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ON THE DARK MARKINGS OF THE SKY
WITH A CATALOGUE OF 182 SUCH OBJECTS

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It would be unwise to assume that all the dark places shown on photographs of the sky are due to intervening opaque masses between us and the stars. In a considerable number of cases no other explanation seems possible, but some of them are doubtless only vacancies.

I do not think it necessary to urge the fact that there are obscuring masses of matter in space. This has been quite definitely proved in my former papers on this subject. If any doubt remains of this it will perhaps be readily dispelled by a close examination of the photographs previously printed. The conclusive ones I think are:

1. The photograph of the nebula about Nu Scorpii[1] which clearly shows partial and complete obscuration by the great wing-like nebula that covers much of the immediate region of Nu Scorpii and extends southward to the great nebula of Rho Ophiuchi.

2. The region of Rho Ophiuchi, where a large space of sky is blotted out by a great and beautiful nebula.[2] The fact of obscuration is clearly evident here, for wherever a trace of the nebula

[1] *Astrophysical Journal*, 31, 1910, Plate I, facing p. 8.

[2] *Ibid.*, Plate II*a*, facing p. 10.

extends, especially to the west, the general background of small stars is sharply blotted out.

3. Especially conclusive is the object (No. 7) which is shown in an article in this *Journal*[1] on a nebulous background in Taurus, where a nebula, only partly luminous, seems to fit in a hole in the sky. Even a casual inspection shows that this nebula can be feebly seen over the entire spot where all the stars are blotted out sharply, and that the absence of stars is due to the obscuring presence of the nebula. This object is really the key to the explanation of most of the dark regions of the sky.

4. The small black spot (No. 92) shown in the photographs in this *Journal* for December 1913,[2] where visual observations prove the existence of a material object.

To me these are all conclusive evidence that masses of obscuring matter exist in space and are readily shown on photographs with the ordinary portrait lenses. What the nature of this matter may be is quite another thing. Slipher has shown spectroscopically[3] that the great nebula about Rho Ophiuchi is probably not gaseous; that is, it does not have the regular spectrum of a gaseous nebula. The word "nebula," nevertheless, remains unchanged by this fact, so that we are free to speak of these objects as nebulae. For our purpose it is immaterial whether they are gaseous or non-gaseous, as we are dealing only with the question of obscuration. In the present paper it is intended to give a catalogue of some of these objects and to show further examples of obscuration and other peculiarities, and to try to emphasize the fact that they are not necessarily confined to the Milky Way but are found in other parts of the sky as well; and also to bring as much evidence as possible to prove that these extra-galactic objects show that space is itself more or less luminous.

Outside of these examples, where the object is partly luminous, there are a number of others which appear to be entirely devoid of light. These are naturally best shown on the bright background

[1] *Astrophysical Journal*, 25, 1907, Plate XI, facing p. 219, and Plate XII, facing p. 221.

[2] *Ibid.*, 38, 1913, Plates XIX and XX, facing p. 496.

[3] *Lowell Observatory Bulletin*, No. 75, 2, 155.

of the Milky Way, against which they appear black on the photographs. Fine examples of these Milky Way objects are the black spots in $\alpha = 18^h8^m$, $\delta = -18°16'$ (No. 92), and in $\alpha = 17^h55^m$, $\delta = -28°$ (No. 86), which are so striking in photographs of the star-clouds in Sagittarius.[1]

The last of these two is very remarkable when seen in a 5-inch telescope with a low power. In such an instrument it appears like a drop of black ink on the bright background of the Milky Way. It was found in my comet-seeking in the early eighties.[2] On account of its extreme blackness it was one of the most impressive objects in the Milky Way. I examined it with the 36-inch refractor of the Lick Observatory with a power of 350 and a field of 6′, on August 18, 1895. It nearly filled the field of view. The western half was fairly well defined, while the eastern half was more diffused. Considerable nebulosity seemed to be connected with it. A photograph on July 11, 1917, with the Crossley reflector, kindly sent me by Dr. H. D. Curtis, shows this black spot to be very remarkable, having considerable nebulosity connected with it. On his photograph its southwest side is very sharply defined, closely resembling in this respect the east side of the black spot in $\alpha = 18^h8^m$, $\delta = -18°16'$ shown in Plate XX.[3] Its east side, like the west side of the foregoing object, is more or less diffused. The star C.D. $-27°12302$ ($7^M.4$) is on the northwest border, while $-27°12310$ ($9^M.0$) is close east of the spot. The beautiful cluster of small bright stars, N.G.C. 6520, is also close east.

Visual observations actually show, however, that the object No. 92 is really feebly luminous. All those that are in the Milky Way are not necessarily devoid of light, for they may appear black by contrast with the greater brightness of the Milky Way. There are numerous examples, however, which are not in the Milky Way and which are perhaps entirely devoid of light. It would seem that such a body would be lost in the blackness of space, but they are

[1] See various plates in *Publications of the Lick Observatory*, 11, and especially Plates 49 and 54.

[2] See *Astronomische Nachrichten*, **108**, 370, 1884, where it is described as "a small triangular hole in the Milky Way. Perfectly black, some 2′ diameter, much like a jet black nebula."

[3] *Astrophysical Journal*, **38**, 496, 1913.

visible as black objects against space itself. I have previously explained this anomaly[1] by suggesting that space is probably filled with a feeble light which forms a slightly luminous background for these dark bodies. Further investigations have fully convinced me that this is actually the explanation of the phenomenon, for there is no evidence of an ordinary nebulous background in these cases. Furthermore, this feeble illumination is widespread and undoubtedly universal (so far, at least, as our stellar universe is concerned), for these dark objects are found in opposite parts of the sky, where there are few stars, and away from any possible brighter background.

One of the finest examples of a dark object seen against the ordinary sky and away from the Milky Way is No. 15, shown on the photographs in $\alpha = 4^h22^m50^s$, $\delta = +46°21'$. It is elliptical, 10′ by 15′ in diameter. The background on which the stars shine is uniform over the entire plate. The object is in a region somewhat larger than itself, where there are relatively few stars, and is black by contrast with the sky alone. It clearly shows the presence of a feeble uniform luminosity in space which, from the appearance of similar objects in widely different parts of the sky, leads to the belief that this feeble illumination of distant space is universal. If this object were seen against the star-clouds of the Milky Way it would appear strikingly black.

There is another and very similar black spot (No. 48) in $\alpha = 16^h53^m$, $\delta = -40°30'$, close west and north of the eighth magnitude star C.D. $-40°11088$. There can be no doubt that this is a material object. There are a number of other similar black masses in this region, as shown by the catalogue.

Another excellent example of this class of objects is No. 160, in $\alpha = 21^h34^m47^s$, $\delta = +55°41'$. The body of this marking is much broken with darker masses. It is convex to the north and passes just below (south of) B.D. $+59°2291$ ($8^M.0$). The western end curves to a slender "tail" which ends close southwest of B.D. $+59°2283$ ($8^M.2$). The eastern end widens out into a large "head" containing much detail, which is more or less convoluted, with sharply defined projections like the horns of an insect.

[1] *Astrophysical Journal*, **43**, 1, 1916.

There seems to be no question but that this is a real, opaque object seen in projection against space. The stars in this region are too few to serve as a luminous background and there is no nebulosity to show it in dark relief, yet it stands out black and strong against the sky.

In previous papers I have dealt mainly with the larger dark masses and occulting nebulosities. The smaller ones that are now treated of are perhaps more interesting in a way than the larger ones. They are more definite and in a sense more clearly show the effect of obscuration of the smaller stars.

The small scale of the portrait lens accentuates the blackness and definiteness of these objects. This is a valuable asset in such a lens; it draws attention to peculiarities which might be lost by diffusion with a more powerful telescope. They are worthy of a careful study, however, with some of the large photographic reflectors. This has already been done, as I have stated, in the case of the black spot (No. 86) in $\alpha = 17^h55^m$, $\delta = -28°$, by Dr. H. D. Curtis with the 36-inch Crossley reflector of the Lick Observatory. I am sure that some of the objects shown in the present photographs will give very interesting results when similarly investigated.

There are two regions which can be reached from the northern hemisphere that are specially rich in these dark markings: (1) the region immediately north of Theta Ophiuchi; (2) the region of the great star-cloud in Scutum near the cluster M 11. There are other regions in which black markings occur, but these two contain the most striking ones, striking for their smallness and peculiarities.

Some of the dark objects in the remarkable region north of Theta Ophiuchi are so strange in their forms that we would find it difficult to match them with similar forms among the real nebulae. This in itself would almost discourage the supposition that they are dark nebulae, and one would rather seek some other explanation for them. In other parts of the sky, however, there seems to be no need of hesitation in accepting them as real, obscuring masses, most probably dark nebulae.

