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Eclipse of 1869
Reports

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Washington D. C Sept 11 1869

Prof. Benj Peirce Supt.
U.S. Coast Survey.

Since you gave me permission to try how what means I could command here to measure the Springfield photographs before resorting to Mr Butterfields machine, I called, in company with Mr Delgard, at Dr. Woodwards at the army Medical Museum. I obtained through his kindness the use of the best microscope, admirably fitted up with horizontal vertical and circular motion for placing the object in position, and with an eye-piece position micrometer of great delicacy for measure. Dr. Woodwards collection of microscopes is unrivalled in the country; he thinks quite a low power will carry us to the limit when the grain of the collodion becomes visible - this, however, I will at once ascertain by experiment. The optical power ranges from 10 to 2000.

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and the micrometer is similar to a position micrometer, this giving position and distance

The pictures of the totality taken by Dr Curtis at Des Moines are superior to all others I have seen, they even distinctly exhibit the form of the protuberances and he has made special examination of the apparent spread or eating in of the Solar clouds on the disk and of the white band of light around the moons edge during the general progress of the eclipse, as is also perfectly exhibited in our pictures. Thus phenomena he succeeded in producing artificially, and in explaining them, A comparison of the protuberances with the figure of the Corona seems to show that the bundles of rays in the latter are associated with the position of new protuberances, and a want of extension in the Corona with the location of old ones in which the gas has already spread itself, and is not as in the winged and the gas flame shaped protuberances, in the very act of outreaching or spouting. This would, if so connect the Corona with the Sun. one of Dr Curtis's photographs shows the appendix (a) giving it the form of a ram's horn as depicted by Dr Gilpert, Now at Springfield that spur was surely wanting and must in the mean time have floated off, dissipated itself or what



(a)

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I suspect, may have turned and presented its edge. The structure of this protuberance appeared spiral in the Sun. You are aware that Prof Morton of Philadelphia reports that Baily's Beads were photographed, thus proving them objective phenomena, weak eyes and imperfect instruments will no more be charged at once to those who happened to see them, tho it leaves the question still open whether they are produced by diffraction or by projecting portions of the Moons outline. the latter view I cannot take from what I have seen. Respecting the undulations of the Corona I can report nothing new from the Des Moines pictures.

Mr Cooper will be kind enough to see to the careful packing of the Springfield negatives and to their transmission to Washington, as soon as Mr Black is done with the preliminary printing. could not the prints of the selected pictures (yet to be submitted to you for approval) be made by Mr Mathiot? It would save all additional expense. They will require no mounting on cards. If it was desirable to have them mounted, they had better be attended to by Mr Black (but in that case they cannot be inclosed in a letter as conveniently)

I remain Sir, Yours very respectfully

A Schott

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Jacksonville Ill Aug. 11 1869

Prof B. Peirce

S. W. S. C. S

Dear Sir;

I inclose to you the report of the Shore Shadows seen by me during the Eclipse of Aug. 7. Had I Commenced for so doing I might have made a more extended Series of Experiments.

I hope you will find what I have written available for the purpose designed. I Should also like to know of the opinions of others and whether those I have ventured are correct

Yours respectfully

Geo T. Carter

Chicago Ill.

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During the progress of the late total Eclipse of the Sun at Springfield Ill.- My attention was called to the peculiar appearance of the shadows cast by trees fences and other objects around me.

I Stood at the top of an embankment some twenty or twenty five feet in height with my back to the sun which was then about 32° above the western horizon and within about ten minutes of total obscuration.

My Shadow was at the foot of the embankment and presented a sharp outline on the edge towards the South while the opposite side appeared as if fringed or blurred, evidently produced by two or more illuminating points My Shadow was about twenty five feet away The fringe or blurred edge seemed to be about four or five inches wide. I tried other objects such as a lead pencil, and my hand, with the fingers Spread apart, and observed the same effect. The Shadows there being at a distance of but a few inches from the object producing them gave a blurred edge of only about three quarters of an inch in width, Shadows at a distance of five or six feet from the object gave an edge of about two inches in width

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As the Sun approached into total obscuration this phenomenon became more and more distinct. As totality came on and my attention (being called) away it did not occur to me to examine the shadows at the reappearance of the Sun, nor have I met with any one who did. The same phenomenon was observed regarding the upper and lower edge of shadows cast the upper giving a sharp outline while the lower was fringed in the same proportion as the north edges.

I mentioned the phenomenon to Prof. Peirce afterwards and at his request I make this report of it. He also suggested to me an experiment with two lights one of less intensity than the other placed near together. I used an ordinary candle and an ordinary gas light near together. about two inches apart, and on the same level. The effect was the same as produced by the Sun though with far less intensity and distinctness. The dark edge was on a line parallel with the brightest light, while the opposite edge of the shadow was double. I then examined the shadows carefully and saw just outside the darkest edge a very faint ~~light~~ shade not visible except on close examination. A diagram might give

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a better idea (not necessary)

By examining the diagram it will be seen that the dark Shadow f-g is produced by the obstruction of both the Candle and gas light a" being the Candle & b" the gas light, c-d the object - The Candle only illuminates the blurred or double edge e-f- So that it is easily visible there, but in the part marked g-h where only the dim Candle light is obscured & moreover receiving direct rays from the more intense light of the gas-jet it would hardly be visible, Were the two flames of equal intensity both edges would appear double, It is doubtless probable that there were faint Shadows outside the dark edges of all the Shadows produced by the Sun in its State of partial eclipse, Circumstances are such that I cannot at present make any but very Simple Experiments, It may be that others can further investigate this subject & determine the cause, Should they consider it worthy their attention, It would seem that the phenomena might be caused by the bright protuberances seen during the total obscuration, Though not visible while the very Smallest portion of the Sun was

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in Light, Yet they would Sufficiently the place of a
better illuminating points. The dark body of
the moon separating the light of the Sun and
that of the protuberances,

Yours very truly
Geo S. Carter Chicago Ill

Read at the Session of the National Academy
at Northampton

To Prof. Benj Peirce:
Sir:

Having ascertained that
such a course will be agreeable to yourself
I avail myself of the opportunity to relate to you
a few observations of my own on the late Solar
Eclipse which were made with the naked eye
at Springfield Illinois. My observations had
reference simply to Several visual aspects
and Illuminations, and to the possible visibility
of the Zodiacal light. For these my Station
was peculiarly favorable; being upon the White
roof of the lofty tower of the Leland House, which
Commanded a horizon of fifteen miles or more

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on every side and occasional hill tops still farther distant seen over the wooded outline which bounded the general view. Overall this extent the dim and sickly hue had become very impressive half an hour before total obscuration, and the gloom very deep fifteen minutes later. At this time the Sky overhead appeared almost black, but with a blue tinge, 5 minutes later or ten minutes before total obscuration, a pale twilight was noticed about 8° high from W 60 S to W 30 S, and this continued at a less altitude, far around to the North, on the one hand and past the South on the other. Venus was first seen at 5h 1m of true local time, at 5h 4½m I could just ~~see~~ read fine no 1 (herein inclosed) by the aid of my ordinary Spectacles. The advancing umbra was discernable on the hilltops to the North West and North, before reaching the wooded line of the horizon, and many seconds before the limit of obscuration was complete at my Station. On its becoming complete, however, having first ascertained by a single sharp and prolonged scrutiny that the Zodiacal light did not manifest itself, I withdrew attention from that to the general appearances. Immediately next the moon there was seen a glistening circle, all around it,

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of yellowish white, the breadth of which was not estimated at the time, but as recollected may have been about 3'. It was almost dazzling and was set in a Corona of dense and calm whitenss exceeding the like (sic) of ordinary annual Streamers. This cushion of light was scalloped into deep and broad indentations resting between four or five blunt, tapering projections arranged around with and approximate regularity and extending to about the moon's diameter in length or a little more. The picturesque effect was something as if the dark - not black - ball of the moon was floated or buoyed in a basin holding leptic light. Also there was seen in the vertical immediately below the Moons Center and projecting beyond its dark disk a copper colored protuberance of oblong shape and in its effect much as if a bright red lamb were seen through smoke. Its extent was not estimated but left the impression of having been about one tenth the visual diameter and seven tenths as broad as it was long. Not so astonishing as this but more impressive was the Contour of the Moons Shadow on the upper atmosphere. The Suns low altitude 21° made the long diameter of the oval to distant for recognition to the East and West; but to the South and the North its edge was somewhat

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sharply defined and left beneath a far reaching and superb orange colored disc having the yellow predominant. It brought plainly to view the thin long streaks of cirrus cloud which could not be seen at all by ordinary daylight; and barring the displacement in azimuth, the two might have been taken for an intensified twilight, on the right and on the left, of a sunrising and a sunsetting seen together. This double twilight, much more than the Corona, I imagine was the source of the remaining light which made objects around still dimly visible, and hid from view all but a small number (four or six) of the brightest stars. Soon however my attention was called from this great light to the returning light seen in a pale yellow streak upon the hills beyond the northern wooded outline along the horizon. This was followed this was followed before the mind could prepare for the change, by a swift elongation and upspreading of the northern illumination which soon reached the Zenith, and made all that half of the hemisphere to glow as if incandescent in contrast with what it had been a few seconds earlier. The total obscuration was, of course, now at its close;

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and the diverse phenomena to the foregoing began to take place in their order. The planet Venus was visible steadily to the assistant at my side till 3h 19 and with brief intermissions to him and to two others of the Company until 3h 29m.

In addition to the foregoing I extract a brief passage from the written statement, just into my hands by the Rev. Charles H. Marshall of Indianapolis, of what he observed with the naked eye at Mattoon Ill. where there were different corps of observers. Mr Marshall is well known to me for discrimination, accuracy and reliable qualities as an observer and witness. "The moment before total obscuration beads of light appeared in great brilliancy apparently about six in number, differing in size and equally distributed over one eighth of the Suns disc. These beads were much brighter than the prominences flashing for an instant upon the sight and then vanishing. I consider that from Mr Marshall as evidence that the Baily's beads are not a phenomenon due as has sometimes been suggested to the colored screens or eyepieces that may be seen by a strong and clear unassisted eyesight Mine also I desire to depend my own statement

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made to the Section at the late Meeting of the Am. Association, that in observing the annular eclipse of 1838, at New York as my station, the ring which should have been complete at a given instant was only completed by some three or four beads, very unequal in size, which the moon's limb dragged along with itself for a very few seconds during which time the middle and larger one kept changing shape till all were gone. Inasmuch as my geodesic position can be ascertained with exactness, I see not why that observation of mine may not be made as valuable on the record as any single observation could be in determining the moons place. The observations of Professor Anderson of Columbia college N. York on this same eclipse were published by most of the New York papers, and I presume give the like statement to my own respecting these beads. This is the eclipse referred to in my paragraphs ¶ 395 Vol 42 of Silliman's Journal having special reference to the use of rosy light. The anticipations there expressed respecting that last phenomenon were realized to an exaggerated degree, it appears, by at least two astronomers.

Yours with much respect

Alex. E. Twining

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Passaic N. J Aug 28 1869

Benjamin Peirce L. L. D.

Dear Sir:

In the report of Your proceedings at Salem Mass Aug 23 no mention of the Association appears to have been the difference between the Corona and the Aurora, which was to me quite evident from my position near New Albany Ind. on a bluff 240 feet above low water, as reported Aug 9 to Dr. E. S. Crozier Sec. Soc. Nat Hist New Albany Ind.

Since then I have combined my report with others to give a definite description of the general characteristics of the Eclipse to Prof. J. L. Conrad Prof. Nat. Sciences Gettysburg Penn. and sent a copy to Dr. E. S. Crozier New Albany Ind and have kept no copy. I describe so much as I believe will be interesting to you.

As the partial Eclipse advanced, all yellow appeared a greenish tint, Countenances looked sickly and green looked very dark green as usual in partial Eclipses. ~~when the direct light of the Sun is partially shut off.~~

During the Total Eclipse the Sun was surrounded by a bluish white Corona of perhaps one

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eighth or ¼ the diameter of the Sun circular at the exterior except away and indefinite This I suppose to be permanent and accounts for the usual tint in partial Eclipses, when the direct light of the Sun is partially shut off and blue predominates. Also that it is self luminous because of a different color from the denser light of the Sun, also that it may explain Seeing the willow leaves, because if the waves rise of this shape their refraction would produce this appearance on the surface of the Sun.

Outside of the Corona rays extended about ¾ its diameter beyond its edge in the direction of the ecliptic and nearly the same at right angles, the whole forming a rhombus nearly square with the sides nearly vertical and horizontal, and the longest diagonal in the direction of the ecliptic. There from the center of the top, electric flashes like smoke in form passed at irregular intervals in about half a second to the left of the corner. The color of the whole outside of the Corona was about the same as that of the Sun. There may have been flashes at other points. I kept my eye fixed on this point only long enough to be certain.

I suppose these to have been an electric current in our own atmosphere perhaps

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the direction of the angles depends upon the general law, that a current of magnetism is always at right angles to a current of electricity. The intensity of the aurora may depend upon the hygrometric condition of the atmosphere so that in some places where there was much moisture the aurora may have overpowered the corona, while the beautiful cloudless and clear atmosphere at that time at New Albany produced a weaker aurora and allowed the corona. I suppose the apparent radiation was the effect of perspective on parallel rays. I suppose that it was electric and hence self-luminous because I saw several electric flashes. Otherwise it might be supposed to be reflected sun light since it was of the same color, and I have seen the rays of the setting sun concentrated at the East like a rising sun when there was not a cloud to be seen. But immediately after sunset the heavens were covered with cumulo-cirri clouds thus proving that even without a cloud the air may be filled with lenses to concentrate the sun-light in streaks. But I think not in this case.

