

**A PHOTOGRAPHIC ATLAS OF SELECTED REGIONS
OF THE MILKY WAY**



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EDWARD EMERSON BARNARD

1857-1923

A PHOTOGRAPHIC ATLAS OF SELECTED REGIONS OF THE MILKY WAY

By

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*Professor of Practical Astronomy in the University of Chicago and Astronomer
at the Yerkes Observatory 1895-1923*

EDITED BY

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PART I

PHOTOGRAPHS AND DESCRIPTIONS



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PREFACE

THE publication of this *Atlas*, in accordance with the desires of Professor Barnard, was assured by a grant made by the Carnegie Institution of Washington in 1907. The long delay in its appearance calls for an explanation. Mr. Barnard was in the throes of preparing for publication a volume of his pioneer celestial photographs made at the Lick Observatory in the years 1889-1895. He had difficulty in satisfying himself that any mode of reproduction could adequately depict the qualities of the original photographs.

That handsome work, which forms Volume XI of the *Publications of the Lick Observatory*, was not printed until 1913. It was natural and proper that the preparation of the present volume should have been delayed while the task of completing the earlier volume was in hand. The mode of reproduction to be adopted for the splendid photographs of this *Atlas* had not been selected at the time the original grant was made, and consequently considerable investigation and experiment were necessary in reaching a decision on this important matter. The attempts made with the photogravure and other processes did not give the assurance of uniformity that was desired, and finally the author was persuaded that actual photographic prints would be more satisfactory and hardly more expensive than any other available method of reproduction. After this decision had been reached and had been approved by the Carnegie Institution of Washington, Professor Barnard began the task of making the reproducing negatives, and then took upon himself the heavy duty of personally inspecting every print of the 35,700 needed in the issue of an edition of 700 copies. He made frequent trips to Chicago during the years 1915, 1916, and 1917 for this purpose and spared no pains to assure himself that the prints were uniform in quality and faithfully represented the originals.

The printed descriptions were written by him after a most careful study of the prints as well as of the original negatives. Professor Barnard's well-known eagerness to observe the heavens whenever the sky was clear left him little time for the remainder of the preparation of the work for publication. The reduction and publication of current observations had, with him, the right of way, and therefore it was not until late in 1922 that the first draft of the descriptions of the photographs was ready. Unfortunately, the form of publication of the whole of the *Atlas* had not been settled up to the time of Mr. Barnard's death, although we had had many discussions upon the subject. It had been decided that, in addition to the photographs, there should be given

pen-and-ink sketches of the fields, with a system of co-ordinates by which the positions of all distinctive markings and other objects of interest could be readily noted. The form of the tables, giving further details of objects designated on the charts, had been arranged for the most part by Professor Barnard. The plan of issuing the work in two parts, so that the student of the *Atlas* can simultaneously have before him the photograph, its description, the key charts, and the tabular data of the objects designated, has been adopted after Mr. Barnard's death, but I believe that it would have had his approval.

In the case of the text descriptive of the photographs, the wording which Professor Barnard used has been preserved as closely as possible. Square brackets have been occasionally placed about sentences or paragraphs for which responsibility could not be assigned to the author. He left many scattered notes intended for the Introduction. These have been utilized as far as possible in carrying out the author's intention. His notes and comments were written down at times within a period of nearly a decade, during which his own views were changing and becoming more definite in certain directions. For example, when the *Atlas* was first planned, Professor Barnard certainly did not entertain the view that the dark markings could be anything else than vacancies in the sky. But his minute study of his many photographs gradually convinced him of the correctness of the views advanced by some other astronomers that these were dark or faintly luminous objects. The reader may easily detect the course of this changing opinion, although it could not always be brought out in its proper chronological sequence.

The increasing interest in these dark objects, as their nature has thus come to be better understood, has seemed an adequate reason for including in Part I "The Barnard Catalogue of Dark Objects," now reaching the number of 349. These will probably be designated most conveniently in the future by their numbers in this catalogue, as B 170 or B 250, etc. Hundreds more of them will doubtless be located and described on these photographs or on others by future investigators.

The title assigned in 1907 to this work was *An Atlas of the Milky Way*. It was not until much later that the final choice of areas to be included was made by Professor Barnard. That title implied that at least a large part of the Milky Way was included. This would have required from three to four times the number of photographs for which provision could be made. Accordingly, it seemed to me best, after the

printing was begun, that the title should be changed to its present form, which correctly indicates that the *Atlas* deals with selected areas of the galaxy and that it does not attempt to include more. The diagram on page 14 of the Introduction will give a proper idea of the distribution of the plates over the galaxy.

During the years of work on the *Atlas*, Mr. Barnard wrote several of his most important articles on the Milky Way for appearance in the *Astrophysical Journal*. The following may be especially cited: "Dark Regions in the Sky Suggesting an Obscuration of Light," *Astrophysical Journal*, **38**, 496-501, 1913; "A Great Nebulous Region Near Omicron Persei," *ibid.*, **41**, 253-258, 1915; "Some of the Dark Markings in the Sky and What They Suggest," *ibid.*, **43**, 1-8, 1916; "On the Dark Markings of the Sky with a Catalogue of 182 Such Objects," *ibid.*, **49**, 1-23, 1919.

It was the author's expressed intention to use freely in his Introduction extracts from these papers, since, as he said, they correctly express the opinions held by him at the time of the conclusion of his work on the *Atlas*. Limitation of space has not permitted the inclusion of many such extracts, and the reader is therefore advised to consult these papers in his use of the *Atlas*. Attention is called to the bibliography of Professor Barnard's principal papers in the field of celestial photography, printed on pages 15-17 of the Introduction.

The writer could hardly have undertaken the responsibility of completing this unfinished work upon the death of Mr. Barnard, had it not been possible for the Observatory to retain the services of Miss Calvert, who, as Mr. Barnard's personal assistant, had been associated with the undertaking from its beginning. She had assisted the author in laying out a system of co-ordinates on the key charts, which she sketched under his personal supervision. She also began with him the preparation of the tables of objects noted on the charts, and later completed these, besides checking, with meticulous care, all numerical data for both parts of the *Atlas*. She also completed the supplementary list of dark objects begun by Mr. Barnard, determined their positions, and assigned them their numbers. I hereby express to her my appreciation of her large share in the editorial duties.

May 31, 1927

I wish also to thank the officials of the Carnegie Institution of Washington for their patience in waiting for so many years for the publication of this work and for the generosity with which they have supported it. I desire also to acknowledge my appreciation of the care and attention which has been given to this publication by the University of Chicago Press, and in particular by Mr. A. C. McFarland, manager of its Manufacturing Department. An acknowledgment of the fine service rendered by the photographers, Messrs. Copelin, has been given on page 13.

To all astronomers and most of the amateurs of the present generation, the remarkable observational achievements of Edward Emerson Barnard are familiar. Since this *Atlas* may come into the hands of some who have had little acquaintance with the development of astronomical photography it may be appropriate to say a few words regarding the career of Mr. Barnard to whom this *Atlas* may be considered in some sense a memorial volume.

Born at Nashville, Tennessee, on December 16, 1857, he had little opportunity for education, owing to poverty. The mystery of the starry heavens caught his attention as a lad, and almost his first purchase beyond actual necessities was a telescope with which he might penetrate farther into the illusive study of the details of the nocturnal sky. As a small boy and until young manhood, he supported himself by working at Nashville in a photographic establishment in which he learned all the details of the art, an invaluable preparation for the future application of this knowledge to the celestial field. He discovered many comets, nebulae, and other objects of interest, with his small visual telescope, and later took courses at Vanderbilt University. He made such a name for himself that he was called to be an astronomer on the staff of the Lick Observatory at its inauguration in 1888. This brilliant period of discovery and observation continued until 1895 when he came to the University of Chicago to be an astronomer at the Yerkes Observatory. Here he labored with extraordinary assiduity and with distinguished success, from the opening of the Observatory in 1897 until ill health put an end to his observations at the close of 1922.

EDWIN B. FROST

INTRODUCTION

MY PRINCIPAL aim in presenting these photographs has been to give pictures of some of the most interesting portions of the Milky Way in such form that they may be studied for a better understanding of its general structure. They are not intended as star charts. Such photographic charts have already been made by Wolf and Palisa and by Franklin-Adams. They are probably more useful for the identification of individual stars. But these do not give us a true picture of the parts of the sky shown, for there are structures and forms that cannot well be depicted in ordinary charts, and it has seemed to me that some of these are of the utmost importance in the study of the universe at large. These photographs may, therefore, be considered as supplementary to the regular charts in that they show the details of the clouds, nebulosities, etc. In this form, however, it is always difficult to identify the individual small stars. To overcome this difficulty charts have been prepared corresponding to each photograph and giving on the same scale a set of co-ordinates, and all the principal stars and objects of especial interest. The most useful reference stars are numbered, as are the dark objects. These charts and the tables, which give fuller data about the reference stars, will be found in Part II. It is recommended that in studying any photograph the reader should open Part II to the corresponding chart, and then he will have before him the photograph or plate, the author's text descriptive of it, the chart, with its co-ordinates, including most of the stars of the *Bonner Durchmusterung*, and the table supplementary to the chart.

The Milky Way has always been of the deepest interest to me. My attention was first especially attracted to its peculiar features during the period of my early comet-seeking. Indeed, there is no work in observational astronomy that gives one so great an insight into the actual heavens as that of comet-seeking. The searcher after comets sees more of the beauties of the heavens than any other observer. His telescope, though small, usually has a comparatively wide field of view, and is amply powerful to show him most of the interesting parts of the sky. To him the Milky Way reveals all its wonderful structure, which is so magnificent in photographs made with the portrait lens. The observer with the more powerful telescopes, and necessarily more restricted field of view, has many things to compensate him for his small field, but he loses essentially all the wonders of the Milky Way. To me the views of the galaxy were the most fascinating part of comet-seeking, and more than paid me for the many nights of unsuccessful work. It was these views of the great structures in the Sagittarius region of the Milky Way that inspired me with the desire to photograph these extraordinary features, and one of the greatest pleasures of my life was when this was successfully done at the Lick Observatory in the summer of 1889.

DESCRIPTION OF THE BRUCE PHOTOGRAPHIC TELESCOPE¹

My experience at the Lick Observatory with the Willard portrait lens impressed me with the importance of that form of instrument for the picturing of large regions of the heavens.

¹ Extracted from Professor Barnard's article in the *Astrophysical Journal*, 21, 35-48, 1905.

That lens, which was purchased at second hand from a photographer in San Francisco, was made for, and originally used in, taking portraits—from which fact its name has come. These large short-focus lenses were necessary in the days of wet-plate photography to gather a great quantity of light and to give a brilliant image to lessen as much as possible the time of sitting. But when the rapid dry plates came into use these lenses were no longer needed, and much smaller, more convenient, and less expensive lenses took their place. The great light-gathering power for which they were so valuable in the wet-plate days makes them specially suitable for the photography of the fainter celestial bodies. They were made on the Petzval system and consisted of two sets of lenses, from which fact they are also called “doublets.” In this paper I shall refer to them mainly as “portrait lenses,” as that name appeals more directly to me.

The main advantage of the portrait lens lies in its grasp of wide areas of the sky and its rapidity of action—this last result being due to its relatively short focus. The wide field makes it especially suitable for the delineation of the large structural details of the Milky Way; for the discovery of the great nebulous regions of the sky; for the investigation of meteors and the determination of their distances; and especially for the faithful portrayal of the rapid changes that take place in the forms and structures of comets' tails.

The portrait combination is not intended in any way to compete with the astrographic telescopes, or with any of the larger photographic refractors or reflectors. It must be considered as supplemental to these, because their limited field confines them to

small areas of the sky. There is a great and valuable work for these larger telescopes, however, in the accurate registration of the places of the stars, for parallax, and, in the reflector, for depicting the features of the well-known nebulae, etc.

There is, I think, however, a question as to the most advantageous size for a portrait lens, and I have believed that the best results can be obtained with an instrument of moderate size; or, in other words, I believe that a portrait lens can be made too large to give the very best results, just as it can be too small. It is also true that both large and small portrait lenses are individually valuable. There is a kind of supplementary relationship between them. The small one will do work that the large one cannot do; and the reverse of this is equally true; for though the small one is quicker for a surface—such, for instance, as the cloud forms of the Milky Way present to it—the larger one, mainly on account of its greater scale, will show details that are beyond the reach of the smaller one. Another important fact is that as the size of the lens increases, the width of the field rapidly diminishes, and width of field is one of the essential features of the value of the portrait lens.

There would, therefore, seem to be a happy mean, when the available funds limit the observer to one lens only.

As a matter of experience, it has seemed to me that a lens of the portrait combination about 10 inches in diameter would best serve the purpose of the investigations that have just been outlined.

For several years I had tried to interest someone in the purchase of such a lens, but without success. Finally, I brought the matter before Miss Catherine

W. Bruce, who had done so much already for the advancement of astronomy. In the summer of 1897 Miss Bruce placed in my hands, as a gift to the University of Chicago, the sum of \$7,000 for the purchase of such an instrument and for the erection of a small observatory to contain it.

The instrument consists of a 5-inch guiding telescope and two photographic doublets of 10 and 6¼ inches aperture, rigidly bound together on the same mounting. An unusual delay was produced by my anxiety to get the best possible lens for the purpose.

The long exposures demanded in the work of an instrument of this kind require an unusual form of mounting to give an uninterrupted exposure. The mounting of the Willard lens was an ordinary equatorial and was not made specially for it. It did not permit an exposure to be carried through the meridian, except in southern declinations. This was a great drawback since in a long exposure it was necessary to give all the time on one side instead of dividing it up to the best advantage on each side of the meridian.

There were two forms of mounting in use that would permit a continuous exposure. These were (1) the English form of equatorial mounting, which is a long polar axis, supported at each end with the tube swung near the middle; (2) the Potsdam astrographic equatorial, in which the polar axis projects far enough to allow the telescope to swing freely under the pier. Neither of these mountings has appeared to me to be entirely the best form for the purpose.

With the short length of this instrument it seemed that if the pier itself were bent to form the polar axis, the telescope could be made to swing freely under the

pier in all positions of the instrument. With this idea in view, I went to Cleveland to confer with Messrs. Warner and Swasey on the matter. Mr. Swasey at once took the deepest interest in the proposed telescope, and eventually evolved the scheme that was ultimately adopted in the mounting. The result was entirely satisfactory, and the mounting is, I believe, the best for the purpose that has yet been made.

The next question was the lens, and here is where the delay occurred. It was my wish to get the widest field possible and the shortest relative focus consistent with such a field. This proved to be a problem of the most extreme difficulty. Dr. Brashear, who was appealed to for the optical part, entered heartily into the subject. So earnest was he in his endeavors to fulfil the required conditions that he made at least four trial lenses of 4 inches diameter and upward. But my ideal was evidently too high and one not attainable with optical skill.

In the interests of the matter I made a visit to Europe to see if better results could be had there, but, in the end, it proved that Brashear's lenses more nearly fulfilled the requirements than any that I saw elsewhere.

In the meantime, Mr. Brashear, with characteristic faith in his skill, ordered the glass and made a 10-inch doublet on his own responsibility. This lens gave exquisite definition over a field some 7° in width and could by averaging be made to cover at least 9° of fairly good definition. Though this did not come up to the width of field originally proposed, it was finally accepted, as it seemed the best that could be obtained.

The glass disks were made by Mantois, of Paris,

and delivered to Brashear in May of 1899, and the lenses were completed in September, 1900.

The following information about the 10-inch lens was supplied me by Dr. Brashear:

The general construction is that which was first found by Petzval years ago, and has proven itself quite the best where great angular aperture with sharp definition is imperative. The curves have been somewhat modified from our experience in the construction of other lenses—particularly of those made for Dr. Max Wolf, of Heidelberg, Germany. It departs, however, from the ordinary practice of opticians in being corrected for short wave-lengths of light. This would be quite objectless in a camera which is to be used for portraits, but is not without moment in astronomical photography.

The materials employed were specially chosen for their transparency—the flint being very light and the crown very white. The focal lengths of the front and rear combinations are in a ratio of about 7 to 12, while the focal length of the system is very nearly five times the aperture. The focal length you may find very slightly modified; indeed, it is our custom to balance the inevitable zonal differences of magnification, which difficulty is found the most formidable to all constructors of astronomical photographic objectives.

The focus of the 10-inch, determined from the photographs, is 50.3 inches (127.8 cm), and the scale is therefore 1 inch = 1°14 or 1° = 0.88 inch. The ratio, $a/f = 1/5.03$, I believe to be the best for the purpose.

The accumulation of interest had by this time permitted the purchase of a 6¼-inch Voigtländer lens of 30.9 inches (78.5 cm) focus, which had been in commercial use.

As indicated, the telescope is really triple in character, there being three tubes bound rigidly together on the same mounting—the 5-inch visual telescope for guiding, and the 10-inch and 6¼-inch photographic doublets. For each of the photographic lenses there

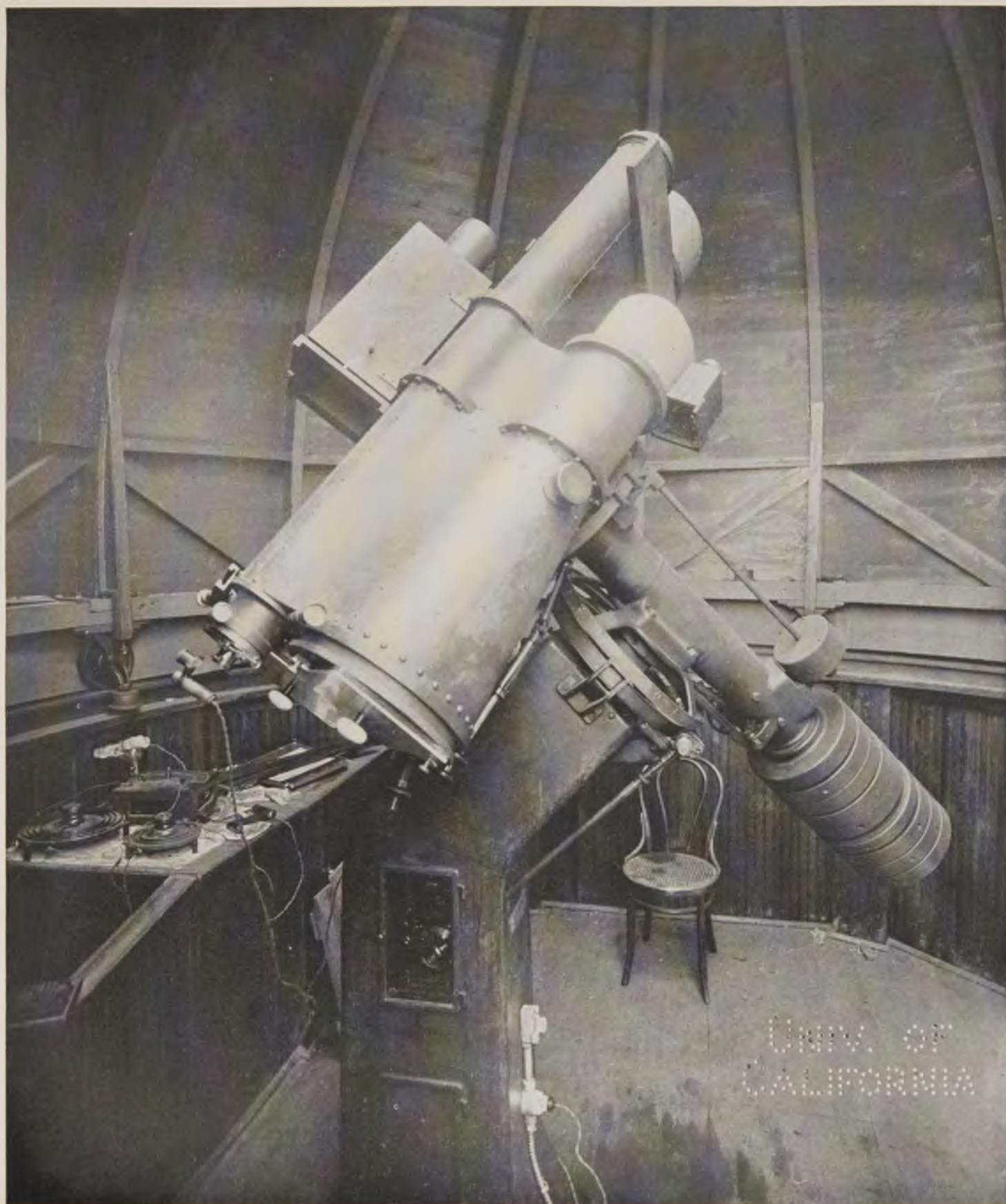
is an inner tube, with focusing scale, which can be racked back and forth for the adjustment of focus. There is considerable change of focus in the 10-inch lens between winter and summer. The change in the focus of the 6-inch is small, however, and requires very little correction.

The plate-holder for the 10-inch carries a plate 12 inches square, while the one for the 6¼-inch carries a plate 8×10 inches.

In the matter of a guiding telescope the limited means would not permit of anything larger than 5 inches, which is sufficiently powerful for ordinary purposes, though for the photography of comets a larger one would have been desirable. The guiding telescope I used with the Willard lens at Mount Hamilton was only 1¾ inches in diameter. Of course, the question of a double-slide plate-holder was considered; but in a small telescope like this the tubes are so rigidly bound together that such a device is not necessary to insure faithful guiding. Furthermore, for work of this kind the double-slide plate-holder would be seriously objectionable.

A high-power eyepiece is used on the 5-inch for guiding in conjunction with a right-angled prism. This is more convenient than direct vision, especially when photographing at high altitudes. The eyepiece has an adjustable motion to the extent of 2° in any direction, thus insuring the finding of a suitable guiding star. This is also valuable in photographing a comet, as it permits the displacement of the comet's head to one side of the center of the plate, thus securing a better representation of the tail.

Two spider-line cross-wires in the eyepiece are used for guiding. They are illuminated by a small



THE BRUCE PHOTOGRAPHIC TELESCOPE IN ITS DOME AT THE YERKES OBSERVATORY

electric lamp by the aid of two small reflecting surfaces which throw the light perpendicularly on the wires. The intensity of the illumination is readily regulated. By this means almost the smallest star visible in the 5-inch can be used for guiding purposes.

The illustration will give a better idea of the Bruce telescope than any mere words can do. Indeed, there are very few things about it that need explanation. One feature, however, will not be clear without a description, viz., the method of adjustment for latitude in case the telescope were removed to a different latitude. It was intended that the instrument should be portable when occasion required, for the purpose of observing eclipses, etc., and for possible transportation to the southern hemisphere.

The pier really consists of two parts. Just above the clockroom it separates into two pieces which are bolted together on the inside of the pier, and hence no break appears in the continuity of the pier.

For change of latitude, it is only necessary to insert a wedge-shaped section between these two parts of such an angle that it will produce the required change of latitude. This ordinarily would necessitate only a slight change in the length of the driving-rod which is adjustable. No other means of adjustment seemed feasible.

As it was possible that the instrument might some time go to the southern hemisphere, Messrs. Warner and Swasey were asked to insert some sort of gearing that would readily permit of a reversal of the motion of the clock. The device they introduced is extremely simple and efficient. In a couple of minutes' time the motion can be changed from west to east. At the point where the driving-rod joins on to the worm-

screw for driving the worm-wheel carrying the telescope, the small gear-wheel which makes the connection can be reversed and placed on the other side of the gear-wheel at the end of the driving-rod; this will reverse the direction of motion of the worm-wheel and hence of the telescope.

The telescope is supplied with fine and coarse right-ascension and declination circles; the fine circles are divided on silver and are read by verniers.

The slow motions for guiding are brought down conveniently to the plate-end of the instrument.

The pier is very heavy, weighing some 1,200 or 1,300 lb. (550-600 kilos). This great weight is necessary to support the overhanging mass of the telescopes and the top of the pier.

The driving-clock is of Warner and Swasey's regular conical pendulum pattern, which by all means seems to be the best form of driving-clock. It is a beautiful piece of mechanism and performs satisfactorily, though we intend to introduce an electric control for work with it hereafter.

The instrument was finally finished and placed in position in its observatory in April of 1904.

The photograph shows the compact and rigid form in which the tubes are mounted, and it will at once be seen how the combination can swing freely under the overhanging pier.

As will be noted, the design is a new one, and although Messrs. Warner and Swasey have made at least one mounting of this kind (for the Tokyo Observatory) before the Bruce telescope was commenced, it was made from their design for the present instrument, so that the Bruce is the original of this particular form of mounting.

As I have said, small portrait lenses have their special advantages as well as the larger ones. Where it is possible, it is desirable that two or more lenses should be used on the same mounting, a very important point being that they mutually verify each other. Duplicate lenses would not seem to be either the most economical or the best arrangement. In that case they would serve only as a verification and could have no other value, unless indeed one of the plates should meet with an accident or be defective—circumstances that would not be of sufficiently frequent occurrence to justify the extra outlay. The best plan would seem to be to have one of the instruments decidedly different from the other so that an independent series of pictures of the same region could be secured on a very different scale. Photographs with these, at the same time that they mutually verified each other, would have other values peculiar to themselves.

The 10-inch and the $6\frac{1}{4}$ -inch, therefore, mounted together, give a very desirable variety in respect to scale, at the same time that the 6-inch is sufficiently powerful to be an almost perfect verification of anything the 10-inch may show.

One minor source of trouble with both these lenses, but worse in the case of the 10-inch, is that the commercial plates that are used are never flat. In one sense this is a distinct advantage as the emulsion is placed on the concave side of the plates; this helps to flatten the field. But the curvature is not always the same, for some plates are curved more than others. This is equivalent to a frequent change of focus with the larger lens. Once in a very long while the emulsion is put on the convex side of the plate. This puts the

sensitive surface too much inside the focus and the result is a spoiled picture.

The Bruce Observatory is a wooden building of size, 15×33 feet, with the greater length lying east and west. The dome, which is central, is 15 feet in diameter and revolves on 8-inch roller-bearing iron wheels.

The large field of the Bruce telescope made a wide opening in the dome a necessity. It was therefore made 4 feet wide, which seems ample for all purposes. The telescope rests on a brick pier, and the observing-room is reached by a small stairway against the inner south wall of the building.

The altitude of the telescope above sea-level is about 1,040 feet (317 meters). Its latitude is $42^{\circ}34'$.

THE WORK AT MOUNT WILSON

Through the interest and courtesy of Professor George E. Hale and the generosity of Mr. John D. Hooker, of Los Angeles, I spent the spring and summer of 1905 in photographic work at the Solar Observatory of the Carnegie Institution on Mount Wilson, California. Mr. Hooker's generous grant made it possible to transport the Bruce telescope to Mount Wilson, where it was installed from February until September, 1905, in a temporary wooden structure, from which the roof could be slid off, giving an unbroken view of the sky. The altitude of the station was about 5,900 feet (1,800 meters), above the sea, and its latitude $34^{\circ}13'$.

The main object of this expedition to Mount Wilson was to secure the best possible photographs of the Milky Way as far south as the latitude would permit.

But little time was available for independent investigations in other parts of the sky, though the conditions for such work were often superb. During this period 154 plates were obtained with the 10-inch Brashear doublet, and 151 with the $6\frac{1}{4}$ -inch Voigtländer doublet, the exposures being simultaneous, almost without exception. The original negatives of 40 of the 50 photographs in this volume were made during this time at Mount Wilson.

During many of the exposures at Mount Wilson two additional cameras were used, being attached to the mounting of the instrument, as shown in the picture. These were a Clark lens of 3.4 inches aperture and 20 inches focus and a so-called "lantern" lens of aperture 1.6 inches and focal length of 6.3 inches. With the Clark lens about 110 negatives were obtained and about 90 with the stereopticon lens.

GENERAL REMARKS ON THE MILKY WAY

The development of astronomical photography, especially where portrait lenses are used, has brought to our knowledge the existence of large areas of faint diffused nebulous matter in different parts of the sky. Some of these have been shown by the spectroscope to be gaseous, while it leaves others either in doubt or distinctly not gaseous. As one is not called upon to decide as to the gaseous nature of this matter, it will be strictly correct to speak of it as "nebulosity." This term seems to have come into use or to have been adopted as more satisfactory and explanatory than the word "nebula," which is more readily applicable to the older known forms of the nebulae as seen with the visual telescope. It seems now to belong distinctly to those large, diffused areas of matter mostly

shown on small-scale photographs within the last thirty years, such as those revealed in Taurus near the Pleiades and south of the Hyades and in Ophiuchus and the Scorpion, and in other parts of the sky. Though these are not strictly confined to the Milky Way they are generally found in connection with it, some of the finest being in the Milky Way itself. There seems to be some evidence of such masses being apparently connected with some of the brighter regions of the Milky Way, a large bed of it being found in $\alpha = 18^{\text{h}}8^{\text{m}}$, $\delta = -21^{\circ}$ near one of the smaller bright star clouds in Sagittarius and in the region of the star Gamma Cygni, where it appears in the form of nebulous tufts and masses over a large area, and in the region of the North America nebula.

While I was at Mount Wilson in 1905 I made a few exposures at various points in a search for diffused nebulosities. The extraordinary nebulosities in Scorpio and Ophiuchus which I found by photography in 1894—those of Rho Ophiuchi, Nu Scorpii, etc.—suggested the immediate region of the upper part of the Scorpion as a suitable hunting-ground. Trial plates were exposed on Rho Scorpii, Pi Scorpii, and elsewhere. The photographs of the region of Pi showed a very remarkable, large, straggling nebula extending from Pi to Delta Scorpii, with branches involving several other naked-eye stars near.

With the exception of the great curved nebula in Orion and some of the exterior nebulosities of the Pleiades, this nebula is quite exceptional in its extent, and in the peculiarities of its various branches. A simple description of it would be inadequate to give a fair conception of these features. It is difficult

to reproduce properly the photograph because of the faintness of some of the extensions of the nebula. Enough can be shown, however, to give some idea of its general structure (Plate 11).

From a long familiarity with the transparency of comets, we perhaps came too soon to the conclusion that the nebulae also are transparent. Unfortunately, it is not possible to either prove or disprove the transparency of the nebulae in the same manner as we do that of the comets, for the nebulae do not conveniently move about over the sky as the comets do. Though we cannot test this question by moving the nebula over different parts of the sky, we can as safely prove it by considerations almost as convincing. These nebulous masses often occur in regions where the sky is uniformly covered with stars, as in the case of the nebula about Nu Scorpii and the region of Rho Ophiuchi. In these cases there is a noticeable lack of stars within the confines of the nebulosity and in some cases a total disappearance of them as if their light were cut out by the intervening nebulosity. An inspection of these photographs, therefore, seems to show that the same nebula may be partly or totally transparent. Also the less luminous parts seem to be the more opaque. Frequently there is a curious apparent mixture of stars and nebulosity—a free mixture, one might say—where though seemingly mixed together there is no apparent condensation of the nebulosity about any of the stars. This apparent association without visible connection happens too frequently to be due to chance.

Some of these, such as the nebulosities exterior to the Pleiades, and elsewhere, are of such irregular brightness as to compel attention. But there are

other regions in which a film of this faint nebulosity uniformly covers the sky for considerable distances. From the wide and uniform distribution of this nebulosity it is not always possible to prove its existence because it covers the entire plate uniformly and cannot be distinguished from the sky-fogging always present on long exposures. But there are certain cases where a dark body projected against it is unmistakably revealed. A very striking case of this kind occurs in Sagittarius in the region of the small, bright star cloud in $\alpha = 18^{\text{h}} 8^{\text{m}}$, $\delta = -18^{\circ}$. In this star cloud (shown on Plate 31) are two black spots, the western of which is the more conspicuous and definite. I have already shown that this spot is a real dark object seen by contrast with the brighter region against which it is projected. On the original negative the eye at once picks this object out as being the darkest part of the entire plate. Such effects sometimes are produced by contrast and may not be real. I have cut holes the size of this spot in a black paper mask with other opening of the same size. With one of the openings over the spot, excluding the stellar background, it is readily seen that this spot, by comparison with other parts of the sky equally free of stars, is very much darker than any other part of the plate. Furthermore, the outline of the eastern edge of the spot is sharply defined, not against the stars but against a thin film of more luminous material. There is scarcely a star close to this outline. This thin, lighter film against which we see the spot permeates the entire star cloud and the rest of the plate. It is this nebulosity that makes the star cloud so conspicuous and not the abundance of stars.

In regard to a region of diffused nebulosity near

Omicron Persei I quote from an article of mine in the *Astrophysical Journal* (41, 253-258, 1915):

Attention has been called frequently in this journal and elsewhere to regions of this kind which are of special interest—where apparently an intimate connection exists between the vacancies and the large masses of nebulosity. It has been shown in these papers that there is evidence of the existence of some kind of dark or partly luminous matter between us and the fainter stars which, by obscuring the stars, produces the apparent vacancies, and that the diffused nebulosities, referred to above, are the visible evidence of this matter. Regions of this kind were found in Scorpio, in Ophiuchus, and in Taurus. In *Publications of the Lick Observatory*, 11, Plate 16, I called attention to a condition like this near the star Omicron Persei in the lower right corner of that photograph. Some of the nebulosity is shown faintly, and it was suggested that a long exposure at that point would perhaps show more of this matter, its presence being indicated by the otherwise unexplained absence of the small stars.

On November 21, 1914, I gave an exposure of 6 hours and 41 minutes on this region with the Bruce 10-inch and 6-inch telescopes. A large, feebly luminous nebulosity with considerable detail in it is shown on these plates. The more obscure parts of this nebula are excessively faint, but the brighter details are well shown. The nebula fits into the vacancy referred to and seems (by obscuring their light) to account for the absence of the small stars. It will be noticed, as in other cases to which I have called attention, that in the brighter part of the nebula west of Omicron Persei the background of small stars is continuous. It is only where the nebulosity is very feeble that the stars seem to be more or less missing.

The photograph referred to above is reproduced as Plate 3 of this *Atlas*.

This region of Omicron Persei is intimately connected with the more remarkable one shown on Plate 5, which lies south and east of the present object. The dark lanes in this region in Taurus seem to be due mainly to an abrupt absence of stars. They

are so distinct and definite that they look artificial, as if they had been made with a stencil. They occur in a luminous region against which they appear in strong contrast, though broken in parts of their length. The strange thing is that the small stars, which are so thickly strewn over the sky here, seem, with few exceptions, to have disappeared, as if the "lanes" had hidden them. Though they are free from stars they apparently are not free from the faint nebulosity.

The faintly luminous film that covers all of the southern half of the plate seems to be beyond the general stratum of stars, for all the stars appear to shine on or in it. The lanes appear to be due in part to the absence of stars. At the same time they seem also to be in the substratum of nebulosity. In places they become blacker than the background on which they appear. This is specially noticeable in the great, partly dark nebula itself, for it is very much darker than the sky against which the stars are seen. In fact, the dark lanes seem to do two things—they blot out the stars, and at certain places they blot out the feeble nebulous background on which the stars shine. Here, as in many other places, one gets the impression that the stratum of stars is not very deep or thick (see *ibid.*, 25, 218-225, 1907).

Some of the dark markings of the catalogue, which follows, may be only vacancies among the stars, but I have tried to avoid such as much as possible. In many cases, however, there seems to be no other interpretation of the appearance than that of an obscuring body. In some cases the dark body itself can be distinctly seen on the photograph, such as Nos. 33, 72, 133, and others, so that there need be no hesitation in accepting the fact that such bodies exist.

One reason why I often think that a small vacant region is an obscuring body, even though a long exposure does not show it, is that in several cases where a long exposure does show such an object, a short exposure simply shows a vacancy with no real suggestion of an obscuring body. I, therefore, think that in many cases it only requires a much longer exposure to show the real object.

There are two classes of these dark spots. Some are merely gray and devoid of stars. Others are extremely black and still others are a combination of these, a gray vacancy with a very black spot in it.

The smallness of some of these objects and their definite form led me to examine a few of them with the 40-inch refractor under suitable conditions. In each case it was shown that a real object of an obscuring nature was present. The results of these visual observations will be found in *ibid.*, 38, 496-501, 1913, and 49, 1-23, 1919.

In my list of dark objects there are several that are seen to be identical with some of those in the list of starless fields given in Webb's *Celestial Objects*, Volume 2, Appendix I, taken from Sir John Herschel's observations made at the Cape.

| Webb's No. | Barnard's No. |
|------------|---------------|
| 10..... | 42 |
| 18..... | 44 |
| 20..... | 45 |
| 22..... | 66 or 67 |
| 27..... | 78 |

In this volume attention is called to various peculiarities found on the photographs, such as thin, dark lanes of uniform width among the stars, curves and straight lines of small stars, often of equal magnitude. I am aware of the fact that these singular features

are believed by many to be fortuitous and that strikingly similar figures can be reproduced by artificial means. While it is possible that they have no meaning in reality, there is a probability that many of them are real and are due to some law that forces such alignments upon the stars. Attention has been called to the most striking of these features so that should it ever be desirable to investigate them, there will be ample material to work on. It is probable that some are due to pure chance, and that others are real and are due to some law that will reveal itself in the course of time.

THE MILKY WAY AS SEEN WITH THE
NAKED EYE

At different times I have tried to visualize the Milky Way and to describe its appearance with the eye alone. It is extremely difficult to do this satisfactorily, mainly because of the indefinite limits to certain portions of it.

Even when a small boy I was struck with the difference in the brightness of the sky to the east and to the west of the Milky Way. The difference is very striking when we compare the sky on opposite sides of the Milky Way near and north of Orion. While the sky is rich and black to the west, at a similar distance to the east it is luminous, so that one cannot locate the eastern limits which seem to extend indefinitely. Not only does this hold in the winter regions of the Milky Way, but it is also noticeable on summer nights, or in the opposite parts of the heavens, where the effect is equally striking. It seems to be a fact that the western side of the Milky Way is almost indefinitely diffused while the opposite side is less diffused, or, in other words, the Milky Way extends farther north-

ward from the plane of the galaxy in the region of Orion and farther southward in the region of Sagittarius. This feature must have been noticed by others, but I have seen no reference to it.

The "coal-sack" north of Alpha Cygni appears blacker than any part of the visible heavens except perhaps far to the west— 30° or so—where the sky is darker. Under exceptional circumstances, when the sky is very transparent, the great dark space that runs to the west under Theta Ophiuchi is a noticeable object to the naked eye. Even in a poor sky, but free from moonlight, its presence is evident.

The beautiful star cloud in which Messier 11 is placed is a striking feature with the naked eye, though its true form is scarcely made out. The small star cloud in $\alpha = 18^h 10^m$, $\delta = -18^\circ 40'$, Messier 8, and the Trifid nebula are also noticeable to the eye.

The region in Sagittarius, however, contains the finest and brightest portions of the Milky Way that are seen from the northern hemisphere. The stars pile up in great cumulous masses like summer clouds. The extreme brilliancy of these great star clouds in Sagittarius is never better shown than on a heavily clouded moonless night when holes or small breaks occur in the (terrestrial) clouds. At such times when these openings pass over Sagittarius the glimpses seen through the breaks appear very bright as if an illumination far greater than the Milky Way was shining through the openings. I have often seen it thus and wondered at its brightness. The reverse of this sometimes occurs when the sky is clear and a few minute cumulus clouds happen to be seen against the great star clouds. Then we have a vivid representation of the black spots found in the photographs of

these bright clouds. I quote from my article in *Astrophysical Journal* for January, 1916 (43, 1-8):

All that is needed to make these dark bodies visible is a luminous region behind them. This is supplied in one way by the rich stellar regions of the Milky Way. An excellent example of how such a thing may be possible is shown by a phenomenon that presented itself to me one beautiful, transparent, moonless night in the summer of 1913, while I was photographing the southern Milky Way with the Bruce telescope. I was struck with the presence of a group of tiny cumulous clouds scattered over the rich star clouds of Sagittarius. They were remarkable for their smallness and definite outlines—some not being larger than the moon. Against the bright background they appeared as conspicuous and black as drops of ink. They were in every way like the black spots shown on photographs of the Milky Way, some of which I was at that moment photographing: The phenomenon was impressive and full of suggestions. One could not resist the impression that many of the black spots in the Milky Way are due to a cause similar to that of the small, black clouds mentioned above—that is, to more or less opaque masses between us and the Milky Way. I have never before seen this peculiarity so strongly marked from clouds at night, because the clouds have always been too large to produce the effect.

On examining the heavens with the naked eye, strange as it may seem, one does not notice any special increase of individual stars in approaching the Milky Way, nor are the stars brighter in general. Of course many of the brightest stars, such as Sirius and Canopus and those in Orion and Cassiopeia, are in the Milky Way, but this is doubtless purely accidental. If, however, the telescope—even a small one—is turned to the sky it is at once seen that as we approach the Milky Way there are many more stars, but it is not until a very powerful telescope or the photographic plate is used that we notice any large increase of stars in the Milky Way or its vicinity.

The Milky Way consists almost wholly of apparently small stars. If all the stars down to the twelfth magnitude, say, were removed from the sky the Milky Way would not be sensibly altered in appearance but it would shine on a dark, unbroken sky. There would not be an individual star visible anywhere on the blackness of space, and the Milky Way would appear as it does now, shorn of a few bright naked-eye stars. Its appearance is due entirely to the light from stars wholly beyond the naked eye and, we can say with assurance, much beyond the reach of ordinary field glasses.

To the naked eye the Milky Way presents a different appearance from that shown by the photographic plate. It does not seem possible to reconcile them entirely. The main difference is due to the penetrating power of the photographic plate and the smallness of the field of the lens used to make the photograph. Pictures taken with a small lens, like that used for Plate 51, covering larger areas of the sky, more nearly approach the appearance presented to the naked eye.

PREPARATION OF THE REPRODUCTIONS

Immediately after the grant for the publication of this *Atlas* was assured by the Carnegie Institution of Washington, investigations were begun as to the best available methods of reproduction. With the cordial co-operation of some firms, experiments were made with the photogravure and other processes. It was feared, however that these methods, though capable of reproducing the sky, might depart from the fidelity necessary in work like this. It was also questioned whether the quality of the reproduction could be maintained uniformly throughout a whole edition.

After long consideration it was decided that the most faithful reproduction could be secured by using photographic prints from second negatives especially prepared for the purpose by copying the original negatives.

There is much to be said in favor of this process as being the best one for reproducing correctly the original photographs. But it also has its limitations, as all things have where the judgment of the human mind is a large factor. The printing is done with a photographic printing machine, where the exact exposure can be automatically controlled, so that each print is given exactly the same exposure time. That part is under perfect control. But this is not all. The development of the prints must depend on the judgment and skill of the operator. If the development is cut short, the proper strength and softness is not secured, while a little too much development will lose the faint nebulosities and details which are the most valuable parts of the photograph. The development apparently cannot be made automatic in a case of this kind to give reliable results. We must depend on the judgment of the operator.

I have personally examined each one of the 35,700 prints and have rejected all that were not up to a certain standard, or which had defects in them. But there were many cases where a rejection was unfair. This was when the print was slightly too dark or too light, but the difference not large. Such a print must be passed, though the desire was great to throw it out. In other words, it seems impossible for the manipulator to attain to perfection in this work.

Much difficulty was at first experienced in getting perfect contact all over the plate in the printing, but this was finally overcome by the printer.

The difficult task of making these photographic prints was intrusted to Messrs. Copelin, commercial photographers of long experience, of Chicago. They devoted to the work great skill and patience during the years 1915, 1916, and 1917, and the author made frequent visits to the city to inspect the sets of prints as they were completed. Those who are best acquainted with celestial photography will appreciate most fully how successfully Messrs. Copelin have accomplished their undertaking. The author would express his most sincere thanks to them for their unfailing courtesy and constant desire to meet his exacting requirements that the qualities of the original negatives should be reproduced as perfectly as possible.

There is always a question as to the permanency of a photographic print. Absolute permanency is perhaps not attainable with any process of reproduction. I have been assured that every precaution was taken to insure permanency, both in the fixing and the washing of the prints, for these are two great sources of uneasiness on the score of permanency. The actual permanency of the paper itself is another source of anxiety. Tests were made as to the effect of light upon them by exposing them to open sunlight for several months. It was found that the paper into the emulsion of which had been introduced a certain dye for color effect was subject to fading. That paper was rejected, though it took away some of the effectiveness of the prints. Unless there is some change from a chemical standpoint in the paper itself, and this can be tested only by lapse of time, I think the prints will be reasonably permanent.

It may be interesting to know how these prints are mounted and burnished. After the final washing the

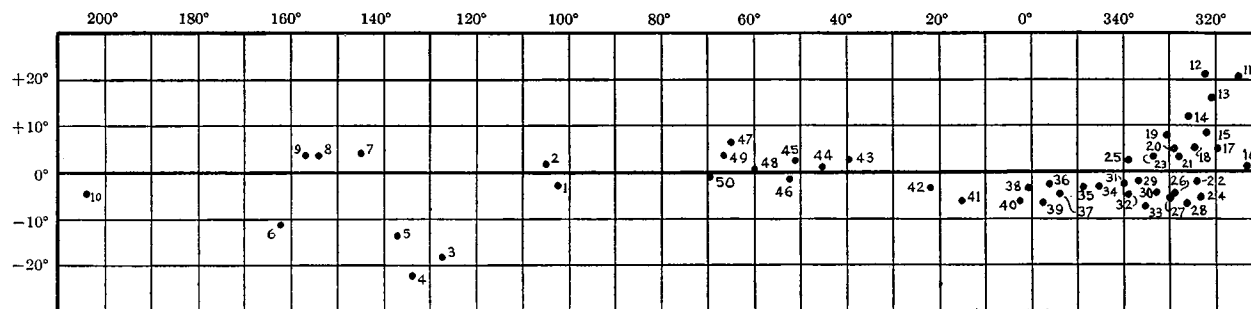
prints are placed, while wet, face down on a ferrotype plate which has a brilliant surface. They are pressed firmly on to this by rubbing out the water and air bubbles with a rubber "squeegee." A piece of cheesecloth, after being covered with starch paste, is pressed and rubbed tight on to the back of the print, a strip of paper having been introduced to serve as a hinge for binding the print into the volume. The plate is then put to dry. When dry, the print thus mounted comes off freely and is beautifully burnished and ready, after trimming, to be bound in the volume. There is nothing new in the process, however.

In every case, for the printing of these plates a second negative was used. The original negatives do not give sufficient contrast or strength for printing purposes. It has been my custom, from the early days at Mount Hamilton, to use second negatives. To secure these the best possible positive is made from the original negative on, say, a Seed "Process" plate which will give a fairly strong but not harsh picture, showing the faintest details. In general, this is strong enough to give a good printing negative with a Seed "23" plate, which will retain the softness and strength necessary for printing. It is a mistake, in general, to use for this second negative a slow plate, such as a Process plate, which only introduces harshness. It is sometimes necessary to use such a plate when the picture is not strong enough. Indeed, a third negative is occasionally, though seldom, required. In this case a second negative is prepared on a Seed 23 plate. From this a positive on a Seed 23 is made, keeping the softness and details as much as possible. This second positive will give a third negative of the required softness and density. It is almost nev-

er necessary to go beyond this stage. A good plan in making the first positive is to overtime the exposure slightly. Then develop up black—or overdevelop. The positive, after being fixed, should be slowly reduced with a weak solution of red prussiate of potash and hypo. This reducer has a tendency to produce contrast. A strong solution is apt to reduce unequally and to spoil the positive if the reduction is prolonged.

DISTRIBUTION OF THE PLATES

The portions of the Milky Way which are included in the *Atlas* may be most easily seen by examining the diagram which shows their distribution according to galactic longitude and latitude. The centers of the plates are represented by the dots, with the corresponding numbers of the plates. The diameter of the field varies according to the enlargement, and ranges



POSITIONS OF THE CENTERS OF THE PLATES IN GALACTIC CO-ORDINATES

A uniform scale of enlargement has not been employed because the author felt that different areas required a different magnification to bring out their most interesting features to the best advantage. Therefore, the scale for each plate is given at the head of its description page.

The positions of the centers as written in the upper right corners of the prints are only approximate, and do not always agree exactly with the positions given elsewhere in type. The epoch for all positions is 1875.0, chosen because of the convenience of using the positions in the catalogues of the *Astronomische Gesellschaft*. For all the photographs, north is at the top. The times of the mid-exposures are given to the thousandth of a day in Greenwich Mean Time (reckoned from Greenwich Mean Noon).

from a minimum of $3\frac{1}{2}^\circ$ to a maximum of $10\frac{1}{2}^\circ$. Galactic longitudes between 230° and 310° were of course too far south to be reached from either the Yerkes Observatory or Mount Wilson. The concentration of plates in the regions of especial interest in Ophiuchus, Sagittarius, and Scorpio is at once apparent on the diagram. It was the author's deep regret that the necessary limit to the number of plates which could be reproduced in a volume like this did not permit the inclusion of a greater extent of the galaxy.

Here, as elsewhere in this book, the galactic positions assume the position of the north galactic pole to be at $\alpha = 12^h 40^m$, $\delta = +28^\circ 0'$ for 1900.0.

ABBREVIATIONS USED

For the benefit of those not familiar with catalogues of stars and nebulae, it may be well to give

some of the abbreviations used in designating such works.

B.D. denotes the *Bonn Durchmusterung* of the northern heavens which is comprised in Volumes III–V of the *Astronomische Beobachtungen auf der Sternwarte der Universität zu Bonn*, by Dr. F. W. A. Argelander, 1859, 1861, and 1862, with its extension (Vol. VIII) to the zones -2° to -23° , by Dr. E. Schönfeld, 1886. The letters B.D. are followed by the zone in declination, with the number of the star in that zone.

The letters C.D. designate the *Cordoba Durchmusterung* of the southern sky, forming Volumes XVI, XVII, and XVIII of the *Results of the National Argentine Observatory*, 1892, 1894, and 1900.

The letters N.G.C. signify *A New General Catalogue of Nebulae and Clusters of Stars*, being the catalogue of the late Sir John F. W. Herschel, Bart., revised, corrected, and enlarged by Dr. J. L. E. Dreyer. This forms Volume XLIX, Part I, of the *Memoirs of the Royal Astronomical Society*, and was published in 1888. It was extended by Dreyer in two supplementary catalogues of objects discovered by later observers, known as *Index Catalogue of Nebulae*, found in the years 1888 to 1894, forming Volume LI of the *Memoirs*, and *Second Index Catalogue*, containing objects found in the years 1895 to 1907, being Volume LIX of the *Memoirs*. These are designated in this *Atlas* as N.G.C. I and N.G.C. II.

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S.M. = *Sidereal Messenger*
A. and Ap. = *Astronomy and Astrophysics*
Ap.J. = *Astrophysical Journal*
A.J. = *Astronomical Journal*
P.A. = *Popular Astronomy*
M.N. = *Monthly Notices of the Royal Astronomical Society*
A.N. = *Astronomische Nachrichten*

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- “On the Exterior Nebulosities of the Pleiades [1 plate],” *A.N.*, 136, 193, 1894. (Reprinted in *A. and Ap.*, 13, 768, 1894.)
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- "Photograph of the Nebula N.G.C. 1499 near the Star ξ Persei [1 plate]," *ibid.*, p. 350, 1895
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named paper.

CATALOGUE OF 349 DARK OBJECTS IN THE SKY

IN HIS article in the *Astrophysical Journal* for January, 1919 (49, 1-23) Professor Barnard gave a list of 182 dark objects in the sky. For the convenience of the user of this *Atlas* this catalogue is printed here. Three of the objects in that list have been omitted here, viz., Nos. 52, 131*a*, and 172, because by inadvertence the same object had been listed twice.

Mr. Barnard had begun a second list, most of the objects for which he had himself selected. Their positions were determined by Miss Calvert. It seemed best to begin the second list with No. 201;

accordingly, there are no objects having the numbers from 176 to 200.

Where the space in the column for description was insufficient, a note has been added at the end of the catalogue, and this is indicated by a dagger (†) at the end of the last column.

Each dark object of the list falling within the field of a plate has been sketched in by Miss Calvert, with its number, on the corresponding chart in Part II. Where these objects have been referred to, in the descriptions of the photographs, and on the charts and in the tables, their numbers have been preceded by the letter "B."