Perhaps one of the finest of the large dark regions (No. 78) lies several degrees southeast of Theta Ophiuchi. It is a large, irregular, dark spot some 3° in diameter and less definite on the eastern

side. There is considerable detail in it of a more or less nebulous character. This is specially evident near the bright star C.D. $-26°12152$ ($6^M.2$). Westward from this region a broken dark lane extends for about 5° to what I have called the "sink hole," because of its peculiar form and outlines. This sink hole (No. 59) is full of rich detail. Similar structural detail shows at frequent intervals along the broken lane (which is about $\frac{3}{4}°$ wide) to its origin in the larger dark region southeast of Theta Ophiuchi. Splendid half-tone reproductions of this remarkable region have been published in *Popular Astronomy*.[1]

The bright nebulae seldom show extraordinary forms. Some of them, however, exhibit structural details and general forms that are very remarkable and that sometimes are very beautiful, such as the zigzag, streaky, or "lace" nebula in Cygnus, the great nebula of Orion, and many of the planetary nebulae. It is possible then that the objects north of Theta Ophiuchi are, after all, only exceptions to the general run of nebulous forms and are similar to such objects as those in Cygnus and elsewhere among the bright nebulae.

A peculiarity of the dark markings in the star-cloud in Scutum is that some of the well-defined spots are uniformly gray, while others are either entirely black or have much blacker, well-defined spaces in them. In nearly every case their outlines are very definite and few have stars in them.

To the east of the $4^M.5$ star B.D. $-4°4582$ (6 Aquilae) and north of the cluster M 11 is a beautiful region of dark structures (No. 111). It forms a wide crescent with the convex side to the west, sharply bounded by the neck and head of the splendid star-cloud in which M 11 is placed. It is irregular and broken to the east. Its width north and south is about 2°. This area is full of dark structures, the more conspicuous ones being Nos. 106, 107, 110, and 113. The two stars B.D. $-5°4775$ ($8^M.3$) and $-5°4778$ ($8^M.4$) are near the middle of this region. The center would be in about $\alpha = 18^h44^m$, $\delta = -5°\ 6'$.

In many cases one side of a dark marking is very definite, while the other side is diffused. This occurs so often that there must

[1] *Popular Astronomy*, 14, 579 (December), 1906, Plates XIII and XIV.

be some reason for it. The same peculiarity is sometimes seen in the bright nebulae, the great nebula of Orion being a striking example. Three of these objects, which are very much alike, and which show this feature strongly, are No. 50, $\alpha = 16^h54^m42^s$, $\delta = -34°12'$; No. 143, $\alpha = 19^h35^m30^s$, $\delta = +10°43'$; No. 160, $\alpha = 21^h33^m40^s$, $\delta = +55°40'$. The first two very closely resemble each other in size and form and the third differs from them only in a small degree.

The dark object (No. 133) close to the $9^M.2$ star B.D. $-7°4852$, which looks like a negative of a comet with a curved tail, more or less fan-shaped, was examined with the 40-inch telescope July 14, 1917 (see Fig. 1). It was clearly evident that there is a faint hazy object

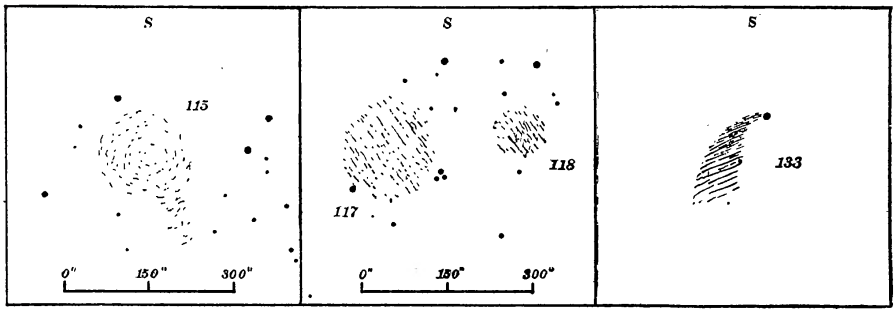


FIG. 1.—Sketched from visual observations of Nos. 115, 117, 118, and 133, with the 40-inch telescope.

at this place. It is dull and feebly luminous compared with the adjacent sky. It is very dark at its south end and curves northward for nearly 10′. The northern part, which is more diffused, is broken by a few faint stars. Obscuring matter of some kind certainly exists at this point. Furthermore, it is not black except by contrast. In this respect it very much resembles the dark object (No. 92) in $\alpha = 18^h8^m$, $\delta = -18°16'$, which was examined with the 40-inch telescope in July 1913.[1] Two other objects, Nos. 127 and 129, were carefully examined on this date. The object No. 127 is similar except in form to the one just described. It seems to be a dull, feebly luminous mass as in the case of the other, with no definite outline. Sweeping rapidly over these objects with the telescope

[1] See *Astrophysical Journal*, 38, 496–501, 1913.

there is no hesitation as to their actual presence where the photograph shows them. There is no evidence of ordinary nebulosity at these points except the feeble, dull appearance described.

One remarkable thing in this visual investigation is the conspicuousness of the B.D. stars everywhere, while on the photographs

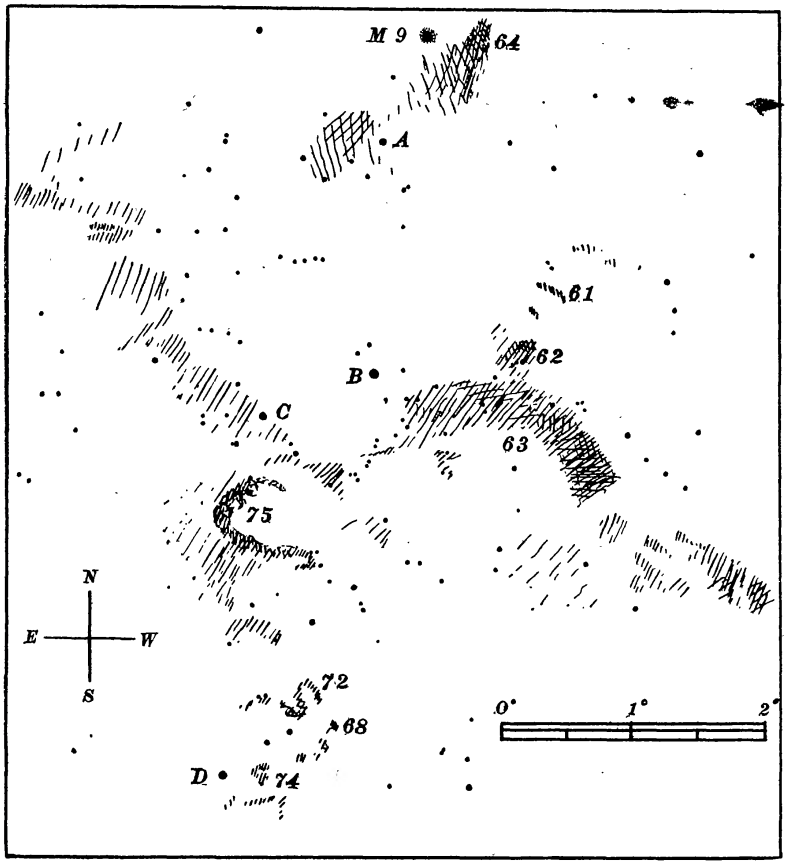


FIG. 2.—Sketch map of Plate I

they are difficult to make out. Evidently the sky comes up luminous on the photographs from the myriads of small stars not seen in the telescope. It is this general effect of unseen stars which do not show individually, either in the telescope or on the photograph, that helps to round out the great star-cloud. Doubtless there is not a star on the plate that cannot be seen in the large telescope, but I am not sure of this. It is mainly the light from unseen stars that makes the white background of the photographs against which the dark markings show so conspicuously.

In these observations the sky was satisfactory and the seeing fairly good. To me the result is conclusive that these markings are real objects seen in dark relief on the bright background of the Milky Way. They are certainly not holes in the star-cloud. The definite outlines which appear so striking on the photographs are not seen in the sky. They are lost through the great magnifying power of the telescope. On July 18, 1917, the small objects Nos. 115, 117, and 118 were similarly examined and sketches made. The spot No. 118 shows some detail, or different degrees of darkness, while No. 117 is uniformly dark or dusky.

The great partially dark nebula (No. 7) in $\alpha = 4^h 4^m 14^s$, $\delta = +28°28'$, reference to which has already been made in the beginning of this paper, is irregularly round, with a wide extension to the west to about $\alpha = 4^h 1^m$, $\delta = +27\frac{1}{2}°$ or $+28°$. The object is unevenly dark with a brighter condensation in its eastern part. Its diameter along the east and west extension is 2°; north and south its diameter is 1°.2. The bright condensation (No. 10) is 8′ in diameter and is in $\alpha = 4^h 10^m 57^s$, $\delta = +27°58'$. There are several small, round, black spots in the northern part of the dark nebula. Their approximate positions are:

α	δ	
$4^h\ 8^m\ 6^s$	$+28°31'.0$	Indefinite; diameter 8′
4 9 26	+28 20.5	Round; diameter 5′
4 10 10	+28 21.6	Round; diameter 5′
4 10 44	+28 9.5	Length 15′ north and south; width 5′; involving B.D. +28°637 ($9^M.5$)

The region for some distance about this great dark nebula is very remarkable and suggestive. Beginning at about $\alpha = 4^h 9^m 50^s$, $\delta = +27°25'$, an irregular dark lane about 10′ wide with unequal dark markings in it runs southeast for $2\frac{1}{2}°$ nearly to another large obscure nebula (No. 22). A similar dark lane beginning at a group of large dark spots (No. 18) in $\alpha = 4^h 23^m 40^s$, $\delta = +24°5'$, runs westerly in a curved and irregular manner for about 4°.