Now I suppose that the red light projecting from the sun and the corona, and the aurora are all self luminous and will complicate the question in the photographic

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experiments.

No one refers to the Zodiacal light. I saw none myself except the aurora or the corona be the Central portion strong enough to be seen in the presence of the other.

Our Smithsonian thermometers gave in the shade, the maximum 75.5 at 3.00 P.M and thence continued to fall to 64.5. at 7.0 P.M The Solar thermometer 89.2 at 3.00 P.M 68.7 during the total eclipse and from 5.20 to 5.30 P.M. 71.2 at 6.20 P.M and then continued to fall. The wet bulb thermometer minimum was 58 at 5.4 P.M. Hence at the minimum the temperature was 10.7 above the dew-point at the place of observation near the earth previously heated by the sun and then radiating the accumulated heat. But at a short distance above I suppose that the temperature was below the dew point and hence the darkness was not the transparent darkness of a clear night but resembled a London fog or a Pittsburgh fog composed of moisture and black coal smoke in the direction of the Eclipse it had not this appearance

Very respectfully

B Aycrigg

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San Francisco Cal.
Sept 9 1869

Prof. Benjamin Peirce
Superintendent U.S. Coast Survey
Washington D.C.

Dear Sir:

The path of totality of the Solar Eclipse of August 7 through Alaska passed nearly parallel to the coast line from the head of Cook's inlet to the Stakeen River, but from the information I gathered in 1867 I found it would be impracticable to carry instruments and provisions up the Sutchetna or Kenek Rivers from Cooks Inlet; across the Mountains that border Prince William Sound; up the Atna or Copper River & across the Mountains at the head of Behrings Bay or up the Alsek R. Natives do cross the St Elias range by the latter river to the valley of the Chilkhat R. but only in winter with Snow Shoes The Yukatat or St Elias Range with its hundreds of glaciers and average elevation of 8000 or 9000 feet effectually bars transportation: Moreover the Country on the East flank is mountainous and throughout affords no means of sustenance

In 1867 I examined the mouth of the

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Chilkaht River emptying into the head of Chatham Strait between two high mountain ranges, in latitude 59° 12' only 40 or 50 miles in a direct line S.S.W from the Central path of totality, this too was the nearest point to that line reached by navigable waters. It also offered the opportunity of my observing the bends of the limbs of the Sun and of the moon during the as I had done at Humboldt Bay in 1854.

In 1867 undertaking the conduct of this Expedition in 1868 I determined to ascend the Yakon River on the Chilkaht. Sir James Douglas, in answer to my inquiries, wrote me that the Chilkaht & Yakon were unexplored: that the latter for 40 or 50 miles passed through a very mountainous region filled with glaciers. This decided me to ascend the Chilkaht, the lower reach of whose valley I had seen for ten or fifteen miles, and having learned from the Indians that they traded as far northward as Fort Selkirk on the Yukon River.

Our first understanding was that not only should observations of precision be made, but observations with the spectroscope; and that photographic pictures should be taken. Your letter of Novem. 18/68 however, limited my action to "secure the greatest precision in observing the phases, time &c. with reference to data for the longitude", while spectroscopic observations and photographic impressions were to be undertaken only in case Volunteers should offer for-

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such duty. On May 18th you informed me that "no spectroscope was available for my use". No volunteers offered for such a long & hazardous undertaking: no steamers were running to Sitka, and from Sitka I had to trust to canoes for a rough trip of 250 miles to my destination.

Set the whole expense and time of the expedition should be lost by a cloudy day on the 7th of August, I determined to determine the latitude & longitude of as many positions en route as practicable, and to make as many flying sketches of harbors as the time and weather would allow. That work I have already reported to you.

The following are the instruments taken for the whole work.

For latitude, time and azimuth, the new Meridian Instrument U.S.C.S. No. 1 of which I have specially reported.

For observations of the eclipse a telescope by Fauth[illegible], object glass 3 inches diameter; focal length 45 inches; astronomical eyepiece with power marked 55. In this eyepiece I had a diaphragm inserted with two threads at right angles, while the inner edge of the diaphragm was cut as a micrometer rack with 9 teeth to each quadrant. The eyepiece which I had suggested for determination of the position, extent

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and elevation of the sun flames was not made.
The instrument was equatorially mounted for a latitude of 45°, and had movement by rack work in two planes. For some days before the eclipse the apparent size of the sun in the field of view was well studied to familiarize myself with the approximate determination of angles and relative size of objects on the limb.
During the eclipse observation it was set up in the open air near the Transit Tent, and protected from a light E.S.E. air by the fly of a tent.
In order to record the times of beginning and ending of the eclipse, beginning and ending of totality, transits of the sun's and moon's limbs over the meridian, occultation of spots, and other phenomena, the Hipp Chronograph, with new helices, was mounted and connected with the Frodsham Break circuit Chronometer No 3479. Both were working very nicely.
From San Francisco I had taken 17 chronometers, of which six belonged to the U.S. Navy, and had been kindly loaned to me by Lieut Com^dr. E. E. Wireman of the Mare Isld. Navy Yard. The Break circuit Chronometer was only used for this special work.
Leaving the dangerous navigation of the Chilkaht R. in canoes, I left nine of the Chronometers at

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Sitka, and carried eight to my station on the River.

Thermometers and Barometers were placed in two positions during the eclipse, but a close systematic series of observations could not be obtained with the limited assistance I had. For the same reason the magnetic instruments were not observed.

I had in addition to the above instruments, a sextant, theodolite, gradienter &c. &c. for local surveys.

By the kindness of Major Gen. Thomas Commanding the Division of the Pacific, I was enabled to reach Sitka on the U. S. Quartermaster's steamer Newbern. Thence there was no vessel available, and I was compelled to undertake the worst part of the journey in an open boat kindly furnished to me by Maj. Gen Davis Commanding the Department of Alaska. A large war canoe with a chief and six men of the Sitka tribe carried part of my provisions and instruments.

My experience upon this coast with Indian tribes was such that I declined any escort of Soldiers.

My party consisted of Mr S. R. Brockmanton Jr. as aid and four men as interpreters; the tribe of Chilkahts numbered 1500, and was considered the most hostile on the coast, especially as Gen. Davis had recently kept their chief ten days in the guard house, and shot one or two of their men in trying

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to pass the guard. The officer looked upon my undertaking as reckless – I didn't.

The day I left Sitka was the commencement of bad weather, and I was attacked with Panama fever, so that we were eleven days in reaching our station "Kohklux" at the Chilkaht Village of Kotkajh-too on the left bank of the Chilkaht River in latitude 59° - 23' - 42" longitude 135° - 58' 12". Here the valley of the river is about two miles wide, and the mountains on each side reach an elevation of about 2500 feet, with very steep sides. I intended to ascend higher, and to get directly in the central line of totality, but the river came from the N. N. W. and I should have been obliged to travel over 100 miles by the windings of the River to make 20, and moreover, that would have landed me in British Columbia. I could not get my instruments and provisions over or upon the mountains, because the Indians are unaccustomed to pack, and no trail led over them.

From July 27. I had fine weather for all preliminary observations of latitude, longitude by Chronometer, Magnetic Declination, dip and Intensity &c.

For three or four days preceding the 7th we had heavy cloudy weather. On the morning of the 7th the weather was cloudy, barometer rising rapidly,

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and at 9 a.m. it appeared likely to break away; but soon after that the sky became quite covered with heavy masses of cumuli.

The beginning of the eclipse was lost by a cloud obscuring the sun for about half a minute. The limb of the moon was very sharply defined, and the outline of the sun very steady and sharp.

At the times of occultations of spots, clouds intervened; at the meridian passage of the sun and moon, a few drops of rain fell, and the transits of the limbs were lost. The atmosphere continued remarkably steady.

As the eclipse progressed the growing darkness was very marked, but altogether different from that of twilight or moonlight. About the time the sun was half obscured the Chief Koh-klux' and all the Indians had disappeared from around the observing tent: they left off fishing on the river banks; all employments were discontinued, and every soul disappeared in their houses, nor was a sound heard throughout the village of 53 houses. Even the everlastingly howling curs seemed to be quieted down. The natives had been warned of what would take place, but doubted the prediction. When it did occur, they looked upon me as the cause of the sun's being "very sick and going to bed". They were thoroughly alarmed,

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and overwhelmed with an undefinable dread.

Two or three minutes before the commencement of totality, the clouds broke away directly around the sun, and the crescent was very beautiful to the unaided eye and in the telescope. In the telescope the borders of the sun and moon were remarkably steady and very sharply defined. In 24 years observing I have rarely, if ever, seen them under such favorable circumstances. I observed them without any shade, and followed the sun's border to the instant of its disappearance. The bright, long, narrow crescent was sharply and regularly defined throughout; the extremities clear cut and pointed. As the width and length of the crescent decreased, this same sharpness of outline and regularity of form were maintained until it became a fine line of living white; and shortening rapidly, it disappeared as a very short, fine, distinct line, and not as a star at its disappearance. There was no breaking of this line into points or beads; no wave motion along it; no disturbance whatever of continuity or regularity of form. [I watched whether the last visible edge of the sun would appear projected upon the black border of the moon, as I have twice observed ε Scorpii projected for 2.5 seconds upon the

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bright limb of the moon at occultation of that star, but no such phenomenon presented itself.

In noting the time of commencement of totality, the chronometer was held within 10 or 12 inches of me, and I distinctly read the seconds and the minutes; whilst my aid made the record in lead pencil, but says it was difficult to read the writing after making the record. We had no artificial light at the station.

Instantly upon the disappearance of the East edge of the sun, the narrow, bright white line of the corona took its place, and was as sharply defined and unbroken as the sun's edge had been.

The appearance of the long, narrow line of the sun's border just before its obscuration may be described as a curved line of silver at a white heat — glowing and living; yet not dazzling; while the curved line of the corona may, in contrast, be described as a fine line of bright burnished silver from which the rays of the corona started; it lacked the vividness of the sun crescent, yet I think an inexperienced observer might have mistaken it for the border of the sun still hanging on with diminishing brightness.

The rose colored flames from the sun's limb were seen before I took my eye from the telescope. After the record of the time of totality, say in less than eight seconds*

* I estimate it less than eight seconds because I observe and record transits of nine seconds apart: and I lost no time here, while the record was made by my aid.

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The spectacle was sublime;- the solemn feeling with which the growing darkness, the bold dark mountains, the rush of the swift flowing river, and the wild surroundings had affected every one, gave way to mute & admiration at this magnificent glory in the heavens.

The Corona was not visible around the moon's whole circumference at the earlier period of totality, but after I had established the position &c. of the flames, it was observed around less than half the circumference, with a pantish glow around the other half, but sufficient to bring out in bold contrast the dark outline of the moon. This may have arisen in part from the cloud which intervened after I had been watching the phenomena about one and a half or two minutes. The extreme height of the rays of the corona was about one third the diameter of the moon: no raviness was seen in the rays. Mr Shackmorton reports that to the naked eye, the rays appeared to extend beyond the outline of the moon about one tenth of the moon's diameter, and to be equally bright around the whole disc.

The annexed sketch shows the general appearance of the flames, their position, extent, elevation and color as closely as I could determine them; and

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the limit of the corona when my attention was particularly directed to that.

When I found that clouds had hidden the moon from me, I looked up the valley of the Chulkah which makes a small angle with the path of totality, and saw at the north east flank of the mountain range on the right bank, the line of the coming light sweeping down rapidly, showing through rifts in the clouds, and beautifully lighting up the snow filled gulches and crests of the mountains.

To the senses the increasing light, after totality, was much more rapid than the decreasing light before totality, although the clouds were, to all appearances, the same. The natives felt its influence at once, and came from their houses in hundreds; gradually they approached and surrounded the observatory.

The limited number of my party prevented the observ. of magnetic changes. A few meteorological observations were made: little or no change of temperature was appreciable to the senses; and I think the sun occasionally breaking through the clouds masked any real change.

The following observ. show the general condition of the temperature.

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August 7th 1869.

	Time	Ther 1*	Ther 2†	aneroid Bar. 1 ‡	aneroid Bar. 2.
Sun in and out	11h-15m	65°.0	61°.0	30in.19	30in.28
Clds. var.	12.00	61.2	59.8	30.20	30.28
Heavy clds.	12.30	57.1	57.0	30.19	30.27
Clds. var.	1h.05	54.4	54.6	30.20	30.26
Drops of rain	1.30	57.4	56.8	30.18	30.25
Clds.	2.00			30.20	30.28

Governor Wm. H. Seward and party were on the river coming up to my Station at the time of the eclipse. As the obscuration advanced the Indians refused to proceed; Landed and fled to the bush, and returned som after totality. The gentlemen had a fine view of the sun flames and crona through a break in the clouds, and from this position had an excellent view of the approaching and retreating shadow as it swept down the valley. A second party on the river witnessed the same phanomena. A third party lost totality on account of clouds.

On the steamer Active, lying in "Anchor Bay" at the mouth of the Chilkaht, the ladies and gentlemen on board had a view of the whole of totality, and Saw Mercury and several Stars through breaks in

*120 feet south of Station: correction for index error + 0°.7
†63 " " " " " " " " not known
‡Barometers at the Station.

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the clouds. From them, I obtained sketches of the relative positions of the Sun, Mercury and Stars, by plotting the Sun on section paper and letting each person place the planet and stars where they judged they saw them, using the Sun's diameter as a measure of relative distance. It was remarkable how well they agreed, and as they saw stars as small as the 4th magnitude, possibly of the 4½ magnitude, I have made a sketch of such as were corroborated, and herewith annex it.

