HENRY DRAPER'S (1837-1882) FIRST LUNAR IMAGES

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Henry Draper was a medical doctor and a pioneer astrophotographer. His father John William Draper (1811-1882) was the first to obtain a daguerreotype image of the moon in 1840[1].

Henry Draper is well known for obtaining the first photograph of the Orion nebula (M 42) on September 30, 1880 (Figure 1). Draper used a 28 cm (11-inch) Alvan Clark refractor supported by an equatorial mount also built by Clark (51 min exposure). Draper also obtains two other photographs of M 42 on 1881/1882 with longer exposure times (104 min and 137 min). In 1872 H. Draper records for the first time a star spectrum (Vega) using a 72 cm reflector and a quartz prism. Three years later (1875) Draper was able to photograph the spectra of almost all the bright stars using the 11-inch refractor and a quartz prism located close to the photographic plate.

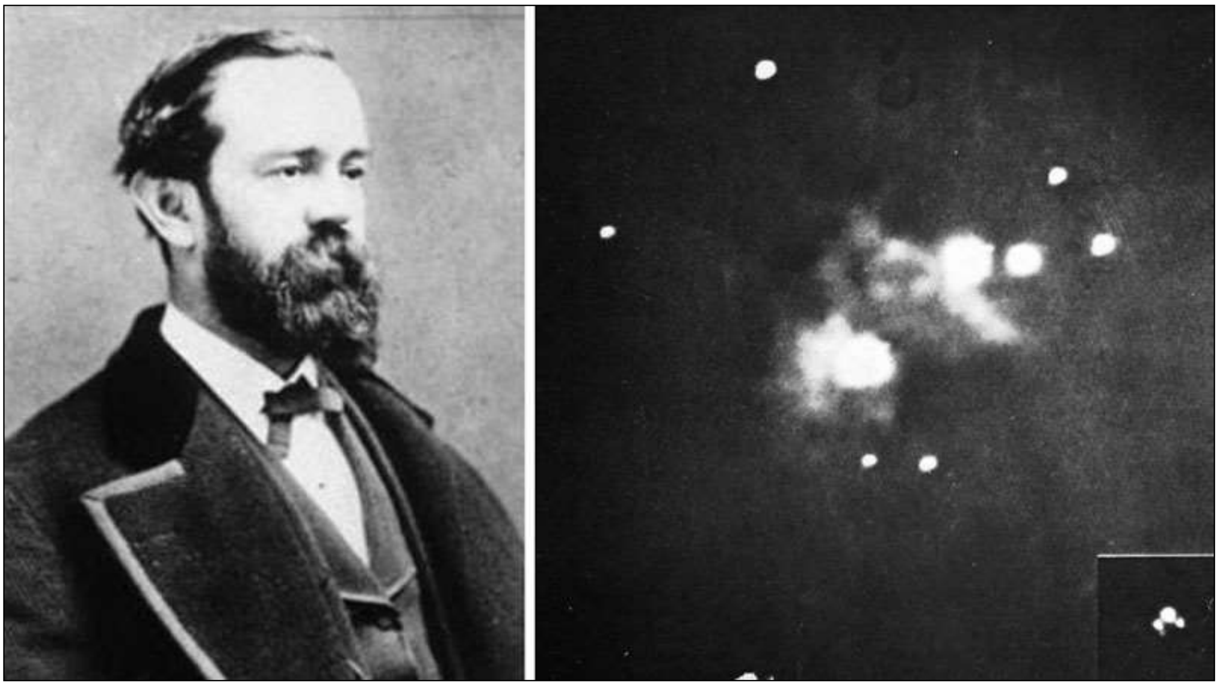

Figure 1- First photographic image of the Orion nebula (M 42) obtained by Henry Draper in 1880.

In his paper published in 1865 (accepted for publication in 1864), *On the Construction of a Silvered Glass Telescope, Fifteen and a Half inches in Aperture, and Its use in Celestial Photography*, Draper describes his investigations into glass-grinding machines (seven different models), glass astronomical mirrors, optical testing, telescope mounts, clock drives and photographic laboratories. This book was intended to be a hand-on guide for building and using glass silvered reflectors. In the first page Drapers mentions:

[1] On the 23d of March 1840, J.W. Draper presented to the Lyceum of Natural History of New York the first representation of the moon's surface ever taken by photography. The daguerreotype plate was exposed for twenty minutes and the image was about an inch in diameter.