These lanes are all definite and dark on the sky, independent of the background of stars.[1] There are indications of considerable

[1] See *Astrophysical Journal*, **25**, 218, 1907, where photographs of the region are given.

areas of feeble nebulosity for several degrees in this region. These will be treated of in a later publication.

No. 144 of the catalogue is a very large, unequally dark area in a very rich region of the Milky Way. Its general outlines are fairly distinct and somewhat abrupt except toward the south, where it widens out and becomes lost in the general groundwork. Over this large area the dense background of small stars is wanting, but there are scattered over it everywhere a great many stars, big and little. Its eastern side near the north end is partly covered by a protrusion over it of the denser part of the Milky Way, which quite obliterates it for a degree or more. The northern end of this area is more or less rounded and is terminated at the northeast side by a sharper projection in $\alpha = 20^h 3^m$, $\delta = +36\frac{1}{2}°$. This great partial vacancy is probably due to an actual thinning out of the small stars in this region, for it does not have the appearance of obscuring matter.

To illustrate the remarkable appearance of some of these objects the accompanying half-tone plates have been prepared. These show the peculiarities as they appear on ordinary portrait-lens photographs. The brief descriptions of the objects shown in the illustrations are based on an examination of the original negatives. The engravings are good, but they fail to show the more delicate structures which are so clear on the photographs and are such important features of these objects. Therefore, if there should be any difficulty in identifying all the features described, it must be attributed to the failure of the half-tones to show them.

DESCRIPTION OF THE PLATES

PLATE I

This shows the region north of Theta Ophiuchi and its rather fantastic markings as a whole. The glow from Theta is seen at the lower edge of the plate. By comparing this picture with the chart (Fig. 2) the relative positions of the various objects shown in some of the other plates can readily be seen.

PLATE II

Two of these queer markings are shown here, the lower being readily recognized as one of those on Plate I. It is a curious, narrow, looped, black marking (No. 75) that covers about a degree in its peculiar windings. It

occupies a considerable space and one position will not represent its place. The upper or north part of it is in $\alpha = 17^h17^m44^s$, $\delta = -21°51'$. From this point it bends to the east, passing close south of the star B.D. $-21°4598$ ($8^M.3$) and then south and west to an abrupt stop in $\alpha = 17^h15^m44^s$, $\delta = -22°21'$. A diffused branch springs from it and curves easterly and southwest again in a very broken manner. At this point there is much dark detail of an irregular nature. Close north and west of this object, just above (and involving) the star B.D. $-21°4591$ ($9^M.5$) is a very dark, irregular figure (No. 67*a*).

This marking is almost exactly duplicated in its scalloped appearance by a similar one (No. 84) in $\alpha = 17^h39^m$, $\delta = -20°12'$, which is shown in the upper picture of this plate. It lies between the stars B.D. $-20°4865$ ($8^M.2$) and $-20°4869$ ($9^M.1$) and curves a little to the north. The resemblance of these two strange objects and their peculiar character is very striking.

PLATE III

These are two more of the dark objects north of Theta Ophiuchi. The upper one (No. 63) is the very large definite curved marking. Its southwest end strikingly and abruptly terminates in $\alpha = 17^h6^m14^s$, $\delta = -21°41'$. In the original negative there is much dark detail in this object.

The lower picture shows the S-shaped marking (No. 72) in $\alpha = 17^h16^m17^s$, $\delta = -23°37'$, and several of the very black spots south of it.

PLATE IV

The upper right-hand object (No. 133) resembles a dark comet with a small definite head and curved fan-shaped tail. The main body seems to be a sharply defined, black, lozenge-shaped object which forms the head and part of the body, from which a diffused extension runs north, forming the tail of the "comet." A description of the visual appearance of this object with the 40-inch telescope is given in the present paper, page 7. The position of the dark head, which lies very close west of the star B.D. $-7°4852$ ($9^M.2$), is $\alpha = 18^h59^m29^s$, $\delta = -7°4'.8$.

The picture immediately beneath this one, to the right, is that of a similar "cometary" object (No. 64), just west of the compressed cluster M 9. It is somewhat cometary in form and has a very black core or head that sharply abuts against the thick stratum of stars; from this it spreads out into a large dark area with much dark detail, filling quite a space close southwest of M 9. It thus resembles a dark comet with a dense and well-defined head and diffused widening tail. The position of the head is $\alpha = 17^h9^m57^s$, $\delta = -18°20'.6$.

The upper left picture of this plate shows a chain of several dark spots, two of which (Nos. 127 and 129) are quite small, black and irregular in form. The northern one (No. 129) has a very narrow black streak running from it to the northeast. I have examined these also with the large telescope with a result similar to that of the spots previously mentioned. Their position is $\alpha = 18^h55^m$, $\delta = -5°40'$.

In the fourth, or lower left, picture is a small, round, well-defined, black spot (No. 98) less than 3′ in diameter. This could readily be taken for a black planetary nebula, which, in reality, it may be. Its position is closely $\alpha = 18^h25^m31^s$, $\delta = -26°9'$. It is not seen on a bright part of the sky for it lies in, and near the south edge of, a rather broad dark pathway in the Milky Way. It is some 3′ south and following the star C.D. $-26°13264$ (10^M).

I did not at first believe in these dark obscuring masses. The proof was not conclusive. The increase of evidence, however, from my own photographs convinced me later, especially after investigating some of them visually, that many of these markings were not simply due to an actual want of stars, but were really obscuring bodies nearer to us than the distant stars. In this way it has fallen to my lot to prove this fact. I think there is sufficient proof now to make this certain. For some years I have tried to secure long-exposure photographs of as many of these bodies as possible. This has resulted in the location of a considerable number of them in different parts of the sky. Their apparent preference for the bright regions of the Milky Way is obviously due to the fact that they are more readily shown with a bright background. They are, however, not strictly confined to the Milky Way.

Among the first to look upon these dark places as real matter was Mr. A. C. Ranyard, whose lamentable death occurred December 14, 1894. A short time previous to his death he gave a series of papers on the Milky Way and the nebulae, in *Knowledge*, of which magazine he was editor. In speaking of the dark lane south and east of Theta Ophiuchi on a Lick photograph of mine which he reproduced,[1] he says: "The dark vacant areas or channels running north and south of the bright star [θ Ophiuchi] at the center . . . . seem to me to be undoubtedly dark structures, or obscuring masses in space, which cut out the light from the nebulous or stellar region behind them."

There is a list of starless fields given in Appendix I of Webb's Celestial Objects, taken from the Cape observations of Sir John Herschel. These, however, are quite different from the ones I have been dealing with and are in most cases perhaps only real vacancies among the stars.

[1] *Knowledge*, **17**, 253 (November) 1894.

For some time I have hoped to make a catalogue of the dark markings shown on my photographs of the sky. The exact location of these objects is desirable so that their study with powerful photographic telescopes may be possible. There seems to be no question that some of them are real objects which are either entirely devoid of light or so feebly luminous when seen against the Milky Way as to appear black. As mere curiosities of the sky alone their cataloguing would be desirable, but as real opaque objects between us and the more distant stars their exact location would seem to be important. Their study with the present means of research will be of the highest interest. With this idea in view I have collected a number of these objects shown on my negatives to form the following catalogue.

This catalogue is necessarily incomplete; it is constantly being added to. Later, a more complete list will be printed. The places are closely approximate. An effort was made to measure the positions with exactness, but on account of the nature of the objects it was found to be practical to do this in only a few cases.

All the positions in the catalogue and throughout this paper refer to the epoch 1875.0.

NOTES ON THE CATALOGUE

No.

8 Very much like the dark lanes east of Rho Ophiuchi.

9 This is the middle of a great vacancy extending east and west, the continuous part of which is $2\frac{1}{2}°$ long and about $\frac{1}{2}°$ wide. It really extends in a more or less broken form for about 6°. There is a wide region extending south of it for a couple of degrees, nearly to the star B.D. $+53°$ 750 ($5^{M}.0$) whose position is $\alpha = 4^{h}6^{m}58^{s}$, $\delta = +53°18'$. To the east it breaks up into more or less separate spots, somewhat resembling those at the east end of the great lane from Rho Ophiuchi, but unlike that lane it does not originate in a larger vacant space or a nebula. Its borders are not so definite as the Rho Ophiuchi lane. It is approximately bounded by the co-ordinates $\alpha = 3^{h}58^{m}$, $\delta = +54°.7$ and $\alpha = 4^{h}20^{m}$, $\delta = +54°.8$. The individual positions of some of the spots are given in the catalogue.

11 This lane is about $2°.6$ long and roughly $22'$ across. It is very much like the lanes east of Rho Ophiuchi. See No. 8.

