Title: "Total Eclipse of the Sun," by Charles F. Himes

Date: 1869

Location: MC 2000.1, B25, F20

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BY PROF. CHARLES F. HIMES, PH. D.,

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Post tenebras lux.

[Reprinted from the Evangelical Quarterly Review.]

GETTYSBURG:

J. E. WIBLE, PRINTER, NORTH-EAST COR. OF WASHINGTON & R. R. STS.

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The total eclipse of the sun of August 7th, 1869, excited scarcely less of a sensation throughout the civilized world than "the Devil, the Turk, and the Comet" in midæval times. Always impressive, this phenomenon had been thrust,*by very recent progress in science, into an unusually prominent position. Never before had such an event promised so much of a revelation. No phenomenon shows more beautifully, in the means of its observance, the startling progress of science in the last decade, and the growing interdependence of its various branches. The seeming lines of cleavage, upon which the study of nature has been devided for sake of convenience, grow fainter with every advance.

In all ages the unusual and terrifying phenomena of total solar eclipses have been marked events, and have frequently affected the face of history. The astronomer, by calculating backwark to them, has been able to rescue from obscurity chronological data. Thus for example, Herodotus unconsciously fixed with mathematical precision the date of a battle between the Medes and Persians, when he narrated that: "while the two armies were engaged the day suddenly became night," and that they desisted from combat, and became desirous on both sides of making peace. It has however only been since the eclipse of 1706, that attempts have been made to observe them with scientific fulness, and accuracy ; and since then, when accessible, they have been closely observed, especially that of 1842, visible as it was in a large portion of the civilized world. The profound interest, which it excited in the minds of the leading scientific men of that day, produced results which, although wanting in definite information, were filled with mysterious hints at the constitution of the sun. The highest talent, and skill was brought to bear on the succeeding eclipses in 1851, and 1858, with but faint hopes however of interpreting much of the mystery. The mass of observations, even of the best trained observers, condensed into the very general statements, that, in the region over which the shadow of the moon careered with its frightful velocity, whilst the black moon hug before the sun, a corona of light flashed out in startling brilliancy, and beauty around it, and red tongues of flame fringed its border; everything assumed an unnatural and unearthly hue; the air grew cool; the wind moaned; dew and clouds formed; animals were deceived by the apparent night; and even the unconscious flowers folded their petals for a night's rest. Whilst all were lost in wonderment, the sun burst forth; the unusual vision passed away, leaving no definite traces on the memory, or in the note book. Statements by the best observers differed; it was impossible, in any case, to sift the objective from the subjective. One thing seemed generally admitted, namely, that the red flames, or prominences, and the corona were accessories of the sun. With the eclipse of 1860 a new era of observation dawned. The photographic camera was impressed into service. Its unblanching eye, with its highly sensitive, and indelibly impressible retina, sees everything, and leaves no chance of slips of memory. There is no inaccuracy with it, no personal equation to be allowed. Under the auspices of the English government, Warren de la Rue obtained excellent photographs of totality in Spain. Much that had escaped the eye of observers was recorded upon them. But photography is color blind. It was still a vexed question, even as to the color of the prominences. There was scarcely ground to hope that a question as to their constitution would ever be answered. But about, the same time, a new mode of analysis made its entree into the scientific world. It had, at many previous periods, exhibited its leading features to scientific men, but it remained for two Germans, Kirchhoff, the physicist, and Bunsen, the chemist, to introduce Spectrum Analysis, as a practical reality. By means of it, chemistry, previously a purely terrestrial branch of science, became cosmical. It reached out into space as far as the telescope could penetrate, and began to analyze the sun and many other *celestial* bodies as readily, and accurately, as the ores in our hills, and thus to show new relationships, of our earth to the universe. To enter into a detailed explanation of the Spectroscope, the instrument used in this analysis, would lead us too far, but a few words will suffice to render apparent the underlying principle, and indicate the nature of the testimony upon which statements are made, which might otherwise pass as purest speculation.

