygni)**

$$\alpha = 20^{\text{h}}49^{\text{m}}7, \quad \delta = +44^{\circ}7' \quad (1925)$$

Negative  $\Delta$  248, Hooker telescope, 1925, July 18. Aperture 84 inches. Eastman 40 plate, exposure  $3^{\text{h}}30^{\text{m}}$

$\Delta$  252, Hooker telescope, 1925, July 20. Eastman Speedway plate, exposure  $4^{\text{h}}45^{\text{m}}$ . Illustrated in Plate VII

The existence of faint nebulosity west of the America nebula is shown on the small-scale photographs of Barnard and Wolf and on plates taken with the 10-inch Cooke lens at Mount Wilson, but these photographs disclose only a little of the interesting detail. The subject of the present study is the brightest portion of this nebulosity, which is situated nearly halfway between  $\alpha$  Cygni and the "isthmus" of N.G.C. 7000. It is shown on the Cooke plate reproduced in my third paper,<sup>1</sup> 30 mm from the right border and 64 mm from the bottom of the illustration.

The character of the nebulosity is much the same as that of the

<sup>1</sup> *Mt. Wilson Contr.*, No. 256, Plate X; *Astrophysical Journal*, 57, Plate XIV, 1923.

southern part of the America nebula proper, consisting of luminous nebulosity in streaks and filaments with numerous dark markings. It is well shown in Plate VII, which is a good reproduction. The brightest star in the illustration is H.D. 199178, visual magnitude 7.56, situated 19 mm from the left edge and 69 mm from the top. In the lower right corner is the glow of light from 56 Cygni, magnitude 5.5. The following features are perhaps especially worthy of notice:

1. The slender dark marking, 2'.5 long, with a faintly luminous core and with a faint star near the end, which extends into the bright nebula eastward from a dark gulf just about the middle of Plate VII.

2. A similar, but shorter, dark indentation in the brightest part of the nebula, about 4' south of the first. Below this are two still smaller dark bays.

3. The long, parallel streaks of luminous nebulosity extending in a SE.-NW. direction across the upper left quarter of the plate.

4. The patch of faint stars extending westward from H.D. 199178.

5. The well-marked line of division between the bright and dark nebulosity that extends southward from the above-mentioned star.

6. The irregularly curved, bright filaments at the south end of the brightest part of the nebula.

The form of the luminous nebulosity has been likened to that of a pelican, the body of the bird being in the brightest part, the head rising nearly to the top of the plate, and the long, open beak extending nearly to the left edge.

Three spectrograms of the star H.D. 199178 are among those made with the spectrograph of the 60-inch telescope. The type is G5, as given in the *Henry Draper Catalogue*, but with unusually diffuse lines. Mr. Adams has kindly told me the result of his determination of the absolute magnitude of the star from these spectrograms, which is 3.5. With the apparent visual magnitude of 7.56 given in the *Henry Draper Catalogue*, this indicates a parallax of about 0".015, corresponding to a distance of 220 light-years. Whether or not this star is associated with the nebula is of course doubtful, but its location at an abrupt turn in the edge of the luminous nebulosity is suggestive.

PLATE VIII

N



E

W

Negative Δ 278

NEBULOSITY FOLLOWING  $\gamma$  CYGNI

Photographed with the 100-inch Hooker telescope, 1925, August 22

Exposure, 4<sup>h</sup>

Scale: 1 mm = 15".8 (same as that of original negative)

**Faint Nebula Following  $\gamma$  Cygni**

$$\alpha = 20^{\text{h}}25^{\text{m}}5, \quad \delta = +39^{\circ}46' (1925)$$

Negative  $\Delta$  273, 60-inch telescope, 1925, August 20. Eastman Speedway plate, exposure 2<sup>h</sup>

$\Delta$  278, Hooker telescope, 1925, August 22. Eastman Speedway plate, exposure 4<sup>h</sup>. Illustrated in Plate VIII

This nebula follows  $\gamma$  Cygni by 6 minutes of time. It is shown 53 mm from the left edge and 82 mm from the bottom of the reproduction of Barnard's photograph made in 1894 with the Willard lens.<sup>†</sup> As shown in Plate VIII, it consists of a mottling of luminous and obscure nebulosities, a conspicuous feature being the large dark marking that extends southwestward from the prominent star, which is 43 mm from the left edge and 37 mm from the bottom of the plate. This star is B.D.  $+39^{\circ}4206 = \text{H.D. } 195255$ , visual magnitude 8.80. Somewhat separated from the main mass of nebulosity, 15 mm from the right edge and 43 mm from the top of Plate VIII, is a nebulous star of the tenth magnitude, the nebulous character of which I believe has never before been recorded. Although not prominent on the photograph, the most conspicuous object seen by the eye in this field is the star 39 mm from the left edge and 44 mm from the bottom of the illustration, which in the field of the great reflector shone out startlingly with a deep red light. It was later identified as the variable star RW Cygni.

On September 1, 1925, I secured a spectrogram of the nebulous star above referred to, and one of H.D. 195255, with the Cassegrain spectrograph of the Hooker telescope, using the rapid camera of 10 inches focal length. Both spectra are of late B type. Mr. Joy, who examined them carefully, considers the brighter star to be of type B<sub>9</sub> and the nebulous star to be somewhat earlier, perhaps B<sub>8</sub>.

**Faint Nebula North-Preceding  $\gamma$  Cygni**

$$\alpha = 20^{\text{h}}14^{\text{m}}1, \quad \delta = +41^{\circ}38' (1925)$$

Negative  $\Delta$  281, Hooker telescope, 1925, August 23. Eastman Speedway plate, exposure 4<sup>h</sup>. Images elongated. Illustrated in Plate IX

This nebula is 1'6 north of  $\gamma$  Cygni, and precedes that star by 5 minutes of time. It is shown 81 mm from the right edge and 94 mm

<sup>†</sup> *Publications of the Lick Observatory*, 11, Plate 76, 1913.

from the top of the reproduction of Barnard's photograph of 1894.<sup>1</sup> It is quite similar in general appearance to the nebula shown in Plate VIII. A nebulous star appears 14 mm from the left edge and 45 mm from the top of Plate IX. This is considerably fainter than the one on Plate VIII, and a spectrogram has not yet been made. The brightest star appearing on Plate IX is B.D. +41°3693, magnitude 8.6, which is 10 mm from the left edge and 20 mm from the top.

MOUNT WILSON OBSERVATORY  
AND WHITTEN OBSERVATORY  
September 1925

<sup>1</sup> *Loc. cit*

PLATE IX

N



W

E

Negative Δ 28r

NEBULOSITY NORTH-PRECEDING  $\gamma$  CYGNI

Photographed with the 100-inch Hooker telescope, 1925, August 23  
Exposure, 4<sup>h</sup>

Scale: 1 mm = 15".7 (1.02 times that of original negative)