FROM THE OBSERVATORY TO THE CLASSROOM: SPACE IMAGES IN THE KEYSTONE “600 SET” AND “1200 SET”

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Abstract

This paper introduces the astronomical images of the Keystone 600 SET and 1200 SET, and the original photographic plates from which they were printed, analysing both the photographic plate and the published card. The astronomer’s work will be discussed together with the method of achieving the stereoscopic effect for the different celestial bodies. Of particular interest was the method of taking advantage of the lunar libration for producing Moon stereographs used by British amateur astronomer Warren de la Rue (1815-1889). He was a pioneer who both established and used this method as early as the 1850s. In addition, this study will also explore the method used decades later on by Edward Emerson Barnard (1857-1923), and other astronomers working at the Yerkes Observatory, to produce stereographs of other celestial bodies. Analysis of how Keystone and other companies enabled a democratization of astronomical portraiture will also be performed and can be attributed to the inclusion of astronomical images in their educational set of stereographs, which were used as leading visual tools to help students learn about our earth and its neighbours.

Keywords: astronomical stereographs, Keystone View Company 600 SET and 1200 SET, moon libration and lunar stereoscopic photographs, Warren de la Rue (1815-1889), Edward Emerson Barnard (1857-1923), Yerkes Observatory.

Collecting stereographs became an attractive occupation among many middle-class families in the late 19th century. People acquired stereographs of tourist sites they had visited, as well as exotic locales that they would only experience through the wonder of the stereoscope. Viewing stereographs was a common activity, much like watching T.V. or going to the movies today.[1] Stereoviews were also used as an educational tool in classrooms, and became the leading media in the classroom in America.[2] Interestingly, astronomical images were also published as stereoscopic cards.

By the turn of the century, there was one main publisher of stereographs: The Keystone View Company in Meadville, Pennsylvania.[3] It was not the first publisher of stereoscopic images in the United States, but in time it became the largest. By 1910 the Keystone View Company had purchased its major competitors in the market (Underwood & Underwood, H.C. White & Co., and the B.K. Kilburn Company), leading to its assimilating the various collections of images. Keystone published hundreds of stereographic images of America and the world through their *Tour of the World* sets, which were categorised by the number of images: 72, 200, 400, 600 and 1200. The sets for school children (600 and 1200 SET) had a guide for the teachers.

As explained to me by Leight Gleason, PhD candidate at Monfort University and curator of photography at the Museum of Photography at University California Riverside, in Keystone’s earliest sets, the so-called “tour of the world,” the final card was always a picture titled “Still, there’s no place like home,” showing an American family in an American parlour, and later in a living room. However, as Keystone developed its sets, and worked with educators and advisors, the final cards changed and “Still, there’s no place like home” was replaced by these space images, as the last pictures in their ‘tour of the world’ sets.[4]

In the “Statement” of the book *Visual Education. Teacher’s Guide to Keystone “600 SET”* we can read,

> When the schools first turned to the stereograph and slide as the most effective forms of visual instructions material, it was soon determined that the standard sets of Travel Tours then in common use for public and private libraries did not meet class-room requirements.[5]

An analysis of the aforementioned book reveals the way in which the SET was conceived, and how it was supposed to be used by the teachers. The copyright notice at the beginning of the book informs us that 1906 was the date of the introduction into school work of a set of stereographs and lantern slides specifically selected to meet school needs and with cross reference classifications to make quickly available the teaching content of the set. Other dates are also noted through this; (1908-1911-1917-1920-1922)[6] when the first set and plan, originated by Keystone, were revised and improved. The 1917 edition of the book provides an amazing example of the use of these astronomical images for educational purposes for the first time.

In the table of contents of the book, a chapter entitled "Earth Neighbours" under the section "Geography" is evident. The chapter is written by James F. Chamberlain, and next to a text about the importance that our celestial bodies do have for everyday life, he introduces the eight space images selected for the set and placed at the very end of it:

593 (16764) – *The Sun photographed through forty-inch telescope*. Yerkes Observatory.

594 (16648) – *The Full Moon*. Yerkes Observatory.

595 (16646) – *Moon at age of seventeen days*. Yerkes Observatory.

596 (16766) – *The planet Mars*. Yerkes Observatory.

597 (16767) – *The planet Saturn*. Yerkes Observatory.

598 (16765) – *The planet Uranus and two of its moons*. Yerkes Observatory.

599 (16647) – *Meteor in constellation of Orion*. Yerkes Observatory.

600 (16645) – *Morehouse's Comet*. Yerkes Observatory.

On Chapter 9 of the book, a section entitled "Earth Neighbours" is identified, written by James F. Chamberlain, with detailed information on the images related to the celestial bodies depicted in the *600 SET*. As he states,

> Astronomical geography is one of the most important as well as one of the most interesting phases of geography. The range of the subject is great, including such topics as the form of the earth, rotation and revolution and their results, latitude, longitude, the zones, the tides and the solar system. The educational value of pictures as applied to human geography is generally recognized. As applied to astronomical geography it would seem at first thought as though only pictures representing the heavenly bodies could be used. This is far from being the case. There are many scenes in the Keystone *600 SET* showing the influences of the earth's neighbours upon human affairs, a study which will prove very valuable.[7]

For instance, he chooses several dozens of stereographs of earthly topics related or caused by the Sun and the Moon, and writes about all celestial bodies (and their influence on the earth) represented in the collection in five different sections: I. The Sun; II. The Moon; III. Planets; IV. Comet; V. Meteor.

Under the section of the Sun, for example, he writes about: A. Solar exploration (1. Solar exploration as related to industry; 2. Solar exploration as related to cloud formation; 3. Overcoming effects of solar evaporation); B. Solar Energy (1. Influence of solar energy upon the colour of skin; 2. Effect of solar energy upon clothes; 3. Protecting plants from excessive solar energy; 4. Releasing solar energy of past ages); C. Influences of high altitude upon human affairs; D. Form of the earth; E. Longitude and time; F. Change of seasons). He also refers to 68 stereographs that illustrate the aforementioned phenomena.

Under the section of the Moon, he writes about: A. Phases of the Moon (594 and 595); B. Influence of the tides (stereograph No. 347, Landing stage, Liverpool, England. It is a floating pier, and it therefore rises and falls with the tide just as the ships do. Because of this, goods and people can be easily loaded or unloaded at any time).

All images published in the Keystone sets are attributed to the Yerkes Observatory, which was founded in 1897 by astronomer George Ellery Halle (1868-1938). The observatory houses a collection of over 170,000 photographic plates.[8] The author, though, of the images has been identified in most of them; it is printed next to each card as well the original photographic plate from which the prints for this series were made, now kept at the Museum of Photography, University of California Riverside.[9] How were those stereoscopic images actually made? Which method was used with each particular celestial body in order to produce the stereoscopic effect?

The Sun

The photographic plate with the number 16764 shows two images of the sun, which must have been taken on the same day (Figure 1a). After consulting An Illustrated Catalogue of Astronomical Photographs (1923)10, it was confirmed that the photographer of the Sun for this stereograph was Miss Calvert11, who took the two photographs, on the 14th February 1917.12

The text written on the back of The Sun photographed through forty-inch telescope (Figure 1b) identifies the photograph was taken through the Yerkes telescope of the University of Chicago, at Williams Bay, Wisconsin. It further informs the reader that "the telescope was mounted in 1896-97 at a cost of $125,000. It has 40-inch lenses, the largest in America. The length of the tube is 65 feet. The telescope weighs nearly 15 tons".

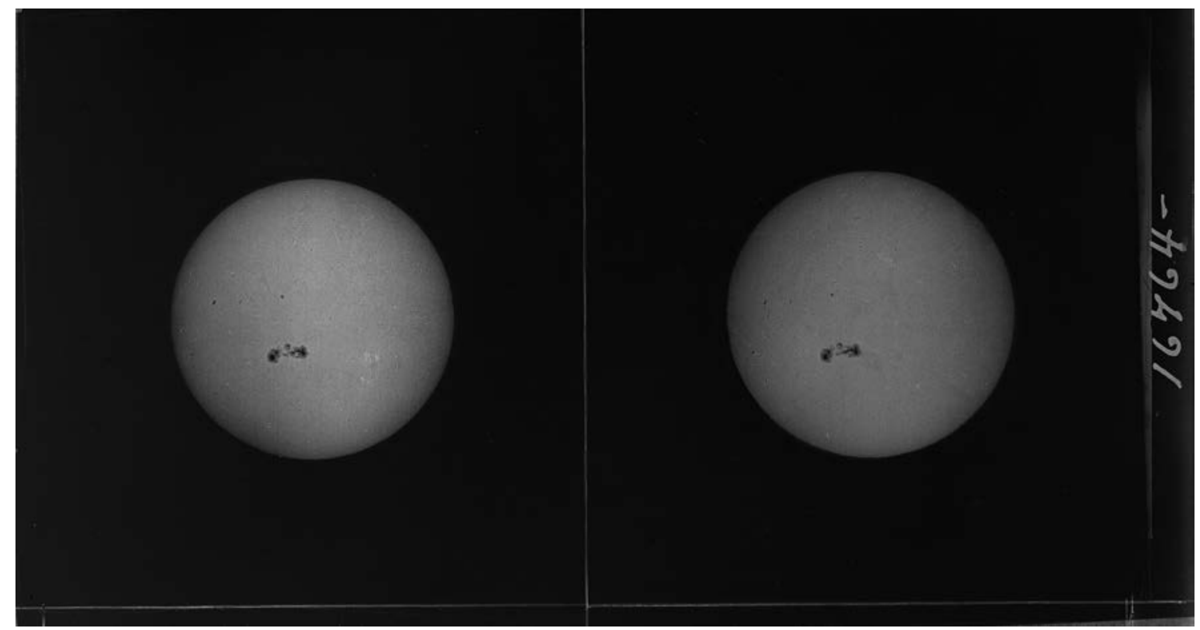


Figure 1a - The Sun photographed through 40" telescope, Yerkes Observatory, Plate number: 16764, Museum of Photography, University of California, Riverside