None of these observers saw any break in the continuity of the disappearing or reappearing edge of the sun: some viewed it through opera glasses.

I will endeavor to make a colored sketch of the appearance of totality, although I cannot hope to approach an adequate representation of the beauty which it presented.

I desire especially to commend to your consideration the assistance I received from temporary aid S. R. Throckmorton Jr. and for the readiness and heartiness with which he entered upon a difficult and dangerous duty.

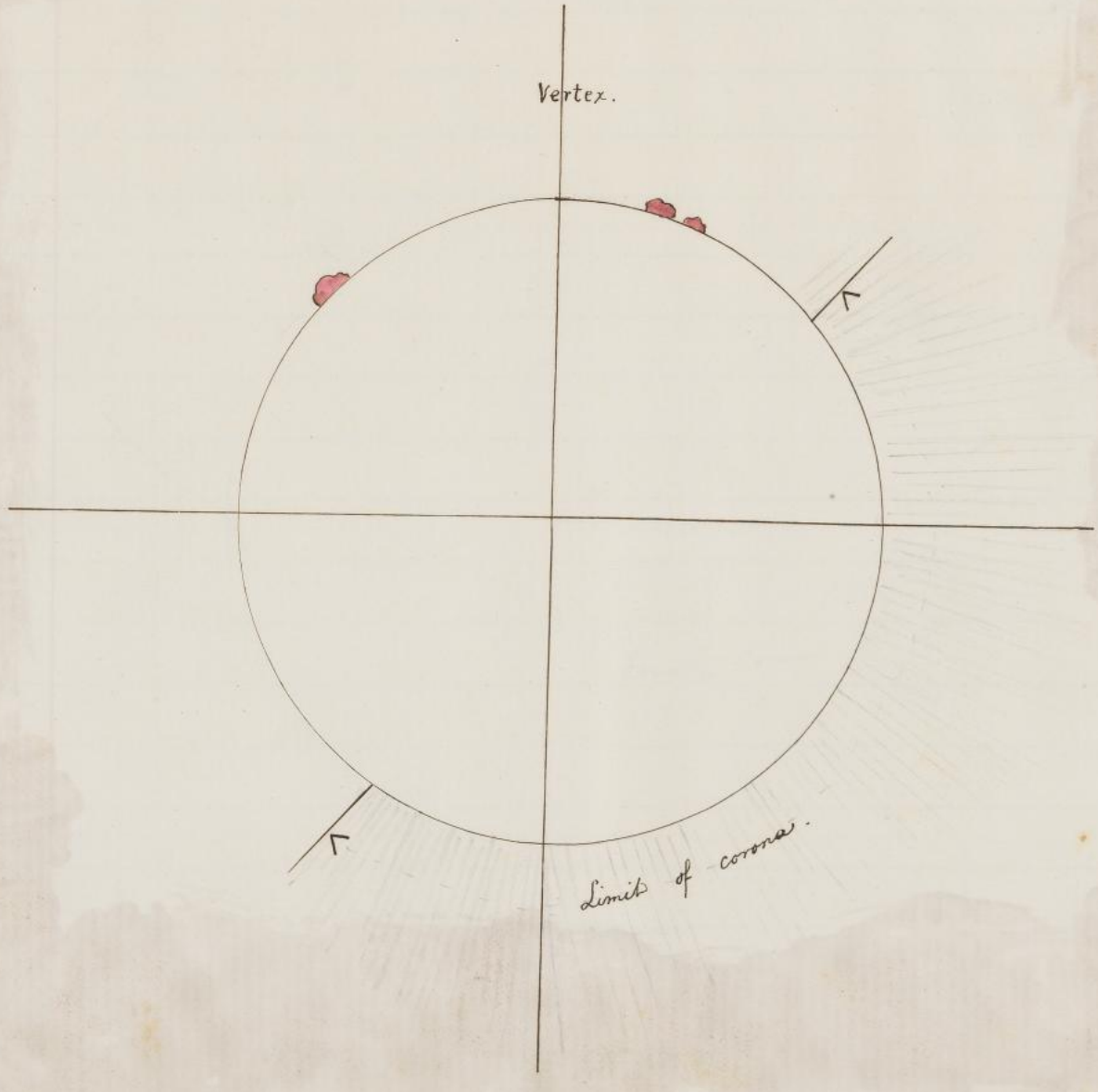
Very respectfully Yours
George Davidson
Ass. U.S.C.S.

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August 7. 1869. U.S.C.S. Station on Chilkaht River, Alaska -

Kohklux; Latitude 59° 23' 42" Longitude 135° 55' 12"
Position, extent and height of rose colored flames; and of the corona during the first part of Totality as seen in an inverting telescope



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Atlanta Eclipse Expedition July 1, 1867. Sketch showing the Stars seen during

South

3 β Ursæ Maj.

3 Ursæ Maj.
4 κ Ursæ Maj 4

Mrs Kinkead saw a star "almost in the zenith and a little to the right [of the vertical] of the sun," in an open space in the clouds.

4 Bac 3059

Clouds

Clouds

4 38 Lyncis

4 α Leonis

Patches of Clouds

Mrs General Davis saw three stars forming a triangle of nearly this shape and in this locality

α Gem. 1½

1½ β Gemini

4 α Gemini

2.

2.

ε Gem.

3½ δ Gem.

Clouds

All the observers saw Mercury located within two or three diameters of the sun of its right position

Mercury

Horizontal line through the Sun

Sun

3½ λ Gem.

2½ γ Gem.

Clouds

Clouds

Sun

Clouds

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Horizontal line through the Sun

Clouds

Sun

Perpendicular through the Sun

Clouds

Clouds

$\frac{3}{3}$ ε Hydrae

4 δ Hydrae

4 β Cancri

Clouds

Clouds

Clouds

Clouds

Clouds

Clouds

Clouds

3 β Can. Min.

1 α Can. Min.

General Geo. B. Thrie says here "one Right star and several smaller ones"

$4\frac{1}{2}$ 22 Monoc.

Clouds

39 Gem.

γ Gem.

2 δ Gem.

The latter by the hour on the Kamm Arch at the North of the Citadel Rock, Gibraltar 59° 10'

George Davidson
Asst. U. S. C. S.
August 9th/69

These squares represent one degree

33

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Coast Survey Office
Washington, D. C.
October 4th 1869.

Dear Sir:

The party for observing the solar eclipse of August 7th at Springfield, Ill, acting under your immediate direction, and organized by me, in accordance with your instructions of June 25, consisted of the following members:

L. F. Pourtales, Asst. C. S.

Prof. J. M. Peirce and J. B. Nawn of Harvard College, stationed at Bloomington, Ill. on the 7th

E. S. Seaver, R. A. McLeod, C. N. Jay, and W. P. Montague of Harvard College, temporary aids.

J. W. Black assisted by R. Fitzgerald photographer, & myself.

The special duty assigned to the party was to obtain measures of precision of the contacts, and to make such collateral observations of the corona, prominences, etc. as the outfit of the party permitted.

Preparatory to these observations Mr. E. P. Austin determined, under Asst. E. Goodfellow's direction, the latitude and longitude of a station in the grounds of the new State-house. Between May 19 and June 6, on eight nights, 65 observations were taken on 18 pairs of stars with Zenith Telescope, C. S. No. 5, for the determination of the latitude; the results are as follows: —

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Pairs of Stars B. A. C.		Seconds of Lat.	Pairs of Stars B. A. C.		Seconds of Lat.
3959	3990	55."71	4564	4594	56."92
4033	4066	57.80	4607	4640	55.24
4110	4159	58.04	4675	4684	56.49
4196	4217	56.20	4701	4723	56.04
4258	4311	57.35	4738	4758	56.38
4341	4360	56.58	4789	4809	56.67
4387	4416	57.09	4870	4897	55.91
4438	4479	57.70	4958	5026	56.98
4519	4552	57.35	5071	5143	57.00

Mean result for latitude $39^\circ\ 47'\ 56."78 \pm 0."12$
Probable error of a single obs. for lat. ± 0.51
" " " " Stars place ± 0.45

One result was rejected for lying outside the proper limits. It was deemed unnecessary to give special weights for number of observations.

For the determination of the longitude, transit observations (with a portable Würdmann transit, No. 6 of the U. S. Naval Observatory) were made May 19, 22, 31, June 2, 3, 4 and 6, and chronometer signals were exchanged, by telegraph, between Omaha, Nebraska and Springfield, Ill., on 3 nights, with the following results:

Difference of longitude, Springfield and Omaha.

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		May 22		June 2		June 4		Mean	
Springfield signals, series	1	25m	08.29	25m	08.11	25m	08.12	25m	08.27
	2		08.20		08.18		08.16		08.15
	3		08.33		08.17		08.21		08.16
Mean		25	08.27	25	08.15	25	08.16	25	08.19
Omaha signals, series	1	25m	08.85	25m	08.55	25m	08.62	25m	08.76
	2		08.64		08.48		08.60		08.57
	3		08.79		08.50		08.63		08.62
		25	08.76	25	08.51	25	08.62	25	08.63
Mean from St & O. signals		25	08.51	25	08.33	25	08.39	25	08.41

We have the Coast Survey telegraphic results:-

Cambridge, West of Greenwich	4h	44m	30.85
Omaha West of Cambridge	1	39	15.03
Springfield East of Omaha		25	08.41
Hence Springfield West of Greenwich	5	58	37.47
	89	39	22.05

The station is marked with a stone 15 inches square, set in the ground 7 feet, and above ground with a block of stone, two feet high; it is on the west side of the foundation of the new State Capitol, and is fully described in the records. A meridian line was also traced out by Mr. Austin, with the northern termination marked by a stone.

July 20. Asst. Goodfellow arrived at Springfield and July 21, Asst. Pourtales; the latter selected a station in the grounds of the Reservoir, about 1/4 mile, N. E. of the centre of the city, favorably situated for observing the eclipse; under Asst. Goodfellow's direction, an astronomical obser-

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valony was erected 10 ft., by 12 ft., and 7 ft. high at the eaves; Troughton and Simms Transit, C. S. No. 6, was mounted on two blocks of seasoned pine; the Mills Clock was mounted on a post, and Chronograph C. S. No. 2 (by Bond) was set up. A Daniell battery of three cups was kindly loaned by the Western Union Telegraph Office. On my arrival at Springfield, on the 28th ult., the observatory was enlarged to meet the wants of the photographers, a dark chamber 4×10 feet was added on the west side, also sufficient covered space for mounting and working the large equatorial. A full description of the station is given in the records. To connect the two astronomical stations, a small triangulation was executed (See accompanying Sketch) & a base-line measured 520.6 feet long, also an astronomical azimuth, determined by means of the Sun. The line was measured twice with a platinet metallic Tape.

We have, by triangulation: Eclipse station N. of Austin's Station 105."75

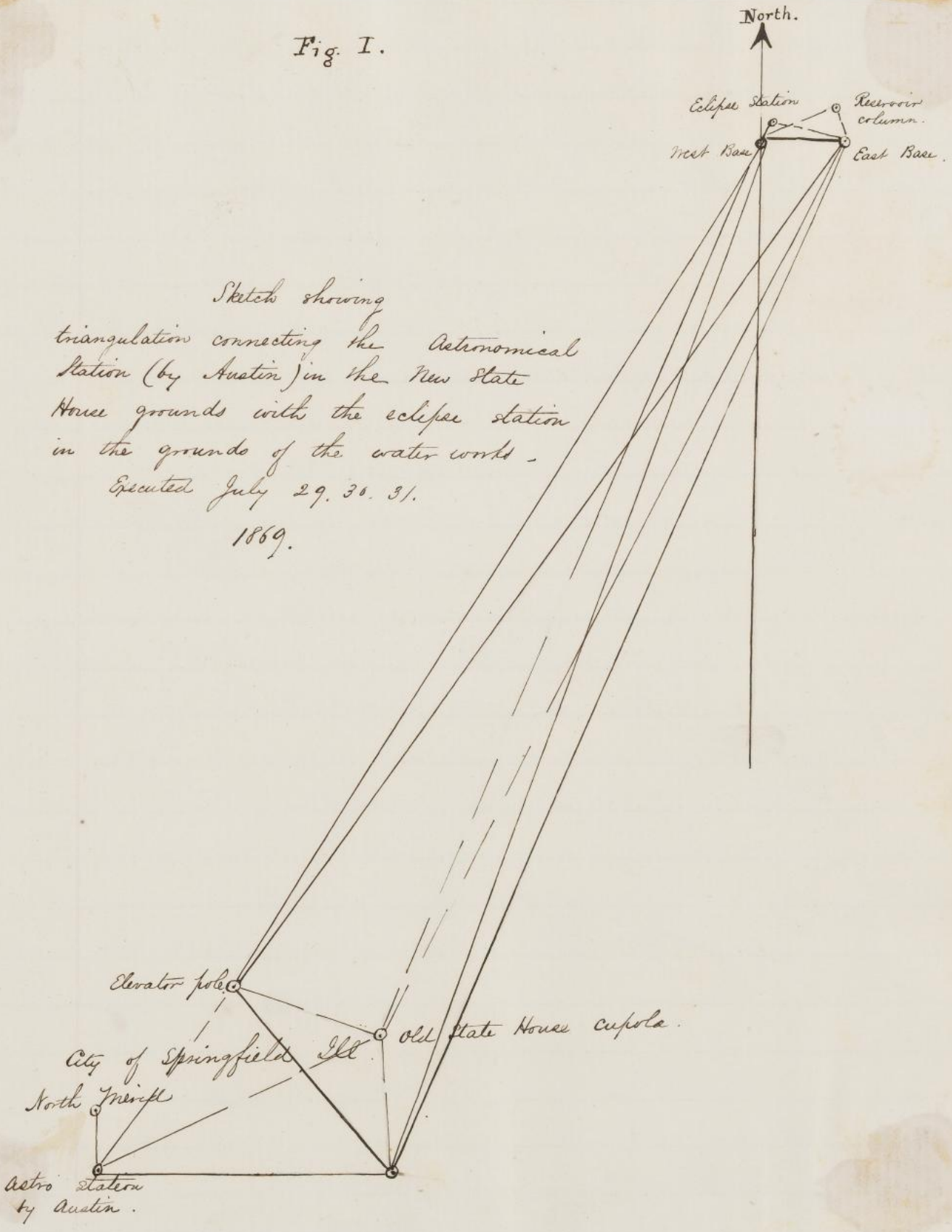
" " E. " " " 0 53.87

Hence the position of the eclipse station (Centre of Transit)

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Fig. I.