12 South of No. 11. Irregularly round with an extension east from the northeast side.

CATALOGUE OF 182 DARK MARKINGS IN THE SKY

No.	α 1875.0	δ 1875.0	Description
1.....	$3^h25^m14^s$	+30°44′	Large, indefinite; diam. ½°
2.....	3 25 44	+31 54	Indefinite; elongated east and west; diam. 20′
3.....	3 32 14	+31 34	Irregular; diam. 20′; dark space in nebula
4.....	3 36 14	+31 24	Very large; indefinite
5.....	3 39 15	+32 8	Indefinite; elongated northeast and southwest; diam. 1°. B.D. +32°667 (5^M8) near northeast side
6.....	3 46 31	+55 45	Round; indefinite
7.....	4 4 14	+28 28	Large, irregular; brighter condensation in southeast part
8.....	4 7 53	+54 56	The center of No. 11
9.....	4 9	+54 45	Dark irregular lane
10.....	4 10 57	+27 58	The bright part of No. 7
11.....	4 16 37	+54 45	East end of irregular lane
12.....	4 19 52	+53 58	Isolated dark spot; diam. 24′
13.....	4 21 17	+54 37	Irregular; diam. 11′
14.....	4 22 13	+25 31	Very small, bright nebula; diam. 3′
15.....	4 22 50	+46 21	Elliptical dark marking; diam. 10′ by 15′ slightly northwest and southeast
16.....	4 23 20	+46 20	Very small; elongated north and south; close to southeast edge of No. 15
17.....	4 23 25	+46 15	Very small; elongated north and south; close to east edge of No. 15
18.....	4 23 40	+24 5	Diam. 1°; group of dark spots
19.....	4 25	+26 0	Large; indefinite; diam. 1°
20.....	4 27 30	+50 43	In the south part of larger, relatively vacant area nearly 1° in diam.
21.....	4 27 51	+55 6	Indefinite; irregularly round; diam. 10′
22.....	4 31	+25 48	Irregular; unequally dark; extended southeast and northwest; diam. 2°
23.....	4 32 41	+29 38	Diam. 5′; sharply pointed to the southeast
24.....	4 35 0	+29 30	Diam. 8′; sharply pointed to the south
25.....	4 42 56	+45 48	Irregularly round; diam. 8′
26.....	4 46 39	+30 25	Irregular; diam. 5′
27.....	4 47 11	+30 21	Irregular; diam. 5′
28.....	4 47 54	+30 26	Irregular; diam. 4′
29.....	4 58 5	+31 55	Round; indefinite; diam. 10′
30.....	5 23 8	+12 21	Large dark area with few stars; diam. 67′
31.....	5 25 8	+12 38	Diam. 30′; extended northeast and southwest; the east part of No. 30
32.....	5 25 8	+12 20	Dark projection from the south end of No. 31 to the east
33.....	5 34 36	− 2 32	Dark mass, diam. 4′, on nebulous strip extending south from ζ Orionis
34.....	5 35 20	+32 21	Round; starless; indefinite; diam. 20′
35.....	5 39 5	+ 8 51	Round; diam. 13′
36.....	5 43 5	+ 7 23	Irregular narrow dark lane 2° long, northeast and southwest
37.....	6 26 14	+10 34	Irregular semi-vacant region 2½°–3° long
38.....	6 26 45	+11 10	Irregular vacancy; diam. 1°
39.....	6 31 8	+10 26	Small, sharply defined.
40.....	16 7 24	−18 39	Diffused dark spot; diam. 15′; small star in it
41.....	16 14 24	−19 20	Diffused dark spot; diam. ¾°
42.....	16 18	−23 9	Great nebula of ρ Ophiuchi

CATALOGUE OF 182 DARK MARKINGS IN THE SKY—*Continued*

No.	α 1875.0	δ 1875.0	Description
43.....	16^h23^m s	−19° 30′	Large dark region
44.....	16 33	−23 50	Dark lane east from Rho Ophiuchi region
44*a*....	16 38 8	−40 6	Round; diam. 2′. Close south of C.D. −40°10662
45.....	16 39 11	−21 22	Rather definite, 2° long
46.....	16 49 42	−22 32	Irregular; definite
47.....	16 52 12	−22 27	Irregular; definite; diam. 15′
48.....	16 53	−40 30	Fairly well defined; 26′ long
49.....	16 54 30	−33 5	Small; close southeast of and involving C.D. −33°11668 ($9^M.3$)
50.....	16 54 42	−34 12	Large, irregular, dark space; 10 mag. star in middle
51.....	16 56 12	−22 12	Definite; diam. 20′
52.....	16 57 14	−22 2	Irregular; diam. 13′
53.....	16 58	−33 25	Large; diffuse, extended north and south
54.....	16 58 30	−34 10	Small, round; diam. 5′; close north of 11 mag. star
55.....	16 59 28	−31 51	Irregular; diam. 16′; best defined southeast
56.....	17 0 43	−31 56	Small; diam. 3′
57.....	17 0 50	−22 43	Diam. 5′; elongated northeast and southwest
58.....	17 2 30	−40 20	Round; diam. 27′; a darker core at northeast side
59.....	17 3 35	−27 19	Sink hole; diam. 1°
60.....	17 4 21	−22 17	Curved; 13′ long; extended northeast and southwest
61.....	17 7 26	−20 18	Small; elongated east and west
62.....	17 8 46	−20 44	Diam. 19′; very black in northwest part
63.....	17 9 19	−21 17	Very large; definite; curved; west end abrupt
64.....	17 9 57	−18 21	Cometary; west of M 9
65.....	17 11 50	−26 34	Definite; elongated east and west
66.....	17 12 2	−26 46	Definite; extended east and west; 8′ long
67.....	17 13 14	−26 44	Definite; extended north and south; joins Nos. 65 and 66
67*a*....	17 14 58	−21 46	Irregular; definite; diam. 13′
68.....	17 15 4	−23 40	Small; irregular; sharply defined; diam. 4′; southwest of No. 72
69.....	17 15 19	−23 48	Very small; irregular; sharply defined; extends north and south 4′
70.....	17 15 30	−23 55	Diam. 4′; sharply defined on west side
71.....	17 15 36	−23 53	Very small; diam. $1\frac{1}{4}$±
72.....	17 16 17	−23 37	S-shaped
73.....	17 16 46	−24 9	Very small; diam. 1′; extended north and south
74.....	17 17 30	−24 2	Diam. 5′
75.....	17 17 47	−21 55	Curved and scalloped marking
76.....	17 18	−24 18	Irregular; narrow
77.....	17 21	−23 45	Indefinite; diam. 1°
78.....	17 25	−25 30	Very large; diam. 3°
79.....	17 27 44	−19 19	$\frac{1}{2}$° long (southeast and northwest); narrow; sharply defined
80.....	17 30 16	−21 11	Small; definite; 3′ long, 1′ wide, southwest and northeast
81.....	17 30 55	−23 51	Very small; diffused
82.....	17 31 0	−23 42	Small; angular; well defined
83.....	17 31 20	−24 6	Irregular; diam. 7′
83*a*....	17 37 57	−19 57	Small, definite; diam. north and south 4′
84.....	17 39	−20 12	Sharply defined; length north and south 22′
84*a*....	17 48 40	−17 9	Round; diam. 16′; extension $\frac{3}{4}$° south
85.....	17 53 50	−23 1	Trifid nebula. See note

