BARNARD'S PHOTOGRAPHIC ATLAS OF SELECTED REGIONS OF THE MILKY WAY

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Edward Emerson Barnard (1857-1923) was one of the greatest astronomers of the 19th century. His last legacy was the *Photographic Atlas of Selected regions of the Milky Way* edited by Edwin B. Frost (1866-1935)[1] and Mary R. Calvert (1884-1974)[2] in 1927 after his death.

Only 700 copies of this Atlas were printed making the original edition a collector's item. Each one the 35700 plates of the Atlas was inspected by Barnard himself. Hundreds or even thousands of plates were rejected until Barnard was satisfied with the results. In the beginning of the twentieth century astronomical photographs were extremely difficult to reproduce satisfactorily.

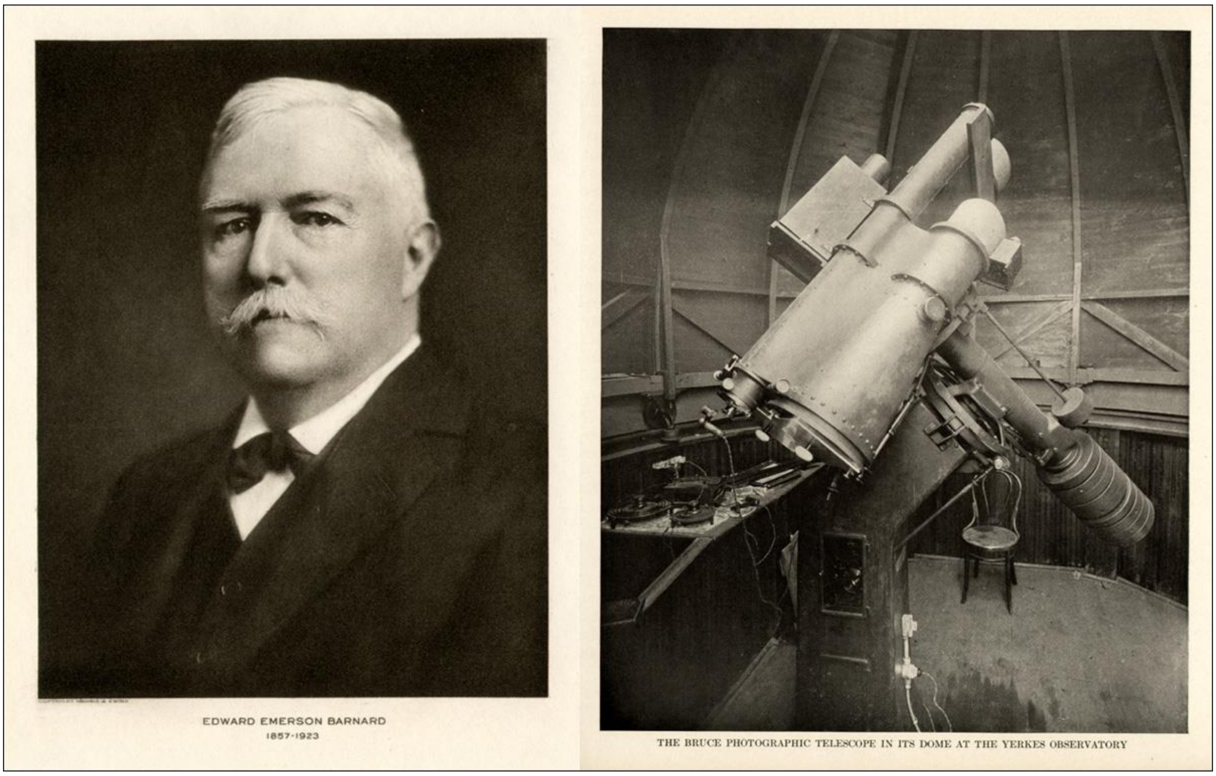


Figure- Edward Emerson Barnard (left) and the Bruce Photographic Telescope (right).