Sketch showing triangulation connecting the Astronomical Station (by Austin) in the New State House grounds with the eclipse station in the grounds of the water works.
Executed July 29. 30. 31.
1869.

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$\varphi = 39^\circ\ 49'\ 02.''53$ $\lambda = 89^\circ\ 38'\ 26.''18$ or $5^h\ 58^m\ 33.^s74$ W. of Gr.

The triangulation also gave the following results:

	Lat.	Long.
Old State House, polar on Cupola	39° 48′ 06.″54	89° 38′ 56.″71
Leland Hotel " " "	39 47 57.50	89 38 33.30
Elevator " " roof	39 48 09.65	89 39 09.13
Reservoir, Column	39 49 04.33	89 38 21.66

I observed transits for local time on July 28, 29, 30, 31, and again, August 2, 3, 4 and 7; those for the last three dates were carefully reduced by the method of least squares, the chronograph sheets being read off to the nearest $0.^s02$. The clock corrections are as follows:

1869.	Aug.	Sid. Time	Clock correction on Springfield sidereal time	+	±
	3	17^h		$2.^s16$	$0.^s02$
	4	$17\frac{1}{2}$	" " " " " "	3.02	0.02
	7	18	" " " " " "	2.80	0.01

Two mean time chronometers were rated by tapping their seats - their corrections on Springfield mean time are as follows:

Dent 2171.

Aug. 2.	at $8\frac{3}{4}$ p.m.	$-0^h\ 50^m\ 34.^s9$	N.B. Between the 6th & 7th	
	3	" "	34.2	the chronometer was
	4	9 "	33.1	taken to the telegraph
	5	5 "	32.3	office and probably suf-
	6	4 "	29.5	fered some change on the
	7	Noon	22.32	return, on the 7th a.m.
	7	$9\frac{1}{2}$ p.m.	22.40	
	9	$2\frac{1}{2}$ p.m.	$-0\ 50\ 20.9$	

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Parkinson and Frodsham, No. 1411, used at Bloomington on the 7th, has the following corrections to Springfield mean time.

August 2	at	$8^h\ 45^m$	p.m.	$+4^h\ 32^m\ 47.^s0$
3		8 45	"	46.2
4		9 0	"	38.9
5		5 0	"	34.6
6		4 0	"	33.5

On the nights of the 6^h and 7^{th} time signals were sent to Des Moines, Iowa.

Transits of solar spots, according to Carrington's method, were observed on several days, but owing to the want of fine motion and means of adjustment of equatorial No. 4, and a troublesome wind, these observations are not so accurate as the method admits of.

The photographic pictures of the eclipse were obtained by means of an equatorially mounted (on a stone block) refractor by Dollond, having about 6½ feet focal length, and a clear aperture of 4 inches. The instrument was adjusted so that by merely turning the handle of the motion in right ascension, the image of the sun could be kept near enough in the middle of the field, during the total duration of the eclipses. The use of photography, at Springfield Station, was decided on but a short time before the eclipses, and was much retarded for want of clock motion to the telescope, and for want of a suitable eye piece; the images of the sun, as

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formed by the object lens, are nearly 2/3 of an inch in diameter. The pictures were taken instantaneously, and the times recorded automatically on the chronograph. The attachment of the plate-holder and the slide and circuit-breaking arrangement is due to Mr Black. The drop-slide has a rectangular adjustable opening of about 1/12 of an inch, and passes over the diaphragm of the telescope in a small fraction ($\frac{1}{30}$) of a second. The telescope was directed by means of the finder, which in the place of the eye-piece was closed with a ground glass having a circle marked on it. When the image of the sun was kept within this circle, the telescope was properly directed, and the solar image was central on the plate. Each plate was arranged for 5 pictures, which, on the average, were taken within an interval of about 9 seconds. When the middle of the opening was opposite the center of the solar image, the lower end of the slide separated two slender brass springs (a, a) in connection with the galvanic circuit, and broke the circuit; about 1/10 of a second later the circuit was restored by a metallic plate inserted in the wooden slide (near b) coming in contact with the springs. For each picture exposed there are two marks on the chronograph, one produced by the up-motion of the slide, while the plate is covered



Fig. 2.

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and one produced by the down-motion; the former being larger and useful as a finder for the latter. During totality, the slit was opened to the full size of the picture, but as the photographs show, the sun was but very imperfectly followed by hand making a series of superimposed pictures, from which, nevertheless, some useful information may be gathered. After totality, the current became from some cause deranged, and interrupted for a few minutes the regularity of the operation. Assistant Pontrales timed the pictures, Mr. Blake attended to the slide and exposure, Mr. Fitzgerald kept the telescope directed, while two attendants in the dark room directly back of the telescope, did the coating and developing and fixing of the plates. 52 plates in all were secured, running out those taken before and after the eclipse and some on which an attempt was made to let the sun trace out a declination parallel to serve for the measure of position angles, 38 remain, containing 178 pictures of phases & 6 pictures during totality.

As some time must necessarily elapse before the measures of the photographic pictures (glass negatives) can be taken and discussed, I propose to submit a special (and supplementary) report of these results, in order not to delay the present general account of our labors.

The weather was remarkably favorable; the cloudy and rainy weather of the two preceding days having changed

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during the night, and on the day of the eclipse, the sun was clear and no cloud to be seen, with a light wind from the N.E. It was also fortunate that the dust of the preceding day fewer had all disappeared. Meteorological observations were taken by Mr. T. Dudley, a Smithsonian observer, who had kindly volunteered his services. His record is given further on.

My observations of the contacts and the general progress of the eclipse were made with the Zenith Telescope, already mentioned; it has a clear aperture of 3.65 inches and a focal length of 4 ft. 2 in. The magnifying power used was about 65 the lowest available. A deep-red shade glass was fastened over the erecting eye-piece. The high power and the presence of micrometer rack and threads made the use of the instrument-less convenient. Mr Seaver used the Small equatorial, also employed by me in the Solar spot observations. Aperture 2.7 in., focal distance 3 ft. 10 in. magnifying power about 55. No shade glass was required, as the Sun's image was spread on the disk to a circle of 4 3/4 inches diameter. The instrument was balanced and roughly adjusted, but for want of fine motion was troublesome to handle. Mr. Fay with telescopes of one and two inch opening, and Mr. McLeod with a binocular marine glass, magnifying 2 or 3 times. These observers need shade-glasses.

The contacts were noted as follows, Mr Montague

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calling out the half and whole seconds of the chronometer Dent 2171

First inner contact at $4^h\ 55^m\ 19.^s5$ by Chas. A. Schott *
21.0 " R. A. McLeod
22.0 " E. P. Seaver †
17.3 " C. N. Jay ‡

The mean of these times giving the second and third half-weight, is $4^h\ 55^m\ 19.^s4$

First inner contact at $5^h\ 55^m\ 54.^s5$ by C. A. S. rate 1s. counting time myself
55.5 " R. A. McL.
56.5 " E. P. S.
55.0 " C. N. J. allowing 3s for lateness.

Giving half weight to the second value, and none to the remainder, we have $5^h\ 55^m\ 54.^s8$

Second inner contact at $5^h\ 58^m\ 43.5$ by C. A. S. well observed
43.5 " R. A. McL.
43.5 " E. P. S.
42.5 " C. N. J.

omitting the last, we have $5^h\ 58^m\ 43.^s5$ for end of totality.

---

*The contact happening nearly ¼ of a minute later than the times predicted from the Naut. Alm. data, & the field of view being comparatively narrow, I crept a little to the right & left of the point of contact, & estimated the correction to my time ($4^h\ 55^m\ 23.^s5$) when the phase was distinctly seen, about 4.s0, judging by the same eye of phases at the ending of the eclipse.

†Time uncertain, 6s deducted from observed time, when the sun showed a decided indentation; see special report.

‡One second deducted from recorded time; see special report.

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Second outer contact at $6^h\,54^m\,07^s.8$ by C.A.S. will observers *
$07^s.5$ " R.A.M.C.S.
$07^s.5$ " E.P.S.
$08^s.5$ " C.N.S.

For the end of the eclipse, I prefer to use the first value alone, or $6^h\,54^m\,07^s.8$.

Applying the chronometer correction ($-0^h\,50^m\,22^s.4$), we have the following observed times of the contacts; - to these are added for comparison the deduced times from data and formulæ given in Supplement to American Ephemeris, 1869

Springfield, mean time.

	observed	predicted +	Diff. O – P.
Eclipse begins	$4^h\,04^m\,57^s.0$	$4^h\,04^m\,35^s.5$	$+21^s.5$
Totality "	5 05 32.4	5 05 20.7	+ 11.7
" ends	5 08 21.1	5 08 10.2	+ 10.9
Eclipse "	6 03 45.4	6 03 41.2	+ 4.2

Total duration of eclipse, by obsn $1^h\,58^m\,48^s.4$
by cmp'n 1 57 05.7 diff. $17^s.3$

Duration of Totality by obsn 2 48.7
by cmp'n 2 49.5 diff. 0.8

The observed time of beginning must be considered liable to a probable error of several seconds, and is most likely too late; the times of the other phases are considered quite

* Counting time myself

+ $5^h\,08^m\,11^s.75$ is the assumed longitude of the Washington Observatory

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trustworthy. An independent set of times, of greater value if it is effected, will be deduced from the photographs.

It may also be stated here that the nearest point in the line of centrality of shadow, as computed from the American Ephemeris, was 0'.7 N. 32° E. from the eclipse station; according to the data from the English Nautical Alm., however, this distance was 3'.0, in the same direction. The elevation of the station above the sea level estimated at about 500 ft.

The contact of the moon's limb with the umbra of spot 4 (see solar spot diagram further on) was observed as follows:

First contact seemed, by chr. 217, at 5h 19m 45.5s C.A.S. } For center of penumbra
43.5 E.P.S. } Mean 5h 20m 02.5s

Umbra disappeared at 5 20 19.5 C.A.S. } = 4 29 40.1 sp. M. T.
21.5 E.P.S. }

In connection with this observation, I noticed a curious and unexpected phenomenon. When the moon's limb had nearly touched the penumbra of the spot, a black band* suddenly shot out from the umbra (one of the width of it) and for an instant connected with the moon's limb, it then retreated & reformed, making apparently a bridge across the penumbra; it was then gradually shortened and covered by the advancing moon. This connection was distinctly seen for several seconds tho' the forming, retreating & reforming was perhaps completed in half a second.

*Otherwise known as the black ligament, Baillaire, and giving rise to a real and apparent contact.

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Noted contact (by chronometer) first Spot 7 at $5^h\ 36^m\ 25^s.5$

7½	5	37	51.0
8	5	39	20.5
9	5	53	50.5

The above disappearances were also noted by Mr. Seaver, together with reappearances, for which see his report. During the progress of the eclipse, the moon's outline was tolerably smooth and the points of the crescent perfectly sharp.* The phenomenon of Baily's beads was seen to great perfection for a few seconds before totality set in, but its existence just after totality was not ascertained, the time being consumed with fixing my shade glass. The accompanying diagram shows the beads, as seen through the inverting telescope. The arrow indicates the direction of their successive formation; the two uppermost ones formed last. I would particularly notice their great regularity, in width, outline and distribution. Their individual shape is given in the corner of the diagram. The phenomenon was seen, both before and after totality, by others of the party as described in their reports.



Fig 3.

* The phenomena of distortion, noted by Mr. McClean, I therefore attribute to the imperfection of his mirror glass.

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Tot.

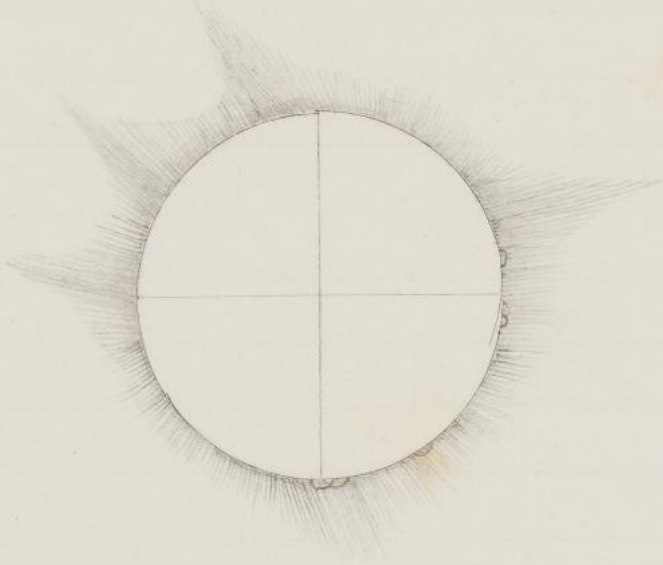


Fig. 5.

Naked eye view of the corona, sketched by L. B. Meade.