FIRST CATALOGUE

| No. | α 1875.0 | δ 1875.0 | Description |
|-----|--|-----------------|---|
| 1 | 3 ^h 25 ^m 14 ^s | +30°44' | Large, indefinite; diam. $\frac{1}{2}^\circ$ |
| 2 | 3 25 44 | +31 54 | Indefinite; elongated SE. and NW.; diam. 20' |
| 3 | 3 32 14 | +31 34 | Irregular, dark space in nebula, diam. 20'; curved, bright strip of nebulosity in SW. side |
| 4 | 3 36 14 | +31 24 | Very large; indefinite |
| 5 | 3 40 0 | +32 30 | Indefinite; elongated NE. and SW.; diam. 1°; Eta Persei (B.D.+32°667, 5 ^m 8) near NE. side |
| 6 | 3 46 30 | +55 45 | Round; indefinite |
| 8 | 4 7 53 | +54 56 | Center of a dark, irregular lane about 2:6 long and 22' \pm across; very much like the dark lanes E. of ρ Ophiuchi |
| 9 | 4 9 | +54 45 | Dark, irregular vacancy † |
| 7 | 4 9 40 | +28 15 | Large, irregular, with brighter condensation (B 10) in SE. part |
| 10 | 4 10 57 | +27 58 | The brightest part of B 7; diam. about 8' |
| 11 | 4 16 37 | +54 45 | East end of irregular lane, B 8 |
| 12 | 4 19 52 | +53 58 | Isolated dark spot SE. of B 11; diam. 24'; irregularly round with extension E. from the NE. side |
| 13 | 4 21 17 | +54 37 | Irregular; diam. 11'; irregularly darker inside with a rather sharp, short, narrow extension toward the S. |
| 15 | 4 22 50 | +46 21 | Elliptical; diam. 10' \times 15' slightly NW. and SE. † |
| 16 | 4 23 20 | +46 20 | Very small; elongated N. and S.; close to SE. edge of B 15 |
| 17 | 4 23 25 | +46 15 | Very small; elongated N. and S.; close to E. edge of B 15 |
| 18 | 4 23 40 | +24 5 | Diam. 1°; group of dark spots |
| 19 | 4 26 | +26 0 | Large; indefinite; diam. 1° |
| 20 | 4 27 30 | +50 43 | In S. part of larger, relatively vacant area nearly 1° in diam. † |
| 21 | 4 27 50 | +55 6 | Indefinite; irregularly round; diam. 10' |
| 22 | 4 31 | +25 48 | Irregular; unequally dark; extended SE. and NW.; diam. 2° † |
| 14 | 4 32 20 | +25 30 | Very small, bright nebula; diam. 3' † |

CATALOGUE OF 349 DARK OBJECTS IN THE SKY—*Continued*

| No. | α 1875.0 | δ 1875.0 | Description |
|-----|--|-----------------|---|
| 23 | 4 ^h 32 ^m 40 ^s | +29°38' | Diam. 5'; sharply pointed to the SE.; B.D.+29°728 (6 ^m 5) in N. part |
| 24 | 4 35 0 | +29 30 | Diam. 8'; sharply pointed to the S. |
| 25 | 4 42 56 | +45 48 | Irregularly round; diam. 8'; a good example of a dark or more or less starless region |
| 26 | 4 46 40 | +30 25 | Irregular; diam. 5'; B 26, 27, and 28 are close NW. of B.D.+30°741 (6 ^m 8), which is involved in feeble nebulosity |
| 27 | 4 47 10 | +30 21 | Irregular; diam. 5' |
| 28 | 4 47 54 | +30 26 | Irregular; diam. 4' |
| 29 | 4 58 20 | +31 25 | Round; indefinite; diam. 10' |
| 30 | 5 23 15 | +12 40 | Large dark area with few stars; diam. 67'† |
| 31 | 5 25 0 | +12 40 | Diam. 30'; extended NE. and SW.; the E. and darkest part of B 30 |
| 32 | 5 25 8 | +12 20 | Dark projection from S. end of B 31 to the E. |
| 33 | 5 34 36 | - 2 32 | Dark mass, diam. 4', on nebulous strip extending S. from ζ Orionis (see <i>Ap.J.</i> , 38, 500, 1913, and Plate XX) |
| 34 | 5 35 20 | +32 35 | Round; starless; indefinite; diam. 20' |
| 35 | 5 38 40 | + 9 0 | Elongated E. and W., 20'×10', with an extension SE.; three small stars N. of it |
| 36 | 5 43 | + 7 23 | Irregular narrow dark lane 2° long, NE. and SW. The NE. end connects brokenly with B 35† |
| 37 | 6 26 | +10 34 | Irregular, semi-vacant region 2½°-3° long† |
| 38 | 6 26 45 | +11 10 | Irregular vacancy; diam. 1°. This seems to refer to a portion of B 37 |
| 39 | 6 31 8 | +10 26 | Small, sharply defined, elongated spot in the nebulosity NW. of 15 Monocerotis |
| 40 | 16 7 24 | -18 39 | Diffused dark spot; diam. 15'; small star in it† |
| 41 | 16 15 0 | -19 20 | Diffused dark spot; diam. ¾° |
| 42 | 16 18 | -23 9 | Great nebula of ρ Ophiuchi† |
| 43 | 16 23 | -19 30 | Large dark region |
| 44 | 16 33 | -23 50 | Dark lane E. from ρ Ophiuchi region† |
| 44a | 16 36 8 | -40 6 | Irregular; diam. 5'; sharpest on SE. side; C.D.-40°10662 (9 ^m 0) close N. Apparently a real, dark object |
| 45 | 16 39 | -21 22 | Rather definite, 2° long† |
| 46 | 16 49 42 | -22 32 | Irregular; definite; a string of small stars in the middle |
| 47 | 16 52 12 | -22 27 | Irregular; definite; diam. 15'; connected with B 51 by two sharp lanes |
| 48 | 16 53 | -40 30 | Fairly well defined; 40' long NE. and SW.; 15' W. and N. of C.D.-40°11088 (8 ^m 0); seems to be a real object |
| 49 | 16 54 30 | -33 5 | Small; close SE. of and involving C.D.-33°11668 (9 ^m 3) |
| 50 | 16 54 40 | -34 12 | Large, irregular dark space† |
| 51 | 16 57 14 | -22 5 | Definite; diam. 20'† |
| 53 | 16 58 | -33 25 | Large; diffuse; extended N. and S. ¾°; curved toward the E. at N. end |
| 54 | 16 58 20 | -34 5 | Small, round; diam. 5'; close S. of 11 mag. star |
| 55 | 16 59 28 | -31 50 | Irregular; diam. 16'; best defined SE.; C.D.-31°13582 (8 ^m 9) near the center |
| 56 | 17 0 43 | -31 56 | Small; diam. 3'; close E. of C.D.-31°13609 (9 ^m 0). This seems to be a real object |
| 57 | 17 0 50 | -22 40 | Diam. 5'; elongated NE. and SW. |
| 58 | 17 2 30 | -40 15 | Diam. 30'; slightly extended N. and S.; a darker core at NE. side |
| 59 | 17 3 35 | -27 20 | Sink hole; diam. 1°; at the W. end of a wide broken lane from B 78 |
| 60 | 17 4 20 | -22 17 | Curved; 13' long; extended NE. and SW.; this and B 57 are the most distinct of a group of dark spots SW. of the |
| 61 | 17 7 35 | -20 20 | Small; elongated E. and W. [square end of B 63 |
| 62 | 17 8 46 | -20 44 | Diam. 19'; very black in NW. part; brightest of three stars in S. part=B.D.-20°4696 (9 ^m 4). Apparently a real |
| 63 | 17 9 | -21 20 | Large, definite, curved figure, convex to N.; the W. end abrupt; 1°37' E. and W., 19' wide [object. |
| 64 | 17 10 0 | -18 21 | Cometary; W. of M 9† |
| 65 | 17 11 50 | -26 34 | Definite; elongated; 12' E. and W. |
| 66 | 17 12 10 | -26 46 | Definite; extended E. and W.; 8' long; C.D.-26°12082 (8 ^m 7) 5' from SE. edge |

CATALOGUE OF 349 DARK OBJECTS IN THE SKY—*Continued*

| No. | α 1875.0 | δ 1875.0 | Description |
|-----|---|-----------------|---|
| 67 | 17 ^h 13 ^m 10 ^s | -26°44' | Definite; extended N. and S.; connects B 65 and 66 |
| 67a | 17 15 0 | -21 46 | Irregular; definite; diam. 13'; B.D.—21°4591 (9 ^M 5) in spot, near S.E. edge |
| 68 | 17 15 0 | -23 40 | Small; irregular; sharply defined; diam. 4'; about 20' SW. of B 72 |
| 69 | 17 15 19 | -23 48 | Very small; irregular; sharply defined; extends N. and S. 4' |
| 71 | 17 15 25 | -23 53 | Very small; diam. 1 $\frac{1}{4}$ ' \pm |
| 70 | 17 15 55 | -23 55 | Diam. 4'; sharply defined on W. side |
| 72 | 17 16 0 | -23 30 | S-shaped† |
| 73 | 17 16 30 | -24 10 | Very small; diam. 1'; extended N. and S. |
| 74 | 17 17 30 | -24 5 | Slightly curved, extending 5' N. from C.D.—24°13325 (7 ^M 1). Sharpest on W. and S. sides |
| 75 | 17 17 47 | -21 55 | Curved and scalloped marking; B.D.—21°4598 (8 ^M 3) on N. edge (see <i>Ap.J.</i> , 49, Plate II, 1919) |
| 76 | 17 18 | -24 18 | Irregular, narrow, black strip, $\frac{1}{2}$ ° long E. and W. |
| 77 | 17 21 | -23 45 | Indefinite; diam. 1°; connected by a vacant strip with B 78 |
| 78 | 17 25 | -25 30 | Very large; diam. 3°; C.D.—26°12152 (6 ^M 2) S. of the middle† |
| 79 | 17 30 0 | -19 32 | $\frac{1}{2}$ ° long SE. and NW.; narrow; sharply defined |
| 80 | 17 30 14 | -21 12 | Small; definite; 3'×1', SW. and NE.; close SE. of B.D.—21°4674 (8 ^M 1) |
| 81 | 17 30 55 | -23 51 | Very small; diffused; close SW. of N.G.C. 6401 |
| 82 | 17 31 0 | -23 42 | Small; angular; well defined; 8' N. of N.G.C. 6401 |
| 83 | 17 31 20 | -24 6 | Irregular; diam. 7'; several small stars in it; narrow extension to the S. |
| 83a | 17 37 54 | -19 57 | Small; definite; diam. 4', N. and S.; about 5' SE. of B.D.—19°4698 (9 ^M 5) |
| 84 | 17 39 0 | -20 12 | Irregular looped figure; sharply defined; 22' long E. and W.; extension from it 20' toward the NW.† |
| 84a | 17 50 20 | -17 39 | Round; diam. 16', with extension $\frac{3}{4}$ ° S.; B.D.—17°4967 (9 ^M 1) in center; perhaps some detail in it |
| 85 | 17 54 50 | -23 1 | Trifid nebula† |
| 86 | 17 55 9 | -27 52 | Diam. 5'; several small stars in it; the cluster N.G.C. 6520 close E.; C.D.—27°12302 (7 ^M 4) on NW. edge† |
| 87 | 17 56 0 | -32 30 | "Parrot's head"; C.D.—32°13679 (9 ^M 3) central; several smaller stars in it† |
| 88 | 17 56 56 | -24 7 | Extended N. and S., 2.7×0.5; in M 8† |
| 89 | 17 57 20 | -24 22 | Very small, diam. 0.5; in M 8 |
| 90 | 18 2 20 | -28 18 | Irregular; elongated; 3' N. and S.† |
| 91 | 18 2 30 | -23 43 | Diam. 5'; edge of diffused nebosity† |
| 92 | 18 8 16 | -18 16 | Black spot; 15' N. and S., 9' E. and W.† |
| 93 | 18 9 35 | -18 6 | Cometary; a sharply defined black head 2' in diam., with a diffused tail 15' long running S.; 20' NE. of B 92 |
| 95 | 18 18 37 | -11 49 | Large; indefinite; diam. 30'; elongated |
| 94 | 18 18 58 | -10 44 | Roundish; diam. 15'; indefinite |
| 96 | 18 19 30 | -10 22 | Small; indefinite; elongated E. and W. |
| 97 | 18 22 12 | -10 0 | Irregular; not very definite; diam. 1° |
| 98 | 18 25 31 | -26 9 | Very small; black; sharply defined; diam 3'† |
| 99 | 18 25 48 | -21 34 | Definite; 11' long E. and W., 3' wide; E. end is the larger, with a faint star in it |
| 100 | 18 25 50 | - 9 14 | Definite; irregular; curved; 16' long NW. and SE.† |
| 101 | 18 25 50 | - 8 54 | Definite; irregular; 13' long NE. and SW.; 4' wide; separated from B 100 by a scattering of small stars |
| 102 | 18 30 37 | -13 51 | Rather definite; elongated NE. and SW., 8'×3' |
| 103 | 18 32 42 | - 6 47 | Irregular; diam. 4'; one small star in it† |
| 104 | 18 40 42 | - 4 40 | Small, definite, caret-shaped object† |
| 105 | 18 41 0 | - 7 3 | Very small; diam. $\frac{1}{2}$ '; close NE. of B.D.—7°4710 (8 ^M 9) |
| 106 | 18 42 11 | - 5 13 | Diam. 2'; extended N. and S.; free of stars |
| 107 | 18 42 52 | - 5 9 | Irregular; diam. 5'; free of stars |

CATALOGUE OF 349 DARK OBJECTS IN THE SKY—*Continued*

| No. | α 1875.0 | δ 1875.0 | Description |
|------|---|-----------------|--|
| 108 | 18 ^h 42 ^m 52 ^s | — 6°27' | Very small; diam. 3'; not black; two narrow diverging lanes extending to the N.; some small stars in it |
| 109 | 18 42 50 | — 7 42 | Irregular; diam. 0.7'; close E. of B.D.—7°4726 (8 ^M 0) |
| 110 | 18 43 30 | — 4 56 | Irregular; diam. 11'; free of stars; a small star near the W. edge |
| 111 | 18 44 | — 5 6 | Region 2° in diam., full of dark structures† |
| 112 | 18 44 25 | — 6 49 | Diffused dark region; diam. 18' ±; perhaps due to want of stars |
| 113 | 18 44 48 | — 4 28 | Irregular; diam. 16'; small star in W. part |
| 114 | 18 46 27 | — 7 6 | Diam. 6'; B.D.—7°4754 (9 ^M 2) near middle; B.D.—7°4755 (9 ^M 1) on S. edge |
| 115 | 18 46 36 | — 6 49 | Very small and black† |
| 116 | 18 46 48 | — 7 20 | Narrow, semi-vacant region extending 20' S. from B.D.—7°4755 (9 ^M 1) |
| 117 | 18 46 58 | — 7 34 | Round; very black; diam. 1'; sharply defined† |
| 117a | 18 47 4 | — 5 0 | Black; irregular; diam. 7' |
| 118 | 18 47 10 | — 7 36 | Definite; diam. 2'; more definite and blacker than B 117 |
| 119 | 18 47 59 | — 4 42 | Very small; close NW. of B.D.—4°4623 (9 ^M 2) |
| 119a | 18 48 0 | — 5 20 | Irregular dark region; diam. $\frac{1}{2}$ °; liberally sprinkled with stars in its NW. half; several narrow dark lanes in SE. part |
| 120 | 18 48 16 | — 4 45 | Very small; close SE. of B.D.—4°4623 (9 ^M 2); E. side bounded by a curve of very small stars |
| 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' N.† |
| 123 | 18 51 2 | — 4 53 | Roundish; diam. 1 $\frac{1}{2}$ '; a narrow spur 4'–5' long from its NE. edge; a narrow lane 18' long and 1 $\frac{1}{2}$ ' wide from its W. side to the NW. |
| 124 | 18 51 5 | — 4 31 | Small dark spot; diam. 3' |
| 125 | 18 51 45 | — 4 33 | Dark; lune shaped; 9' E. and W.; fairly well defined on N. border; some faint stars in it |
| 126 | 18 52 25 | — 4 42 | Dusky; round; rather definite; diam. 8'† |
| 127 | 18 54 52 | — 5 37 | Irregular; diam. 4 $\frac{1}{2}$ '† |
| 128 | 18 55 3 | — 4 45 | Irregular; dusky; fairly well defined; diam. 10'† |
| 130 | 18 55 16 | — 5 45 | Dusky; not well defined; length 7' |
| 129 | 18 55 25 | — 5 29 | Very black; sharply defined; diam. 5'; a small star at the W. end† |
| 131 | 18 55 39 | — 4 33 | Black spot, about 2'×4'† |
| 132 | 18 57 51 | — 4 37 | Dark; fairly well defined† |
| 133 | 18 59 29 | — 7 5 | Cometary; close W. of B.D.—7°4852 (9 ^M 2)† |
| 134 | 19 0 11 | — 6 26 | Round; diam. 6'; dark, but not sharply defined; a small star on S. edge; a similar one on N. edge |
| 135 | 19 0 57 | — 4 7 | Dusky spot; diam. 13'; B.D.—4°4698 (9 ^M 2) on N. border; B.D.—4°4702 (9 ^M 2) on SE. edge |
| 136 | 19 2 14 | — 4 12 | Dusky spot; diam. 8'; 10 mag. star near middle |
| 137 | 19 9 32 | — 1 33 | Projection near S. end of B 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 SE. edge† |
| 140 | 19 13 39 | + 5 0 | Semi-vacant region; diam. 1° |
| 141 | 19 13 52 | + 1 40 | Semi-vacant region; N. of the N. end of B 138; diam. 20' |
| 142 | 19 33 45 | +10 14 | Large; irregular; about 40' E. and W.; B.D.+10°4016 (8 ^M 7) in E. part |
| 143 | 19 35 30 | +10 43 | Rather narrow, angular marking; the outline of a square $\frac{1}{2}$ ° in diameter, with the W. side missing |
| 144 | 19 54 | +35 0 | Large, semi-vacant region; 6°×3°, N.E. and SW.; rather definite at NE. end; diffused to the SE. |
| 145 | 19 58 16 | +37 20 | Sharply defined; $\frac{3}{4}$ ° long E. and W.† |
| 146 | 19 58 49 | +35 40 | Very small; like a dark border to the SW. side of the star B.D.+35°3930 (7 ^M 0) |
| 147 | 20 2 7 | +35 1 | Very narrow sinuous dark lane 11' long E. and W.; B.D.+34°3871 (8 ^M 3) at W. end |
| 148 | 20 44 50 | +59 10 | Very small; round; indefinite; diam. 3' |
| 149 | 20 46 7 | +59 4 | Very small; round; indefinite; diam. 2'. This spot and B 148 each in a larger dusky space |

CATALOGUE OF 349 DARK OBJECTS IN THE SKY—*Continued*

| No. | α 1875.0 | δ 1875.0 | Description |
|-----|---|-----------------|--|
| 150 | 20 ^h 47 ^m 50 ^s | +59°50' | Curved dark marking; 1° long† |
| 151 | 21 4 40 | +55 49 | Very small; very dark; diam. 1'; about 14' N. of B.D.+55°2529 (7 ^M 5); apparently a real object in a slightly larger [vacancy |
| 152 | 21 11 30 | +61 13 | Small; 15'×3' SE. and NW.† |
| 153 | 21 17 20 | +55 55 | Black; irregular; diam. 1'; 5' S. of B.D.+55°2565 (7 ^M 4) |
| 154 | 21 17 40 | +56 5 | Narrow; 8' long NE. and SW.; B.D.+55°2565 (7 ^M 4) at the S. end |
| 155 | 21 27 25 | +44 25 | Round; diam. 13'; indefinite; four small stars in a line crossing it E. and W. |
| 156 | 21 29 17 | +45 2 | Diam. 8'; sharp pointed to N.; B.D.+44°3865 (4 ^M 1) in center |
| 157 | 21 29 38 | +54 7 | Round; diam. 5'; 8'± W. of B.D.+54°2576 (8 ^M 3); a semi-circle of faint stars forms the western border |
| 158 | 21 32 22 | +42 51 | Dark spot; diam. 3'; similar to those in the region of B 159. There are some others N. and W. of this |
| 159 | 21 33 30 | +42 40 | Irregular partially vacant region; diam 25'† |
| 160 | 21 34 0 | +55 40 | Large, dark, irregular; diam. 31' NE. and SW.† |
| 161 | 21 36 30 | +57 15 | Small, black spot† |
| 162 | 21 37 8 | +55 45 | Very thin, curved, dark strip, 13' N. and S.; a curve of small stars on the SW. end |
| 163 | 21 38 10 | +56 8 | Small; very black; pointed to the S.; two dark streams running from this toward the N. |
| 164 | 21 42 2 | +50 31 | V-shaped vacancy; 20' N. and S. |
| 165 | 21 45 10 | +59 38 | Length E. and W. 18', width 1'; B.D.+59°2424 (7 ^M 8) near the E. end |
| 166 | 21 47 16 | +59 30 | Round; diam. 5'; small star on SW. edge |
| 167 | 21 48 8 | +59 29 | Small; irregularly round; diam. 5'; about 7' N. of B.D.+59°2427 (7 ^M 7) |
| 168 | 21 48 32 | +46 41 | Small nebula at E. end of dark lane† |
| 170 | 21 54 0 | +58 22 | Irregular black strip 26' long NE. and SW., 4' wide† |
| 169 | 21 54 48 | +58 10 | Elliptical black ring; diam. 1°† |
| 171 | 21 57 12 | +58 16 | Irregular broken region; diam. 19'; at the E. end of the "island" of small stars |
| 174 | 22 3 8 | +58 28 | Narrow; irregular; 19' long NE. and SW. |
| 173 | 22 3 20 | +59 4 | Diam. 4'; rather definite; a small star on N. edge and one on SW. edge |
| 175 | 22 11 | +69 19 | Large; diam. 1°; bright nebula in N. part† |

SECOND CATALOGUE

| | | | |
|-----|---------|--------|--|
| 201 | 2 4 20 | +56 30 | Small; diam. 10'; 45' W. of N.G.C. 869 |
| 202 | 3 18 0 | +29 50 | Elongated NW. and SE., 33'×12' |
| 203 | 3 18 10 | +30 20 | Elongated E. and W.; B.D.+30°539 (9 ^M 0) in N. edge |
| 204 | 3 20 50 | +29 45 | Irregular; diam. 14'±; 15' SW. of B.D.+29°566 (6 ^M 8) |
| 205 | 3 20 50 | +30 40 | Two dark strips, 15' long N. and S., with B.D.+30°547 (9 ^M 3) between them; close SW. of B.D.+30°548 (neb.) |
| 206 | 3 21 30 | +29 45 | Diffused; diam. 5'± |
| 207 | 3 57 0 | +26 0 | Small black spot, elongated nearly N. and S.; 7' N. of B.D.+25°670 (8 ^M 3) |
| 208 | 4 4 0 | +24 50 | Darker spot in dark lane |
| 209 | 4 4 40 | +28 0 | Center of a broad extension from B 7, toward the W. |
| 210 | 4 8 0 | +24 45 | Darker spot in dark lane |
| 211 | 4 9 30 | +27 30 | North end of dark lane running SE. from B 7; extends from position given to $\alpha=4^{\text{h}}20^{\text{m}}0^{\text{s}}$, $\delta=+25^{\circ}50'$ (B 217) |
| 212 | 4 11 40 | +25 0 | Darker spot in dark lane |
| 213 | 4 13 30 | +26 45 | Dark spot in lane |
| 214 | 4 14 10 | +28 15 | Diam. 5'; close N. of B.D.+28°645 (9 ^M 1) |
| 215 | 4 16 0 | +24 45 | Darker spot in dark lane |
| 216 | 4 16 20 | +26 20 | Dark spot in lane |
| 217 | 4 20 0 | +25 50 | Southeast end of dark lane running from B 7 |

CATALOGUE OF 349 DARK OBJECTS IN THE SKY—*Continued*

| No. | α 1875.0 | δ 1875.0 | Description |
|-----|--|-----------------|--|
| 218 | 42 ^h 0 ^m 30 ^s | +26° 0' | Triangular; diam. 15'; extension to the E. |
| 219 | 4 27 | +29 20 | Partly vacant space; 55'×3", NE. and SW. |
| 220 | 4 33 50 | +25 45 | Round, diam. 7'; feebler extension runs NW. for 1°; B.D. +25°723 (8 ^M 3) near W. edge |
| 221 | 4 36 | +31 30 | Partly vacant region; diam. about $\frac{1}{2}$ ° |
| 222 | 5 0 18 | +32 0 | Round; indefinite; diam. 10' |
| 223 | 5 14 40 | + 8 12 | Fan-shaped nebula; diam. 8' ± † |
| 224 | 5 17 0 | +10 30 | Indefinite; diam. 20' |
| 225 | 5 22 | +11 30 | South end of extension running S. for 35' from B 30 |
| 226 | 5 28 20 | +33 37 | Dark spot; diam. 17'; S. of M 36 |
| 227 | 6 0 0 | +19 40 | Round, diam. 12'; one or two faint stars in it |
| 228 | 15 37 | -34 7 | Large vacant region about 4° long NW. and SE. † |
| 229 | 16 10 | -27 0 | Indefinite, partially vacant region; diam. $\frac{3}{4}$ ° |
| 230 | 16 20 | -16 30 | Round; diam. about 1° |
| 231 | 16 30 10 | -35 10 | Dusky; diam. 30'; sharpest on W. side, diffuses to the E. |
| 232 | 16 35 10 | -39 35 | Dusky; 10' N. and S.; two small stars in it |
| 233 | 16 36 30 | -35 10 | Diffused; 55' N. and S.; 20' wide |
| 234 | 16 38 30 | -30 15 | Narrow; nearly $\frac{1}{2}$ ° long, 6' wide |
| 235 | 16 38 8 | -44 15 | Diam. 7'; elongated NE. and SW.; darkest part at SW. end |
| 236 | 16 41 | -29 35 | Center of system of indistinct dark lanes |
| 237 | 16 41 0 | -29 45 | Dark lane N. of C.D.—30°13487 (8 ^M 0) † |
| 238 | 16 44 50 | -22 55 | Irregular; diam. 13'; B.D.—22°4232 (8 ^M 0) on NW. edge |
| 239 | 16 47 | -30 55 | Curved; 15' long; very black and narrow; rimmed with stars on S. and E. sides |
| 240 | 16 51 0 | -35 10 | Black; diam. 20' |
| 241 | 16 51 30 | -30 0 | Dusky; diffused; 18' long E. and W., 6' wide; about 20' W. of M 62 |
| 242 | 16 57 0 | -32 15 | Dusky; elongated E. and W., 30'×8' |
| 243 | 17 1 50 | -29 25 | Very irregular; diam. 25' |
| 244 | 17 3 0 | -28 15 | Irregular; sharpest on W. side; about 30' long N. and S., 20' wide; from S. end a narrow projection runs W. for about |
| 245 | 17 4 0 | -29 15 | Round; diffused; diam. 8'; several bright stars in it |
| 246 | 17 4 30 | -22 30 | Irregular; diam. about 15' |
| 247 | 17 5 8 | -30 6 | Black; diam. 4' |
| 248 | 17 5 10 | -28 50 | Irregular; 10' E. and W. |
| 249 | 17 5 10 | -29 0 | Very thin, short, black line, 5' long, 20'' ± wide; 25' NW. of N.G.C. 6304; small star at NE. end |
| 250 | 17 5 10 | -28 15 | Diffused; diam. 15' |
| 251 | 17 6 25 | -20 0 | Dusky; elongated NE. and SW., 20'×5' |
| 252 | 17 7 12 | -32 0 | Triangular; 20' N. and S.; eastern side diffused † |
| 253 | 17 8 | -22 25 | Irregular dark region; diam. nearly 1°; B.D.—22°4307 (8 ^M 8) in western part |
| 254 | 17 12 30 | -30 0 | Irregular; diffused; elongated E. and W., 1°×20' |
| 255 | 17 13 0 | -23 20 | Dusky; diam. 5' |
| 256 | 17 14 18 | -28 42 | Very irregular and diffused; 50' E. and W.; B.D.—28°13101 (7 ^M 7) near E. end |
| 257 | 17 14 25 | -35 30 | Dusky spot; diam. 15'; about 10' NW. of C.D.—35°11505 (6 ^M 7) |
| 258 | 17 14 40 | -34 36 | Irregular area of dark markings; diam. 40' ± |
| 259 | 17 14 40 | -19 10 | Irregular dark area; diam. $\frac{1}{2}$ °; B.D.—19°4605 (6 ^M 5) on W. border; B.D.—19°4617 (7 ^M 8) in E. part |
| 260 | 17 17 6 | -25 30 | Diffused; elongated N. and S., 12'×7' |
| 261 | 17 17 30 | -22 55 | Elongated E. and W., 14'×5'; diffused on S. side, reaching almost to C.D.—23°13378 (7 ^M 6), about 18' SE. of the |

CATALOGUE OF 349 DARK OBJECTS IN THE SKY—*Continued*

| No. | α 1875.0 | δ 1875.0 | Description |
|-----|---------------------------------|-----------------|--|
| 262 | 17 ^h 18 ^m | 0 | Large dark region; diam. $\frac{1}{2}^{\circ}$; diffused except on N. border† |
| 263 | 17 18 | 0 | Diam. 30' NE. and SW. |
| 264 | 17 19 | 30 | Narrow; black; 10' E. and W.; bends N. at E. end; 15' W. of C.D.—25°12179 (7 ^M 3) |
| 265 | 17 19 | 55 | Irregular; 18' N. and S.; 7' wide; diffused on E. side; about 5' W. of C.D.—25°12171 (9 ^M 2) |
| 266 | 17 20 | 40 | Curved; 30' long NE. and SW.; B.D.—20°4775 (7 ^M 8) just S. of S. edge |
| 267 | 17 20 | 50 | Small, very black; elongated NW. and SE., 5'×3'; C.D.—25°12177 (9 ^M 3) at NW. end |
| 268 | 17 24 | —20 25 | Irregular dark area, 1 $\frac{3}{4}$ ° N. and S.; 50' wide |
| 269 | 17 24 | 40 | Dusky region, 1° long NW. and SE.; B.D.—22°4369 (7 ^M 5) near SE. end |
| 270 | 17 25 | 20 | Round; diam. 11'; in NE. part of B 268 |
| 271 | 17 26 | —34 10 | Dusky; curved; 2° N. and S., 10'± wide; C.D.—33°12241 (8 ^M 7) near N. end |
| 272 | 17 30 | —23 20 | Region of irregular dark markings; diam. $\frac{3}{4}^{\circ}$; C.D.—23°13469 (8 ^M 0) near middle |
| 273 | 17 30 | 16 | Dark spot at N. end of B 271; diam. 15' |
| 274 | 17 30 | 30 | Triangular; definite; 18' N. and S.; B.D.—22°4383 (7 ^M 5) in N. end |
| 275 | 17 30 | 50 | Round; diam. 13'; about 20' W. of M 6 |
| 276 | 17 32 | 15 | Broken region of dark markings; diam. $\frac{3}{4}^{\circ}$; B.D.—19°4677 (8 ^M 3) in NW. part |
| 277 | 17 33 | 10 | Narrow; 18' long E. and W.; B.D.—22°4387 (8 ^M 3) at W. end. A less distinct branch running 30'± to the SE. forms [a large V, open to the E. |
| 278 | 17 34 | 30 | Round; diam. 15'; about 30' E. of M 6 |
| 279 | 17 37 | —22 30 | Irregular dark area; diam. 1°; B.D.—22°4405 (7 ^M 3) near N. edge; B.D.—22°4411 (8 ^M 7) in E. part |
| 280 | 17 37 | 30 | Irregular dusky area; diam. 1°± |
| 281 | 17 39 | 10 | Dark loop close E. of C.D.—23°13548 (8 ^M 1) |
| 282 | 17 ^h 41 ^m | 0 ^s | 18' long NE. and SW.; sharp on NW. side; C.D.—23°13589 (8 ^M 0) near NE. end |
| 283 | 17 43 | —33 50 | Irregular, dusky area 1 $\frac{1}{2}$ °± E. and W.; 1° N. and S. |
| 284 | 17 43 | 0 | Curved; 35' NE. and SW., 5' wide; outline sharp except at SW. end; B.D.—14°4780 (8 ^M 0) about 5' NW. of the center |
| 285 | 17 44 | 30 | Diffused; diam. 15' |
| 286 | 17 44 | 40 | Diffused; diam. 15'±; C.D.—35°12013 (7 ^M 1) in SW. part |
| 287 | 17 46 | 5 | Irregular, semi-vacancy; diam. $\frac{1}{2}^{\circ}$ ±; SE. of M 7 |
| 288 | 17 48 | 36 | Black; diam. 2'; diffuses toward NE.; 25' SW. of C.D.—36°12060 (6 ^M 3) |
| 289 | 17 48 | 40 | Dark space between star clouds, about 7'×35' |
| 290 | 17 50 | 50 | Very small; diam. 3'±; extends N. faintly for 25', to and beyond C.D.—36°12060 (6 ^M 3) |
| 291 | 17 51 | 27 | Small, round, black; diam. 5'† |
| 292 | 17 52 | 20 | Irregular, broken, dark region; diam. 1°± |
| 293 | 17 52 | 50 | Dusky; curved; like an inverted U, 18' across; C.D.—35°21259 (8 ^M 5) near the center |
| 294 | 17 53 | 35 | Definite; diam. 3'; star in SW. part |
| 295 | 17 56 | 0 | Irregular, dark region, diam. 50'; full of rich, soft details of an apparently nebulous character |
| 296 | 17 56 | 24 | Narrow; black; 6'×1'; on S. edge of M 8 |
| 297 | 17 57 | —18 45 | Region of irregular, dark markings, 2° E. of M 23; covers an area 1 $\frac{1}{2}$ ° E. and W. and about 1° N. and S. |
| 298 | 17 57 | 10 | Small; diam. 4'; 5' SE. of N.G.C. 6528 |
| 299 | 17 58 | 30 | Several small spots in star cloud, each about 3' in diameter |
| 300 | 17 58 | 50 | Broken dark region about 30' E. of B 87 |
| 301 | 18 1 | 30 | Dusky lane; 45'± long NE. and SW.; 2' wide |
| 302 | 18 1 | 35 | Dark spot; diam. about $\frac{1}{2}$ '; close N. of C.D.—24°13962 (7 ^M 8) |
| 303 | 18 1 | 50 | Very black; lune shaped, convex to E.; diam. about 1'; 3' SE. of C.D.—24°13962 (7 ^M 8) |
| 304 | 18 6 | —18 45 | Dusky lanes in star cloud extending toward the SW. from B 92 for 1 $\frac{1}{2}$ ° |
| 305 | 18 6 | 30 | Dark; irregular; diam. 13'† |

CATALOGUE OF 349 DARK OBJECTS IN THE SKY—*Continued*

| No. | α 1875.0 | δ 1875.0 | Description |
|-----|---|-----------------|---|
| 306 | 18 ^h 8 ^m 0 ^s | -25°45' | Small, narrow, black; 4' long NE. and SW.; C.D.-25°12920 (8 ^M 2) 5' SW. of W. end; similar to B 249 |
| 307 | 18 11 20 | -18 0 | Narrow, dusky mark in star cloud; 6' long NE. and SW. |
| 308 | 18 11 36 | -22 17 | Curved; dusky; 7' E. and W., 5' wide |
| 309 | 18 15 30 | -24 5 | Irregular; dusky; diam. 5' |
| 310 | 18 22 53 | -18 40 | Diam. 2'; small star near center; 20' SW. of B.D.-18°4988 (6 ^M 0) |
| 311 | 18 23 10 | -17 45 | Black, elliptical; diam. 6' NE. and SW.; in a semi-vacant strip 35' long |
| 312 | 18 25 | -15 40 | Large dark area; 1½° NW. and SE., about 30' wide† |
| 313 | 18 28 46 | -15 47 | Narrow; curved; 15' E. and W. |
| 314 | 18 30 12 | - 9 49 | Irregular, dusky marking, 35' long NE. and SW. |
| 315 | 18 34 54 | -20 9 | Round; dark; diam. 5' |
| 316 | 18 35 20 | - 2 15 | Dark; diam. 6'; sharp on its S. end, gradually diffusing to the N. into a wide open space |
| 317 | 18 38 40 | -14 20 | Dusky; 30' NE. and SW., 5' wide |
| 318 | 18 43 0 | - 6 32 | Long, straight, dark line† |
| 319 | 18 45 30 | - 1 25 | Thin, curved, dark marking; length 7'; B.D.-1°3586 (9 ^M 5) at the NE. end |
| 320 | 18 46 6 | - 6 0 | Irregular; diam. 15' ±; B.D.-6°4941 (7 ^M 5) near center; at S. end of the large crescent-shaped marking, B 111 |
| 321 | 18 47 5 | -11 27 | Dusky; 15' long E. and W., 7' wide; B.D.-11°4795 (7 ^M 8) near W. end |
| 322 | 18 49 10 | - 4 37 | Very small; black; diam. 2'; at NE. end of the "crescent," B 111 |
| 323 | 18 51 0 | - 3 35 | A dark parallelogram, 17' N. and S.; B.D.-3°4423 (9 ^M 2) in W. part |
| 324 | 18 52 50 | - 3 10 | Definite, dusky loop† |
| 325 | 18 53 18 | - 4 14 | Irregular; dusky; 15' NW. and SE. |
| 326 | 18 57 | - 0 34 | Narrow; 25' long E. and W., 3' wide |
| 327 | 18 57 48 | - 5 19 | Curved, dusky lane; 30' N. and S., 3' wide |
| 328 | 18 58 13 | - 4 26 | Small; black; diam. 4'; 13' S. of B.D.-4°4684 (5 ^M 7) |
| 329 | 19 0 44 | + 3 0 | Dusky spot in star cloud; diam. 6' ±; B.D.+2°3789 (9 ^M 0) near E. edge |
| 330 | 19 13 30 | + 7 20 | Dark; round; diam. 30'; B.D.+7°4028 (7 ^M 8) on NE. border |
| 331 | 19 20 | + 7 20 | Dusky, narrow lane 1° long NW. and SE., 3' wide |
| 332 | 19 22 | + 8 30 | Area of dark lanes. A black spot, connected with these lanes, is located about 15' N. of B.D.+8°4112 (7 ^M 5) |
| 333 | 19 23 | +10 25 | Area of irregular dark lanes; diam. 1° ±; these irregular lanes have a uniform width of about 2' or 3' |
| 334 | 19 29 15 | +12 3 | Small, dark marking; diam. 3'† |
| 335 | 19 30 50 | + 7 20 | Small; very black; diam. 6'; in a slightly larger dusky area; B.D.+7°4151 (7 ^M 8) near its SW. edge |
| 336 | 19 30 50 | +12 4 | Dark; diam. 1'-2'; in a slightly larger vacant space; B.D.+11°3912 (8 ^M 6) in SW. part |
| 337 | 19 31 10 | +12 7 | Dark; diam. 3', with narrow extension for 17' to NW.† |
| 338 | 19 36 58 | + 7 10 | Dusky; diam. 8'; just S. of B.D.+7°4191 (8 ^M 8); in S. part of B 339 |
| 339 | 19 38 | + 8 0 | Broken, dusky region covering more than 1° |
| 340 | 19 42 50 | +11 6 | Irregular; curved; diam. 7'; 25' S. of B.D.+11°3994 (5 ^M 8); a narrow extension for 15' to the N. |
| 341 | 19 45 18 | +33 58 | Narrow, dark lane; about ½° E. and W.† |
| 342 | 20 5 10 | +40 50 | Small, dark marking; 4' E. and W. |
| 343 | 20 9 0 | +39 54 | Elongated; 13' long NW. and SE.; sharpest at SE. end; several stars in S. part; 10' ± E. of B.D.+39°4082 (7 ^M 5) |
| 344 | 20 11 45 | +39 50 | Dusky spot, 7' long; like an arrowhead, pointed SE.; small star at NE. end |
| 345 | 20 17 0 | +46 10 | Curved; convex to the E.; 15' long; bordered by two parallel curves of small stars |
| 346 | 20 22 30 | +43 20 | Curved, black spot; diam. 10'; embraces to the N. a triangular mass of small stars |
| 347 | 20 23 55 | +39 30 | Dark streak in nebulous cloud; less than 1' wide, extending 10' SW. from B.D.+39°4206 (8 ^M 8) |
| 348 | 20 30 | +41 40 | Narrow; dusky; nearly 1° long NE. and SW.† |
| 349 | 20 43 0 | +43 30 | Small; curved; dusky; diam. 6'† |

CATALOGUE OF 349 DARK OBJECTS IN THE SKY—*Continued*

| No. | α 1875.0 | δ 1875.0 | Description |
|-----|---|-----------------|---|
| 350 | 20 ^h 44 ^m 50 ^s | +45°25' | Small; round; dusky; diam. 3'; 14' S. of B.D.+45°3291 (5 ^M 6) |
| 351 | 20 48 16 | +46 56 | Crooked, dusky lane, 3' wide; 25' long NE. and SW.; $\frac{1}{2}$ ° W. of B.D.+46°3111 (6 ^M 0) |
| 352 | 20 52 50 | +45 25 | Large; black; diam. 22'; sharply defined on SE. side; a row of five stars runs nearly N. and S. across its E. end |
| 353 | 20 53 0 | +45 0 | Definite; dusky; 12' N. and S.; 6' wide |
| 354 | 20 55 | +57 40 | Dusky; irregular; 1° NE. and SW. |
| 355 | 20 55 5 | +42 42 | Dark; definite; 5' E. and W.; like a letter V—the open end toward the E. |
| 356 | 20 55 40 | +46 12 | Irregular; dusky; diam. 24'; B.D.+46°3141 (7 ^M 6) on SE. border; irregular extension for $1\frac{1}{2}$ ° toward the NE. |
| 357 | 20 56 20 | +55 5 | Irregular; dusky; diam. 30'; B.D.+55°2495 (7 ^M 9) in NW. edge; B.D.+54°2455 (9 ^M 0) near center |
| 358 | 21 1 5 | +42 47 | Diam. 20'; diffuses to NE.; a curve of stars along N. edge; B.D.+42°3960 (9 ^M 5) at W. side |
| 359 | 21 3 20 | +56 40 | Narrow; dusky; 20' long NE. and SW.; B.D.+56°2527 (8 ^M 7) about 7' W. of SW. end |
| 360 | 21 4 20 | +56 0 | Irregular dark marking† |
| 361 | 21 8 23 | +46 55 | Round; diam. 20'; irreg. extension to W. for $\frac{1}{2}$ ° ± |
| 362 | 21 19 40 | +49 40 | Elongated; 15' NE. and SW.; B.D.+49°3517 (9 ^M 0) on NE. edge |
| 363 | 21 20 30 | +48 24 | Irregular; dusky; 40' long NE. and SW.; B.D.+48°3390 (5 ^M 5) 7' ± E. of SE. side |
| 364 | 21 30 | +54 0 | Region of many small dark lanes; diam. $1\frac{1}{4}$ ° ± |
| 365 | 21 31 0 | +56 10 | Dark S-shaped object; 22' long N. and S.; B.D.+55°2604 (9 ^M 0) near SW. end |
| 366 | 21 36 40 | +59 0 | Roundish; dusky; diam. 10'; 12' S. of B.D.+59°2409 (6 ^M 9); two small stars on N. border |
| 367 | 21 40 25 | +56 36 | Small; dark; 5' NW. and SE.; about 5' NW. of B.D.+56°2635 (9 ^M 5) |
| 368 | 21 47 0 | +58 24 | Dusky spot, 14' long NE. and SW.; a row of small stars in it; about 4' SW. of B.D.+58°2340 (9 ^M 0) |
| 369 | 22 11 20 | +55 24 | Round; dusky; diam. 5'; about 13' NE. of B.D.+55°2709 (7 ^M 8) |
| 370 | 22 30 | +56 0 | Region of narrow dark lanes |

NOTES ON THE CATALOGUE

- 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^M0) whose position is $\alpha=4^{\text{h}}6^{\text{m}}58^{\text{s}}$, $\delta=+53^{\circ}18'$. 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 coordinates $\alpha=3^{\text{h}}58^{\text{m}}$, $\delta=+54^{\circ}7'$ and $\alpha=4^{\text{h}}20^{\text{m}}$, $\delta=+54^{\circ}8'$. The individual positions of some of the spots are given in the catalogue.
- 15 One of the finest examples of a dark object seen against the ordinary sky and away from the Milky Way. 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.
- 20 This is the dark object mentioned by Espin in *Monthly Notices*, 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 B 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 (B 14). This is undoubtedly a brighter condensation of the great obscuring mass surrounding it. The position of this small nebula is $\alpha=4^{\text{h}}32^{\text{m}}20^{\text{s}}$, $\delta=+25^{\circ}30'$.
- 14 A bright spot in the dark nebula B 22. (Position given in *Astrophysical Journal*, 49, 14, 1919, in error by 10^{m} in α .)
- 30 There is a nebulous border, $\frac{1}{2}$ ° wide, to the semi-vacant region extending 1° east and north from B.D.+12°803 (7^M0). 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^m9). There is a small fan-shaped nebula close north of a small star in the position $\alpha=5^{\text{h}}24^{\text{m}}30^{\text{s}}$, $\delta=+12^{\circ}3'9$. A small strip of nebulosity extends 5' southwest from this star. These two nebulae are probably the brighter parts of a large obscure nebulosity.
- 36 Well shown on Plate 21, *Lick Observatory Publications*, 11, 1913.
- 37 This region is abruptly terminated on the south side by the nebulosity extending north from 15 Monocerotis. Its west side ends abruptly in $\alpha=6^{\text{h}}22^{\text{m}}15^{\text{s}}$, $\delta=+12^{\circ}26'$. B 37, 38, and 39 are shown in Plates 28 and 29 (*ibid.*).
- 40 This spot and B 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 $\alpha=16^{\text{h}}23^{\text{m}}$, $\delta=-19^{\circ}30'$ (B 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 $3\frac{1}{2}^{\circ}$ in diameter. For references to the visual discovery and early observations of this strange region see *Astronomische Nachrichten*, 138, 211, 1895; *Popular Astronomy*, 5, 227, 1897; 14, 581, 1906; *Lick Observatory Publications*, 11, 19, 1913 and Plate 36.
- 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 beginning in a vacant area in which is the star 22 Scorpii (C.D.—24°12695, 5^m5). It runs slightly northeast to about $\alpha=16^{\text{h}}40^{\text{m}}$, $\delta=-23^{\circ}40'$. From this point it extends in a broken chain of dark spots to a little south of B 63. Its total length is therefore about 10°.
- 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.
- 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 $\frac{1}{2}^{\circ}$. The star C.D.—34°11418 (9^m8) is near the middle. The stars C.D.—34°11422 (9^m8) and —34°11427 (9^m9) are on the eastern border.
- 51 One of a straggling group toward the eastern end of the dark lane from Rho Ophiuchi. Two irregular, dark lanes run west from it to B 47.
- 64 This object 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 $\alpha=17^{\text{h}}9^{\text{m}}57^{\text{s}}$, $\delta=-18^{\circ}20'6$.
- 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°13375 (9^m1). Its average thickness is about 2'–3'. The position in the catalogue is for the southern part of the figure, or the bottom of the S (see *Astrophysical Journal*, 49, 1919, Plate III).
- 78 This vacant region, with its extension to the west running south of Theta Ophiuchi, is visible to the naked eye (see *Popular Astronomy*, 14, 580 1906.)
- 84 B.D.—20°4865 (8^m2) near west end and B.D.—20°4869 (9^m1) near east end (see *Astrophysical Journal*, Plate II).
- 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 For the visual discovery of this object see *Astronomische Nachrichten* 108, 370, 1884.
- 87 C.D.—32°13666 (9^m6) on northwest edge. C.D.—32°13687 (9^m6) on southeast edge.
- 88 There are other well-known markings in this nebula. This one and B 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 In an irregular dusky space 13' in diameter. 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, known to me in my early days of comet seeking, 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 *ibid.*, 38, 496, 1913, Plate XX, for an account of this remarkable object).
- 98 This object looks like a dark planetary nebula. C.D.—26°13264 (10^m) is about 4' northwest, and C.D.—26°13262 (8^m6) about 10' southwest of the spot (see *ibid.*, 31, 12, 13, 1910; 49, 1919, Plate IV).
- 100 Larger at east end. A small star in the southeast edge; B.D.—9°4761 (9^m0) at northwest end.
- 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' 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.
- 111 This is a beautiful region of dark structures, to the east of 6 Aquilae (B.D. $-4^{\circ}45'82''$, 4^m5) and north of the cluster M 11. It forms a wide crescent, with the convex side to the west. To the east it is irregular and broken. The stars B.D. $-5^{\circ}47'75''$ (8^m3) and $-5^{\circ}47'78''$ (8^m4) are near the middle of this region.
- 115 Very narrow, running north and south for 7'; width 1.4. It is in a small vacant region (see *ibid.*, pp. 7-9, for visual observations of B 115, 117, and 118).
- 117 This is at the south end of a larger dark region (B 116) with dark lanes running to the north and northeast. It is separated from B 118 by several 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.
- 126 An irregular narrow dark streak extends 9' to the northeast; another from its south side runs close to B.D. $-4^{\circ}46'50''$ (7^m4). A small star in the northeast edge.
- 127 Very black in its southeast portion, diffused on the west side. B 127, 129, and 130 are connected in an irregular curve, convex to the west (see *ibid.*, p. 7, and Plate IV for an account of visual observations, and a photograph of this object and of B 129).
- 128 A narrow extension 13' long from the northeast side. A small star close southwest of it. This is in a larger vacant region.
- 129 Somewhat rectangular in form with projections to the east. It is the blacker portion of a dark region 10' in diameter.
- 131 This is a very small black spot with a small star on the north border and another on the south; a fine curve of six or seven very small stars runs northwest from its north edge. It is located at the northeast end of the narrow extension from B 128.
- 132 Tadpole shaped; 16' long east and west. Diameter of the larger (east) part 8', with B.D. $-4^{\circ}46'80''$ (9^m0) in center.
- 133 This object begins very closely west of B.D. $-7^{\circ}48'52''$ (9^m2). 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 four or five small stars in it (see *ibid.* pp. 7, 11, and Plate IV).
- 138 This great curved "lane" extends from about $\alpha = 19^{\text{h}}16^{\text{m}}$, $\delta = +1^{\circ}4'$ to $\alpha = 19^{\text{h}}12^{\text{m}}$, $\delta = -1^{\circ}6'$, its concave side to the east. Perhaps its most striking feature is the definiteness of its eastern outline. To the west it is less definite, and in the southern 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. The southern end terminates in the small black spot, B 139
- 139 This spot is at the southern end of B 138. It is comet shaped, about $4' \times 12'$; very black and sharply defined on its south edge. This is apparently a real object.
- 145 This is a triangular semi-vacant area. It is covered by a sprinkling of considerable small stars with the star B.D. $+37^{\circ}37'36''$ (9^m5) in the center. B.D. $+37^{\circ}37'35''$ (7^m0) is just north of the north edge, and B.D. $+37^{\circ}37'48''$ (8^m7) near the east end.
- 150 This curved marking, convex to the north, is much broken with darker masses. The position given is for its center. The star B.D. $+59^{\circ}22'91''$ (8^m0) is close to its northeast edge. Its east end is in about $\alpha = 20^{\text{h}}51^{\text{m}}0^{\text{s}}$, $\delta = +59^{\circ}45'$. The west end curves southward and ends near B.D. $+59^{\circ}22'83''$ (8^m2) (see *ibid.*, 43, 1-8, 1916, Plate I, and *Proceedings of the National Academy of Sciences*, 1, 394-96, 1915).
- 152 Close north of B.D. $+61^{\circ}21'03''$ (8^m9). The west end is larger, with a small star in it. (In *Astrophysical Journal*, 43, 5, 1916, it is wrongly stated that this object is south of the B.D. star.)
- 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 nebula, as there are several small darker spots in it. It lies 40' northwest of Nova Cygni of 1876, and involves the stars B.D. $+42^{\circ}41'77''$ (5^m2), $+42^{\circ}41'72''$ (8^m4), and $42^{\circ}41'64''$ (7^m7). 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.
- 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).
- 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. B.D. $+58^{\circ}23'71''$ (8^m5) is in the northeast part of the "island" of stars.
- 170 This is the northwest border of the island of small stars. It is sharply defined and darker than the sky.
- 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. $+69^{\circ}12'31''$ (8^m8) which is nebulous. This is apparently a large dark nebula, the brighter part of which forms the star $+69^{\circ}12'31''$. 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 $5^{\text{h}}0^{\text{m}}$ 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.
- 223 This nebula is close southwest of, and apparently attached to, B.D.+8°933 (6^M5). It is possibly the bright part of an obscuring nebula.
- 228 This vacant region is about 4° long, extending from $\alpha = 15^h 31^m$, $\delta = -32^\circ 45'$ to $\alpha = 15^h 43^m$, $\delta = -35^\circ 30'$. Its average width is about $\frac{1}{2}^\circ$. It is strongest marked at the north end. There are fragments of other dark markings several degrees west of this.
- 237 Beginning about 10' northwest of C.D.-30°13487 (8^M0) this dark lane runs northeast for 37' and then turns abruptly to the east for 18'.
- 252 Abrupt dark marking in a bright, apparently nebulous, region. C.D.-31°13763 (7^M7) near northeast end.
- 262 A hooklike projection from the west side, with the star B.D.-22°4338 (9^M6) on west edge of this hook.
- 291 C.D.-33°12697 (8^M3) is on the east edge of this spot; a very faint star in the center. A dark lane 2' wide runs southerly from the spot for a distance of 25' and ends in a dark broken region. From the eastern side of the lane, 8' south of the star, a similar dark lane runs easterly, then north, for 35', ending in the broken region B 292.
- 305 Dark streamers radiate from this spot to the north for more than $\frac{3}{4}^\circ$ and broken ones for $\frac{1}{2}^\circ$ toward the southwest.
- 312 This dark area is almost elliptical in form. It is sharply defined on its north and northwest sides, but is diffused to the south, and elsewhere. There is a heavy sprinkling of small stars all over it.
- 318 This dusky line, just south of M 11, extends east and west for about $1\frac{1}{2}^\circ$. It is uniformly about 2' wide.
- 324 The crooked dusky lane forming this marking is 2'-4' wide. The length of the east side is 35'. The conspicuous star in the north-east part of the loop is B.D.-3°4439 (7^M4).
- 334 An extension from this small spot curves to the southwest. The star B.D.+11°3897 (8^M8) is on the south edge of this curve.
- 337 This small spot, with its narrow extension, is in a relatively darker space in the star cloud.
- 341 This is one of several similar dark lines in this region. They are very clear cut and narrow, not more than $1\frac{1}{2}'$ wide.
- 348 The southwest end of this dusky lane curves west and then north, curving around the star B.D.+41°3799 (6^M7).
- 349 Elongated north and south, with dusky extension running 15' northwest. A short line of small stars close west.
- 360 This, together with the dusky space in which B 151 is located, forms an irregular, zigzag marking 54' long.

THE PHOTOGRAPHS

| Plate No. | α 1875.0 | δ 1875.0 | Area |
|-----------|--------------------------------|-----------------|--|
| 1 | 2 ^h 12 ^m | +57°0 | REGION OF THE DOUBLE CLUSTER IN PERSEUS |
| 2 | 2 44 | +60.0 | IN PERSEUS AND CASSIOPEIA |
| 3 | 3 30 | +31.0 | IN PERSEUS AND TAURUS |
| 4 | 3 39 | +23.8 | REGION OF THE PLEIADES |
| 5 | 4 16 | +28.0 | NEBULOUS REGION IN TAURUS |
| 6 | 5 28 | + 9.8 | IN ORION |
| 7 | 5 43 | +32.5 | REGION OF THE CLUSTER MESSIER 37 IN AURIGA |
| 8 | 6 2 | +24.4 | REGION IN GEMINI, NEAR THE CLUSTER MESSIER 35 |
| 9 | 6 9 | +22.2 | REGION IN GEMINI, SOUTHEAST OF MESSIER 35 |
| 10 | 7 11 | -23.1 | REGION IN CANIS MAJOR |
| 11 | 15 47 | -25.0 | REGION IN SCORPIUS AND LIBRA |
| 12 | 16 8 | -19.2 | REGION OF NU SCORPII |
| 13 | 16 18 | -23.5 | REGION OF THE GREAT NEBULA OF RHO OPHIUCHI |
| 14 | 16 45 | -22.5 | DARK LANES IN OPHIUCHUS |
| 15 | 16 48 | -27.9 | IN SCORPIUS AND OPHIUCHUS |
| 16 | 16 49 | -39.3 | IN THE SOUTHERN PART OF SCORPIUS |
| 17 | 16 53 | -31.8 | REGION IN SCORPIUS, NEAR MESSIER 62 |
| 18 | 17 6 | -27.6 | REGION IN OPHIUCHUS AND SCORPIUS |
| 19 | 17 13 | -21.3 | REGION NORTH OF THETA OPHIUCHI |
| 20 | 17 18 | -24.2 | DARK MARKINGS NEAR THETA OPHIUCHI |
| 21 | 17 22 | -26.0 | REGION OF THETA OPHIUCHI AND EASTWARD |
| 22 | 17 32 | -32.2 | REGION IN SCORPIUS AND SAGITTARIUS, NEAR MESSIER 6 |
| 23 | 17 36 | -21.5 | REGION OF 58 OPHIUCHI |
| 24 | 17 46 | -34.7 | REGION IN SCORPIUS AND SAGITTARIUS, NEAR MESSIER 7 |
| 25 | 17 50 | -16.9 | REGION IN SERPENS AND SAGITTARIUS |
| 26 | 17 54 | -29.3 | GREAT STAR CLOUDS IN SAGITTARIUS |
| 27 | 17 56 | -29.0 | GREAT STAR CLOUDS IN SAGITTARIUS |
| 28 | 17 56 | -32.8 | REGION SOUTH OF THE GREAT STAR CLOUD IN SAGITTARIUS |
| 29 | 18 1 | -21.2 | REGION IN SAGITTARIUS, NORTH OF THE GREAT STAR CLOUD |
| 30 | 18 3 | -25.7 | A REGION IN SAGITTARIUS |
| 31 | 18 10 | -18.7 | SMALL STAR CLOUD IN SAGITTARIUS |
| 32 | 18 17 | -20.2 | REGION IN SAGITTARIUS, SOUTHEAST OF THE SMALL STAR CLOUD |
| 33 | 18 20 | -25.2 | REGION IN SAGITTARIUS |
| 34 | 18 23 | -14.2 | IN AQUILA AND SAGITTARIUS |
| 35 | 18 30 | -11.4 | REGION IN AQUILA AND SAGITTARIUS |
| 36 | 18 41 | - 4.8 | REGION OF THE STAR CLOUD IN SCUTUM, NORTHERN PART |
| 37 | 18 45 | - 7.1 | THE GREAT STAR CLOUD IN SCUTUM |
| 38 | 18 53 | - 1.0 | REGION IN AQUILA, WESTERN PART |
| 39 | 18 58 | - 5.4 | REGION IN AQUILA |

THE PHOTOGRAPHS—*Continued*

| Plate No. | α 1875.0 δ 1875.0 | Area |
|-----------|--|--|
| 40 | 19 ^h 7 ^m + 0 ^s .6 | IN AQUILA, NORTHEAST OF THE STAR CLOUD IN SCUTUM |
| 41 | 19 30 +10.8 | IN AQUILA, NORTHWEST OF ALTAIR |
| 42 | 19 34 +17.5 | REGION OF SAGITTA |
| 43 | 19 55 +35.6 | REGION IN CYGNUS, SOUTHERN PART |
| 44 | 20 19 +39.6 | REGION OF GAMMA CYGNI |
| 45 | 20 32 +44.8 | REGION OF ALPHA CYGNI |
| 46 | 20 53 +43.7 | REGION OF THE NORTH AMERICA NEBULA |
| 47 | 21 10 +58.2 | REGION IN CEPHEUS |
| 48 | 21 14 +50.1 | REGION IN CYGNUS, NORTHEASTERN PART |
| 49 | 21 35 +57.0 | REGION IN CEPHEUS |
| 50 | 22 11 +55.2 | REGION IN CEPHEUS, CYGNUS, AND LACERTA |
| 51 | | NINE SELECTED AREAS OF THE MILKY WAY PHOTOGRAPHED ON A SMALL SCALE |

PLATE 1

REGION OF THE DOUBLE CLUSTER IN PERSEUS

Right Ascension = $2^{\text{h}} 11^{\text{m}} 50^{\text{s}}$, Declination = $+57^{\circ} 0'$

PLATE 1

REGION OF THE DOUBLE CLUSTER IN PERSEUS

$\alpha = 2^{\text{h}} 11^{\text{m}} 50^{\text{s}}$, $\delta = +57^{\circ} 0'$

1904 September 15.793 G.M.T.

Galactic Long. = 102° , Lat. = -3°

Exposure = $5^{\text{h}} 55^{\text{m}}$

Scale: 1 cm = $25'.6$, or 1 inch = $64'.9$

The region of the double cluster of Perseus is not an especially rich one, for the two clusters do not seem to be placed in a very dense stratum of stars. The stars of the background are perhaps brighter than the average of those which form many of the denser parts of the Milky Way, such as the great star clouds in Sagittarius, and they are probably nearer to us. One gets the impression that this part of the Milky Way is relatively thin. There is not a very great range of magnitude which might imply great depth in distance. Although in the southwest half of the plate there are many very faint stars, at the limit of the photograph, the northeast half consists of a much thinner background where there are relatively fewer faint stars. One also gets the impression that the two clusters are in this stratum and form a part of it. Apparently there is also a suggestion of a third cluster $30'$ following and in a line with the main ones.