CATALOGUE OF 182 DARK MARKINGS IN THE SKY—*Continued*

No.	α 1875.0	δ 1875.0	Description
86.....	$17^h55^m\ 9^s$	−27° 52′	Diam. 5′; several small stars in it
87.....	17 56 14	−32 6	"Parrot's head"; C.D. −32°13686 ($9^M.8$) central; several smaller stars in it
88.....	17 56 56	−24 7	Length north and south 2′.7, width 0′.5; in M 8
89.....	17 57 20	−24 22	Very small; diam. 0′.5; in M 8
90.....	18 2 20	−28 18	Irregular; diam. 2′.7
91.....	18 2 30	−23 43	Diam. 5′; edge of diffused nebulosity
92.....	18 8 16	−18 16	Black spot, 15′ north and south, 9′ east and west
93.....	18 10 14	−17 52	Cometary
94.....	18 18 37	−10 44	Roundish; diam. 15′; indefinite
95.....	18 18 37	−11 49	Large; indefinite; diam. 30′; elongated
96.....	18 19 7	−10 19	Small; indefinite; elongated
97.....	18 23 7	−10 0	Irregular; not very definite; diam. 1°
98.....	18 25 31	−26 9	Very small; sharply defined
99.....	18 25 48	−21 34	Definite; 11′ long east and west, 3′ wide
100.....	18 26 7	− 9 14	Definite; irregular; curved; 16′ long northwest and southeast
101.....	18 26 7	− 8 54	Definite; irregular; 13′ long northeast and southwest, 4′ wide
102.....	18 30 37	−13 51	Rather definite; 8′ long northeast and southwest, 3′ wide
103.....	18 32 42	− 6 47	Irregular; diam. 4′; one small star in it
104.....	18 40 42	− 4 47	Small, definite, caret-shaped object
105.....	18 41 2	− 7 3	Very small; diam. ½′; close northeast of B.D. −7°4710 ($8^M.9$)
106.....	18 42 11	− 5 13	Diam. 2′; extended north and south; free of stars
107.....	18 42 52	− 5 9	Irregular; diam. 5′; free of stars
108.....	18 42 52	− 6 27	Very small, diam. 3′
109.....	18 42 57	− 7 43	Irregular; diam. 0′.7; close east of B.D. −7°4726 ($8^M.0$)
110.....	18 43 30	− 4 59	Irregular; diam. 11′
111.....	18 44	− 5 6	Region 2° in diam., full of dark structures
112.....	18 44 25	− 6 49	Diffused dark region; diam. 18′±
113.....	18 44 43	− 4 28	Diam. 16′; irregular; small star in west part
114.....	18 46 27	− 7 6	Dark spot with two small stars in it
115.....	18 46 36	− 6 49	Very small and black
116.....	18 46 48	− 7 11	Narrow semi-vacant region running south from B.D. −7°4755 ($9^M.1$)
117.....	18 46 58	− 7 34	Round; very black; diam. 1′; sharply defined
117*a*....	18 47 4	− 5 0	Black; irregular; diam. 7′
118.....	18 47 10	− 7 36	Definite; diam. 2′
119.....	18 47 59	− 4 42	Very small; close northwest of B.D. −4°4623 ($9^M.2$)
119*a*....	18 48 0	− 5 20	Irregular dark region; diam. ½°
120.....	18 48 16	− 4 45	Very small; close southeast of B.D. −4°4623 ($9^M.2$)
121.....	18 48 48	− 4 46	Small dusky spot; 12 mag. star in center
122.....	18 50 11	− 4 55	Small; diam. 4′; narrow extension 4′ north
123.....	18 51 2	− 4 53	Roundish; diam. 1½′
124.....	18 51 5	− 4 31	Small dark spot; diam. 3′
125.....	18 51 45	− 4 33	Dark; lune-shaped; diam. 9′
126.....	18 52 25	− 4 42	Dusky; round; rather definite; diam. 8′
127.....	18 54 52	− 5 37	Irregular; diam. 4½′
128.....	18 55 3	− 4 45	Irregular; dusky; fairly well defined; diam. 10′
129.....	18 55 3	− 5 29	Very black; sharply defined; diam. 5′
130.....	18 55 16	− 5 45	Dusky; not well defined; length 7′

CATALOGUE OF 182 DARK MARKINGS IN THE SKY—*Continued*

No.	α 1875.0	δ 1875.0	Description
131.....	$18^h55^m39^s$	− 4° 33′	Black spot; diam. 0′.7; curve of small stars north
131*a*....	18 56 32	− 4 31	Diam. 3′
132.....	18 57 51	− 4 37	Dark; fairly well defined; diam. 8′
133.....	18 59 29	− 7 5	Cometary; close west of B.D. −7°4852 ($9^M.2$)
134.....	19 0 11	− 6 26	Round; diam. 6′
135.....	19 0 57	− 4 7	Large dusky spot; diam. 13′
136.....	19 3 0	− 4 12	Dusky spot; diam. 8′; 10 mag. star near middle
137.....	19 9 32	− 1 33	Projection near south end of No. 138
138.....	19 10	0 0	Great curved semi-vacant lane over 3° in length
139.....	19 11 32	− 1 38	Narrow black spot; 10 mag. star on southeast edge
140.....	19 13 39	+ 4 59	Semi-vacant region; diam. 1°
141.....	19 13 52	+ 1 40	Semi-vacant region north of north end of No. 138; diam. 16′
142.....	19 34 0	+10 18	Large; irregular; close west of B.D. +10°4016 ($8^M.7$)
143.....	19 35 30	+10 43	Rather narrow angular marking
144.....	19 54	+34 30	Large semi-vacant region; 6° by 3°
145.....	19 58 16	+37 21	Sharply defined; ¾° long east and west
146.....	19 58 49	+35 40	Very small
147.....	20 2 7	+35 1	Very narrow sinuous dark lane 11′ long east and west
148.....	20 45 30	+59 12	Very small; round; indefinite; diam. 3′
149.....	20 46 28	+59 4	Very small; round; indefinite; diam. 2′
150.....	20 47 47	+59 50	Curved dark marking; 1° long
151.....	21 4 41	+55 49	Very small; very dark; diam. 1′
152.....	21 11 30	+61 13	Small; 15′ by 3′ southeast and northwest
153.....	21 17 42	+55 55	Black, irregular; diam. 1′
154.....	21 18 1	+56 5	Narrow; 8′ long northeast and southwest
155.....	21 27 25	+44 25	Round; diam. 13′; indefinite
156.....	21 29 17	+45 2	Diam. 8′; sharp-pointed to north
157.....	21 29 34	+54 1	Round; diam. 5′
158.....	21 32 22	+42 51	Dark spot; diam. 3′
159.....	21 33 30	+42 40	Irregular partially vacant region; diam. 25′
160.....	21 33 40	+55 40	Large, dark, irregular; diam. 31′ northeast and southwest
161.....	21 36 38	+57 5	Small, black spot
162.....	21 37 8	+55 55	Very thin, curved, dark strip north and south
163.....	21 37 38	+56 5	Small; very black; pointed to the south
164.....	21 42 2	+50 31	V-shaped vacancy; diam. 5′–10′
165.....	21 45 10	+59 38	Length east and west 18′, width 1′
166.....	21 47 16	+59 30	Round; diam. 5′; small star on southwest edge
167.....	21 48 8	+59 29	Small; irregularly round; diam. 5′
168.....	21 48 32	+46 41	Small nebula at east end of dark lane
169.....	21 53 38	+58 25	Elliptical black ring; diam. 1°
170.....	21 51 50	+58 22	Irregular black strip 26′ long northeast and southwest
171.....	21 57 43	+58 16	Irregular broken region; diam. 19′
172.....	22 2 43	+58 36	Irregular dark spot
173.....	22 2 53	+59 4	Diam. 4′; rather definite
174.....	22 3 8	+58 28	Narrow; irreg.; 19′ long northeast and southwest
175.....	22 11	+69 19	Large; diam. 1°; bright nebula in north part

No.

13 Irregularly darker inside with a rather sharp, short, narrow extension toward the south.

14 A bright spot in the dark nebula No. 22.

15 See description on page 4.

20 This is the dark object mentioned by Espin in *M.N.*, **58**, 334, 1898. It is close north of a small group of faint stars and is 6′ or 8′ in diameter. In a somewhat larger vacant space. It is not so definite as No. 15.

22 This is a very large region of obscure nebulosity with several darker streaks in it trending northwest. It is partly separated from another starless region lying about 2° to the west and north. Near the middle of the first of these regions is a small luminous nebula with a faint fan-shaped extension for 10′ to the northeast. This is undoubtedly a brighter condensation of the great obscuring mass surrounding it. The position of this small nebula is: $\alpha = 4^h32^m13^s$, $\delta = +25°30'.7$.

25 This is a good example of a dark or more or less starless region.

26 Nos. 26, 27, and 28 are close northwest of B.D. +30°741 ($6^M.8$). (This star is involved in feeble nebulosity.)

30 There is a nebulous border, ½° wide, to the semi-vacant region extending 1° east and north from B.D. +12°803 ($7^M.0$). Apparently this nebulous border extends many degrees east in a very diffused manner. There is a narrow dark lane extending south from the semi-vacant region, running close west of B.D. +12°803 to a point nearly 1° due south of B.D. +12°801 ($6^M.9$). There is a small fan-shaped nebula close north of a small star in the position $\alpha = 5^h24^m30^s$, $\delta = +12°3'.9$. A small strip of nebulosity extends 5′ southwest from this small star. These two nebulae are probably the brighter parts of a large obscure nebulosity.

33 See *Astrophysical Journal*, **38**, 496, 1913, Plate XX.

35 This has an extension to the southeast. There are three small stars north of it.

37 This region is abruptly terminated on the south side by the nebulosity extending north from 15 Monocerotis. Its west side ends abruptly in $\alpha = 6^h22^m15^s$, $\delta = +12°26'$.

39 A small elongated spot in the nebulosity from 15 Monocerotis.

40 This spot and No. 41 are connected with the great nebula about Nu Scorpii and are doubtless denser opaque masses of the nebula. There is a larger dark region belonging to this same system in $\alpha = 16^h23^m$, $\delta = -19°30'$ (No. 43), from which broken dark lanes somewhat like those from Rho Ophiuchi, though less marked, run eastward for some degrees.

42 This object is put in the list because, though not wholly dark, it is partly so, and the evident obscuration produced by it puts it in the class for which the catalogue is made. The semi-vacant region in which this, the great nebula of Rho Ophiuchi, lies is about 3½° in diameter.

44 This is the middle of the main part of the great vacant lane that runs east from the region of Rho Ophiuchi. It is about 32′ wide and has its

No.

beginning in a vacant area in which is the star C.D. $-24°12695$ ($5^{M}.5$), $\alpha = 16^{h}22^{m}38^{s}$, $\delta = -24°51'$. It runs slightly northeast to about $\alpha = 16^{h}40^{m}$, $\delta = -23°40'$. From this point it extends in a broken chain of dark spots to a little south of No. 63. Its total length is therefore about 10°.