The construction of a reflecting telescope capable of showing every celestial object now known, is not a very difficult task. It demands principally perseverance and careful observation of minutiae. The cost of materials is but trifling compared with the result obtained, and I can see no reason why silvered glass instruments should not come into general use among amateurs. The future hopes of Astronomy lie in the multitude of observers, and in the concentration of the action of many minds.

He also concludes the manual by writing:

My experience in the matter, strengthened by the recent successful attempt of M. Foucault to figure such a surface more than thirty inches in diameter, assures me that not only can the four and six feet telescopes of those astronomers be equalled, but even excelled. It is merely an affair of expense and patience. I hope that the minute details I have given in this paper may lead someone to make the effort.

Draper's telescope and observatory are described in detail in the book (Figure 2):

A short historical sketch of this telescope may not be uninteresting. In the summer of 1857, I visited Lord Rosse's great reflector, at Parsonstown, and, in addition to an inspection of the machinery for grinding and polishing, had an opportunity of seeing several celestial objects -through it. On returning home, in 1858; I determined to construct a similar, though smaller instrument; which, however, should be larger than any in America, and be especially adapted for photography. Accordingly, in September of that year, a 15-inch speculum was cast, and a machine to work it made. In 1860, the observatory was built, by the village carpenter, from my own designs, at my father's country seat, and the telescope with its metal speculum mounted. This latter was, however, soon after abandoned, and silvered glass adopted. During 1861, the difficulties of grinding and polishing that are detailed in this account were met with, and the remedies for many of them ascertained. The experiments were conducted by the aid of three 15 ½-inch disks of glass, together with a variety of smaller pieces. Three mirrors of the same focal length and aperture are almost essential, for it not infrequently happens that two in succession will be so similar, that a third is required for attempting an advance beyond them. One of these was made to acquire a parabolic figure and bore a power of 1,000. The winter was devoted to perfecting the art of silvering, and to the study of special photographic processes. A large portion of 1862 spent with a regiment in a campaign in Virginia, and but few photographs produced till autumn, when sand clocks and clepsydras of several kinds having made, the driving mechanism attained great excellence. During the winter, the art of local corrections was acquired. and two 15 ½-inch mirrors, as well as two 9 inches for the photographic enlarging apparatus, were completed. The greater part of 1863 has been occupied by lunar and planetary photography, and the of the small negatives obtained at the focus of the great reflector. negatives have been produced which have been magnified to 3 feet in diameter. I have also finished two mirrors 15 ½-inch in aperture, suitable for a Herschelian telescope, that is, which can only converge oblique pencils to a focus free from aberration. This work has all been accomplished in the intervals of professional labour. The details of the preceding operations are arranged as follows: § 1. GRINDING AND POLISHING THE MIRRORS; § 2. THE TELESCOPE MOUNTING; § 3. THE CLOCK. movement; § 4. THE OBSERVATORY; § 5. THE PHOTOGRAPHIC LABORATORY; § 6. THE PHOTOGRAPHIO ENLARGER.

THE TELESCOPE MOUNT

The telescope is mounted as an altitude and azimuth instrument, but in a manner that causes it to differ from the usual instrument of that kind. The essential feature is, that the eyepiece or place of the sensitive plate is stationary at all altitudes, the observer always looking straight forward, and never having to stoop or assume inconvenient and constrained positions.