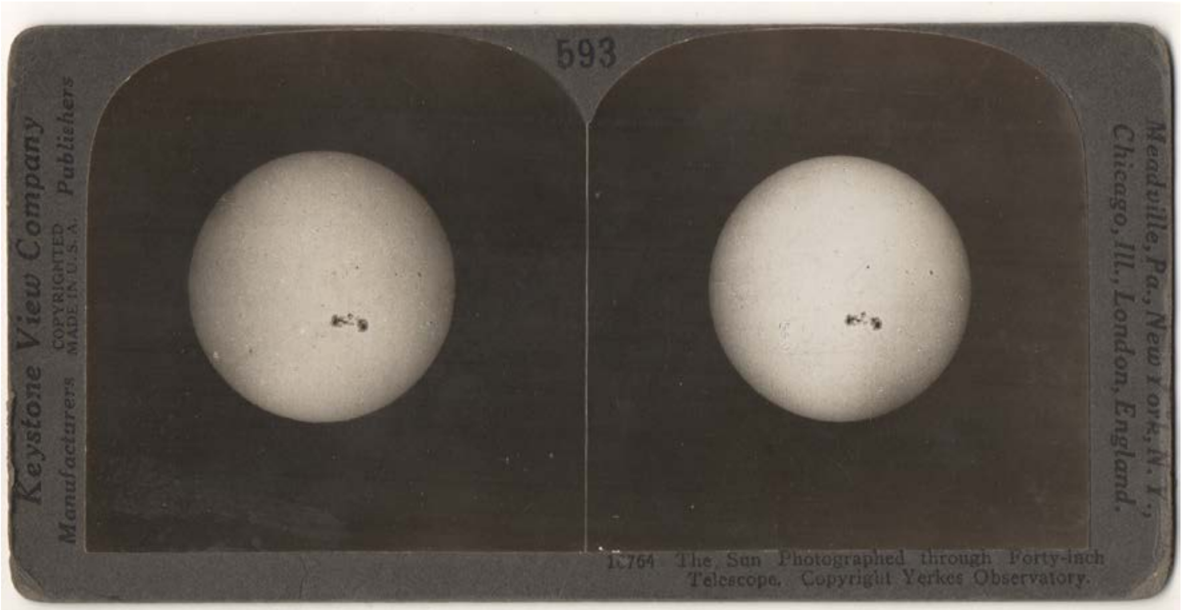
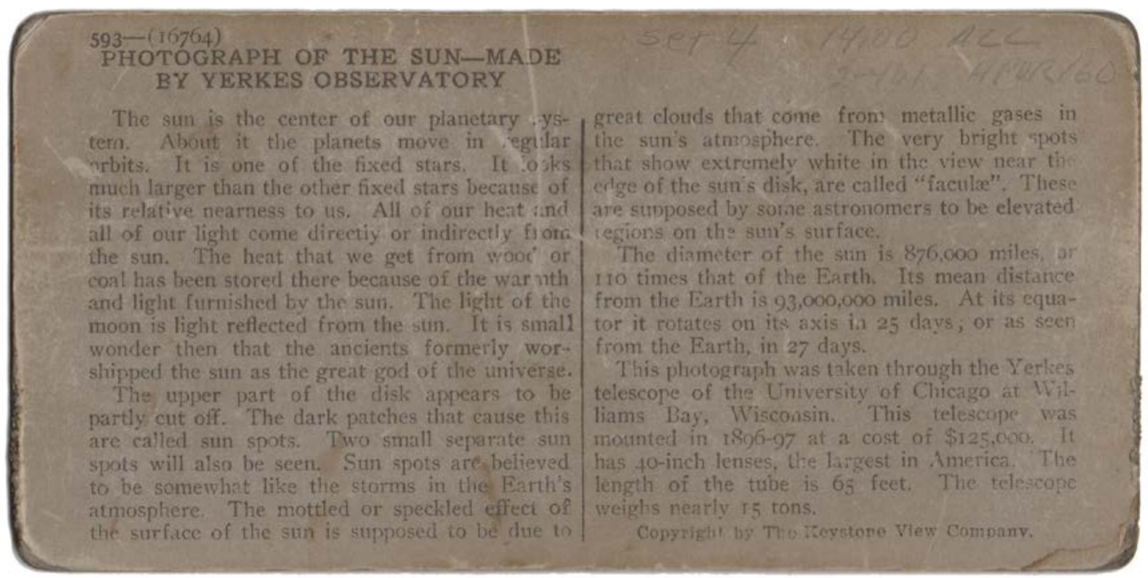


Figure 1b - 593 – 16764, The Sun photographed through forty-inch telescope, Yerkes Observatory, Author's Collection



593—(16764)
PHOTOGRAPH OF THE SUN—MADE BY YERKES OBSERVATORY

The sun is the center of our planetary system. About it the planets move in regular orbits. It is one of the fixed stars. It looks much larger than the other fixed stars because of its relative nearness to us. All of our heat and all of our light come directly or indirectly from the sun. The heat that we get from wood or coal has been stored there because of the warmth and light furnished by the sun. The light of the moon is light reflected from the sun. It is small wonder then that the ancients formerly worshipped the sun as the great god of the universe.

The upper part of the disk appears to be partly cut off. The dark patches that cause this are called sun spots. Two small separate sun spots will also be seen. Sun spots are believed to be somewhat like the storms in the Earth's atmosphere. The mottled or speckled effect of the surface of the sun is supposed to be due to great clouds that come from metallic gases in the sun's atmosphere. The very bright spots that show extremely white in the view near the edge of the sun's disk, are called "faculæ". These are supposed by some astronomers to be elevated regions on the sun's surface.

The diameter of the sun is 876,000 miles, or 110 times that of the Earth. Its mean distance from the Earth is 93,000,000 miles. At its equator it rotates on its axis in 25 days, or as seen from the Earth, in 27 days.

This photograph was taken through the Yerkes telescope of the University of Chicago at Williams Bay, Wisconsin. This telescope was mounted in 1896-97 at a cost of $125,000. It has 40-inch lenses, the largest in America. The length of the tube is 65 feet. The telescope weighs nearly 15 tons.

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The Moon

Of all celestial bodies, the Moon is no doubt the most interesting with regards the method of obtaining the two photographs needed to obtain the stereograph. The first stereoscopic photographs of the Moon were taken towards the end of the 1850s. The great amateur astronomer Warren de la Rue (1815-1889)[13] used lunar photographs to produce extraordinary stereoscopic pictures by grouping pairs of photographs taken at different stages of lunar libration at the Cranford Observatory, as he explained in detail in his article "The Present State of Celestial Photography in England" published in 1859 in *The Report of the 29th Meeting of the British Association for the Advancement of Science:*

> Taking advantage of the libration, we may, by combining two views taken at sufficiently distant periods, produce stereoscopic pictures, which present to the eyes the moon as a sphere. It has been remarked by the Astronomer Royal, that such a result is an experimental proof of the rotundity of our satellite. A dispute has been going on between photographers as to the proper angle for taking terrestrial stereoscopic pictures, and I infer that one side of the disputants would consider my arrangement of moon-pictures to produce stereographs unnatural, because under no circumstances could the moon itself be so seen by human eyes; but, to use Sir John Herschel's words, the view is such as would be seen by a giant with eyes thousands of miles apart: after all, the stereoscope affords such a view as we should get if we possessed a perfect model of the moon and placed it at a suitable distance from the eyes, and we may be well satisfied to possess such means of extending our knowledge respecting the moon, by thus availing ourselves of the giant eyes of science. It does not follow as a matter of course that any two pictures of the moon taken under different conditions of libration will make a true stereoscopic picture; so far from this being the case, a most distorted image would result, unless attention he paid first to the selection of the lunar pictures, and then to their position on the stereoscopic slide. It is possible to determine beforehand, by calculation, the epochs at which the two photographs must be taken in order to produce a stereoscopic picture; but so many circumstances stand in the way of celestial photography, that the better course is to take the lunar photographs on every favourable occasion, and afterwards to group such pictures as are known to be suitable.[14]

De la Rue provides further details in his description of the exhibited stereographs:

> At the meeting at Leeds last year, there were exhibited some of my stereoscopic lunar pictures 8 inches in diameter, and an apparatus constructed expressly for viewing them. The instrument is of similar construction to Wheatstone's reflecting stereoscope; but, the objects being transparent, the usual arrangements and adjustments are considerably modified. Prisms with slight curvatures worked on their surfaces are employed, instead of mirrors, for combining the pictures, which can be revolved and moved horizontally and vertically in order to place them in the true position. The effect of rotundity is perfect over the whole surface; and parts, which appear like plane surfaces in a single photograph, in the stereoscope, present the most remarkable undulations and irregularities.[15]

Herschel, among many other astronomers, expressed his wonder and admiration at their effect:

Figure 2a – The Full Moon, Yerkes Observatory, Plate number: 16648, Museum of Photography, University of California Riverside

> It is a step in <u>nature</u> but beyond <u>human</u> nature as if a giant with eyes some thousands of miles apart looked at the Moon through binoculars. What surprises me most is the extraordinary difference in the two pictures as seen by either of the eyes separately not only in form but in shadow & light & the way in which they blend into one is something quite astonishing.[16]

Smith, Beck & Beck published De la Rue's lunar stereographs, with detailed observational information of the two photographs utilised for the stereograph on their back.[17] The images of the Moon published in the Keystone sets were done using the same method that De la Rue used some decades before, but the text on their backs was of another nature, written in a precise and clear way to match the student's educational needs.