The Preface of the Atlas, written by Edwin Frost, describes Barnard's pioneering work:

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*

[1] Edwin Frost joined the Yerkes observatory staff in 1898 becoming its director in 1905 when George Ellery Hale resigned.

[2] Maria Calvert, Barnard's niece, started working at Yerkes observatory in 1905 as an assistant and computer for his uncle. After Barnard's death in 1923, Calvert became a curator of the Yerkes photographic plate collection until her retirement in 1946.

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 preparations 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 photographs, 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 around 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 direction. 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," new 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 B250, 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 the 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 indicated 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 of 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.*, 4 , 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 Introductions 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 service of Miss Calvert, who, as Mr. Barnard's person 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 editorial duties.*

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.

Barnard’s *Photographic Atlas of Selected Regions of the Milky Way* in composed of two volumes. Part I “*Photographs and Descriptions*” and Part II “*Charts and Tables*”. Volume I contain 52 original prints produced from Barnard's original negatives, and 31 pages of Barnard's description of each plate. All Milky Way photographs were obtained with the 10" and 6.25" Bruce photographic refractors at Yerkes observatory or at Mt. Wilson observatory. The plates are glued to linen paper and have the appearance of original photographic prints. Volume 2 contains 51 charts showing objects of interest on the plates and the coordinates of the objects on the page facing the chart.

Barnard wrote in the introduction of Part I:

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 the 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.

The contents of the second volume of the Atlas are described in the Introduction of Part II:

This second part of the Atlas *has been provided to aid in the convenient use and study of the photographs contained in Part I, for reasons which were stated in notes by Professor Barnard as follows:*

When comparing astronomical photographs made with long exposures with star charts I have frequently had much trouble, through the want of an approximate position, in identifying stars and other objects on the photographs. Also, very often the colors of the stars so change their relative intensities that they are not easily recognized on the chart. The photographs in the present work are intended as pictures of the sky and it would have been impossible to mark co–ordinates on them without spoiling their pictorial value. It was therefore decided to make a map, with co–ordinates, corresponding to each photograph and on the same scale. Though this has required much work, the charts assist greatly in the approximate location of any object shown on the photographs. They have been of great service to me in studying the photographs and I believe will be a welcome addition to the Atlas.

The photographs are not all enlarged in the same proportion, and therefore are not uniform in scale. All of the fainter stars shown on the Durchmusterung charts were not put on the diagrams, but it is believed enough of them are given to permit a ready identification of objects in any part of a photograph. Found stars on each photograph, located near the corners, were identified and used for determining its scale and for locating the system of co–ordinate lines. The epoch 1875.0 was adopted and is used throughout this work. A high degree of accuracy is not claimed for these charts, but they are sufficiently precise to locate and object closely enough for identification in a catalogue.

All of the dark objects listed by Professor Barnard which fall within the limits of the various plates have been roughly outlined on the charts so as to aid in their identification. Some of these are so indefinite that no mere outline can represent them. In general, a dotted line is used to indicate outlines that are vague, while a solid line implies more definiteness. Each of these dark objects is designated by the letter B *followed by its number in Professor Barnard's list printed in the* Astrophysical Journal *or in his supplementary list, both of which are given in Part I.*

Nebulosity shown on the photographs is indicated on the charts by parallel lines.

Numbers have been given on the diagrams to such stars and objects as were mentioned in the text accompanying the photographs in Par I, and to such others as might assist in the easy location of details in any part of the plate. The numbers were carried consecutively though the whole series of diagrams but are not always repeated when they occur on several charts.

These numbered stars and objects are listed in the tables that face the diagrams, with their positions for 1875.0 and the other data which were thought to be useful.