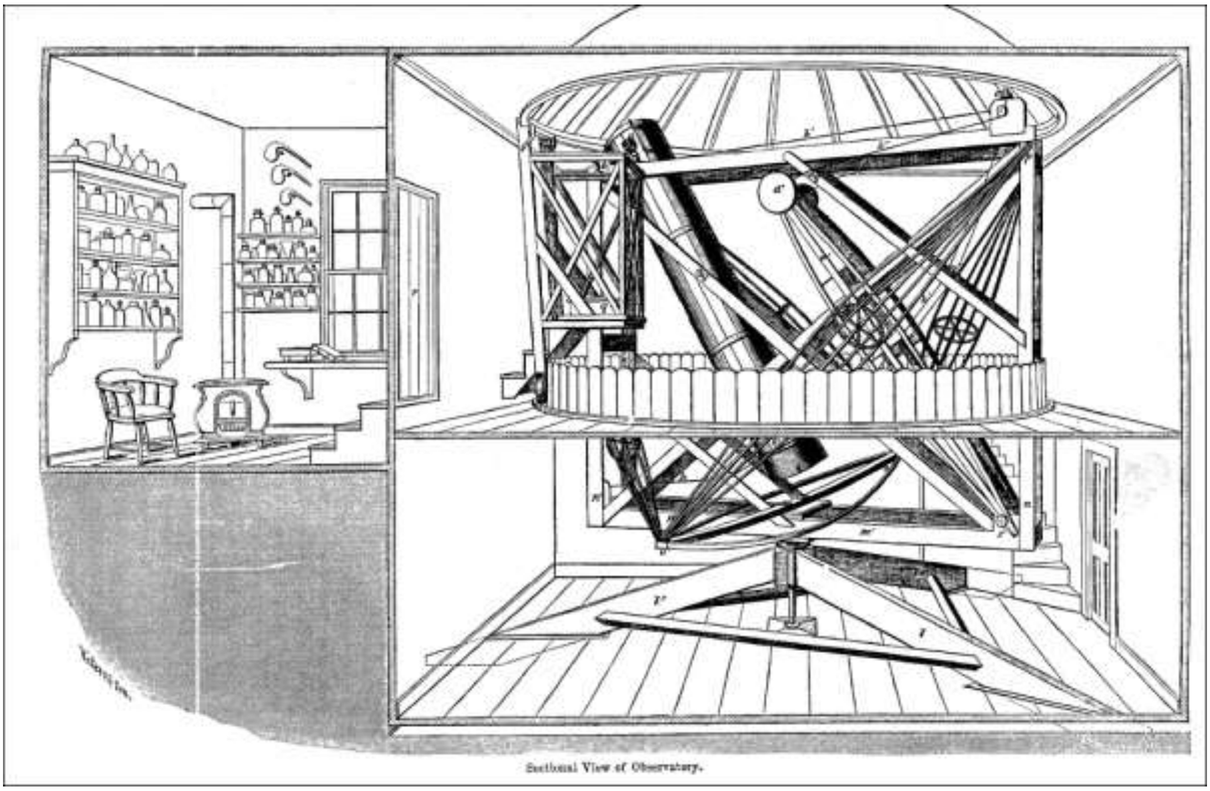

Figure 2- Henry Draper's observatory and Photographic laboratory.

The telescope tube is a sixteen-sided prism of walnut wood, 18 inches in diameter, and 12 feet long. The staves are 3/8 of an inch thick and are hooped together with four bands of brass, capable of being tightened by screws. Inside the tube are placed two rings of iron, half an inch thick, reducing the internal diameter to about 16 inches. At opposite sides of the upper end of the tube are screwed the perforated trunnions upon which it swings. Surrounding the other end is a wire rope, the ends of which go over the pulleys on friction rollers and terminate in disks of lead. These 'counterpoises are fastened on the ends of levers which turn below on a fixed axle.

By this arrangement as the tube assumes a horizontal position and becomes, so to speak, heavier, the counterpoises do the same, while when the tube becomes perpendicular, and most of its weight falls upon the trunnions, the counterpoises are carried mostly by their axle. A continual condition of equilibrium is thus reached, the tube being easily raised or depressed to any altitude desired.

THE CLOCK MOVEMENT

Warren De La Rue, who has done so much for celestial photography, was the first to suggest photographing the moon on a sensitive plate, carried by a frame moving in the apparent direction of her path. He never, however, applied an automatic driving mechanism, but was eventually led to use a clock which caused the whole telescope to revolve upon a polar axis, and thus compensate for the rotation of the earth, and on certain occasions for the motion of the Moon herself. In this way he has produced the best results that have been obtained in Europe. Lord Rosse, too, employed a similar sliding plate-holder, but provided with clockwork to move it at an appropriate rate. I have not been able yet to procure any precise account of either of these instruments.