44*a* This appears to be a real, dark object.

45 Extended northeast and southwest with an irregular projection southwest that connects it with the Rho Ophiuchi region. This appears to be a real, dark object.

46 A string of small stars in the middle.

47 Connected with No. 51 by two sharp lanes.

48 Extended northeast and southwest. Close west and north of C.D. $-40°11088$ ($8^{M}.0$). This seems to be a real object.

50 This is an irregular square 15′ in diameter, sharply defined on the east side and diffused on the west, where there are broken extensions for ½°. The star C.D. $-34°11418$ ($9^{M}.8$) is near the middle. The stars C.D. $-34°11422$ ($9^{M}.8$), $-34°11426$ ($9^{M}.8$), and $-34°11427$ ($9^{M}.9$) are on the eastern border.

51 Two straggling dark lanes run west to No. 47.

52 One of a straggling group toward the eastern end of the dark lane from Rho Ophiuchi.

55 C.D. $-31°13582$ ($8^{M}.9$) near the center.

56 Close east of C.D. $-31°13609$ ($9^{M}.0$) and $-31°13618$ ($9^{M}.3$). This seems to be a real object.

59 At the west end of a wide broken lane from No. 78.

60 This and No. 57 are the most distinct of a group of dark spots southwest of the square end of No. 63.

62 This seems to be a real object.

63 This is the center of a great curved figure convex to the north 1°37′ long and 19′ wide. See description of Plate III.

64 See description of Plate IV.

72 This is a striking object. It is a thin, curved black marking, the exact form of the letter *s* or the figure 5, as the imagination or point of view may dictate. The southeast branch runs east for some distance passing close south of the star C.D. $-23°13370$ ($9^{M}.9$). Its average thickness is about 2′ to 3′. The position in the catalogue is for the southern part of the figure, or the bottom of the *s*. See Plate III.

74 Slightly curved, extending 5′ north from the star C.D. $-24°13325$ ($7^{M}.1$). It is sharpest on the west and south sides.

75 B.D. $-21°4598$ on the north edge. See description of Plate II.

76 This is a broken, black strip, ½° long, extending east and west.

77 Connected by a vacant strip with No. 78.

78 C.D. $-26°12152$ ($6^{M}.2$) is south of the middle.

80 Close southeast of B.D. $-21°4674$ ($8^{M}.1$).

81 Close southwest of N.G.C. 6401.

No.

82 8′ north of N.G.C. 6401.

83 Narrow extension to the south. Several small stars in it.

84 See description of Plate II.

84*a* B.D. −19°9457 ($9^{M}5$) in the center.

85 This is the southern part of the Trifid Nebula, N.G.C. 6514. The dark markings in this nebula are too well known to insert in this catalogue.

86 There is a small cluster close east of this spot. See page 3.

88 There are other well-known markings in this nebula. This one and No. 89 are given as illustrations of dark markings in the sky shown in relief against a nebulous or other luminous background. In this case these may be non-luminous opaque parts of the nebula itself.

90 There are many similar dark spots in this region, but this one is perhaps the most distinct and is fairly characteristic of the others.

91 This is a round, sharply defined, dark bay in the east side of a very diffused nebulosity which extends east from M 8. Photographs on July 26 and 27, 1905, show the planet Uranus in this bay. It was nearly central in the bay on July 27.

92 This black spot is very sharply defined on its east edge but less definite on the west. There is a twelfth magnitude star near the middle with several other small stars. See *Astrophysical Journal*, **38**, 496, 1913, Plate XX, for an account of this remarkable object.

93 This object has a sharply defined black head 2′ in diameter with a diffused tail 15′ long running south. See Plate XX, as in last note.

98 See description of Plate IV.

99 The east end is the larger with a faint star in it.

100 Larger at east end; diameter 12′. There is a small star in the southeast edge.

101 Separated from No. 100 by a scattering of small stars.

103 Apparently a real object, the south of several dark markings covering a space 45′ in diameter. They form a notched outline to the northwest side of the large star-cloud in Scutum.

104 This consists of a narrow straight black line 16′ long north and south, with a narrow spur at the south end extending west and north for 5′. The width of these lines is about 0′.7.

108 This object is not black. There are two narrow diverging lanes extending to the north. Some small stars in it.

110 Free of stars. A small star near the west edge.

111 See page 6 for description.

112 Perhaps due to want of stars.

115 Very narrow, running north and south for 7′; width 1′.4. It is in a small vacant region.

117 This is on the border of a larger dark region with dark lanes running to the north and northeast. It is separated from No. 118 by several very small stars.

No.

118 More definite and blacker than No. 117.

119*a* This is liberally sprinkled with stars in its northwest half. There are several narrow dark lanes in its southeast portion.

120 The east side is bounded by a curve of very small stars.

122 Round, small, and black. The entire object is fairly well defined and uniformly dark. There is a small star 4′ to the northeast.

123 This has a narrow spur 4′–5′ long from its northeast edge, and a narrow lane 18′ long and 1½′ wide from its west side to the northwest.

125 Fairly well defined on the north border. Some faint stars in it.

126 An irregular narrow dark streak extends 9′ to the northeast; another from its south side runs close to B.D. −4°4650 ($7^{M}.4$). A small star in the northeast edge.

127 Very black in its southeast portion, diffused on the west side. A short line of faint stars on its west edge.

128 A narrow extension 13′ long from the northeast side. A small star close west of it. This is in a larger vacant region.

129 Very black, sharply defined, with a considerable small star at the west end. Somewhat rectangular in form with projections to the east. It is the blacker western portion of a dark region 10′ in diameter. Nos. 127, 129, and 130 are connected in an irregular curve convex to the west.

131*a* This is a very small black spot with a small star on the north border and another on the south, with a fine curve of six or seven very small stars running northwest from its north edge.

132 Tadpole-shaped with B.D. −4°4680 ($9^{M}.0$) in center of the larger (west) part. Length east and west 16′.

133 This object begins very close west of B.D. −7°4852 ($9^{M}.2$). From this it gradually widens and curves north like a plume, with the convex side west, to a distance of about 18′. The south end is intensely black. The northern part is dark with 4 or 5 considerable (small) stars in it. See description of Plate IV.

134 This is dark, but not sharply defined. There is a small star on the south edge and a similar one on the north edge.

135 The star B.D. −4°4698 ($9^{M}.2$) is on the north border and B.D. −4°4702 ($9^{M}.2$) on the southeast border.

138 Perhaps the most striking feature of this great curved "lane" is the definiteness of its eastern outline. To the west it is less definite and in the lower, south, half it consists of dark branching structures which blend into a part of the Milky Way relatively dimmer than that to the east. The stars embraced by the curve to the east are much brighter or coarser than those to the west. If the stars to the west were fewer in number, or fainter, the eastern outline would closely resemble the great head of the star-cloud near M 11 in Scutum. The southern termination is in a small, comet-shaped, very black spot, apparently a real object, sharply defined on its south edge.

No.

139 This spot is the beginning of a great curved lane ending in about $\alpha = 19^h14^m$, $\delta = +1\frac{1}{2}°$. This lane is concave to the east, on which side it is more definite.

143 The outline of a square $\frac{1}{2}°$ in diameter, with the west side missing.

144 See page 10.

145 This is a triangular semi-vacant area. It is covered by a sprinkling of considerable small stars with the star B.D. $+37°3736$ ($9^M.5$) in the center.

146 This spot is like a dark border, to the southwest side of the star B.D. $+35°3930$ ($7^M.0$).

150 This is the center of the dark marking. Its head is in the position $\alpha = 20^h51^m0^s$, $\delta = +59°45'$. The west end or tail is in $\alpha = 20^h43^m50^s$, $\delta = +49°20'$. This object is fully described in the text.

151 This appears to be a real object in a slightly larger vacancy.

152 Close north of B.D. $+61°2103$ ($8^M.9$). See *Astrophysical Journal*, **43**, 1, 1916. It is there wrongly stated that the object is south of the B.D. star. The west end is larger with a small star in it.

154 The star B.D. $+55°2565$ ($7^M.4$) is at the south end.

155 There are four small stars in a line crossing this object east and west.

156 The star B.D. $+44°3865$ ($4^M.1$) is central.

157 A semicircle of faint stars forms the western border.

158 This spot is similar to those in the region of No. 159. There are some others north and west of this.

159 This is the center of an irregular, partially vacant region 25′ in diameter. It is suggestive of the presence of a dark or faint nebulosity, as there are several small darker spots in it. It lies 40′ northwest of Nova Cygni of 1876, and involves the stars B.D. $+42°4177$ ($5^M.2$), $+42°4172$ ($8^M.4$) and $+42°4164$ ($7^M.7$). It is somewhat extended east and west. A very long exposure on this region would doubtless be interesting.

160 The east side is best defined with two dark projections from it 30′ apart. An irregular, narrow, dark lane runs north from it for 2° to a large nebulous region.