The two images of the Moon (Figures 2a, 3a and 2b, 3b) present in the 600 set are, interestingly, not attributed to any astronomer-photographer, nor to an observatory, in the back of the card. However, these could be attributed to Wallace[18] after going through the list of stereographs published in the aforementioned An Illustrated Catalogue of Astronomical Photographs (1923), who used lunar libration, as explained above, to get the two photographs needed for the stereograph.[19]

The text written on the back of the first lunar stereograph reads:

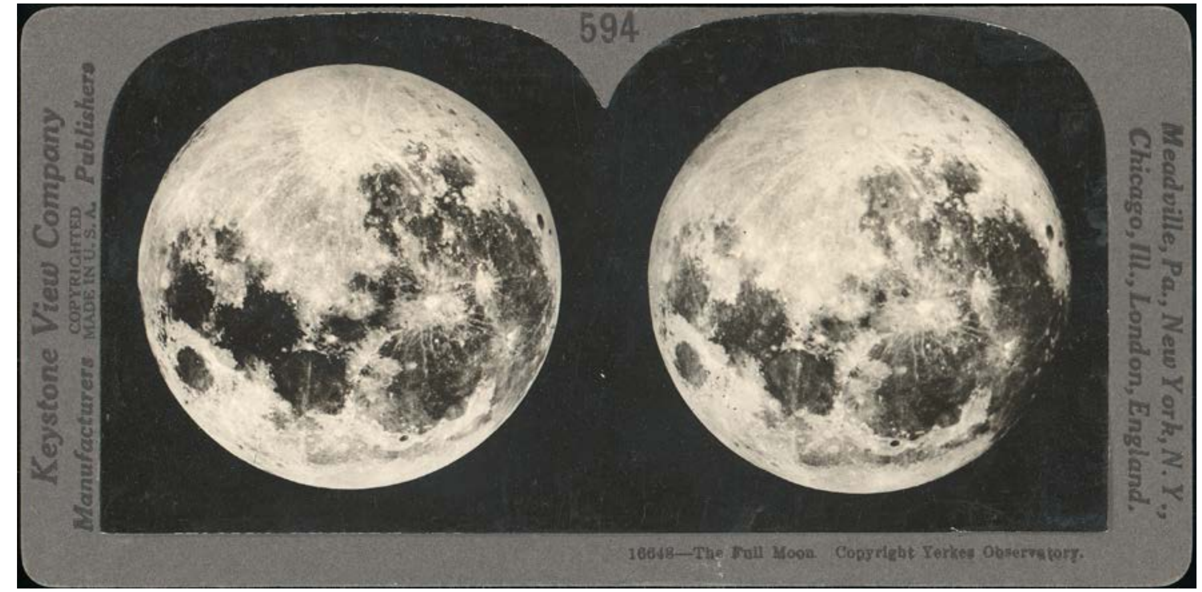
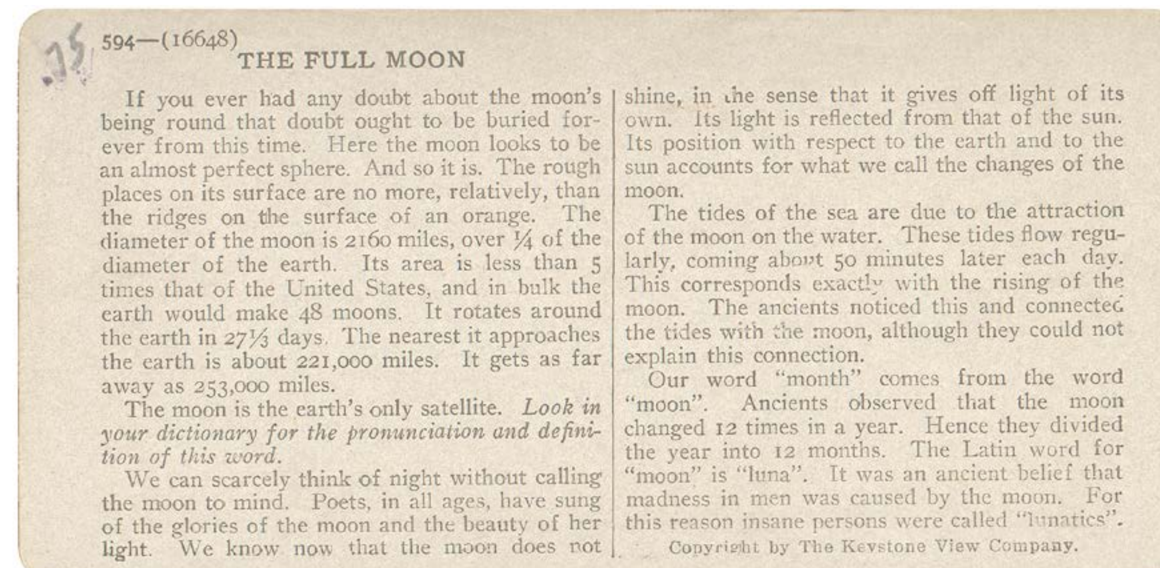


Figure 2b – 594 – (16648), The Full Moon, Author's Collection



594—(16648)

THE FULL MOON

If you ever had any doubt about the moon's being round that doubt ought to be buried forever from this time. Here the moon looks to be an almost perfect sphere. And so it is. The rough places on its surface are no more, relatively, than the ridges on the surface of an orange. The diameter of the moon is 2160 miles, over ¼ of the diameter of the earth. Its area is less than 5 times that of the United States, and in bulk the earth would make 48 moons. It rotates around the earth in 27⅓ days. The nearest it approaches the earth is about 221,000 miles. It gets as far away as 253,000 miles.

The moon is the earth's only satellite. *Look in your dictionary for the pronunciation and definition of this word.*

We can scarcely think of night without calling the moon to mind. Poets, in all ages, have sung of the glories of the moon and the beauty of her light. We know now that the moon does not shine, in the sense that it gives off light of its own. Its light is reflected from that of the sun. Its position with respect to the earth and to the sun accounts for what we call the changes of the moon.

The tides of the sea are due to the attraction of the moon on the water. These tides flow regularly, coming about 50 minutes later each day. This corresponds exactly with the rising of the moon. The ancients noticed this and connected the tides with the moon, although they could not explain this connection.

Our word "month" comes from the word "moon". Ancients observed that the moon changed 12 times in a year. Hence they divided the year into 12 months. The Latin word for "moon" is "luna". It was an ancient belief that madness in men was caused by the moon. For this reason insane persons were called "lunatics".

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Figure 3a – The Moon at the age of 17 days, Yerkes Observatory, Plate number: 16646

594 – (16648) THE FULL MOON – If you ever had any doubt about the Moon being round, that doubt ought to be buried forever from this time. Here the moon looks to be an almost perfect sphere. And so it is. […] The tides of the sea are due to the attraction of the moon on the water. These tides flow regularly, coming about 50 minutes later each day. This corresponds exactly with the rising of the moon.

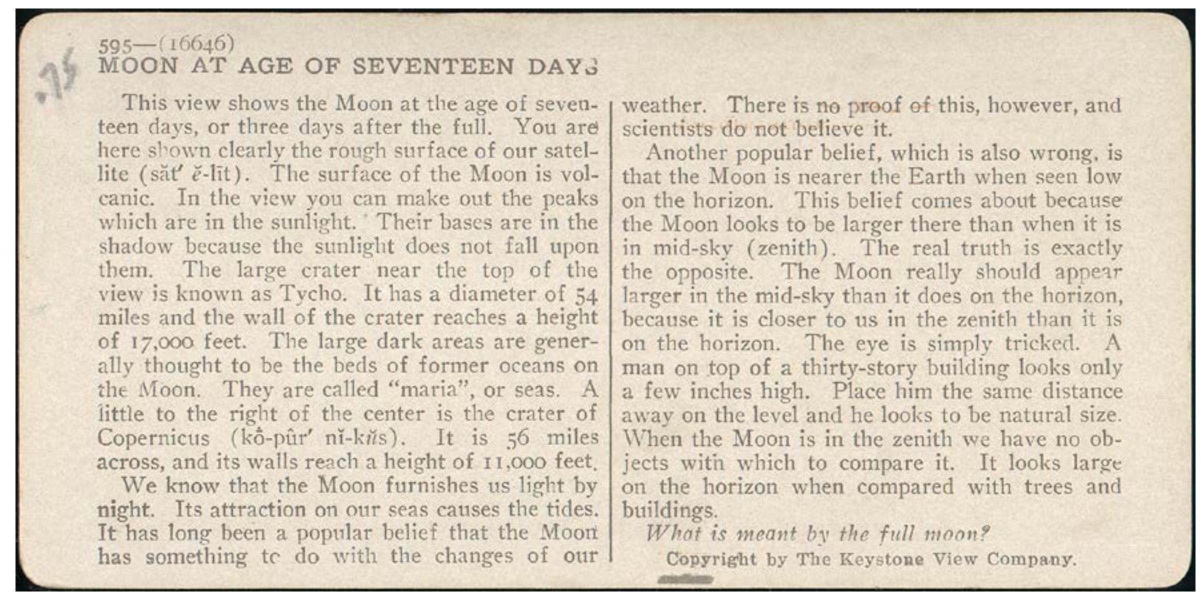
The back of the second one reads:

595 – (16646) MOON AT THE AGE OF SEVENTEEN DAYS – This view shows the Moon at the age of seventeenth days, or three days after the full. You are here shown clearly the rough surface of our satellite. The surface of the Moon is volcanic.

Astronomers believed in the 19th century that the Moon's surface was volcanic, which was later demonstrated not to be the case. Hence, these cards also bear pieces of information which were assumed to be correct then, but which became misleading after some time. Both cards also devote space to clarifying some ancient myths and wrong popular beliefs about the Moon:

It was an ancient belief that madness in men was caused by the Moon. For this reason, insane persons were called "lunatics". (594)

Figure 3b – 595 – (16646), Moon at age of seventeenth days, Author's Collection



595—(16646)
MOON AT AGE OF SEVENTEEN DAYS

This view shows the Moon at the age of seventeen days, or three days after the full. You are here shown clearly the rough surface of our satellite (săt' ĕ-līt). The surface of the Moon is volcanic. In the view you can make out the peaks which are in the sunlight. Their bases are in the shadow because the sunlight does not fall upon them. The large crater near the top of the view is known as Tycho. It has a diameter of 54 miles and the wall of the crater reaches a height of 17,000 feet. The large dark areas are generally thought to be the beds of former oceans on the Moon. They are called "maria", or seas. A little to the right of the center is the crater of Copernicus (kô-pûr' nĭ-kŭs). It is 56 miles across, and its walls reach a height of 11,000 feet.

We know that the Moon furnishes us light by night. Its attraction on our seas causes the tides. It has long been a popular belief that the Moon has something to do with the changes of our weather. There is no proof of this, however, and scientists do not believe it.

Another popular belief, which is also wrong, is that the Moon is nearer the Earth when seen low on the horizon. This belief comes about because the Moon looks to be larger there than when it is in mid-sky (zenith). The real truth is exactly the opposite. The Moon really should appear larger in the mid-sky than it does on the horizon, because it is closer to us in the zenith than it is on the horizon. The eye is simply tricked. A man on top of a thirty-story building looks only a few inches high. Place him the same distance away on the level and he looks to be natural size. When the Moon is in the zenith we have no objects with which to compare it. It looks large on the horizon when compared with trees and buildings.

