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

CARMEN PÉREZ GONZÁLEZ
IZWT (Interdisciplinary Centre for Science and Technology Studies) Bergische Universität Wuppertal

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), 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.
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 Hale (1868-1938). The observatory houses a collection of over 170,000 photographic plates. 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. 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), it was confirmed that the photographer of the Sun for this stereograph was Miss Calvert, who took the two photographs, on the 14th February 1917.

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](image-url)
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) 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. 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. Herschel, among many other astronomers, expressed his wonder and admiration at their effect.
It is a step in nature but beyond human 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.  

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

**THE FULL MOON**

*If you ever had any doubts 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 ripples on the surface of an orange. The diameter of the moon is 2160 miles, over 1/6 of the diameter of the earth. Its area is less than 3 times that of the United States, and if both the earth would make 38 moons. It rotates around the earth in 27 1/3 days. The nearest it approaches the earth is about 221,000 miles. It gets as far away as 255,000 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 “moon” comes from the word “moon”. Ancient observers observed that the moon changed 12 times in a year. For this reason, the names were “lunacy”.*
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 seventeen 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)
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.120

![Figure 4a - The planet Mars, Yerkes Observatory, Plate number: 16766, Museum of Photography, University of California, Riverside](image)

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

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 Sullivan) 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).

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

Figure 7 - 599 – (16647), Meteor in constellation of Orion, E. E. Barnard (with Frank Sullivan), Author’s Collection
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; Carnegie 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
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.

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Endnotes

3 The Johnson-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.
6 Most of these guides can be accessed online: 1917: https://archive.org/details/visualeducationt04keys; 1919: https://archive.org/details/visualeducationt01keys; 1920: https://archive.org/details/visualeducationt02keys also https://archive.org/details/visualeducation00compgoog
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.
An Illustrated Catalogue of Astronomical Photographs, p. 29.

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


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

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


Barnard 1923, p. 188.

Barnard 1923, p. 189.

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)

Barnard 1923, p. 189.

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


In the excel table with the astronomical plates kept at the Photographic Archive at Yerkes Observatory, we can see that Barnard photographed the Morehouse’s 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.

Barnard 1909, p. 624.

Barnard 1909, p. 626.

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)

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