

ASTRONOMY

Dark Nebulae

"A Classic of Science"

Strange Dark Shapes Against the Background of Stars Appear to be Nebulae of Dead, Non-luminous Matter

ON THE DARK MARKINGS OF THE SKY with a Catalogue of 182 such Objects. By E. E. Barnard. In *The Astrophysical Journal*, vol. XLIX, No. 1, Chicago, 1919. This is an exact reprint of extracts from the original publication.

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 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. The fact of obscuration is clearly evident here, for wherever a trace of the nebula 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* 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, 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 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 of the Milky Way, against which they appear black on the photographs. . .

All those that are in the Milky Way are not necessarily devoid of light, for

they 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 visible as black objects against space itself. I have previously explained this anomaly 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. . . .

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 $\alpha=17^{\text{h}}55^{\text{m}}$, $\delta=-28^{\circ}$, by Dr. H. D. Curtis with the 36-inch Crossley re-

Lanston Monotype

the other giant, which shares with the linotype the work of getting out our constant flood of printed literature, will be the next Classic Invention.

Edward Emerson Barnard died February 6, 1923, at the age of 66. At the time of his death he was working on an Atlas of the Milky Way, since published by the Carnegie Institution, to which his investigation of dark nebulae was incidental. Another of his outstanding contributions to astronomy was his discovery of the fifth satellite of Jupiter, September 9, 1892.

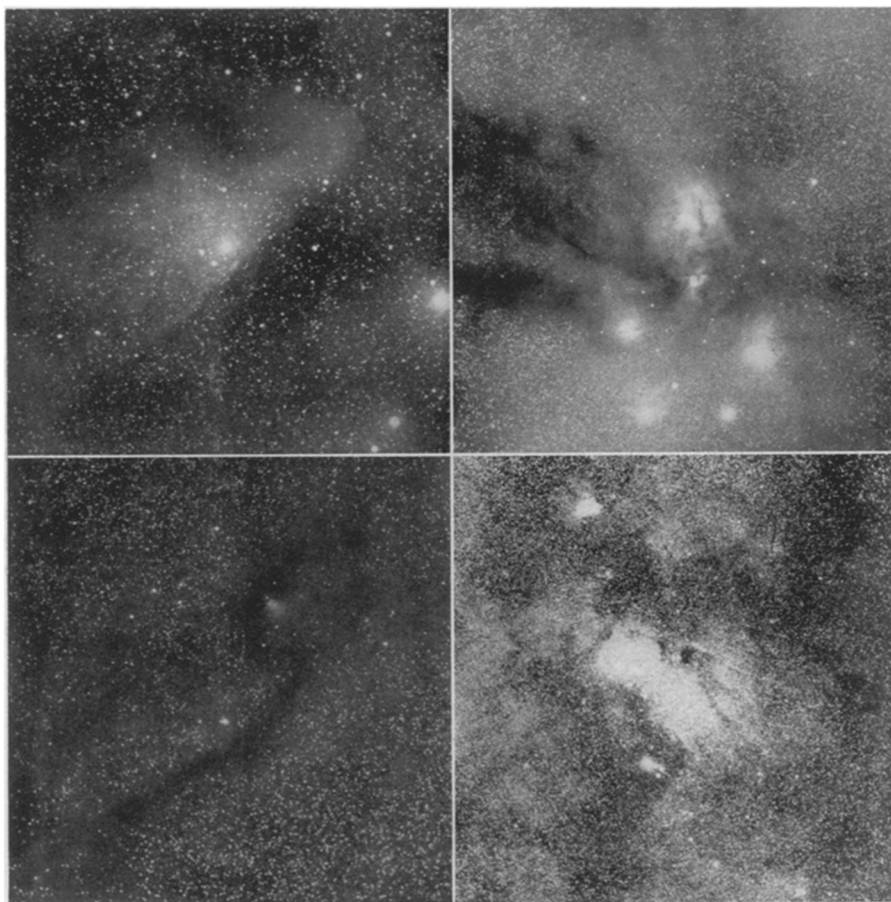
flector of the Lick Observatory. I am sure that some of the objects shown in the present photographs will give very interesting results when similarly investigated.