By allowing a ray of sunlight to fall through a small opening upon a triangular glass prism, Newton obtained upon a screen a parti colored band of light, called the Solar Spectrum. This demonstrated, that the white sunlight was formed by the coalescence of the many colors of the band into which it was spread out in the spectrum,—usually described as shades of one of seven colors. Subsequent investigation showed that there were dark lines crossing this colored band, separating the finely blended colors. Many of these black lines were carefully mapped, and named, by letters of the alphabet, by Frauenhofer, of Munich, and called after him Frauenhofer's dark lines. Now many substances, when vaporized, give characteristic colored flames, of which fact the pyrotechnist takes advantage, in the manufacture of different colored fires,—as the red and green fires. It was noticed that, by allowing light from one of these sources to pass through a prism, a spectrum was obtained, crossed by bright lines, instead of dark ones. Further investigation showed that the same substance always gave the bright lines in the same place, and, of course, of the same color, in the spectrum. Thus Baryta, the base of green fire, gives various bands of green lines; Strontia, the base of red fire, red and orange, and unexpectedly, a beautiful blue one; Lithia an intense characteristic red, and fainter orange. These combinations of bright lines then are characteristic of the elements producing them, and render the presence of almost infinitesimal quantities perceptible. By closing a book violently, within ten feet of the instrument, the presence of the almost omnipresent Sodium, in the dust, manifests itself at once by a bright yellow line. The presence of several elements at the same time, does not, as a rule, cause any difficulty. But in the sunlight, either direct or reflected by the planets and moon, and starlight only dark lines had been noticed. There was no hint at a connection between them and the bright lines given by terrestrial elements. Whilst preparing a chart of the bright lines, given by different substances, for purpose of description, it occurred to Kirchhoff to arrange his apparatus in such a way, that a spectrum of sunlight might be thrown immediately above that produced by the substance under investigation, so that the bright lines it gave might be described by their positions, relatve to the dark lines of the solar spectrum. The remarkable fact then revealed itself, that the bright lines produced by many terrestrial elements were represented by dark lines in the solar spectrum. Thus, sixty bright lines produced by iron, when in state of incandescent vapor, corresponded with sixty dark lines. So with the bright lines of other elements. The inference became irresistible, that the coincidences were not a matter of chance, but that they indicated some connection between the dark lines of the sun, and these terrestrial elements; that iron had something to do with the formation of some of these dark lines.

Further investigation showed, that if light, from a source giving bright lines, was made to pass through vapor of the substance emitting the light, before falling on the prism, dark lines would be produced in place of the bright ones. This theory of exchanges formed the foundation of solar, or cosmical, chemistry. With as great a degree of certainty as attaches to any scientific statements, it could be affirmed, that part of the light of the sun is emitted by incandescent iron, and passes outward toward the earth through a solar atmosphere partially composed of vapor of iron, which reverses the bright lines of the iron spectrum. For similar reasons the presence of Sodium, Copper, Nickel, Gold, and many other terrestrial elements is affirmed in the sun, and many of the fixed stars, indicating to some extent a common composition. A little experiment will enable any one to appreciate this fact. If a little salt is placed upon the wick of a tallow candle, and its flame is brought before the flame of another tallow candle, similarly treated, (or what is much better that of an alcohol lamp colored by a soda compound,) it will be found, on close inspection, that the yellow flame will be bordered by a black line,—the yellow soda light from one source is absorbed by the vapor of soda, formed on the margin of the other.

Another fact, in this connection, has a bearing on our subject. It is found that the light emitted by solids or liquids, intensely heated, gives a continuous spectrum, without dark or bright lines, that that of an incandescent gas —with few exceptions—gives bright lines, and that we are in a condition therefore to determine, in many cases, the state of the body emitting the light. Thus nebulae, (not such as consist of remote groups of stars), and comets have been made to give an account of themselves, and, up to this time, seem to be composed of incandescent gases. These few facts in regard to the spectroscope will enable any one to form an idea of the reasonableness of the high expectations from the observance of a total eclipse, subsequent to that of 1860. Even the rigid mathematical astronomer felt that a total eclipse was good for something more than the correction of celestial measures, and weights, and grew interested in the prospect of learning something in regard to our relationship to our great central luminary. The expeditions to Aden and Guntoor to view the total eclipse in the preceding year, by partial success, had only excited more irresistible interest in that of the past year, and had indicated the best points and methods of observation.

It is not surprising then, that, for weeks beforehand, corps of scientific men, sent forward by governments, institutions of learning, liberality of private individuals, all handsomely supplemented by the liberality and courtesy of railroad companies, were to be seen converging upon the most accessible points in the belt of totality, about 140 miles wide, extending from Sitka to our North Carolina coast. Armed with all the recent appliances of science, telescopes, spectroscopes, polariscopes, thermometers, barometers, actinometers, and others of the large families of—scopes and—meters, the number of trained observers, and the number and variety of stations tended to eliminate the chances of clouds or haze, or other local, or accidental causes of failure.