What is meant by the full moon?

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It has long been a popular belief that the Moon has something to do with the changes in our weather. There is no proof of this, however, and scientists do not believe it.

Another popular belief, which is has also been shown to be wrong, is that the Moon is nearer the earth when seen low on the horizon. This belief comes about because the Moon looks to be larger than when it is in mid-sky (zenith). The real truth is exactly the opposite. The Moon really should appear larger in the mid-sky than it does in the horizon, because it is closer to us in the zenith than it is on the horizon. The eye is simply tricked. (**595**)

Mars

In his article "Photographing the Sky" (1923), Edward Emerson Barnard (1857-1923) describes the nine photographs that he took of Mars and printed in his article, two of them being used for the photographic plate (Figure 4a), later used to get the stereograph published in the 600 SET:

> Here are some photographs of the planet Mars taken with the great telescope at Yerkes Observatory (see Plate XIV). The white spot at the upper part of the disc is the south polar cap – presumably of snow and ice. There is a similar one at the North Pole. These white spots, during the winter of the planet, become very large and extend to middle latitudes; while in the Martian summer they melt away almost entirely. They perhaps consist of a comparatively thin sheeting of snow.[20]

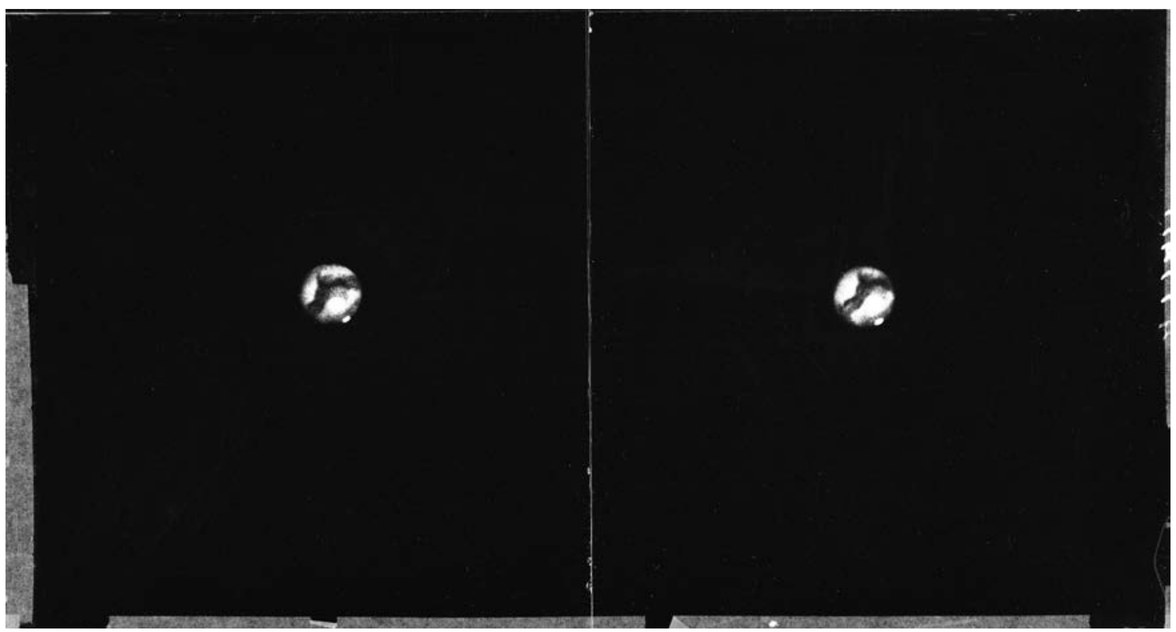
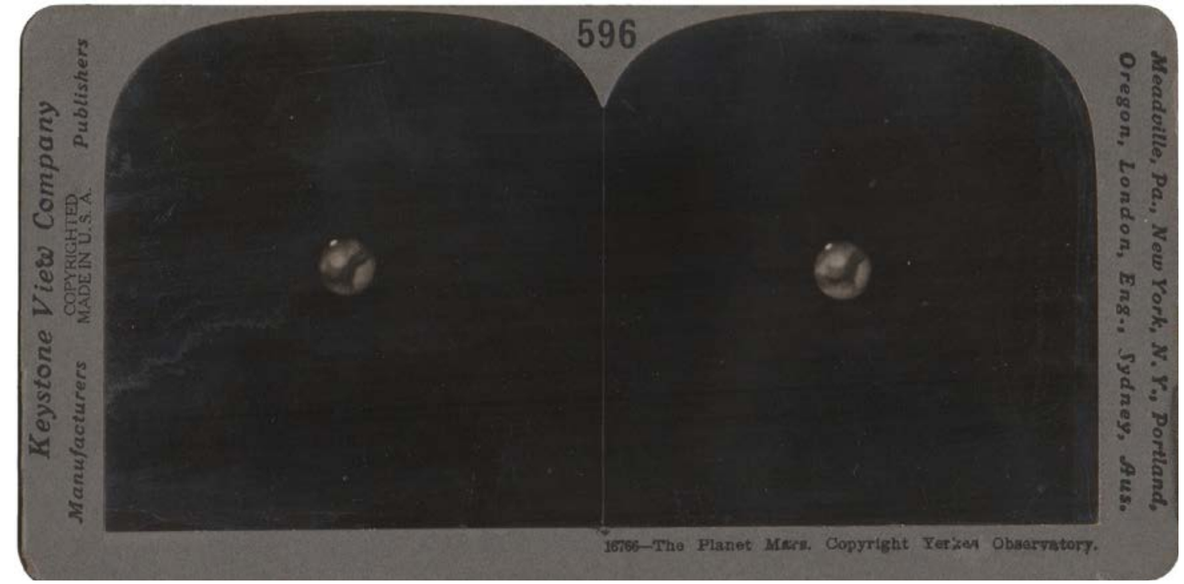


Figure 4a – The planet Mars, Yerkes Observatory, Plate number: 16766, Museum of Photography, University of California, Riverside



596—(16766)

THE PLANET MARS

If you look at the sky on a clear night you will see a countless number of "stars". Some are very bright, others are very dim, and others are clustered so thickly together that they form a great Milky Way across the heavens. The heavenly bodies are divided into planets, stars, and comets or meteors. The word planet means wanderer. Here is one of these wanderers of the sky. It is the red planet Mars.

It is the nearest planet neighbor of the Earth. By means of high-power telescopes, we know that its surface is made up of fixed dark and light areas. These are possibly regions of vegetation and desert land. There are on the planet no great bodies of water like our oceans. It has a thin atmosphere in which clouds are almost never seen. The small white spot on the upper part of the disk is the south polar cap. It is probably snow. The cap shown here is about 500 miles across. A few months earlier it covered a much larger area. But the heat of the summer of Mars melted most of it. During the winter of Mars, in its greatest extent the cap is about 2,000 miles across.

The mean distance of Mars from the sun is 142,000,000 miles. Its diameter is 4,300 miles, a little over half that of the Earth. Its distance from us when this view was taken, was 48,000,000 miles.

We have no proof that there is any life on the planet. Some astronomers believe people live there now. They base their guesses on what are called the "Martian Canals". These appear through the telescope as a network of dark lines. But they may be something entirely different from canals—nobody knows.

[This photograph was taken on September 28th, 1909, by E. E. Barnard, at the Yerkes Observatory, through a 40 inch telescope.]

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Figure 4b - 596 – (16766), The Planet Mars, E. E. Barnard, Mt. Wilson Observatory, 28.09.1909, 40 inch telescope, Author's Collection

He then goes on to provide further information that hint towards how he managed to produce the stereoscopic effect by combining two of the images that he took that night:

> You will see that these photographs show the turning of the planet on its axis, from west to east. This great dark spot here, called the Syrtis Major, is to the right of the center, and here you see it three hours later to the left of the center, thus showing the rotation of the planet on its axis, producing day and night.[21]

Following on, in the case of Mars, the stereoscopic effect could be (and was) achieved by taking the two photographs within around 3 hours of difference.

On the back of Keystone stereograph The Planet Mars (Figure 4b), factual information can be read. This information for example included facts such as the photographs were taken by Barnard of the Yerkes Observatory, through a 40-inch telescope. Nevertheless, as in the case of the card of the Moon, in the card of Mars various incorrect scientific information can also be read which was believed by some astronomers who specialized on Mars at that time:

> **596 – (16766) THE PLANET MARS –** We have no proof that there is any life on the planet. Some astronomers believe people live there now. They base their guesses on what are called the "Martian Canals". These appear through the telescope as a network of dark lines. But they may be something entirely different from canals – nobody knows.