161 This is one of the comet-shaped objects. The head is very sharp and black, 3′ across. This extends north for some 3′, then widens out into a less dense tail about 13′ long.

162 A curve of small stars on the southwest end.

163 There are two dark streams running from this to the north.

165 B.D. $+59°2424$ ($7^M.8$) is on the north edge and B.D. $+59°2427$ ($7^M.7$) near the southeast end.

168 This nebula is 10′ in diameter with over a dozen small stars of different magnitudes in it. There is no central condensation, nor does the nebula condense about any of the stars. There are some dark markings in it. The dark lane is 1°.7 long and 9′ wide. See *Lick Observatory Publications*, **11**, Plate 81.

No.

169 This incloses an island of small stars. The dark ring is broadest on its east side where its thickness is 22′. The northern part is very black and straight.

170 This is the northwest border of the island of small stars. It is sharply defined and darker than the sky.

171 This is at the east end of the island of small stars.

173 There is a small star on the north edge and also one on the southwest edge.

175 This is a large dark spot, extended north and south, 62′ in its largest diameter. In its upper part is the star B.D. +69°1231 ($8^{M}.8$) which is nebulous. This is apparently a large dark nebula, the brighter part of which forms the star +69°1231. In *Monthly Notices*, **69** (December) 1908, Dr. Max Wolf gives a photograph of the nebula, stating that the object was discovered by Dr. Kopff at Heidelberg on October 12, 1908. It is conspicuous on a photograph of mine made with the Willard lens at the Lick Observatory, September 24, 1895, with $5^{h}0^{m}$ exposure. It is also shown on a photograph of mine made with the Bruce telescope, July 20, 1904, with an exposure of $3^{h}1^{m}$. By inadvertence reference to this object was omitted in *Lick Observatory Publications*, **11**, where it is cut out by the matting in Plate 83.

I am greatly indebted to Miss Mary R. Calvert for invaluable aid in the preparation of this catalogue.

YERKES OBSERVATORY, WILLIAMS BAY, WIS.
December 10, 1918

STUDIES BASED ON THE COLORS AND MAGNITUDES IN STELLAR CLUSTERS[1]

NINTH PAPER: THREE NOTES ON CEPHEID VARIATION

By HARLOW SHAPLEY

At least three classes of stars may be independently used to ascertain the distances of globular clusters through luminosity correlations—Cepheid variables, B-type stars, and the giants of the redder spectral classes. The giant red stars in local parts of the galactic system, as well as in globular clusters, are now known to have a limited dispersion of absolute luminosity; and if we should assume the absolute magnitude in the mean to be the same in both regions, it is readily shown that the resulting parallaxes of the clusters would be closely comparable with the values obtained in the present investigation.[2] The stars of spectral type B (color-class *b*) form a second class of objects that are generally recognized as valuable criteria of distance, not only because of a fairly small dispersion of intrinsic brightness, but also because much is known of the actual absolute magnitudes through studies of community motion and parallactic drift. Apparently, however, there is a tendency for B-type stars to fall into groups that may differ in real brightness by one or two magnitudes,[3] thus introducing a large percentage of uncertainty into the distances depending on magnitude correlations. If, as seems necessary from related investigations, the most luminous *b*-class stars in clusters are equated in luminosity with the galactic B stars that have an average absolute magnitude near zero, the distances of globular clusters (and of all Cepheids) are essentially as now adopted. On the other hand, if the brightest *b*-class stars

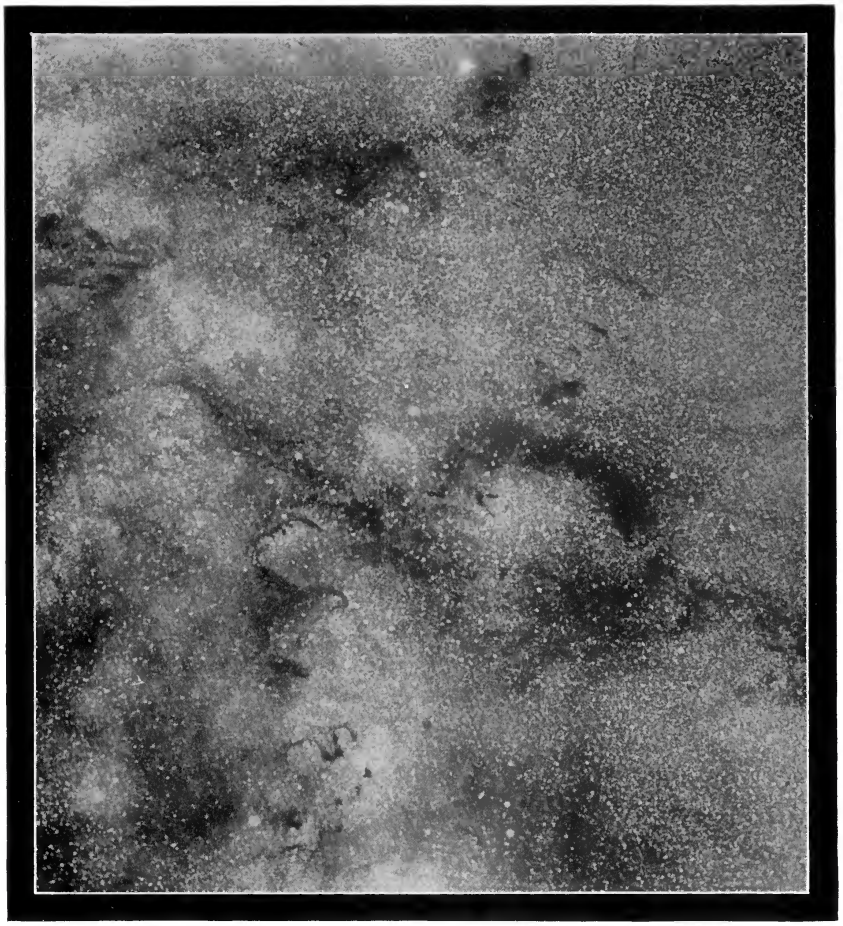
[1] *Contributions from the Mount Wilson Solar Observatory*, No. 154.

[2] For example, see Division III of the parallax determinations of Messier 13 listed in Table XXVII of *Mt. Wilson Contr.*, No. 116, 1915. The parallax there derived from red giants is 0".00010; that now adopted is 0".00009. Applying this method we would readily obtain also the absolute magnitudes of all Cepheids, and then derive practically the same individual parallaxes for them as given in the eighth paper.

[3] Kapteyn, *Mt. Wilson Contr.*, No. 82, 1914; Charlier, *Meddelanden från Lunds Astronomiska Observatorium*, Series 2, No. 14, 1916.

PLATE I

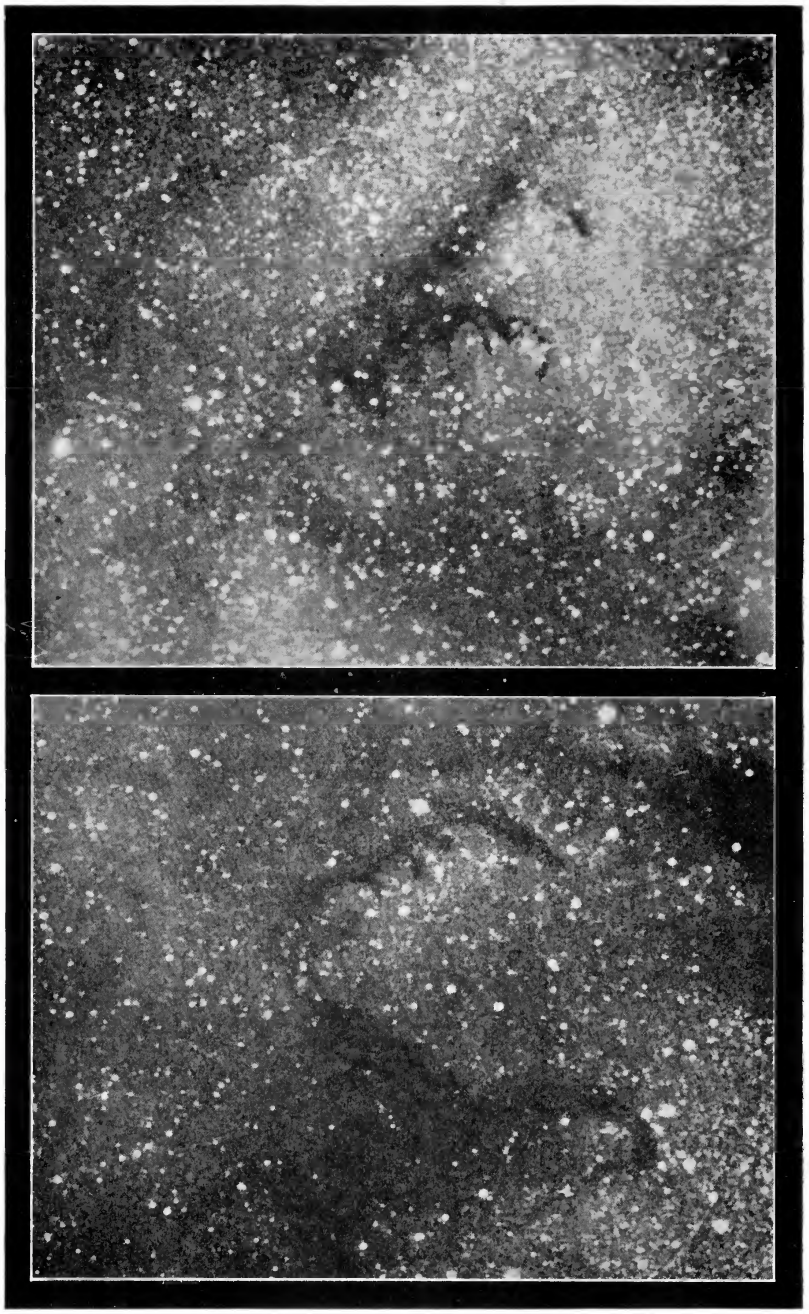
North



REGION NORTH OF THETA OPHIUCHI
$\alpha = 17^h\ 13^m$, $\delta = -21^\circ\ 0'$
Scale: $1^{mm} = 234''$