All scraps of experience of previous parties had been collated, and carefully considered, and all previous experience indicated the necessity of most thorough division of labor. The great concentration of mental and physical energy upon the observation of this phenomenon was not therefore to be frittered away by diffused investigation, but each observer, with a friendly interest in every other feature of the phenomenon, devoted himself wholly to one. The highest accuracy was required of all, so that there were scarcely posts of honor, but there were posts of sacrifice. Some assigned to the photographic dungeon had to leave all hope of seeing the eclipse behind, others kept their eye on the chronometer to mark the time, others were devoted wholly to the dissection of the light, of the red prominences, or of the corona, by means of the prism of the spectroscope, to elicit new contributions to the rapidly increasing facts of cosmical chemistry, and so forth.

It was the fortune of the writer to be placed in charge of the section of Prof. Morton's photographic expedition, under government auspices, stationed at the ambitious young city of Ottumwa, Iowa. The instrument employed was that belonging to Pennsylvania College, a refractor with an aperture of six inches, and focal length of eight and half feet. It is from the celebrated establishment of Merz & Sohn in Munich. It is equatorially mounted, or in such a manner, that when ranged upon the sun, or a star, it can be made to follow the celestial object, in its apparent movement over the earth, by a movement on a single axis. This movement of the telescope, which directs it continually to the star, and thus keeps it in view, is accomplished by clock work, which, when properly regulated, relieves the observer from any care on this point. This is especially necessary to adapt it to photographic purposes. For if a picture of an object is desired, which cannot be made to remain stationary, but that will move with a regular motion, the only plan left, to catch a well defined image, is to follow the object by a corresponding motion of the instrument, and thus cause its image to remain accurately upon the same portion of the photographic plate. This motion can only be effected, with the requisite degree of smoothness, and regularity, by means of a clock-work driver. The telescope with this adjustment alone is, however, simply fitted for purely astronomical observations. The eye piece unfits it for photographic purposes. For this reason the German expedition, to Aden, in 1868, employed the objective of the telescope alone. But the picture of the sun obtained in this way was so small, that it required subsequent enlargement, and, in enlarging, all defects of a photographic negative, taken under such peculiarly difficult circumstances, are correspondingly enlarged. For this reason it was deemed best to have modified eye pieces adapted to the instrument, that would render it possible to take negatives directly about two and a half inches in diameter, from which satisfactory prints could be made without enlarging. An ordinary photographic camera was screwed to the eye piece, and the image of the sun, formed by the telescope, brought into focus on the ground glass; the usual dark slide with prepared photographic plate then substituted for it, exposed to the image of the sun, and developed, the telescope merely playing the part of the short brass tube, with its lenses, on the ordinary camera. There were, however, several difficulties to be overcome. It is an easy matter for a photographer to expose his sensitive plate for just the requisite length of time to the image of the object to be copied, by removing the cap, or dark cloth, from the lens and replacing it. He deals with seconds of time. But the comparatively inconceivably short time required, and allowed to fix the image of the sun, and consequent effect of minute differences of time, render such a leisurely method of exposure unavailable for the solar photographer. A rather complicated apparatus was devised to control this operation satisfactorily. Without a drawing a detailed description would hardly be intelligible, but its general construction may be indicated. A brass slide, about three inches long, and about an inch wide, was adapted to move smoothly in grooves between the eye piece, and the sensitive plate. In this slide a slit was made, transverse to its movement, one-fortieth of an inch wide. This slit was made to shoot past the eye piece, by means of one, or all, of three springs, readily attached, or detached, to regulate with nicety the time of exposure. A trigger held the slide in position, so as to prevent the image of the sun from falling upon the prepared plate. When all was ready a slight touch on the trigger released the slide, and, impelled by the springs, the slit flashed past the eye piece, the upper part of the slide covering the eye piece again, when it came to rest on a pin beneath. The passage of the slit occupied, probably, from the one-twentieth to one-fortieth of a second, and the light from the different parts of the image of the sun scarcely rested upon their part of the plate, the one-thousandth of a second, and yet in that time the image of the sun was impressed. Instantaneous as this may seem, it was found necessary, in addition, to cover a portion of the field glass of the telescope, (six inches in diameter), by placing a cap on it, with an opening of only two inches, in order to prevent an over exposure of the plate. This was done in preference to making the slit narrower, because light in passing through very narrow slits is diffracted, as physicists say, and the sun's image would have been rendered indistinct. During the total phase, when the sun was obscured, and only the corona, and red flames were to be photographed, the light from which is comparatively,—or rather photographically,—feeble, it was found necessary to take the cap off of the objective, and expose the plate from six to sixteen seconds, by substitution of another slide with a large circular opening, held in position by another trigger, for the desired number of seconds.