The space covered by these two great clusters is about 2° east and west and somewhat over 1° north and south, though there appear to be outlying streams of brighter stars that may be connected with them. Both clusters seem to diffuse toward the south and to terminate more abruptly to the north. In each one the condensation is not symmetrical with respect to the smaller stars. It will be noticed that, though their fainter outliers appear to merge into each other, the brighter parts, which are distinctly separate, seem to diffuse in a direction away from each other, as if the central masses, $22'.5$ apart, were being drawn toward each other. If they are at the same distance from us it seems probable that some of the fainter stars may be common to both groups.

There are numerous dark lanes or crack-like markings in the immediate neighborhood of the two clusters. A small vacant spot $10'$ in diameter lies $45'$ west of the western cluster. It is B 201 of the list of dark objects.

Though these two clusters are free from any nebulosity, several of the others (in the upper part of the plate) are involved in very large and faint nebulosities. The brighter stars in this region have a tendency to form into clusters. This is strikingly the case in the upper left and right corners of the plate. It is re-

markable that at a number of places there is also a tendency to clustering of the small stars as if there was an attraction at these points which drew them together. This is especially noticeable at the following places:

| | | |
|--|----|--------|
| $\alpha = 1^{\text{h}} 43^{\text{m}}$, $\delta = +56^{\circ} 25'$ | | |
| 1 | 50 | +54 50 |
| 2 | 6 | +58 45 |
| 2 | 21 | +60 5 |
| 2 | 25 | +56 58 |
| 2 | 29 | +55 30 |
| 2 | 42 | +55 25 |
| 2 | 43 | +60 0 |

{ Broken massing of stars covering
 a degree or more
 N.G.C. 957
 Involved in nebulosity

One can scarcely resist the temptation to call the two masses of stars in the upper left part of the plate "the second double cluster of Perseus" because, though wider apart, they very much resemble the two great clusters.

The stars seem to thin out in the upper or northern part of the plate, especially between the two sets of nebulous clusters.

One gets a better impression of the extent of the main clusters by holding the picture at some distance from the eyes, say three or four feet or more. The general background of the sky will then interfere less.

The stars B.D. $+54^{\circ} 444$, of magnitude 7.9, and B.D. $+57^{\circ} 647$, of magnitude 8.9, (Nos. 7 and 33 on the diagram and in the list for this plate in Part II) appear noticeably fainter on the photograph than on the B.D. chart. They may be either variable, or reddish in color.

The positions given for N.G.C. 1027 and N.G.C. II 1824 differ by $1^{\text{m}} 30^{\text{s}}$ in right ascension and $3'$ in declination. An inspection of the photograph shows that these must both refer to the same cluster, and that the position given in N.G.C. II should be corrected by $+1^{\text{m}} 30^{\text{s}}$. The position of N.G.C. II 1805 is apparently in error by the same amount.

The original negative, No. 118, was made at the Yerkes Observatory.

$\alpha = 2^{\text{h}} 40^{\text{m}} 56^{\text{s}}.7$

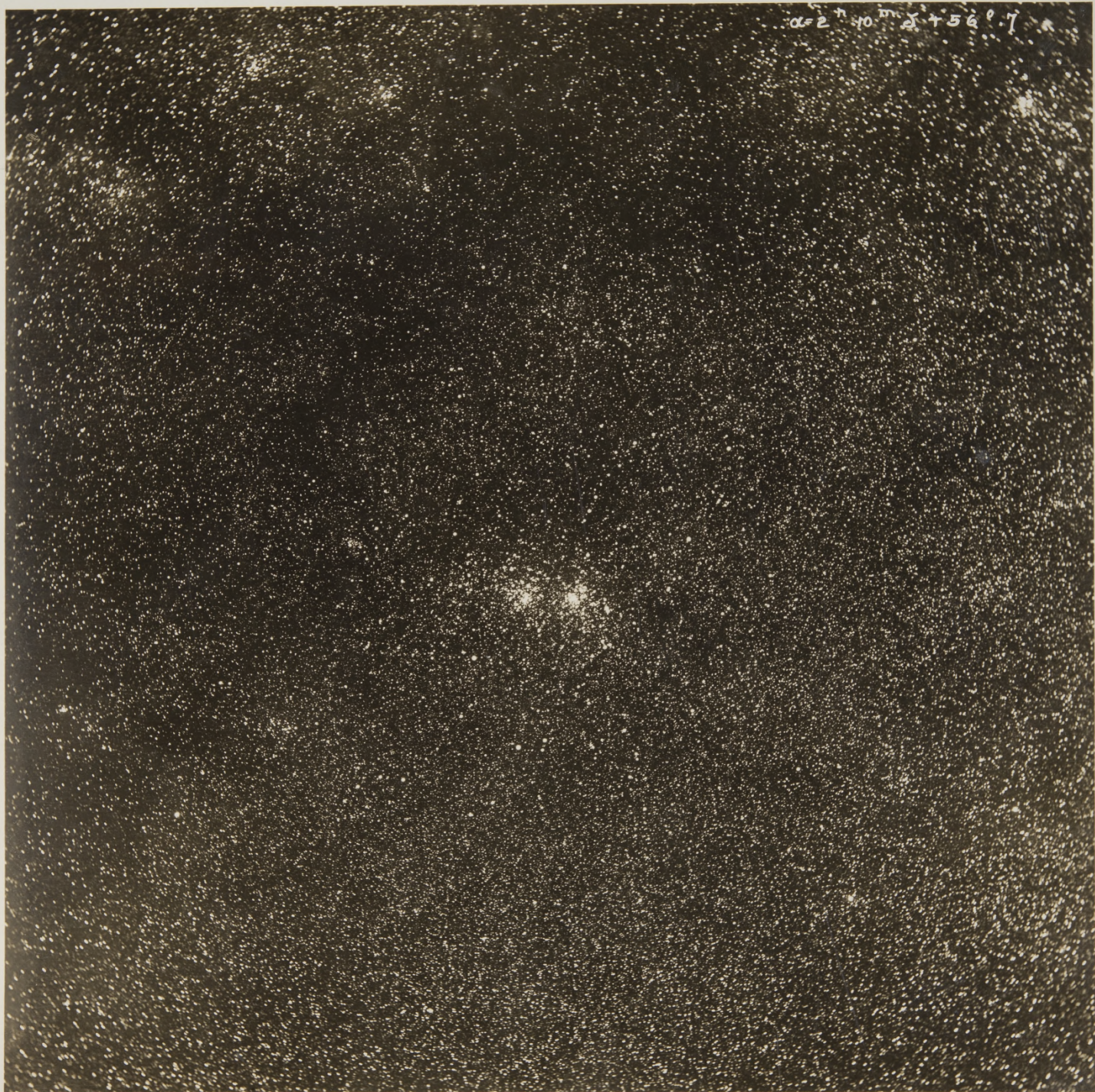


PLATE 2

IN PERSEUS AND CASSIOPEIA

Right Ascension = $2^{\text{h}} 44^{\text{m}} 20^{\text{s}}$, Declination = $+60^{\circ} 0'$

PLATE 2

IN PERSEUS AND CASSIOPEIA

$\alpha = 2^{\text{h}} 44^{\text{m}} 20^{\text{s}}$, $\delta = +60^{\circ} 0'$

1907 December 1.640

Galactic Long. = 105° , Lat. = $+2^{\circ}$

Exposure = $5^{\text{h}} 15^{\text{m}}$

Scale: 1 cm = $19'.9$, or 1 inch = $50'.4$

This photograph was specially made to show the two clusters which appear in the upper part of Plate 1, and which are involved in faint and diffused nebulosities. In the center of this plate are a number of clusters, or masses of brighter stars with many smaller ones, covering nearly 2° in right ascension. This whole group is immersed in a bed of very feeble nebulosity which seems to conform in extent and position with the two or three groupings of stars, but it is really greater in all directions. Although the nebulosity covers their full extent, it more strongly affects the western portion. There seem to be only one or two places in which it condenses about the individual stars.

The two clusters in the upper right quarter of the plate are N.G.C.II 1805 (No. 21 of the list of stars in Part II) and N.G.C. 1027 (No. 27). The eastern cluster is free of any nebulosity and contains more stars, the brightest one being B.D. $+60^{\circ} 548$ (No. 26) of magnitude 7.1. The western of the two clusters, the principal star of which is B.D. $+60^{\circ} 502$ (No. 20) of magnitude 7.5, is involved in a roundish mass of diffused nebulosity about $50'$ in diameter, beginning near the middle of the cluster and extending one-half way to the eastern group. In the eastern edge of the nebulosity is a deep indentation which is more definite than any other portion of its outline. [Unfortunately many of the prints are so dark that the nebulosity around the clusters, here and near the center of the plate, does not show.]

There is apparently a small, bright condensation close east of the bright stars of the western cluster, which may be due to a small group of faint stars. Both these clusters, especially the eastern one, seem to be simply condensations in the slightly

richer parts of the Milky Way. A dark vacancy south and west of the eastern cluster separates the two from a large mass of small stars some $53'$ in diameter. A considerable region nearly 2° in diameter, just east of the center of the plate, is also rather lacking in stars. The distribution of the stars of this whole region is decidedly unequal and the stars show the same tendency to clustering as do those in Plate 1, although (with the exception of the principal clusters already described) in a less marked degree. We have examples in $\alpha = 2^{\text{h}} 21^{\text{m}}$, $\delta = +60^{\circ} 5'$; $\alpha = 2^{\text{h}} 25^{\text{m}}$, $\delta = +56^{\circ} 50'$ (N.G.C. 957); $\alpha = 2^{\text{h}} 25^{\text{m}}$, $\delta = +59^{\circ} 30'$; $\alpha = 3^{\text{h}} 2^{\text{m}}$, $\delta = +62^{\circ} 45'$; $\alpha = 3^{\text{h}} 7^{\text{m}}$, $\delta = +59^{\circ} 30'$.

In the lower left corner of the plate, in $\alpha = 3^{\text{h}} 7^{\text{m}}$, $\delta = +56\frac{1}{2}^{\circ}$, there seems to be another patch of faint, diffused nebulosity similar to that in and near N.G.C.II 1805.

A nebulous strip in $\alpha = 2^{\text{h}} 42^{\text{m}} 20^{\text{s}}$, $\delta = +57^{\circ} 41'$, close to and south of the star B.D. $+57^{\circ} 651$ (No. 34) of magnitude 6.2, seems partly to involve that star. The star B.D. $+60^{\circ} 596$ (No. 36), of magnitude 9.3, is nebulous. About $5'$ north of it is a fainter nebulous star. South of it, in $\alpha = 2^{\text{h}} 47^{\text{m}} 30^{\text{s}}$, $\delta = +60^{\circ} 2'$ is a star, perhaps as bright as magnitude $8\frac{1}{2}$, which is not on the B.D. charts nor in the catalogue.

On the original negative, beyond the east margin of the print, the star B.D. $+58^{\circ} 607$ (No. 46) of magnitude 5.0, is involved in very feeble nebulosity nearly $\frac{1}{2}^{\circ}$ in diameter.

The brighter stars show a slight trail, due to trouble with the driving clock.

The original negative, No. 439, was made at the Yerkes Observatory.

$\alpha = 2^h 44^m 51.60^s$



PLATE 3

IN PERSEUS AND TAURUS

Right Ascension = $3^{\text{h}} 29^{\text{m}} 30^{\text{s}}$, Declination = $+31^{\circ} 0'$

PLATE 3
IN PERSEUS AND TAURUS

$\alpha = 3^{\text{h}} 29^{\text{m}} 30^{\text{s}}$, $\delta = +31^{\circ} 0'$ Galactic Long. = 127° , Lat. = -18°
1914 November 21.701 Exposure = $6^{\text{h}} 41^{\text{m}}$
Scale: 1 cm = $18'.2$, or 1 inch = $46'.2$

This is a region of obscure and obscuring nebulosity, which lies mainly west and southwest of Omicron Persei,¹ but which also seems to affect the entire plate. This nebulosity is clearly shown by the relative blackness of the large spot 1° northeast of Omicron Persei. This spot (which is B 5 of the list of dark objects) is intensely black, so black indeed that every other portion of the plate is more luminous than it. It is $16'$ west of Eta Persei, of magnitude 5.8 (No. 73 in the list of stars). It resembles the spots B 48 and B 58 which are shown on Plate 16. I believe that a very long exposure with a great reflector will show the dark body.

A large nebulosity occupies the center of the plate, gradually merging into the large apparent vacancy south of Omicron. This apparent vacancy extends nearly to the western edge of the plate and although few stars are in it, it is filled with obscure matter. Nearly one degree west of Omicron and slightly south is a triangular dark spot, B 3, in the brighter nebulosity. Beginning at about $\alpha = 3^{\text{h}} 26^{\text{m}}$, $\delta = +32^{\circ} 5'$ and ending at $\alpha = 3^{\text{h}} 29^{\text{m}}$, $\delta = +31^{\circ} 0'$ there is apparently an opening in the visible nebulosity which shows some of the unobscured background of small stars beyond. This background of stars is more or less obscured by the nebulosity elsewhere, and entirely disappears in the darker regions. The dark or obscuring nebulosity extends to the limit of the plate to the south and southwest. To the right and below the center are many dark spots in the obscure nebulosity.

All of the southern part of the plate, up to at least $\delta = +30^{\circ}$, is noticeably covered with a film of faint nebulosity. At the lower edge, extending from $\alpha = 3^{\text{h}} 28^{\text{m}}$ to $\alpha = 3^{\text{h}} 37^{\text{m}}$, and as far north as $\delta = +29^{\circ}$, are seen some of the brighter portions of the nebulous wisps that originate about the Pleiades. In places they merge into the nebulosity of the present plate. In the

upper right corner, in $\alpha = 3^{\text{h}} 14^{\text{m}}$, $\delta = +33^{\circ} 20'$, there seems to be a large mass of diffused and faint nebulosity.

About $7'$ southeast of Omicron Persei is a small star (B.D. $+31^{\circ} 643$ of magnitude 8.2 = our No. 61) involved in dense nebulosity which extends faintly for $20'$ or more all about it, apparently enveloping Omicron. Closely south of this star are several very small nebulous stars from which the nebulosity extends in streams southward for $5'$ or $6'$. A very small, bright nebula, like a nebulous star, is $7'$ east and slightly north of Omicron Persei. This is slightly west of and involves a small star not in the *Bonner Durchmusterung*.

Situated a degree and a half (2 inches) west of the center of the photograph is N.G.C. 1333 (No. 50) in which is the 9.5 magnitude star B.D. $+30^{\circ} 549$. The nebula (which also has the B.D. number $+30^{\circ} 548$) is round, $7'$ in diameter, with a brighter nebulous strip in it running southwest from the star. Another thin, short strip of nebulosity lies closely south of this one, extending northwest and southeast. About $55'$ northwest and at the same distance southwest of the nebula are the stars B.D. $+31^{\circ} 597$ (No. 44) and B.D. $+30^{\circ} 540$ (No. 45) of magnitudes 7.0 and 8.8 respectively. These stars seem to be closely involved in nebulosity, as they appear hazy. In the lower right part of the plate B.D. $+29^{\circ} 565$ (No. 48) of magnitude 9.1 (about $1\frac{1}{2}^{\circ}$ south and slightly west of N.G.C. 1333) has a nebulous wing east and another west of it.

For a general description of the nebulosity in the region of Omicron Persei see the *Astrophysical Journal*, **41**, 253, 1915 and *Monthly Notices of the Royal Astronomical Society*, **60**, 261, 1900. The proof of the existence here, over a large part of the sky, of dark and partly dark obscuring matter is quite conclusive.

The original negative, No. 933, was made at the Yerkes Observatory.

¹This is Flamsteed's 38 Persei, not to be confused with his 40, to which the Latin letter σ was assigned.

$\alpha = 3^{\text{h}} 28^{\text{m}} 51.0^{\text{s}}$



PLATE 4

REGION OF THE PLEIADES

Right Ascension = $3^{\text{h}} 38^{\text{m}} 40^{\text{s}}$, Declination = $+23^{\circ} 50'$

PLATE 4

REGION OF THE PLEIADES

$\alpha = 3^{\text{h}} 38^{\text{m}} 40^{\text{s}}$, $\delta = +23^{\circ} 50'$
1905 September 7.937
Scale: 1 cm = 9'.1, or 1 inch = 23'.2

Galactic Long. = 134° , Lat. = -22°
Exposure $3^{\text{h}} 48^{\text{m}}$

This plate was intended to illustrate the distribution of some of the exterior masses of nebulosity that surround the Pleiades. Unfortunately, defects have been introduced in the printing so that there will be some uncertainty as to the reality of some of these masses. The picture, however, is a fine example of portrait lens work on this cluster. It shows a greater extension of the nebulosity beyond the star B.D. +23°524 (No. 69 of the list of stars in Part II), of magnitude 8.4, than is usually shown on photographs of this nature. This star gives a soft image, as if it were closely nebulous. It is of spectral type A0. It is No. 1154 of the A. G. Catalogue, Berlin B.

The original negative, No. 314, was made at Mount Wilson.

[It was Mr. Barnard's expressed intention to indicate on the diagram accompanying this field those markings which may be regarded as certainly real and not due to any imperfections inherent in the plate or introduced in the process of printing. In his article in the *Monthly Notices of the Royal Astronomical Society*, **60**, 258, 1900 Mr. Barnard employed as an illustration a drawing made by Mr. E. Calvert after a careful study of a number of photographs taken with different instruments. This drawing brings out the faint details of the nebulosities exterior to the Pleiades. We quote from Mr. Barnard's statement in that paper as follows.

"One startling fact brought out by the study of these photographs is that the Pleiades and their involved nebulosities are but the central condensation of an enormous nebula, intricate in details, and covering at least 100 square degrees of the sky.

"The great magnitude of this nebula or nebulosity appears almost beyond belief. Taken, however, in the light of other

masses of nebulosity revealed by photography, such as those in Monoceros, in Cygnus, and in Ophiuchus, not to mention the great curved nebula stretching across a large portion of the constellation of Orion, it should not appear at all strange. Indeed, however strange it may appear is of little consequence, for it is an established fact that must be faced and accepted.

.

"The drawing does not show the full extent of the nebulosities, and is therefore only a partial map of these remarkable features. The nebulosities extend for a considerable distance in all directions beyond what is shown on the drawing, which terminates rather abruptly. Especially does the nebulosity extend to the eastward much farther than shown."

The interior nebulosities of the Pleiades were intentionally omitted from the drawing, and for details of these we advise the reader to consult the excellent photograph made by G. W. Ritchey with the 24-inch reflector of the Yerkes Observatory with an exposure of $3\frac{1}{2}$ hours. This was reproduced as Plate XXVI of Volume II of the *Publications of the Yerkes Observatory*.

Among earlier papers by Professor Barnard dealing with visual and photographic observations of these nebulosities we may cite: "The Merope Nebula," *Sidereal Messenger*, **1**, 57, 1882; *Astronomische Nachrichten*, **139**, 41, 1895. "On the Nebulosities of the Pleiades and on a New Merope Nebula," *Astronomische Nachrichten*, **126**, 293, 1891. "The Exterior Nebulosities of the Pleiades," *Astronomy and Astrophysics*, **13**, 768, 1894; *Astronomische Nachrichten*, **136**, 193, 1894; *Monthly Notices of the Royal Astronomical Society*, **59**, 155, 1899, and **60**, 258, 1900.]

$\alpha=3^h 38^m 5+23^{\circ} 8$



PLATE 5

NEBULOUS REGION IN TAURUS

Right Ascension = $4^{\text{h}} 16^{\text{m}} 5^{\text{s}}$, Declination = $+27^{\circ} 57'$

PLATE 5

NEBULOUS REGION IN TAURUS

$\alpha = 4^{\text{h}} 16^{\text{m}} 5^{\text{s}}$, $\delta = +27^{\circ} 57'$
1907 January 9. 633

Galactic Long. = 137° , Lat. = -14°
Exposure = $5^{\text{h}} 29^{\text{m}}$

Scale: 1 cm = $26'.5$, or 1 inch = $67'.3$

Very few regions of the sky are so remarkable as this one. Indeed the photograph is one of the most important of the collection, and bears the strongest proof of the existence of obscuring matter in space.

The principal object of interest outside the curious dark lanes is the partly bright nebula slightly west (to the right) and south of the center. With its feebler light it covers what appears to be an abrupt, irregular, vacant hole in the dense background of small stars. But there is every evidence that this is not a hole in the stratum of stars, for over its entire extent is a feeble veil of nebulosity with small, round dark spots in it. This veil brightens at its southeastern part until it merges into the small bright nebulosity (No. 92 of the list of stars in Part II), which is abrupt on its north-northeastern side but shades off gently to the west. There can be no question that this nebula with its fainter portions, acting as a screen, causes the apparent vacancy by cutting out our view of the stellar background. From its southern edge a narrow, irregular lane about 3° long runs toward the southeast nearly to the western edge of a great obscuring nebula (B 19), with which it is partly connected. A similar lane in the lower part of the plate, starting in about $\alpha = 4^{\text{h}} 16^{\text{m}}$, $\delta = +24^{\circ} 45'$, runs in a broken manner for some $3^{\circ} - 4^{\circ}$ to the west, where it ends in about $\alpha = 4^{\text{h}} 0^{\text{m}}$, $\delta = +24^{\circ} 40'$. Its eastern end fails to connect with the group of curved, dark markings (B 18 of the list of dark objects) by an abrupt break half a degree wide in $\alpha = 4^{\text{h}} 18^{\text{m}}$, $\delta = +24^{\circ} 30'$. This and the lane from the great nebula are uniformly $10'$ wide, very sharp and free from stars and both have darker spots in them. See B 208, 210, 212, 213, 215, 216. [Further comment on this strange region will be found in Professor Barnard's article in the *Astrophysical Journal*, **25**, 218, 1907.]

In the lower left corner is a great mass of feebly luminous nebulosity, some of which seems to obscure the stars just as the matter in the lanes does. The entire lower half of the plate is

covered with a film of nebulosity in which the small stars seem to be placed.

To the lower right side, in $\alpha = 3^{\text{h}} 56^{\text{m}}$, $\delta = +26\frac{1}{2}^{\circ}$, are portions of some of the nebulous streaks and masses exterior to, but connected with, the Pleiades. Those extending to the east seem possibly to become the dark streaks in the region shown here. (See *Astrophysical Journal*, **41**, 253-58, 1915, where attention is called to this fact.) This nebulosity extends irregularly south-eastward to about $\alpha = 4^{\text{h}} 3^{\text{m}} 5$, $\delta = +24^{\circ} 25'$. There is a long mass of it also in $\alpha = 4^{\text{h}} 0^{\text{m}}$, $\delta = +24^{\circ} 30'$.

About $20'$ above the bright star B.D. + $28^{\circ} 666$, of magnitude 5.7, (No. 104) a broad, partly vacant space (B 219) $55'$ wide, whose edges are rather definite, extends at a slight angle toward the northeast, from about $\alpha = 4^{\text{h}} 20^{\text{m}}$, $\delta = +29^{\circ} 0'$ to its entrance into a large, partly vacant region at the upper left corner of the plate (B 221), which is sprinkled over with comparatively few brighter stars.

A very minute bright nebula (No. 100), in $\alpha = 4^{\text{h}} 19^{\text{m}} 30^{\text{s}}$, $\delta = +25^{\circ} 47'$, is not listed in the N.G.C. The small bright nebula N.G.C. 1514 involves the star B.D. + $30^{\circ} 623$ (No. 89), of magnitude 8.8. The small nebula at $\alpha = 4^{\text{h}} 14^{\text{m}} 10^{\text{s}}$, $\delta = +28^{\circ} 9'$, resembles a miniature comet with a head and two widely diverging tails. From the "head," which is the star B.D. + $28^{\circ} 645$ (No. 96), of magnitude 9.1, the main "tail" runs north for about $10'$ and becomes a dark mass (B 214) that hides the stars. In this respect it somewhat resembles the nebula in the vacancy, B 7, to the west of it.

Two asteroids (numbered as 88 and 95 in our list of stars in Part II) are shown on this plate. The trails, in each case, are about $80''$ long.

A slight trail to the bright stars on this plate was due to trouble with the driving clock.

The original negative, No. 380, was made at the Yerkes Observatory.

$\alpha = 4^h 14^m 28.0^s$



PLATE 6

IN ORION

Right Ascension = $5^{\text{h}} 27^{\text{m}} 30^{\text{s}}$, Declination = $+9^{\circ} 48'$

PLATE 6

IN ORION

$\alpha = 5^{\text{h}} 27^{\text{m}} 30^{\text{s}}$, $\delta = +9^{\circ} 48'$
 1906 January 25.581
 Scale: 1 cm = 20'.5, or 1 inch = 52'.2

Galactic Long. = 163°, Lat. = -11°
 Exposure = 2^h 6^m

The brightest star of the group near the center of the picture is Lambda Orionis. It is unsymmetrically involved in very faint, diffused nebulosity nearly half a degree in diameter, to which I called attention many years ago. (*Knowledge*, 17, 17, 1894.) The most interesting feature, however, is the partly vacant region in the upper portion of the plate. This terminates rather abruptly toward the south. There is some feeble nebulosity on its southeastern border and the impression given is that the absence of stars here is due to a darker part of the nebulosity which obscures the more distant background of small stars. The center of this obscuring mass (B 30 of the list of dark objects) is in about $\alpha = 5^{\text{h}} 24^{\text{m}}$, $\delta = +12^{\circ} 40'$. It has a darker spot in it (B 31 near its eastern edge, 25' long and extending nearly north and south, and also a long, narrow extension (B 225) south from it for about 35', to the position $\alpha = 5^{\text{h}} 22^{\text{m}}$, $\delta = +11^{\circ} 30'$. Another dark object, B 224, 20' in diameter, is shown in $\alpha = 5^{\text{h}} 17^{\text{m}}$, $\delta = +10^{\circ} 30'$. A dark form seen at the left side of the plate (1.7 inches from the lower edge) is a portion of B 36. It is well shown in Plate 21, Volume XI of the *Publications of the Lick Observatory*, where its northern end will be seen to connect brokenly with the dusky marking B 35.

In the lower right part of the plate a very interesting, somewhat fan-shaped nebula (not in N.G.C.) is close southwest of the 6.5 magnitude star B.D.+8°933 to which it seems to be attached. I have examined this nebula with the 40-inch telescope of the Yerkes Observatory. It is so faint and diffused visually that its presence is shown only by a feeble dulling of the sky, which one would hardly have noticed without the aid of the photograph. It seems to be partly dark, and to obscure the small stars in the region of B.D.+8°933 (No. 116 of the list of stars in

Part II). The bright portion, as seen in this plate, is only a small part of this nebula. On the original negative all the blank region about the star is filled with feeble nebulosity. Especially is this so to the north of the star and it probably covers all of the space in this region where the stellar background seems to be thin. It is probably of the same nature as the obscuring nebulosity seen in the upper part of the plate.

The image of Gamma Orionis (Bellatrix) in the lower right part of the plate is almost suggestive of being densely nebulous, the nebulosity being symmetrical and about $\frac{1}{2}^{\circ}$ in diameter. A rather strange thing is the absence of small stars close to Gamma, as if something here had blotted them out.

It is interesting to note the rather sudden change in the stellar background. To the northwest of an irregular line extending from the dark mass, B 30, to the fan-shaped nebula, B 223, most of the small stars disappear and a thin scattering of brighter ones takes their place.

There are four defects near the upper left corner of the photograph which look like nebulous stars. They are located with respect to the upper and left edges of the print as follows: 0.2 inches (0.5 cm), 3.2 inches (8.2 cm); 0.2 inches (0.5 cm), 3.1 inches (7.8 cm); 1.6 inches (4.1 cm), 1.4 inches (3.5 cm); 1.7 inches (4.2 cm), 0.5 inches (1.3 cm).

While the difference in galactic latitude between this plate and Plate 5 is slight, there is a gap of about 20° in galactic longitude between the borders of the two pictures. In fact this plate follows in galactic longitude Plates 7, 8 and 9 instead of preceding them.

The original negative, No. 320, was made at the Yerkes Observatory.

$\alpha = 5^h 26^m 5.10^s$

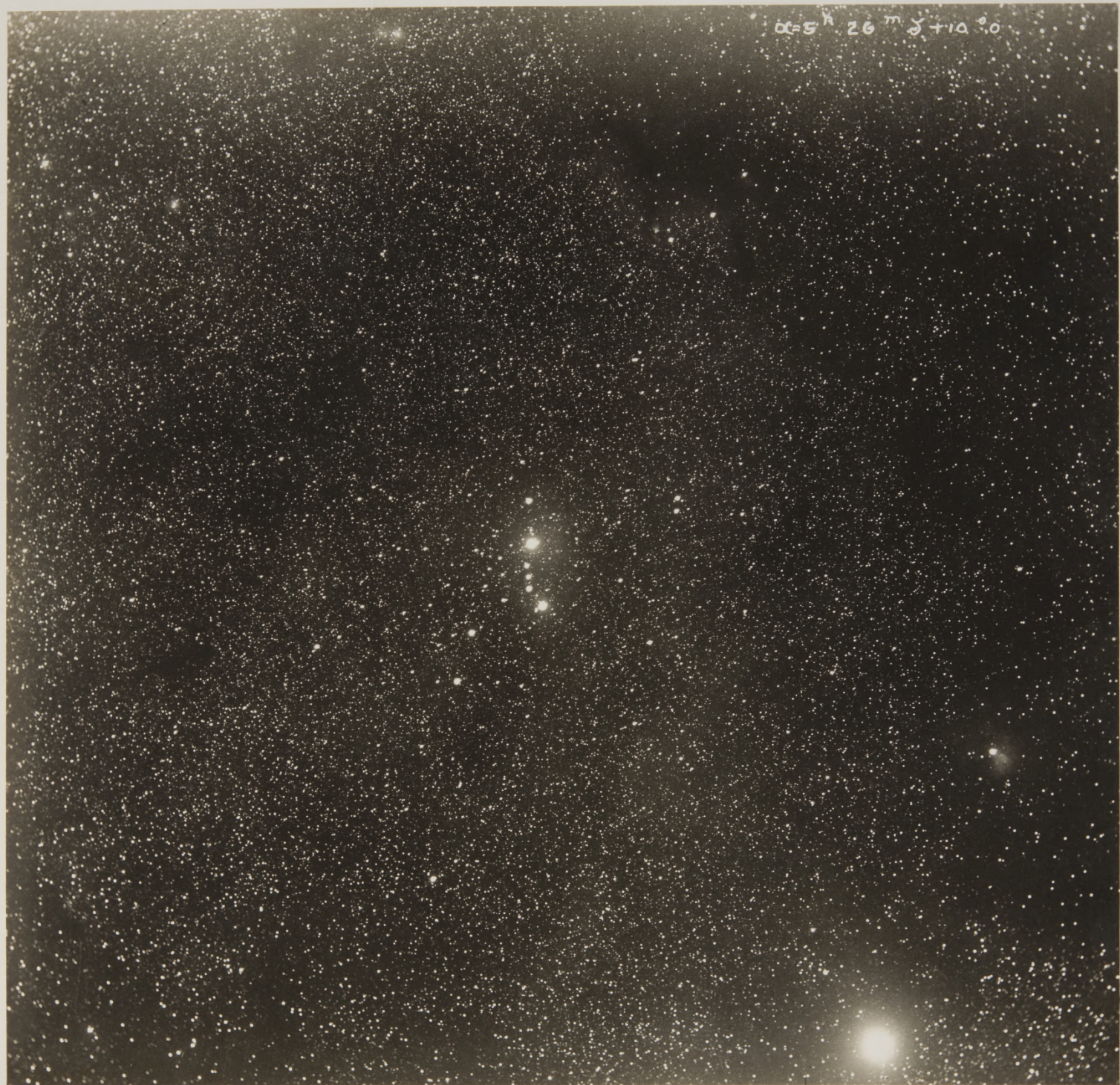


PLATE 7

REGION OF THE CLUSTER MESSIER 37 IN AURIGA

Right Ascension = $5^{\text{h}} 43^{\text{m}} 5^{\text{s}}$, Declination = $+32^{\circ} 30'$

PLATE 7

REGION OF THE CLUSTER MESSIER 37 IN AURIGA

$\alpha = 5^{\text{h}} 43^{\text{m}} 5^{\text{s}}$, $\delta = +32^{\circ} 30'$

1905 March 31.663

Scale: 1 cm = 16'.1, or 1 inch = 40'.8

Galactic Long. = 145°, Lat. = +4°

Exposure = 1^h 30^m

The impression is given here that the cluster near the center, Messier 37, is a condensation of the stellar stratum. Its fainter outliers seem to diffuse into the general background, so that it is difficult to tell where the cluster ends. There is no hesitation, however, in putting its diameter as over 25', but one gets the impression that it is far greater than that. It is probably globular in form. The star stratum in which it is placed, or against which it is projected, does not apparently have any great depth. There seems to be first, a stratum of more or less coarse stars, and then a final stratum—far denser—of very small stars.

Nearly two degrees west (or about three inches to the right) of Messier 37 is a curious black spot (B 34 of the list of dark objects), over 20' in diameter, of nearly the same size as the cluster. There are a few very feeble stars in it, but it stands out so definite in blackness that one is almost tempted to suppose it is a case of obscuration. Although this may really be the fact, there is no reason why an actual vacancy should not be present here, for the stratum of stars appears to be a relatively thin one. Nevertheless, from its general appearance, it is probable that a very long exposure will show something at its place.

This region seems to be remarkable for the customary dark lanes and star lines. They are specially prevalent in the space near to and south of Messier 37. A conspicuous one of these seams or lines of stars runs northeast from a point above and to the left of the dark spot B 34, nearly to the 7.7 magnitude star B.D.+34°1172 (No. 137 on the diagram and in the list of stars in Part II). A similar line runs from the south end of the above mentioned line to a point south and west of Messier 37, in $\alpha = 5^{\text{h}} 43^{\text{m}} 30^{\text{s}}$, $\delta = +32^{\circ} 15'$. The dark lanes, all nearly of uniform width, seem to be produced by curved lines of small stars running parallel to each other while the spaces between the different lanes are sometimes filled with very small stars. These are so striking and conspicuous that it is not necessary to describe them. Though these lanes are perhaps not real and are due to a

chance arrangement of the stars, it is strange that they should be so uniform in width and extend over such large distances. Of course, all the stars, near and distant, are projected on one plane, and what appears to be a definite black lane, as seen from some other direction in space, would probably produce an entirely different figure. At various places there seems to be a bunching together of sheets of stars of apparently the same magnitude. Sometime, when we understand them better, all these features may have a different and a more important meaning to us. If all these peculiarities are due to mere chance, then chance is very methodical, for it shows a wonderful method in making things appear different from what they really are! In Messier 37 are some curves of stars. One, in the western border of it, resembles a question mark, which perhaps is intended to apply to this whole region.

It will be noticed that Messier 37 is in a somewhat denser part of the Milky Way and that this denser region extends southward to the edge of the plate. It also extends northwest nearly to the region of Messier 36, close to the right edge of the plate. Just south of this last cluster is a dark spot, B 226, 17' in diameter.

There is a small nebula or nebulous star (No. 155) in $\alpha = 5^{\text{h}} 56^{\text{m}} 30^{\text{s}}$, $\delta = +30^{\circ} 30'$, near the lower left edge of the plate. This seems to be B.D.+30°1096. It is not listed in the N.G.C.

There are three defects on this photograph that might be mistaken for small, faint nebulae. They are found 2.8 inches (7.0 cm) from the right edge of the print and 1.2 inches (3.0 cm) from the lower edge; 3.5 inches (9.0 cm) from the left, and 1.0 inch (2.5 cm) from the lower edge; 3.7 inches (9.4 cm) from the left, and 0.5 inch (1.3 cm) from the upper edge. Another small defect 3.2 inches (8.1 cm) from the left, and 0.4 inch (1.1 cm) from the upper edge of the print looks like the trail of an asteroid.

The original negative, No. 168, was made at Mount Wilson.

$\alpha = 5^{\text{h}} 43^{\text{m}} 5^{\text{s}}$ $\delta = 32^{\circ} 5'$



PLATE 8

REGION IN GEMINI, NEAR THE CLUSTER MESSIER 35

Right Ascension = $6^{\text{h}} 1^{\text{m}} 55^{\text{s}}$, Declination = $+24^{\circ} 22'$

PLATE 8

REGION IN GEMINI, NEAR THE CLUSTER MESSIER 35

$\alpha = 6^{\text{h}} 1^{\text{m}} 55^{\text{s}}$, $\delta = +24^{\circ} 22'$

1905 March 22.642

Scale: 1 cm = 15'.7, or 1 inch = 40'.0

Galactic Long. = 154° , Lat. = $+3^{\circ}$

Exposure = $0^{\text{h}} 50^{\text{m}}$

This is not an especially interesting region. Messier 35 occupies the center of the plate. The cluster itself seems to be comparatively poor. It gives the impression of a flat cluster of bright stars with many smaller ones. Its extreme diameter must be greater than 44', while its brighter part is 24' in diameter. It is very inferior to Messier 37. Sometimes a question rises whether these loose clusters are spherical or more or less flat. The impression is that they must be spherical; that they are, in a way, loose globular clusters, for we never find them greatly elongated.

There are several vacant spots here, but their nature is uncertain and they may well be due to a real absence of stars. Apparently there is only a slight tendency to clustering in the stars of the general background, but their distribution is not uniform. A denser and wide strip of stars runs diagonally across the plate from southeast to northwest. It includes Messier 35 and widens out to the northwest. The general appearance of the sky here is that of a thin stratum of stars with no great depth. It is not so rich as the region of Plate 7. Beside Messier 35 several other interesting groups may be seen. In $\alpha = 5^{\text{h}} 53^{\text{m}} 40^{\text{s}}$, $\delta = +23^{\circ} 25'$ (about 2° southwest of Messier 35) is a

small group of several bright stars. In $\alpha = 5^{\text{h}} 54^{\text{m}} 15^{\text{s}}$, $\delta = +24^{\circ} 50'$ (2 inches from the right and 3.8 inches from the upper edge of the plate) is a rather pretty group of small stars of equal magnitude. Fifteen minutes of arc east of this is a small loop, open to the south, of similar stars. Just southwest of Messier 35 is N.G.C. 2158, a small, compressed cluster of faint stars. Nearly an inch to the right of this cluster, in $\alpha = 5^{\text{h}} 57^{\text{m}} 20^{\text{s}}$, $\delta = +24^{\circ} 0'$, is a group of a few small stars.

A curious thing is that many of the dark lanes on this plate are several times broader than those on Plate 7 in the region of Messier 37. Some are as much as 8' broad. Some of the most striking objects of this character are near the eastern (left hand) edge of the plate.

The star B.D.+23°1301 (No. 168 of our list of stars), in the southeast quarter of the plate, is nebulous. It is also listed as N.G.C. I 444.

The cluster Messier 35 and the southeast portion of the plate are also well shown in Plate 9.

This plate received the shortest exposure of any of the photographs in the *Atlas*. The original negative, No. 161, was made at Mount Wilson.

$\alpha = 6^{\text{h}} 1^{\text{m}} 5.24^{\text{s}}$



PLATE 9

REGION IN GEMINI, SOUTHEAST OF MESSIER 35

Right Ascension = $6^{\text{h}} 8^{\text{m}} 50^{\text{s}}$, Declination = $+22^{\circ} 10'$

PLATE 9

REGION IN GEMINI, SOUTHEAST OF MESSIER 35

$\alpha = 6^{\text{h}} 8^{\text{m}} 50^{\text{s}}$, $\delta = +22^{\circ} 10'$

1905 April 4.680

Scale: 1 cm = 16'.2, or 1 inch = 41'.0

Galactic Long. = 157° , Lat. = $+4^{\circ}$

Exposure = 2^h 0^m

The irregular nebula, N. G. C. 2175, 25' in diameter, in the lower right part of the plate is an interesting object. It is a mixture of considerable stars and nebulosity, with much detail in the nebula. There are some dark spots in it preceding the bright star B.D. +20°1284 (No. 163 of the list of stars in Part II). The stars involved in the nebula are many of them closely nebulous. Photographs of this object taken with a large reflector would be of the greatest interest. Twenty minutes of arc east and 8' north of the center of this nebula is a nebulous star, B.D. +20°1293 (No. 164) of magnitude 9.4, one of several stars involved in faint nebulosity extending from the nebula.

North of the center of the plate are some nebulous knots which seem to be the brighter parts of a very large, diffused nebula. One of these is a curved mass of nebulosity, with the convex side to the east, in $\alpha = 6^{\text{h}} 10^{\text{m}}$, $\delta = +22^{\circ} 45'$. The nebulous star B.D. +23°1301 (No. 168), of magnitude 7.5, northeast of the center of the plate is a striking object. It is also listed as N.G.C. I 444.

In the northwest quarter Messier 35 is situated in a relatively bright part of the Milky Way. As stated previously (Plate 8) it gives the impression of being a condensation in the Milky Way.

The plate is full of curves and straight lines of small stars with many dark lanes.

Prominent on the photograph is the trail of Comet 1905 III (Giacobini) which was found on the plate before Giacobini's discovery was known to me. The trail is conspicuous half-way to the left side of the picture. Its position from the chart was $\alpha = 6^{\text{h}} 17^{\text{m}} 7^{\text{s}}$, $\delta = +22^{\circ} 15'$. On the following night the comet was examined with the 5-inch guiding telescope. It was quite faint in that instrument.

East of the comet trail, at a distance of 8 mm (0.35 inch) from the left edge and 114 mm (4.5 inches) from the top of the picture, is the image of the planet Neptune. Its motion was too slow to make any trail, so that its image cannot be distinguished from that of a star of about the eighth magnitude.

The trail of a faint meteor runs almost entirely across the upper part of the photograph. Beginning at a point on the left edge of the print 0.63 inch (1.6 cm) from the upper corner it extends slightly south of west, and can be faintly traced to the southern part of the cluster Messier 35.

The original negative, No. 175, was made at Mount Wilson.

$\alpha = 6^h 9^m 53.22^s$

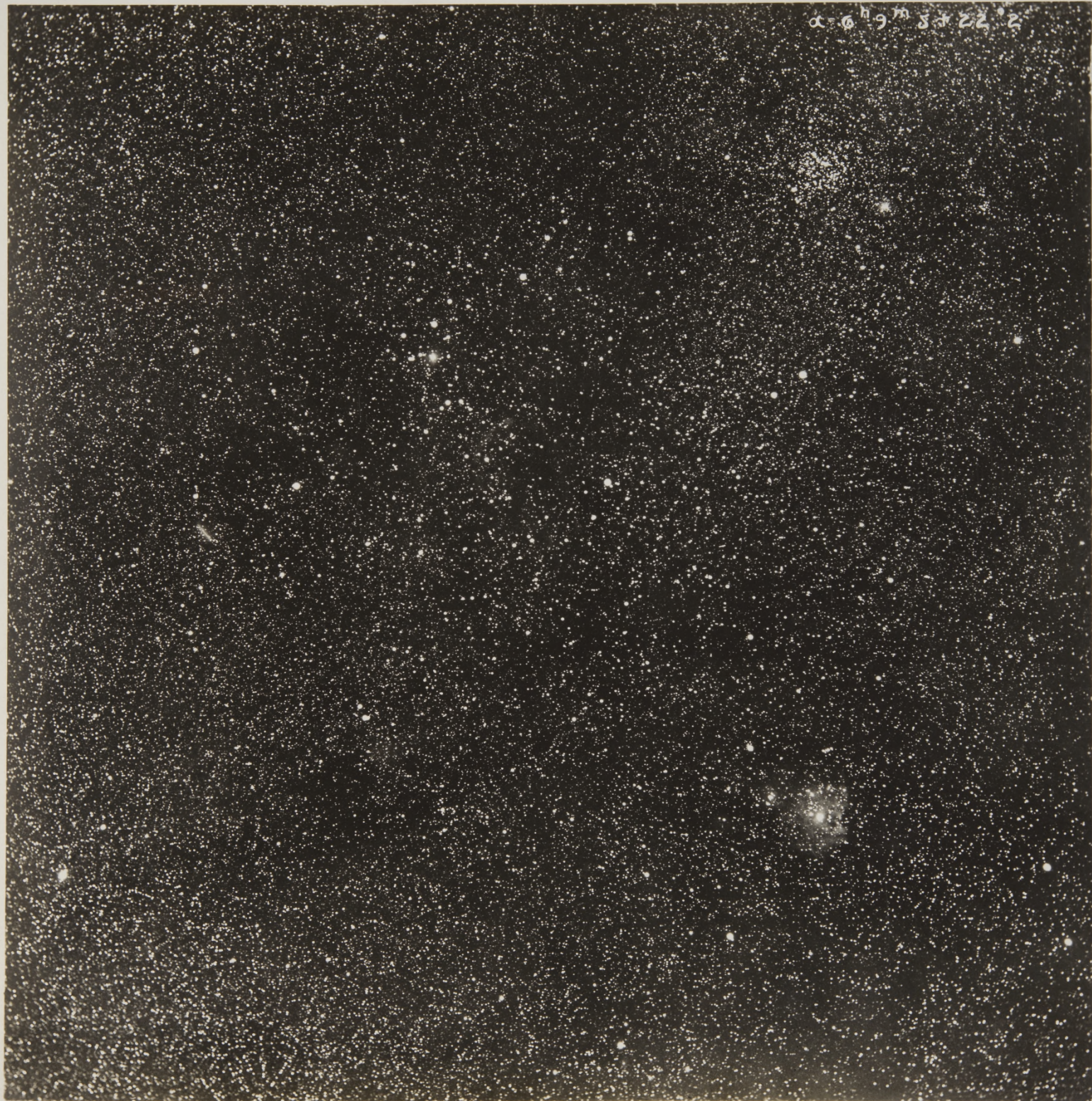


PLATE 10

REGION IN CANIS MAJOR

Right Ascension = $7^{\text{h}} 10^{\text{m}} 40^{\text{s}}$, Declination = $-23^{\circ} 7'$

PLATE 10

REGION IN CANIS MAJOR

$\alpha = 7^{\text{h}} 10^{\text{m}} 40^{\text{s}}$, $\delta = -23^{\circ} 7'$

1905 March 3.710

Galactic Long. = 204° , Lat. = -4°

Exposure = $3^{\text{h}} 45^{\text{m}}$

Scale: 1 cm = $17'.6$, or 1 inch = $44'.8$

Though there are no distinct cloud forms here, the stars are not uniformly distributed. There is also evidently a considerable thickness of the stellar stratum, for the range of magnitude is large. There are many very minute stars—some at the limit of visibility on the plate. Everywhere there are peculiar alignments of stars and some dark lanes. A darker region near the lower left corner gives the suggestion of cloud forms in that part of the plate.

The western two of three stars in a slight curve, about a degree ($1\frac{1}{2}$ inches) southeast of the middle of the plate, are closely nebulous and probably also the third. They are really in a very feeble nebulosity that involves all three. They are C.D. $-23^{\circ} 5277$, $-23^{\circ} 5285$ and $-23^{\circ} 5296$, of magnitudes 9.2, 8.9 and 9.3 respectively.

Near the left edge of the plate the sixth magnitude star B.D. $-22^{\circ} 1897$ (No. 203 of the list of stars in Part II) is in a very feeble, diffused nebulosity nearly $10'$ in diameter. On the original negative the star C.D. $-25^{\circ} 4775$ (No. 204) of magnitude 7.3, is seen to be in a faint round nebula about $10'$ – $15'$ in diame-

ter. Probably also the 5.4 magnitude star C.D. $-25^{\circ} 4828$ (No. 205) is nebulous, but this is not certain. These last two stars are beyond the limits of the present print.

In some places on the photograph there seems to be an effect of clustering, as in $\alpha = 7^{\text{h}} 22^{\text{m}}$, $\delta = -23^{\circ} 40'$, about 1.3 inches (3 cm) from the left edge and 3.7 inches (9.5 cm) from the lower edge of the plate. There are several of the catalogued clusters shown. N.G.C. 2354 (No. 188 of our list), in the lower part of the picture, is an irregular, scattering cluster of small stars. It is $20'$ in diameter and has a long dark spot in the middle. It seems to be distinct from the general background, with a curve of small stars running nearly north and south $13'$ east of it. N.G.C. 2362 (No. 192) is conspicuous south and a little east of the middle. N.G.C. 2383 (No. 197), $7'$ in diameter, N.G.C. 2384 (No. 198) and N.G.C. 2367 (No. 195) are seen in the upper left part of the plate. In this same region, in $\alpha = 7^{\text{h}} 17^{\text{m}}$, $\delta = -21^{\circ} 20'$, is a large, roundish, uniform field of stars outlined by a series of irregular dark lanes.

The original negative, No. 150, was made at Mount Wilson.

$\alpha = 7^{\text{h}} 10^{\text{m}} 8^{\text{s}} . 23$

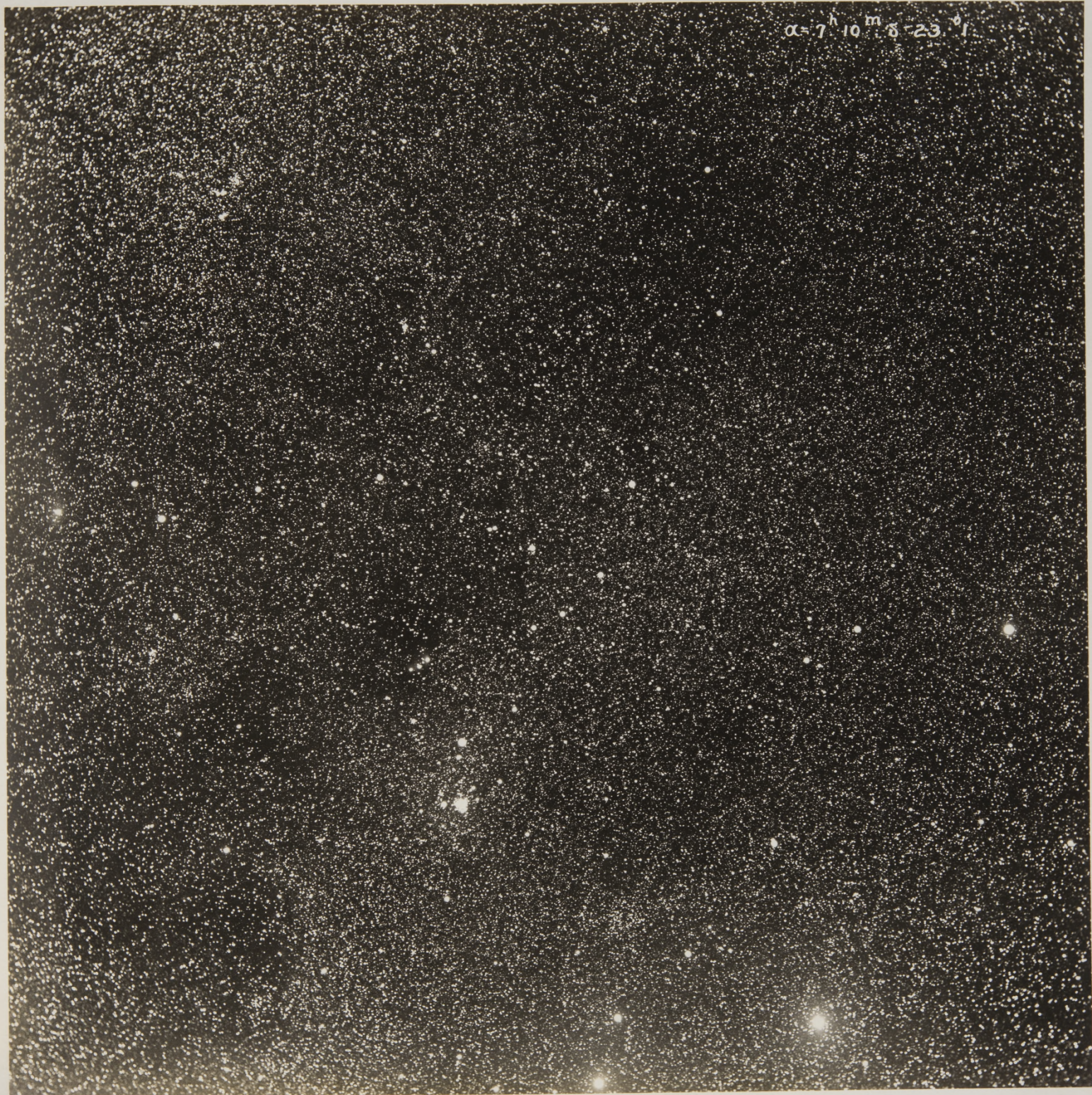


PLATE 11

REGION IN SCORPIUS AND LIBRA

Right Ascension = $15^{\text{h}} 46^{\text{m}} 55^{\text{s}}$, Declination = $-25^{\circ} 0'$

PLATE 11

REGION IN SCORPIUS AND LIBRA

$\alpha = 15^{\text{h}} 46^{\text{m}} 55^{\text{s}}$, $\delta = -25^{\circ} 0'$
1905 April 29.871-30.858

Galactic Long. = 315° , Lat. = $+20^{\circ}$
Exposure = $8^{\text{h}} 40^{\text{m}}$

Scale: 1 cm = $18'.7$, or 1 inch = 47.6

It will be noted that there is a gap of more than 8 hours in right ascension, or of about 110° in galactic longitude, between the center of this plate and the one next preceding it.

The very remarkable nebulosity in this region is probably connected with that in the vicinity of Nu Scorpii and of Rho Ophiuchi. A longer exposure on a better sky would doubtless have shown this connection clearly. The exposure given covered parts of two nights, but both nights were rather poor and unsuited for delicate nebular work.