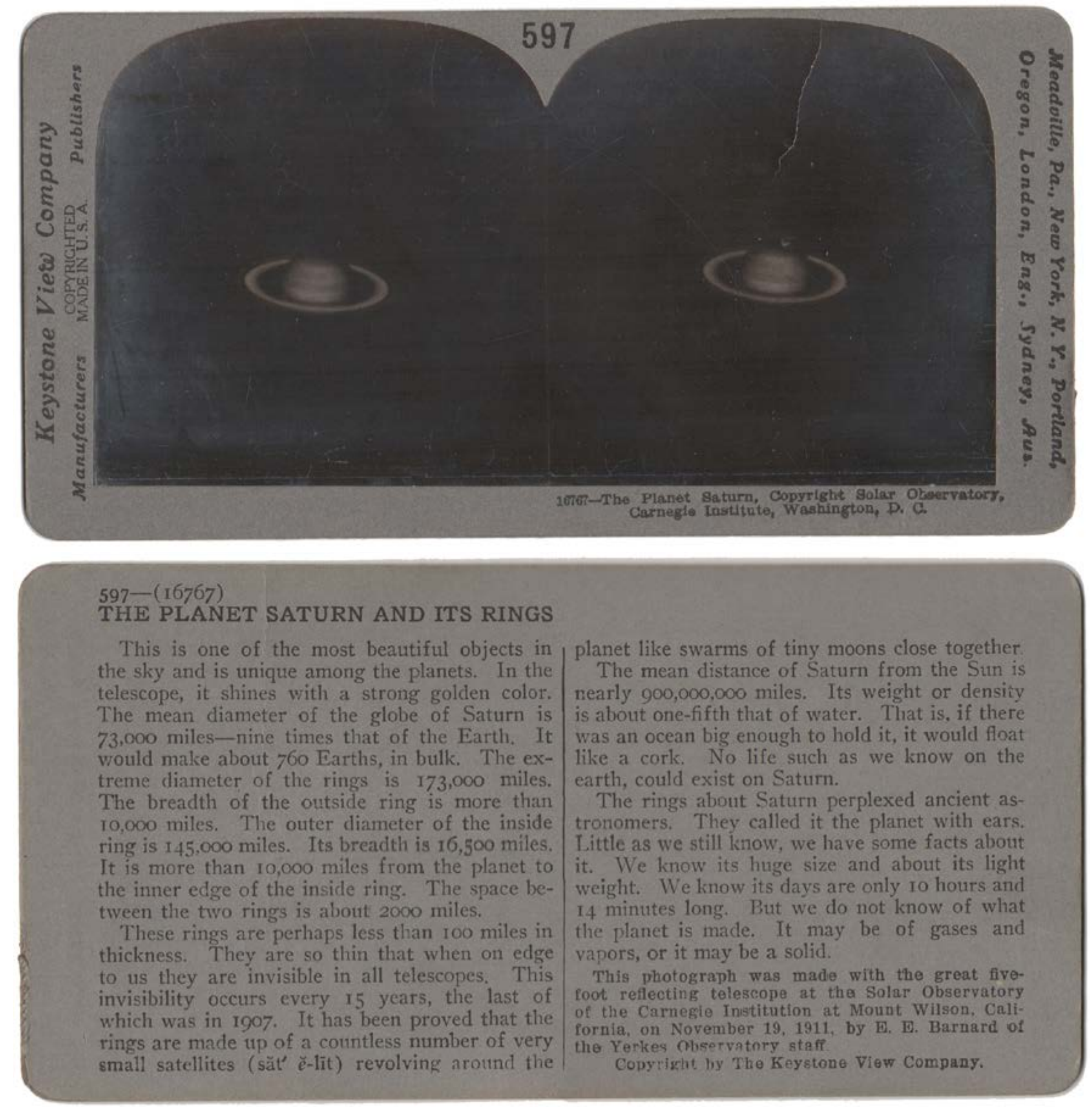
The canals of Mars were first identified and described by the Italian astronomer Giovanni Schiaparelli (1835-1910) during the opposition of 1877. Percival Lowel

(1855-1916) fabricated the theory that the canals were built for irrigation by an intelligent civilization of Mars.[22]

Saturn

In Barnard's article *Photographing the Sky,* he also explains about the six plates of Saturn that he took in the night of the 19th of November 1911. Two of these images were used to produce the stereograph of Saturn presented here, which means that, as with the case in Mars, the two photographs needed for the stereograph could be taken during the same night. The astronomer gives detailed information on the photographs he took of Saturn and about what was known or believed about the planet:

> This is a photograph of the wonderful ringed world Saturn (see Plate XIV). What a splendid object it is! In the telescope, it appears like a golden globe (76,000 miles in diameter) surrounded by a system of great flat rings that are perfect circles. These rings are 172,000 miles in diameter; yet they are so thin that we cannot see them when they are on edge to us, a circumstance, which occurs every fifteen years.[23]



597—(16767)
THE PLANET SATURN AND ITS RINGS

This is one of the most beautiful objects in the sky and is unique among the planets. In the telescope, it shines with a strong golden color. The mean diameter of the globe of Saturn is 73,000 miles—nine times that of the Earth. It would make about 760 Earths, in bulk. The extreme diameter of the rings is 173,000 miles. The breadth of the outside ring is more than 10,000 miles. The outer diameter of the inside ring is 145,000 miles. Its breadth is 16,500 miles. It is more than 10,000 miles from the planet to the inner edge of the inside ring. The space between the two rings is about 2000 miles.

These rings are perhaps less than 100 miles in thickness. They are so thin that when on edge to us they are invisible in all telescopes. This invisibility occurs every 15 years, the last of which was in 1907. It has been proved that the rings are made up of a countless number of very small satellites (săt' ĕ-līt) revolving around the planet like swarms of tiny moons close together.

The mean distance of Saturn from the Sun is nearly 900,000,000 miles. Its weight or density is about one-fifth that of water. That is, if there was an ocean big enough to hold it, it would float like a cork. No life such as we know on the earth, could exist on Saturn.

The rings about Saturn perplexed ancient astronomers. They called it the planet with ears. Little as we still know, we have some facts about it. We know its huge size and about its light weight. We know its days are only 10 hours and 14 minutes long. But we do not know of what the planet is made. It may be of gases and vapors, or it may be a solid.

This photograph was made with the great five-foot reflecting telescope at the Solar Observatory of the Carnegie Institution at Mount Wilson, California, on November 19, 1911, by E. E. Barnard of the Yerkes Observatory staff.

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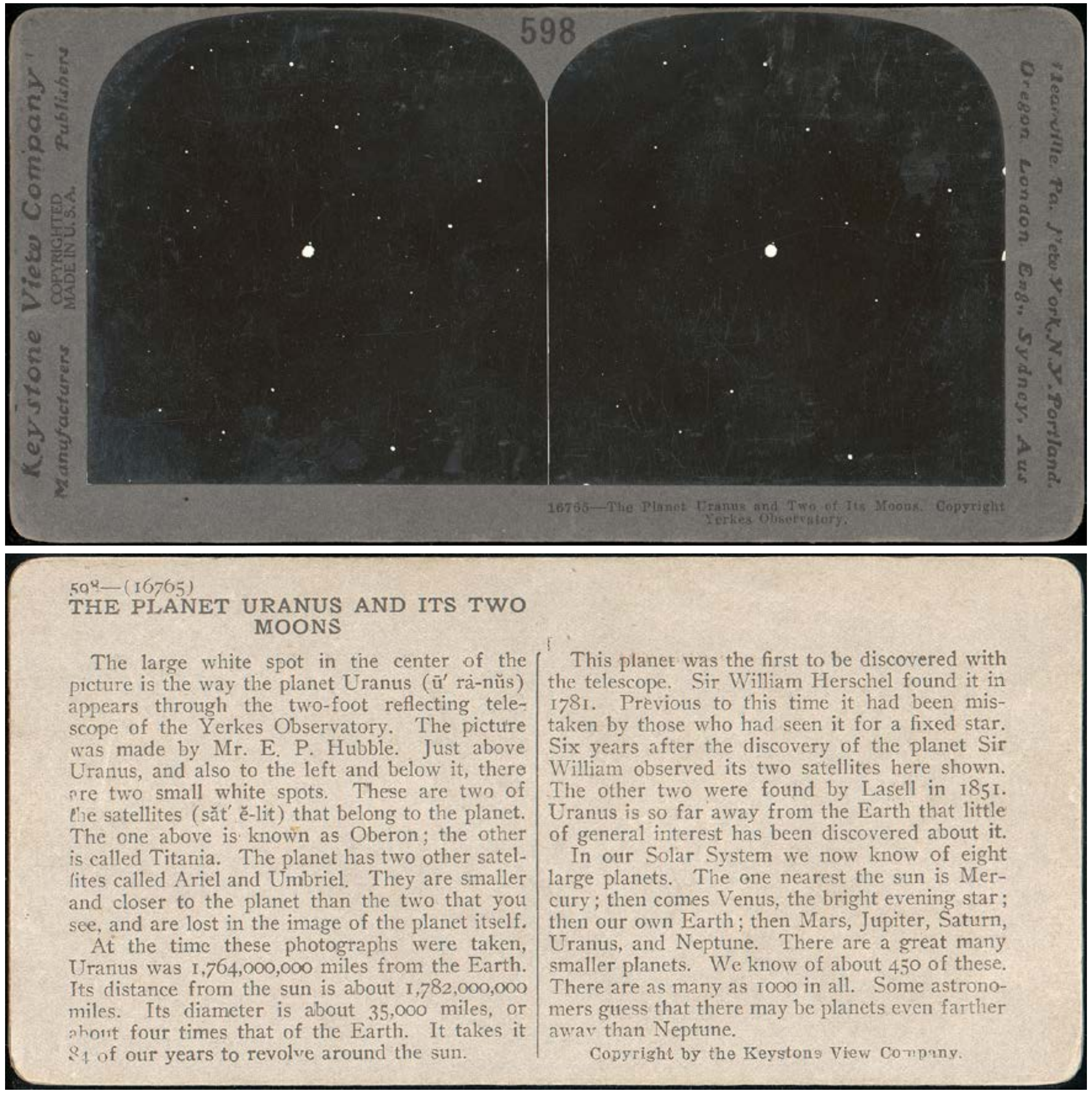
Figure 5 - 597 – (16767), The Planet Saturn and Its Rings, E. E. Barnard, Mt. Wilson Observatory, 19.11.1911, Author's Collection

On the back of the Keystone stereograph The Planet Saturn and Its Rings (Figure 5), there is an explanation that the photographs were taken with the great five-foot reflecting telescope at the Solar Observatory of the Carnegie Institution at Mount Wilson (California) on 19th November 1911, by Barnard.

Uranus and Meteor in Constellation of Orion

On the back of the Planet Uranus and Its Two Moons (Figure 6), it is detailed that the photographs were taken with the two-foot reflecting telescope of the Yerkes Observatory by Edwin Powell Hubble (1889-1953).

Barnard (with Frank Sulivan) took the photographs for the stereograph Meteor in Constellation of Orion (Figure 7), as it has been written on the back of this stereograph and also as it can be read on An Illustrated Catalogue of Astronomical Photographs (1923).



598—(16765)
THE PLANET URANUS AND ITS TWO MOONS

The large white spot in the center of the picture is the way the planet Uranus (ū′ rā-nŭs) appears through the two-foot reflecting telescope of the Yerkes Observatory. The picture was made by Mr. E. P. Hubble. Just above Uranus, and also to the left and below it, there are two small white spots. These are two of the satellites (săt′ ĕ-lit) that belong to the planet. The one above is known as Oberon; the other is called Titania. The planet has two other satellites called Ariel and Umbriel. They are smaller and closer to the planet than the two that you see, and are lost in the image of the planet itself.