There is still another difficulty encountered in the use of an ordinary telescope for photography. The image formed on the ground glass, although beautiful, and well defined to the retina of the eye, is not so to the photographic plate;—it sees things in a different light. The eye is impressed principally by the yellow and red light, the photographic plate by the blue rays, or the invisible ones beyond. These different colored rays form images at different distances from the eye piece, that by the blue rays lying a little within that formed by the red and yellow. If the photographic plate is placed where the visual image is most distinct, the photographic image, which impresses it, will be indistinct. Ordinary photographic lenses are constructed with a view to correct this defect, and Mr. Rutherford, whose lunar photographs are unrivalled, had a lens constructed for his telescope for photographic work. We were not in a condition to have that done; the objective at present with the instrument being worth probably two thousand dollars. But by placing the prepared plate a little nearer the eye piece, than the point at which the visual image was most distinct, after repeated trials the place of the most distinct photographic image was very accurately determined, and marked. For several weeks before hand, experiments were made with the telescopes of the expedition, placed in position in West Philadelphia, until most satisfactory pictures of the sun were obtained, finely marked with the dark spots and bright faculae on his surface, and nicely graduated in tone from the central parts to the periphery.

But whilst physicists, and chemists were concentrating the mental and physical toil of weeks upon investigations to be made during Totality, to which calculation assigned a duration at the most favorable points, of less than three minutes, the astronomer was hoping for a correction of the data upon which his calculations were founded,—to make for example a more accurate determination of that somewhat uncertain constant, the diameter of the moon. The exactness of the exact sciences rests primarily on facts of observation, and progress toward accuracy in the prediction of an eclipse, for example, could only attend increased accuracy of celestial data. No error is supposable in the computation of an eclipse, for mathematics, in the hands of a practical computer, is a practically perfect machine else. The astronomer had determined by calculation the instant at which the black moon would begin to roll between the eye and the sun, and to him it was of great importance to know the magitude of the error of his prediction. He desired the exact time of the beginning of the eclipse, beginning of totality, end of totality, end of the eclipse. It is very difficult to notice the exact time at which the invisible moon, should touch the bright sun; there is room for an error of the eye in detecting it, and the ear in noting the second. But, by taking several photographs of the partial phases, and noting their times accurately, they can by subsequent measurement be used for determining the instant of contact by calculation. An attempt was therefore made to gratify the astronomer, by eliminating the errors of eye, and ear; the photographic plate was substituted for the one, and an electric chronograph for the other. The trigger which released the slide to allow it to flash past the plate, as it did so, was made to send an electric current to register the instant of exposure, by a pen similar to a telegraph pen, on a fillet of paper, aside of the seconds' marks made by another pen, tapped by an observer in charge of the chronometer. So accurate have been the results obtained in this way, that Prof. Pierce of Cambridge regards them as observations worthy of the highest confidence, and doubtless the previously adapted value for the diameter of the moon will be modified by them. The moon did not appear at the calculated time, being from five to ten seconds late, but the time calculated from the photographs obtained at one place, agreed to the one-third of a second with the observed time; the accuracy of the observed time being due to a new and beautiful application of the Spectroscope for this purpose. The eye piece of the telescope was supplied with a reticule of two spider lines, at right angles to each other, which were adjusted respectively parallel and at right angles to the celestial equator, and being photographed with the sun, served to fix the position of the sun and the moon, and objects of interest on the margin of the sun. The perfection of the arrangements was largely due to the scientific knowledge and skill of the celebrated optician Zentmayer of Philadelphia.