Parts of this nebula are shown on my Lick Observatory plates made in 1895. The brightest part lies close south of Pi Scorpii, below and to the left of the middle of the picture, and seems to be connected with that star by a nebulous extension. Another mass is similarly placed with respect to C.D. - $24^{\circ} 12352$ (No. 216 of the list of stars in Part II), near the center of the picture. It appears that the star C.D. - $24^{\circ} 12354$ (No. 217) is also actually connected with a part of the nebula. A faint stream of the nebulosity runs northeast to Delta Scorpii (No. 225) and extends even beyond that star in a much fainter condition. A small, round, nebulous condensation occurs in this stream in $\alpha = 15^{\text{h}} 51^{\text{m}} 10^{\text{s}}$, $\delta = -23^{\circ} 10'$. It is $8'$ in diameter and lies $10'$ east of the 7.4 magnitude star C.D. - $23^{\circ} 12597$ (No. 222 on the diagram). The large glow about Delta Scorpii is probably atmospheric. At points on the plate, especially in its western half, and northeast and southeast of Delta Scorpii, are faint diffusions of nebulosity. The principal masses are well shown.

Some of the fainter parts of the nebulous branches are lost in the prints by a little too heavy printing, such as the second branch running from $\alpha = 15^{\text{h}} 47^{\text{m}}$, $\delta = -24^{\circ} 50'$ to $\alpha = 15^{\text{h}} 49^{\text{m}}$, $\delta = -24^{\circ} 0'$, and the east and west strip running from $\alpha = 15^{\text{h}} 46^{\text{m}}$, $\delta = -23^{\circ} 35'$ to $\alpha = 15^{\text{h}} 56^{\text{m}}$, $\delta = -23^{\circ} 45'$. These are very faint on the original negative. They are well brought out in the halftone Plate X, facing page 144 of Volume 23 of the *Astrophysical Journal* (1906). Just below the center of the picture a broad, roundish opening, nearly one degree in diameter, in the nebulosity has its center roughly in $\alpha = 15^{\text{h}} 46^{\text{m}}$, $\delta = -25^{\circ} 20'$. This is bounded on the east by the broad mass of nebulosity running

south from the star C.D. - $24^{\circ} 12365$ (No. 219), a branch of which curves west and then north. In this opening it will be seen that the starry background is exactly like the rest of the sky elsewhere. The nebulosity about it, however, dulls the stars and hides many of the smaller ones. This effect, I think, is not due to contrast from the brightness of the nebulosity.

There is apparently a scattering of very diffused nebulosity over a large part of the plate from Pi Scorpii to the northeast. An examination of the original negative shows that most of this at least is due to very feeble nebulosity. The stars Tau Librae (No. 206) of magnitude 3.8, Rho Scorpii (No. 221), magnitude 4.5, and C.D. - $27^{\circ} 10841$ (No. 241), magnitude 5.3, are all probably nebulous. These three stars, well shown on the original negative, are just outside the limits of the present print.

There is much to be learned from a study of this plate, especially with respect to the question of obscuration.

About 3.1 inches (= 8 cm) from the right edge and the same distance from the upper edge of the print is the trail of an asteroid in $\alpha = 15^{\text{h}} 42^{\text{m}} 30^{\text{s}}$, $\delta = -23^{\circ} 55'$. Its trail on the following night was 0.25 inch (6 mm) to the right, or west, in $\alpha = 15^{\text{h}} 41^{\text{m}} 50^{\text{s}}$, $\delta = -23^{\circ} 55'$, the motion being retrograde.

At 1.55 inches (4 cm) from the right edge and 3.55 inches (9 cm) from the lower edge of the print is the trail of another and fainter asteroid, with the impression on the second night 0.25 inch to the right. Its positions on the two nights were $\alpha = 15^{\text{h}} 37^{\text{m}} 0^{\text{s}}$, $\delta = -25^{\circ} 50'$, and $\alpha = 15^{\text{h}} 35^{\text{m}} 55^{\text{s}}$, $\delta = -25^{\circ} 50'$. [From an examination of the "Oppositions-Ephemeriden" issued by the Rechen-Institut of Berlin, Professor Van Biesbroeck has identified the brighter of these asteroids as probably 349 Dembowska and the fainter one as probably 75 Eurydice.]

A little above the middle of the plate is a defect, which I think will deceive no one. It is 3.8 inches (9.6 cm) from the right edge and 3.5 inches (8.9 cm) from the upper edge of the print.

The original negative, No. 189, was made at Mount Wilson, and had the longest exposure of any of the plates used in this *Atlas*.

$\alpha 15^h 46^m \delta -25^{\circ} 0'$



PLATE 12

REGION OF NU SCORPII

Right Ascension = $16^{\text{h}} 7^{\text{m}} 30^{\text{s}}$, Declination = $-19^{\circ} 13'$

PLATE 12

REGION OF NU SCORPII

$\alpha = 16^{\text{h}} 7^{\text{m}} 30^{\text{s}}$, $\delta = -19^{\circ} 13'$

1905 April 4.911

Galactic Long. = 323° , Lat. = $+21^{\circ}$

Exposure $4^{\text{h}} 55^{\text{m}}$

Scale: 1 cm = 13.9 , or 1 inch = 35.3

The explanation of this picture is difficult. There can be no question, however, that there is obscuration of light by parts of the nebula, which seems to be really *in* the stratum of stars.

This great nebula beautifully illustrates the effect of total and partial absorption. That there are bright and dark portions of it is at once apparent, and that the darker parts cut out the light of the stars beyond more than the lighter portions is also evident. Indeed, near Nu Scorpii (No. 242 of the list of stars in Part II) either the background of the stars is nearer to us, which is not improbable, or the brighter part of the nebula is fully transparent. It is quite clear that there is a partial obscuration of the stars in its northern part, for they become abruptly fainter within the boundaries of the nebula up to its very edge. The total obscuration is very marked near the two nebulous stars B.D. $-19^{\circ}4359$ and $-19^{\circ}4361$ (Nos. 254 and 256) east and south of the middle of the picture, and especially to the northeast of them. In $\alpha = 16^{\text{h}}11\frac{1}{2}^{\text{m}}$, $\delta = -19^{\circ}15'$, about midway between Nu Scorpii and the east edge of the picture, there is a space free from obscuring matter, a rift in the nebula, where a piece of the distant background clearly comes into view again. There is another small rift in the nebula $25'$ long and $4'$ wide in $\alpha = 16^{\text{h}}6^{\text{m}}50^{\text{s}}$, $\delta = -19^{\circ}25'$ (about $0^{\circ}.6$ southeast of Nu Scorpii) through which the background is visible. All evidence seems to point to the fact that part of the nebula is nearer to us than some of the stars and farther away than others. With the exception of a head, the brighter part is suggestive of some great bird flying southwest or, more correctly, like a ghostly aeroplane headed in that direction. The nebulosity about Nu Scorpii extends to the east in a diffused manner for $1\frac{3}{4}^{\circ}$ and northwest of Nu for about $80'$. Its visible length northwest by southeast is more than $3\frac{1}{2}^{\circ}$.

The position angle of the west edge is about 135° . It seems to extend south in a very diffused manner nearly to Rho Ophiuchi. There is evidence that most of the plate is covered with a thin film of very faint nebulosity. Nu Scorpii is a spectroscopic binary of the spectral type B3.

There is a diffused dark spot, B 40 of the list of dark objects, in $\alpha = 16^{\text{h}}7\frac{1}{2}^{\text{m}}$, $\delta = -18^{\circ}40'$, just above the middle of the plate. From the three nebulous stars, B.D. $-19^{\circ}4357$, $-19^{\circ}4359$, and $-19^{\circ}4361$ (Nos. 253, 254, and 256), irregular vacant spaces extend to and beyond the east edge of the plate, ending in $\alpha = 16^{\text{h}}30^{\text{m}}40^{\text{s}}$, $\delta = -18^{\circ}18'$. They also extend south for a degree.

The stars B.D. $-19^{\circ}4359$ and $-19^{\circ}4361$ (mentioned above) are involved in dense nebulosity and are connected by a slender nebulous thread with B.D. $-19^{\circ}4357$. A narrow dark lane in the nebulosity runs close to and parallel with the two eastern stars. It is noticeable that the western star, which visually is the brightest of the three, appears faintest on the photograph. This may be due to the large color index or to the effect of nebulosity about the other stars, which would tend to intensify their images.

What appears to be a cluster of small stars in $\alpha = 16^{\text{h}}17^{\text{m}}30^{\text{s}}$, $\delta = -19^{\circ}20'$ close west of three small stars in a line near the middle of the east edge of the plate is a defect, but the three stars are real. Another defect, in the upper half of the plate, looks like a small, faint nebula a little north of the great nebula. Its position on the print is 2 inches (5 cm) from the top and 4 inches (10 cm) from the right edge.

The original negative, No. 176, was made at Mount Wilson. The second negative from which this print was made was enlarged twofold from the original negative.

$\alpha = 16^{\text{h}} 5^{\text{m}}$ $\delta = 19^{\circ} 02'$



PLATE 13

REGION OF THE GREAT NEBULA OF RHO OPHIUCHI

Right Ascension = $16^{\text{h}} 18^{\text{m}} 5^{\text{s}}$, Declination = $-23^{\circ} 28'$

REGION OF THE GREAT NEBULA OF RHO OPHIUCHI

$\alpha = 16^{\text{h}} 18^{\text{m}} 5^{\text{s}}$, $\delta = -23^{\circ} 28'$

1905 April 5.917

Scale: 1 cm = 21'.1, or 1 inch = 53'.5

Galactic Long. = 321°, Lat. = +16°

Exposure = 4^h 30^m

The region of Rho Ophiuchi is one of the most extraordinary in the sky. The nebula itself is a beautiful object. With its outlying connections and the dark spot in which it is placed and the vacant lanes running to the east from it, it makes a picture almost unequaled in interest in the entire heavens. Like the partly obscure nebula in Taurus shown in Plate 5, which occupies a similar dark area and also has dark lanes connected with it, it gives every evidence that it obscures the stars beyond it. It is clear, from an inspection of the picture, that the actual background of the sky here consists of a uniform distribution of faint stars. If part of the picture is covered so as to hide the large nebula and the dark lanes, this fact becomes more apparent. The conclusion is therefore irresistible that there is no real vacancy at this point, but that the nebula is between us and the background of stars and blots out the more distant ones. This is strikingly shown close to the west side of the nebula where, from the rather abrupt western edge of the bright part, a fainter portion extends westward for about 40'. Wherever this fainter nebulosity is seen (its limits are very definite) the background of the small stars disappears. The few rather bright stars that remain are doubtless this side of the nebula. To the eastward there are far-reaching but feeble traces of an extension of the nebula in which occur dark structures. This fainter, diffused nebulosity extends beyond the limits of the plate.

The dark lanes to the east are remarkable, especially the very long ones whose sides are so sharply defined. The main lane begins roughly at the star 22 Scorpii (No. 272 of the list of stars in Part II), below and to the left of the center of the plate, and runs eastward, extending brokenly nearly to the region of Theta Ophiuchi. The continuation of this remarkable lane is strikingly shown in Plate 14.

The details of the nebula and its various parts are very remarkable and striking. About Rho Ophiuchi (No. 267), which is in the eastern of the two main condensations near the center of the plate, the nebulosity assumes a splendid ribbed appearance. A condensation around two stars, the brighter of which is C.D.-24°12684 (No. 265, 1.1 inches below Rho Ophiuchi), takes the form of four bright and beautiful whorls which center at this star. The star 22 Scorpii strikingly resembles a human eye, the lids being formed by two strips of nebulosity, one above it and one below. The nebulosity extends southward in wave-

like forms over Antares (No. 271) and even beyond Tau Scorpii (below the lower edge of the print). In this region the nebulosity does not seem to obscure the distant stars. Sigma Scorpii (No. 257, below and to the right of the center of the picture) is involved in a very dense mass which connects with the fainter part of the great nebula. The condensation about this star is irregular, and extends mostly north and south. A rather broad, indefinite lane runs southward from the west of Sigma Scorpii to a larger, partly vacant region in about $\alpha = 16^{\text{h}} 10^{\text{m}}$, $\delta = -27^{\circ}$. The star 13 Scorpii (No. 241), at the lower right edge of the print, is seen to be nebulous. The relative nearness to us of the nebula is shown by the fact that it condenses about the brighter stars of this region.

The cluster Messier 4 is a conspicuous object about 80' west of Antares. The bright, irregular object (No. 248) about 2° west of Rho Ophiuchi is the compressed cluster Messier 80, 4½' in diameter. In this a new star of the seventh or eighth magnitude appeared in May, 1860.¹ Two variable stars, R and S Scorpii (Nos. 251 and 252 on the diagram), are visible closely east of this cluster. R is nearly at minimum while S is bright. The small cluster N.G.C. 6144 (No. 268), 4' in diameter, is 40' (1.8 cm) to the right of and above Antares.

In the upper part of the photograph is seen the southern portion of the nebulosity about Nu Scorpii, which is described in Plate 12.

On the original negative the three stars that form Rho Ophiuchi are clearly and strongly shown, as are also the two small stars which are the center of the beautiful whorls. The stars of Messier 4 are visible to the center of the cluster. This group, 22' in diameter, is a fine subject for a portrait lens.

One very striking thing about all the nebulosity in this region is the fact that it is so faint that it cannot be seen with the eye even in a powerful telescope. Its light seems to be almost entirely photographic. The faintness of the image of Antares is due to the star's strong red color, to which the plate was less sensitive.

At 1.8 inches (4.6 cm) from the left, and 1.6 inches (4.0 cm) from the upper edge of the photograph are two spots which are rather easily seen to be defects.

The original negative, No. 177, was made at Mount Wilson.

¹ Nova T Scorpii (1860), discovered by A. Auwers while watching for the variations of R and S Scorpii.

$\alpha=16^h 18^m 5.23^s$

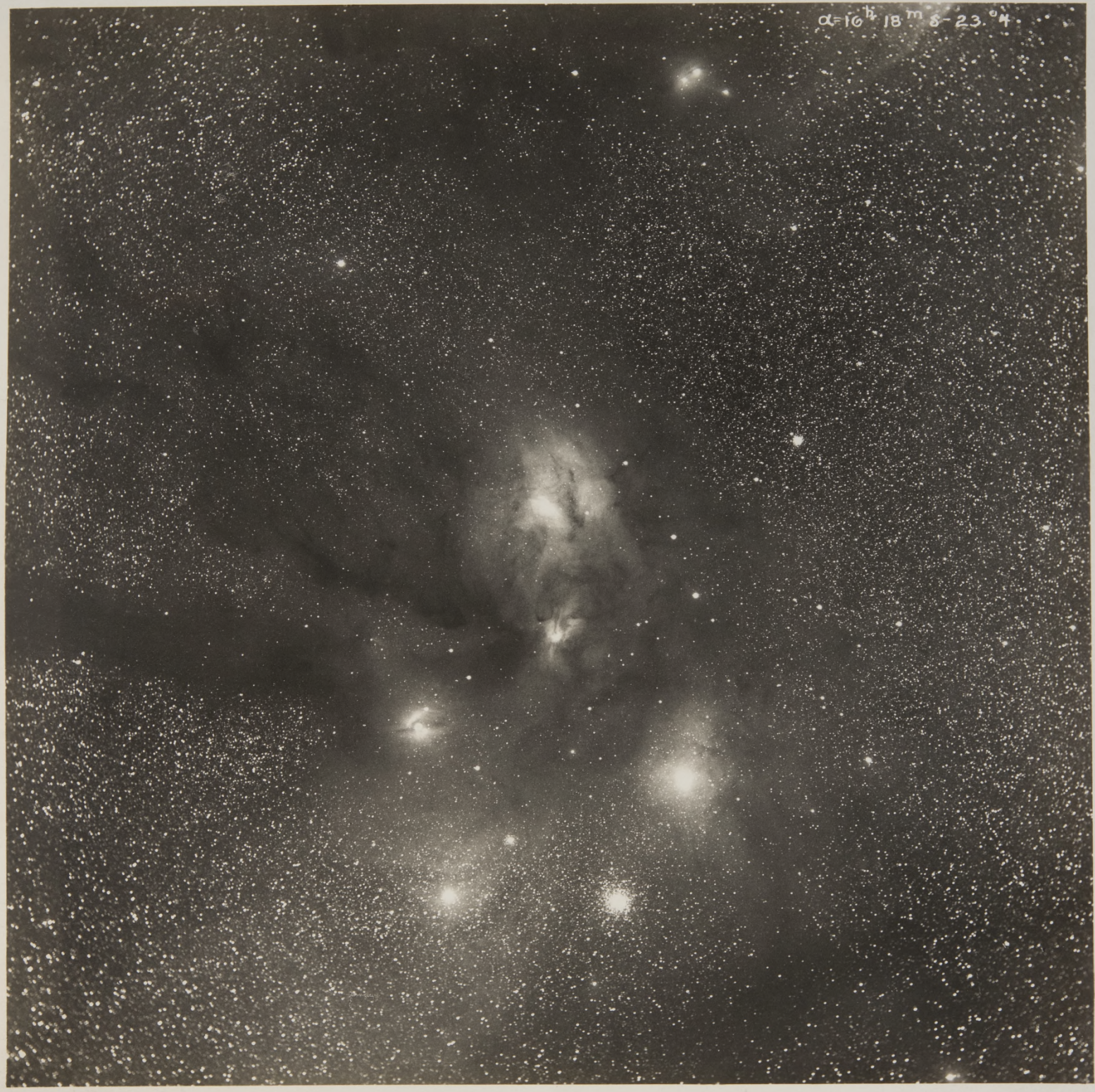


PLATE 14

REGION OF DARK LANES IN OPHIUCHUS

Right Ascension = $16^{\text{h}} 44^{\text{m}} 35^{\text{s}}$, Declination = $-22^{\circ} 32'$

PLATE 14

REGION OF DARK LANES IN OPHIUCHUS

$\alpha = 16^{\text{h}} 44^{\text{m}} 35^{\text{s}}$, $\delta = -22^{\circ} 32'$

1905 June 3.771

Scale: 1 cm = 25'.2, or 1 inch = 63'.9

Galactic Long. = 326° , Lat. = $+12^{\circ}$

Exposure = $3^{\text{h}} 0^{\text{m}}$

This photograph shows a continuation toward the east of the extraordinary region of Rho Ophiuchi. It was specially made to bring out the peculiar structure of the lanes running east from the great nebula.

The main lane, which averages over 40' across, is continuous for more than 6° from the nebula. Then it gradually shatters into fragments and continues in broken spots as far east as the no less wonderful region of Theta Ophiuchi (Plate 19), a total length of over 10° . These lanes and spots, though mostly devoid of all stars, are not truly vacant, for there is apparently some sort of obscuring material in them. This is especially marked in the large, elongated spot B 45, above and to the right of the middle of the picture, which is a fragment of another lane running east from Rho Ophiuchi. It seems to contain a dark body like B 133, shown in Plate 37.

There does not seem to be any luminous nebulosity in this

region except that about 22 Scorpii, and also north and south of it in the lower right corner.

About the middle of the extreme left side of the picture is part of the great curved marking B 63, north and west of Theta Ophiuchi. The darkness of the upper right corner of the plate is partly real, but the blackness is accentuated by overprinting, as also is most of the remaining right side of the plate.

Near the middle of the plate is the small cluster N.G.C. 6235 (No. 311). The very small cluster N.G.C. 6287 (No. 332) is in the region of broken spots between the middle and the left edge, while N.G.C. 6284 (No. 329) is in the lower left part of the plate. These three small globular clusters are also listed in the Cordoba Durchmusterung as Nos. $-21^{\circ}4439$, $-22^{\circ}11815$, and $-24^{\circ}13069$.

The original negative, No. 209, was made at Mount Wilson.

$\alpha = 16^{\text{h}} 44^{\text{m}}$ $\delta = 22^{\circ} 5'$

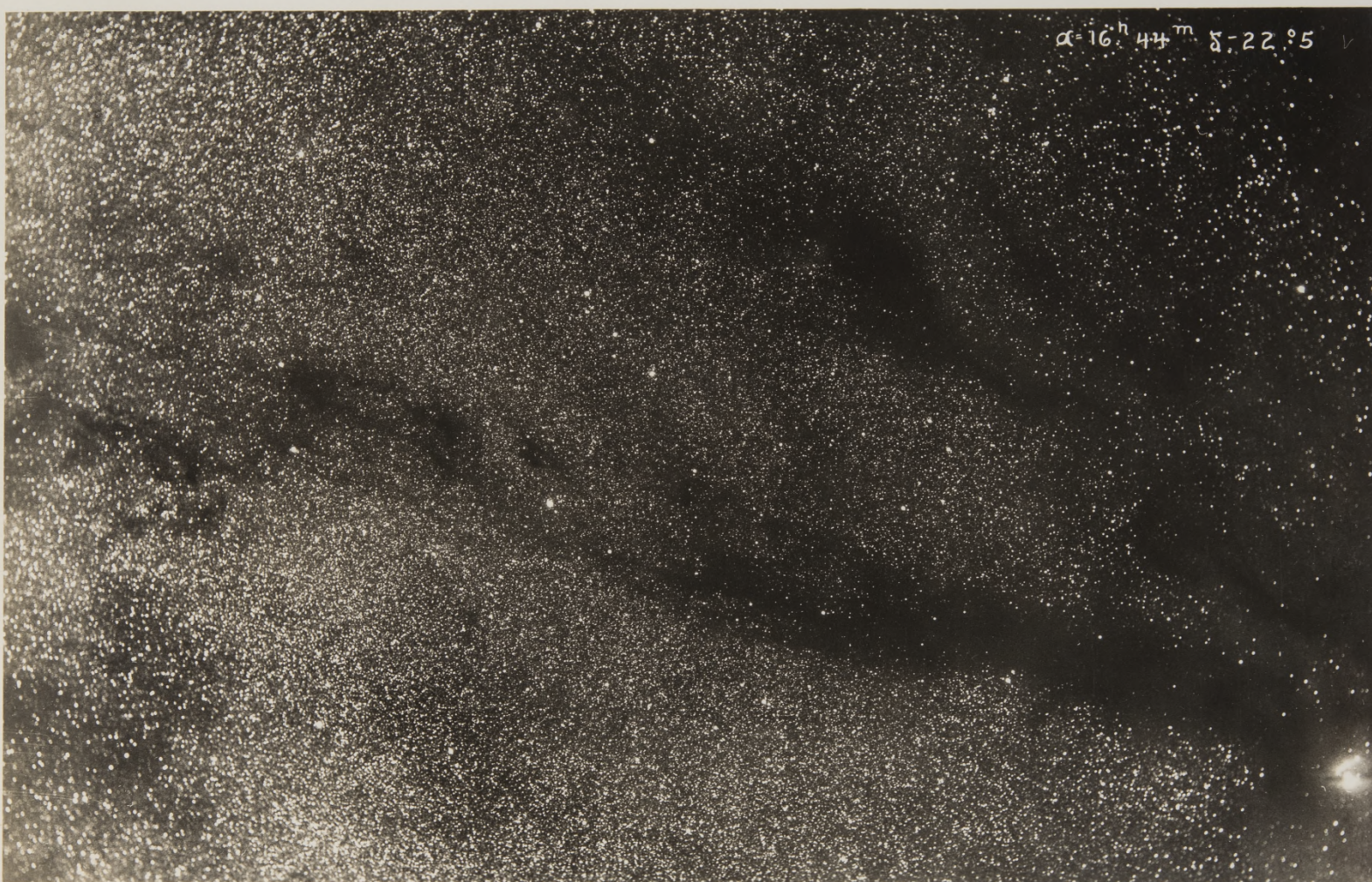


PLATE 15

IN SCORPIUS AND OPHIUCHUS

Right Ascension = $16^{\text{h}} 48^{\text{m}} 20^{\text{s}}$, Declination = $-27^{\circ} 53'$

PLATE 15

IN SCORPIUS AND OPHIUCHUS

$\alpha = 16^{\text{h}} 48^{\text{m}} 20^{\text{s}}$, $\delta = -27^{\circ} 53'$
1905 May 29.840

Galactic Long. = 322° , Lat. = $+8^{\circ}$
Exposure $3^{\text{h}} 42^{\text{m}}$

Scale: 1 cm = $24'5$, or 1 inch = $62'2$

The end of the great dark lane, which passes south under Theta Ophiuchi is shown to the left. The plate brings out well at the sides of this dark object the appearance of a "sink-hole,"¹ which is described more fully in the text for Plate 18. There is much detail in this object. One degree south of the end of the "sink-hole" is an irregular dark marking (B 244) in $\alpha = 17^{\text{h}} 3^{\text{m}} 0^{\text{s}}$, $\delta = -28^{\circ} 15'$. It is sharpest or most definite on the west side. It runs south for about $30'$ and then in a narrower form turns abruptly to the west for some $10'$. In $\alpha = 17^{\text{h}} 1^{\text{m}} 50^{\text{s}}$, $\delta = -29^{\circ} 25'$ is another irregular dark marking (B 243) on the bright cloud. All these masses are probably of the same nature as the "sink hole" (B 59).

The density of the stratum of small stars diminishes rather rapidly toward the west where, though there are a great many considerable stars, the general background is made up of very minute stars, as if these were much farther away.

In the lower part of the left side of the plate, separated from the upper bright region, are some masses of small stars which seem to be part of a layer of somewhat brighter stars between us and the more distant ones. The clouds end rather abruptly to the west where they blend into the thinner sky. In the fine mesh of small stars in the west half of the plate are many curves of stars and small dark lanes of uniform width. In $\alpha = 16^{\text{h}} 41^{\text{m}}$, $\delta = -29^{\circ} 35'$ (about 2.7 inches, or 6.9 cm from the right edge and 2.9 inches or 7.4 cm from the lower edge of the print) is the center of a system of these dark lanes. One of these lanes (B 237) is noticeable north of the eighth magnitude star C.D. - $30^{\circ} 13487$ in $\alpha = 16^{\text{h}} 41^{\text{m}} 0^{\text{s}}$, $\delta = -29^{\circ} 45'$. This star is No. 300 of the list in Part II. The lane runs northeast for $37'$ and then turns abruptly to the east for a distance of some $18'$. Near its south end is a small star, C.D. - $30^{\circ} 13475$ of magnitude 9.5 (No. 296), in $\alpha = 16^{\text{h}} 40^{\text{m}} 1^{\text{s}}$, $\delta = -30^{\circ} 7'$. This is in the focus of an almost complete ellipse of small stars, $9'$ in diameter. About $25'$ to the west of this star is a rather narrow dark mark (B 234) nearly $\frac{1}{2}^{\circ}$ long and

some $6'$ wide. North of it is a smaller elongated, dark spot. Another eighth magnitude star, C.D. - $31^{\circ} 13282$, listed in Part II as No. 304, is placed near the middle of an almost complete but irregular ellipse of smaller stars about $25'$ in diameter. This ellipse, which just misses a similar star to the west, is situated 3.0 inches (7.7 cm) from the right edge and 1.2 inches (3.0 cm) from the lower edge of the print.

The lower bright cloud contains several dark spots, two of which are of interest. The first, B 55, is irregular, about $15'$ in diameter and sharp at its south end. A curve of small stars runs into it from above. The second spot, B 56, $12'$ east, is triangular, about $2'$ in diameter and very black. It is well defined, with four small stars, forming a very small square, at its west side and one close to the east. Other dark markings appear here and elsewhere on the plate. One very curved and striking object of this kind is B 239, 1.7 inches (4.2 cm) from the middle of the lower edge of the print. It is very black and narrow, and is rimmed with stars on its south and east sides. The great black region in the upper right corner is a portion of the black lane east of Rho Ophiuchi. The star 22 Scorpii, situated at the west end of the lane, is about a degree beyond the limit of the plate.

Among the noticeable bright objects on the plate are Nos. 19 and 62 of Messier's list. Messier 62 (No. 319) is seen below and to the left of the middle of the picture, with a rather diffused dark strip, B 241, $18'$ long east and west, some $20'$ west of it. The globular cluster Messier 19 (No. 325), in the upper left quarter of the plate, is elongated in position angle 20° . The small globular cluster N.G.C. 6304 (No. 358) is seen as a hazy star against the bright star cloud near the east edge of the plate. N.G.C. 6284 (No. 329) and N.G.C. 6293 (No. 342), both in the upper left part of the plate, also appear as stars. The star Tau Scorpii (No. 282) is just off the plate. A portion of the glow about it is visible at the middle of the west edge of the print.

The original negative, No. 206, was made at Mount Wilson.

¹ [The *Century Dictionary* defines a sink-hole as follows: "One of the cavities formed in limestone regions by the removal of the rock through the action of rain or running water, or both. The rock being dissolved away underneath, local sinkings of the surface occur, and these are sometimes wholly or partly filled with water, forming pools."]

$\alpha 16^h 48^m 5.28^s$

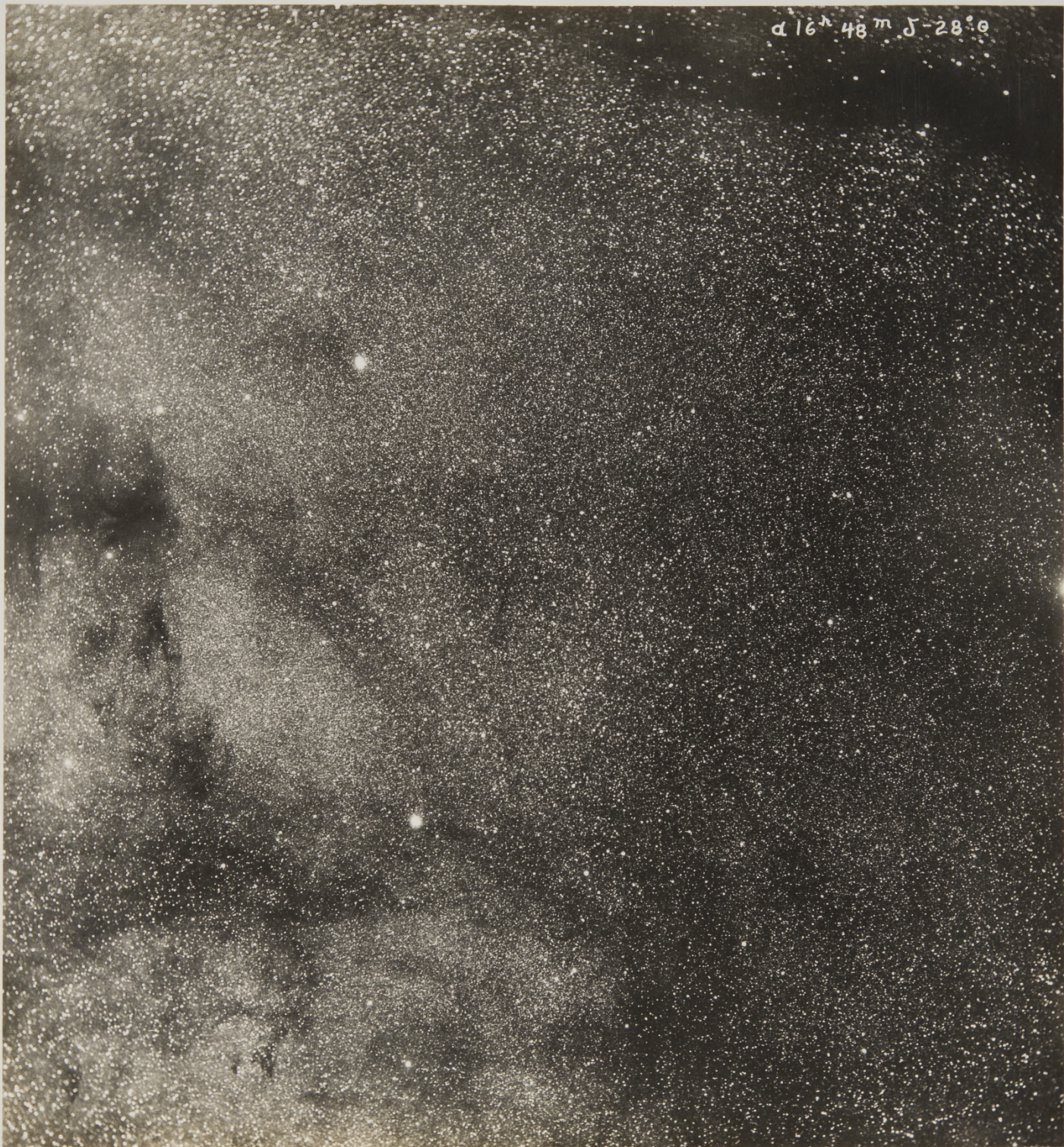


PLATE 16

IN THE SOUTHERN PART OF SCORPIUS

Right Ascension = $16^{\text{h}} 48^{\text{m}} 55^{\text{s}}$, Declination = $-39^{\circ} 20'$

PLATE 16

IN THE SOUTHERN PART OF SCORPIUS

$\alpha = 16^{\text{h}} 48^{\text{m}} 55^{\text{s}}$, $\delta = -39^{\circ} 20'$

1905 June 21. 735

Galactic Long. = 313° , Lat. = $+1^{\circ}$

Exposure = $1^{\text{h}} 57^{\text{m}}$

Scale: 1 cm = $26'.3$, or 1 inch = $66'.9$

Though this part of the Milky Way is pretty far south to photograph, even from Mount Wilson, the picture seems to be successful and is of great interest, for it extends farther toward the south the remarkable region shown in Plate 17. Some scattering star clusters and several masses of nebulosity are shown. There are also some dark spots that appear to be real opaque objects. Their positions are given in the catalogue of dark spots. One of these, B 44a, to the right of and below the center of the picture with the star C.D. $-40^{\circ}10662$ on its north edge, is remarkable for its smallness and distinctness. The position of this object is erroneously given 2^{m} too great in my catalogue in *Astrophysical Journal*, **49**, 1, 1919.

In the eastern (left) half of the plate there are some more or less definite cloud forms, which consist of comparatively coarse stars with a background of very much smaller ones. In the western half the cloud forms consist of smaller stars mixed with either a stratum of very faint stars not individually visible, or with a nebulous substratum, in which are many dark forms, especially to the west and northwest. One of these, B 231, $20'$ in diameter is near the upper right corner. It is sharpest on the western side and diffused to the east. This feeble stratum really covers the western half of the plate.

In the northern part of the plate are some smeary clouds which seem to extend westward in a broken manner. In the brighter ones at the north edge of the plate are two black spots, shown better in Plate 17. They are B 50 and B 240. This part

of the picture looks as if it had been swept over with a large brush or broom in a direction a little north of west, giving the impression of a general drift of the stars in that direction.

A little below the center of the plate is a mixture of nebulosity and stars. It is listed as N.G.C. II 4628. The nebulosity, about $30'$ in diameter, is placed in the northeastern part of a group of stars about 1° in diameter. The extreme diameter of the nebulosity toward the northeast is about $50'$.

In $\alpha = 17^{\text{h}}6^{\text{m}}$, $\delta = -39^{\circ}25'$, about 1.7 inches from the middle of the east edge of the print, is a mass of small stars about $50'$ in diameter that probably is affected with very faint nebulosity. There is a dark gap in its north side. Close northeast of this mass of stars, in $\alpha = 17^{\text{h}}7^{\text{m}}20^{\text{s}}$, $\delta = -39^{\circ}15'$, is a small, compact cluster about $5'$ in diameter, elongated north and south, which is possibly nebulous.

C.D. $-36^{\circ}11341$ (No. 353), given as a star of magnitude 9.1 in the catalogue, is marked as a nebula on the C.D. chart. On the original negative the image is a little soft—not as sharp as the images of the other stars. It is N.G.C. 6302.

A defect on the photograph in $\alpha = 17^{\text{h}}14^{\text{m}}$, $\delta = -38^{\circ}2'$ looks almost exactly like the image of a star of about the sixth magnitude. It is 0.2 inch (0.5 cm) from the left edge and 3.7 inches (9.4 cm) from the upper edge of the print.

The scale of this photograph is smaller than the average, covering a wider area. The original negative, No. 225, was made at Mount Wilson.

$\alpha = 16^{\text{h}} 49^{\text{m}} \delta = 39^{\circ} 3'$

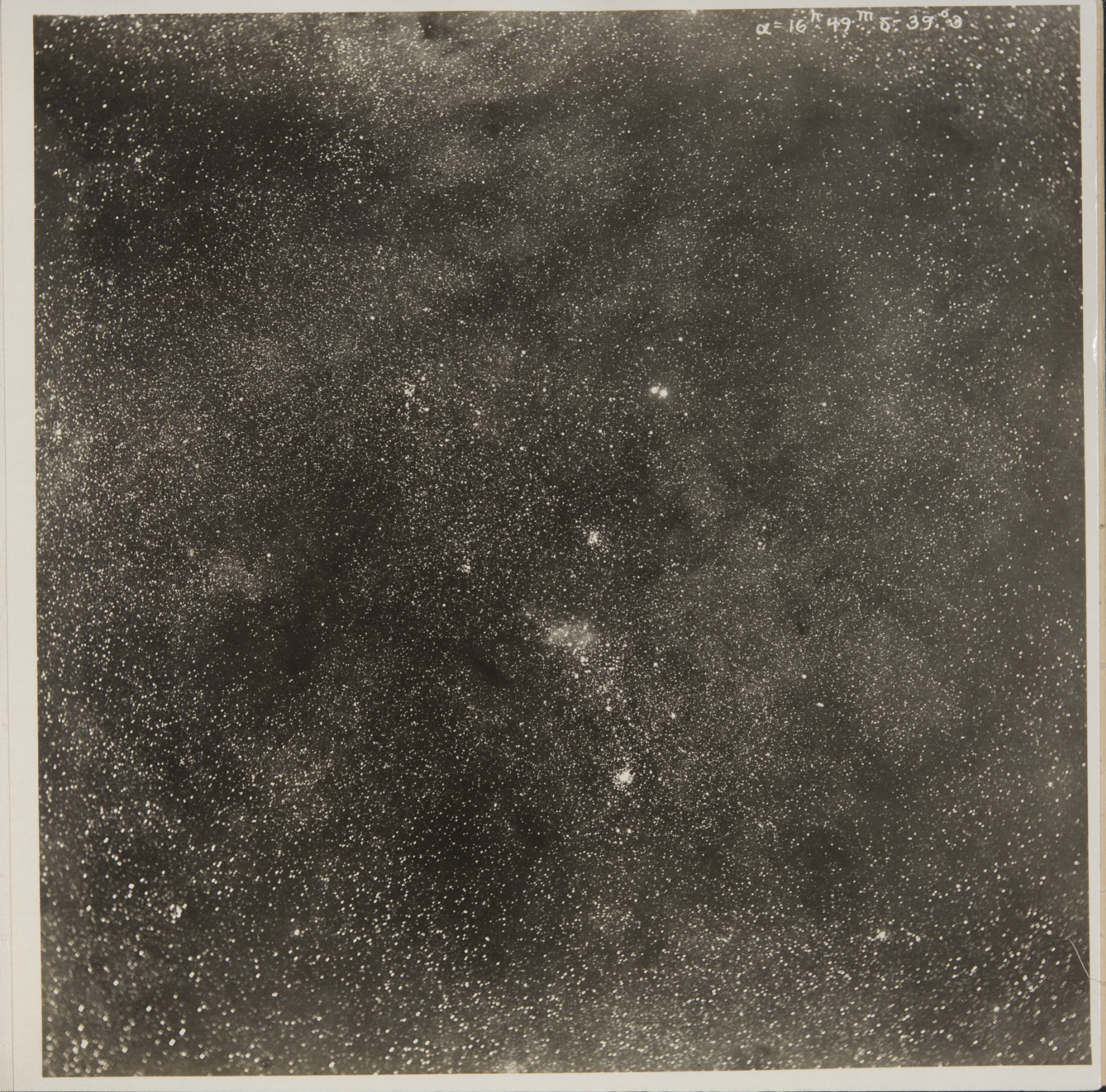


PLATE 17

REGION IN SCORPIUS, NEAR MESSIER 62

Right Ascension = $16^{\text{h}} 53^{\text{m}} 25^{\text{s}}$, Declination = $-31^{\circ} 50'$

PLATE 17

REGION IN SCORPIUS, NEAR MESSIER 62

$\alpha = 16^{\text{h}} 53^{\text{m}} 25^{\text{s}}$, $\delta = -31^{\circ} 50'$

1905 April 13. 946

Galactic Long. = 320° , Lat. = $+5^{\circ}$

Exposure = $2^{\text{h}} 23^{\text{m}}$

Scale: 1 cm = $15'.8$, or 1 inch = $40'.1$

In some ways this region of the Milky Way is very remarkable. It is different from other portions in its groundwork of subdued cloud forms. The surface seems to be a matrix of some dense material, probably mostly stars too distant to show distinctly, or some form of nebulous matter. The dark markings are peculiar. One of them is B 50, with C.D. $-34^{\circ}11418$ of magnitude 9.8 near its center. There are also three other C.D. stars on its eastern border. This remarkable object is the center of what is apparently a drift of the stars toward the west. Almost the entire plate gives this impression, but it is more marked near the black spot and especially south of it as shown in the upper part of Plate 16. There are other parts of the Milky Way where a suggestion of a general drift of the stars is thus shown, but none so marked as this one.

The black spot, B 50, is characteristic of a number of other black spots in that one edge of it is sharply terminated while the other is more diffused. There must be some reason for this peculiarity, for it happens too often to be mere chance. Several other black spots of the list will be noticed on this photograph. Examples are B 49, 53, 55, 56, etc.

The bright region whose center is in $\alpha = 17^{\text{h}}4^{\text{m}}$, $\delta = -31^{\circ}20'$, near the middle of the eastern edge of the plate, is peculiar. It is of an irregular figure and extends $1^{\circ}40'$ north and south.

It seems also to extend several degrees east and west, where it joins the dense mass near the middle of the plate whose structure seems to be stellar.

Close to the left edge of the print, in $\alpha = 17^{\text{h}}7^{\text{m}}$, $\delta = -32^{\circ}0'$, an abrupt dark marking (B 252) extending north and south is on the eastern edge of this apparently nebulous bright region. It is triangular, with its eastern side diffused. There are some small stars in it. Near the upper left corner of the plate, in $\alpha = 17^{\text{h}}1^{\text{m}}50^{\text{s}}$, $\delta = -29^{\circ}25'$, there is a very irregular dark spot, (B 243) $26'$ in diameter.

The brighter part of the globular cluster Messier 62 (No. 319 of the list in Part II), above the middle of the picture, is $5'$ in diameter, but there seem to be some considerable outliers, to a diameter of perhaps $20'$. One degree to the northeast of this cluster is a stronger cloud of distinct stars.

The small hazy spot 3.1 inches (8.0 cm) from the right edge and 0.4 inch (1.1 cm) from the lower edge of the print is a defect on the photograph.

The large size of the stars and the softness of the structural details in the middle of the plate are possibly due to the plate being slightly inside the true focus. The scale of the print is about 1.7 times that of the original negative, No. 181, which was made at Mount Wilson.

$\alpha = 16^h 53^m 3.7^s$

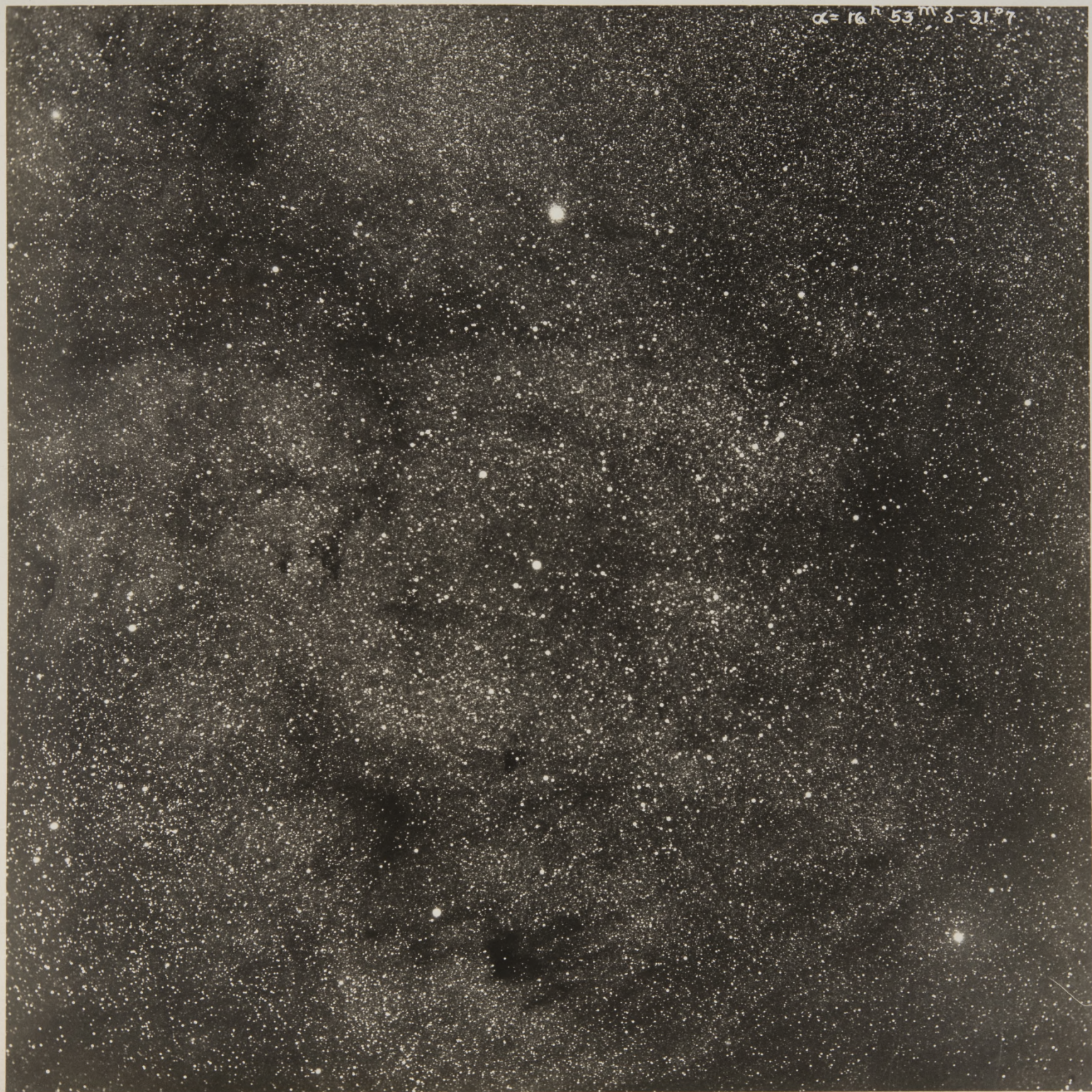


PLATE 18

REGION IN OPHIUCHUS AND SCORPIUS

Right Ascension = $17^{\text{h}} 6^{\text{m}} 5^{\text{s}}$, Declination = $-27^{\circ} 35'$

PLATE 18

REGION IN OPHIUCHUS AND SCORPIUS

$\alpha = 17^{\text{h}} 6^{\text{m}} 5^{\text{s}}$, $\delta = -27^{\circ} 35'$

1905 June 28.788

Scale: 1 cm = 25'.9, or 1 inch = 65'.8

Galactic Long. = 325° , Lat. = $+5^{\circ}$

Exposure = $4^{\text{h}} 33^{\text{m}}$

The eastern half of this plate, which is slightly east and north of Plate 17, contains some of the most remarkable features in the sky. They are difficult to describe. The great vacancy, B 78, in the upper left quarter, south and east of Theta Ophiuchi (No. 380 of the table and chart in Part II) is covered with a veiling of what is probably obscure nebulosity, with some detail, hiding the background of stars beyond it. It abruptly terminates to the west against the great, bright region of stars in which Theta Ophiuchi is placed. This dark area, 3° across, diffuses toward the east. It is better seen in Plates 20 and 21. An irregular extension, $1\frac{3}{4}^{\circ}$ wide, runs south of Theta where, in a broad, irregular path, it sweeps westward for over 4° and then abruptly terminates against a bright region. In this long, dark region are various darker markings which seem to be in feeble nebulosity or possibly in a far distant stratum of stars too faint to show as such.

I have called the west end of this remarkable structure (B 59) the "sink-hole" because of its form and the form of the structures in it. Beside these greater dark regions there are many other dark markings, especially to the south and north of Theta. In the upper right corner is seen a portion of the dark lane from the region of Rho Ophiuchi.

There are, in the southeast quarter, some small cloudlike spots that seem to be smaller condensations in the Milky Way. They are not star clusters in the ordinary sense but apparently are simply condensations in the Milky Way—possibly nebulous. Several of these deserve to be recorded. They are enumerated herewith in tabular form.

| | | | |
|---|----------------------------|---|---------------|
| $\alpha = 17^{\text{h}} 11^{\text{m}} 0^{\text{s}}$ | $\delta = -28^{\circ} 45'$ | Intensification on the eastern edge of a | |
| 17 15 10 | -27 44 | Diameter 20' | [larger cloud |
| 17 15 55 | -29 5 | Diameter 30' | |
| 17 15 55 | -29 45 | Diameter 30' | |
| 17 17 50 | -27 25 | Cond. small cloud, irreg. with a large star | |
| | | in s.e. side | |

Another condensation, in $\alpha = 17^{\text{h}} 20^{\text{m}} 0^{\text{s}}$, $\delta = -29^{\circ} 25'$, assumes the dignity of a cluster, 6' in diameter.

About an inch ($2\frac{1}{2}$ cm) below the middle of the plate, in $\alpha = 17^{\text{h}} 5^{\text{m}} 10^{\text{s}}$, $\delta = -29^{\circ} 0'$ is B 249, a very thin, short, black line like a negative asteroid trail 5' long and about 20'' wide. It is 25' northwest of N.G.C. 6304, and has a small star at its NE. end.

At a distance of 1.4 inches (3.5 cm) from the east edge and 4.0 inches (10.2 cm) from the lower edge of the print in $\alpha = 17^{\text{h}} 23^{\text{m}} 3^{\text{s}}$, $\delta = -28^{\circ} 13'$ is the trail of a bright asteroid (No. 403) perhaps of the 11th magnitude. It is 160'' long, almost due east and west—the east end slightly north of east. There is a small star close south of it. The trail is about 12' east of C.D. -28°13214 of magnitude 9.0.

Visible on this plate are some nine objects listed in Dreyer's *New General Catalogue*, which are given in the table opposite the diagram in Part II.

A small defect, which at first glance might be mistaken for a very small, elongated group of faint stars in the dark area, is located on the print 1.6 inches (4.0 cm) from the left edge and 4.0 inches (10 cm) from the top.

The scale differs very little from that of the original negative, No. 232, which was made at Mount Wilson.

$\alpha=17^{\text{h}} 8^{\text{m}} 27.4^{\text{s}}$

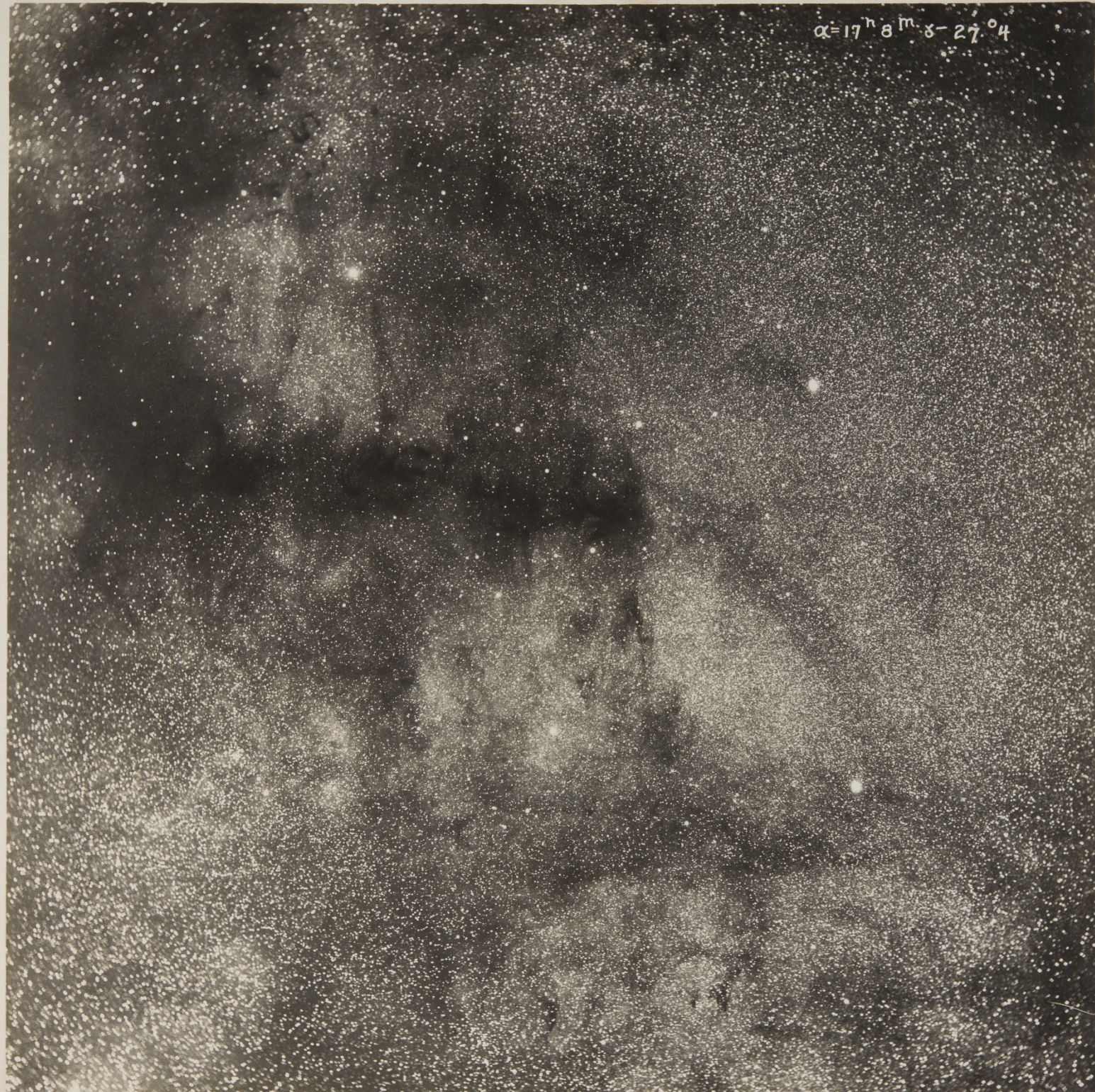


PLATE 19

REGION NORTH OF THETA OPHIUCHI

Right Ascension = $17^{\text{h}} 12^{\text{m}} 35^{\text{s}}$, Declination = $-21^{\circ} 18'$

PLATE 19

REGION NORTH OF THETA OPHIUCHI

$\alpha = 17^{\text{h}} 12^{\text{m}} 35^{\text{s}}$, $\delta = -21^{\circ} 18'$

1905 May 8.908

Galactic Long. = 331° , Lat. = $+8^{\circ}$

Exposure = $3^{\text{h}} 30^{\text{m}}$

Scale: 1 cm = 19.6 or 1 inch = 49.7

This photograph shows a part of that wonderful area between $\alpha = 15^{\text{h}} 30^{\text{m}}$ and $17^{\text{h}} 52^{\text{m}}$ and $\delta = -16^{\circ}$ and -38° , or over $2^{\text{h}} 20^{\text{m}}$ in right ascension and 22° in declination. This includes the remarkable regions of Pi Scorpii (Plate 11), Nu Scorpii (Plate 12), Rho Ophiuchi (Plate 13), the dark lanes from Rho Ophiuchi (Plate 14), the dark region south of Theta Ophiuchi (Plate 18), dark markings north of Theta Ophiuchi (present plate), Theta Ophiuchi (Plates 20 and 21) and 58 Ophiuchi (Plate 23). Another region of similar interest is that extending from $\alpha = 3^{\text{h}} 4^{\text{m}}$ to $4^{\text{h}} 44^{\text{m}}$, and from $\delta = +20^{\circ}$ to $+37^{\circ}$, which contains the nebulosities near Omicron Persei (Plate 3), the exterior nebulosities of the Pleiades (Plate 4), and the dark lanes in Taurus (Plate 5). These portions of the sky are fuller of strange and curious things than any other regions with which my photographs have made me familiar.