My first trials were with a frame to contain the sensitive plate, held only at three points. Two of these were at the ends of screws to be turned by the hands, and the third was on a spring so as to maintain firm contact. 'This apparatus worked well in many respects, but it was found that however much care *might be taken the hands always caused some tremor in the instrument. It was evident then that the difficulty from friction which besets the movements of all such delicate machinery, and causes jerking and starts, would have to be avoided in some other way.*

I next constructed a metal slide to run between two parallel strips and ground it into position with the greatest care. This, when set in the direction of the moon's apparent path, and moved by one screw, worked better than the preceding. But it was soon perceived that although the strips fitted the frame as tightly as practicable, an adhesion of the slide took place first to one strip and then to the other, and a sort of undulatory or vermicular progression resulted. The amount of deviation from a rectilinear motion, though small, was enough to injure the photographs.

My brother, Daniel Draper, to whose mechanical ingenuity I have on several occasions been indebted for assistance in the manifold difficulties that have arisen while constructing this telescope, continued these experiments at intervals. He presented me with a slide and sand-clock, with which some excellent photographs have been taken. He had found that unless the slide above mentioned was made ungovernably long, the same trouble continued (Figure 3).

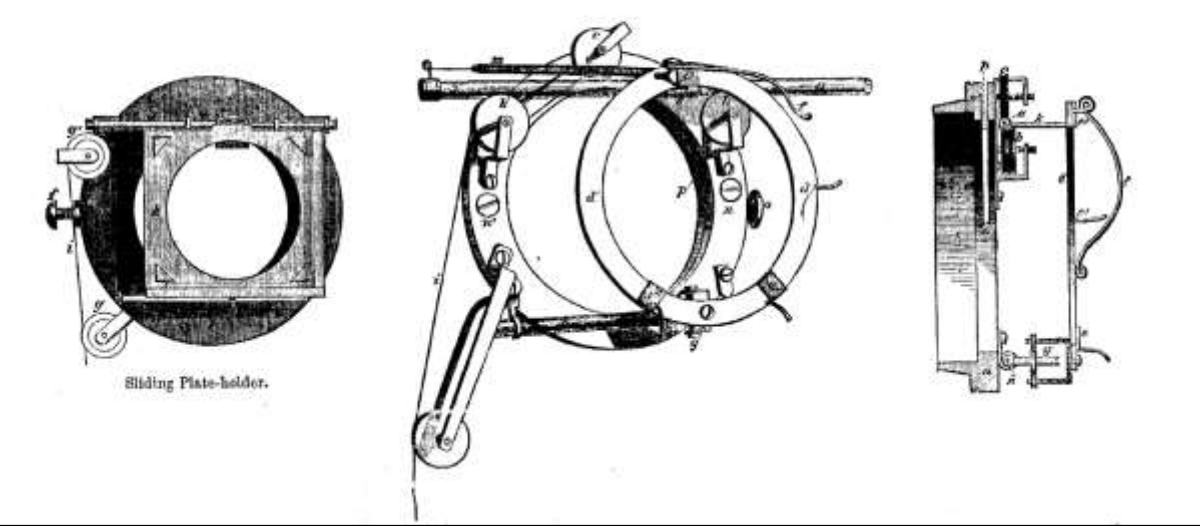

Figure 3- Sliding plate holder

The length of time that such a slide can be made to run is indefinite, depending in my case on the size of the diagonal flat mirror, and aperture of the eyepiece holder. I can follow the moon for nearly four minutes but have never required to do so for more than fifty seconds. At the mouth of the instrument, where no secondary mirror is necessary, the time of running could be increased.

My prime mover was a weight supported by a column of sand, which, when the sand was allowed to run out through a variable orifice below, could be made to descend with any desired velocity and yet with uniformity. In addition, by these means an unlimited power could be brought to bear, depending on the size of the weight. Previously it was proposed to use water and compensate for the decrease in flow, as the column shortened, by a conical vessel but it was soon perceived that as each drop of water escaped from the funnel-shaped vessel, only a corresponding weight would be brought into play. This is not the case with sand, for in this instance every grain that passes out causes the whole weight that is supported by the column to come into action. In the former instance a movement consisting of a series of periods of rest and periods of motion occurs, because power has to accumulate by floating weight lagging behind the descending water, and then suddenly overtaking it. In the latter case, on the contrary, there is a regular descent, all minor resistances in the slide being overcome by the steady application of the whole mass of the weight. When these advantages in the *flow of sand were ascertained, all the other prime movers were abandoned. Mercury-clocks, on the principle of the hydrostatic paradox, air-clocks, in great variety, had been constructed.*

I determined to try a clepsydra as a prime mover. The reason which led to this change was that it was observed on a certain occasion when the atmosphere was steady, that the photographs did not correspond in sharpness, being in fact no better than on other nights when there was a considerable flickering motion in the air. A further investigation showed that in these columns of sand there is apt to be a minute vibrating movement. At the plateholder above this is converted into a series of arrests and advances. On some occasions, however, these slight deviations from continuous motion are entirely absent, and generally, indeed, they cannot be seen, if the parts of the image seem to vibrate on account of currents in the air. By the aid of the microscopic exaggeration described on a former page which was subsequently put in practice they may be observed easily if present.