The second column contains the number of the star or other object in the Bonner Durchmusterung*(B.D.), the* Cordoba Durchmusterung *(C.D.), or the* New General Catalogue *(N.G.C.) of the late J. E. L. Dreyer based on the observations of the Herschels and later astronomers. Numbers taken from Dreyer's extensions of the N.G.C., published in the first and second index catalogues, are designated as N.G.C. I and II. No attempt has been made* *to include all the objects of the N.G.C. that occur within the limits of the photographs, and only the more conspicuous of them are listed. Nebulous stars are generally noted.*

The magnitude in the third column is the visual estimate for the star as given in the Bonner *or the* Cordoba Durchmusterung. *Clusters and nebulae are also indicated in the column. The right ascensions and declinations as given are, in general, not the* Durchmusterung *positions but have been taken from the catalogues of the Astronomische Gesellschaft and have been rounded off to the tenth of a second of time in a and the tenth of a minute of arc in d.*

The data for the photometric (visual) and photographic magnitudes and for the type of spectrum have been taken from the Henry Draper Catalogue, Annals of the Harvard College Observatory, *91–99. For the benefit of those not technically acquainted with these matters it may be stated that types O, B, and A include the blue and bluish–white stars; F and G, the yellow stars; while K stars have an orange tinge and those of type M are distinctly red.*

The column of "Remarks" gives the Greek letter and Flamsteed number of such stars as may have them, and Messier's numbers. The N.G.C. number is printed here when the object has a Durchmusterung *number already entered in the second column. Nebulous stars are also indicated in this column.*

The approximate positions of the dark objects shown on the various photographs are given below the table for each chart.

It is assumed that the user of the Atlas *making a careful study of a particular photograph will open both parts to the corresponding place. He will then have at once before him, without the necessity of turning pages, the photograph, faced by the author's description of its features, while the chart will give the approximate co–ordinates in right ascension and declination and the designation of the stars and other objects, for which full details are given in the table opposite to it. This plan of publishing the* Atlas *in two parts had not been decided upon before Professor Barnard's death, but it is believed that it would have met his approval. Most of the charts had been prepared in a preliminary way by Miss Calvert under Professor Barnard's supervision. She later sketched in the dark objects and inserted their numbers and those of the reference stars, after completing the computation s and checking necessary for the tables.*

In this introduction, Barnard makes a detailed description of the Bruce photographic telescope:

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. 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 especially suitable for the photography of the fainter celestial bodies. They were made on the Petzval systems and consisted of two sets of lenses, from which fact they are also called "doublets." In this paper I shall refer to them namely 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 (...)

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 6 ¼ 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 especially 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 o the meridian (…)

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 several years ago, and has proven itself quite the best where great angular aperture and 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 wavelengths of light. This would be quite objectless in a camera which is to be used for portraits, but it 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 to all constructors of astronomical objectives. The focus of the 10–inch, determined form 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 6 ½–inch Voigtlander 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 6 1/4 –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 ten–inch carries a plate 12 inches square, while the one for the 6 ¼ –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 1 ¾ 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 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 pier really consists of two parts. Just above the clock room is 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 sometime go to the southern hemisphere, Messers. 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 the 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 guising are brought down conveniently to the plate–end of the instrument.

The pier is very heavy, weighing some 1,200 or 1,300 lbs. (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 1904(...)

The 10–inch and the 6 ¼–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°34' (...)

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°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 into 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 Brashbear doublet, and 151 with the 6 ¼–inch Voigtlander doublet, the exposures being simultaneous, almost without exception. The original negatives of 40 of the 50 photographs in this volume were made during the 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.