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In the accompanying sketch (Fig. 4.) I have tried to produce a faithful picture of the corona and prominences during totality. It is drawn, relatively, to scale and the coloring is that seen by me. The corona appeared white with the slightest tinge of a very faint amber-colored rama tint, and the prominences of a light red. The relative darkness of the sky and moon is preserved. The various directions given on the margin are the result of computation. The position of the prominences are from one photographs and the outline of the corona from the experienced pencil of Mr. T. B. Peck, of the Geological Survey of Illinois, who kindly consented to attend to this phenomenon (Fig. 5). In general the outline of the corona was quite well defined, and to some presented five, to others, perhaps the majority, four cusps or tufts of light. It was striated and extended all round the covered sun; to the naked eye, the maximum extent of the bundles of rays was nearly 3/4 of the Sun's radius, but in general the coronal development was no greater than about 1/5 of the radius.

The accompanying sketch (Fig. 6) is intended to exhibit the symmetrical relation of the corona to the Sun's axis of rotation. There are two (principal) bundles of rays to the west in about 52° heliographical north and south latitude; and two (principal) bundles of rays to the east in about 32° north and south latitude, with a feeble devel-

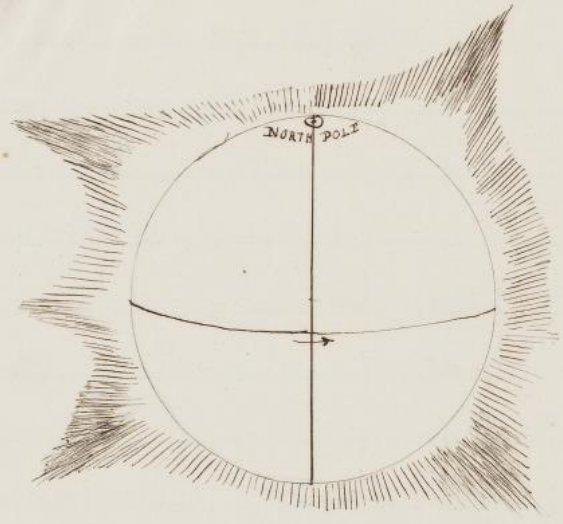
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spement of rays between the latter and over the equatorial region. The rays do not converge to the Sun's apparent centre.

The large prominence near the lowest point of the Sun, was seen first with the naked eye, and was the only one remaining visible throughout the totality. Those on the eastern limb appeared immediately after totality set in. Two of these were separate from the rest, which consisted of two large patches of intensely bright light of a white color, whereas all other prominences were of a delicate pink. When the three prominences on the western limb had become fully uncovered by the retreating moon, all traces of those on the eastern limb were gone. A few seconds before the end of totality, a long narrow ridge of red-colored matter united the largest and lowermost prominence with the next one to the westward. On the following limb the chromosphere was whiter than on the preceding limb;

Fig 6.



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its thickness on the latter, I estimate at less than half a minute, and widest in the middle of its extent. The elevation of the lower prominence was about 1'.8 somewhat less than three turns of the micrometer.

We have the following approximate position angles (from the photographs) counted from the north, through east, of the range of flame like matter following limb between 75° and 135°

Most elevated prominence, same limb	150°
Second " " " "	161°
Largest cloudlike prominence on lower limb	232
Small prominence on preceding limb	282
Winged " " " "	288
Flame-like " " " "	314.5

A small triangular prominence was also seen on the western limb; position probably in 344°, but doubtful.

Relative to the solar equator, the chromosphere & prominences do not appear in any high north or south latitude; thus, in common with the corona, these phenomena seem to have some relation to the sun's axis.

When viewed with a high power they appeared with the most distinct outline, and were objects of exquisite beauty. The careful drawings made of these forms (Fig 7.) will admit of a somewhat close description and scrutiny; of those examined by me, after the middle of totality and within half a minute of its close — they were all on the preceding limb. The largest prominence, opposite

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the outer, No. 1 of the drawings, resembled a cumulus cloud, with delicate deeper markings or fringes within the mass; it showed also patches, of lighter color; - No. 3 was of a remarkable shape, resembling the out-stretched wings of a bird; with shading giving them a solid appearance. As the moon uncovered more of its stem, markings of a twisted form became visible, together with a smaller projection. It seemed as if gases had been ejected, had reached their highest point and had commenced to sink. No. 4 showed the form of a gas flame; its outlines were confined by straight lines, and the central jet appeared of the sharpness of a needle. Its surface seemed flat, as if gas escaping thro' a narrow longitudinal slit, having three wider openings. With the exception of a slight, yet distinct quivering, especially in form No-3, no motion was noticed in these objects

Fig 1.



Prominences on the western limb of the sun near totality.

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Prominence No. 4 was perhaps the most recent, next No. 3, and last No. 1, in which the gases has already fully spread out.

The prominences on the eastern limb I did not sketch as my eyes were somewhat affected by the long use of the telescope, and required over half a minute before I was able to clearly note the appearance of the corona and take a look at the heavens and landscape in general.

When returning to the telescope I occupied myself with the above sketches. In the region of the heavens, between N. W. & N. E. there appears a tolerably well defined line of separation of color about 15° above the horizon and as I am informed, extending all around the Southern horizon; above this line, the dark, bluish, threatening tint of the sky, and below it a dirty, yellow tint, very strongly marked;* here we evidently see through the entire width of the shadow, and the good definition of this chromatic partial almucantar would seem to deserve more attention. The landscape has much the appearance of being lit by the full moon, with the addition of a greenish coloring, which gave it a peculiarity distinct from that of a moon-light night; the darkness was not so great as to interfere with coarse writing, or the reading of large type; we used no artificial light, tho' provided for, in case of need. Personally, I only noticed Mercury

* This tint is well reproduced in the Astr. Obsers. made at the Edinburgh Obs. vol XI for 1849-54 Plate 7.

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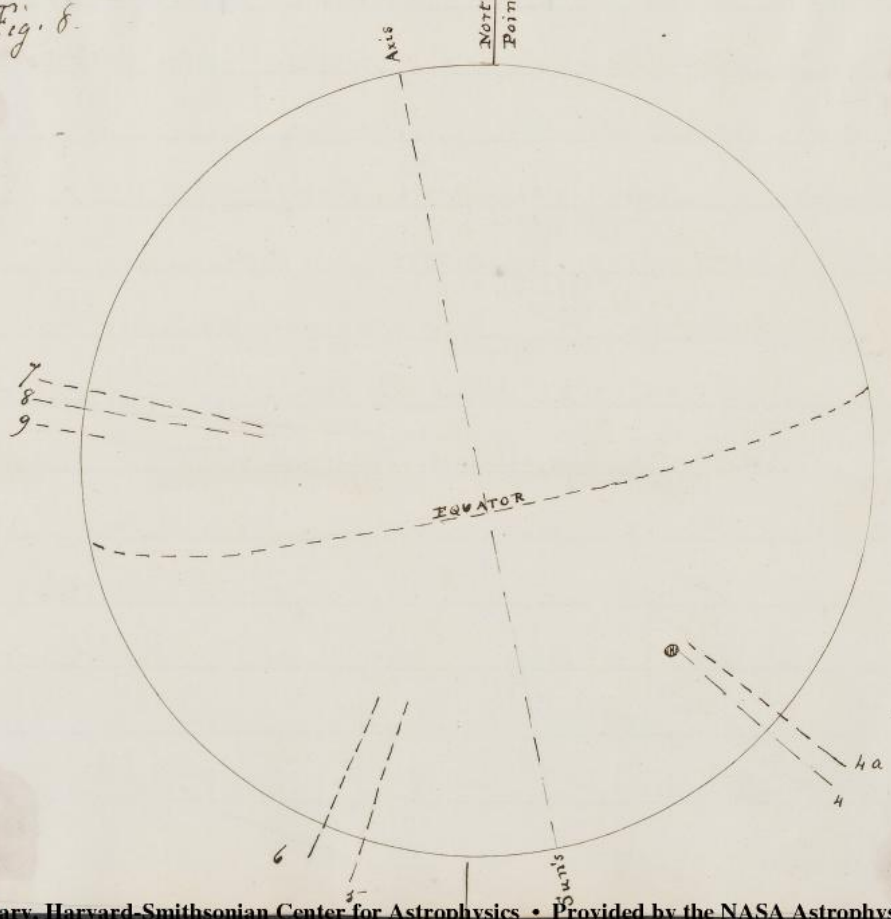
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and Venus, but I only scrutinized the region close to the moon. Not to make this report of too great length, I only communicate the results of the Solar Spot-observations:

Positions of the principal Solar Spots observed August 7 near 11½ a.m. The measures refer to $\delta^h 37^m 31^s 6$ Sp. Sid. Time, and the spots are laid down on the accompanying diagram from the Tabular quantities (Fig 8) The distances are expressed in parts of the Solar radius.

Spot No.	Position Angle		Distance from centre
4	229°	09′	0.660
4a	232	00	0.627
5	165	52	0.596
6	159	44	0.645
7	80	42	0.417
8	83	25	0.501
9	86	32	0.958

Fig. 8.



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The occultation of Spot No 4 having been observed more particularly, and as the times will probably also be obtained from the photographs, from which the values of the lunar diameter may be deduced, the position for No. 4 is more conveniently expressed in difference of right accension ($\Delta\alpha$) and difference of declination ($\Delta\delta$) between the Sun's centre and Spot* D said:

Aug 3 (a.m.) from 3 Sets at	$8^h 18^m 16^s$	$\Delta\alpha = +4'19''$	$\Delta\delta = -9'23''$
" 7 " " 5 " "	8 37 32	$-7\ 52$	$-6\ 49$
8 (p.m.) " 3 " "	13 14 48	$-11\ 00$	$5\ 46$

The following meteorological observations were made by Mr Timothy Dudley of Loami, Ill.
The thermometers were suspended in the shade at the eastern side of the observatory. The barometer readings can only be used as differential values. He adds the following notes: At $13^h 50^m$ atmosphere of a grayish hue. $14^h 12^m$ Mercury, Venus and Mars visible at totality. During totality the horizon, both north & south of the place of observation, was of a beautiful bright orange color & continued for nearly three minutes.

* To change these coördinates into heliographic latitude and longitude I have assumed $I = 7° 15'$ (inclination of ☉'s equator to ecliptic) & $\Omega = 73° 30'$ (longitude of ascending node of ☉'s equator) which gives for the three dates:

N. Lat. $-25° 55'$	H. Long. $211° 34'$
$-26\ 39$	$266\ 47$
$-26\ 16$	$282\ 41$

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Sid. Time		Temp. in Shade	Temp. Wet Bulb	Atmos. Pressure	Wind Dir'n & Force
13h	00m	73°	61.5	29.in 52	N.E. 2
	10 Ecl. begin.	73	62	.52	"
	20	72	62	.50	"
	30	72	61.5	.50	"
	40	71	61	.50	N.E. 1
	50	70	59.5	.50	"
14	00	69	59	.50	"
	10 Totality	67	59	.50	"
	20	65	60	.47	"
	30	66	60	.45	"
	40	67	60	.45	"
	50	66	61	.45	"
15	00	67	62	.45	"
	10 Ecl. end.	67	61	.45	"
	20	66	60	.45	"

The number 1 in the column of wind indicates a very light breeze and 2 a gentle breeze. After 9h no cloud was noticed. The direct effect of the eclipse on the temperature of the air in the shade was a depression of nearly 5°; the wet bulb thermometer was depressed about 1°, the atmospheric pressure was not notably affected, and a gentle breeze at the beginning of the eclipse changed into a very light one towards its end, preserving its direction from the N.E.

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The report of Prof. J. H. Peirce and me by Mr. J. B. Warner, giving an account of the observations taken at Bloomington Ill. are appended. The position of Bloomington I find from the sectional map of Illinois to be 41' N. and 40' E. of Springfield State-house, hence the latitude 40° 29' and the longitude 88° 59 W. of Gr. The line of 2m duration of totality, as drawn on the map, passes through this place. The reports by Messrs. H. A. McCleod, E. P. Seaver and C. H. Fay are likewise appended.

The substance of the above report is made up from notes made during the eclipse, and from impressions recorded after the close of the transit observations on Aug. 7.

I remain Sir
Yours very respectfully
Chas. A. Schott.
Asst. U. S. C. S.

Prof. Benjamin Peirce L. L. D.
Supt. U. S. C. S.

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Springfield, Illinois, 9 August 1869

To Charles A. Schott, Esq.,
Assistant in the U.S. Coast Survey.

Sir.

I left this place on the 7th instant, accompanied by Mr. J. B. Warner, for the purpose of observing the solar eclipse at Bloomington.

We arrived there about half past two in the afternoon and, after a necessarily hasty reconnaissance, selected the platform on the roof of the new storehouse of the Chicago and Alton Railroad as a position easily identified and in other respects well suited to our purposes. The building is of stone, now unfinished, on the west of the track, and just north of the machine shops belonging to the road. We were assisted in securing possession of this platform by John A Jackman Esq., Superintendent of Machinery of the Chicago and Alton Railroad, to whom we are indebted for various kind offices in our behalf -

We were provided with a binocular marine glass belonging to the Coast Survey. This was attached to the west balustrade of the platform. Mr Warner has also a good opera glass with dark screens. Our chronometer was "Parkinson and Frodsham, No. 1411". We had also a stop-watch.

In the observation of the several contacts and of most of

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the other phenomena of the eclipse, I used the glass, while Mr. Warner read the chronometer, and noted the time at my call. The chronometer was at first read audibly, and both Mr. Warner and myself noted the instant of my first call (at the beginning of the eclipse), but it was afterwards judged best to leave the estimate of the time wholly to Mr Warner.