The present photograph lies between the regions of Rho Ophiuchi (Plate 13) and 58 Ophiuchi (Plate 23). It is in some respects as remarkable as either of those areas and has some of the characteristics of both in the very extraordinary nature of its phenomena. It is so extremely puzzling that one attempts a description of it with hesitation. That most of these dark markings which, in a word, ornament this portion of the sky are real dark bodies and not open space can scarcely be questioned. There seems to be every evidence of their reality. What their true nature is does not seem clear. That they are some form of nebulosity is possible if not probable; but that they are real obscuring bodies seems evident. A few of them have recently been photographed with the large reflectors at Mount Wilson by J. C. Duncan. These photographs impress one deeply and bear out the assumption that the markings are real objects.

There seems to be considerable nebulous matter in various parts of the plate, matter at least that does not resolve itself into individual stars and which appears to be more or less intimately connected with the dark markings.

We are too prone to think of but two things in space—stars and nebulosity. Is there not something else that may explain these markings other than the supposition that they are “dead” nebulae? Their very unusual forms might suggest that they are not necessarily due to non-luminous nebulosity, for their forms

do not correspond with those of many of the bright nebulae. Indeed their forms would be so unusual among the bright nebulae that it does not seem safe to assume that they really are simply nebulae devoid of light, though some of them are partly luminous and are connected with real nebulosity. What is more unique and strange than the peculiar, curled, dark figure B 75, almost 3° (9 cm) north of Theta Ophiuchi or the S-shaped marking B 72, $1\frac{1}{4}^{\circ}$ (4 cm) north of the same star?

The great curved, dark marking near the middle of the plate (B 63), with its west end so sharply defined, is full of details on the original negative. Its eastern end, not so definite, is curved toward the south and has tentacles at the end, like those of an insect. The western of these “tentacles” springs from a point in $\alpha = 17^{\text{h}} 11^{\text{m}} 30^{\text{s}}$, $\delta = -21^{\circ} 40'$. The most remarkable object here, however, is the narrow curled figure, B 75, just below and to the left of the middle of the plate, with small black tufts on its inner side. South of this an irregular dark area, B 262, extends south in a diffused manner to $\alpha = 17^{\text{h}} 18^{\text{m}}$, $\delta = -22^{\circ} 50'$. On its west side is a very sharp and black loop, or hooked projection. The lower portion, diffused on the south side and almost separated from the rest, is 14' long in an east and west direction and 5' wide north and south.

The small, well-defined, but irregular black spot, B 68, $2\frac{1}{2}'$ in diameter, 20' southwest of the S seems certainly to be opaque matter. The abrupt dark marking B 64, in the upper part of the plate, west of the cluster Messier 9, is certainly an opaque body. Several photographs of these dark markings made with the Bruce telescope have been enlarged and reproduced in *Astrophysical Journal* for January, 1919, with a list of 182 of these dark objects.

To the east edge is part of the strange cloud region of 58 Ophiuchi, while near the western edge of the plate are the dark spots into which the lane from Rho Ophiuchi finally develops.

A defect on the print, which might be mistaken for a small group of stars, is in $\alpha = 17^{\text{h}} 18^{\text{m}} 10^{\text{s}}$, $\delta = -23^{\circ} 50'$, 3.0 inches (7.7 cm) from the left edge and 1.5 inches (3.9 cm) from the lower edge of the picture.

The original negative, No. 194, was made at Mount Wilson.

$\alpha = 17^{\text{h}} 11^{\text{m}} 5.21^{\text{s}}$

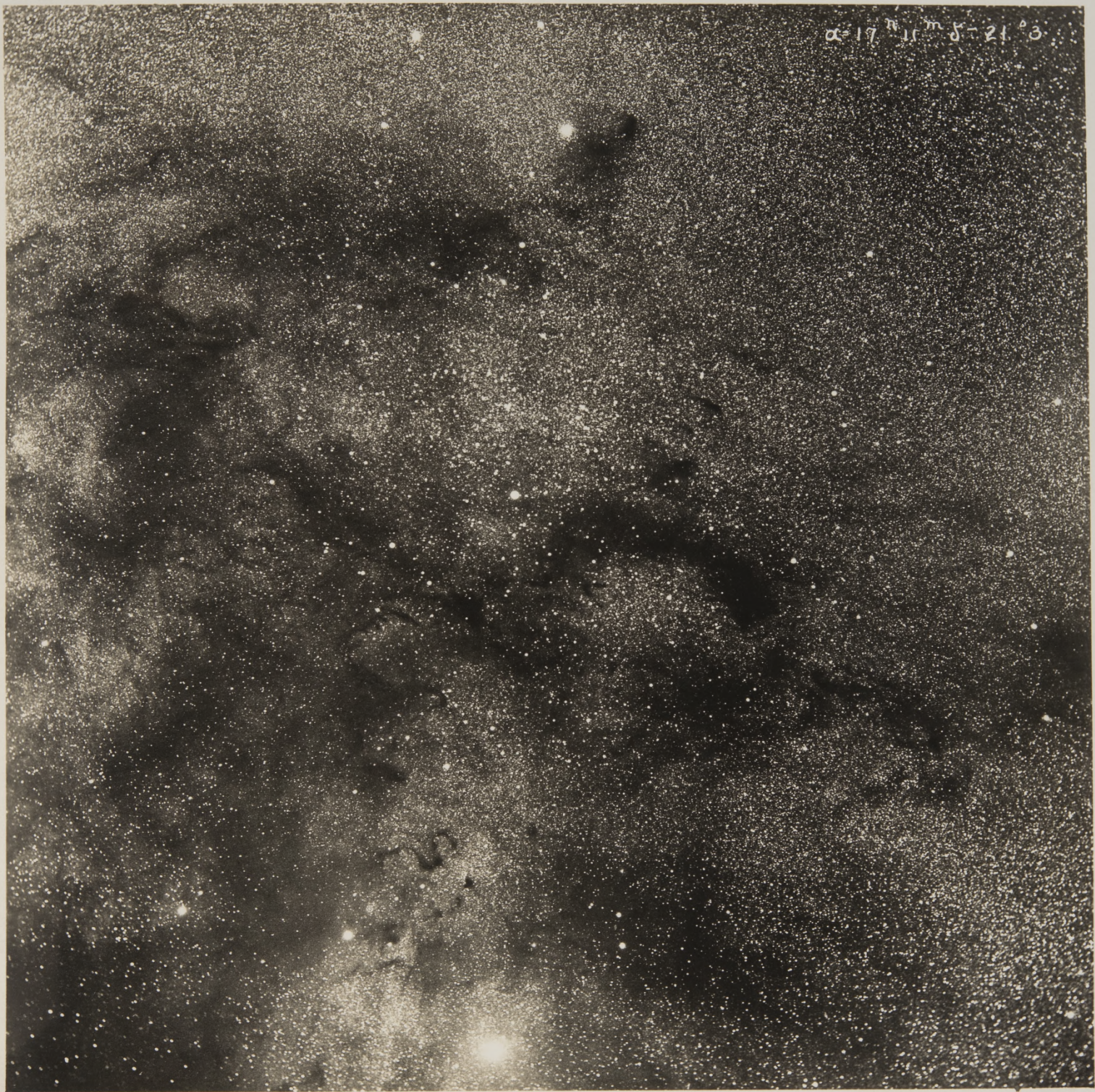


PLATE 20

DARK MARKINGS NEAR THETA OPHIUCHI

Right Ascension = $17^{\text{h}} 18^{\text{m}} 0^{\text{s}}$, Declination = $-24^{\circ} 10'$

PLATE 20

DARK MARKINGS NEAR THETA OPHIUCHI

$\alpha = 17^{\text{h}} 18^{\text{m}} 0^{\text{s}}$, $\delta = -24^{\circ} 10'$

1905 June 5.826

Scale: 1 cm = 21'.8, or 1 inch = 55'.5

Galactic Long. = 329° , Lat. = $+5^{\circ}$

Exposure = 4^h 45^m

This region is so closely related in many of its phenomena to that of Rho Ophiuchi that they really go to make up one most extraordinary picture, which unfortunately is too large to be covered by any one plate. The two are connected by straggling vacancies, and the structural details, though different, are of the same order of vacancies within vacancies.

This picture was especially made to show the remarkable blank space east and south of Theta Ophiuchi, the bright star below and to the right of the center of the picture. It also brings out the irregular continuation of the dark area running to the west, 2° south of Theta, for a distance of about 4° , nearly to the edge of the print. Though the present plate fails to include more than the immediate space about Theta, for want of a wider field, the large scale itself brings out the great beauty of the main features. This photograph is printed somewhat too dark to show the structures in the large dark space (B 78) 2° or 3° to the south and east of Theta. Their description is, therefore, reserved for Plate 21, where they are better seen. But the broad, irregular lane south of Theta, with its structural markings, is well shown. The star C.D. -26°12152 of 6.2 magnitude (No. 405 in the list of stars in Part II) in the lower part of the large dark spot, seems isolated in a sea of blackness over which a few stars of less magnitude are scattered.

In the upper left quarter of the plate are some of the small clouds of which 58 Ophiuchi is the center. Remarkable as is the region south and east of Theta Ophiuchi, the most curious of the dark markings lie to the north of it. Some of these objects have already been described in Plate 19. The S-shaped figure, B 72, just above the center of the picture, is much darker than

the great dark region southeast of Theta. Near it are several small dark markings. The curled figure, B 75, is, perhaps, as strange an object as can be found anywhere in the sky. In the upper right part of the plate is the great curved dark marking, B 63. The dark patches south and west of B 63 are at the eastern end of the dark lane (shown in Plates 13 and 14) which extends from this point westward to the region of Rho Ophiuchi. Certainly this is one of the most surprising and curious regions in the sky.

This plate shows the trails of three asteroids. The first trail (No. 406) is quite faint. It is in $\alpha = 17^{\text{h}} 24^{\text{m}} 0^{\text{s}}$, $\delta = -22^{\circ} 25'$, 3.1 inches (7.9 cm) from the left edge and 2.95 inches (7.5 cm) from the upper edge of the print. The second trail (No. 407), in $\alpha = 17^{\text{h}} 25^{\text{m}} 1^{\text{s}}$, $\delta = -23^{\circ} 19'$, is 2.9 inches (7.4 cm) from the left edge and 4.0 inches (10.1 cm) from the upper edge of the picture. The third and brightest of the trails (No. 418), in $\alpha = 17^{\text{h}} 28^{\text{m}} 4^{\text{s}}$, $\delta = -24^{\circ} 21'$, is 2.2 inches (5.5 cm) from the left edge and 4.4 inches (11.1 cm) from the lower edge of the print.

On the lower part of the curled figure, B 75, in $\alpha = 17^{\text{h}} 17^{\text{m}} 10^{\text{s}}$, $\delta = -22^{\circ} 20'$, is a small defect on this photograph which looks like a group of faint stars. There is another small defect on the print, 0.9 inch (2.2 cm) above and to the right of Theta Ophiuchi, in $\alpha = 17^{\text{h}} 11^{\text{m}} 10^{\text{s}}$, $\delta = -24^{\circ} 25'$. A similar spot, very small, is 5 mm above and to the left of this one. Another small, bright defect in the lane south of Theta Ophiuchi is in $\alpha = 17^{\text{h}} 14^{\text{m}} 40^{\text{s}}$, $\delta = -26^{\circ} 55'$. It is 3.7 inches (9.5 cm) from the right edge and 1.8 inches (4.6 cm) from the lower edge of the print.

The original negative, No. 213, was made at Mount Wilson.

00-17^h 18^m 5^s 24^o

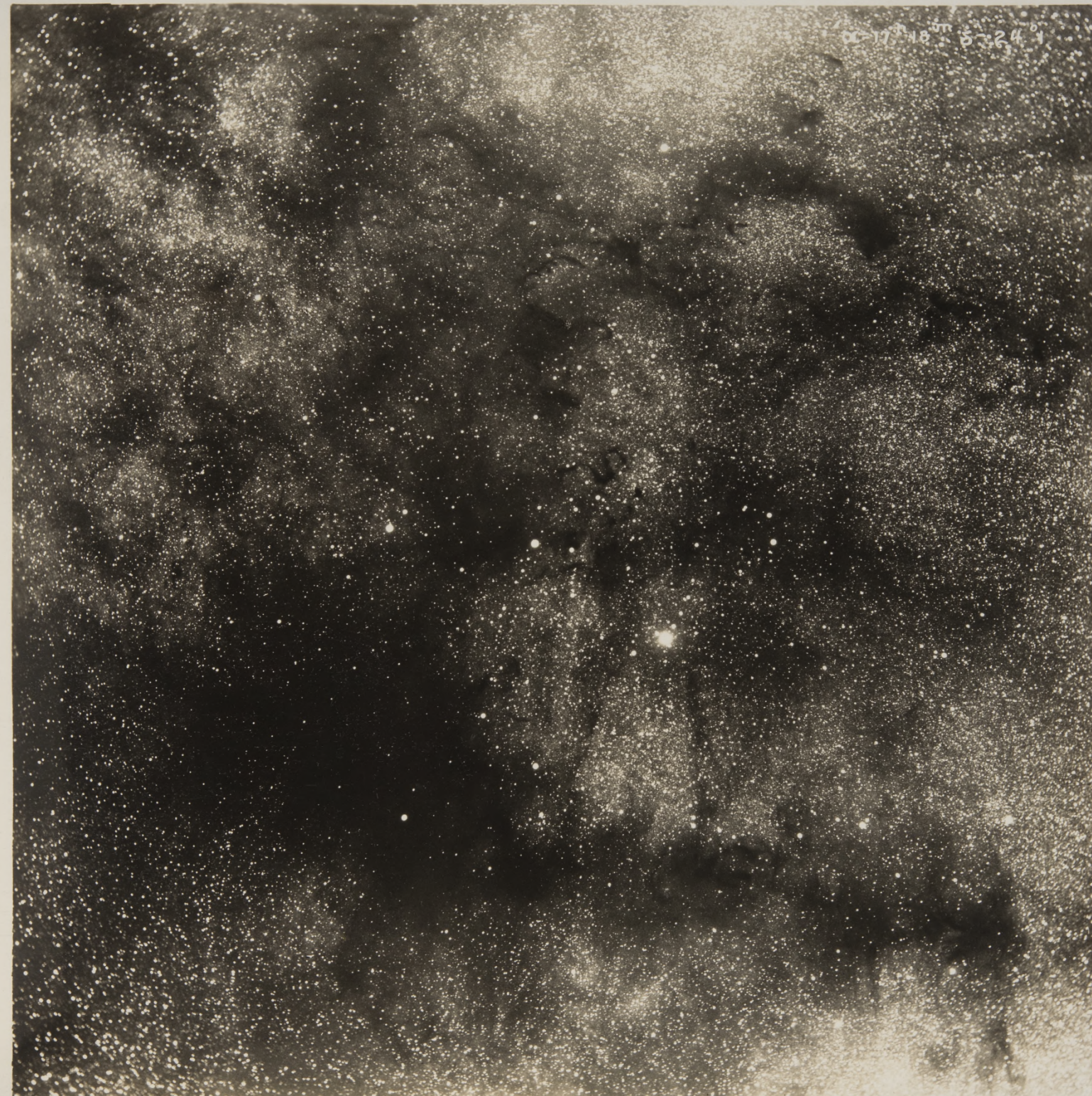


PLATE 21

REGION OF THETA OPHIUCHI AND EASTWARD

Right Ascension = $17^{\text{h}} 22^{\text{m}} 0^{\text{s}}$, Declination = $-26^{\circ} 0'$

PLATE 21

REGION OF THETA OPHIUCHI AND EASTWARD

$\alpha = 17^{\text{h}} 22^{\text{m}} 0^{\text{s}}$, $\delta = -26^{\circ} 0'$

1905 June 30.790

Scale: 1 cm = 21'.8, or 1 inch = 55'.2

Galactic Long. = 328° , Lat. = $+3^{\circ}$

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

This plate covers much of the region shown on Plate 20. Its purpose is to bring out by lighter printing some of the luminous forms that exist in the great vacancy, No. 78, which occupies the middle of the plate, and in the lane extending from it to the west. This photograph fairly represents the general structures, although they are not so well shown as in the original negative.¹ The extent of the great dark region is 3° northeast and southwest. Its breadth is about 2° . There is, however, an irregular extension from the northwest end for a degree or more. Over the northern part of this dark area is a sprinkling of distinct stars. From the northeastern side is a curved, dark extension which ends in $\alpha = 17^{\text{h}} 34^{\text{m}}$, $\delta = -24^{\circ} 30'$. A similar curved dark lane extends from it toward the southeast, running south to $\alpha = 17^{\text{h}} 24^{\text{m}}$, $\delta = -28^{\circ} 0'$. These two dark projections are like curved horns extending from a black head, as if the head were in the act of charging toward the east.

It is clearly shown that there is some kind of matter in the great vacancy, which is feebly luminous over its entire area. It is not uniformly luminous, however, for much of the brighter matter is near the star C.D. - $26^{\circ} 12152$, No. 405, of magnitude 6.2. Whatever the material in the dark spot may be, it is evident that we are not looking out into space through an opening in the Milky Way. The structure of the great dark lane under the bright region of Theta Ophiuchi is also shown much better here than in Plate 20. The matter in this lane, which is so full of details, is the same that is seen in the different spots and un-

doubtedly also fills the great spot. A much longer exposure would probably fill the large dark space with interesting details, some of which are already shown close to the bright star, notably a narrow, curved, dark marking $5'$ southeast of it.

Theta Ophiuchi (No. 380) is placed in a great, bright, flat stratum of stars which abruptly terminates to the east on the edge of the large dark area. In the eastern edge of the cloud in which Theta is situated is a small, very black spot, B 267, somewhat elongated northwest and southeast. It is $5'$ by $3'$ with one or two small stars at the northwest end.

In the lower part of the picture the stars appear to gather into small masses. One distinct cluster, $10'$ in diameter, may be found near the middle of the lower edge of the plate in $\alpha = 17^{\text{h}} 20^{\text{m}} 30^{\text{s}}$, $\delta = -29^{\circ} 20'$. In the lower left quarter are many strings and curves of stars.

The angular black spot at the northwest corner is not a defect, but is part of the west end of the great, curved dark marking B 63 (Plates 19 and 20). The peculiar, curled figure, B 75, is shown at the upper edge of the plate. Above Theta Ophiuchi are others of the familiar dark markings that make this region so remarkable. In the upper left quarter is part of the strange region of small clouds of which 58 Ophiuchi seems to be the center. (See Plate 23.)

It should be noted that in making the second negative there was a slight error in orienting the plate. The original negative, No. 234, was made at Mount Wilson.

¹[Unfortunately many of the prints for Plate 21 are a little darker than the one Professor Barnard had before him when he wrote this description.]

$\alpha 17^{\text{h}} 22^{\text{m}} 5.26^{\circ}$

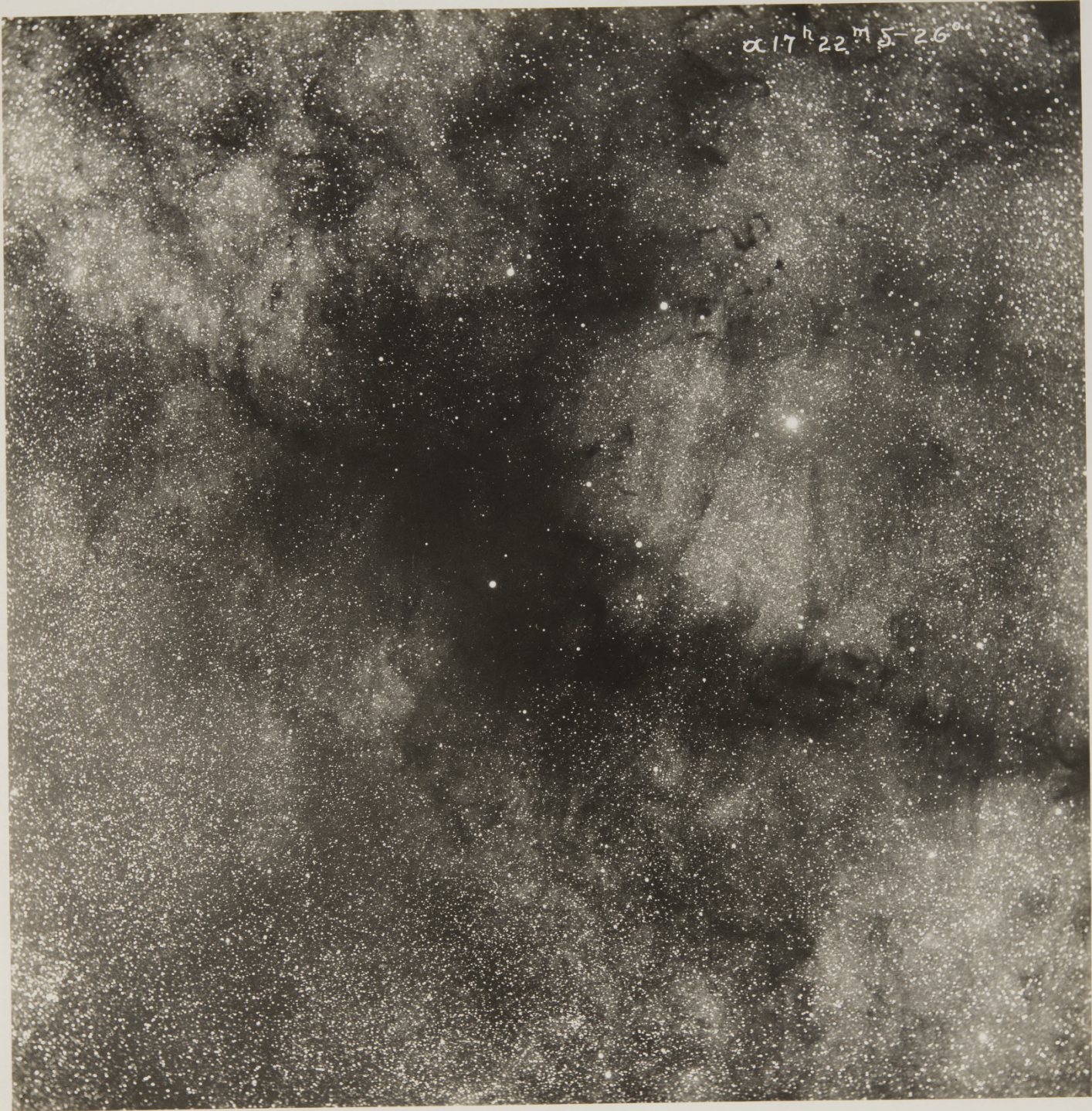


PLATE 22

REGION IN SCORPIUS AND SAGITTARIUS, NEAR MESSIER 6

Right Ascension = $17^{\text{h}} 32^{\text{m}} 10^{\text{s}}$, Declination = $-32^{\circ} 10'$

PLATE 22

REGION IN SCORPIUS AND SAGITTARIUS, NEAR MESSIER 6

$\alpha = 17^{\text{h}} 32^{\text{m}} 10^{\text{s}}$, $\delta = -32^{\circ} 10'$

1905 July 4.776

Galactic Long. = 324° , Lat. = -2°

Exposure = $4^{\text{h}} 15^{\text{m}}$

Scale: 1 cm = 20.6 , or 1 inch = 52.4

This plate is immediately south and east of the great dark region below Theta Ophiuchi, shown in Plates 18, 20, and 21. The great star clouds at the east side terminate rather abruptly at their western edges against an open field, as it were, or a thin and more or less irregular sheet of stars. In this field is situated, at the center of the plate, the beautiful cluster Messier 6. Around Messier 6, and to the north, the stars are very thinly scattered, but all the rest of the plate shows more or less cloud structure.

The cloud structure in the lower left corner, in the star cloud in which Messier 7 is located, gradually diminishes in strength toward the middle of the picture but extends diagonally across the plate, becoming somewhat brighter again toward the upper right corner.

Just east and just west of Messier 6 are two round dark spots (B 278 and 275), each about $15'$ in diameter. A large curved dark marking (B 271) runs from a dark spot, B 273, in $\alpha = 17^{\text{h}} 30^{\text{m}}$, $\delta = -33^{\circ} 10'$, 1.2 southwest of Messier 6. This curved marking extends south, with the convex side to the west, to about $\alpha = 17^{\text{h}} 28^{\text{m}}$, $\delta = -35^{\circ} 10'$. It averages $10'$ across. A curious "kink" occurs in it just above a small bright star, C.D. $-33^{\circ} 12241$ (No. 416 of the list of stars), where the dark lane partially encircles a group of small stars.

One degree west and south of Messier 6 is the densest part of what seems to be a large nebulous area. It extends 3° north-west by 2° in a southwesterly direction. Its position is approximately $\alpha = 17^{\text{h}} 28^{\text{m}}$, $\delta = -32^{\circ} 30'$. A similar nebulous condition

seems to exist in the upper right corner at two places, $\alpha = 17^{\text{h}} 16^{\text{m}}$, $\delta = -29^{\circ} 50'$ and $\alpha = 17^{\text{h}} 16^{\text{m}}$, $\delta = -29^{\circ} 20'$, where there seems to be a mixture of nebulosity and stars. The nebulosity is present also in two feeble condensations of stars in $\alpha = 17^{\text{h}} 21^{\text{m}}$, $\delta = -31^{\circ} 20'$, and in $\alpha = 17^{\text{h}} 23^{\text{m}}$, $\delta = -31^{\circ} 50'$.

In the lower right corner of the plate there is a suggestion of nebulosity with dark markings in it. This last region is one either of dark masses or few stars. A continuation of this region is shown at the left side of Plate 17, there being a gap of only a degree between the borders of the two plates.

Fifty minutes east of Messier 6 is N.G.C. 6416 (No. 439), a scattering group of small stars $25'$ in diameter. In $\alpha = 17^{\text{h}} 38^{\text{m}} 54^{\text{s}}$, $\delta = -31^{\circ} 28'$, about $1\frac{1}{2}^{\circ}$ (4.5 cm) northeast of the center of the picture, N.G.C. 6425 (No. 446) is seen as a small patch of stars $10'$ in diameter. Still farther toward the northeast, in the western edge of the star clouds, is N.G.C. 6451 (No. 458), a rather compact cluster $8'$ in diameter. In the upper right quarter, in $\alpha = 17^{\text{h}} 20^{\text{m}}$, $\delta = -29^{\circ} 20'$, is a small group of considerable stars, about $10'$ in diameter. These are not a part of the cloud structure but are bright enough to be considered as irregular clusters.

There are several places where curious curves and alignments of stars are noticeable. One system of entangling curves of stars covers a degree or more in $\alpha = 17^{\text{h}} 34^{\text{m}}$, $\delta = -34^{\circ}$. Another system of star lines is in $\alpha = 17^{\text{h}} 41^{\text{m}}$, $\delta = -33^{\circ}$. There are other curious alignments of stars at various positions on the plate, making it very interesting to pick them out.

The original negative, No. 239, was made at Mount Wilson.

$\alpha=17^{\text{h}} 32^{\text{m}} \delta=32^{\circ}$

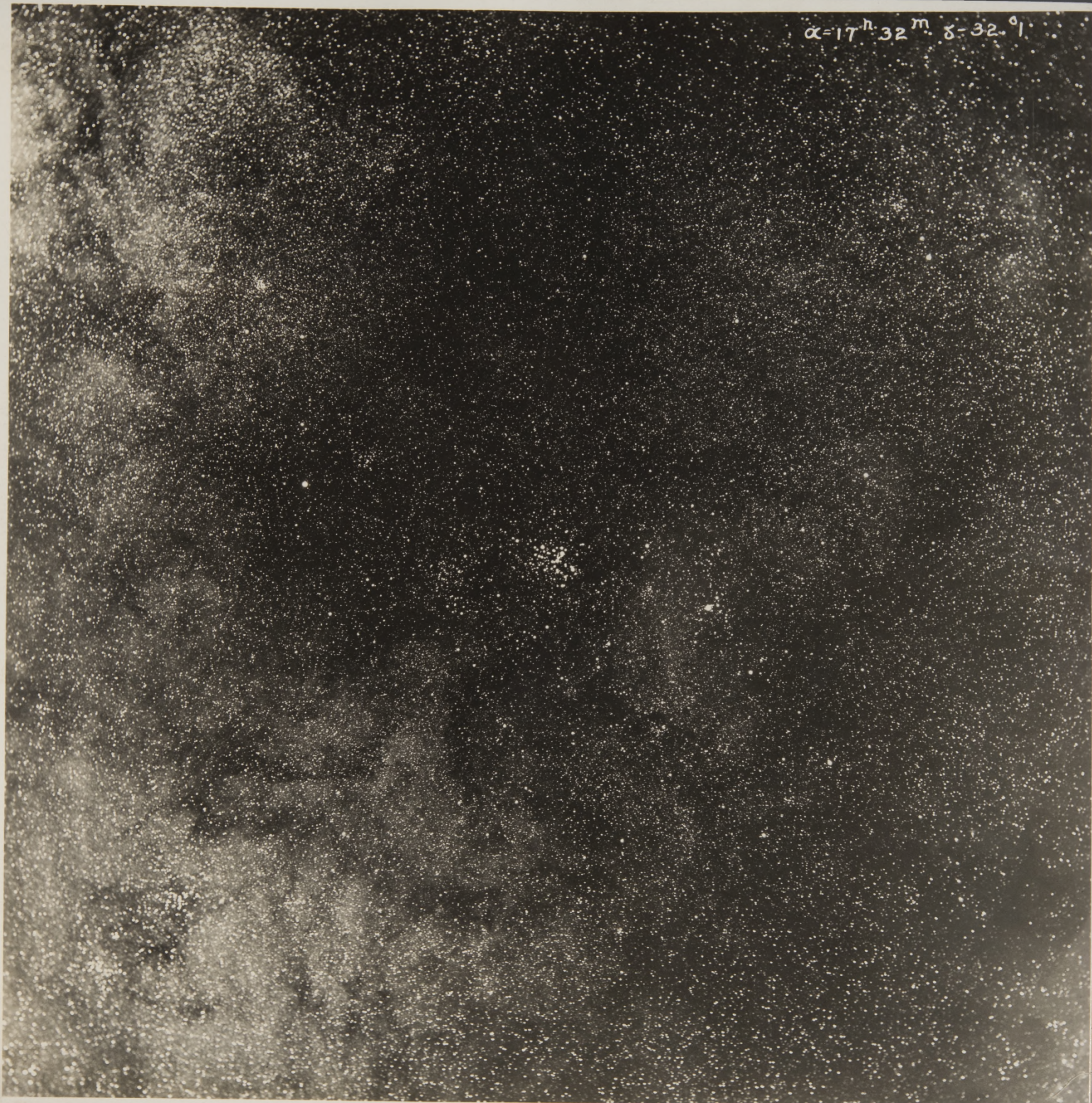


PLATE 23

REGION OF 58 OPHIUCHI

Right Ascension = $17^{\text{h}} 35^{\text{m}} 40^{\text{s}}$, Declination = $-21^{\circ} 32'$

PLATE 23

REGION of 58 OPHIUCHI

$\alpha = 17^{\text{h}} 35^{\text{m}} 40^{\text{s}}$, $\delta = -21^{\circ} 32'$
1905 August 2.755

Galactic Long. = 334° , Lat. = $+3^{\circ}$
Exposure = $4^{\text{h}} 0^{\text{m}}$

Scale: 1 cm = $17'.5$, or 1 inch = $44'.4$

The naked-eye star 58 Ophiuchi (B.D. $-21^{\circ}47'12''$, of magnitude 5.2), close to the middle of the plate, is apparently placed in the midst of a large mass of small, cloudlike forms that probably have nothing to do with it, though the star seems to be in the center of one of them. These clouds are quite distinctly different in appearance from any in other parts of the Milky Way, for though they are partly granular with small stars they do not give the impression of being entirely stellar. They do not all show the granulation so striking in the eastern part of the plate or in the other star clouds of the Milky Way. They are probably entirely stellar, however, though this does not seem altogether certain. If stellar they probably are relatively very far away, though from their brightness this does not seem to be the case. Between us and these stars is a generous sprinkling of considerably larger stars which extends to the western (right-hand) part of the plate; they are doubtless much nearer to us than the clouds.

In the lower left quarter of the picture the sky is very granu-

lar with small stars which seem to have a general trend to the south. In the lower southwest part some of the peculiar matter, for one who hesitates to call it nebulosity, near Theta Ophiuchi is shown. In the upper left corner is the beautiful cluster Messier 23. Above the middle of the picture and slightly to the left is the curious curved dark marking, B 84, which has several sharp loops on its south edge. Its form is better shown in the enlarged reproduction, which is Plate II in my article in the *Astrophysical Journal* (49, 1-23, 1919).

There are many dark markings on this plate; among them are Nos. 80, 82, 83a, 84, 268, 272, and 276. All these probably have some meaning. There are many other markings which, though not recorded, possibly have a meaning.

This region is well shown in Plates 42 and 44, Volume XI of the *Publications of the Lick Observatory*, which, on account of their smaller scale, cover a wider field. The present plate covers an area 7° by 7° .

The original negative, No. 267, was made at Mount Wilson.

$\alpha = 17^{\text{h}} 34^{\text{m}} 21.5^{\text{s}}$

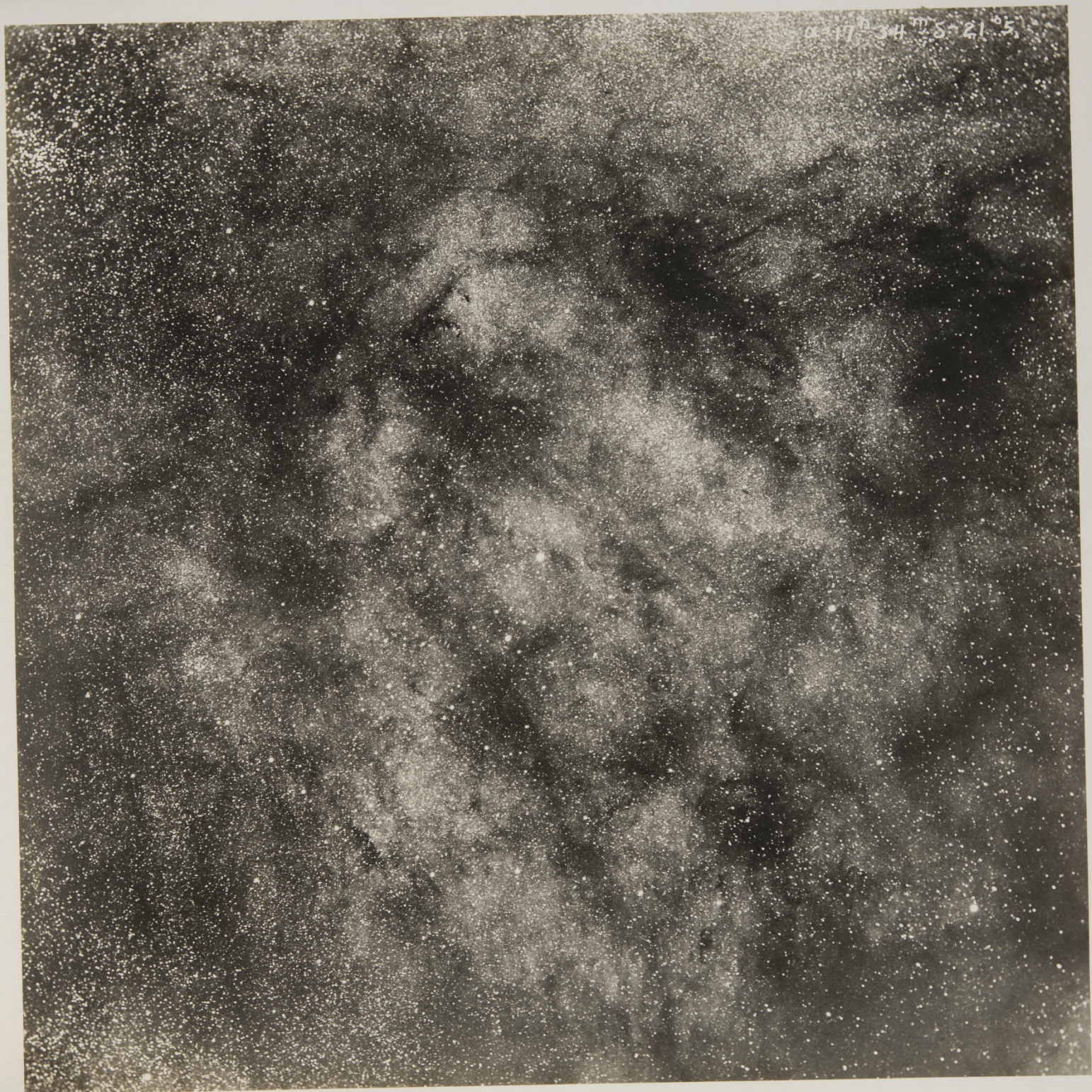


PLATE 24

REGION IN SCORPIUS AND SAGITTARIUS, NEAR MESSIER 7

Right Ascension = $17^{\text{h}} 45^{\text{m}} 50^{\text{s}}$, Declination = $-34^{\circ} 40'$

PLATE 24

REGION IN SCORPIUS AND SAGITTARIUS, NEAR MESSIER 7

$\alpha = 17^{\text{h}} 45^{\text{m}} 50^{\text{s}}$, $\delta = -34^{\circ} 40'$
1905 July 25.744

Galactic Long. = 323° , Lat. = -6°
Exposure = $3^{\text{h}} 18^{\text{m}}$

Scale: 1 cm = 20'.5, or 1 inch = 52'.1

The bright cloud and cluster in the center of the picture are visible to the naked eye as a small luminous spot. The cloud itself, which is so much brighter than the rest of the Milky Way here, gives the impression of being much nearer to us. It seems to be somewhat broken up into several smaller masses, especially in its western part.

In the midst of this small cloud is the coarse but beautiful cluster Messier 7 (N.G.C. 6475). The cluster is roughly 36' in diameter, while the cloud itself is more than $1\frac{3}{4}^{\circ}$ in diameter. Messier 7 is in the western edge of a semi-vacancy (B 287) in the cloud. On the southeastern edge of this semi-vacancy is a scattering cluster of smaller stars, 18' in diameter, with a brighter star, C.D. -35°12084 of magnitude 8.3 (No. 471 in Table 24 in Part II) on its northern edge. The position of the cluster is $\alpha = 17^{\text{h}} 48^{\text{m}}$, $\delta = -35^{\circ} 15'$. It is not given in the N.G.C. A small area of local intensification of the Milky Way situated $1\frac{1}{4}^{\circ}$ northeast of Messier 7 is a noticeable object. It is round and 20' in diameter.

The cluster Messier 6 (No. 429), which is centrally located on Plate 22, will be found in the upper right part of this plate. N.G.C. 6416, 45' east of Messier 6, is a loose scattering of stars, brighter than the general background but less bright than most of those composing Messier 6. It is roughly 25' in diameter, and seems to be uniformly scattered with no condensation. About 45' west of Messier 6, in $\alpha = 17^{\text{h}} 28^{\text{m}} 30^{\text{s}}$, $\delta = -32^{\circ} 20'$ is a small cluster, 8' in diameter, with few stars. There are a few other close groupings of stars which perhaps do not quite fall in the cluster class. Several of these are objects given in the N.G.C. and are noted in Table 24 in Part II.

In $\alpha = 17^{\text{h}} 45^{\text{m}}$, $\delta = -35^{\circ} 45'$ is a straight line of small stars about 50' long, running nearly east and west. It will be readily located 4.4 inches (11.2 cm) from the right edge and 3.3 inches (8.4 cm) from the lower edge of the print. Another, but less noticeable line, is just north of this one, below a considerable star (C.D. -35°12013, 7.1 magnitude) in a small vacancy (B 286). There are several submerged, irregular dark markings 1° east and south of Messier 7. One of these, B 293, is like an inverted U 18' across and has near its center the small star C.D. -35°12159 of magnitude 8.5, a little brighter than the other stars near it. This object is 3.0 inches (7.7 cm) from the left edge and 3.9 inches (9.9 cm) from the lower edge

of the print. These irregular markings are about 2' wide. They continue eastward for a distance of $1\frac{1}{2}^{\circ}$.

About $1\frac{1}{2}^{\circ}$ northeast of Messier 7 the star C.D. -33°12697, of magnitude 8.3, is on the east edge of a small, round, black spot (B 291) 5' in diameter, bordered on the north by a curve of small stars and having a very faint star in its center. From this spot a dark lane 2' wide runs southerly for a distance of 25' and ends in a dark broken region. Springing from the eastern side of the lane, 8' south of the star, a similar dark lane runs easterly, then north for a distance of 35'. This is a very curious feature.

South and east of the center of the plate, the bed of small stars which makes up the Milky Way is composed of excessively minute points of light with here and there a few brighter ones. In strong contrast to this, the diagonally opposite part of the plate, in the upper right quarter, is covered with a thin stratum of considerable stars in which are Messier 6 and the several other smaller groupings.

The sky just north of Messier 7 seems to be covered in several places by a soft nebulosity. Especially is this the case in $\alpha = 17^{\text{h}} 41^{\text{m}}$, $\delta = -33^{\circ} 50'$, just north of the bright mass of stars. Here a smear of nebulosity extending east and west, 68' long and 15' wide, crosses a partly vacant region. Half a degree east of this is another mass of similar nebulosity. The profile of the "parrot's head," B 87, is shown in the upper left quarter with the 9.3 magnitude star C.D. -32°13679 in its center forming the "eye." The position of this object and identification of the star given in my article in the *Astrophysical Journal* (49, 16, 1919) are incorrect. Its position should be $\alpha = 17^{\text{h}} 56^{\text{m}} 0^{\text{s}}$, $\delta = -32^{\circ} 30'$.

Lambda Scorpii (No. 408, cut by the lower part of the right edge of the print) is nebulous, with a symmetrical glow 10' in diameter. Its spectrum is given in the *Henry Draper Catalogue* as B2. Three degrees east of Lambda in $\alpha = 17^{\text{h}} 41\frac{1}{2}^{\text{m}}$, $\delta = -37^{\circ} 0'$ are apparently two bright stars. The eastern one (No. 456) is really a small globular cluster, numbered -37°11916 in the Cordoba Durchmusterung and 6441 in the N.G.C. The western star (No. 454) is C.D. -37°11907 of magnitude 3.4.

A defect on the second negative shows on the prints as a white spot, resembling a short asteroid trail, 2.75 inches (7.0 cm) from the right, and 3.25 inches (8.3 cm) from the lower edge.

The original negative, No. 253, was made at Mount Wilson.

$\alpha = 17^{\text{h}} 46^{\text{m}} 5.34^{\text{s}}$

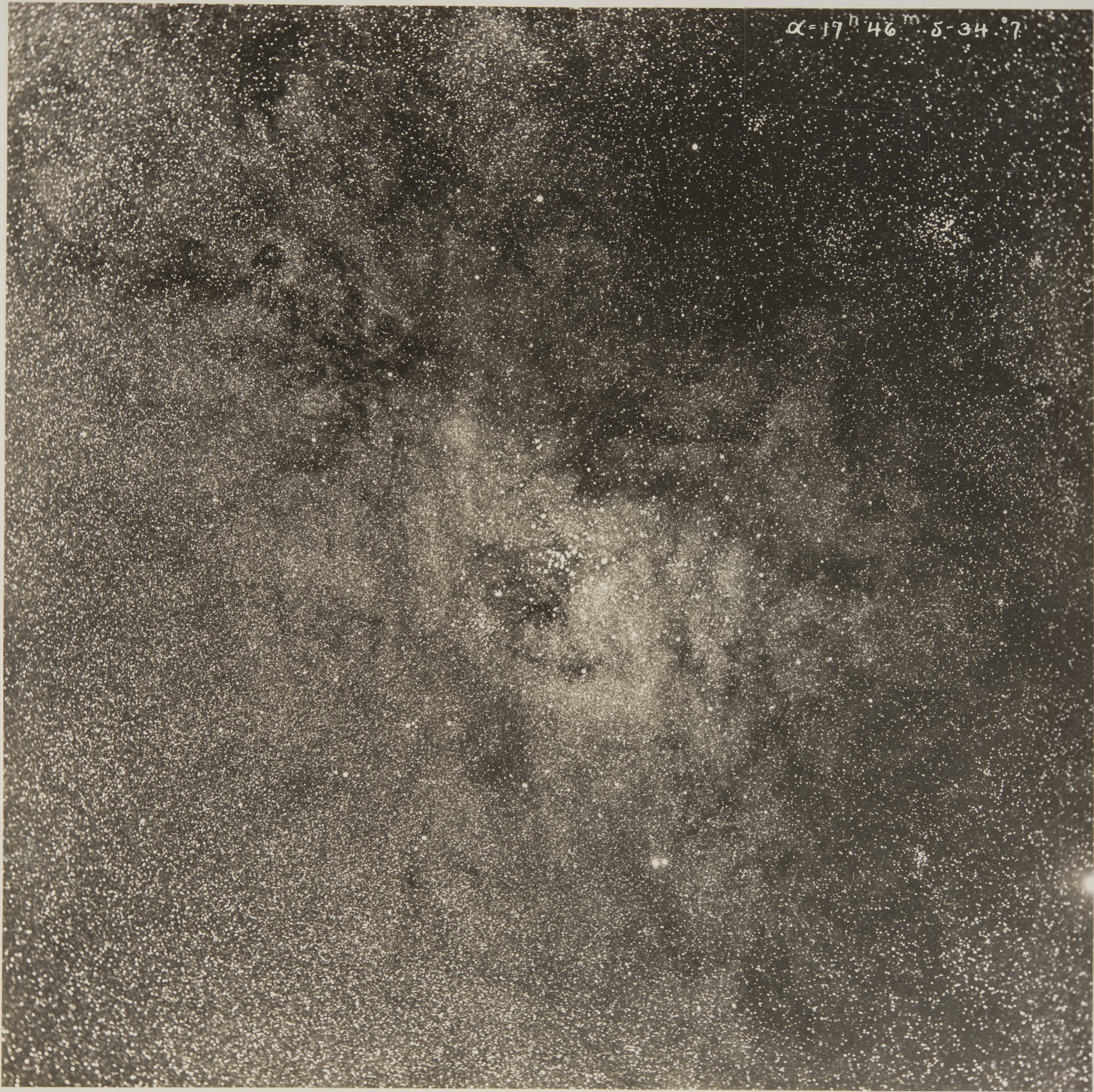


PLATE 25

REGION IN SERPENS AND SAGITTARIUS

Right Ascension = $17^{\text{h}} 49^{\text{m}} 30^{\text{s}}$, Declination = $-16^{\circ} 56'$

PLATE 25

REGION IN SERPENS AND SAGITTARIUS

$\alpha = 17^{\text{h}} 49^{\text{m}} 30^{\text{s}}$, $\delta = -16^{\circ} 56'$

1905 July 25.764

Galactic Long. = 339° , Lat. = $+3^{\circ}$

Exposure = $4^{\text{h}} 10^{\text{m}}$

Scale: 1 cm = $22:8$, or 1 inch = $57:9$

This is an interesting region of minor subdued star masses. It lies north and east of the peculiar region of 58 Ophiuchi—some of whose cloud forms show in the lower right corner. A sprinkling of small stars between us and the more distant clouds is noticeable. At the eastern edge of the plate is the small star cloud with the black spot B 92 in it. Below the center is the dark spot B 84a, 14' in diameter, with the 9.1 magnitude star B.D. -17°4967 in its center. Besides this star there are some very minute stars in it and perhaps some detail. This black spot has an extension, much less distinct, for 45' toward the south.

Below the spot is the beautiful cluster Messier 23 (N.G.C. 6494), which is surrounded by a group of small stars, about $1\frac{1}{2}^{\circ}$ in diameter, somewhat brighter than the ordinary background in that region. These stars may really be a part of the cluster. In the upper edge of the cluster is a partial ellipse of small stars open to the east, with a faint star in the middle. This partial ellipse, continued to the north by some small stars, really forms a letter **S**. The bright star near the northwest edge of the cluster is B.D. -18°4686 of magnitude 6.0. Several curved sprays of small stars stretch out from the cluster in different directions, somewhat resembling those from Messier 13 (Hercules).

Between this rather bright region of star masses in the middle of the plate and the brighter clouds to the east, the darker sky is thinly sprinkled with a fine powdering of small stars with some vacant places in its south part in about $\alpha = 17^{\text{h}} 57^{\text{m}}$, $\delta = -18^{\circ} 45'$. [A defect that looks much like a very small cluster has occurred in the negative in this region. It is located 2.6 inches (6.7 cm) from the left, and 3.7 inches (9.3 cm) from the lower edge of the print.]

The star masses on this plate do not assume the real cloud-like forms of other parts of the Milky Way, though in the middle there is a slight tendency to that condition.

The curved dark strip, B 284, in the upper right quarter is about $\frac{1}{2}^{\circ}$ long. Its south side is rather abrupt, while on its north side are a great many small, distinct stars, apparently spreading south from B.D. -14°4780 of magnitude 8.0 (No. 460). In $\alpha = 17^{\text{h}} 44^{\text{m}} 30^{\text{s}}$, $\delta = -12^{\circ} 50'$ (0.6 inch, or 1.5 cm from the upper edge of the print) is the diffused dark spot, B 285, 15' in diameter. Near the upper left corner is what appears to be diffused nebulosity mixed with some considerable stars in $\alpha = 18^{\text{h}} 1^{\text{m}}$, $\delta = -13^{\circ} 10'$. It is about 1° in diameter and seems to extend southward for a degree.

The original negative, No. 255, was made at Mount Wilson.

$\alpha=17^{\text{h}}49^{\text{m}}\delta=17^{\circ}0'$

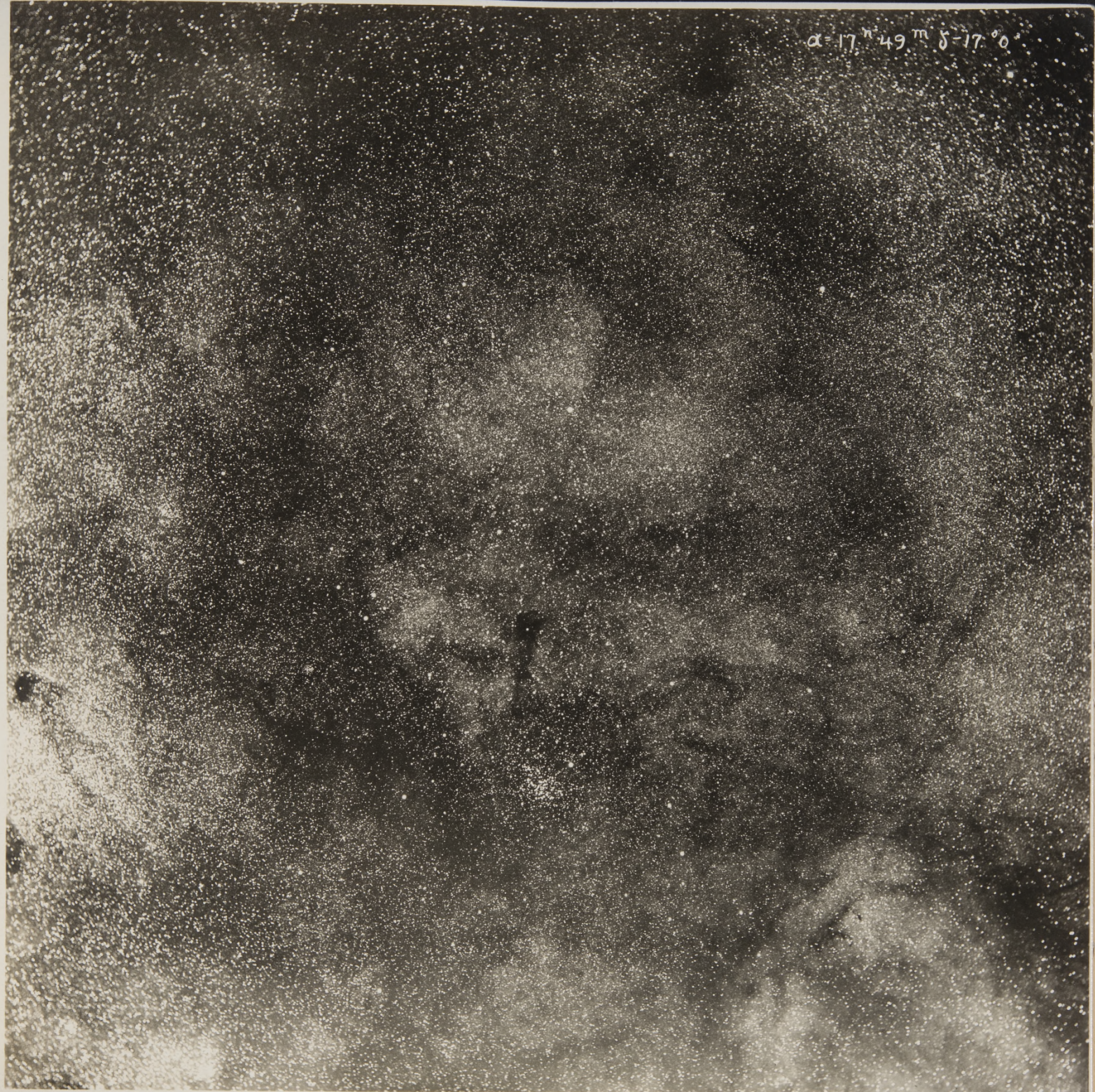


PLATE 26

GREAT STAR CLOUDS IN SAGITTARIUS

Right Ascension = $17^{\text{h}} 54^{\text{m}} 15^{\text{s}}$, Declination = $-29^{\circ} 20'$

PLATE 26

GREAT STAR CLOUDS IN SAGITTARIUS

$\alpha = 17^{\text{h}} 54^{\text{m}} 15^{\text{s}}$, $\delta = -29^{\circ} 20'$

1905 July 6.815

Galactic Long. = 329° , Lat. = -4°

Exposure = $3^{\text{h}} 58^{\text{m}}$

Scale: 1 cm = $26'.5$, or 1 inch = $67'.5$

These great clouds were among the first portions of the Milky Way to be photographed by the writer with the Willard lens at the Lick Observatory, in the year 1889. They are the most magnificent of the galactic clouds visible from this latitude. For many years I had been familiar with their remarkable structures, while comet-seeking with a 5-inch refractor at Nashville. Previous efforts to photograph them with several different lenses had been a failure, mainly because the lenses were too slow. The Willard lens, with its short focus and large aperture, brought out for the first time the remarkable forms and structural details of these immense star clouds.

These great broken clouds, so beautiful and bright to the eye and on the photograph, rapidly thin out to the south and east, the stars being fewer and fainter. This gives, especially to the south, the impression of greater distance. The western boundary of the clouds, however, is abrupt and definite. The narrow strip in $\alpha = 18^{\text{h}} 1^{\text{m}}$, $\delta = -27^{\circ} 30'$ apparently is an actual bridge between two bright portions of the great cloud. The western of the two masses thus connected is irregular and broken, while the eastern one is more uniform. A striking feature of one of these star masses on the western edge of the clouds, projected against a region of few stars, is the crude form of a beast, with round head, nose, mouth, ears, and great staring eyes. A rope of stars, seemingly attached to its neck, trails northward, while the body of the beast extends above the head and curves to the northwest. The "rope" and the fragment of another close east of it is made

up, apparently, of nebulosity and stars and is $14'$ wide. The space between the "rope" and the star cloud to the east is $13'$ wide. One striking feature of the "beast" is that the stars forming it are fewer and perhaps individually brighter, as if it were a nearer part of the clouds. In locating it, the middle of the body is in $\alpha = 17^{\text{h}} 46^{\text{m}}$, $\delta = -28^{\circ} 40'$, while the head lies in $\alpha = 17^{\text{h}} 45^{\text{m}}$, $\delta = -30^{\circ} 0'$.