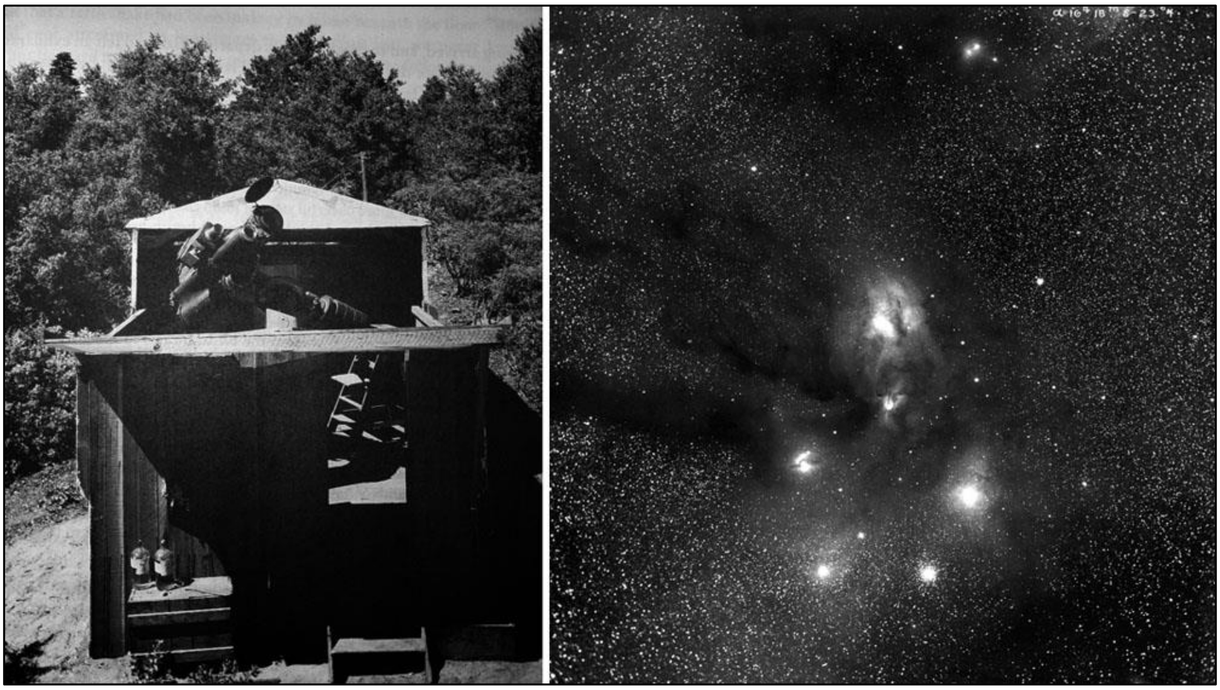


Figura 2- Bruce photographic telescope in a temporary roll-off-roof observatory on Mt. Wilson (1905) (left). Rho Ophiuchi region, exposure 4h30m, April 5, 1905 (right).