At the time these photographs were taken, Uranus was 1,764,000,000 miles from the Earth. Its distance from the sun is about 1,782,000,000 miles. Its diameter is about 35,000 miles, or about four times that of the Earth. It takes it 84 of our years to revolve around the sun.

This planet was the first to be discovered with the telescope. Sir William Herschel found it in 1781. Previous to this time it had been mistaken by those who had seen it for a fixed star. Six years after the discovery of the planet Sir William observed its two satellites here shown. The other two were found by Lasell in 1851. Uranus is so far away from the Earth that little of general interest has been discovered about it.

In our Solar System we now know of eight large planets. The one nearest the sun is Mercury; then comes Venus, the bright evening star; then our own Earth; then Mars, Jupiter, Saturn, Uranus, and Neptune. There are a great many smaller planets. We know of about 450 of these. There are as many as 1000 in all. Some astronomers guess that there may be planets even farther away than Neptune.

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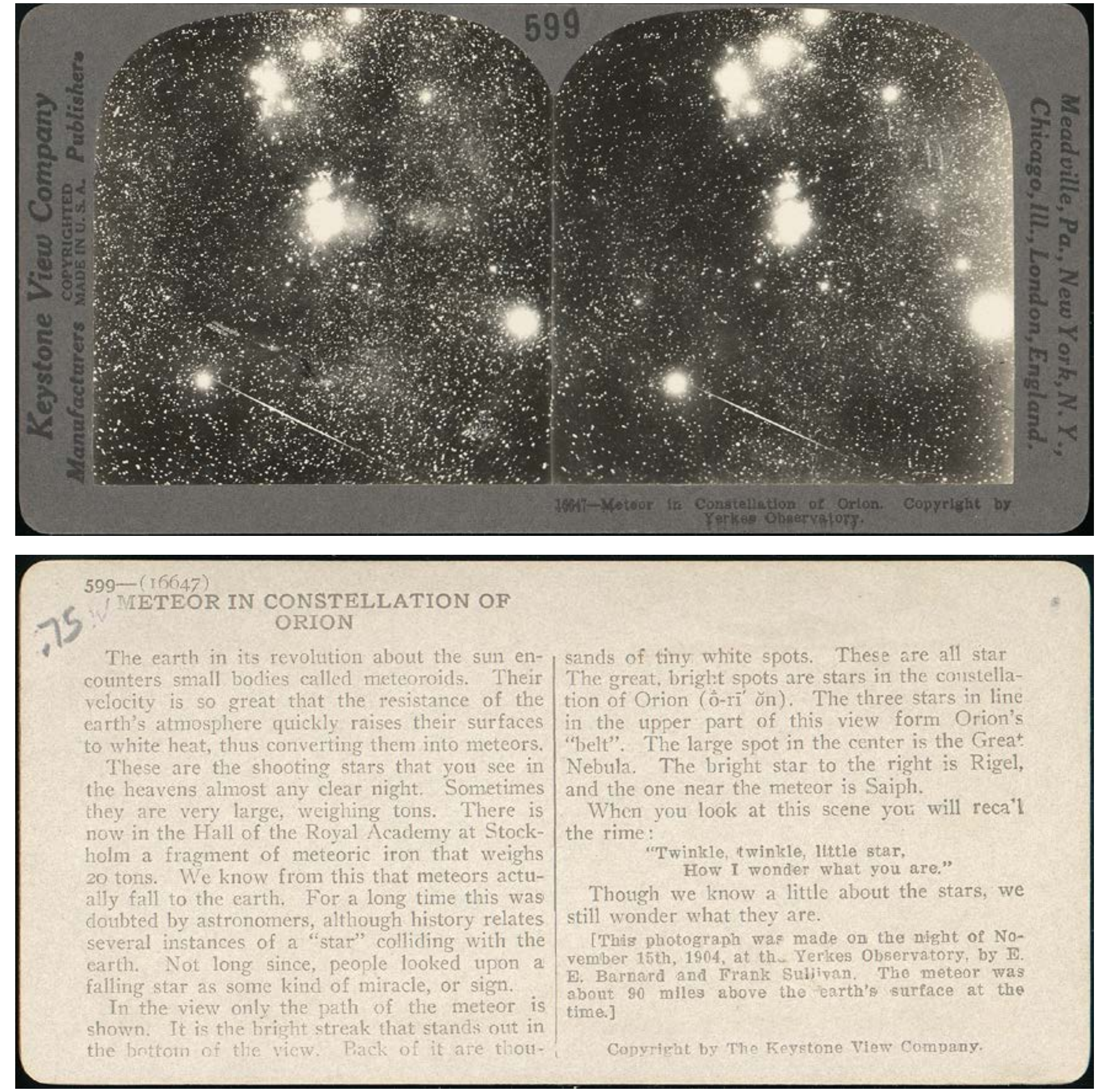
Figure 6 - 598 – (16765), The Planet Uranus and its two moons,
E. P. Hubble, two-foot reflecting telescope, Yerkes Observatory, Author's Collection



599—(16647)
METEOR IN CONSTELLATION OF ORION

The earth in its revolution about the sun encounters small bodies called meteoroids. Their velocity is so great that the resistance of the earth's atmosphere quickly raises their surfaces to white heat, thus converting them into meteors.

These are the shooting stars that you see in the heavens almost any clear night. Sometimes they are very large, weighing tons. There is now in the Hall of the Royal Academy at Stockholm a fragment of meteoric iron that weighs 20 tons. We know from this that meteors actually fall to the earth. For a long time this was doubted by astronomers, although history relates several instances of a "star" colliding with the earth. Not long since, people looked upon a falling star as some kind of miracle, or sign.

In the view only the path of the meteor is shown. It is the bright streak that stands out in the bottom of the view. Back of it are thousands of tiny white spots. These are all star The great, bright spots are stars in the constellation of Orion (ō-rī′ ŏn). The three stars in line in the upper part of this view form Orion's "belt". The large spot in the center is the Great Nebula. The bright star to the right is Rigel, and the one near the meteor is Saiph.

When you look at this scene you will recall the rime:

"Twinkle, twinkle, little star,
How I wonder what you are."

Though we know a little about the stars, we still wonder what they are.

[This photograph was made on the night of November 15th, 1904, at the Yerkes Observatory, by E. E. Barnard and Frank Sullivan. The meteor was about 90 miles above the earth's surface at the time.]

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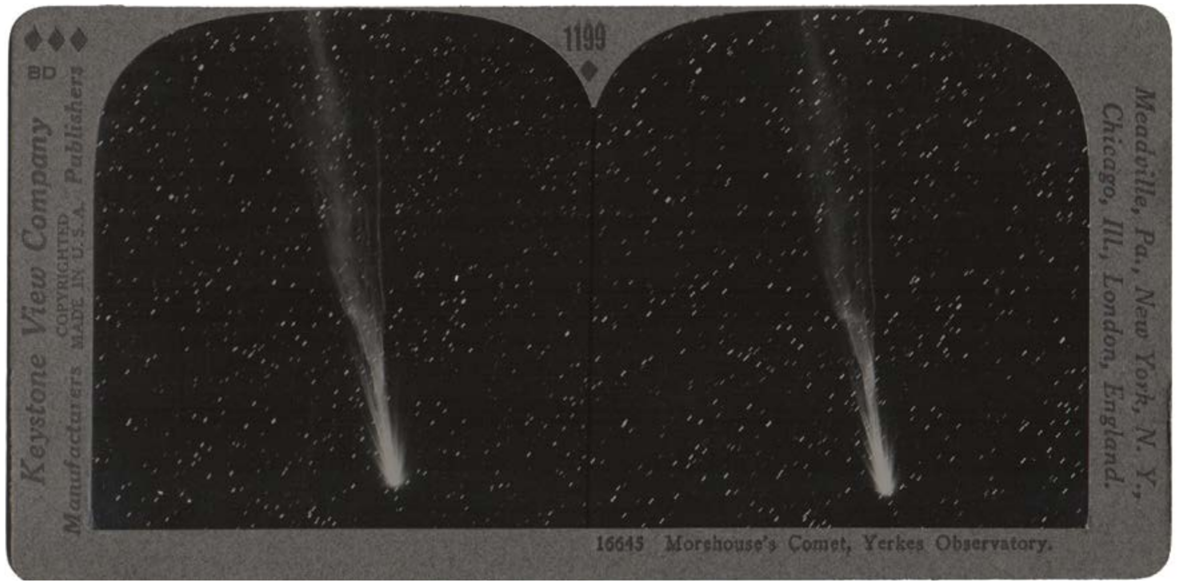
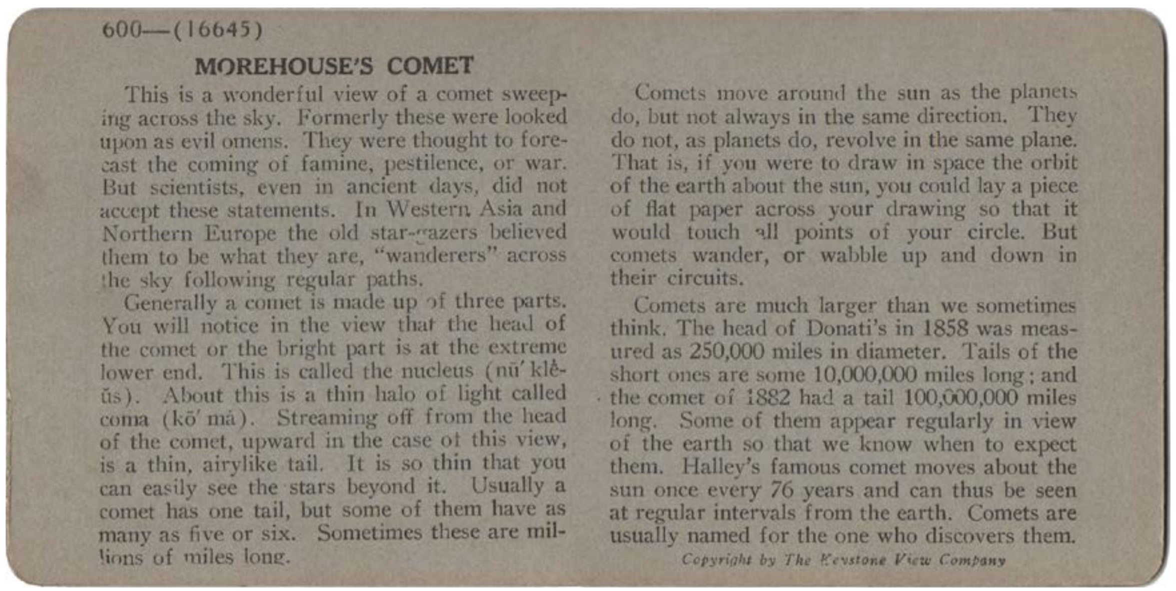
Figure 7 - 599 – (16647), Meteor in constellation of Orion,
E. E. Barnard (with Frank Sulivan), Author's Collection

Morehouse Comet





600—(16645)

MOREHOUSE'S COMET

This is a wonderful view of a comet sweeping across the sky. Formerly these were looked upon as evil omens. They were thought to forecast the coming of famine, pestilence, or war. But scientists, even in ancient days, did not accept these statements. In Western Asia and Northern Europe the old star-gazers believed them to be what they are, "wanderers" across the sky following regular paths.