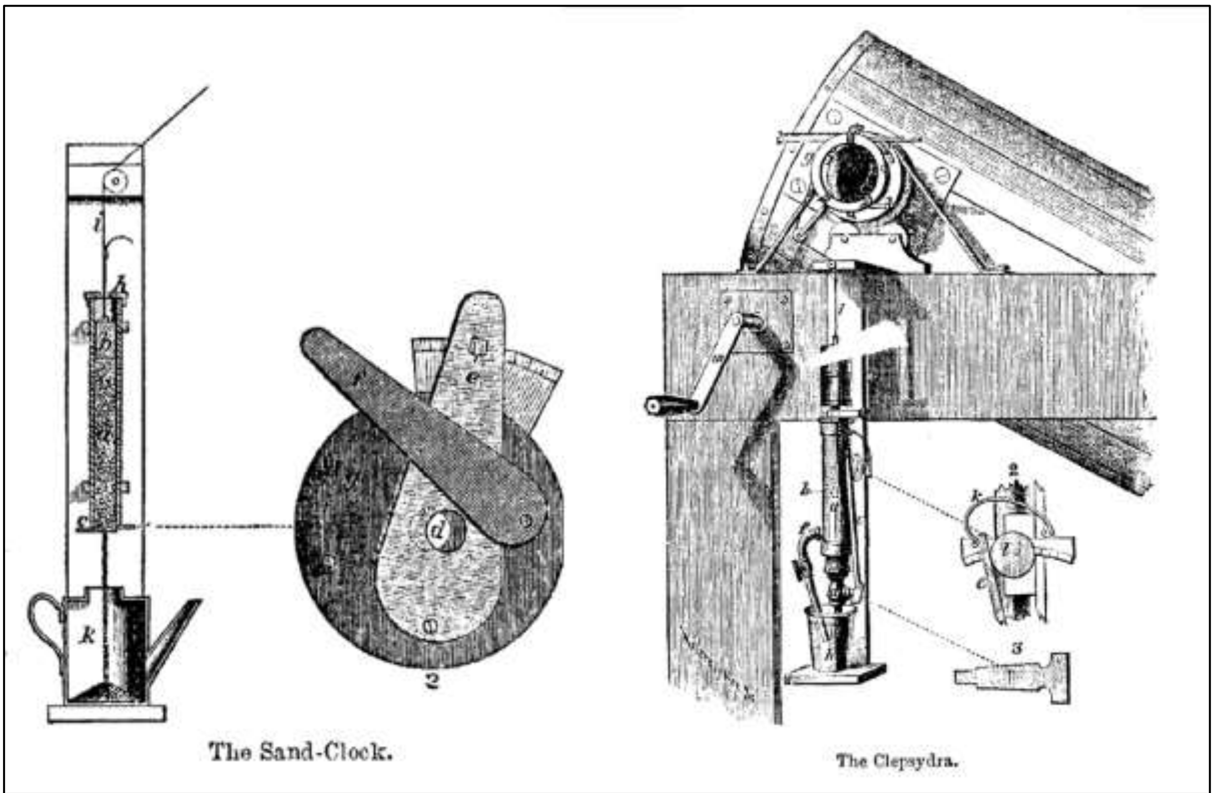

Figure 4 – Sand-Clock and Clepsydra.

It is obvious that in a water-clock, where the mobility of the fluid is so much greater than that of solid grains, this difficulty would not arise. The following contrivance in which the fault of the ordinary clepsydra, in varying rate of time as the column shortens, is avoided, was next made. With it the best results are attainable, and it seems to be practically perfect.

Draper brough the telescope to a complete rest before exposing, then moved the plate holder to track the movement of the Moon. During the exposures, lasting several seconds, the photographic plate was driven automatically by a Clepsydra connected to the plate holder by a chord (Figure 4).