PLATE II

North



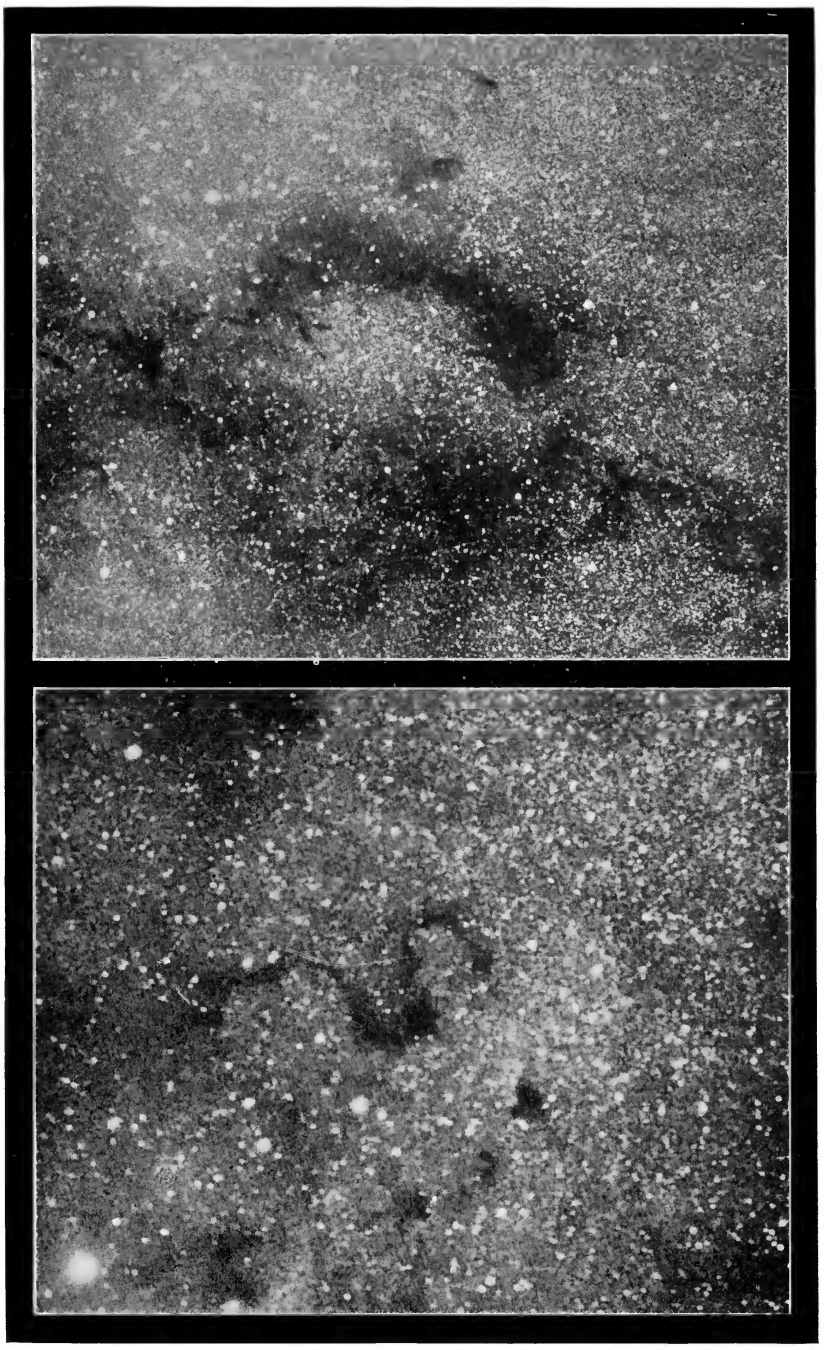
a

b

a) No. 84. $\alpha = 17^h39^m$, $\delta = -20°12'$. Scale: $1^{mm} = 49''$
b) No. 75. $\alpha = 17^h18^m$, $\delta = -21°55'$. Scale: $1^{mm} = 59''$

PLATE III

North



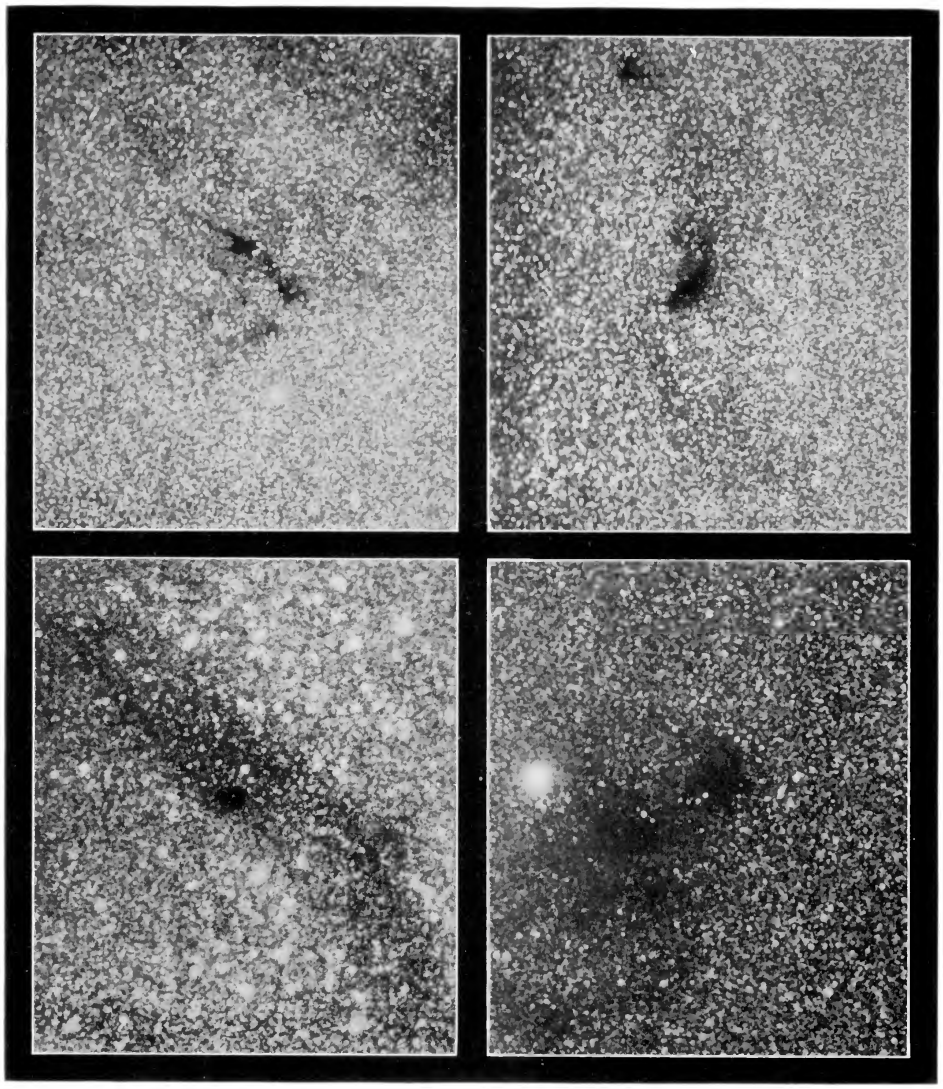
a

b

a) No. 63. $\alpha = 17^h\ 9^m$, $\delta = -21°17'$. Scale: $1^{mm} = 160''$
b) No. 72. $\alpha = 17^h 16^m$, $\delta = -23°37'$. Scale: $1^{mm} = 60''$

PLATE IV

North



a) Nos. 127 and 129. $\alpha = 18^h55^m$, $\delta = -5°37'$
Scale: $1^{mm} = 93''$

b) No. 133. $\alpha = 18^h59^m$, $\delta = -7°5'$
Scale: $1^{mm} = 89''$

c) No. 98. $\alpha = 18^h26^m$, $\delta = -26°9'$
Scale: $1^{mm} = 63''.5$

d) No. 64. $\alpha = 17^h10^m$, $\delta = -18°21'$
Scale: $1^{mm} = 78''$