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. $-26^\circ 12152$ ($6^m.2$). 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 $\frac{1}{2}^\circ$ 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*.

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.



NEBULAE BLOTTING OUT STARS

These four photographs seemed to Dr. Barnard conclusive proof that the dark masses of matter are between us and the stars, cutting off their light from us.

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. . . .

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

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 oc-

curred 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, he says: "The dark vacant areas or channels running north and south of the bright star (Theta Ophiuchi) at the center. . . . seem to me to be undoubtedly dark structure, 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.

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. . . .

Science News Letter, February 4, 1933

PSYCHOLOGY

Women Quicker but Men Better at Prolonged Thought

WOMEN are superior to men in those mental tasks which require attention to details and a quick adaptation to a rapidly changing situation. But men are superior where quick responses are not so important as a grasp of the problem as a whole—where it is necessary to hold the attention for a prolonged period in order to carry a thing through to its logical conclusion.

These sex differences were observed in the psychological laboratories of Indiana University, Bloomington, by Dr. Hanna M. Book, who reported her findings in the *Journal of Social Psychology*.

In a test such as that of comparing two parallel columns of figures, where each item is quickly finished and one must go on to the next, women were found to excel. Men were better on maze tracing where the whole pattern must be kept in mind until a solution is found.

After a nerve fiber has been excited by any stimulus such as those constantly occurring during mental work, there follows a brief period during which the nerve fiber is inactive and cannot respond to further excitement. This refractory or inexcitable or non-irritable period is extremely short, measured in mere thousandths of a second, and is very difficult to determine. So far sex

differences, if any, have not been noted. But Dr. Book explains the sex differences in mental activity she has observed as being possibly a result of such sex differences in the refractory period.

Women, she said, probably have shorter refractory periods. Therefore, their nerves transmit a greater number of impulses per unit of time, which, being physiologically a more intense stimulus, would account for their ability to respond quickly to more details and to rapid changes in environment. Men have longer refractory periods and therefore fewer impulses per unit of time, which would account for a slow, massive, deliberative sort of thinking in men.

"In general, if the task is fractional, that is divided up into parts, the women are better; if, however, the task is continuous, the men are superior," Dr. Book said.

Science News Letter, January 28, 1933

New knowledge of the Bacchic mysteries is gained by study of a statue base of the second century A.D., which once supported a statue of a priestess of the Dionysian cult and which bears the names of about 400 initiates who dedicated the monument to her.

GENERAL SCIENCE

Foundations Alter Support of Researches

AMERICAN foundations continued their support of research during 1931 despite economic conditions, it appears from a report issued by the Twentieth Century Fund.

Although the total of grants for research was cut more than two million dollars from 1930 to 1931, this reduction represented less than 19 per cent. of nearly thirteen millions which were given out in 1930. The type of research aided changed considerably, however, reflecting a change of interests during the year. Researchers in general education, international relations and aesthetics were reduced 78 per cent., 64 per cent., and 73 per cent. respectively; while research in social welfare was increased 205 per cent., research in government increased 263 per cent., and research in agriculture and forestry increased 264 per cent.

Other less extreme instances in which funds were diverted to channels aiding the present situation more directly are shown by the following increases and decreases in grants for research: Physical sciences decreased 48 per cent., engineering reduced 12 per cent., social sciences increased 21 per cent., and humanities decreased 28 per cent. Research in economics was increased 49 per cent.

Medical research received more aid from foundations in 1931 than in 1930, gaining 40 per cent., although medical education suffered a loss of more than thirteen million dollars.

Over \$54,000,000 Given

The total of the grants covered in the report of the Twentieth Century Fund amounted to fifty-four and a half millions of dollars, of which by far the greatest proportion went for aid in education. The wide variety of activities to which money has been donated, the report said, range all the way from cave dwellers' art and the causes of pessimism in the Middle Ages to the preserving of game birds, maintenance of undertaking parlors and research into ventilation, comfort stations and interstellar complications of modern times. The decrease in the total below the amount granted in 1930 was about 24 per cent.

Science News Letter, February 4, 1933