Above the middle of the plate, in the star cloud, is the small, dark, triangular spot B 86, with the cluster N.G.C. 6520 (No. 494) closely east of it. In the lower right side of the picture is the cluster Messier 6 (No. 429), while Messier 8 is cut by the upper edge of the photograph. The "parrot's head" (B 87) is conspicuous in the lower part of the plate (see also Plates 24, 27, and 28). A broken area, B 300, lies about $30'$ east of the "parrot's head" in $\alpha = 17^{\text{h}} 59^{\text{m}}$, $\delta = -32^{\circ} 40'$. In the lower left part of the plate, in $\alpha = 18^{\text{h}} 6^{\text{m}} 30^{\text{s}}$, $\delta = -31^{\circ} 50'$, is a dark, irregular spot (B 305) $13'$ in diameter. From it radiate dark streamers to the north for over $\frac{3}{4}^{\circ}$, and broken ones for $\frac{1}{2}^{\circ}$ to the southwest. In its lower part is the globular cluster N.G.C. 6569 (No. 536) which appears as a small star.

The whole star cloud is broken up with many rich structures which it would be difficult to describe. Nebulous matter seems to be spread through parts of this great cloud; but perhaps this appearance may be due to masses of extremely distant small stars.

The original negative, No. 241, was made at Mount Wilson.

$\alpha = 17^{\text{h}} 53^{\text{m}} 8.29^{\text{s}}$

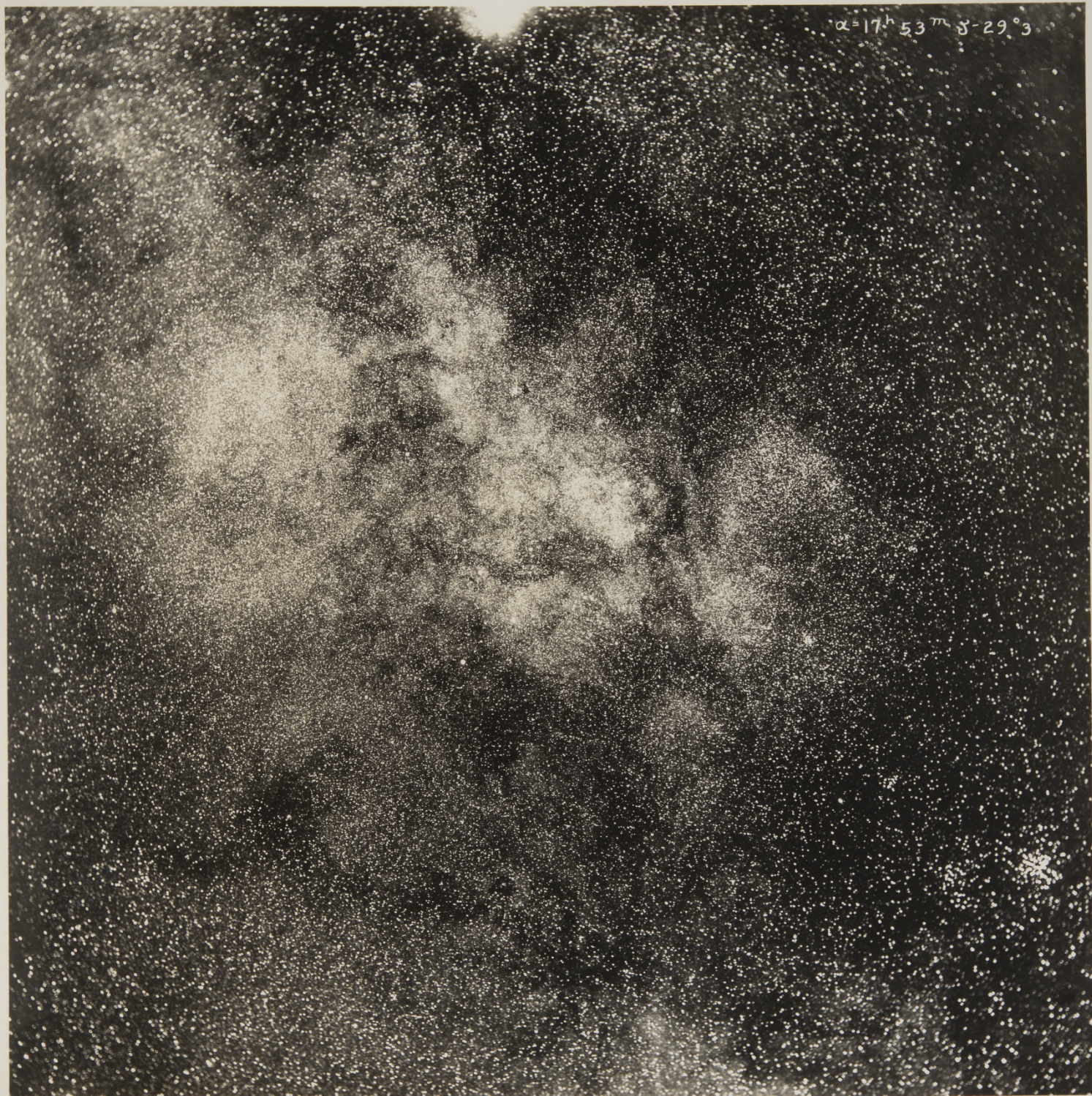


PLATE 27

GREAT STAR CLOUDS IN SAGITTARIUS

Right Ascension = $17^{\text{h}} 55^{\text{m}} 55^{\text{s}}$, Declination = $-29^{\circ} 0'$

PLATE 27

GREAT STAR CLOUDS IN SAGITTARIUS

$\alpha = 17^{\text{h}} 55^{\text{m}} 55^{\text{s}}$, $\delta = -29^{\circ} 0'$
1905 July 6.815

Galactic Long. = 330° , Lat. = -5°
Exposure = $3^{\text{h}} 58^{\text{m}}$

Scale: 1 cm = $21'9$, or 1 inch = $55'5$

[This plate was made from the same original negative as that used for Plate 26, but has been printed from a different working negative and has been somewhat enlarged. The center falls about 3^{m} farther east than on Plate 26. The quality of this print also differs from that of the preceding plate, being somewhat softer, and therefore showing better some of the details in the densest parts of the star clouds. The attentive student of this region, one of the finest in the Milky Way, will no doubt welcome this duplication as giving a better insight into this marvelous aggregation of stars.

Mr. Barnard did not write a separate description for this plate.

To illustrate the progressive improvement in the delineation and in the reproduction of this remarkable region we refer the reader to the following articles by Professor Barnard: *Monthly Notices of the Royal Astronomical Society*, **50**, 310, 1890, Plate 3; **59**, 354, 1899, Plate 7; *Astrophysical Journal*, **2**, 351, 1895, Plate 12; *Publications of the Lick Observatory*, **11**, Plates 49 and 50.

The original negative, as already stated, was made at Mount Wilson.]

$\alpha = 17^h 56^m 8.29^s$

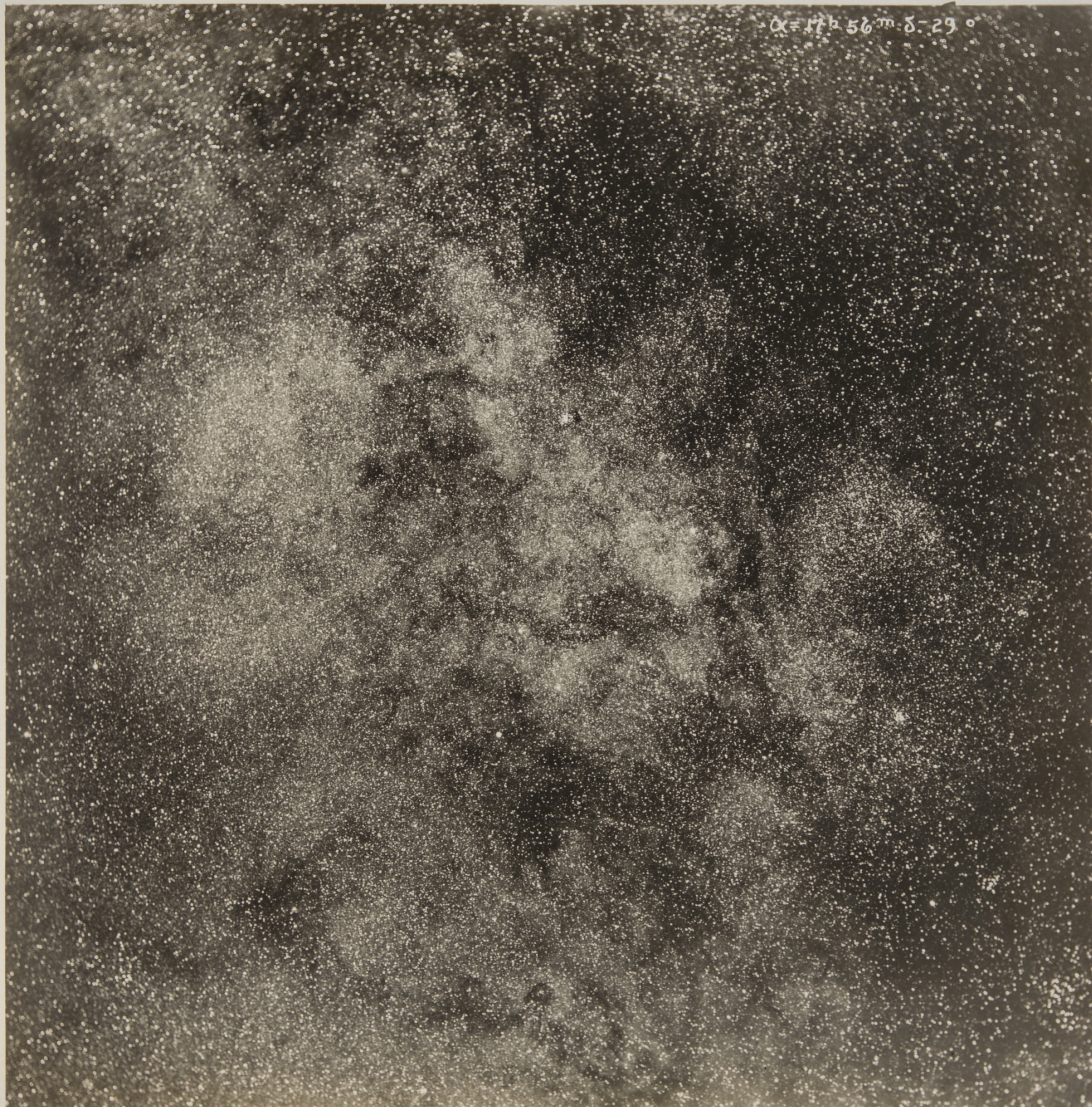


PLATE 28

REGION SOUTH OF THE GREAT STAR CLOUD IN SAGITTARIUS

Right Ascension = $17^{\text{h}} 56^{\text{m}} 20^{\text{s}}$, Declination = $-32^{\circ} 50'$

PLATE 28

REGION SOUTH OF THE GREAT STAR CLOUD IN SAGITTARIUS

$\alpha = 17^{\text{h}} 56^{\text{m}} 20^{\text{s}}$, $\delta = -32^{\circ} 50'$
1905 July 3.785

Galactic Long. = 326° , Lat. = -7°
Exposure = $4^{\text{h}} 30^{\text{m}}$

Scale: 1 cm = $15\frac{1}{4}$, or 1 inch = $39\frac{1}{2}$

The dark spot, B 87, which I have called the "parrot's head," is shown in the middle of the plate, with the beak to the left, and the eye formed by the star C.D. $-32^{\circ}13679$, of magnitude 9.3. This object, $12'$ in diameter, is in a bright and conspicuous part of the star cloud. Its northeastern part is remarkably well defined and sharp. There are a few faint stars scattered over it, while some dark structures radiate from the south side of the head, forming a "neck."

To the southwest of this object, in $\alpha = 17^{\text{h}}52^{\text{m}}20^{\text{s}}$, $\delta = -33^{\circ}20'$, is an irregular, broken, dark region (B 292) over $40'$ in diameter, that shows much structure of a soft nature, looking almost like nebulosity. It may perhaps consist of very small stars, too faint to be seen individually. This peculiarity is most strikingly shown in a small visual telescope. In my early comet-seeking, when sweeping over the Milky Way with a 5-inch telescope having a field of nearly 1° , I often wondered at the strangeness of this part of the sky. I am sure it would pay to photograph some of these structures, such as those shown here, with some of the large reflectors. Such a photograph would show whether what we see in these structures is nebulosity or only masses of very faint stars. In the lower part of this dark region is the star C.D. $-33^{\circ}12700$, of magnitude 7.4 (No. 483 in the list of stars for this plate in Part II).

Toward the left side of the picture, in $\alpha = 18^{\text{h}}6^{\text{m}}30^{\text{s}}$, $\delta = -31^{\circ}50'$, is an irregular, rather dark region (B 305) east of what appear to be two conspicuous stars. The northern of these is the

globular cluster N.G.C. 6569 (No. 536). From this dark form dusky streamers radiate to the north for nearly a degree, and similar ones for half a degree to the southwest. The impression is given of a streaming of the stars toward the dark region.

Above the center of the plate, in $\alpha = 17^{\text{h}}56^{\text{m}}$, $\delta = -31^{\circ}10'$, is an irregular dark region (B 295), $50'$ in diameter, which is full of rich, soft details of an apparently nebulous character. Really all the northwest quarter of the plate is full of such soft details suggestive of nebulosity.

In the upper part of the plate is the lower portion of the great star clouds of Plates 26 and 27. The bed of stars in the lower left quarter of the plate, and at other points, seems to be very thick. The scattered group of bright stars near the lower right corner is the cluster Messier 7. About 1° northeast of this cluster, in $\alpha = 17^{\text{h}}49^{\text{m}}$, $\delta = -33^{\circ}45'$, is a small bright spot or condensation of the Milky Way, $20'$ in diameter. Both of these last features are shown near the center of Plate 24 and have already been described in the text for that plate.

There is a tangle of several curves of small stars of equal brightness in $\alpha = 18^{\text{h}}1^{\text{m}}$, $\delta = -33^{\circ}40'$ (3.5 inches, 9.0 cm, from the left edge and 3.4 inches, 8.5 cm, from the lower edge of the print).

Besides the bright cloud forms, there is, over most of the plate, a general sprinkling of distinct stars which seem to be nearer to us than the clouds.

The original negative, No. 238, was made at Mount Wilson.

$\alpha = 17^{\circ} 56'$ $\delta = 32^{\circ} 53'$



PLATE 29

REGION IN SAGITTARIUS, NORTH OF THE GREAT STAR CLOUD

Right Ascension = $18^{\text{h}} 1^{\text{m}} 25^{\text{s}}$, Declination = $-21^{\circ} 15'$

PLATE 29

REGION IN SAGITTARIUS, NORTH OF THE GREAT STAR CLOUD

$\alpha = 18^{\text{h}} 1^{\text{m}} 25^{\text{s}}$, $\delta = -21^{\circ} 15'$
1905 July 26.760

Galactic Long. = 337° , Lat. = -2°
Exposure = $4^{\text{h}} 0^{\text{m}}$

Scale: 1 cm = 16'.6, or 1 inch = 42'.1

Among the many interesting features on this important plate is the star cloud in the upper left quarter, in which are situated the dark markings B 92 and B 93, and the dusky lanes extending from them toward the south.

The lower portion of this cloud, which is very sharply defined to the southeast, has an abrupt extension running south-east at nearly a right angle for almost 2° . This extension, so sharply defined on its easterly side which is bordered with nebulous tufts, consists of many small stars apparently imbedded in nebosity. The strongest part of this nebosity is $30'$ wide, but it extends in a fainter form indefinitely to the west and perhaps all over the plate. A considerable number of coarse stars mixed with it seem to be a part of the star cloud to the north. The evidence is quite strong on the original negative that this is real nebosity. For further information on these nebulosities see my article in *Astronomische Nachrichten*, **177**, 231, 1908.

The southeast edge of the cloud and the east side of the nebulous extension bound a relatively blank region in which is placed a group of nebulous stars, the principal one of which, B.D. $-19^{\circ}4953$ of magnitude 7.6 (No. 557 of the list in Part II), is surrounded with bright, diffused nebosity $15'$ in diameter.¹ Scattered areas of very diffused nebosity are feebly shown in this darker region, especially in the vicinity of the star just named, and north of it.

The cluster in the upper right corner is Messier 23. Two degrees east of this cluster is an almost vacant region (B 297) several degrees long.

Messier 8 and the Trifid nebula are shown in the lower right quarter of the plate. A faint extension of nebosity from Messier 8, nearly a degree wide, runs east for about $1\frac{1}{2}^{\circ}$, where it

brightens up and involves a smaller group of nebulous stars.² In the eastern part of this nebosity is an abrupt, dark bay (B 91), open to the east, in which the planet Uranus happened to be located on this date (see also Plate 30). The structural details in the bright parts of Messier 8 and the Trifid, which are clearly shown in the original negative, are lost on the print.

There are several cases in which considerable stars are apparently in ellipses or partial ellipses of smaller stars. A noticeable one is the fourth-magnitude star B.D. $-21^{\circ}4908$ (No. 539, 1.5 inches to the left of the center of the print) which, though not located in the apparent focus of the ellipse, is near it. Still another case is a small star, B.D. $-23^{\circ}14017$, magnitude 8.6 (No. 530), in the group of nebulous stars east of Messier 8, which lies on the east edge of what appears to be a parabola of small stars.

Other curves and chains of stars are easily picked out on the plate. Running southwesterly from the immediate vicinity of the dark spot, B 92, are several striking lines. One of these can be traced as a straight line for at least $1\frac{1}{2}^{\circ}$, from about $\alpha = 18^{\text{h}}4^{\text{m}}$, $\delta = -19^{\circ}25'$ to $\alpha = 18^{\text{h}}0^{\text{m}}$, $\delta = -20^{\circ}25'$. Some $25'$ to the north of this, and almost parallel with it, is a similar but shorter line of stars. They both can be traced northeast, nearly to the black spots. These peculiarities are best seen by holding the picture obliquely and looking along the line of stars. There are two shorter, diverging lines of brighter stars running west and south, respectively, from a point in $\alpha = 18^{\text{h}}6^{\text{m}}10^{\text{s}}$, $\delta = -18^{\circ}50'$ (3 inches, or 7.6 cm, from the left edge and 1.3 inches, or 3.4 cm, from the upper edge of the print). They do not quite join at their origin. For a better account of these striking lines of stars see *Publications of the Lick Observatory*, **11**, Plate 54.

The original negative, No. 256, was made at Mount Wilson.

¹ One of the stars of this group, B.D. $-19^{\circ}4946$ (No. 554), is listed as N.G.C. 6595. N.G.C. 6590 is the same object, with an error in the right ascension given. N.G.C. II 4700 also refers to this same star (see *Astronomische Nachrichten*, **130**, 77, 233, 1892 and **177**, 231, 1908).

² See *Publications of the Lick Observatory*, **11**, Plates 51 and 52; also *Astronomische Nachrichten*, **130**, 233, 1892 and **177**, 231, 1908.

$\alpha = 18^{\text{h}} 1^{\text{m}} 8.21^{\text{s}}$

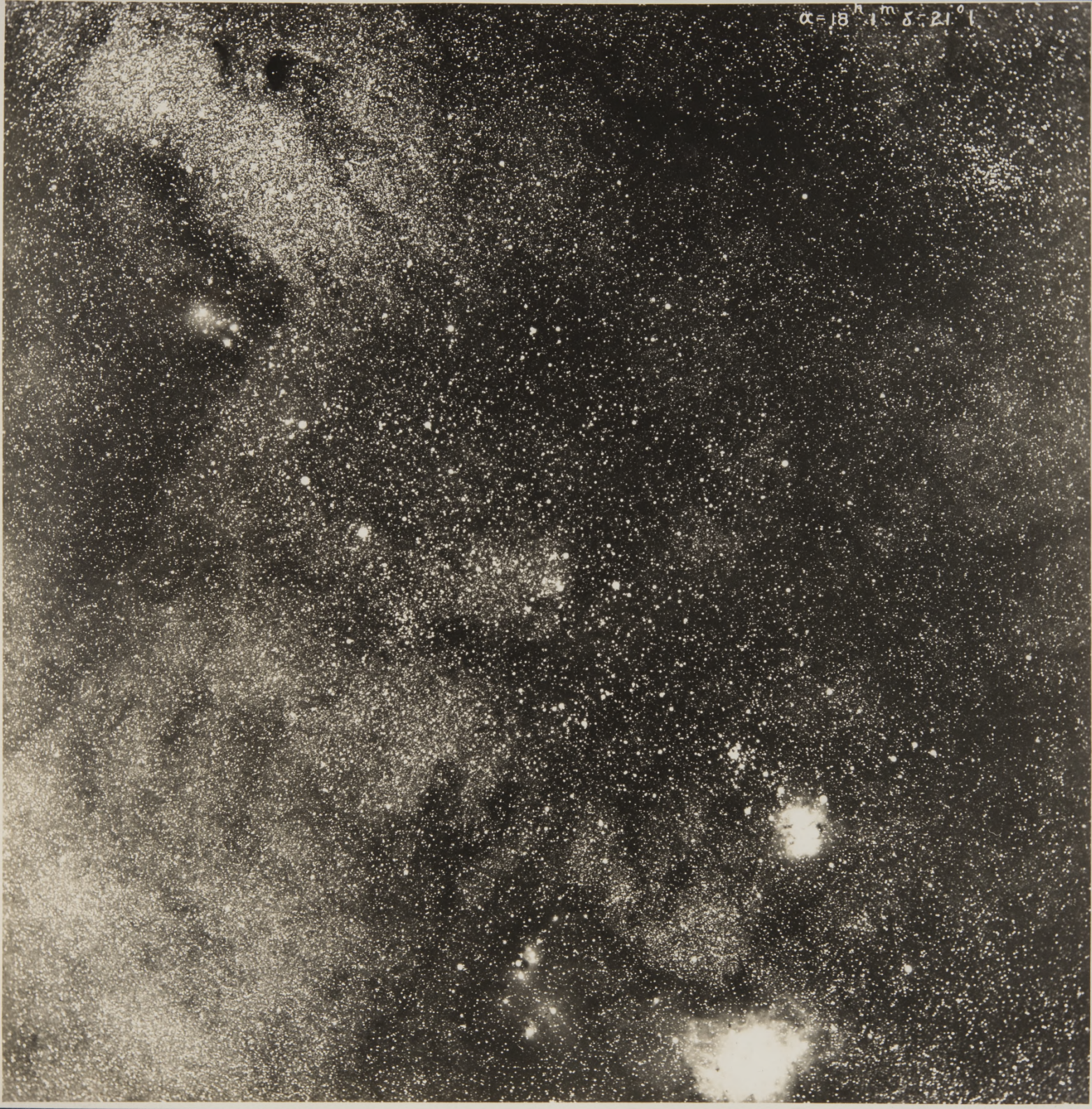


PLATE 30

A REGION IN SAGITTARIUS

Right Ascension = $18^{\text{h}} 3^{\text{m}} 20^{\text{s}}$, Declination = $-25^{\circ} 40'$

PLATE 30

A REGION IN SAGITTARIUS

$\alpha = 18^{\text{h}} 3^{\text{m}} 20^{\text{s}}$, $\delta = -25^{\circ} 40'$

1905 July 27.762

Galactic Long. = 333° , Lat. = -4°

Exposure = $4^{\text{h}} 5^{\text{m}}$

Scale: 1 cm = $15'.9$, or 1 inch = $40'.4$

This fine region lies north of the great star clouds in Sagittarius (Plates 26 and 27) and includes, in its upper right quarter, Messier 8 and the Trifid nebula. Messier 8 is in a thinly covered region among these clouds, some of which are close to it on the west.

On the original negative the details in Messier 8 are very clear and beautiful. Two of the remarkable, small, sharp, black spots are shown in the print, B 88 in the north edge of the nebula and B 89 southeast of the center. In the south edge of the nebula are two sharp indentations; the western projection produced by these is bordered by a narrow black strip, B 296, 6' long and 1' wide. There are many small bright stars near the middle of the nebula but these, together with most of its details, are effaced on the print because of the heightened contrast necessary to bring out the fainter nebulosities in this region. Some of the black markings in the Trifid, in the upper right corner, are shown, especially the two striking ones in the east and west edges.

All the region for several degrees about Messier 8 is covered with a slightly uneven film of nebulosity—especially to the east. The broad, faint extension of nebulosity running eastward from Messier 8 is better shown in Plate 29. The brightening of this nebulosity in the vicinity of the star C.D. $-24^{\circ}13962$ (No. 521), of magnitude 7.8, is well shown on the original negative. It does not condense about the star, which seems to be accidentally projected upon it. About 3' southeast of this star is a very black spot in the nebulosity (B 303), about 1' in diameter. It is lune-shaped—convex to the east. A similar, less definite, but smaller spot (B 302) is about 1' north of the star. In this nebulosity are several other dark markings. Twelve minutes to the southeast are two stars, C.D. $-24^{\circ}13984$ (No. 524) and $-24^{\circ}13985$ (No. 525), of magnitudes 9.1 and 10. These stars appear as a single

image on the print. They are involved in an irregular but small nebulosity, which has a dark rift north and another east of the stars. About 25' north of this nebulosity is the group of nebulous stars already referred to in the description for Plate 29. It will be noticed that the planet Uranus (No. 526) occupies a slightly different position in the dark bay in the nebulosity from that in Plate 29.

Northeast of Messier 8, in $\alpha = 17^{\text{h}}58^{\text{m}}50^{\text{s}}$, $\delta = -24^{\circ}0'$, are the stars C.D. $-23^{\circ}13906$ (No. 510) and $-23^{\circ}13908$ (No. 511), of magnitudes 9.7 and 8.3. The first named of these stars, C.D. $-23^{\circ}13906$, is in a nebulous strip extending northwest and southeast, sharp on the west edge but diffused to the east.

Near the lower right corner, in the large star cloud, is the small black spot B 86, with the small cluster N.G.C. 6520 just east of it. A very small, well-defined, black spot, B 90, is located 0.9 inches, or 2.2 cm, from the middle of the lower edge of the print. It is elliptical, 3' in diameter north and south, and is in an irregular, dusky space 13' in diameter.

The arrangement of the stars in the lower left quarter of the plate gives the impression of a possible drift toward the northwest, but this feature is not marked. The brightest part of the globular cluster Messier 28, near the east edge of the plate, is 2.7 in diameter.

Four defects have occurred in some of the prints for this plate. Three of them are irregular white spots, while the fourth looks like a star image. They are located with respect to the right-hand and lower edges of the print as follows: 3.1 inches (7.9 cm), 2.2 inches (5.6 cm); 3.15 inches (8.0 cm), 2.1 inches (5.3 cm); 3.95 inches (10.0 cm), 2.1 inches (5.3 cm); 4.1 inches (10.5 cm), 2.4 inches (6.1 cm).

The original negative, No. 257, was made at Mount Wilson.

α 18 h 4 m 5.25 6

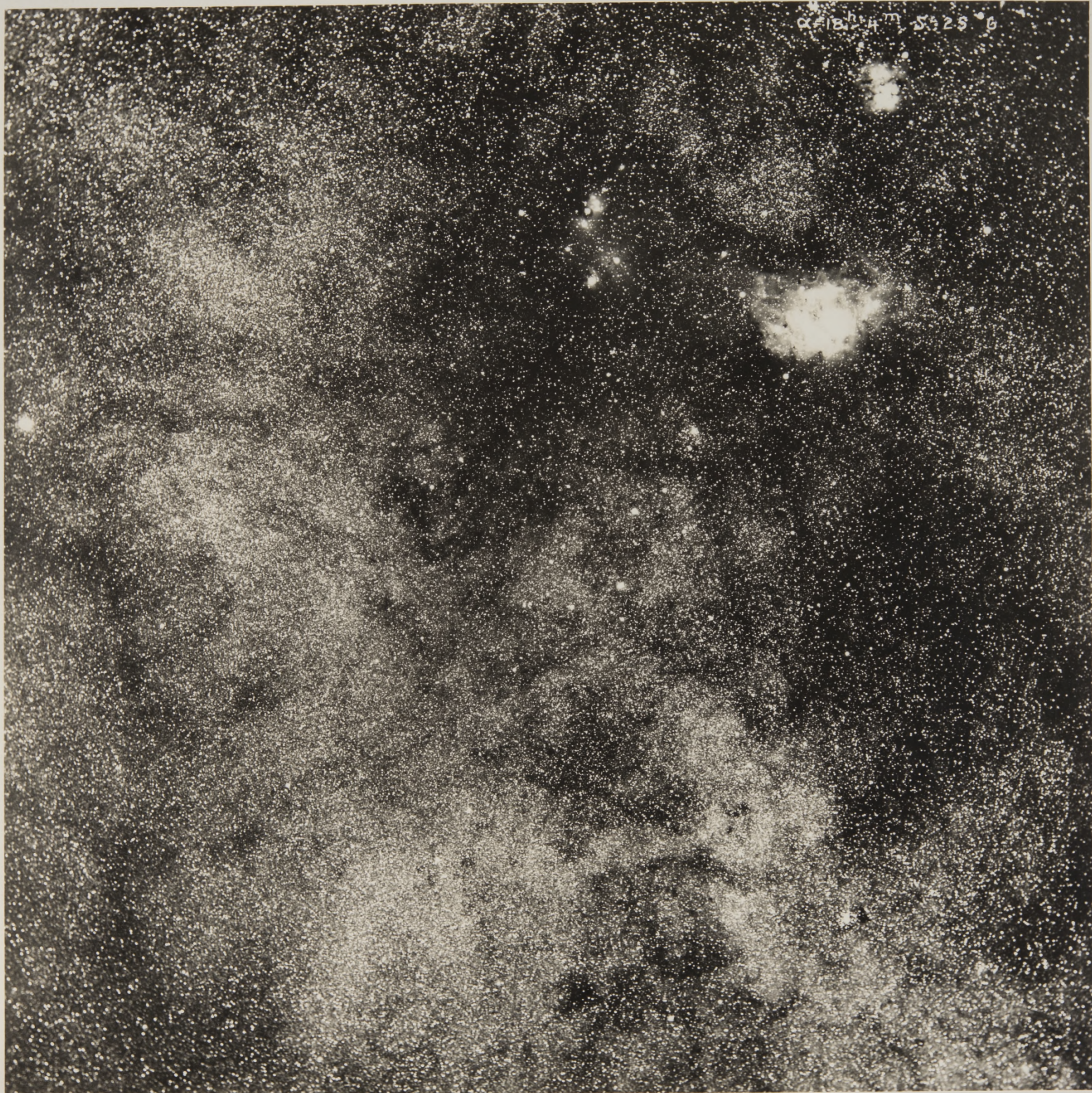


PLATE 31

SMALL STAR CLOUD IN SAGITTARIUS

Right Ascension = $18^{\text{h}} 9^{\text{m}} 30^{\text{s}}$, Declination = $-18^{\circ} 42'$

SMALL STAR CLOUD IN SAGITTARIUS

$\alpha = 18^{\text{h}} 9^{\text{m}} 30^{\text{s}}$, $\delta = -18^{\circ} 42'$
1905 July 31.767

Galactic Long. = 340° , Lat. = -2°
Exposure = $4^{\text{h}} 30^{\text{m}}$

Scale: 1 cm = $16\frac{1}{3}$, or 1 inch = $41\frac{1}{4}$

This splendid star cloud, with its dark spots and lanes, with its straight and curved lines of stars, is well shown on this plate. The region to the northwest of it apparently consists of a relatively very thin stratum of stars. Perhaps the irregular dark spot B 297, at the right side of the plate, in $\alpha = 17^{\text{h}} 57^{\text{m}}$, $\delta = 18^{\circ} 45'$, is a fragmentary opening in this star stratum. The same may be said of the region near the upper right corner. The star cloud itself is worthy of further description than was given in Plate 29. It is really small compared with some of the other clouds of the Milky Way. The northeast end, so abruptly terminated, is 1° across. The upper edge of the cloud blends into a poorer part of the Milky Way that bridges the space between this and some feebler clouds 2° to the north. The east and southeast edges are abruptly terminated. The sharply defined extension running for 2° to the southeast is almost at right angles to the outline of the cloud. The conspicuous black spot in the upper part of the cloud is No. 92 of the list of dark objects. The eastern edge of this spot is very sharp cut and definite. If drawn with a brush and India ink it could not be any more definite. In it is a twelfth-magnitude star with a faint companion close west of it (see *Astrophysical Journal*, **38**, 496-501, 1913). The two lines of considerable stars which have their origin near this spot stretch toward the southwest corner of the plate.

On the original negative the sharp angular extension to the southeast from the lower part of the star cloud consists of a thin sheet of feeble nebulosity mixed with stars. The stronger part of this nebulosity is $30'$ broad and its full length nearly 2° . It extends in a fainter form indefinitely to the west, covering all the western part of the plate. Over the dark region is a thin stratum of stars and a very feeble background of nebulosity, gradually increasing in star density to the east where it merges into a relatively strong region of dim star clouds. About $20'$ north of the nebulous star B.D. - 19°4953 (No. 557), which is conspicuous in the dark region, an irregular mass of faint but stronger nebulosity streams eastward and north for about 1° .

A very important fact shown by a careful examination of the original negatives in connection with the black spots in the star cloud is that the entire cloud is permeated with the same diffused nebulosity that forms the abrupt sheet running southeast from its lower part. Indeed, the entire plate is covered with this film

of nebulosity. It is this nebulosity mixed with the stars that gives such prominence to the star cloud, for the cloud itself has relatively few stars in it compared with the great clouds farther south in Sagittarius. A close examination of the larger of the dark spots (B 92) shows that its conspicuousness is not due entirely to the background of stars, but to the projection of the dark body against this nebulous stratum. On examining the original negative with a slight magnifying power, it is clearly seen that the east edge of the spot, so sharply defined, is free of stars, and that the dark object is projected against this faint nebulosity, and not against a background of stars. For some little distance its eastern outline does not touch any star, but is strongly defined against the feeble nebulosity itself. Indeed, this spot is the darkest part of the entire plate. To avoid any prejudice, a mask was made with two holes in it the size of the dark object so that a portion of the partly blank region south of the group of nebulous stars, which is apparently one of the darkest parts of the plate, could be directly compared with it. When thus compared on the original negative it was seen at once that the spot was half as dark again as any other part of the plate. This proves what was already decided, that the spot is much darker than any other part of the sky shown here. This fact can best be appreciated when the beautiful details of the original negative are examined. Much of this soft and delicate beauty is necessarily lost in the reproduction. Examination of the corresponding negative made with the 6-inch lens confirms the fact that the entire region within a radius of at least 6° of this star cloud is covered with feeble nebulosity, and there are suggestions that it extends very much farther to the south.

Many small dark lanes are seen both east and west of the star cloud. Some are curved, some irregular, and some straight, but all are of the same width—about $2'$.

The upper part of the plate contains the Omega nebula, Messier 17, whose nebulosity extends north and south for $50'$ and east and west $37'$. Two small stars (Nos. 564 and 565), $20'$ northwest of Messier 17, are involved in a very small, irregular nebulosity.¹ One degree to the west of Messier 17 is an irregular mass of small stars 1° in diameter that seems to be filled with a stronger part of the nebulosity that covers the plate.

The original negative, No. 263, was made at Mount Wilson.

¹ [It would seem that the stars referred to in the descriptions for N.G.C. II 4706 and 4707 are B.D. - $16^{\circ} 4812$ ($9^{\text{m}}2$) and - $16^{\circ} 4813$ ($9^{\text{m}}4$). This identification is not correct. They should be B.D. - $16^{\circ} 4811$ ($9^{\text{m}}1$) and - $16^{\circ} 4812$ ($9^{\text{m}}2$).]

$\alpha = 18^{\text{h}} 8^{\text{m}} 5.18^{\text{s}}$

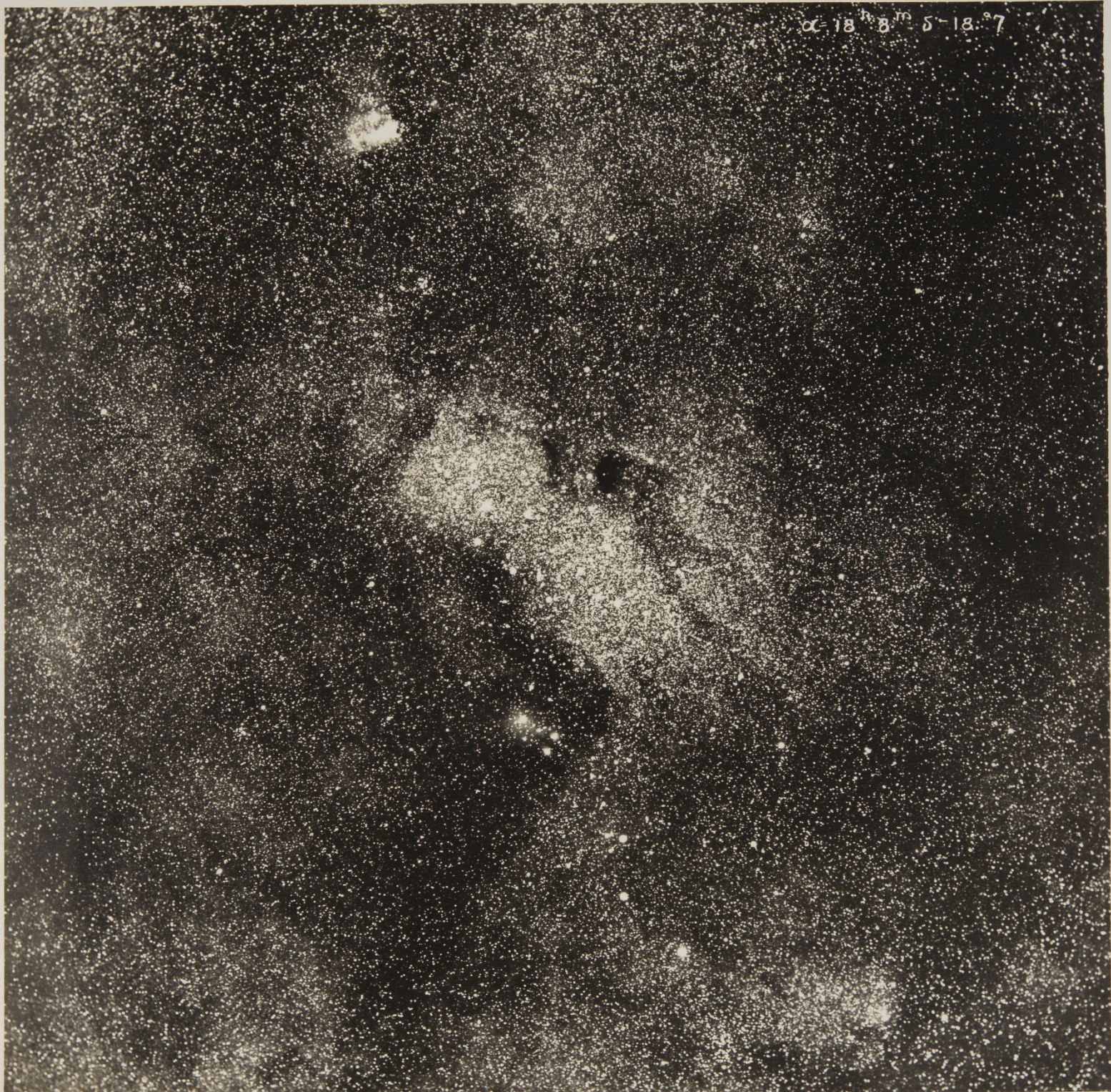


PLATE 32

REGION IN SAGITTARIUS, SOUTHEAST OF THE SMALL STAR CLOUD

Right Ascension = $18^{\text{h}} 17^{\text{m}} 20^{\text{s}}$, Declination = $-20^{\circ} 15'$

PLATE 32

REGION IN SAGITTARIUS, SOUTHEAST OF THE SMALL STAR CLOUD

$\alpha = 18^{\text{h}} 17^{\text{m}} 20^{\text{s}}$, $\delta = -20^{\circ} 15'$

1905 July 22.735

Scale: 1 cm 15'.8, or 1 inch = 40'.0

Galactic Long. = 339° , Lat. = -4°

Exposure = $2^{\text{h}} 35^{\text{m}}$

This plate was intended to show the dark region immediately southeast of the small star cloud, and its relation to the clouds surrounding it to the east. Some of the features seen here are also shown in Plates 29 and 31.

Northeast of the center of the plate is a loose cluster of bright stars $35'$ in diameter, in $\alpha = 18^{\text{h}} 24^{\text{m}} 19^{\text{s}}$, $\delta = -19^{\circ} 14'$. This is Messier 25, which, though not in Dreyer's N.G.C., is given as No. 4725 in his *Second Index Catalogue*. The description, however, "Cl, pC," which is the abbreviation for "Cluster, pretty compressed," is erroneous. Just above the center of the print, in $\alpha = 18^{\text{h}} 17^{\text{m}} 20^{\text{s}}$, $\delta = -19^{\circ} 45'$, is a small group, $6'$ in diameter, of a few bright stars.

Attention has already been called to the black spots in the star cloud in the upper right part of the plate. A small black spot, B 311, $6'$ in diameter, is situated in the upper left quarter, in $\alpha = 18^{\text{h}} 23^{\text{m}} 10^{\text{s}}$, $\delta = -17^{\circ} 45'$. In the lower left quarter of the plate, in $\alpha = 18^{\text{h}} 25^{\text{m}} 48^{\text{s}}$, $\delta = -21^{\circ} 34'$, the dark marking B 99 is very well shown.

This plate is of interest also because it shows in a dark region east of its center the trail of an unknown comet. This comet was never seen on any other plates or by visual observation. Strangely enough the trail escaped detection while the writer was at Mount Wilson, and was not seen until a year later. The circumstances are more fully given in the *Astronomische Nachrichten*, **174**, 3-8, 1907. It was thought that the chances of its being a periodic comet warranted the publishing of a careful measure of its position. However, up to the time of the publication of this *Atlas* no notice has ever been published of its recovery.

The plate was slightly inside the focus, which makes the stars near the middle a little larger, relatively, than they should be.

A defect on the second negative, which might be mistaken for the image of a star, will be seen 1.3 inches, or 3.3 cm, from the lower edge and 2.3 inches, or 6 cm, from the left edge of the print.

The original negative, No. 252, was made at Mount Wilson.

$\alpha = 18^{\text{h}} 17^{\text{m}} \delta = 20^{\circ} 0'$

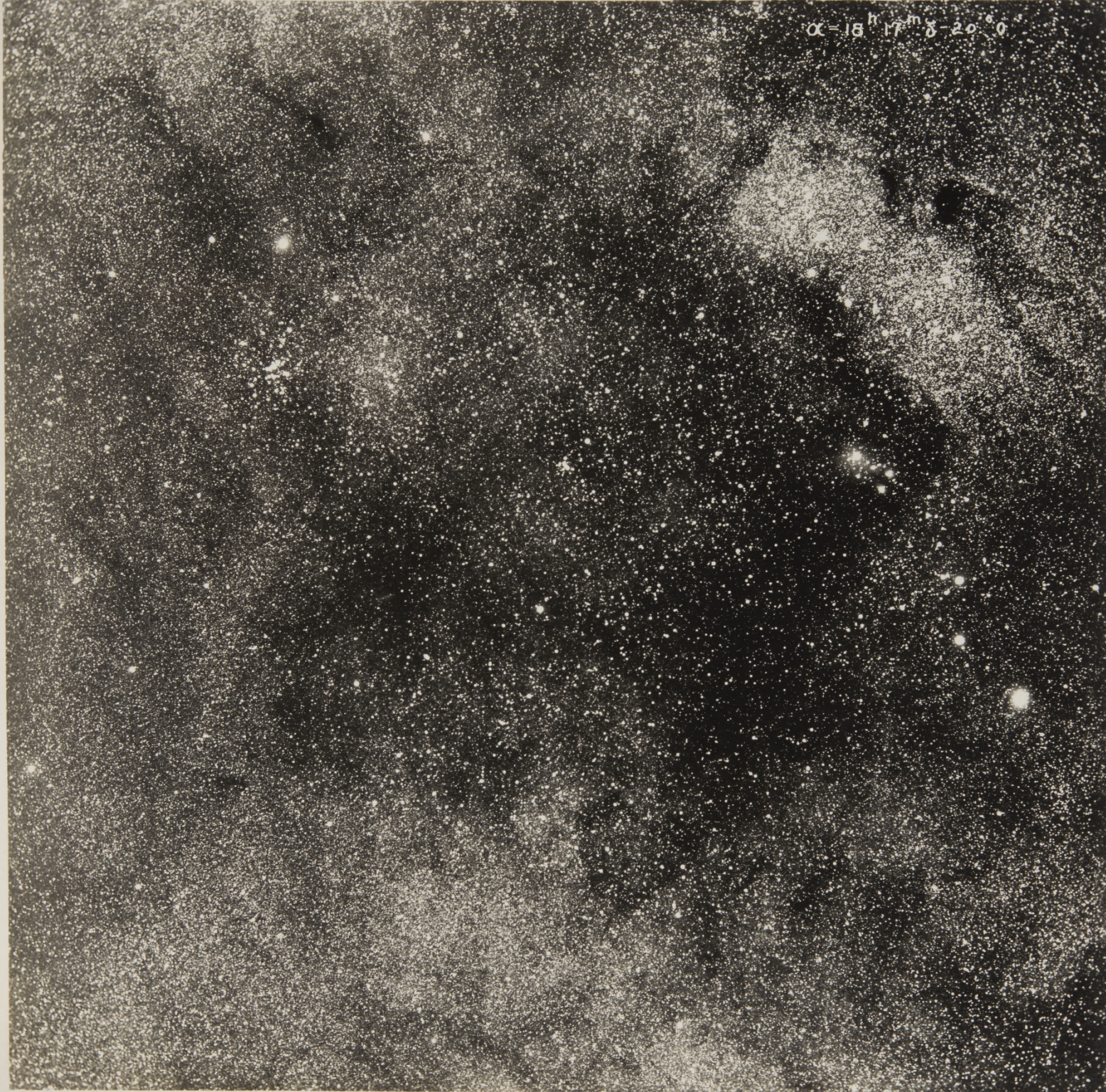


PLATE 33

REGION IN SAGITTARIUS

Right Ascension = $18^{\text{h}} 20^{\text{m}} 20^{\text{s}}$, Declination = $-25^{\circ} 10'$

PLATE 33

REGION IN SAGITTARIUS

$\alpha = 18^{\text{h}} 20^{\text{m}} 20^{\text{s}}$, $\delta = -25^{\circ} 10'$

1905 June 9.903

Galactic Long. = 335° , Lat. = -7°

Exposure = $3^{\text{h}} 18^{\text{m}}$

Scale: 1 cm = $16\frac{1}{6}$, or 1 inch = $42\frac{1}{6}$

This plate covers part of the eastern side of the great clouds of Sagittarius (Plates 26, 27, and 30). These cloud forms are made up of very small stars with a liberal sprinkling of brighter stars that appear to be nearer to us. The masses to the west are the brightest part of the great clouds. The eastern part of the plate is composed of broken structures with many dark details, some of which are extremely interesting. The photograph, unfortunately, is printed too dark, and many of the details which are well shown in the original negative are missing. In one of these dark regions in $\alpha = 18^{\text{h}} 25^{\text{m}} 31^{\text{s}}$, $\delta = -26^{\circ} 9'$ (3.0 inches, or 7.6 cm, from the left edge and 3.3 inches, 8.5 cm, from the lower edge of the print) is an object (B 98) that looks like a dark planetary nebula. It is small, black, 3' in diameter, and sharply defined. It does not show well here because the plate is overprinted. It is better shown in Plate IV of the *Astrophysical Journal* for January, 1919 (49, 1). The description applies more directly to the original negative where it is very distinct. There are many other small dark markings which it has not been thought necessary to describe.

The splendid globular cluster Messier 22, to the left of the center, is 23' in diameter including the fainter outlying stars. The more condensed portion is strongly elliptical in position

angle 24° and is $10\frac{1}{5}$ by $8\frac{1}{5}$ in diameter. The raylike sprays of small stars formed by the outliers—especially from the southerly part of the cluster—are beautifully shown. In the immediate region of the cluster are some narrow dark lanes.

What appears to be a slightly hazy star in $\alpha = 18^{\text{h}} 23^{\text{m}} 13^{\text{s}}$, $\delta = -25^{\circ} 35'$ (No. 601, about an inch below and to the left of the center of the plate) is the globular cluster N.G.C. 6638. To the right of the middle is the globular cluster Messier 28, which is also N.G.C. 6626. The diameter of the brighter part is 5'. There are few outliers. Its total diameter may be 8' or 9'.

In the upper right quarter of the plate is the planet Uranus (No. 559). Its image partly overlaps that of the star C.D. $-23^{\circ} 14' 19.5''$ (9^M1).

There are many strings and curves of stars, especially in the upper right quadrant. This plate, from overprinting, does not show this part of the sky as strongly as Plate 56 in Volume 11 of the *Publications of the Lick Observatory*, although the duration of exposure for the two plates was nearly the same. The sensitive film seems to have been very slightly inside the exact focus, which has a tendency to make the stars appear somewhat too large.

The original negative, No. 218, was made at Mount Wilson.

$\alpha = 18^{\text{h}} 20^{\text{m}} \delta = 25^{\circ} 0'$

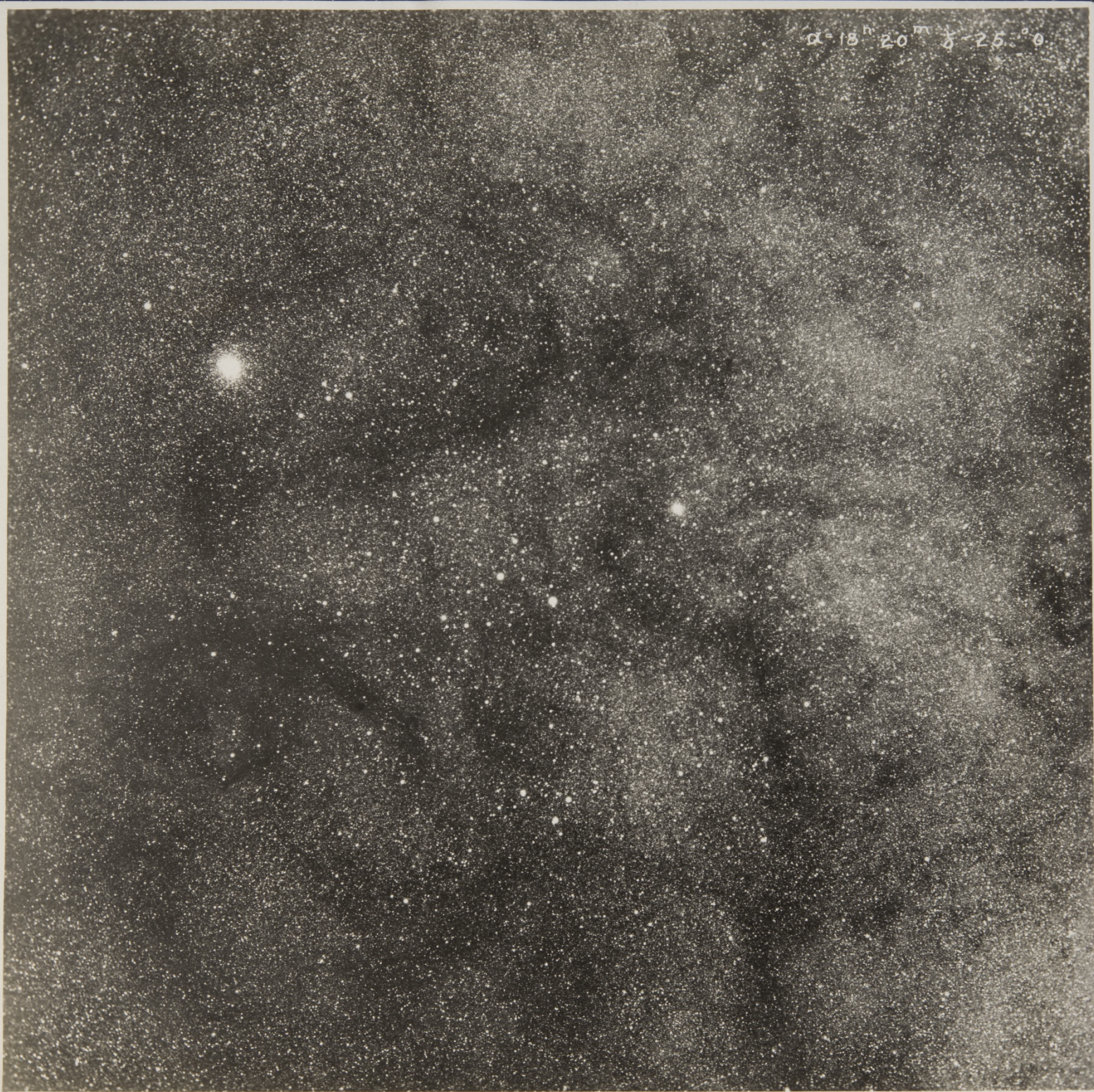


PLATE 34

IN AQUILA AND SAGITTARIUS

Right Ascension = $18^{\text{h}} 22^{\text{m}} 45^{\text{s}}$, Declination = $-14^{\circ} 12'$

PLATE 34

IN AQUILA AND SAGITTARIUS

$\alpha = 18^{\text{h}} 22^{\text{m}} 45^{\text{s}}$, $\delta = -14^{\circ} 12'$
1905 July 24.758

Galactic Long. = 345° , Lat. = -3°
Exposure = $3^{\text{h}} 52^{\text{m}}$

Scale: 1 cm = $20''.4$, or 1 inch = $51''.7$

This region lies west and south of the beautiful star cloud in Scutum shown at the center of Plate 37. In the upper part of the plate is the naked-eye star B.D. — $10^{\circ}4713$ (No. 605) of magnitude 5.5, which is densely nebulous. The nebulosity, some $15'$ in diameter and containing much detail, is not symmetrical about the star, a brighter portion extending for $15'$ to the northeast. Miss Agnes M. Clerke called attention many years ago to the fact that the star itself could not be of the spectral type early assigned to it at Harvard. It is placed in class B3 in the *Henry Draper Catalogue*. It lies in a partially vacant region some $2\frac{1}{2}^{\circ}$ in diameter from which an irregular, broad, curved, dark stream, diffused on its eastern side, runs southeast, forming the eastern border of a large, wedge-shaped cloud which extends northward nearly to the star. Below the middle of this cloud, in $\alpha = 18^{\text{h}}25^{\text{m}}$, $\delta = -15^{\circ}40'$, is a large dark area (B 312), very sharply defined at its northern edge and at the northwest side. It diffuses to the south and elsewhere. There is a heavy sprinkling of small stars all over it. It is almost elliptical in form, its diameter northwest and southeast being $1^{\circ}50'$ while the shorter diameter is $27'$. There is a less definite dark area to the east of it.

Messier 16, in the western part of the plate, is a mixture of stars and nebulosity which rather closely resembles the great nebula of Orion. The width of the nebulosity of this object, in a southwest by northeast direction, is nearly $30'$. It extends in a faint and irregular form from the bright part for perhaps 1° to the west and south. It also extends fully 1° to the east. Indeed, there seems to be diffused nebulosity everywhere in this region. South of this is Messier 17, the Omega nebula. This seems to lie partly on an area of small stars somewhat larger than itself, with a dark rift in its northeast side. The flat group of stars is roundish and about $40'$ in diameter. The nebula extends over these stars in a very diffused manner for $32'$ east and west and nearly as far north and south. Its western edge is very sharp with two small black spots touching it. The southern of these, placed between the nebula and a small group of rather bright stars, perhaps appears black only by contrast.

N.G.C. 6649 (No. 612), near the upper edge of the picture, is a very small cluster of considerable stars. Its position, $40'$ north-east of the large nebulous star, is $\alpha = 18^{\text{h}}26^{\text{m}}34^{\text{s}}$, $\delta = -10^{\circ}28'.9$. In the lower part of the plate, in $\alpha = 18^{\text{h}}25^{\text{m}}24^{\text{s}}$, $\delta = -16^{\circ}58'.5$, is the rather pretty cluster N.G.C. 6645 (No. 607). It is $22'$ in diameter and seems to have two condensations—neither being strong. It lies partly in a dimmer area of the Milky Way of about the size of the cluster itself. If away from the Milky Way, it would be a conspicuous and interesting object. No. 6647 in Dreyer's *Catalogue* does not exist. It must be an erroneous observation of this object, 6645, which is approximately in the catalogue position. There is no other cluster near.