Generally a comet is made up of three parts. You will notice in the view that the head of the comet or the bright part is at the extreme lower end. This is called the nucleus (nū' klē-ŭs). About this is a thin halo of light called coma (kō' mȧ). Streaming off from the head of the comet, upward in the case of this view, is a thin, airylike tail. It is so thin that you can easily see the stars beyond it. Usually a comet has one tail, but some of them have as many as five or six. Sometimes these are millions of miles long.

Comets move around the sun as the planets do, but not always in the same direction. They do not, as planets do, revolve in the same plane. That is, if you were to draw in space the orbit of the earth about the sun, you could lay a piece of flat paper across your drawing so that it would touch all points of your circle. But comets wander, or wabble up and down in their circuits.

Comets are much larger than we sometimes think. The head of Donati's in 1858 was measured as 250,000 miles in diameter. Tails of the short ones are some 10,000,000 miles long; and the comet of 1882 had a tail 100,000,000 miles long. Some of them appear regularly in view of the earth so that we know when to expect them. Halley's famous comet moves about the sun once every 76 years and can thus be seen at regular intervals from the earth. Comets are usually named for the one who discovers them.

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Figure 8 - 600 – (16645), Morehouse's Comet, Attr. E.E. Barnard, between the 1st of September and the 16th October 1908, Author's Collection

Although the text written on the back of the Morehouse's Comet card (Figure 8) does not identify the photographer, it was surely taken by Edward Emerson Barnard as well.[24] This is easy to probe by inspecting the article he wrote on the photographs he took of the aforementioned comet,[25] and also by viewing the originals of these images retained at the Yerkes Observatory Archive.[26] In one of his articles, published in 1909, he notes:

> In the case of the Moon the perspective is obtained by the aid of libration; and as the phase has to be exactly the same, a very long interval is required. In the case of a bright asteroid an interval of an hour, or of a proper motion star of several years, will produce the required effect. The short interval is also applicable to a comet, and beautiful and startling effects are produced by this means in the case of a comet with a tail. Few bright comets, however, are above the horizon long enough to permit the two photographs to be made for this purpose. On account of its high north declination, and its consequent visibility through all or nearly all the night, comet c 1908 (Morehouse) was especially suited for spectroscopic photographs, and the material acquired for this purpose is abundant.[27]

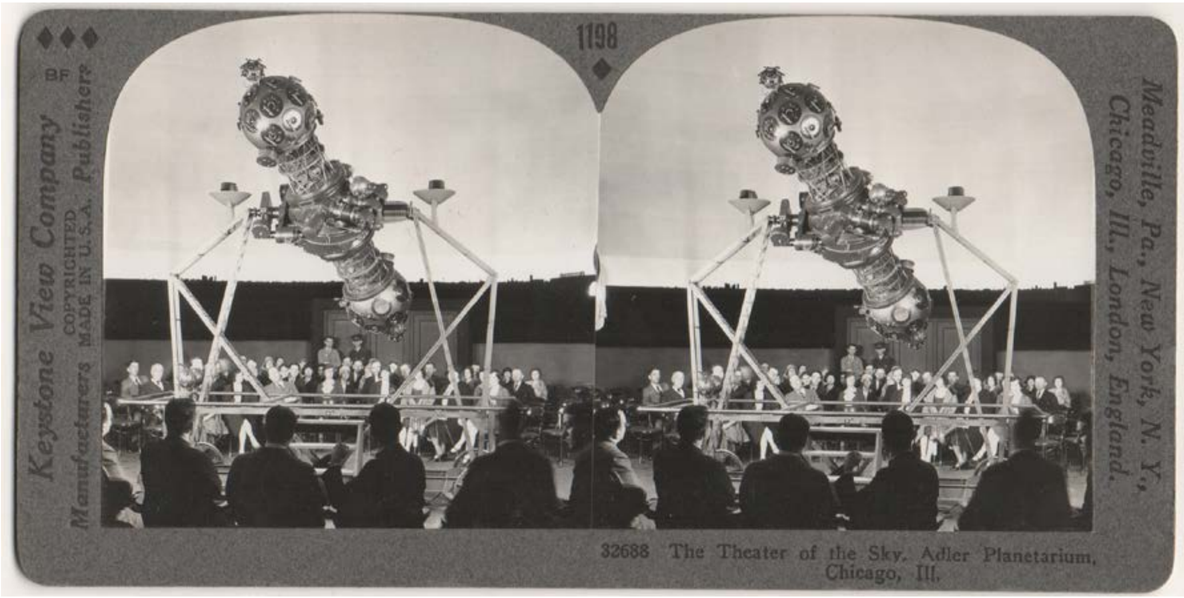
Barnard reflects, in the way that de la Rue did previously, about the limitations of the stereographic medium to achieve a fully faithful image of the celestial body represented:

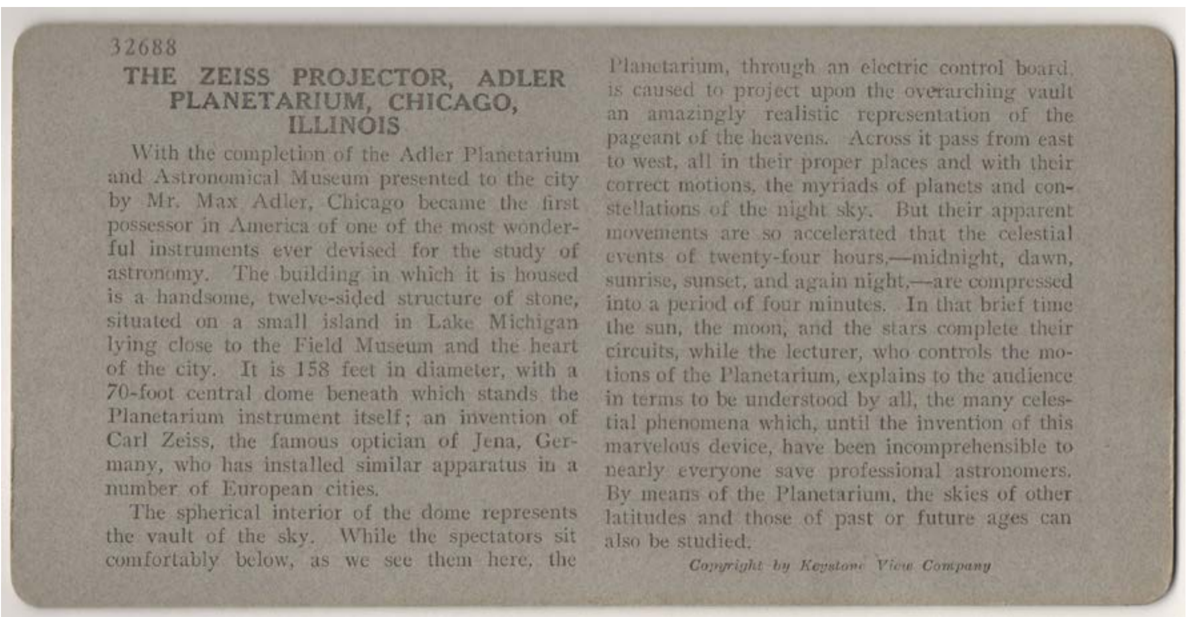
> Though the appearance, in a stereograph, of any one comet may be partly false, there is certainly no other method that can show us how a comet really looks like in space; and for this reason, if for no other, it will, I believe, in a truthful manner, help us to understand the features of comets in general.[28]

The 1200 SET also included three astronomical stereographs; two already printed in the 600 SET and one, which was printed for the first time (Figure 9). The images were:
1998 – (32688): The Theater of the Sky, Adler Planetarium, Chicago III.
1999 – (16645): Morehouse's Comet, Yerkes Observatory
1200 – (16648): The Full Moon, Yerkes Observatory

It is also important to note that the text written on the back of the Moon card changed as well. This was confirmed by comparing the two cards from the two sets.

In addition to the Keystone Company, there were many other companies, which published space images. To date, we have been able to locate space images within the sets of these companies, most of them American: Keystone View Company; Underwood & Underwood; Edward Bierstad; Kilburn Brothers; Stereo Gems; Strohmeyer and Wyman; Smith, Beck & Beck; Charles Bierstad; Whiple; T.W. Ingersoll; Carniege Institute; Liberty Brand Stereoviews; and E. & H.T. Anthony. Further studies in the use of the space images in other collections are greatly encouraged.[29]





32688

THE ZEISS PROJECTOR, ADLER PLANETARIUM, CHICAGO, ILLINOIS

With the completion of the Adler Planetarium and Astronomical Museum presented to the city by Mr. Max Adler, Chicago became the first possessor in America of one of the most wonderful instruments ever devised for the study of astronomy. The building in which it is housed is a handsome, twelve-sided structure of stone, situated on a small island in Lake Michigan lying close to the Field Museum and the heart of the city. It is 158 feet in diameter, with a 70-foot central dome beneath which stands the Planetarium instrument itself; an invention of Carl Zeiss, the famous optician of Jena, Germany, who has installed similar apparatus in a number of European cities.