We were instructed that the principal object of our observations was to determine the times of inner contact. We obtained them as follows:

First inner contact $12^h 32^m 19^s.9$,

Second inner contact $12^h 34^m 18^s.0$; giving for the

Duration of Totality $1^m 58^s.1$

Mr. Warner felt great confidence in the accuracy of his estimate of both these times as given by my call. I believe that the latter of the two observations may be relied on as very accurate. In the former case, I think my call was half a second late, but Mr Lyelander, hearing me express this opinion, declared that I had spoken "full early."

Mr Jackman held the stop-watch during the total phase, starting it, and stopping it at my call. The indication of the duration was $1^m 58^s.8$ or $58^s.9$. The estimated correction for the error in stopping this watch is $-0^s.5$

I was unable to make accurate determinations of the times of outer contact. My calls indicated them as follows:

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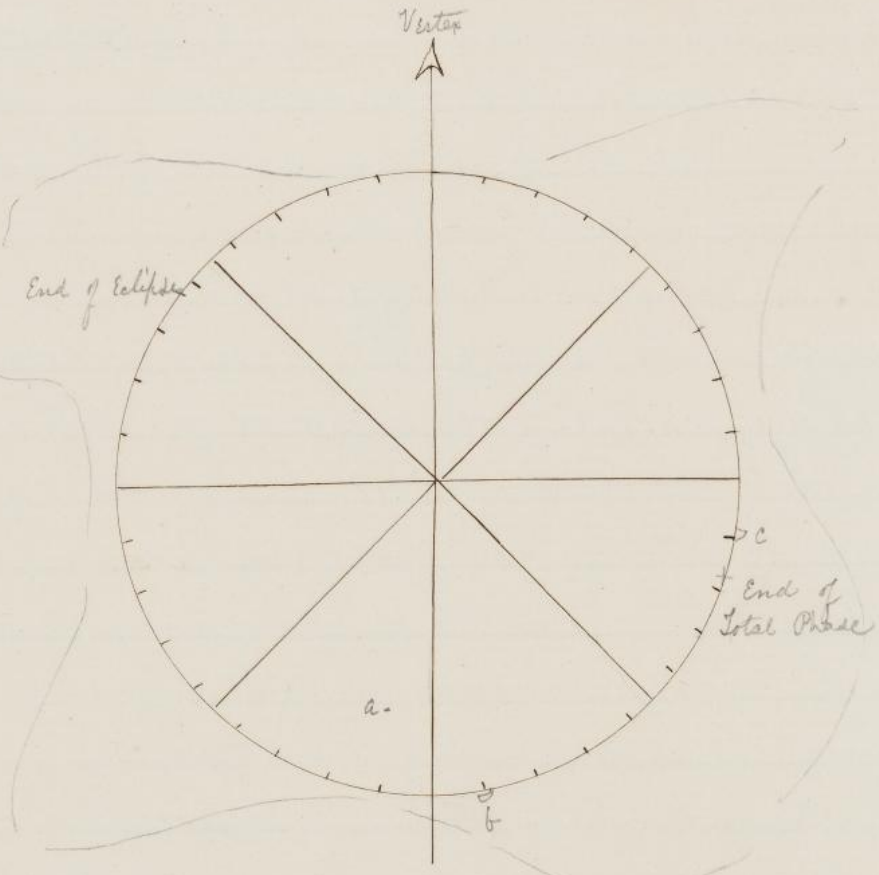
First outer contact $11^h 31^m 53^s.5$,
Second outer contact $13^h 29^m 40^s.5$ giving for the
Duration of Eclipse $1^h 57^m 47^s.0$
The former of these times is probably 10^s too late. I suspected the indentation in the sun's limb at the call of 48^s and I believe that it existed several seconds earlier. This determination was made almost immediately after we had got our glass and chronometer into their positions and before I was able to arrange myself in a convenient attitude. The end of the eclipse may have taken place at $13^h 29^m 19^s.5$, when I first called it. The recorded time indicated the moment at which the tremulousness of the sun's limb appeared to cease.

One large Solar Spot, about the place marked a in the accompanying sketch, was visible with my glass. This spot was bisected by the moon's advanced limb at $11^h 53^m 53^s.9$, and by her following limb at $12^h 49^m 00^s.0$

We took notes of a few general phenomena, to which it may be proper to refer without ascribing to them scientific value. Six minutes after the beginning of the eclipse (at $11^h 38^m$) I thought that the moon's limb could be traced beyond the sun. At a later time, this observation was doubted, but it was again made 22^m before totality (at $12^h 10^m$) and again 20^m after totality at $12^h 34^m$ Eighteen minutes before totality (at $12^h 14^m$) the truncation of the cusps, especially of the lower cusp, was pointed out by

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The form of the corona as it appeared to me is very roughly indicated. J. M. Peirce.

the Prairie. This was afterwards seen by both J and h to be more apparent with the feebler glass than with the stronger.

Twelve minutes before Totality (at $12^h 20^m$), the light on the Landscape seemed ghastly and of a bluish green color; but at $12^h 30^m$ it had become yellow and resembled unnaturally brilliant moonlight. The shadows were strongly defined, and the whole landscape presented a remarkable and beautiful aspect. In casually glancing at the

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bystanders, I was struck by the pallor of their faces, but I have not noted at which of the two times just mentioned I observed this phenomenon.

The Total Phase came on with startling suddenness, and the end of totality was likewise marked by an instantaneous change in sky and landscape. But I was unable to see the limit of the shadow moving over the ground.

During totality the sky was of a violet blue above which it was livid near the horizon, at any rate in the north. The spectacle was of an indescribable beauty and one for which the mind was by no means prepared by the more and more rapid succession of aspects preceding the period of complete obscuration. The moon had not to my eye the spherical look which is ascribed to it in some accounts of total eclipses. It resembled rather a black-jagged rayless, a portentous blot in the midst of the brightness of the corona.

The corona impressed me as distinctly circular, the principal projections occurring near the north, south, east and west points. But these projections had not the character of rays, such as are seen in the phenomenon called "the sun-drawing water," but were irregularly curled, the whole resembling somewhat the corona occasionally seen in the aurora borealis. The light of the corona seemed to me pearly white, but the Brahmin thought it had a ruddy color.

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We saw two protuberances which I noted as gold-colored. We marked them independently in nearly the same places, (and c in the accompanying Sketch) that is, at about 190° and 260° from the Vertex.

We had no means of making measurement of the corona and the protuberances.

Thirteen minutes after Totality (at 12h 47m), Venus was still seen by a bystander.

At the beginning of the eclipse, the wind blew freshly from the East and was quite troublesome to us in our exposed position. But 18m after Totality (at 12h 52m), we noticed that it had entirely died away, and we thought that this change had taken place some 20m before Totality.

I was provided with two sets of screens, one of a very deep blue (?)* and a lighter one of red; but I found it impossible to use the lighter glass at any time during the eclipse. The attempt to use it just before the beginning of totality disconcerted me and caused the already mentioned doubt of the accuracy of my observation of the first inner contact. The total phase was observed without a screen.

All which is respectfully submitted
J. M. Peirce

* green

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Springfield Illinois
August 9th 1869

Charles A. Schott Esq.
Assistant in the U.S. Coast Survey

Sir;

I was directed to accompany Prof. J. M. Peirce to Bloomington for the purpose of assisting in observations on the total eclipse of August 7th and accordingly left this place at noon on the day of the eclipse.

I was instructed to note with a chronometer the times of contact, and to notice such other phenomena as I had time to attend to.

The times as I observed them have been communicated to Prof. J. M. Peirce for report to you. I think that they were obtained with considerable accuracy, particularly the time of the second inner contact which I was able to get with precision. The difference of 7^s or 8^s in the estimates of the duration of totality as observed by the stop-watch and the chronometer is, I think, to a great degree to be accounted for, by the imperfection of the former instrument, which had been observed before this occasion to make an error of at least 5^s.

The general effects of the eclipse were extremely grand and impressive, and from an elevated position

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could be well observed. I was provided only with an opera glass and this I used but seldom.

There was little change in the light during the half hour after the first contact, but objects began to assume a somewhat greenish and very gloomy hue, and during the five minutes immediately before the second contact, the light was very weird and strange, giving an unearthly hue to the landscape as it lay outstretched beneath us. The shadows had the cold unreal appearance of moon shadows and the whole effect on the mind was chilling.

The cusps of the sun, especially the lower one, appeared truncated. My glass was not of sufficient power to show the edge of the moon serrated, nor did it bring out at all the dark limb of the moon.

About a minute and a half before the second contact, Venus appeared, and Mercury soon followed.

The instant that the last ray of light was intercepted, the country assumed a hue yet more strange and awful, and it was impossible to prevent a sort of dread from seizing on the mind.

The black disc of the moon appeared edged with a silver rim of great brilliancy, which was within the corona and far excelled it in brightness.

The corona seemed to me of a whitish, perhaps slightly green-tinted color; and had a rolling, curling

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motion like smoke. Streamers issued from it in several directions, but my attention was principally held by the waving band slightly West of the vertex which seemed to me the most active and conspicuous, and which waved towards the vertex. I cannot tell how many of these streamers there were, or what their arrangement was.

On first looking up from the chronometer, my eye was taken with two very bright projections from the black disc which seemed of an orange color. The larger of these was at about 170° (reckoning to the right) from the vertex; the smaller at about 105°.

I had been provided with a chart of the stars in the vicinity of the sun, but was too much occupied with the corona to search for them. I noticed however, that Regulus did not shine out as I had expected between Venus and the sun. The darkness was not deep, and I think that I could have dispensed with the lighted lantern which stood by the chronometer. Before the light had become faint, I had fixed on a new unpainted shed which was about 35 rods distant, and I found that I could descry its yellow shingles during the total phase.

Along the Southern horizon, there lay what seemed a cloud, (though before or after totality, no cloud was perceptible in the sky) colored bright orange, stretching away toward the East.

The town below us was perfectly quiet during the

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darkness, though very noisy immediately before and after.

Venus continued to shine brightly after the sun had reappeared, and was watched for thirteen minutes by bystanders. The phenomena of the passing off of the moon were similar to those of its advance.

We were informed by people of the town that a very peculiar doubling of shadows had been observed just before and after the total phase when the sun was reduced to a crescent, but this we had no opportunity to observe.

As I could allow my attention to be diverted from the chronometer only a minute and a half, I had no opportunity to make many or accurate observations.

Respectfully
Joseph B. Warner

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Aug. 8th/ 1869.

Mr. Chas. A. Schott;

Sir:

The instrument with which I observed the Solar eclipse of Aug. 7th was a binocular marine glass magnifying 2½ times. It was furnished with red shade glasses so dark that the features of the landscape were invisible through them, on a bright day. The power of the glass was such that in looking with it at the largest spot on the sun, on the day of the eclipse and two days before, the shape of the spot was distinctly defined, but the smaller spots were not discernible. The instrument was secured to a firm stand, and had movement in altitude and azimuth.

I had been directed, in estimating lengths to take the Sun's diameter as a unit.

At 4h 53m 21s.8 observed the first inter contact.
by chron. Dent. 2171
2d was instantaneous, but occurred at a point from 5° to 10° higher than where I had expected it. Immediately before the contact, I noticed no agitation of the Sun's limb, nor could I perceive at all the approaching moon.

During the progress of the eclipse, the large spot near the Sun's lower limb, seemed at sometimes, much darker and more distinctly defined than at others, but I made no accurate observations upon it.

At 4h 30m S.mt. the upper cusp appeared distorted as

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shown in Fig. 1.

At 4h 35m S.mt. the blue of the sky overhead had become perceptibly darker, while along the E. horizon, the tint seemed unusually light.

At 4h 38m S.mt. the lower cusp appeared as in Fig. 2.

At 4h 50m S.mt. the cusps appeared as Fig. 3.

At 4h 55m S.mt. the sky on the W. horizon was of a very light azure, but the color deepened gradually as the eye followed it up towards the zenith where the blue was intense. The shadows of objects near me as thrown on the ground, were peculiarly soft. The water of a pond near by looked very black. The woods, 400 or 500 yards distant, presented a singular appearance. Beneath them, the gloom was strikingly deep, while the tree-tops seemed of a lighter green than usual. The sun's light had a bluish tint, making the faces of those who were near me appear ghastly. The general effect of the light suggested that produced by bright moonlight.

At 4h 59m S.mt. the upper cusp appeared as in Fig. 4. The lower cusp was also bifurcated, but I made no sketch of it. The length of the dark line in Fig. 4 was 1/10

At 5h 1m S.mt. the cusps appeared as in Fig. 5. Width of lower end was 1/15

At 5h 2½m S.mt. the cusps appeared as in Fig. 6. The lower cusp rapidly changed, and in about one minute

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had the form shown in Fig. 7.

At $5^h 4\frac{1}{2}^m$ S.m.t. a glance at the sky showed the S. much lighter than the N.

At $5^h - ^m 21\frac{5}{2}$ Chr. the lower one appeared as in Fig. 8. but was rapidly changing its form.

I observed the extinction of the last solar ray at $5^h 55^m .55\frac{15}{2}$ Chr. Some seconds before, the cusps had the shape given in Fig. 9. quickly changing to that given in Fig. 10. one portion of the crescent being separated from the rest by a dark line. It then broke up into small fragments which disappeared quickly, one after the other, the lowest one going first, and the final extinction being somewhat above the centre of the line of beads as at first seen.