About 2 inches, or 5 cm, to the right and below the nebulous star, is the large dark marking B 95. A little more than an inch above this is the dark spot B 94. Near the lower right corner of the plate are the two curious black spots B 92 and 93 (shown near the center of Plate 31).

In $\alpha = 18^{\text{h}}23^{\text{m}}10^{\text{s}}$, $\delta = -17^{\circ}45'$, near the middle of the lower edge of the plate, is a small, very black spot (B 311), $5'$ in diameter, extending northeast and southwest. It is in a large, dark, straggling strip that reaches irregularly to the dark region of the cluster N.G.C. 6645.

One cannot avoid the conclusion, when examining the original negative, that the entire plate is covered with a faint film of nebulosity. I have given a more extended description of this region in the *Astronomische Nachrichten*, **177**, 233, 1908, to which the reader is referred.

The difference between the visual and photographic magnitudes of stars of different spectral type is strikingly shown by the stars B.D. — $14^{\circ}5099$ (No. 608) and B.D. — $14^{\circ}5106$ (No. 611), which are situated in the southern part of the star cloud. Visually, they are almost equal in brightness. The inequality in magnitude on this photograph is very noticeable, and appears even greater than the difference of $1^{\text{m}}21$ taken from the *Henry Draper Catalogue*.

The original negative, No. 254, was made at Mount Wilson.

$\alpha = 18^{\text{h}} 23^{\text{m}} \delta = 14^{\circ} 2'$

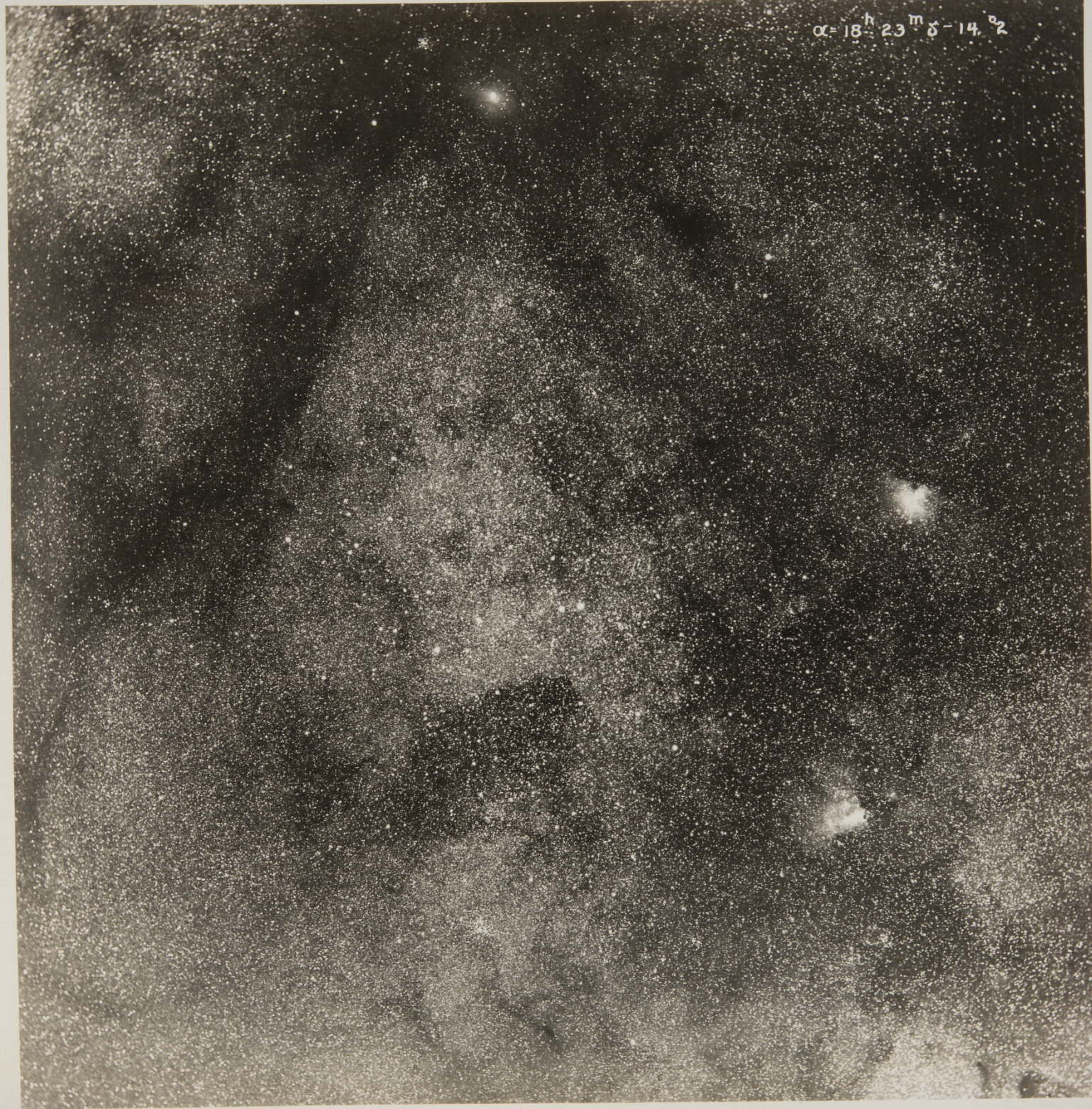


PLATE 35

REGION IN AQUILA AND SAGITTARIUS

Right Ascension = $18^{\text{h}} 29^{\text{m}} 55^{\text{s}}$, Declination = $-11^{\circ} 27'$

PLATE 35

REGION IN AQUILA AND SAGITTARIUS

$\alpha = 18^{\text{h}} 29^{\text{m}} 55^{\text{s}}$, $\delta = -11^{\circ} 27'$
1905 August 1.776

Galactic Long. = 349° , Lat. = -3°
Exposure = $5^{\text{h}} 0^{\text{m}}$

Scale: 1 cm = $19'.7$, or 1 inch = $50'.0$

A portion of the star cloud near Messier 11 occupies the northeast quarter of the plate, forming the easterly edge of the dark region in which is situated the bright nebulous star B.D. $-10^{\circ}4713$ (No. 605 on the diagram and in the list in Part II), and in which are many dark forms. Forty minutes to the northeast of the nebulous star is the small cluster N.G.C. 6649, like a small cloud of light in a vast sea of darkness. About a degree north of the cluster, in $\alpha = 18^{\text{h}}25^{\text{m}}50^{\text{s}}$, $\delta = -9^{\circ}14'$, is a dark, curved marking, B 100. In $\alpha = 18^{\text{h}}38^{\text{m}}22^{\text{s}}$, $\delta = -9^{\circ}31'$, situated in the rich region in the upper left quarter of the plate, is the cluster Messier 26 (N.G.C. 6694). Its denser part is $7'$ in diameter with apparently scattering outliers to a diameter of $20'$ or more.

N.G.C. 6664, a scattering cluster about $25'$ in diameter, is in $\alpha = 18^{\text{h}}29^{\text{m}}54^{\text{s}}$, $\delta = -8^{\circ}19'$ (0.9 inch, or 2.3 cm, from the middle of the upper edge of the plate). Fifty minutes southeast of this, in $\alpha = 18^{\text{h}}33^{\text{m}}0^{\text{s}}$, $\delta = -8^{\circ}35'$, is a small cluster or another intensification of the Milky Way, $10'$ in diameter, with a dark lane curv-

ing around the north and southeast sides. This is located on the print 1.2 inches (3 cm) from the upper edge and 3.7 inches (9.4 cm) from the left edge. Two degrees northwest of the nebulous star (B.D. $-10^{\circ}4713$) are several other slight condensations of stars. In $\alpha = 18^{\text{h}}19^{\text{m}}42^{\text{s}}$, $\delta = -9^{\circ}16'$ (1.7 inches, 4.3 cm, from the right edge and 2.1 inches, 5.3 cm, from the upper edge of the print) there is a considerable star (B.D. $-9^{\circ}4736$ = No. 590) with a chain of small stars running to the northwest for nearly $40'$, while a similar chain also runs from it to the southwest for $50'$. The appearance is striking, as if the star were on a parabolic curve of small stars $1\frac{1}{2}^{\circ}$ long.

Below the portion of the fine star cloud in Scutum shown in the northeastern part of the plate is a large dark region in which are situated some rather obscure star clouds that extend over a considerable area in a northwest and southeast direction. The dark spot B 95 is a noticeable feature near the right edge of the plate.

The original negative, No. 265, was made at Mount Wilson.

$\alpha=18^{\text{h}} 29^{\text{m}} 5-11^{\circ} 5$

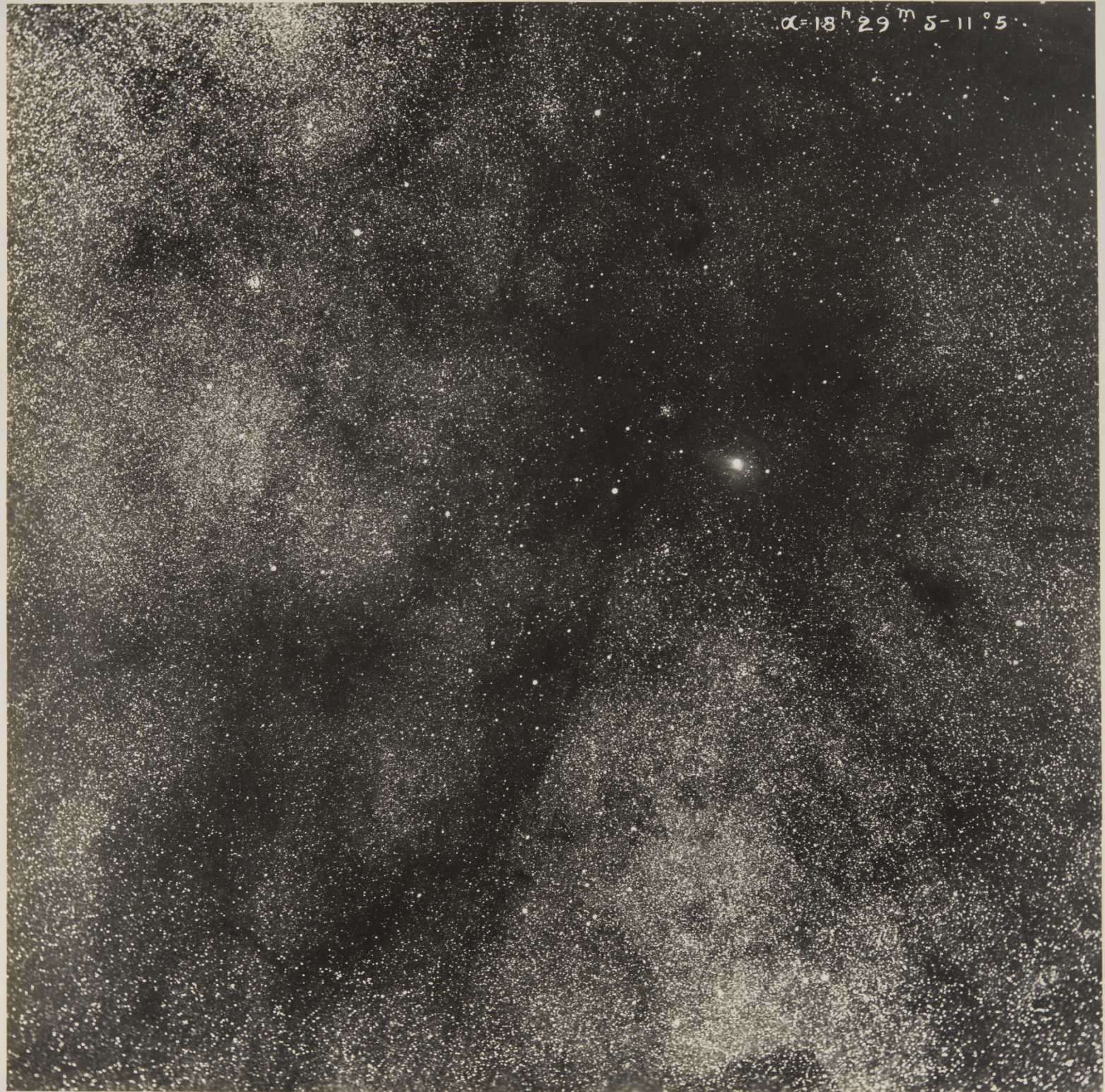


PLATE 36

REGION OF THE STAR CLOUD IN SCUTUM, NORTHERN PART

Right Ascension = $18^{\text{h}} 41^{\text{m}} 10^{\text{s}}$, Declination = $-4^{\circ} 45'$

PLATE 36

REGION OF THE STAR CLOUD IN SCUTUM, NORTHERN PART

$\alpha = 18^{\text{h}} 41^{\text{m}} 10^{\text{s}}$, $\delta = -4^{\circ} 45'$

1905 August 4.795

Scale: 1 cm = 17'.9, or 1 inch = 45'.6

Galactic Long. = 356° , Lat. = -2° ,

Exposure = $4^{\text{h}} 30^{\text{m}}$

The upper part of the splendid star cloud of Scutum, with the bright cluster Messier 11, is shown here. The partly vacant region just above Messier 11 is full of dark structures which are mostly lost in the printing. To the right of the large cloud, in $\alpha = 18^{\text{h}} 33^{\text{m}}$, $\delta = -4^{\circ} 50'$, is a small, isolated or detached cloud, 40' in diameter. It is composed of considerable stars, comparable with those in the main cloud. Possibly this was once a part of the greater cloud which in past ages has been slowly detached from it. On its western edge is the 6.8 magnitude star B.D. - $4^{\circ} 45' 18''$ (No. 626). Just free from the main cloud is a similar but smaller mass of stars, which is possibly now in the act of separating from the larger cloud.

There are several detached, or partly detached, masses in the upper part of the cloud, surrounding and near the bright star β Scuti (B.D. - $4^{\circ} 45' 52''$, of magnitude 4.5). Two of these masses, in form, suggest a ram's horns, with the star as the head. The first of these, in $\alpha = 18^{\text{h}} 40^{\text{m}}$, $\delta = -4^{\circ} 45'$, extends about 35' east and west and 15' north and south. The star (B.D. - $4^{\circ} 45' 52''$) is involved in its southeast end. The other mass is in $\alpha = 18^{\text{h}} 42^{\text{m}}$, $\delta = -4^{\circ} 35'$. It is round, about $\frac{1}{2}^{\circ}$ in diameter, with an extension running southwest to the bright star.

There are other detached masses, especially a very small one 5' in diameter in $\alpha = 18^{\text{h}} 36^{\text{m}} 20^{\text{s}}$, $\delta = -4^{\circ} 15'$ and a similar one in $\alpha = 18^{\text{h}} 34^{\text{m}} 20^{\text{s}}$, $\delta = -4^{\circ} 10'$. These small groups of stars are about $\frac{1}{2}^{\circ}$ northeast of the detached cloud first mentioned.

In the east half of the plate, northeast of Messier 11, are several bright patches of stars which roughly form a broken part of the upper portion of the great cloud. They also give the im-

pression of having become detached from the larger cloud. In these are many black spots.

There is some little indication that Messier 11 is in the great cloud, though probably it is nearer to us. It cannot be farther away or it would be hidden by the cloud. The brighter portion of the cluster is 11' in diameter, while the diameter of the feebler limits is about 30'. Close below Messier 11 is a straight, horizontal, ill-defined, dark line (B 318), $1\frac{1}{2}^{\circ}$ long and uniformly about 2' wide, which seems to be due mainly to a line of small stars at its lower edge. This remarkable dusky lane is illusive in some positions but is strongly shown by tilting the west side of the picture, inclining it some 60° or 80° from the horizontal and looking along the direction of the lane. The approximate position of the west end of this very curious object is $\alpha = 18^{\text{h}} 40^{\text{m}}$, $\delta = -6^{\circ} 30'$, and of the east end $\alpha = 18^{\text{h}} 46^{\text{m}}$, $\delta = -6^{\circ} 35'$.

To the southeast of Messier 11, a straggling dark streak, with its center at $\alpha = 18^{\text{h}} 46\frac{1}{2}^{\text{m}}$, $\delta = -7^{\circ} 12'$, has an extent north and south of 45'. In this broken strip are the small dark objects B 114, 115, 116, 117, and 118.

Two defects on the print, each resembling the image of a considerable star, are located, one, 3.9 inches (10 cm) from the right edge and 2.1 inches (5.3 cm) from the lower edge, and the other, 3.1 inches (7.9 cm) from the right and 0.5 inch (1.1 cm) from the upper edge. Another sharp white spot occurs on some of the prints. Its position is 4.4 inches (11.1 cm) from the left edge of the print and 3.2 inches (8.2 cm) from the upper edge.

The original negative, No. 270, was made at Mount Wilson.

$\alpha = 18^{\text{h}} 39^{\text{m}} \delta = 4^{\circ} 5'$

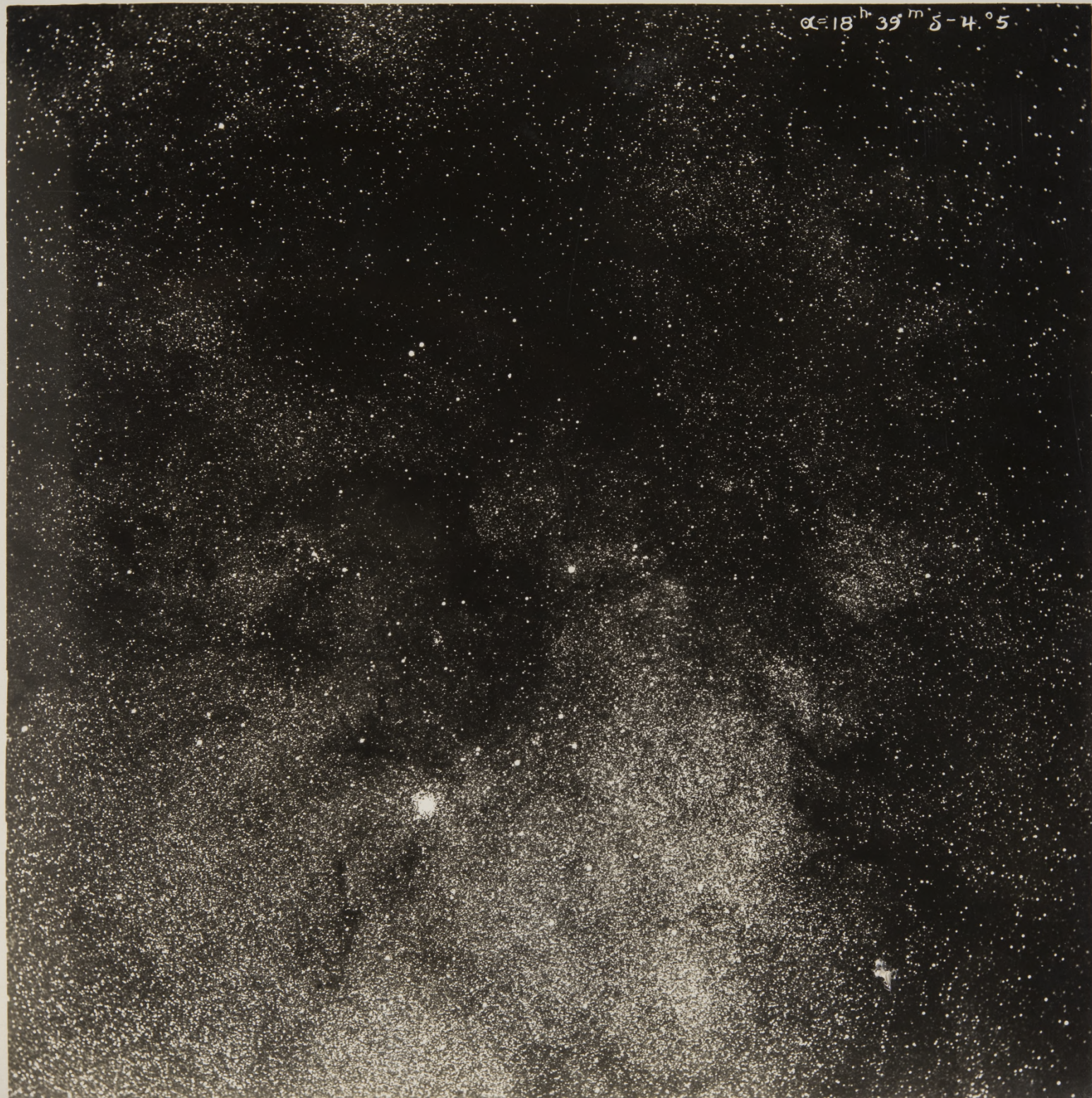


PLATE 37

THE GREAT STAR CLOUD IN SCUTUM

Right Ascension = $18^{\text{h}} 44^{\text{m}} 50^{\text{s}}$, Declination = $-7^{\circ} 5'$

PLATE 37

THE GREAT STAR CLOUD IN SCUTUM

$\alpha = 18^{\text{h}} 44^{\text{m}} 50^{\text{s}}$, $\delta = -7^{\circ} 5'$
1905 July 30.788

Galactic Long. = 354° , Lat. = -4°
Exposure = $5^{\text{h}} 30^{\text{m}}$

Scale: 1 cm = 28.0 , or 1 inch = 71.1

This, the gem of the Milky Way, is the finest of the star clouds. It is interesting from many points of view. The main body is apparently made up of extremely minute stars. The great hammer-like head, however, looms up to the west with much coarser stars, as if it were much nearer to us. In looking at this great cloud one cannot imagine that it is anything but a real cloud in form, with a depth comparable with its width. The serrated edge of the right side resembles the southern edge of the nebula Messier 8. The original negative gives the impression that these serrations are possibly due to dark, obscuring matter.

This beautiful object presents a more uniform surface, in general, than most of the other star clouds. For this reason it serves well as a background against which intermediate opaque or non-luminous objects may be seen. A number of dark spots are so projected against the upper portion of its bright surface. The most striking of these are just above or north of Messier 11. Although one feels uncertain as to the nature of these objects, there are others, especially in the upper left quarter and to the left of the middle of the plate, that are clearly opaque bodies seen against the bright star stratum. One of these, B 133 (1.2 inches, or 2.8 cm, from the left edge of the plate), is especially striking and convincing. It looks like a small, dark comet, with a tail curving to the north.

On the upper part of the "neck" of the cloud is the beautiful cluster Messier 11. Its stars are crowded into a bright mass by the long exposure, but the outlying members are distinctly visible. The extreme diameter of the cluster is $35'$ or perhaps more. The globular cluster N.G.C. 6712 (No. 658, about 2 inches below and slightly to the left of Messier 11) is projected on a bright portion of the cloud. It is evidently nearer to us

than the bright surface against which it is seen. It is quite evident that most of the globular clusters in the Milky Way are nearer to us than the background of faint stars against which they are seen, or they would be hidden by this dense screen of small stars.

Immediately above Messier 11 is a great, dark, crescent-shaped form (B 111) nearly 2° in diameter as measured in a northeast direction. The convex side of the crescent is to the northwest. To the southeast it diffuses to nearly a half-moon in shape. In this crescent-shaped region is a complicated system of small, well-defined, dark spots. A number of these are listed in the catalogue of dark objects given in the Introduction to this volume.

In the upper part of the "head" of the great cloud is the star β Scuti (B.D. $-4^{\circ}4582$ = No. 645 in the list of stars in Part II) from which two curved structures of stars seem to radiate. The northeastern one of these appears to overlap part of the dark crescent mentioned.

To the extreme east and at the corners of the plate the stars are larger, through a want of flatness of the field. These poorly defined portions have been included to make the picture more complete. This, however, does not account for the apparent coarseness of the stars in the great head of the cloud, for they are really larger. At the lower right corner is the bright nebulous star B.D. $-10^{\circ}4713$ (No. 605), shown also on Plates 34 and 35.

Two defects that might easily be mistaken for stars occur on this plate. One of these will be found 3.9 inches, or 10 cm, from the right edge and 2.5 inches, 6.5 cm, from the lower edge of the print. The other is 1.1 inches, or 2.8 cm, from the left edge and 3.4 inches, 8.6 cm, from the lower edge.

The original negative, No. 262, was made at Mount Wilson.

$\alpha 18^{\circ} 44' 57.2''$

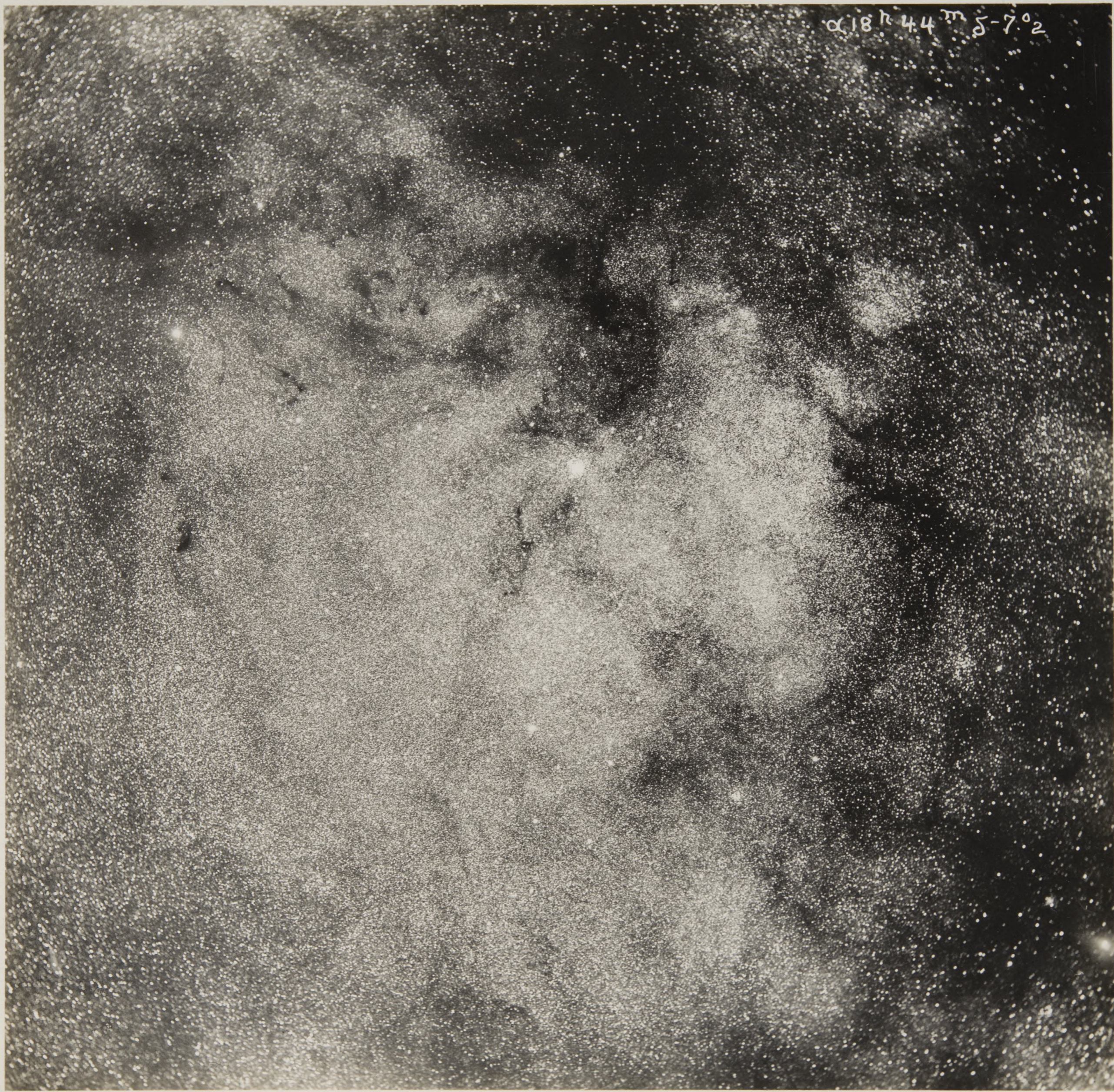


PLATE 38

REGION IN AQUILA, WESTERN PART

Right Ascension = $18^{\text{h}} 53^{\text{m}} 15^{\text{s}}$, Declination = $-1^{\circ} 0'$

PLATE 38

REGION IN AQUILA, WESTERN PART

$\alpha = 18^{\text{h}} 53^{\text{m}} 15^{\text{s}}$, $\delta = -1^{\circ} 0'$

1905 July 9.908

Galactic Long. = 1° , Lat. = -3°

Exposure = $3^{\text{h}} 5^{\text{m}}$

Scale: 1 cm = $23'6$, or 1 inch = $60'0$

This photograph is north of and joins Plate 37. The contrast between the great density of the stars in the east part of the plate and the paucity of those in the west is very effective and makes a beautiful picture.

The large angular mass of stars west of the center, in $\alpha = 18^{\text{h}} 46^{\text{m}}$, $\delta = -1^{\circ} 0'$, gives the impression of separating from the greater masses toward the east. It is apparently projected against the blackness of space, which seems to be covered here by only a thin sheet of considerable stars. This thin stratum perhaps does not have a very great depth, for the stars in it do not differ greatly in brightness. It was in this thin stratum that the brilliant Nova Aquilae appeared on June 8, 1918. The present photograph was made thirteen years before the outburst. The position of the nova is $\alpha = 18^{\text{h}} 42^{\text{m}} 31^{\text{s}}.9$, $\delta = +0^{\circ} 26'.8$. It is shown on the print 0.18 inch, or 0.5 cm, to the right of and 0.25 inch, or 0.6 cm, below the star B.D. $+0^{\circ} 40' 27$ (No. 650). From its position in this partially vacant region, it would seem that the chances of collision (one of the theories to account for its outburst) would be very small compared with a position in the dense star cloud itself.

There is comparatively little in the way of lines and curves of stars in the thin region to the northwest—a rather unusual feature, for such peculiarities seem to be more noticeable in just such regions.

In the upper left corner a portion of the sky included is in the region of bad definition where the star images are large. This must be taken into consideration in any comparison of the relative brightness and number of the stars in different parts of the plate.

An interesting feature in the lower part of the plate is a rather wide, fan-shaped sheeting of small stars extending $36'$ toward the north from the star B.D. $-3^{\circ} 44' 60$ (No. 674) of magnitude 5.7. This star (1.1 inches, or 2.8 cm, from the lower edge of the print) and the small ones north of it look something like a comet with a bright nucleus and widely diverging, fan-shaped tail. (The small, round, dusky spot shown on some of the prints 0.4 inch, or 1 cm, above and slightly west of this star is due to a defect on the second negative. It is not on the original negative.)

Some of the dark spots of Plate 37 are visible near the lower

edge of the present plate. One of these, B 126, with an extension to the south, resembles a cocoanut tree bent by a strong wind from the west. This object is shown at the middle of the lower edge of the print. North of it, and slightly west, in $\alpha = 18^{\text{h}} 50^{\text{m}} 50^{\text{s}}$, $\delta = -3^{\circ} 35'$, is a dark parallelogram (B 323), $17'$ north and south, with a star of 9.2 magnitude (B.D. $-3^{\circ} 44' 23$) west of the center.

Near the bottom of the plate (about 2 inches, or 5 cm to the left of the middle), in $\alpha = 19^{\text{h}} 1^{\text{m}}$, $\delta = -4^{\circ} 7'$, is an irregular gray spot, not black. It is B 135 and is destitute of stars except for one of the ninth magnitude (B.D. $-4^{\circ} 46' 98$) in its north edge. Two other stars are on its south limit. This gray mass without stars is also noticeable on Plate 37. In all this immediate region the stars seem to shine on a gray background, which does not look like distant stars. Indeed, a peculiar feature of the main cloud, especially in the lower part of it, is that all the markings are of a more or less light-gray color. Some of them are gray and starless but have very black spots in them. This is well shown by spots B 127 and 129 (shown on Plate 37), which are in a gray, starless area larger than the spots themselves.

The star B.D. $-3^{\circ} 44' 39$ (No. 665), of magnitude 7.4, is just on the inner edge of a sharply defined, dark loop, B 324, that sweeps around it from the southwest, then runs south and slightly east from it for $30'$. This loop is of uniform width—less than $2'$. The southeast end is in $\alpha = 18^{\text{h}} 54^{\text{m}} 0^{\text{s}}$, $\delta = -3^{\circ} 25'$, while the west end is in $\alpha = 18^{\text{h}} 52^{\text{m}} 50^{\text{s}}$, $\delta = -3^{\circ} 20'$. So peculiar and striking is this object that it is thought worthy of special attention. The star is located on the photograph 2 inches, or 5 cm, from the middle of the lower edge.

In the large star mass west of the middle of the plate, in $\alpha = 18^{\text{h}} 45^{\text{m}} 30^{\text{s}}$, $\delta = -1^{\circ} 25'$, is a peculiar, thin, curved dark marking (B 319), $7'$ long, with a line of small stars near its middle. A portion of the "lizard" of Plate 40 (B 138) is visible against the east middle edge of the plate.

In the lower left part of the plate, in $\alpha = 18^{\text{h}} 59^{\text{m}}$, $\delta = -3^{\circ} 0'$, is a strong asteroid trail (No. 681). It is $150''$ long and is inclined 45° to the parallel, northeast or southwest. It is located on the print 2.5 inches, or 6.4 cm, from the left edge and 2.0 inches, 5.1 cm, from the lower edge.

The original negative, No. 244, was made at Mount Wilson.

$\alpha 18^h 52^m 5.1^s$

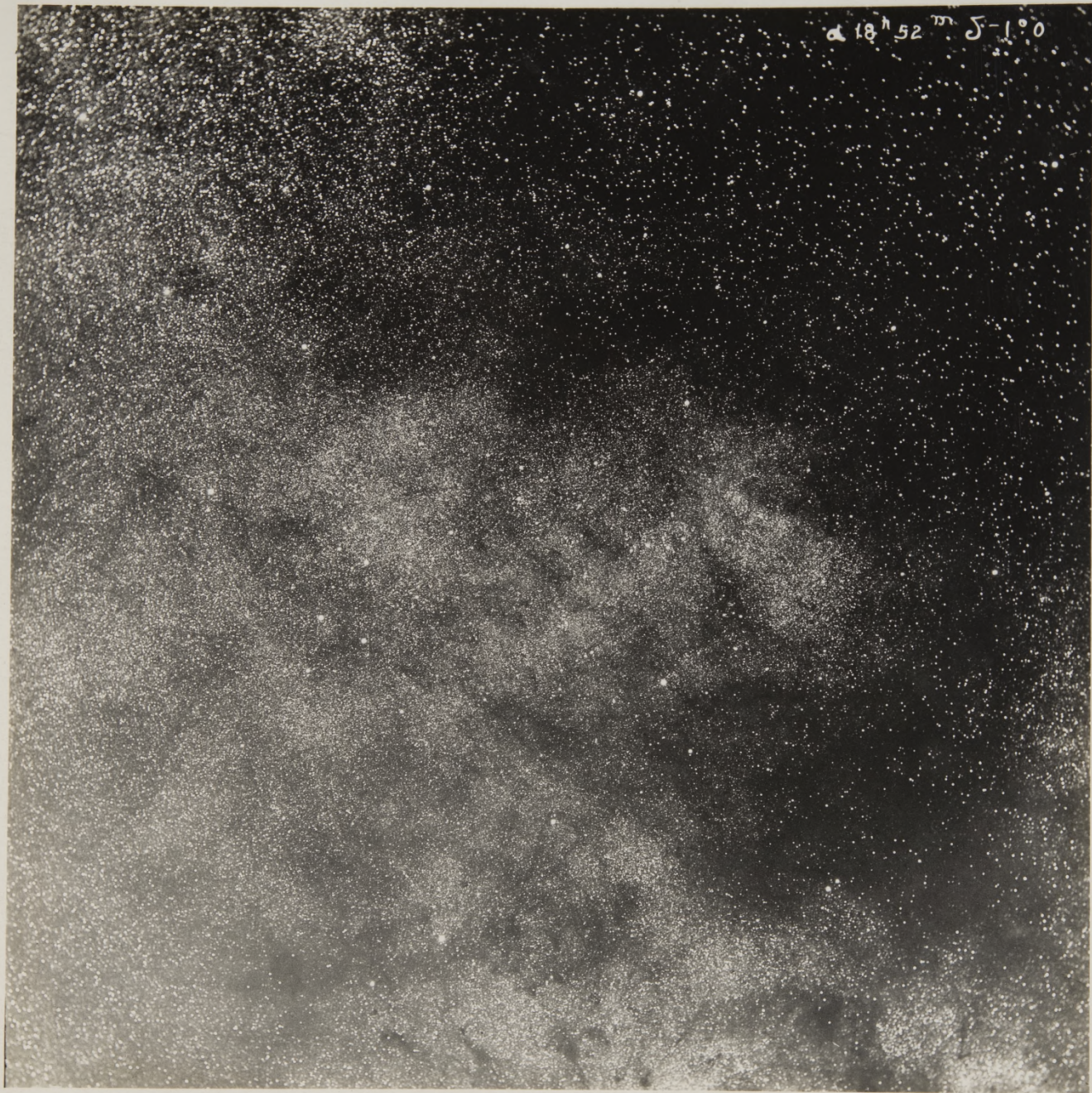


PLATE 39

REGION IN AQUILA

Right Ascension = $18^{\text{h}} 58^{\text{m}} 30^{\text{s}}$, Declination = $-5^{\circ} 25'$

PLATE 39

REGION IN AQUILA

$\alpha = 18^{\text{h}} 58^{\text{m}} 30^{\text{s}}$, $\delta = -5^{\circ} 25'$

1908 June 25.769

Galactic Long. = 357° , Lat. = -7°

Exposure = $4^{\text{h}} 5^{\text{m}}$

Scale: 1 cm = $23\frac{1}{4}$, or 1 inch = $59\frac{1}{4}$

This photograph, which is printed a little too heavily, is of the region northeast of Messier 11, which is seen near the right edge. The plate partially overlaps Plates 36, 37, and 38. The main features seem to center in a dark, irregular, almost vacant space about $40'$ in diameter just above the middle of the photograph. In this space are the dark objects B 135 and B 136. There are many dark forms in this region and to the right. The black "palm tree," B 126, also shown and described in Plate 38, is conspicuous just to the right of the center. The dark spot B 133 is noticeable below the middle of the print. In the upper left corner is an elongated dark spot, B 139. It is cometary in form,

18' long, with a well-defined head $4'$ in diameter, and diffuses to the northwest. It is very much like B 133. This spot (B 139) is at the southern end of B 138, which is shown on Plate 40.

The third-magnitude star Lambda Aquilae is conspicuous slightly above and to the left of the center of the plate.

The trail of a bright asteroid is shown 3.1 inches, or 8.0 cm, from the right edge and 3.6 inches, or 9.0 cm, from the upper edge of the print. The length of the trail is about $2\frac{1}{5}$, and its direction very slightly north of east or south of west.

The original negative, No. 455, was made at the Yerkes Observatory.

$\alpha = 18^{\text{h}} 58^{\text{m}} 5^{\text{s}}$

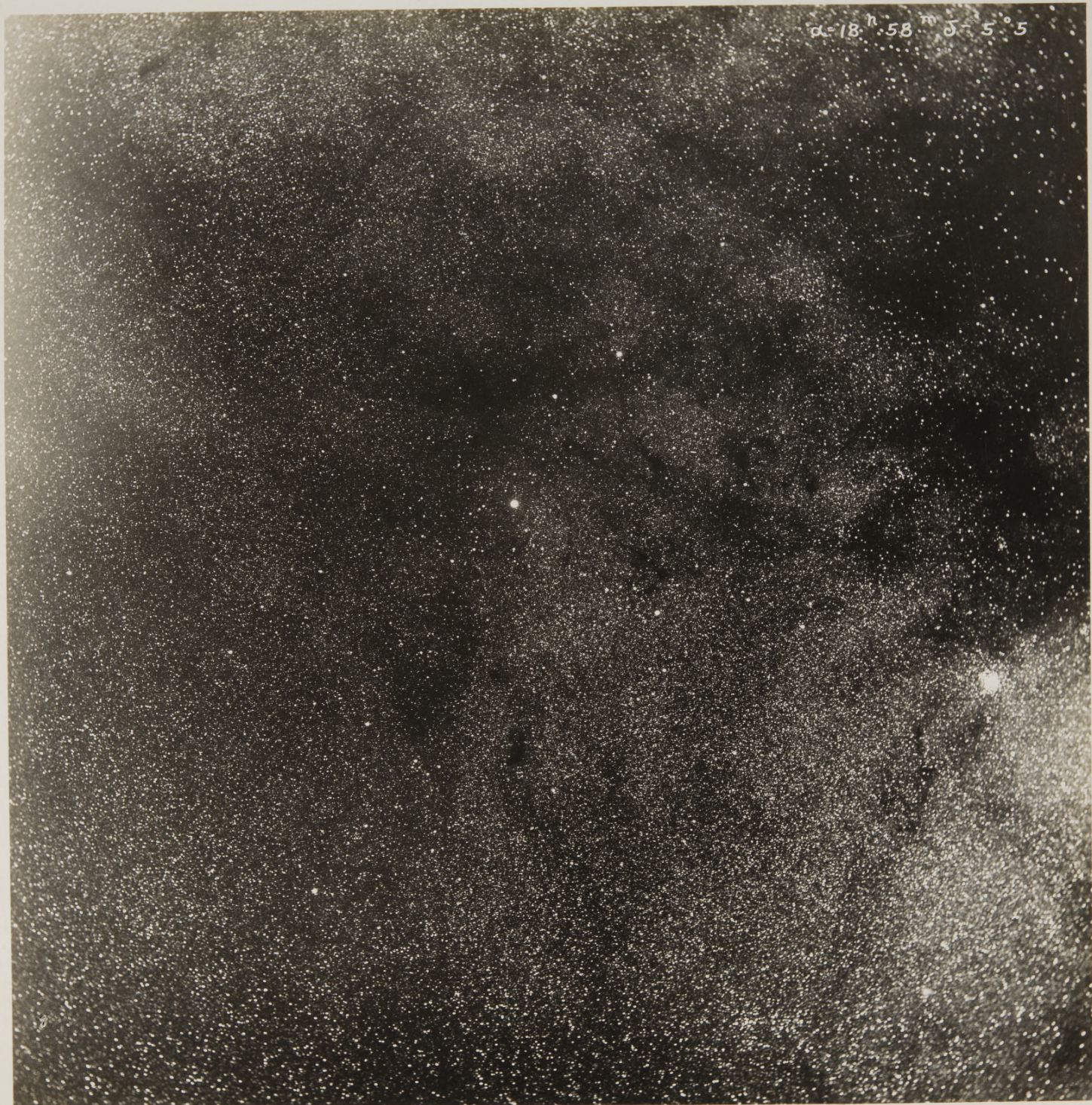


PLATE 40

IN AQUILA, NORTHEAST OF THE STAR CLOUD IN SCUTUM

Right Ascension = $19^{\text{h}} 6^{\text{m}} 50^{\text{s}}$, Declination = $+0^{\circ} 35'$

PLATE 40

IN AQUILA, NORTHEAST OF THE STAR CLOUD IN SCUTUM

$\alpha = 19^{\text{h}} 6^{\text{m}} 50^{\text{s}}$, $\delta = +0^{\circ} 35'$

1905 July 8.885

Scale: 1 cm = 15'.8, or 1 inch = 40'.2

Galactic Long. = 3° , Lat. = -6°

Exposure = $4^{\text{h}} 0^{\text{m}}$

This plate consists of regions of unequal brightness where the cloud forms are not very large or very marked. It is probable that there is one large cloud, more or less broken up into smaller bright areas.

Perhaps the most interesting object is the large, curved, dark marking, B 138, stretching over most of the southeast quarter of the plate, finally curving toward the southeast and ending in a sharp, black spot. Its eastern side is quite definitely outlined while the western side is everywhere more or less diffused. The stars immediately west of it are relatively fainter. They seem to be thinned out and dimmer but gradually increase in brightness as the distance from the dark, curved figure increases, until they roll up into irregular clouds to the west. The curved object, averaging 10' in width, looks like a great, black lizard crawling south. Its body is curved toward the west, and its head is the sharply defined black spot B 139. The "lizard" even has legs, one of which is a sharp, dark projection, B 137, that ends in $\alpha = 19^{\text{h}} 9^{\text{m}} 30^{\text{s}}$, $\delta = -1^{\circ} 35'$. If this curious form were stretched out straight its entire length would be 4° . At the bend in the body are several black streaks or streamers running

toward the northwest. The most pronounced of these connects with the main body in $\alpha = 19^{\text{h}} 8^{\text{m}} 30^{\text{s}}$, $\delta = -0^{\circ} 35'$ and runs to the northwest for about 25'. But the strange part is that the "head" is imbedded in a continuation of the thick stratum of stars lying to the east, and which passes to the west, apparently behind the black "head," to join the brighter clouds in the southwest part of the plate.

B 141, a dark spot 16' in diameter, north of the end of the tail of the "lizard," is probably only a thin place in the star stratum.

The clouds in the southwestern and northern portions consist of brighter stars than the average on this plate, perhaps due to their being nearer to us.

Slightly to the right of and above the middle of the plate, in $\alpha = 19^{\text{h}} 4^{\text{m}} 49^{\text{s}}$, $\delta = +0^{\circ} 50'$, is the object N.G.C. 6760 (No. 690), which Pease has shown with the 5-foot reflector of Mount Wilson to be a globular cluster of about one thousand stars. Its resemblance to a cluster is readily shown in the original negative of the present plate by its close outlying stars.

The original negative, No. 243, was made at Mount Wilson.

$\alpha = 19^{\text{h}} 7^{\text{m}} \delta + 0^{\circ} 5$

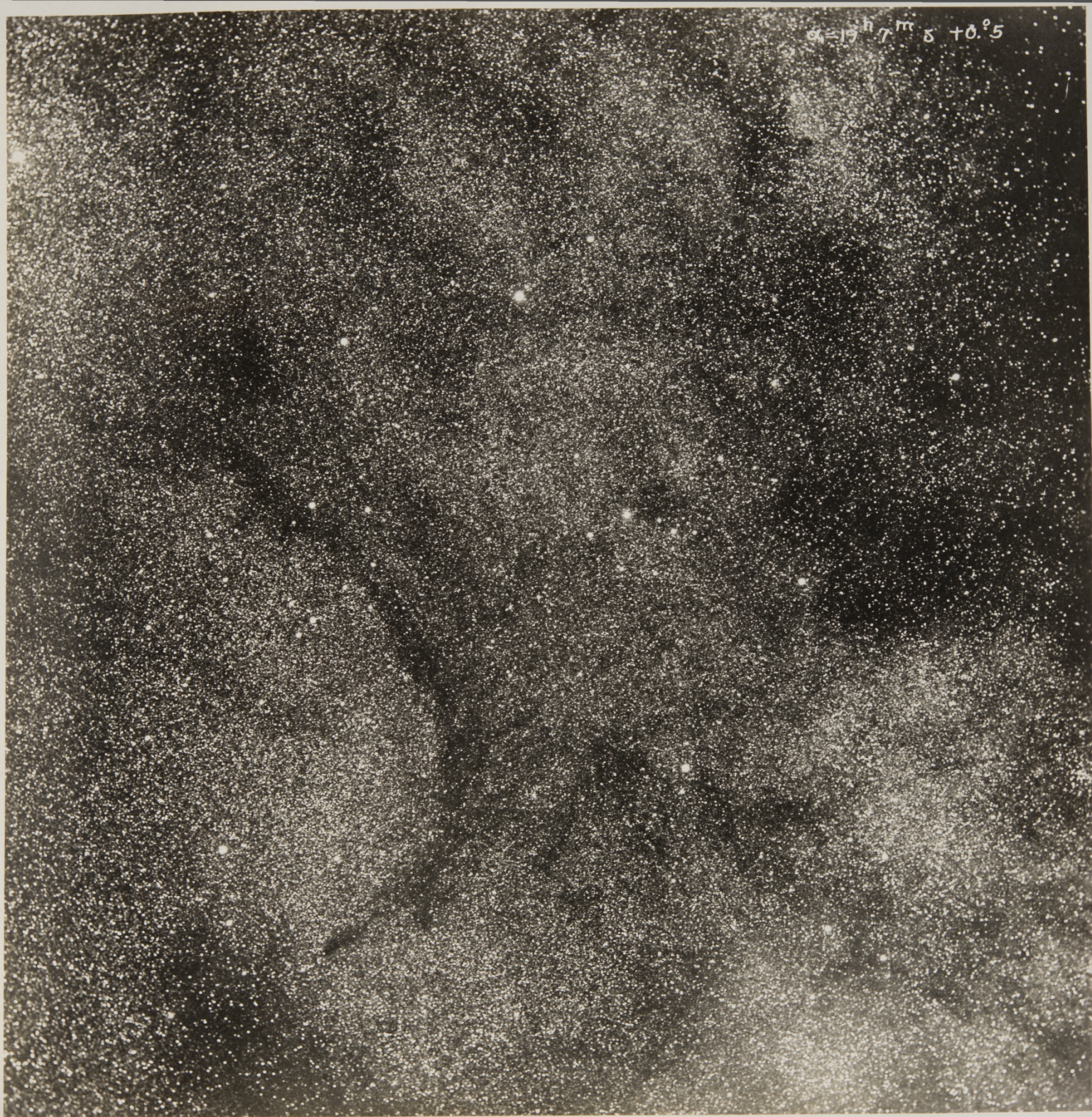


PLATE 41

IN AQUILA, NORTHWEST OF ALTAIR

Right Ascension = $19^{\text{h}} 30^{\text{m}} 25^{\text{s}}$, Declination = $+10^{\circ} 50'$

PLATE 41

IN AQUILA, NORTHWEST OF ALTAIR

$\alpha = 19^{\text{h}} 30^{\text{m}} 25^{\text{s}}$, $\delta = +10^{\circ} 50'$
1905 August 27.772

Galactic Long. = 16° , Lat. = -6°
Exposure = $4^{\text{h}} 5^{\text{m}}$

Scale: 1 cm = $24'.4$, or 1 inch = $62'.0$

The first-magnitude star Altair, in the lower left part of the plate, lies in a specially dense stratum of small stars in which are some very curious dark markings. In its immediate region on this plate the stars appear coarser, but this is mainly because it is in the region of poor definition causing slightly larger images. Near the right lower corner, on the edge of the great cloud, is a headlike projection of stars $1^{\circ}40'$ in diameter. This somewhat closely resembles the great "head" of the star cloud in Scutum shown on Plate 37.

The dark markings are perhaps the most important features of the plate. The fact that they occur in so rich a region of the sky, where the depth of the star stratum must be very great, leads to the belief that they are not real vacancies penetrating through the entire cloud, but that they are more probably obscuring matter of some kind. These spots were shown on my earliest photographs made at the Lick Observatory. It was on a plate of this region, taken on October 12, 1892, that the trail of Comet V 1892—the first comet discovered by photography—was impressed (see Plates 71 and 101, *Lick Observatory Publications*, 11, 1913).

One inch (2.5 cm) above the middle of the lower edge of the plate is a very small black spot, B 335, which looks like a defect, but is not. It is probably of the same nature as the larger ones just mentioned. It can hardly be a hole through the star cloud.

Along the western edge of the cloud are many interesting,

irregular, dark lanes having a uniform width of about $2'$ or $3'$. These are especially striking in $\alpha = 19^{\text{h}}23^{\text{m}}$, $\delta = +10^{\circ}25'$, where they cover a space over 1° wide and form a rather complicated system of twistings and turnings of dark lanes. This region (B 333) is $2\frac{1}{2}$ inches, or 6 cm, from the right edge and 4 inches, or 10 cm, from the lower edge of the print. Another area of these queer markings (B 332) lies about $1\frac{1}{2}^{\circ}$ south of B 333. One of these lanes is like part of the Greek letter ω . The strange thing about all such lanes is that they always are of uniform width throughout their ramifications. This must have some meaning beyond mere chance.

The great mass, or cloud of stars, that covers more than half the plate ends toward the west rather definitely, but irregularly. Beyond this the rest of the plate is covered with a very thin sprinkling of stars until a denser mass begins again in the upper right corner.

Beginning at about $\alpha = 19^{\text{h}}32^{\text{m}}$, $\delta = +14^{\circ}$ ($1\frac{1}{2}$ inches, or 4 cm, from the top and 4 inches, or 10 cm, from the left edge of the print), three slightly diverging lines of small stars run south for about 2° to the group of small, dark spots, B 334, 336, and 337. Their south ends are approximately in $\alpha = 19^{\text{h}}28^{\text{m}}10^{\text{s}}$, $\delta = +12^{\circ}25'$; $\alpha = 19^{\text{h}}29^{\text{m}}30^{\text{s}}$, $\delta = +12^{\circ}20'$; and $\alpha = 19^{\text{h}}31^{\text{m}}40^{\text{s}}$, $\delta = +12^{\circ}10'$. By tilting the print and looking in the direction of these lines they come out quite strongly. They seem to be partly dark lanes and partly lines of stars.

The original negative, No. 294, was made at Mount Wilson.

$\alpha = 19^{\text{h}} 30^{\text{m}} \delta + 11^{\circ} 0'$

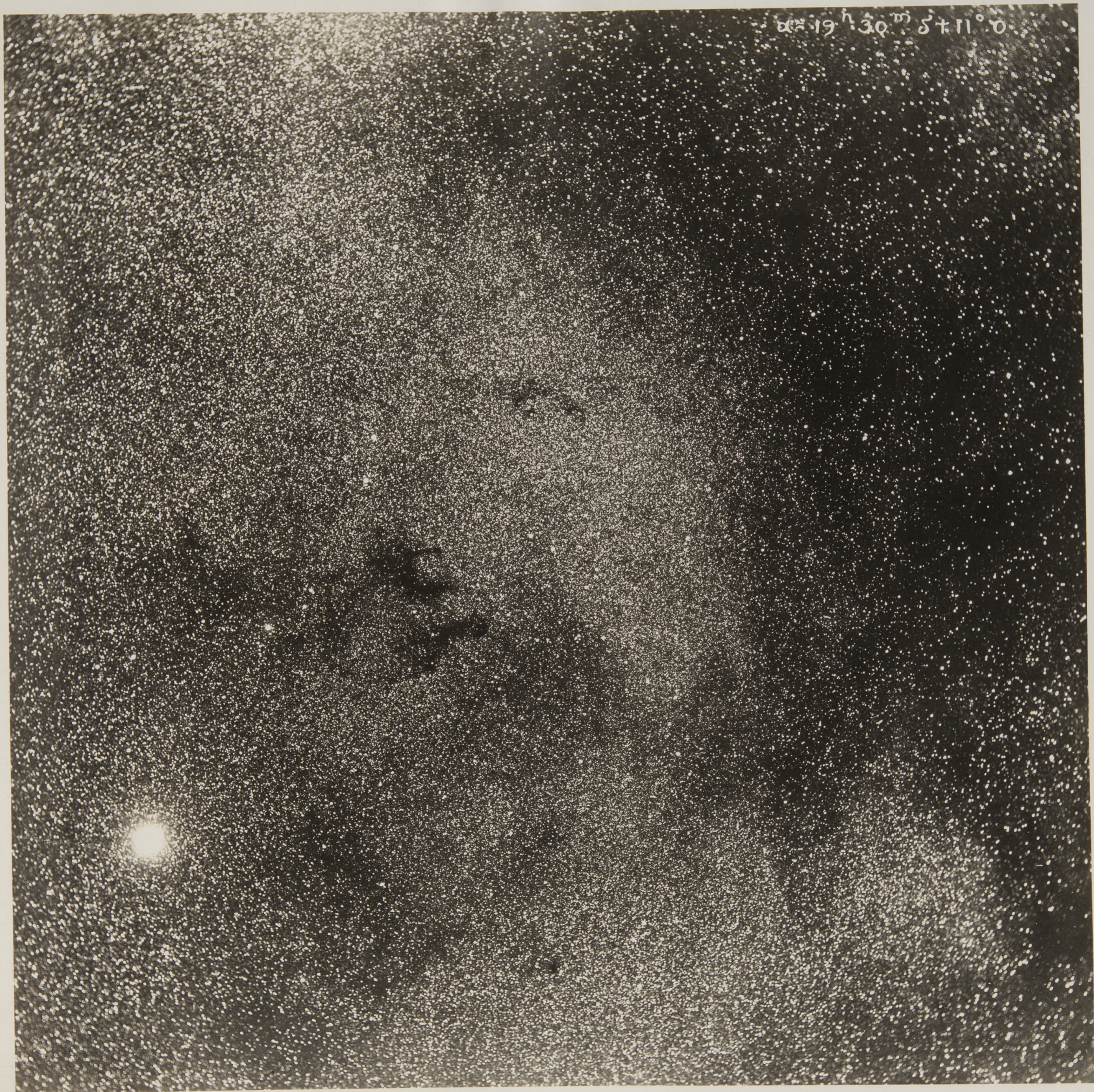


PLATE 42

REGION OF SAGITTA

Right Ascension = $19^{\text{h}} 34^{\text{m}} 20^{\text{s}}$, Declination = $+17^{\circ} 28'$

PLATE 42

REGION OF SAGITTA

$\alpha = 19^{\text{h}} 34^{\text{m}} 20^{\text{s}}$, $\delta = +17^{\circ} 28'$

1916 September 24.628

Scale: 1 cm = 18'.6, or 1 inch = 47'.2

Galactic Long. = 22° , Lat. = -3°

Exposure = $4^{\text{h}} 4^{\text{m}}$

This region, which touches on the north of that shown on Plate 41, is divided nearly diagonally between a rich stratum of stars to the southeast and a poorer one of smaller stars to the northwest. The line of demarcation between the two shows some irregular cloud effects. The most prominent one, whose center is in $\alpha = 19^{\text{h}} 36^{\text{m}}$, $\delta = +17^{\circ} 40'$, is 52' in diameter and extends, with diminishing intensity, far out into the open field, as if the stars were gradually diffusing outward. There are some lines of stars noticeable on the dense cloud in the eastern part of the plate, but few conspicuous ones in the poorer region. All along the edge of the cloud—and this is noticeable in other parts of the Milky Way—the impression is strong that the stars are gradually moving out, as if disintegration of the cloud were in progress.