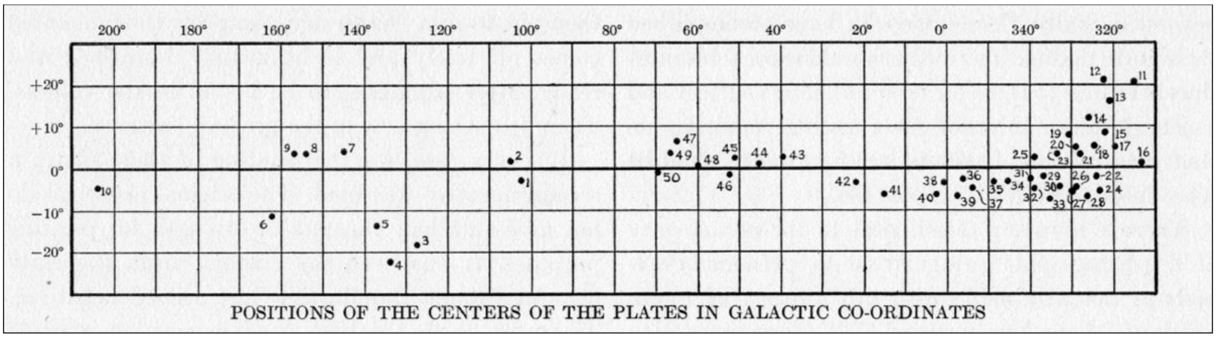
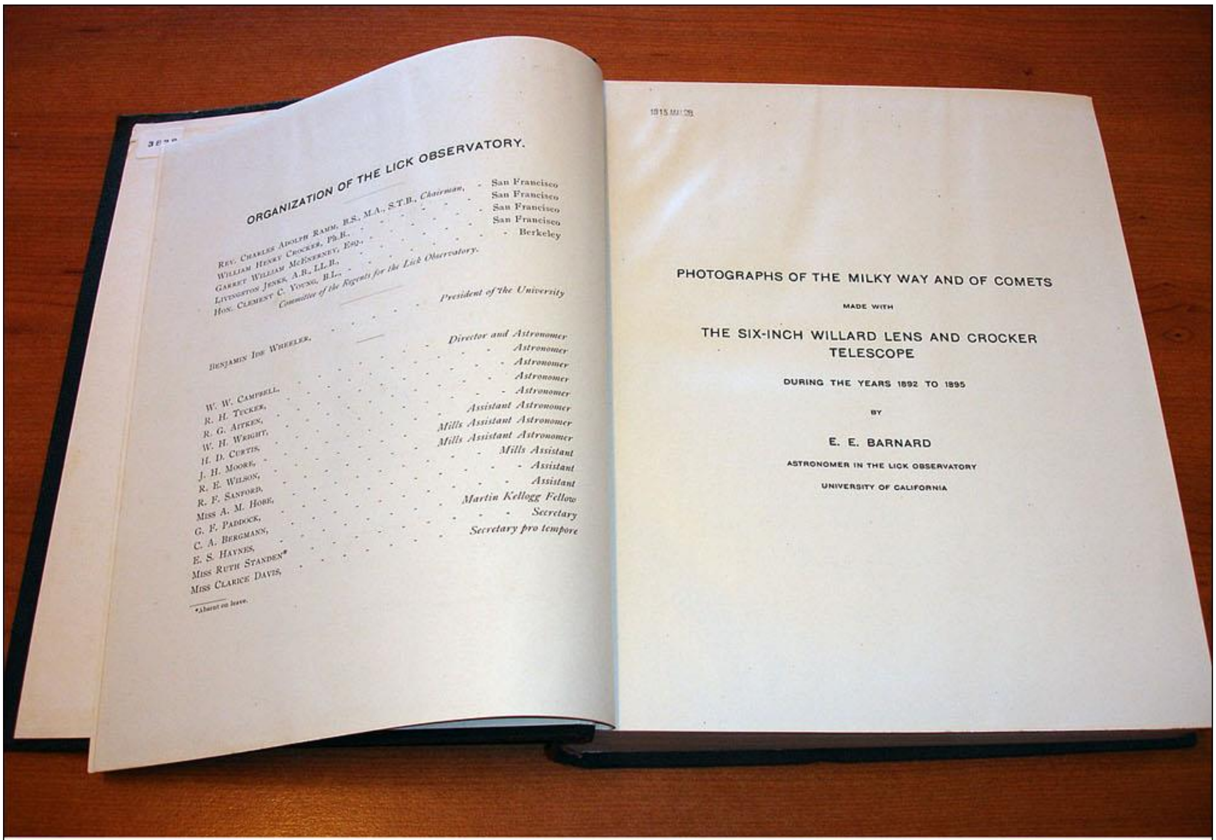


Figure 3- Plate coordinates (*Photographic Atlas of Selected Regions of the Milky Way*).