Equipped with this instrument, and all necessary accessories, the party was transported in a special car, furnished by the Pennsylvania R. R., to their destination; sections similarly equipped having been dropped at Burlington, and Mt. Pleasant, Iowa. Upon our arrival, on Wednesday evening preceding the eclipse, we found a convenient shelter shed, with sliding roof, already erected, under instructions from Professor Coffin, of the Naval Bureau, on what will be hereafter known as Observatory Hill, about a mile north east of the city. Next day the telescope was set up on cross beams, firmly set in the ground. The clock-work, somewhat deranged by transportation, was put in order. Cloudy weather set in on Thursday, and interfered with the proper adjustment of the instrument; but, notwithstanding the depression caused by the state of the weather, the work of preparation went on with apparently as much faith in clear weather as in the mathematical calculation; this unremitted work created an impression on the minds of many, that the astronomical party had some guarantee of fair weather. A severe thunder storm on Friday morning, unroofed our shed, and in the evening, with sky overcast, we were inquiring by telegraph in all directions the prospects of the weather, with no encouragement from the chat. The most harrassing thought was, that even an unexceptionable eclipse might find us unprepared at the critical moment, by reason of absence of clear sky for a few hours preceding the eclipse, to make the final adjustment. About four A. M. on Saturday, Polaris exhibited himself, but for an instant, to the observer on the look out for stars. The morning after dawn was full of promise mingled with doubt, but finally the clouds began to resolve, a dry wind set in from the East, by ten o'clock only threatening little clouds were floating about, and by noon not even a sentinel cloudlet remained above the horizon. Silently, and almost breathlessly, but busily, preparations were completed; the last touches made in the adjustment of the instruments; the chronograph, and batteries set up, and one pen connected with the camera, the other with the key on which seconds were to be tapped. Other observers were busy with their particular preparations. An hour before the long expected moment all was in readiness. There was a lull that called to mind, that preceding the clash of immense armies, as they lie before each other manœuvering for position. A few minutes before the calculated time of contact, every one was at his post; the time caller began his clear but monotonous count of the seconds, only interrupted by the click of the chronograph pen as it recorded them. The telescope was accurately directed to the sun, a sensitive plate placed in the camera, and all glasses raised to catch the first contact. Finally the merest trace of a dark object was seen to indent the margin of the sun. The camera trigger was touched, the slide flashed past, and clicked upon the sup porting pin beneath, and the chronograph pen tapped the response, as it registered the instant. Plate after plate was exposed in quick succession, and developed in the dark room, until five were secured. Then exposures were made every ten minutes, until the rapidly dwindling solar cresent indicated the approach of Totality. Four plate-holders were filled with prepared plates, and five other plates brought to the last stage of preparation. Three plates were quickly exposed to the rapidly vanishing sun, the third catching finely the last quivering line of the sun, cut up into liquid, bead-like fragments by the projecting peaks of the lunar mountains. In a tenth of a second the phenomenon changed; as the last ray of pure sunlight, from Bailey's Beads, as the fragments are called, disappeared, the transition to comparative darkness was sudden. The stars seemed to spring out with peculiar brilliancy, without their usual struggle through twilight, but, superior to every other feature, in its impress on mind, and heart, the corona flashed forth in its indescribable beauty, extending far beyond the black central moon, of silvery whiteness, fibrous, slightly curled or twisted, like a cirrus cloud, reminding forcibly of a sudden outburst of a grand aurora. To the naked eye rose colored, approaching crimson, protuberances or tongues of flame studded the border of the moon, some seeming to indent it, as if volcanic eruptions on its surface. The unusual light gave a ghastly illumination to the landscape, and birds fluttered by in a troubled way. Breathless silence reigned among the scientific observers, as well as others, who had crowded observatory hill, in spite of the police guard. All seemed awed. The facts of cause and prediction seemed lost. An irresistible feeling of helplessness, and desolation, or rather desertion, took hold of every one. The great sustaining orb of day, that for an hour had been dying away, seemed finally extinguished; the rayless mass hung out in space, with the last flickering outbursts of light in the corona and protuberances preceding final darkness. "Great Pan is dead" seemed audible in the air, and written on the weird scene. But this was the time for full, and accurate observation. But human senses, unreliable at best, in presence of such a phenomenon, with a consciousness of extremely limited time, almost fail. The most self-possessed become confused. Without instrumental aids, such as have been alluded to, it is easy to comprehend, why a Total Eclipse of the sun should remain a wonder, and nothing more. We can almost pardon De la Rue for mentally registering a vow, as he was obliged to turn, from a sense of duty, from such a sight, to the prosy, practical work of photographing it, that he would never take part in such observations again, except as a mere untrammeled observer; a resolution which, to the regret of all, he has strictly kept.