Up to the time of total immersion, I had not seen the preceding limb of the moon, but, the next instant, I perceived its jagged edge in relief against a faint red glow surrounding it. The glow grew brighter every moment, and soon appeared as a band all around the moon. I at once removed my shade glasses and saw the same aspect of the moon, for an instant, with my naked eye. Upon returning my eyes to the glass, I found the corona and the accompanying rays already visible in all their brilliancy. Fig. 11 is from a sketch roughly made, perhaps 10 seconds after my first sight of this beautiful phenomenon.

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At this moment, the corona was brightest on the upper part of the following side, in the space between two points 30° and 80° from the vertex. D and E in Fig. 11, represent what looked like two mountains of light being apparently portions of the corona itself, not differing from the rest of it at all in color, but being much brighter. D and E were entirely unlike the protuberances in appearance. The corona's width, in this part, appeared to be about $\frac{1}{16}$, but this estimate is quite uncertain, as I could perceive no sharply defined exterior limit to the corona but, from an intense brilliancy, close to the moon's edge, it gradually softened away into faint fringe-like rays. The color of the corona where it was brightest, was pure white, but its dimmer portions partook of a golden tinge. I remarked, about a minute later, that the corona's brightness on the following side had diminished.

At the time of my sketch only 3 protuberances were visible. Their estimated distances from the vertex were

A 175°

B 115°

C 100°

Of these A was by far the largest, and its shape very decided to my eye. It was struck by its solid appearance. It looked, not like a flat jet of flame, but like a solid conical body. Its length was about $\frac{1}{3}$ and it was of a rosy color. I did not notice B and C with

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much care but observed the contrast of their pale rosy tint with the white of the corona. One of them had the shape given in Fig. 12. but which one, I omitted to record, and cannot say with certainty. I did not notice the appearance afterwards of any protuberances on the preceding side, my attention being directed to other features.

From the outer rim of the corona, bright white rays emanated, on every side, but their length was greatest in 4 directions as represented in Fig. 11. The 4 sets of rays were of unequal length F being by far the longest, G the shortest, and H and I of about equal lengths. I took especial pains to estimate the length of F, and could trace it to the distance of nearly 2 diameters of the moon. The angle of the axis of F with the vertical was about 20°. The angle did not change with a slight motion of my glass. The end of the longest ray was slightly curved towards the vertical.

During the total phase, I noticed several flashes or tremors of light across the corona, apparently in a radial direction from the center out. The moon did not present that inky blackness which I had expected to see, but was much lighter. Glancing, for a moment, at the landscape, I found that the darkness was much less than that of a starlight night. The appearance of the sky was as if a blackish-blue hemi-spherical cover were hanging down from overhead, its rim reaching

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to within about 12° of the horizon. Between this line and the horizon, to the N. and as far around as I looked, the sky was of a dusky yellow.

Shortly before the end of the totality, the corona and rays had faded away from the preceding limb of the moon, on which my attention was now fixed.

At 5h — m. 4½ Chr, a red band became visible around that limb, crossed, here and there, by dark lines which were continually changing their position. One line, shown in Fig. 13, did not seem to undergo any change except to grow broader and darker, as the moment of emersion approached. It was very near the point where the sun reappeared.

I observed the 2nd inner contact at 5h 58m 43½ Chr. The sun's reappearance seemed more sudden to my unprotected eye than his disappearance had seemed, viewed through the shade-glasses.

At 5h 10m S.m.t. the upper cusp appeared as in Fig. 14, and at 5h 12m S.m.t. as in Fig. 15.

The effects on the landscape produced by the increasing light, as the moon passed off the sun's disc, were by no means so striking as those produced before the totality, by the diminishing light. This fact was doubtless owing to the different condition of my eyes in the two cases.

I observed the 2nd outer contact at 6h 54m 7½s Chr.

Respectfully

Robt. A. McLeod

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Note 1. In regard to the distortions of the cusps, it should be borne in mind, that the appearances which I observed and have sketched were those presented to my eye by a comparatively weak and very darkly shaded glass. I have since seen photographic pictures, taken in various stages of the eclipse, and in perhaps every case, the cusps are sharp and undistorted. Observers also with powerful glasses have perceived no distortion. On the other hand, the distortions have been quite uniformly seen by observers with simple opera glasses. My own attention was first called to the appearance given in Fig. 2 by Mr. Montague who was looking at the time through a small transit instrument.

The explanation of these facts is perhaps as follows. The sun's disc, as is well known, presents to us a surface the brightness of which, is by no means, the same in every part, and the difference in brightness of adjacent parts is, as in the case of the faculae, most perceptible near the edge of the visible disc. Accordingly, during the progress of an eclipse, a cusp, extending along the rim of the disc, frequently reaches points where the inequality of the solar light for small adjacent portions of the disc is very great. The dark body of the moon on one side of the narrow strip of the crescent near the cusp and empty space, on the other, shield the eye from the usual glare, and enable it to appreciate the peculi-

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cities of the strips. Under these circumstances, it is only the brightest portions of the strips (the tops, probably, of the waves of the luminous solar envelopes which emit enough light to be visible through glasses of small size or furnished with very dark shade glasses), the darker portions (the hollows, probably, between the waves) appearing black; while the sensitive paper in the camera or the eye of an observer who looks through a powerful glass or through one lightly shaded receives light from the darker as well as the brighter portions of the strips, and sees the outline of the crest complete. Accordingly, accurate observations of the distortions of the crests might give interesting information in regard to the shape of the surface of the luminous solar envelope.

Perhaps, a similar explanation may be given of the very different shape of the same solar protuberance, as seen through different glasses. The outlines given by weak glasses are probably the outlines of the densest and most luminous parts, while those given by glasses of higher power enclose also a certain portion of the more rarified gaseous matter surrounding the inner and denser part, — the size of the portion increasing with the power of the glass. A comparison of the shapes given by different glasses, may, therefore, show the comparative densities of different portions of the protuberance.

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Note 2. Of 6 gentlemen, all of perfect vision, who experimented, during the totality, with cards prepared for the purpose, 3 could read distinctly Diamond type; 1, nothing smaller than Pearl; 1, nothing smaller than Nonpareil; 1, nothing smaller than Brugeois.

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Fig. 1



Fig 3.



Fig. 4



Fig. 2.

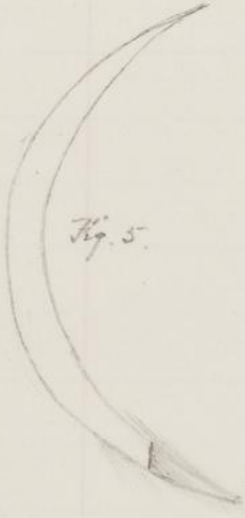


Fig. 5.

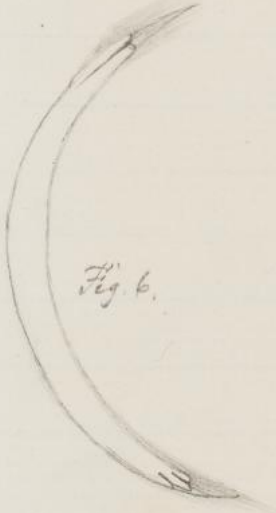


Fig. 6.



Fig 7.

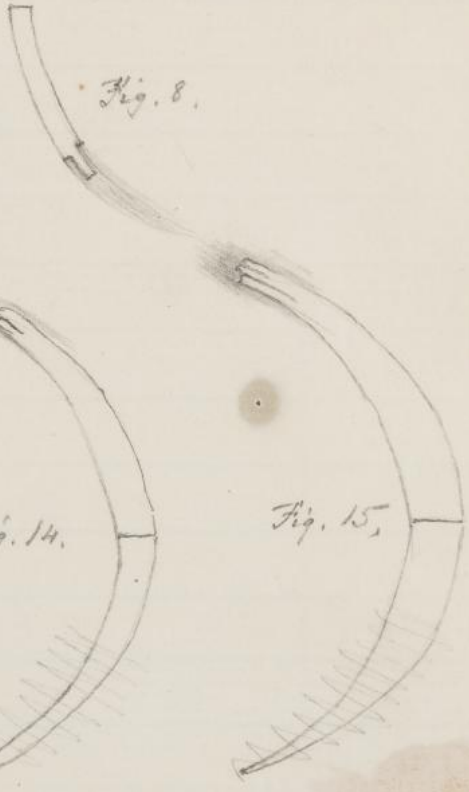


Fig. 8.



Fig. 9.



Fig 10.

Fig. 14.

Fig. 15.

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Mc Leod

Vertex.



Fig. 12



Permanent black line.

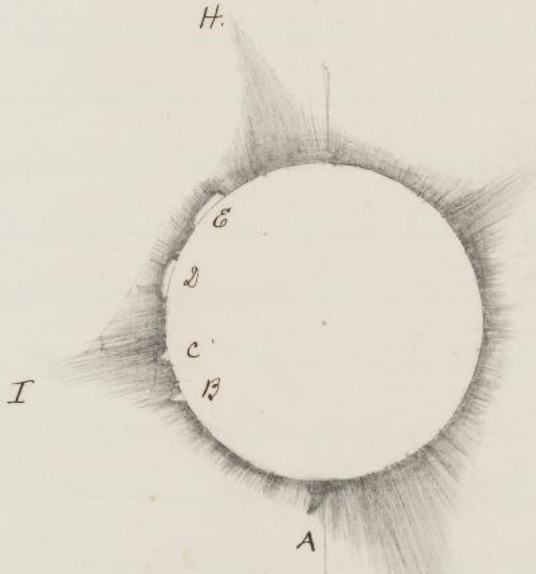


Fig. 11.

H.

Corona &c. as seen about
10 seconds after its appearance.
D & E should properly be black
as being extremely bright.

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Mr. C. A. Schott,

Assistant in charge of Astronomical Expedition, U. S. Coast Survey.

Sir:- I have respectfully to report the following observations made by me during the Total eclipse of the sun, August 7, 1869, at Springfield, Illinois.

1. The instrument used by me was a recognoitering telescope, C. S. No. 4, mounted equatorially and provided with a camera.

2. The disc of the sun projected upon the screen, was 4 3/4 inches in diameter, and displayed several distinctly marked solar spots which were designated by the numbers 4, 4a, 5, 6, 7, 7½, 8 and 9. Numbers 4 and 9 were much larger than the others, and exhibited well defined umbrae and penumbrae. The others appeared to be about as large as dots made by a common lead-pencil on the screen, and their contacts with the limb of the moon could be noted with great accuracy, but their disappearances could not be so well ascertained, and only two were noted.

3. The first external contact of the sun and moon was noticed at 4h 55m 28s;* but the actual contact must have occurred some seconds earlier; for there was a de-

* all times noted by chron. Dent 2171

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ceded indentation of the sun's limb before I was sure of the fact of contact. This delay arose partly from the inherent difficulty of observing soon enough such a contact, and partly from the fact that the contact actually occurred at a point on the sun's disc, some 30° from where I had expected to see it. Judging from my subsequent observation of the rate of progress of the moon's limb over the sun's disc, I am certain that 6^s should be subtracted from the time given above and that the time of actual contact was 4^h 56^m 22^s.

4. Contact of 4a occurred at 5^h 19^m 20^s
The first of the three minute spots which composed 4a, was the one observed.

5. Contact of the umbra of 4 occurred at 5^h 19^m 43.5^s
Disappearance of the umbra of 4 occurred at 5^h 20^m 21.5^s

6. As the spot 4 approaches the limb of the moon, it seemed to grow fainter, and between the two epochs noted above it gradually melted away, so that the disappearance was not well defined, and the observation not very satisfactory.

7. Contact of spot 7 occurred at 5^h 36^m 19.5^s Not a very satisfactory observation.

8. Contact of spot 7½ occurred at 5^h 37^m 43^s. A satisfactory observation. This spot was much more clearly defined than it was this forenoon.

9. Contact of spot 8 occurred at 5^h 39^m 20.5^s Satisfactory.

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10. at $5^h 46^m$ shadows were defined on the grass with startling distinctness. The light was a hard, cold grey-blue. The air felt decidedly chilly.

11. at $5^h 50^m 50^s$ the lower cusp of the sun's disc, appeared to be forming a bead in a manner resembling a drop of water forming at the end of a straw. This phenomenon lasted about 20^s. Did not notice it again, though I looked for it frequently.