The spherical interior of the dome represents the vault of the sky. While the spectators sit comfortably below, as we see them here, the Planetarium, through an electric control board, is caused to project upon the overarching vault an amazingly realistic representation of the pageant of the heavens. Across it pass from east to west, all in their proper places and with their correct motions, the myriads of planets and constellations of the night sky. But their apparent movements are so accelerated that the celestial events of twenty-four hours,—midnight, dawn, sunrise, sunset, and again night,—are compressed into a period of four minutes. In that brief time the sun, the moon, and the stars complete their circuits, while the lecturer, who controls the motions of the Planetarium, explains to the audience in terms to be understood by all, the many celestial phenomena which, until the invention of this marvelous device, have been incomprehensible to nearly everyone save professional astronomers. By means of the Planetarium, the skies of other latitudes and those of past or future ages can also be studied.

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Figure 9 - 1998 – (32688) – The Zeiss Projector, Adler Planetarium, Chicago, Illinois, Author's Collection

To conclude, the astronomical stereographs produced by pioneer astronomer-photographers during the 1850s and 1860s remained rather unknown to the non-scientific audience. These circulated mostly among astronomers, even if they were printed in much reduced sets by Smith, Beck & Beck. Towards the end of the century, the photographic dry plate enabled systematic photographic surveys of the Moon and beyond. The American publishing companies, most notably Keystone, and other companies, played a fundamental role in bringing these astronomical images to a wider audience. They enabled a democratization of astronomical portraiture which could be attributed to the inclusion of astronomical images in their educational set of stereographs, which were used as leading visual tools to help students learn about our earth and its neighbours. The astronomical images of the Keystone 600 SET and 1200 SET were produced by professional astronomers working on leading observatories, most remarkably the Yerkes Observatory. However, the texts printed on their backs were written to match the student's educational needs, very much in contrast to the texts on the backs of De la Rue's lunar stereographs, which were detailed observational data of the nights in which the two photographs were taken.

Acknowledgments

I would like to thank Leigh Gleason for her help on providing high resolution scans of all the photographic plates of the space images of Keystone View Company published in this article, which are kept at the *California Museum of Photography* (University of California, Riverside), and for sharing her knowledge of the company with me. I also want to thank Julie Stoner from the *Prints and Photographs Division, Library of Congress* (Washington), and Karen Martin, curator of the Johnson-Shaw Stereoscopic Museum in Meadville.

Endnotes

1 Darrah, William C. (1977). The World of Stereographs. Gettysburg: W.C. Darrah Publisher; Jenkins, Harold F. (1957). Two points of view: the history of the parlor stereoscope. Elmira, N.Y: World Color Productions.

2 For detailed studies on the role of the stereograph as an educational tool in the classroom, see: Babbitts, Judith (2004). Stereographs and the construction of a visual culture in the United States. In Kabinovitz, Lauren and Geil, Abraham (Eds.), *Memory Bytes. History, Technology and Digital Culture.* Durham and London: Duke University Press; Bak, Meredith A. (2012). Democracy and discipline: Object lessons and the stereoscope in American education, 1870-1920. *Early Popular Visual Culture* 10(2), 147-167; and Plunket, John (2008). Selling stereoscopy, 1890-1915: Penny arcades, automatic machines and American salesman. *Early Popular Visual Culture* 6(3), 239-255; Judge, Arthur W. (1926). The educational value of the stereoscope. In *Stereoscopic photography. Its application to science, industry and education.* Boston: America Photographic Publishing Co.

3 The Johson-Shaw Stereoscopic Museum, which is a small museum, founded by two brothers who had three generations of their family working for the Keystone View Company, can be visited online in: http://www.johnsonshawmuseum.org/

4 E-mail communication, 05.10.2016.

5 *Visual Education. Teacher's Guide to Keystone "600 SET"*, iii.

6 Most of these guides can be accessed online: 1917: https://archive.org/details/cu31924013429612 also https://archive.org/details/visualeducationt04keys; 1919: https://archive.org/details/visualeducationt01keys; 1920: https://archive.org/details/visualeducationt02keys also https://archive.org/details/visualeducation00compgoog

7 Chamberlain, James F. (1922). Earth Neighbours. In *Visual Education. Teacher's Guide to Keystone "600 SET"*, pp. 140-41.

8 http://astro.uchicago.edu/yerkes/plates/plates2.html (accessed 25.01.2017)

9 I thank Leigh Gleason, curator of photography at the Museum of Photography, University of California Riverside, for providing me with the scans of all plates (done specially for my research). Leigh Gleason is PhD candidate at Monfort University, writing her dissertation of the marketing and publishing strategies of the Keystone View Company.

10 An Illustrated Catalogue of Astronomical Photographs including Latern Slides, Transparencies, and Prints from Negatives Made at yerkes Observatory (1923, 3rd edition). Chicago: Chicago University Press.

11 Miss Rhode Calvert was the wife of Edward Emerson Barnard: Frost, Edwin B. (1927). Edward Emerson Barnard, 1857-1923. Memoirs of the National Academy of Sciences. Volume XXI, 14th Memoir. Washington: Government Printing Office.

12 An Illustrated Catalogue of Astronomical Photographs, p. 29.

13 For a detailed study of his live and work, see: Le Conte, David (February 2011). Warren De La Rue – Pioneer astronomical photographer. *The Antiquarian Astronomer* 5, 14-35.

14 De la Rue, Warren (1859). The Present State of Celestial Photography in England. *The Report of the 29th Meeting of the British Association for the Advancement of Science*, 130.

15 De la Rue (1859), *The Present State of Celestial Photography in England*, 130.

16 Letter from Herschel to de la Rue, 10 October 1858 (Royal Society HS.6.D.143)

17 To see the set of images published by Smith, Beck & Beck online, please go to: http://www.londonstereo.com/modern_stereos_moons.html (accesed 14.05.2017).

18 William Wallace Campbell (1862-1938)

19 An Illustrated Catalogue of Astronomical Photographs, p. 29.

20 Barnard 1923, p. 188.

21 Barnard 1923, p. 189.

22 For a detailed chronology of the research on Mars in the 19th century, see NASA's website on Mars: http://mars.nasa.gov/allaboutmars/mystique/history/1800/ (accessed 03.02.2017)

23 Barnard 1923, p. 189.

24 This stereograph of Morehouse's comet was published also in several books, for example, in Judge, 1926, p. 197.

25 Barnard, E.E. (1909 May 3). On the Erroneous Results of a Stereoscopic Combination of Photographs of a Comet". *Yerkes Observatory,* 624-627.

26 In the excel table with the astronomical plates kept at the Photographic Archive at Yerkes Observatory, we can see that Barnard photographed the Morehouse Comet in the course of 35 nights between the 1st of September 1908 and the 16th October 1908. Next to this, in *An Illustrated Catalogue of Astronomical Photographs* (1923), we can read that Barnard took the photographs of the Morehouse's Comet.

27 Barnard 1909, p. 624.

28 Barnard 1909, p. 626.

29 An interesting set of 43 astronomical stereographs have been digitalized and are on display at the Metropolitan Museum's website: http://www.metmuseum.org/art/collection/search/288121 (accessed 25.01.2017)

Bibliography

Babbitts, J. (2004). Stereographs and the construction of a visual culture in the United States. In L. Kabinovitz and A. Geil (Eds.), *Memory Bytes. History, Technology and Digital Culture.* Durham and London: Duke University Press.

Bak, M. A. (2012). Democracy and discipline: Object lessons and the stereoscope in American education, 1870-1920. *Early Popular Visual Culture* 10(2), 147-167.

Barnard, E.E. (3rd May 1909). On the Erroneous Results of a Stereoscopic Combination of Photographs of a Comet. *Yerkes Observatory*, 624-627.

Barnard, E.E. (June 1923). Photographing the Sky. *The Journal of the Royal Astronomical Society of Canada* XVII (5), 177-196.

Chamberlain, J. F. (1922). Earth Neighbours. In Visual Education. Teacher's Guide to Keystone "600 SET" (pp. 140-41). Meadville: Keystone View Company.

Darrah, W. C. (1977). *The World of Stereographs.* Gettysburg: W.C. Darrah Publisher.

De la Rue, W. (1859). The Present State of Celestial Photography in England. In *The Report of the 29th Meeting of the British Association for the Advancement of Science*, 130.

Frost, E. B. (1927). Edward Emerson Barnard, 1857-1923. *Memoirs of the National Academy of Sciences. Volume XXI, 14th Memoir*. Washington: Government Printing Office.

Gill, D. (1887). The application of photography to astronomy. *Obs.* (10), 267-72, 283-94

Herschel (1858). Letter from Herschel to de la Rue, 10 October 1858 (Royal Society HS.6.D.143)

Judge, A. W. (1926). The educational value of the stereoscope. In *Stereoscopic photography. Its application to science, industry and education.* Boston: America Photographic Publishing Co.

Keystone View Company (1917). *Visual Education. Teacher's Guide to Keystone "600 SET"* (1917). Meadville: Keystone View Company.

Keystone View Company (1917). *Visual Education. Teacher's Guide to Keystone "600 SET"* (1919). Meadville: Keystone View Company.

Keystone View Company (1917). *Visual Education. Teacher's Guide to Keystone "600 SET"* (1920). Meadville: Keystone View Company.

Keystone View Company (1917). *Visual Education. Teacher's Guide to Keystone "600 SET"* (1922). Meadville: Keystone View Company.

Le Conte, D. (February 2011). Warren De La Rue – Pioneer astronomical photographer. *The Antiquarian Astronomer* 5: 14-35.

Plunket, J. (2008). Selling stereoscopy, 1890-1915: Penny arcades, automatic machines and American salesman. *Early Popular Visual Culture* 6(3), 239-255.

Rutherford, L. M. (1865). Astro. Photography. *American Journal of Science: an international earth science journal* 39: 304-309.

Warner, D.J. (1971). L.M. Rutherfurd: Pionner astronomer, photographer and spectroscopist. *Technol. Culture* 12.

Yerkes Observatory (1923, 3rd edition). *An Illustrated Catalogue of Astronomical Photographs including Latern Slides, Transparencies, and Prints from Negatives Made at yerkes Observatory*. Chicago: Chicago University Press.