The cap was hastily removed, a slide with circular opening substituted for the one with the slit, plates were exposed respectively six, twelve and sixteen seconds, the fourth, after a few seconds' exposure, caught the first rays of the reappearing sun. A joyous feeling of relief succeeded the previous depression, which manifested itself in merry chatter and even loud applause. This was however no time for relaxation by the photographic corps. The astronomer desired negatives near this contact. The cap and previous slide were quickly restored, five negatives were rapidly taken, then others more leisurely, until the final contact was near, when, by rapid exposures, the last faint indentation by the moon was obtained and our two hours' work ended,—the eclipse was with the past. With the absence of the stimulus we began to feel the exhaustion of the travel, labour and anxiety of the past week, but the labor of taking down and repacking the instruments was light compared with the adjustment of them under the depressing circumstances. It must be confessed that we were disappointed to find that we had obtained only four negatives of Totality, but closer study of them, and accounts of similar parties have rendered us more than satisfied with our results. And as parties homeward bound crossed each other's paths a hasty comparison of experience showed an all-pervading feeling of satisfaction.

Space forbids a recapitulation even of facts, much more of deductions from them. In time, a full report will be published under auspices of the Naval Bureau by the government. In the meantime every scientific Journal, domestic and foreign has its quantum of Eclipse notes. The various reports, official and informal, in the September and October numbers of the Franklin Institute Journal, are especially satisfactory.

The photographs give only traces, many indeed nothing, of the corona. It does not impress the photographic plate readily. The red prominences are indicated by white markings on the margin of the moon, sometimes indenting it. Glass copies only are adapted to the rendering of the full details of the negatives, but the paper prints, exposed for sale, exhibit some prominences with spreading branches at the top, as might be expected in a rapidly rotating cloud-mass—incandescent in this case, throwing off sprays in all directions. The spectroscope by the bright lines, which it detected in their light, declares them to be gaseous—mainly hydrogen, but the different lines, not yet fully interpreted, in different prominences, indicate a probable variation of kind and quantity of elements in them. Some were pointed, jutting out like the Aiguilles of the Alps—some, seventy thousand miles high, others seem to cling to the border of the sun, others to lie loosely like a rolling cloud-mass stretching hundred thousand miles, with, here and there, portions wholly detached from the sun. The latest view regards all these rosy masses as local aggregations of a gaseous envelope of the sun, called the chromosphere. The sun then would consist of a nucleus, intensely heated to be sure, but of feeble, radiating power, surrounded by a photosphere of high radiating power, constituting what we see and measure as the sun, most probably liquid or solid matter, but, as recent investigations show, possibly gaseous; upon it rests the chromosphere to a height varying, generally, from three thousand to eight thousand miles, except where elevated into prominences, and far beyond this, about a million of miles, extends the true atmosphere of the sun. This latter was supposed to cause the corona, by reflecting the light of the obscured sun, but the fact of the polarization of its light, upon which this hypothesis rested, has not been substantiated by use of better polariscopes in the recent eclipse, whilst the spectroscope, by the discovery of bright lines, singularly coincident with those of the Aurora of April 15th, 1869, suggests that the corona has an electrical origin and is a permanent Aurora, connected with the sun, only visible when his bright light is cut off by the interposed moon. Sun spots, and faculae are variously explained; the former as rents in the luminous photosphere by upward, or downward, rush of gaseous matter; the latter as portions of the photosphere thrown high up into the atmosphere, and consequently losing less light by its absorptive power.

The indentation of the moon by the prominences, and the marked increase of brightness, in the pictures of the partial phase, of the edge of the sun nearest the moon, a fact before noticed, but not decidedly enough to withstand explanation by the word subjective, hint at a lunar atmosphere, in spite of long admitted facts to the contrary. These photographs also, when slightly magnified by a reading lens, show beautifully, that the edge of the moon projected on the sun is not smooth, but jagged by the projecting peaks, that ultimately give rise to Bailey's Beads. The improvement produced by mounting the pictures as stereoscopic slides, as has been done, is due solely to the magnifying power of the lenses, as all the conditions necessary for true stereoscopic effect are wanting ; and single pictures will, therefore, produce a like effect, if magnified.

These few facts will illustrate the nature of the observations, and deductions from them, and, it is hoped, serve the general reader, in some measure, as an introductory to the fuller reports upon this subject.