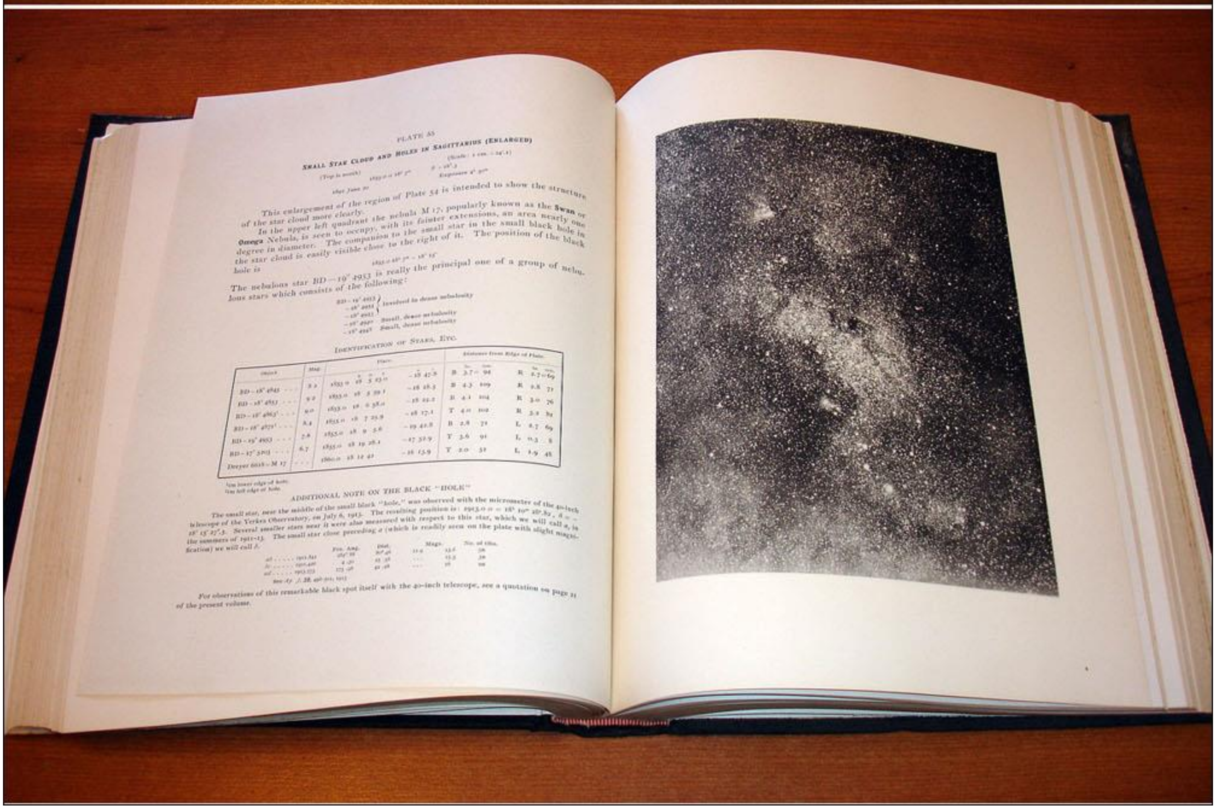


Figure 4- Barnard, E.E. (1913). *Photographs of the Milky Way and of Comets*. Publications of Lick Observatory, vol. 11. Library of the Lisbon Observatory.