In $\alpha = 19^{\text{h}} 24^{\text{m}} 50^{\text{s}}$, $\delta = +18^{\circ} 0'$ the star B.D. +17°3986, of magnitude 9.4, is in a small, diffused nebula. This nebulosity, though quite noticeable on the negative with the 10-inch lens, is scarcely visible on that with the 6-inch. This star (No. 720) is a little above the middle and 1.7 inches (4.2 cm) from the right edge of the plate.

Near the upper right corner, in $\alpha = 19^{\text{h}} 21^{\text{m}}$, $\delta = +19^{\circ} 40'$,

is a fine group of five bright stars equally distant in a straight line east and west. [The western star of this group is not visible here, having been cut off by the matting of the plate.] With two others to the south they make a remarkable figure, only part of which is shown here. This group, which is in Sagitta, is especially beautiful on the plates made with the 6-inch lens.

The small, irregular, bright streak (No. 721) at the east end of this line of stars is very striking. It is N.G.C. 6802, a very thin cluster of small stars extended nearly north and south, and may be a flat cluster seen on edge. Its position is $\alpha = 19^{\text{h}} 25^{\text{m}} 9^{\text{s}}$, $\delta = +20^{\circ} 0'$.

The bright, compressed cluster near the left edge of the plate is Messier 71 (N.G.C. 6838). It looks like a globular cluster, the stars showing quite well on the original negative.

None of the listed dark objects occur on this plate. The stars are unevenly distributed, some regions having no bright stars, but there is always apparently a background of faint ones.

The original negative, No. 1107, was made at the Yerkes Observatory.

$\alpha 19^h 34^m + 17^\circ 7'$



PLATE 43

REGION IN CYGNUS, SOUTHERN PART

Right Ascension = $19^{\text{h}} 54^{\text{m}} 35^{\text{s}}$, Declination = $+35^{\circ} 38'$

PLATE 43

REGION IN CYGNUS, SOUTHERN PART

$\alpha = 19^{\text{h}} 54^{\text{m}} 35^{\text{s}}$, $\delta = +35^{\circ} 38'$
1905 September 3.812

Galactic Long. = 40° , Lat. = $+2^{\circ}$
Exposure = $4^{\text{h}} 0^{\text{m}}$

Scale: 1 cm = $17'.1$, or 1 inch = $43'.3$

This rich region in Cygnus is 5° east and nearly 18° north of that shown on Plate 42. It is remarkable mainly for the great parabolic dark spot (B 144) which extends for some $4\frac{1}{2}^{\circ}$ in a southwesterly direction from east of the middle to the lower part of the plate. The outlines of this semi-dark region are rather definite, with the exception of its southwest portion which diffuses into the regular stellar background. Near the upper left side a part of the regular background spreads halfway over the darker portion of the figure.

Many alignments of stars and dark lanes are seen in the dark region, especially in its southwestern part. This large dark space does not give the impression of obscuring matter but of an opening in the dense star stratum, through which the blackness of space beyond, with a liberal sprinkling of small stars over it, is visible. Near the middle of the dark area are the two stars B.D. +34°3828 and +34°3830, of magnitudes 9.1 and 8.4, the northwestern and brighter one of which is closely nebulous.

These two stars, and a smaller one to the north, are involved in an irregular but faint mass of nebulosity some 4' or 5' in diameter, with much detail. There are patches of nebulosity to the east of the large dark region. One of these, covering an area about 1° in diameter, seems to have its center in about $\alpha = 20^{\text{h}} 2^{\text{m}}$, $\delta = +35^{\circ} 30'$.

The smaller, triangular, dark marking (B 145) to the northwest of the upper part of the large figure is remarkably well defined. It includes only one considerable star (B.D. +37°3736, 9^m5), but is sprinkled over with a few fainter ones of uniform brightness. The seventh-magnitude star B.D. +37°3735 (No. 770) is just north of its north edge.

To the west the stars become very minute and the star stratum is less definite, but in the lower part of the plate they begin to form cloud masses. Some of the nebulosities near Gamma Cygni are shown in the upper left corner.

The original negative, No. 306, was made at Mount Wilson.

$\alpha = 19^{\text{h}} 54^{\text{m}} 35.6^{\text{s}}$

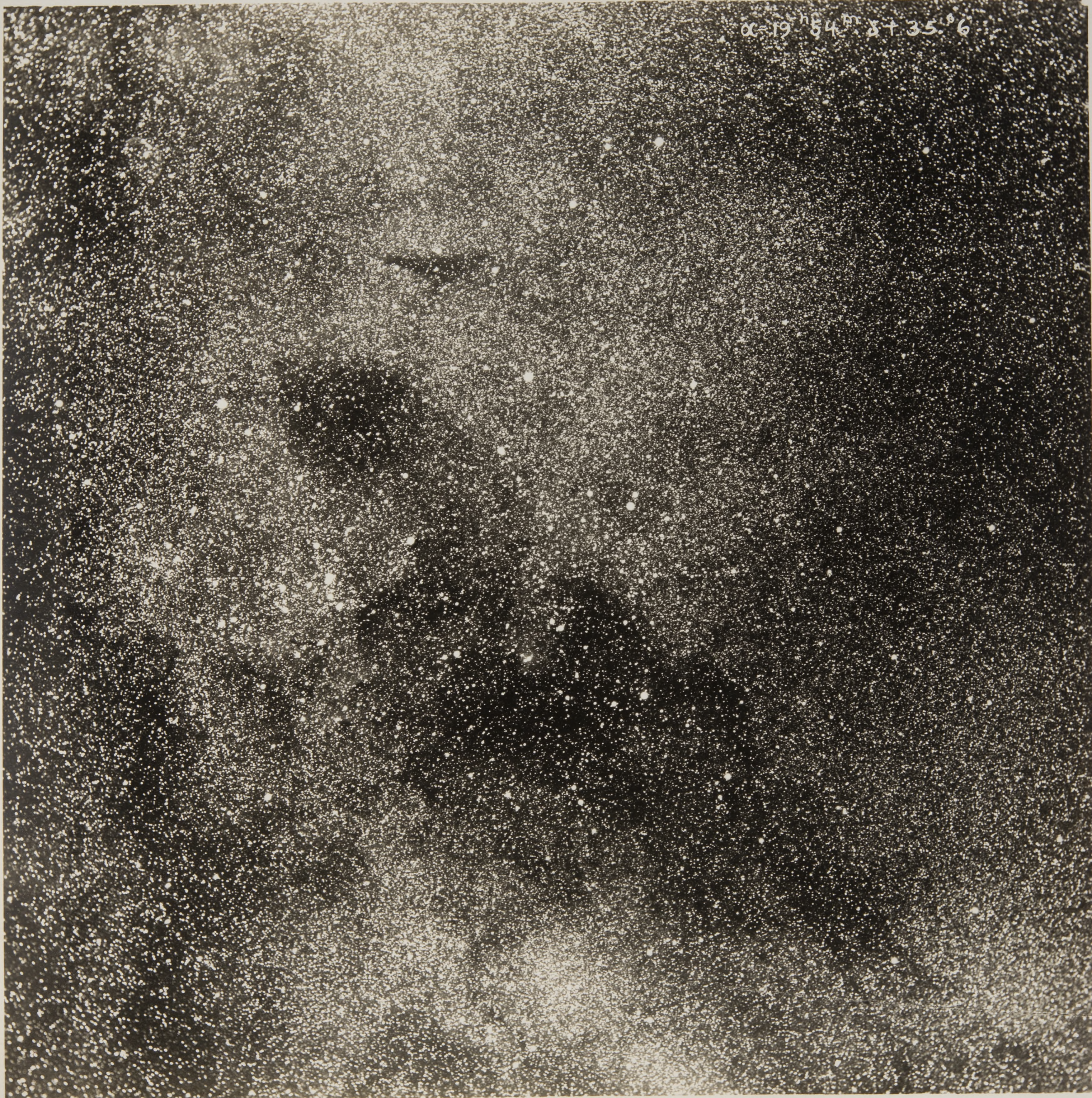


PLATE 44

REGION OF GAMMA CYGNI

Right Ascension = $20^{\text{h}} 18^{\text{m}} 40^{\text{s}}$, Declination = $+39^{\circ} 35'$

PLATE 44

REGION OF GAMMA CYGNI

$\alpha = 20^{\text{h}} 18^{\text{m}} 40^{\text{s}}$, $\delta = +39^{\circ} 35'$
1905 August 28.788

Galactic Long. = 46° , Lat. = $+1^{\circ}$
Exposure = $6^{\text{h}} 30^{\text{m}}$

Scale: 1 cm = $15\frac{1}{6}$, or 1 inch = $39\frac{1}{5}$

This region about the star Gamma Cygni is extraordinary from the vast amount of nebulosity that covers almost the entire plate in tufts and masses and sheets of filmy light. There is a very broken and wild look about this part of the sky that is impressive. Undoubtedly these are only the brighter portions of one great nebulous system. Faint connecting nebulosity seems to spread all over the sky among the brighter masses. All the northeast quarter is covered with a stratum of faint nebulosity which extends even into the star clouds to the west. This stratum begins at the group of nebulous stars (Nos. 801, 803, 804, etc.) in $\alpha = 20^{\text{h}} 20^{\text{m}}$, $\delta = +42^{\circ}$, where its edge is abrupt. For 1° toward the east it is quite strong; it then diffuses in a feeble manner to the extreme eastern limit of the plate. It extends southward in a widening mass from a point north of these nebulous stars to Gamma Cygni in the center of the plate. Around Gamma is a diffused area of feeble nebulosity that extends to the east for $\frac{1}{2}^{\circ}$ or more.

About $45'$ east and north of Gamma Cygni, in $\alpha = 20^{\text{h}} 22^{\text{m}}$, $\delta = +40^{\circ} 5'$, is a triangular mass of bright nebulosity which is very unequal in brightness. Just west of this, in $\alpha = 20^{\text{h}} 20^{\text{m}} 10^{\text{s}}$, $\delta = +40^{\circ} 5'$, is a condensation of nebulosity $10'$ in diameter, extending in a faint form for several degrees to the northwest.

One degree east and south of Gamma, in $\alpha = 20^{\text{h}} 23^{\text{m}} 30^{\text{s}}$, $\delta = +39^{\circ} 35'$, is another bright nebulous mass some $30'$ in diameter, somewhat extended northeast and southwest. It has a dark streak in it (B 347), $10'$ long and less than $1'$ wide, extending to the southwest. This dark streak passes close south of B.D. $+39^{\circ} 4206$ (No. 809) of magnitude 8.8. The star B.D. $+39^{\circ} 4209$ (No. 811) of magnitude 8.9, in the northeast part of the nebulous cloud, is itself nebulous. Two very feeble nebulous patches connected with several faint stars are situated about $\frac{1}{2}^{\circ}$ east and slightly north of this last star. Their position, $\alpha = 20^{\text{h}} 27^{\text{m}} 30^{\text{s}}$, $\delta = +39^{\circ} 50'$, is located 2.1 inches (5.5 cm) from the middle of the left edge of the print.

About 1° northwest of Gamma, in $\alpha = 20^{\text{h}} 13^{\text{m}} 40^{\text{s}}$, $\delta = +40^{\circ} 20'$, an irregular mass of nebulosity over $\frac{1}{2}^{\circ}$ in diameter is centered about the bright star B.D. $+40^{\circ} 4103$ (No. 794) of magnitude 6.3. North of this, in $\alpha = 20^{\text{h}} 13^{\text{m}}$, $\delta = +41^{\circ} 30'$, is a bright, triangular nebulous cloud $30'$ in diameter, with extensions to the west.

In the lower right quarter of the plate the star B.D. $+37^{\circ} 3821$ of magnitude 7.1 (No. 780, also shown on Plate 43) is eccentrically placed in an elliptical, disklike nebula (N.G.C. 6888) whose longer axis is northeast and southwest. It is $16'$ in diameter. The star is northwest of the center.

A rather queer-looking, bright nebula $6'$ in diameter, at the left side of the lower edge of the plate, is full of details on the original negative. Its position is $\alpha = 20^{\text{h}} 26^{\text{m}} 10^{\text{s}}$, $\delta = +36^{\circ} 30'$. It is just north of the star B.D. $+36^{\circ} 4105$ (No. 813) of magnitude 6.5.

In $\alpha = 20^{\text{h}} 28^{\text{m}} 33^{\text{s}}$, $\delta = +41^{\circ} 3'$, in the upper left part of the plate, the seventh-magnitude star B.D. $+40^{\circ} 4225$ (No. 816) is the center of a scattering group of fainter stars $30'$ in diameter. From this seems to radiate a number of streams of considerable stars, especially to the west where one curved line extends for over a degree.

Northeast of this group of stars, in the region of faint nebulosity, is a narrow, black streak (B 348) nearly 1° long which, running south, curves west, then north at its south end like a hook, with the star B.D. $+41^{\circ} 3799$ (No. 814) near the barb of the hook. Its northeast end is in $\alpha = 20^{\text{h}} 31^{\text{m}}$, $\delta = +42^{\circ} 10'$, and the south end in $\alpha = 20^{\text{h}} 29^{\text{m}}$, $\delta = +41^{\circ} 25'$.

A sharply defined, black marking (B 343) $13'$ long and extended southeast and northwest is in $\alpha = 20^{\text{h}} 9^{\text{m}} 0^{\text{s}}$, $\delta = +39^{\circ} 54'$ —about $1\frac{1}{2}^{\circ}$ west of Gamma. It is best defined at the southeast end. It is about $20'$ east and slightly south of B.D. $+39^{\circ} 4075$ (No. 779) of magnitude 6.8.

The original negative, No. 296, was made at Mount Wilson.

$\alpha = 20^{\text{h}} 20^{\text{m}}$ $\delta = +39^{\circ} 5'$

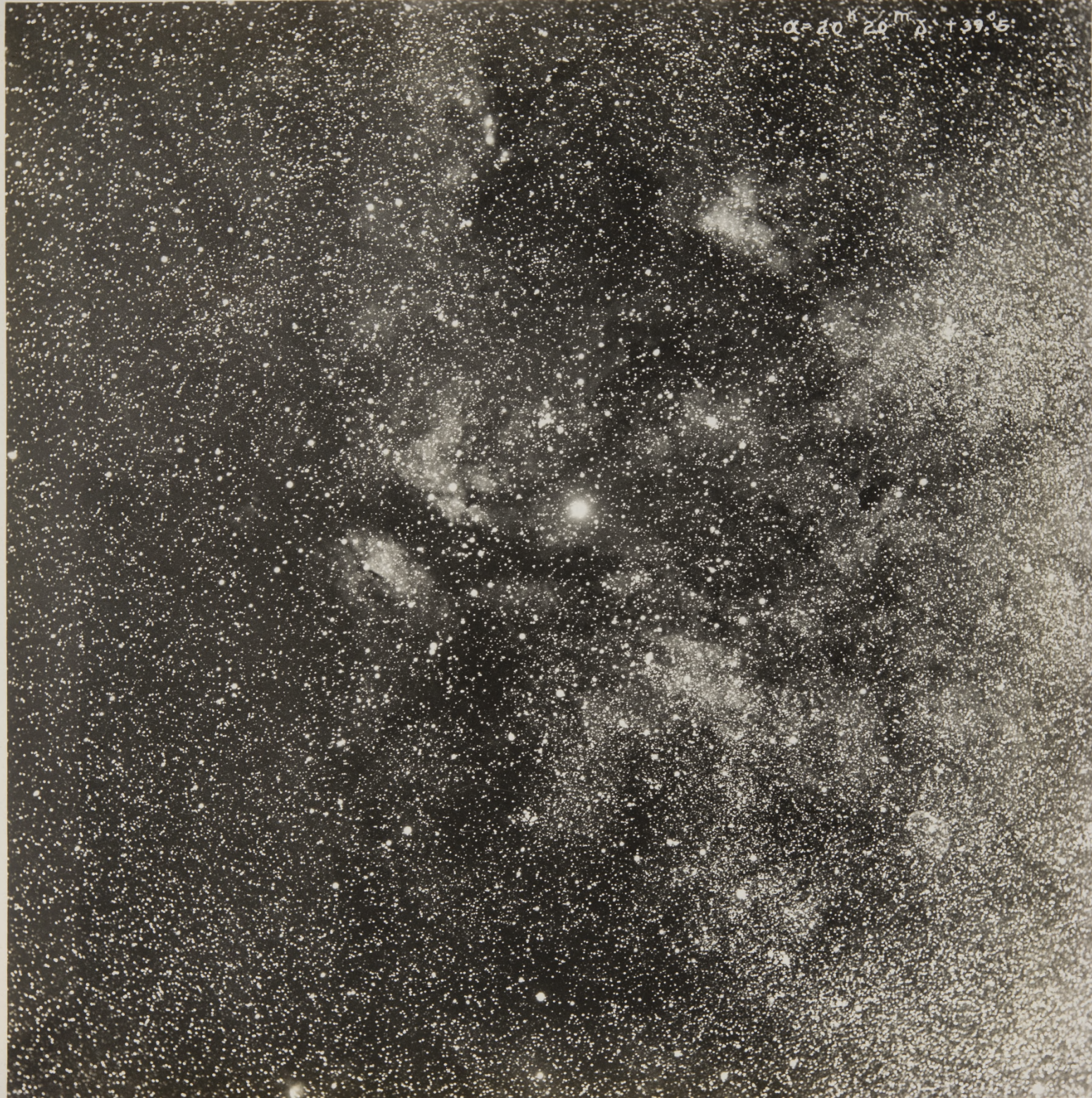


PLATE 45

REGION OF ALPHA CYGNI

Right Ascension = $20^{\text{h}} 31^{\text{m}} 35^{\text{s}}$, Declination = $+44^{\circ} 47'$

PLATE 45

REGION OF ALPHA CYGNI

$\alpha = 20^{\text{h}} 31^{\text{m}} 35^{\text{s}}$, $\delta = +44^{\circ} 47'$
1905 August 8.920

Galactic Long. = 51° , Lat. = $+2^{\circ}$
Exposure = $3^{\text{h}} 10^{\text{m}}$

Scale: 1 cm = $22\frac{1}{2}$, or 1 inch = $56\frac{1}{4}$

This region is made up partly of stars and partly of nebulosity. Alpha Cygni is in a uniform sheeting of stars that descends from the north and extends beyond it and rather abruptly ends $35'$ south of the star. Beyond this, to the south, is a semi-vacant region, in which are masses of outlying nebulosity from the "North America nebula" (which is cut across by the eastern edge of the plate), like a great, irregular "island" off the coast of the "continent." This "island," about $1^{\circ}30'$ long north and south, has its center in $\alpha = 20^{\text{h}}47^{\text{m}}$, $\delta = +43^{\circ}40'$, and lies between two bright stars, B.D. $+43^{\circ}3739$ (No. 837), which is in it, and B.D. $+43^{\circ}3755$ (No. 841), on the east edge. A rather strong condensation occurs in it at $\alpha = 20^{\text{h}}46^{\text{m}}30^{\text{s}}$, $\delta = +43^{\circ}55'$.

To the west of this nebulous cloud, in $\alpha = 20^{\text{h}}42\frac{1}{2}^{\text{m}}$, $\delta = +43^{\circ}10'$, is a mass of small stars about $50'$ long north and south and $20'$ wide. These stars extend north in a broken manner to the star cloud east of Alpha Cygni, and also seem to be involved in part of the fainter nebulosity which, to the south, joins one of the large masses of brighter nebulosity. Between this flat mass of stars and the "island" is a small, irregular black spot

(B 349) about $5'$ in a diameter. Its position is $\alpha = 20^{\text{h}}43^{\text{m}}0^{\text{s}}$, $\delta = +43^{\circ}30'$. A straggling dark strip extends south from this, along the east edge of the star mass, for $45'$. The western half of the plate is full of dark lanes.

The bright star in the lower left corner of the plate is Nu Cygni (No. 850), of magnitude 4.0. In the southwest corner are some of the nebulosities of the region of Gamma Cygni, referred to in the description of Plate 44. The small triangular cloud in $\alpha = 20^{\text{h}}13^{\text{m}}$, $\delta = +41^{\circ}30'$ is one of these. One-and-a-half degrees east and north of this triangular mass are the three rather bright nebulous stars (Nos. 801, 803, and 804) also discussed in the description for Plate 44.

The small nebula N.G.C. II 5076, with the sixth-magnitude star B.D. $+46^{\circ}3111$ (No. 847) close to the east of and probably involved in it, is located on the print 0.8 inch (2 cm) from the upper left edge. This object is better shown near the lower right corner of Plate 48.

The original negative, No. 275, was made at Mount Wilson.

$\alpha = 20^{\text{h}} 32^{\text{m}} \quad \delta = +44^{\circ} 6'$



PLATE 46

REGION OF THE NORTH AMERICA NEBULA

Right Ascension = $20^{\text{h}} 53^{\text{m}} 20^{\text{s}}$, Declination = $+43^{\circ} 40'$

PLATE 46

REGION OF THE NORTH AMERICA NEBULA

$\alpha = 20^{\text{h}} 53^{\text{m}} 20^{\text{s}}$, $\delta = +43^{\circ} 40'$
1905 September 4.861

Galactic Long. = 52° , Lat. = -2°
Exposure = $4^{\text{h}} 20^{\text{m}}$

Scale: 1 cm = 9.5 , or 1 inch = 24.1

This wonderful object, which has so happily been called the "North America nebula" by Dr. Max Wolf, is shown here in great perfection. It is a splendid mixture of stars and nebulosity. According to Wolf, the nebula is gaseous. Around the nebula are scattered masses of nebulosity, like islands in a sea off the mainland.

The beautiful nebula, with the outlying nebulosities, is in splendid contrast with the blackness of the sky, which is relieved here and there by bright stars—like lighthouses in a great sea—and by a liberal sprinkling of lesser stars.

The similarity of form of the nebula and the great star mass in the upper part of the plate suggests that the stars and the nebula are at the same distance. Though this seems to be the case, there is no actual condensation of the nebulosity about any of the stars. This peculiarity, however, occurs in other parts of the sky where nebulosity and stars seem to be similarly associated.

The most conspicuous of the outlying "islands" is an irregular mass $1\frac{1}{2}^{\circ}$ long north and south. It is somewhat less in extent east and west and fades out toward the west. The brighter condensation in its northern part, in $\alpha = 20^{\text{h}} 46^{\text{m}} 30^{\text{s}}$, $\delta = +43^{\circ} 55'$, is mixed with a few stars. This "island" alone, photographed with a large reflector, would be a most interesting object. Besides the beautiful sheeted nebulosities of this "island," there are indefinite nebulous masses covering nearly all the rest of the dark area. The lower right quarter of the plate is filled with them. In about $\alpha = 20^{\text{h}} 55^{\text{m}} 30^{\text{s}}$, $\delta = +45^{\circ} 0'$, north of the great nebula and apparently separated from it, is a diffused patch of nebulosity $25'$ in diameter, among bright stars.

The lower, projecting portion of the great nebula curves toward the west. On its southern edge is a rather bright rim from which the nebulosity brushes out over the dark sky toward

the north almost like electrical or auroral streamers. There are two considerable stars in this bright rim, one of which is possibly nebulous. This star is B.D. +42°3925 (No. 853), of magnitude 9.2. Extending southwest from this star is a brighter, curved strip in the nebulosity. A little south of this the nebulosity turns southeast and, in a fainter form, spreads out over a large, irregular area in which are many small stars. The center of this fainter portion is in $\alpha = 20^{\text{h}} 55\frac{1}{2}^{\text{m}}$, $\delta = +42^{\circ} 40'$. In this dimmer nebulosity is a dark, V-shaped spot (B 355), pointing west, about $5'$ in length. This is perhaps an opening in the nebulosity.

Some faint nebulosity appears in the star stratum in the lower left part of the picture. In this is an elongated black spot (B 358), bordered on its north side by a curve of six or eight stars. This spot diffuses to the northeast where, on the original negative, its limit is indefinite. It is some $20'$ in diameter. Its place is $\alpha = 21^{\text{h}} 1^{\text{m}}$, $\delta = +42^{\circ} 47'$.

North of the great nebula, in $\alpha = 20^{\text{h}} 53^{\text{m}} 0^{\text{s}}$, $\delta = +45^{\circ} 0'$, is a dark, angular spot (B 353), $15'$ long north and south, sprinkled over with faint stars. North of this, in $\alpha = 20^{\text{h}} 52^{\text{m}} 50^{\text{s}}$, $\delta = +45^{\circ} 25'$, is the southern part of a definitely outlined black spot (B 352) with some stars in it.

The smaller plate, made with the 6-inch lens at the same time that this was taken with the 10-inch, shows extended, feeble nebulosity in the star stratum to the east of the great nebula. Its extent north and south is about 4° , and it seems to spread over almost all the star stratum in this region. This is shown on Plate 78 of Volume 11 of the *Publications of the Lick Observatory*, where I have called attention to an apparent drift of the stars on that plate. The space in the present picture is too limited to show this feature, but it is clearly brought out in the plate made with the 6-inch lens.

The original negative, No. 308, was made at Mount Wilson.

$\alpha = 20^{\text{h}} 52^{\text{m}} \delta + 42^{\circ} 6'$

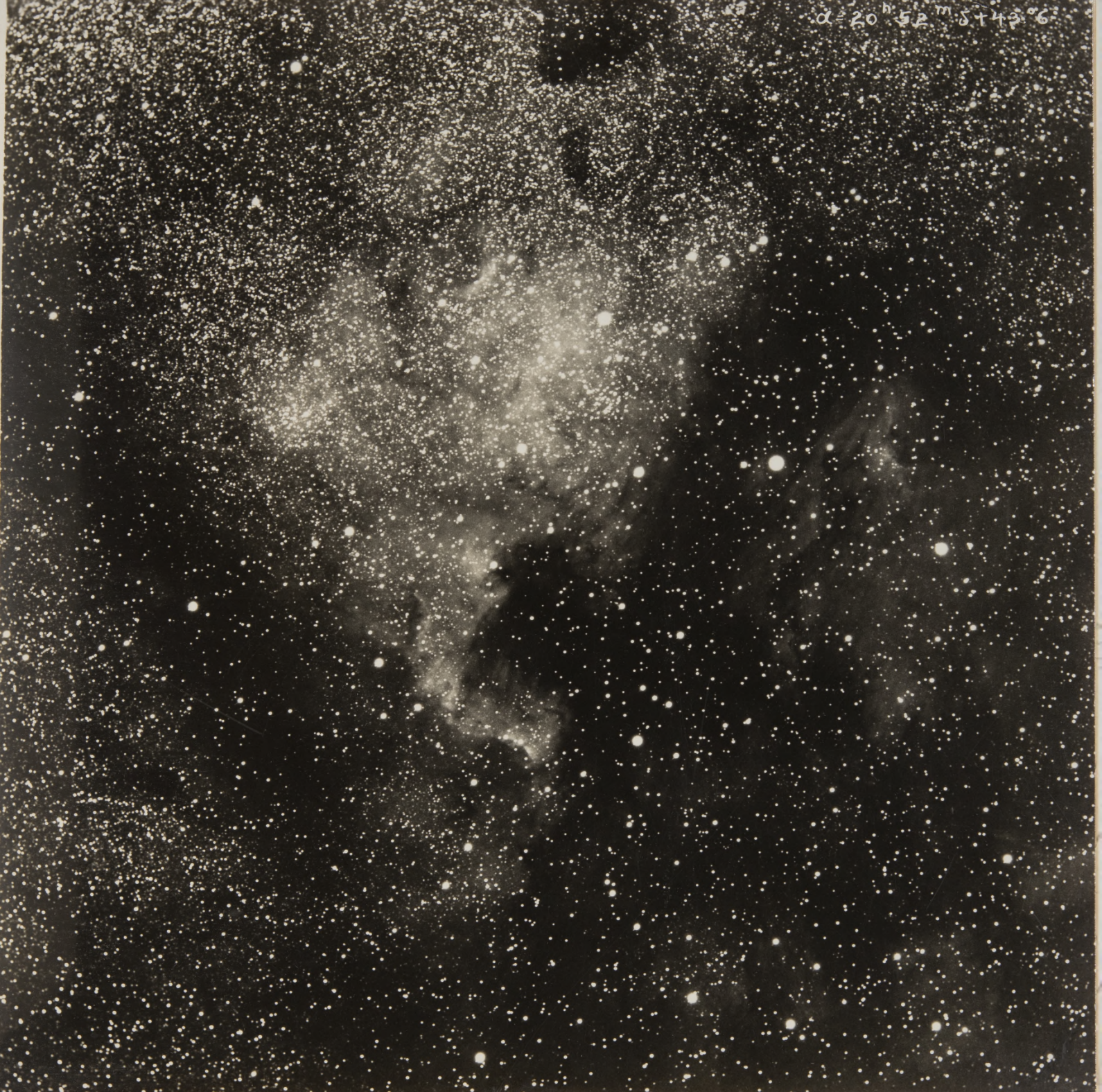


PLATE 47

REGION IN CEPHEUS

Right Ascension = $21^{\text{h}} 9^{\text{m}} 40^{\text{s}}$, Declination = $+58^{\circ} 15'$

PLATE 47

REGION IN CEPHEUS

$\alpha = 21^{\text{h}} 9^{\text{m}} 40^{\text{s}}$, $\delta = +58^{\circ} 15'$
1910 October 1.669

Galactic Long. = 65° , Lat. = $+7^{\circ}$
Exposure = $6^{\text{h}} 2^{\text{m}}$

Scale: 1 cm = $21' .2$, or 1 inch = $54' .0$

This region, though almost devoid of the usual cloud forms, presents other features of unusual interest. The middle portion of the plate is filled with irregular, diffused nebulosity which becomes quite dense in parts, especially at two points where it condenses about stars or star masses. On each side of the middle of the picture is a dark region. These are darker than the open sky in other parts of the plate, especially in the north.

Near the middle, in $\alpha = 21^{\text{h}} 9^{\text{m}}$, $\delta = +58^{\circ} 50'$, is the brightest part of what appears to be half of a large ring of nebulosity. It is about $50'$ long and curves to the northeast, then turns north through what seems to be several small stars in nebulosity, and then to the northwest. There is some feeble nebulosity inside this partial ring as far west as the sixth-magnitude star B.D. +59°2334 (No. 875). Doubtless a longer exposure would fill this space with nebulous matter.

The extraordinary dark marking near the upper right side of the picture, B 150, is quite evidently an obscuring body of some kind. The faint illumination between this dark object and the west edge of the picture is due to a slight fogging of the plate, and is not real nebulosity. An exposure of $5^{\text{h}} 35^{\text{m}}$ on October 9, 1915, with the dark object central, does not show any nebulosity in its immediate vicinity. The following paragraphs are quoted from my description of this object given in the *Astrophysical Journal* for January, 1916 (43, 1-8):

For this and many other reasons I am constrained to believe that the dark object is really a non-luminous nebula seen against a luminous background. There is no visible evidence of the ordinary nebulosity in the immediate region of this dark object; that is, the background is not the ordinary diffused nebulosity so frequently shown on photographs, nor is the stellar stratum dense enough to serve as a luminous

background. There is every evidence in the original photograph of a continuous, uniform luminosity over this entire region that is real and not due to the ordinary fogging of the plate by atmospheric luminosity. The idea has therefore suggested itself to me, and the suggestion has been strengthened by the appearance of other regions, that there is possibly a feeble luminosity in space, sufficiently strong to impress itself on the sensitive plate by prolonged exposures. I am, of course, familiar with the fact that our atmosphere is more or less luminous and that it fogs the plate with prolonged exposures, but palpably this could never serve as a background for the distant nebulae.

That the "dark" nebula of Plate I [of this article] is between us and the stars in this region is clearly proved by the fact that it blots out the few stars that must be behind it. From an inspection of the original negatives it is clear that its visibility is not due to that fact, however, for the stars are too few at that point to serve as a luminous background.

Near the top of the plate, in $\alpha = 21^{\text{h}} 11^{\text{m}} 30^{\text{s}}$, $\delta = +61^{\circ} 13'$, is a sharply defined, elongated, dark spot, B 152, with a small star in it. In the article just quoted this object is erroneously described as being south of B.D. +61°2103. It is north of that star. This spot is in very strong black contrast with the vacant, starless spaces here, which, seen between the stars, appear luminous. This luminous condition seems strongly to affect the sky in different parts of the plate.

Near the middle of the plate, the star B.D. +57°2309 (No. 880), of magnitude 6.5, is densely nebulous. B.D. +56°2495 (No. 839) appears to be feebly nebulous. The nebulosity is about $10'$ in diameter. This star, of magnitude 6.8, is located in the lower right part of the plate.

The original negative, No. 634, was made at the Yerkes Observatory.

$\alpha = 21^h 8^m 58.2$



PLATE 48

REGION IN CYGNUS, NORTHEASTERN PART

Right Ascension = $21^{\text{h}} 14^{\text{m}} 0^{\text{s}}$, Declination = $+50^{\circ} 7'$

PLATE 48

REGION IN CYGNUS, NORTHEASTERN PART

$\alpha = 21^{\text{h}} 14^{\text{m}} 0^{\text{s}}$, $\delta = +50^{\circ} 7'$
1915 June 13.760

Galactic Long. = 60° , Lat. = $+1^{\circ}$
Exposure = $4^{\text{h}} 37^{\text{m}}$

Scale: 1 cm = $24'.0$, or 1 inch = $61'.1$

Though too dark, the print from which I am working shows some of the star clouds very well. Trouble with the driving clock during the exposure caused the brighter stars to trail slightly.

Near the middle of the plate is a rather wide straggling cluster about 1° in diameter. These stars seem to be independent of the ordinary cloud forms, and hardly to belong to the rather dim cloud in which they appear. The brightest star in this group is B.D. +50°3317 (No. 885) of magnitude 8.2. [A defect on the print which might be mistaken for a star occurs 5 cm below the image of this star.]

N.G.C. 7092 (No. 896) is seen in the lower left quarter of the plate, in $\alpha = 21^{\text{h}} 28^{\text{m}}$, $\delta = +47^{\circ} 53'$. It is a pretty group of ten or twelve stars, brighter than the other stars in the immediate region, and rather reminds one of the constellation Delphinus. Possibly they are physically connected.

The cluster N.G.C. 7086 (No. 894), in $\alpha = 21^{\text{h}} 26^{\text{m}} 14^{\text{s}}$, $\delta = +51^{\circ} 2'$, is irregular and small, with an extreme diameter of $6'$. It is shown on the photograph as a small group of faint stars above and to the left of the center.

The small elongated nebula, with the sixth-magnitude star B.D. +46°3111 (No. 847, 0.85 inch, or 2.2 cm from the lower right side of the plate) close to the east of it, is probably the object N.G.C. II 5076. The place for N.G.C. 6991 ($\alpha = 20^{\text{h}} 50^{\text{m}} 22^{\text{s}}$, $\delta = +46^{\circ} 48'$), described in Dreyer's *Catalogue* as a "cluster, large, poor, very slightly compressed," would fall about 1^{m} west of this star. This probably refers to the rather scattering groups of stars (it can hardly be called a cluster) shown here on the photograph.

This photograph should be studied with Plate 81 of Volume 11 of the *Lick Observatory Publications*, which shows a part of the same region and is printed to just the right depth. The star B.D. +48°3504 (No. 912, $4^{\text{m}} 5$), close to the eastern edge of this plate, is just below the middle of the Plate 81, while B.D. +48°3345 (No. 882, $5^{\text{m}} 4$), a little below the middle of this plate, is close to the western edge of Plate 81. A portion of the star cloud in which the North America nebula is situated is seen in the lower right corner.

The original negative, No. 970, was made at the Yerkes Observatory.

$\alpha = 21^h 18^m 50.0^s$

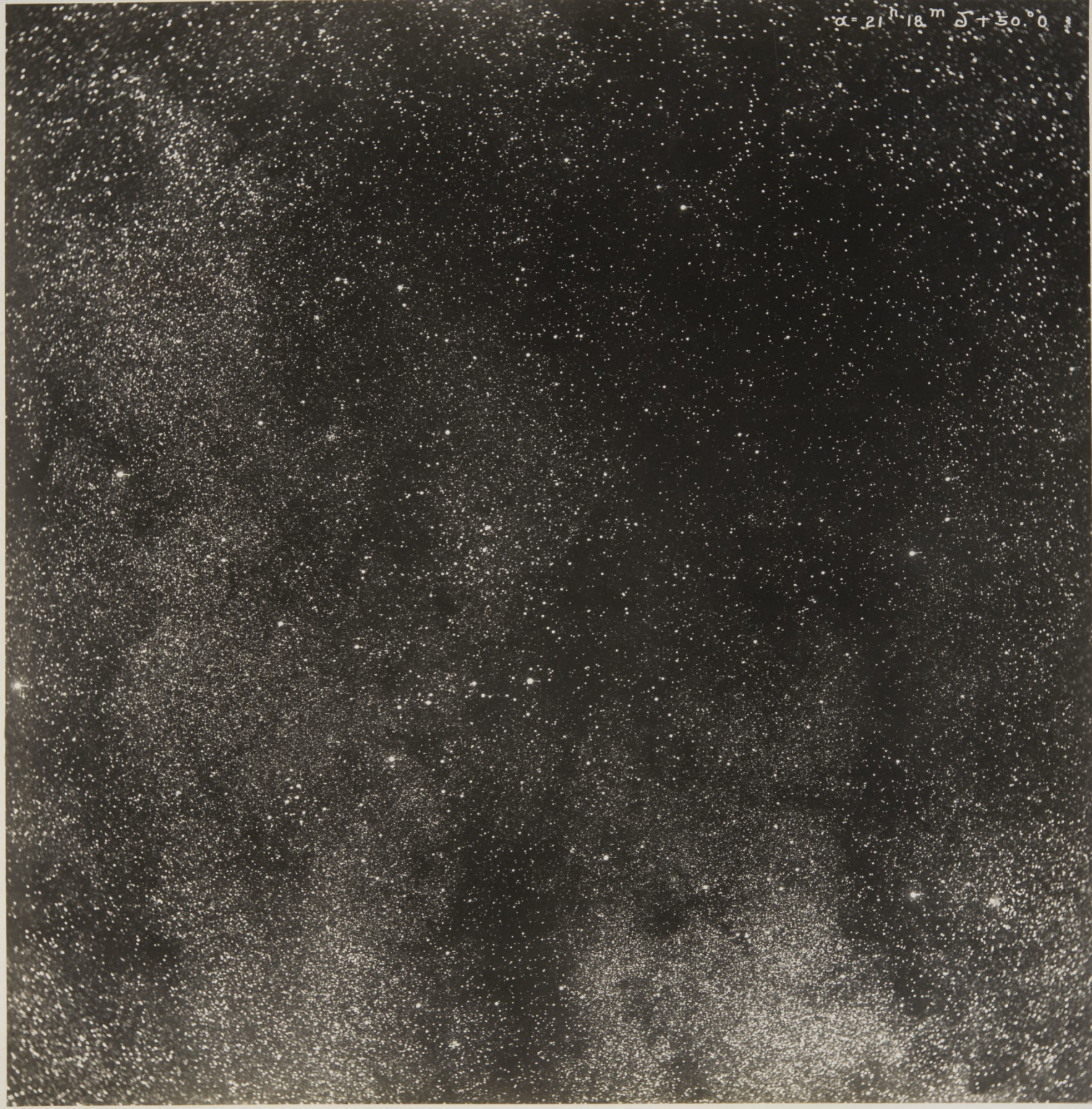


PLATE 49

REGION IN CEPHEUS

Right Ascension = $21^{\text{h}} 34^{\text{m}} 45^{\text{s}}$, Declination = $+57^{\circ} 0'$

PLATE 49

REGION IN CEPHEUS

$\alpha = 21^{\text{h}} 34^{\text{m}} 45^{\text{s}}$, $\delta = +57^{\circ} 0'$
1905 September 1.768

Galactic Long. = 67° , Lat. = $+4^{\circ}$
Exposure = $4^{\text{h}} 47^{\text{m}}$

Scale: 1 cm = $21'.8$, or 1 inch = $55'.3$

This is a very extraordinary region of widespread nebulosity and dark markings. To the right is part of the sky covered by Plate 47. The center is occupied by a large, irregular nebula with a patch of brighter stars than usual. The nebula has been given the number I 1396 in Dreyer's *Index Catalogue*. The very center of these nebulous masses is gritty with small stars which are entirely free of nebulosity. All around this the stars for some distance are veiled in nebulosity. It would seem probable that the group of bright stars is connected with the nebula, which is outlined by a system of sharp, black irregularities, apparently common to the nebula and the stratum of stars behind it. A straggling zigzag lane (B 365) runs south from the western side

of the nebula to a larger dark marking (B 160) in $\alpha = 21^{\text{h}} 34^{\text{m}}$, $\delta = +55^{\circ} 40'$. B 160 is sharply defined on its eastern (left) edge where two dark projections occur, but it diffuses gradually to the west. Above the middle of the nebula there is a small narrow, black marking (B 161) with a small star in it. It is sharp toward the south but diffuses to the north.

In the upper right quarter are the nebulous star B.D. $+57^{\circ} 2309$ (No. 880) and the fragments of a nebulous ring in which is the bright star B.D. $+59^{\circ} 2334$ (No. 875). They are better shown on Plate 47. In the upper left quarter is the ring-shaped dark object, B 169, encircling a mass of stars.

The original negative, No. 302, was made at Mount Wilson.

$\alpha = 21^{\text{h}} 35^{\text{m}} \delta + 56^{\circ} 9'$

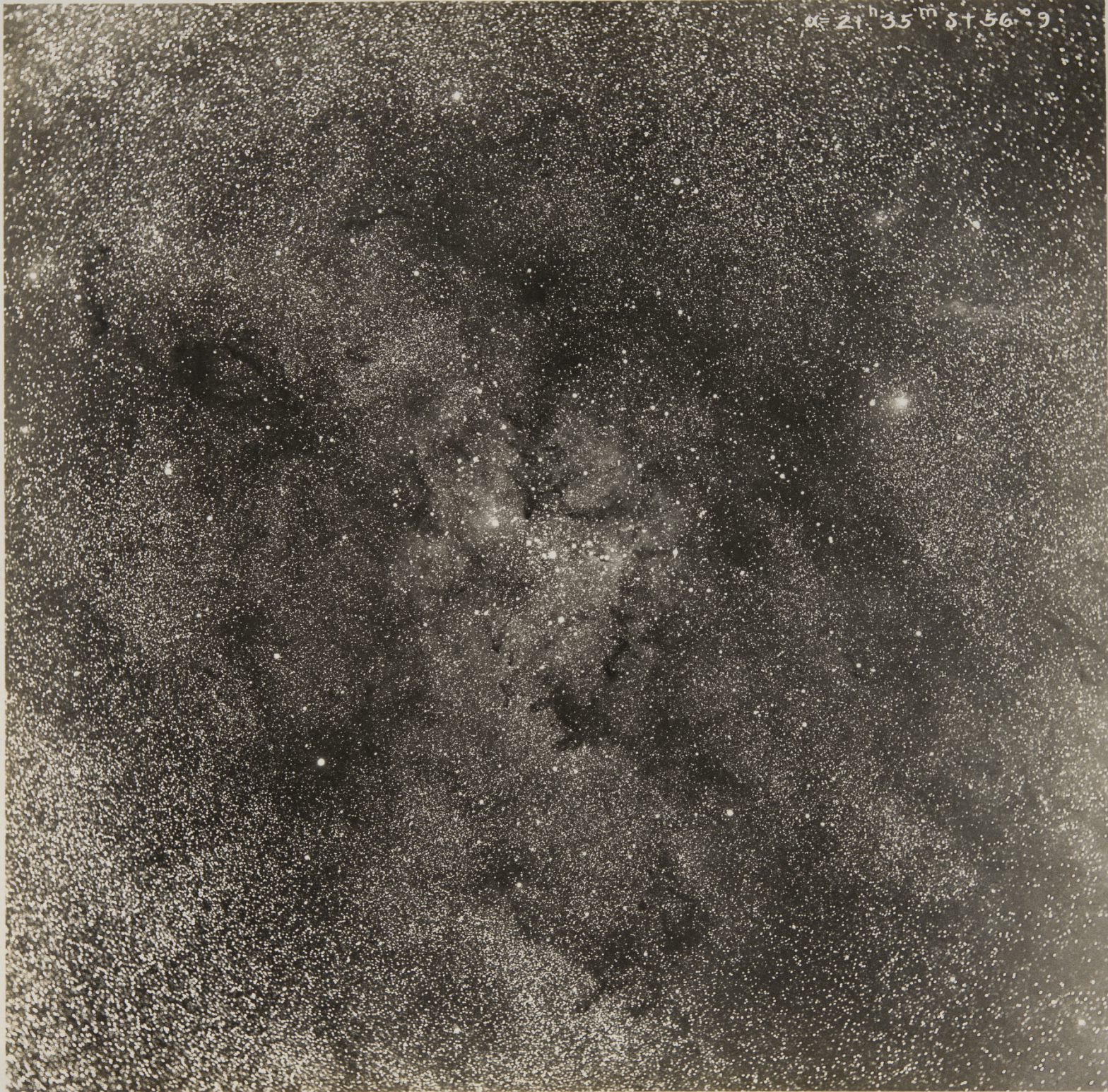


PLATE 50

REGION IN CEPHEUS, CYGNUS, AND LACERTA

Right Ascension = $22^{\text{h}} 10^{\text{m}} 40^{\text{s}}$, Declination = $+55^{\circ} 10'$

PLATE 50

REGION IN CEPHEUS, CYGNUS, AND LACERTA

$\alpha = 22^{\text{h}} 10^{\text{m}} 40^{\text{s}}$, $\delta = +55^{\circ} 10'$

1915 June 9.763

Scale: 1 cm = 23'.5, or 1 inch = 59'.6

Galactic Long. = 70° , Lat. = -1°

Exposure = $4^{\text{h}} 34^{\text{m}}$

This is a region of small stars which do not produce very marked cloud forms. It contains, to the west, the region of Plate 49. The upper part of the plate is more or less mottled with small clusterings of stars. Indeed, this clustering tendency is apparent over most of this region. Two of these small groups have been identified in Dreyer's *Catalogue*. N.G.C. 7235 (No. 928), about $1\frac{1}{2}^{\circ}$ north of the center of the photograph, is situated some 25' northwest of the fifth-magnitude star Epsilon Cephei (No. 929). N.G.C. I 1434 (No. 925), a round cluster of faint stars, has a line of small stars running east from its north side for about 12'. It is located on the print, slightly to the right of the middle and 1.4 inches (3.6 cm) from the lower edge.

Though there are some cloud forms in this region they are not conspicuous. There is a scattering of generally bright stars over the middle of the plate that almost attains to the dignity of a cluster. There is also some irregular, feeble nebulosity here, about a degree in extent.

The large, elliptical dark spot, B 169, whose center is occupied by a group of small stars, is seen in the northwest quarter. The small, round, dark spot (B 369), 5' in diameter, is near the middle of the photograph in $\alpha = 22^{\text{h}} 11^{\text{m}} 20^{\text{s}}$, $\delta = +55^{\circ} 24'$. There are many dark lanes in this region, especially in the eastern half of the plate. This is very striking in about $\alpha = 22^{\text{h}} 28^{\text{m}}$, $\delta = +56^{\circ}$ or $+57^{\circ}$, where many of these lanes appear, some at right angles to each other. Indeed, the more carefully the plate is examined the more plentiful are the interesting details, which at first seem to be wanting. But the general background is made up of ex-

ceedingly minute stars, as if this were a very distant part of the Milky Way.

The conspicuous star in the upper left part of the picture is Delta Cephei (No. 935 of our list), the prototype of the class of variable stars whose light varies continuously, and therefore are known as the Cepheids. On the original negative it appears to be involved in feeble nebulosity which even shows slightly on the present plate. Other stars of similar brightness on the photograph do not show this effect. On September 16, 1920, an exposure of $7^{\text{h}} 38^{\text{m}}$ was made with the Bruce telescope, with this star central. This apparent nebulosity does not appear, but the image of the star is rather soft and somewhat different from those of the other stars on the plate, which may be due to some peculiarity in its light. That there can be no ordinary nebulosity about the star is proved by the fact that Hubble gave an exposure of six hours with the 60-inch reflector of the Mount Wilson Observatory, and found no nebulosity.

Two small defects have occurred in making the second negative. The first of these, 1.35 inches (3.5 cm) from the top and 3.3 inches (8.4 cm) from the right edge of the print, will deceive no one. The second one, however, looks very much like the image of a star, and was not found to be unreal until after the chart for this plate had been made. Its location on the print is 3.5 inches (9.0 cm) from the top and 1.2 inches (3.1 cm) from the right edge.

The original negative, No. 969, was made at the Yerkes Observatory.

$\alpha = 22^{\text{h}} 10^{\text{m}} \delta + 54^{\circ} 9'$



PLATE 51

NINE SELECTED AREAS OF THE MILKY WAY PHOTOGRAPHED ON A SMALL SCALE

(Including the Regions Covered by Plates 13-46)

NINE SELECTED AREAS OF THE MILKY WAY PHOTOGRAPHED ON A SMALL SCALE

(Including the Regions Covered by Plates 13-46)

Scale: 1 cm=3°1, or 1 inch=7°9

[It seems important to state at the outset that the selection of pictures shown on this plate was not made with the intention of presenting a view of the whole Milky Way, or even of all the areas shown in this volume. This would have been impossible. It will be seen that these photographs overlap, the same features often appearing on more than one picture.

The numbering of the nine pictures and their arrangement on the plate should not be regarded as significant. They will be taken in order of right ascension. Their orientation is not exact.]

The photographs of this plate were selected from a number made with a small stereopticon lens attached to the mounting of the Bruce telescope, with which exposures were often made simultaneously with those of the 10-inch lens. In selecting these small photographs it was thought best to cover the most interesting and important regions—those showing structures and cloud forms. Only that part of the sky covered by Plates 13-46 could be represented, however, because the number of the small pictures used had to be limited to nine.

The small lens, of ratio 1:4, had a diameter of 1.6 inches (4.0 cm) and a focal length of 6.3 inches (16.0 cm). The diameter of the field shown in these photographs is 23°2. Besides giving wider views of the Milky Way, these pictures serve admirably to connect the different plates made with the 10-inch lens in this part of the sky and to show their relation to one another.

To make all the second negatives for this plate of uniform density was difficult, but was finally accomplished by making the glass positives as nearly alike as possible. They were then arranged together and the large negative was prepared.

The data as to the separate pictures is contained in the following table, the positions of the centers being given only approximately.

| No. | R.A. | Decl. | Gal. Long. | Gal. Lat. | Date | Exposure | Plates Included |
|------|-------------------|-------|------------|-----------|---------|--------------------------------|-------------------------|
| | | | | | 1905 | | |
| 9... | 17 ^h 1 | -23° | 324° | +5° | June 27 | 4 ^h 35 ^m | 13-24, 26-30 |
| 6... | 17.5 | -22 | 332 | +4 | Aug. 2 | 4 0 | 14, 15, 17-33 |
| 3... | 17.9 | -33 | 326 | -7 | July 23 | 3 18 | 20-22, 24, 26-30, 33 |
| 8... | 18.0 | -20 | 338 | -1 | July 31 | 4 30 | 19-21, 23, 25-27, 29-35 |
| 2... | 18.5 | -16 | 344 | -5 | July 24 | 3 52 | 25, 29-37, 39 |
| 5... | 18.6 | -7 | 354 | -2 | Aug. 4 | 4 30 | 34-40 |
| 7... | 19.0 | +2 | 5 | -3 | July 8 | 4 0 | 36-41 |
| 4... | 19.4 | +10 | 14 | -5 | Aug. 5 | 5 30 | 40, 41, 42 |
| 1... | 20.2 | +39 | 44 | +1 | Aug. 6 | 4 45 | 43-46 |

Number 9 shows, from west to east, the region from Rho Ophiuchi to the great star clouds of Sagittarius; and, from north to south, in about $\alpha=17^{\text{h}}0$, from $\delta=-15^{\circ}$ to -40° .

Number 6: The region of 58 Ophiuchi is central. Its relation to the phenomenal region of Theta Ophiuchi is well shown. The great dark space southeast of Theta and its extension running south of that star to the west much resembles its appearance to the naked eye. This photograph extends over areas included on plates 14 to 33, excepting plate 16, which is too far South.

Number 3 presents the Milky Way from north of Messier 8 to a point a little south of Theta Scorpil, showing the great star clouds of Sagittarius and their relation to other features. It strikingly brings out the rather abrupt termination of the western part of the east branch of the Milky Way here and its gradual diffusion to the east.

Number 8 extends from $\alpha=18^{\text{h}}5$, $\delta=-10^{\circ}$ on the north to the great star clouds of Sagittarius on the south. The small star cloud in Sagittarius, with its black spots, is near the middle of the plate.

Number 2 covers the region from north of Messier 11 to south of Messier 8.

Number 5 shows the beautiful star cloud in Scutum at the center, and its relation to adjacent features north and south. It covers the region from $\alpha=19^{\text{h}}0$, $\delta=+3^{\circ}$ on the north to the small star cloud in Sagittarius on the south. It shows well the outlying masses from the cloud in Scutum toward the west.

Number 7 covers the region between Alpha Aquilae and the star cloud in Scutum.

Number 4 extends from about $\alpha=19^{\text{h}}5$, $\delta=+20^{\circ}$ southward to the Equator. The diffusion of the Milky Way to the east is clearly shown.

Number 1 reaches from the North America nebula, southward, to a point south of the dark region in Cygnus shown in Plate 43. It brings out clearly the longitudinal division which is such a notable feature of this part of the Milky Way to the naked eye.

In all these it is very noticeable how the Milky Way to the east gradually diminishes in brightness, while its western part is very abrupt. There is, of course, a fainter branch to the west. These photographs represent, in nearly every case, the western or interior edge of the eastern branch of the Milky Way.