By 1863 Draper obtained more than 1500 collodion wet plates of the Moon. These were regarded as some of the best lunar photographs ever taken, maybe only surpassed by Lewis Morris Rutherfurd image of the first quarter moon obtained in March 6, 1865 in almost perfect seeing conditions.

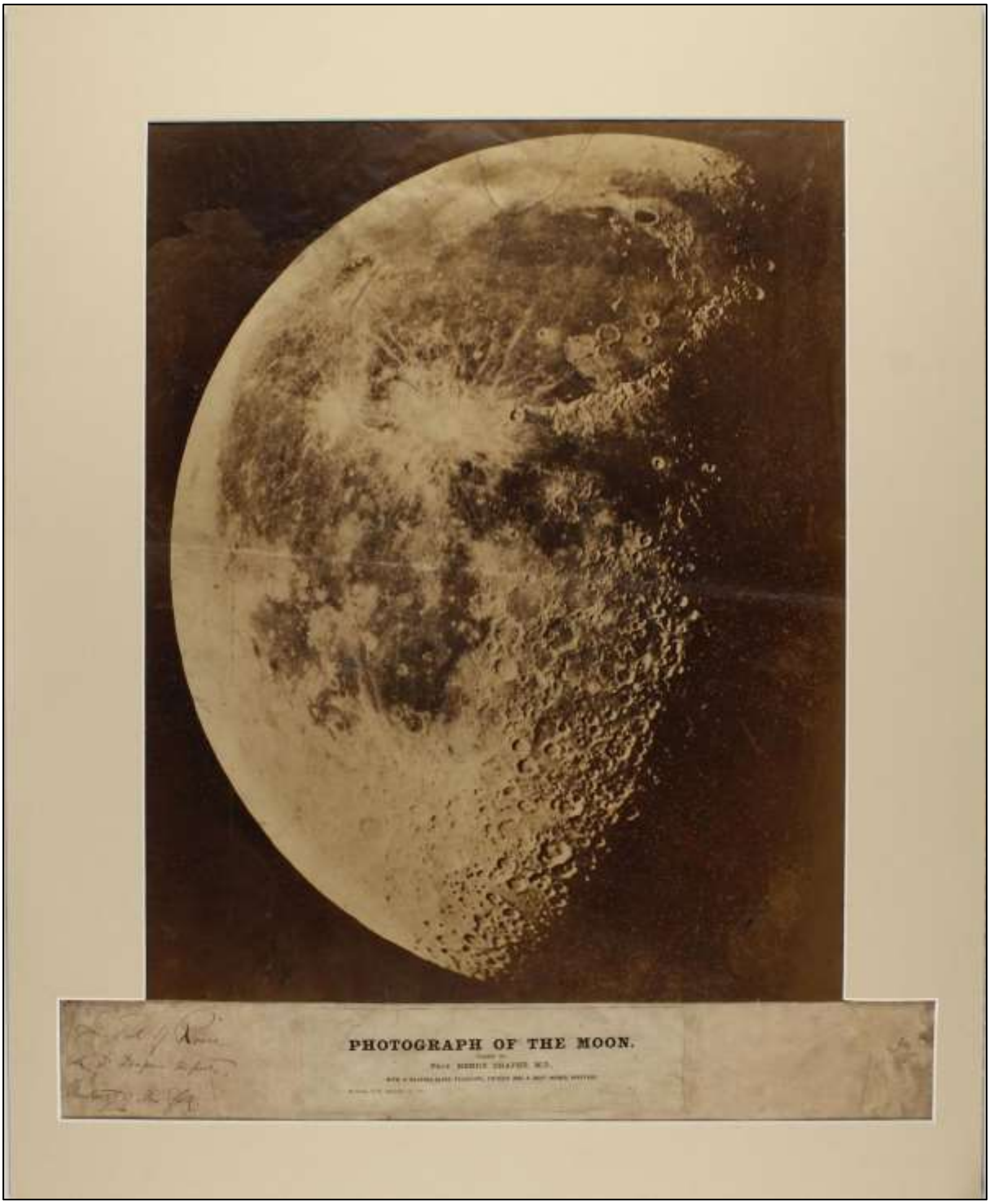

Figure 6- Henry Draper albumen silver print photograph of the Moon (1863).

Sources:
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