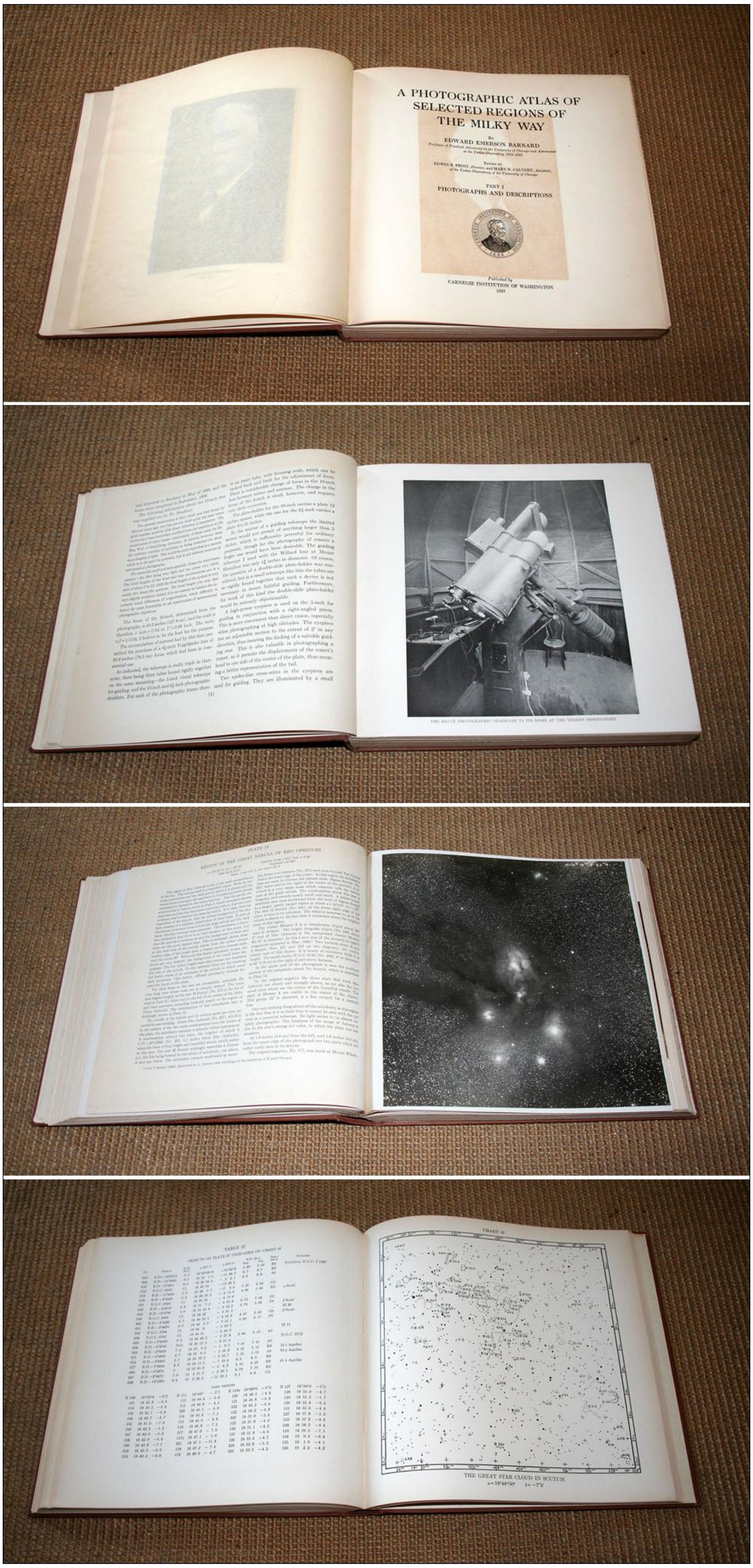


Figure 5- Barnard, E.E. (1927). *Photographic Atlas of Selected Regions of the Milky Way*.
Author’s personal copy.

Sources:

- Barnard, E.E. (1905). The Bruce photographic telescope of the Yerkes Observatory. *Astrophysical Journal*, 21: 35-48
- Barnard, E.E. (1913). *Photographs of the Milky Way and of Comets*. Publications of Lick Observatory, vol. 11.
- Banard, E.E. (1927). *A Photographic Atlas of Selected Regions of the Milky Way*. Carnegie Institution of Washington. Publication No. 247 (Part I and Part II).
- A Photographic Atlas of Selected Regions of the Milky Way (Web Page). http://www.library.gatech.edu/barnard/
- Sheehan, W. (1995). *The Immortal Fire Within: The Life and Work of Edward Emerson Barnard*. Cambridge University Press, ISBN 0 521 44489 6.