12. Spot 9 bisected, as shown in the figure by moon's limb at $5^h 53^m 52^s.5$. The figure also shows accurately the form of the penumbrae of 9 at this moment. It was well defined



13. Beginning of the total phase occurred at $5^h 55^m 56^s.5$

14. As the crescent grew very thin, beads began to form at each end, little black lines with sharp ends, apparently shooting from the moon's disc in a radial direction across the thin crescent, and chopping it into beads. At last the crescent was reduced to a string of beads about an inch and a half long, which trembled for an instant, and then suddenly disappeared. The disc of the moon was faintly irradiated near the beads while they were visible and for a time (I should say 15^s) after they disappeared. The beads were not globular, but diamond shaped, from an apparent adhesion to each other and to the limbs of the sun and moon. They were exceedingly bright, particularly at the

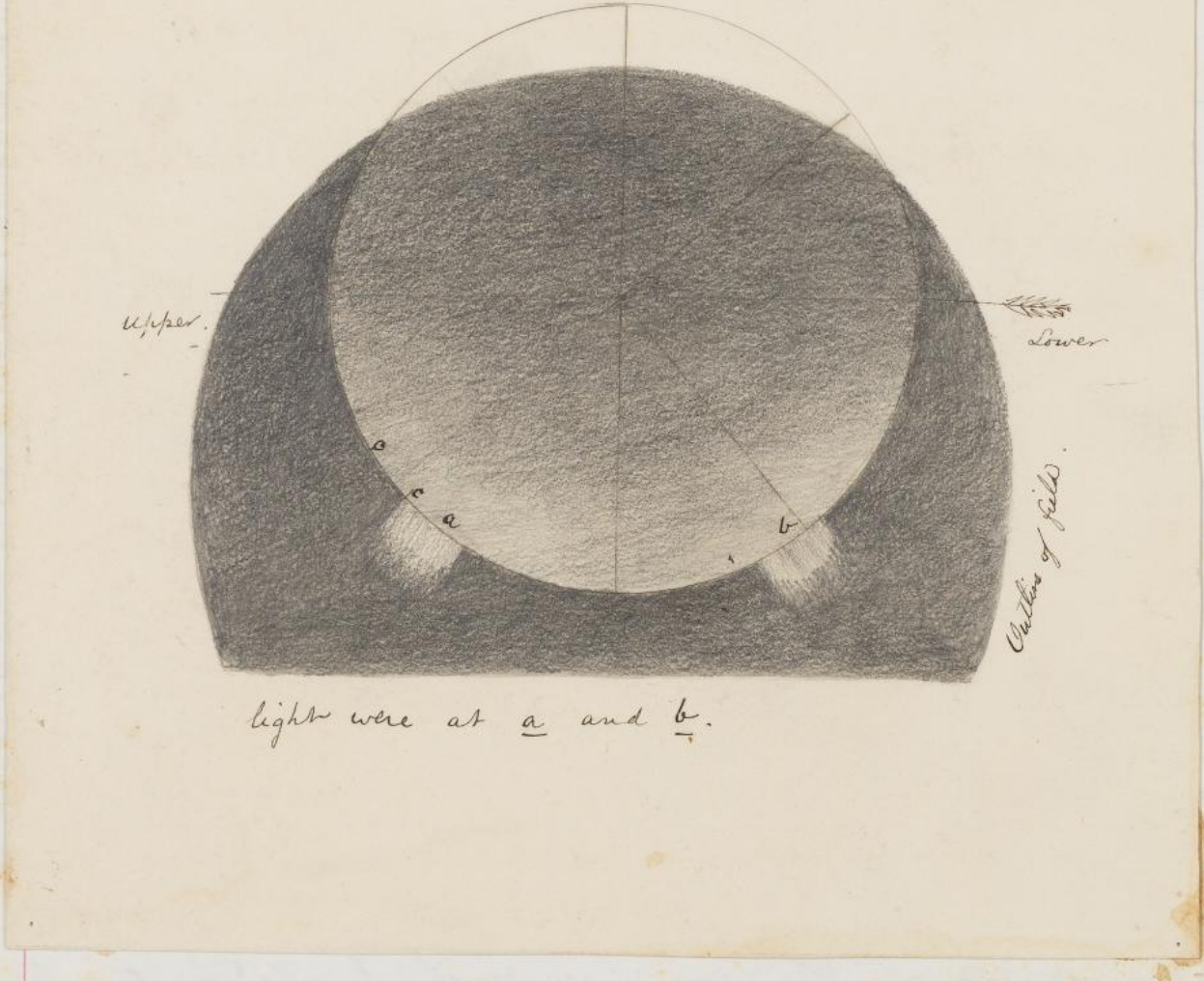
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points of adhesion.

Sketch showing the appearance of the Moon's following limb about 30^s before the end of the Total phase. The reappearance took place at c c. The bright patches of light were at a and b.

E. P. Sears.



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15. I now glanced upwards to the corona which appeared silvery white. In the southern horizon I saw a bright yellow sky shading downwards to a deep orange and copper color. I had noticed previously that the horizon in this quarter was of a deep blue, almost black. The stars flashed out with extraordinary brilliancy.

16. Returning to my camera, I noticed that the whole moon's disc on the screen was faintly irradiated, the irradiation increasing in intensity towards the edge of the disc which was so bright and sharply defined as to enable me to keep the point of the approaching contact well in the centre of the field during the total phase. As the instant of contact approached, the edge of the moon's disc grew brighter and brighter and finally was all a glow. See Sketch.

17. During the total phase two rather bright patches of light appeared on the screen. They were first noticed early in the phase and lasted till the reappearance of the sun's disc. Their forms and relative situations are approximately given in the sketch. They are marked a and b.

18. Suddenly at $5^{h}\,58^{m}\,43^{s}.5$ appeared a beautiful string of beads, at c c in the sketch, similar to those already described, but brighter. The irradiation and bright patches of light just described disappeared at the same instant. The beads trembled for an instant

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and then melted into a thin streak of light with beads at the ends. When the crescent had appeared around 50° of the Sun's disc no more beads appeared on the cusps.

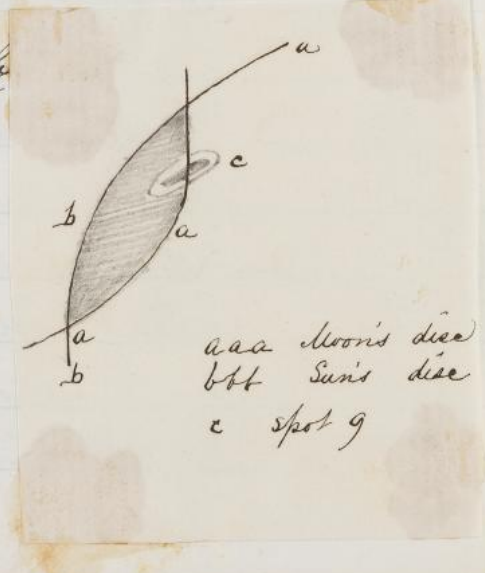
19. Glancing at the southern horizon, after making the record of time above, I saw that the sky there had changed again to a deep blue.

20. At 6h 18m noticed that the exterior edge of the penumbra of Spot 4 was much more sharply defined than it was before its disappearance. The reappearance of this Spot was not noted.

21. At 6h 33m 30s (about) Spot 6 reappeared.

22 At 6h 37m 59s Spot 8 reappeared distinctly. I judge that it was bisected by the moon's limb 25 earlier.

23. At 6h 49m 40.5s Spot 9 appeared bisected by the moon's limb, as shown in the figure. The figure also shows the shape of the penumbra as it appeared a few minutes later, the shape having changed during obscuration.



24. End of the eclipse was satisfactorily observed at 6h 54m 7.5s

E. P. Seaver.

Springfield, Illinois, August 7 1869

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Report of C. H. Kay, Asst in observing Eclipse of Aug. 7th 1869. at Springfield Ill.

Arrived in Springfield on Wednesday the 4th at 6 p.m. From Wednesday to Saturday Spent time in visiting station, and in making preparations. Succeeded in borrowing seven foot refractor, two inch aperture, from — Watson, of this place, who was the maker, is an amateur. On Saturday set up this instrument, and a transit borrowed from City Surveyor. Set up for third a seat and rest to accommodate two persons.

At $4^h 55^m$ Washington mean time, time Keeper began to call. Used small transit just mentioned, with this instrument, about 1 inch aperture, 10 inch focal length, magnifying some 20 diameters, saw first contact at $4^h 55^m 18.3^s$* suspected contact at least one second before recording. Saw no limb of moon before contact. Saw no disturbance of sun's limb before contact. After contact left transit to adjust refractor above mentioned. Observed cusps with refractor and transit both. Has attention called to irregularity in lower cusp, but failed to see it. Noticed no agitation in them. Noticed light at about $5^h 40^m$; it was sickly and in effect resembled a yellow moonlight. Sky was turning gray. At $5^h 50^m$ took refractor to observe 2nd contact. Saw the formation of Bailys beads running

* By chron'r Dent 2171.

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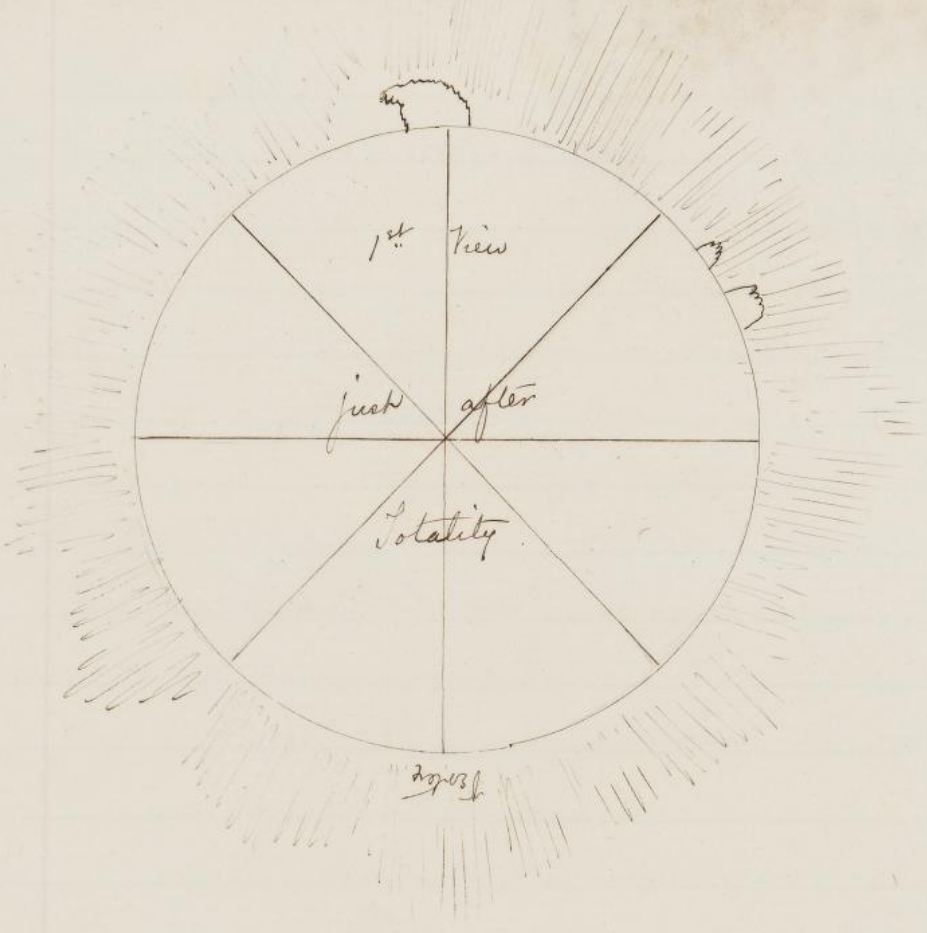
from the top downwards; beads were more crowded at top. Totality followed at $5^h 55^m 58^s$ by Dent 2171, showing nearly Wash'n mean time. Think this observation at least three seconds slow as glow on limb of moon was deceptive. Pencil broke while recording this, remaining phenomena of totality were noted immediately after from memory. Stopped to take off glasses. Corona appeared while doing so. Saw protuberances as in diagrams, took naked eye and saw them. Saw no appearance of streaks on preceding limb just before totality. Corona brightest at quadrants counting from vertex. Streaks or rays reached limit of moon in intervals of these quadrants. Protuberances at first seen on following limb, then disappeared behind moon's limb, and others appeared on preceding limit. Color of corona that of electric spark in hydrogen. Saw no Baily's beads at end of totality. Observed end of totality at $5^h 58^m 42^s.5$ by chronometer. Did not look at ray fr. glass exc. as mentioned. Observed final contact, also with refractor, at $6^h 54^m 08^s.5$ by chron.

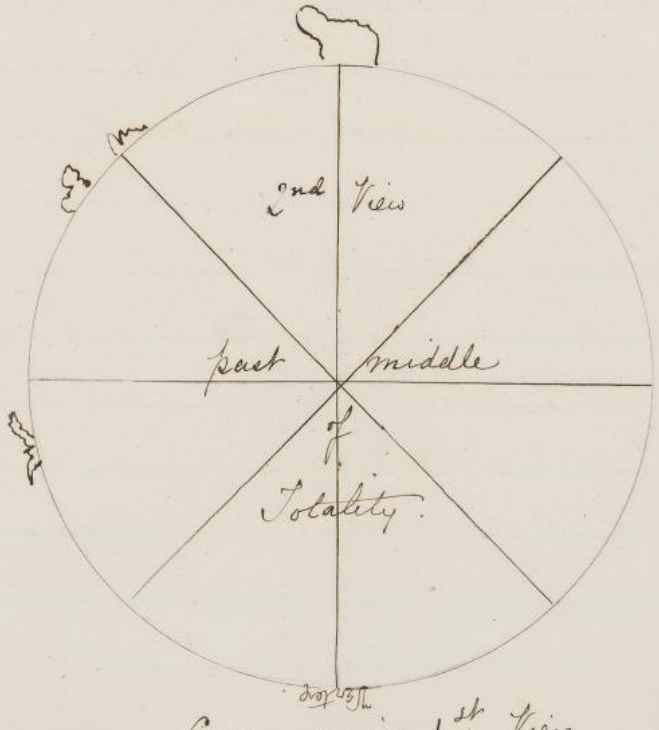
Remarks. Just before totality, thought I saw continuation of upper limb of the moon. Probably owing to instrumental imperfection. Saw one or two flashes across the field before totality. As they traversed the whole field, inferred they were effects of nervous fatigue.

Chas. R. Cay.

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Corona as in 1st View

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Marquette. Mich.
August 30th '69

C. A. Schott Esq -

Dear Sir:

As to the protuberances, I am unable to give a more definite form to the two you mention, but I have thought since the eclipse, that, taking down their positions from memory as I did, I interchanged the "wings" with the lowermost of the two you refered to.

That is, the "wings" should be at the upper side of the horizontal diameter instead of below it, and rather nearer to it than the position given to the lowest of the pair under discussion.

My address is

C. H. Kay
Marquette
Michigan

Yours respectfully
Charles H. Kay.

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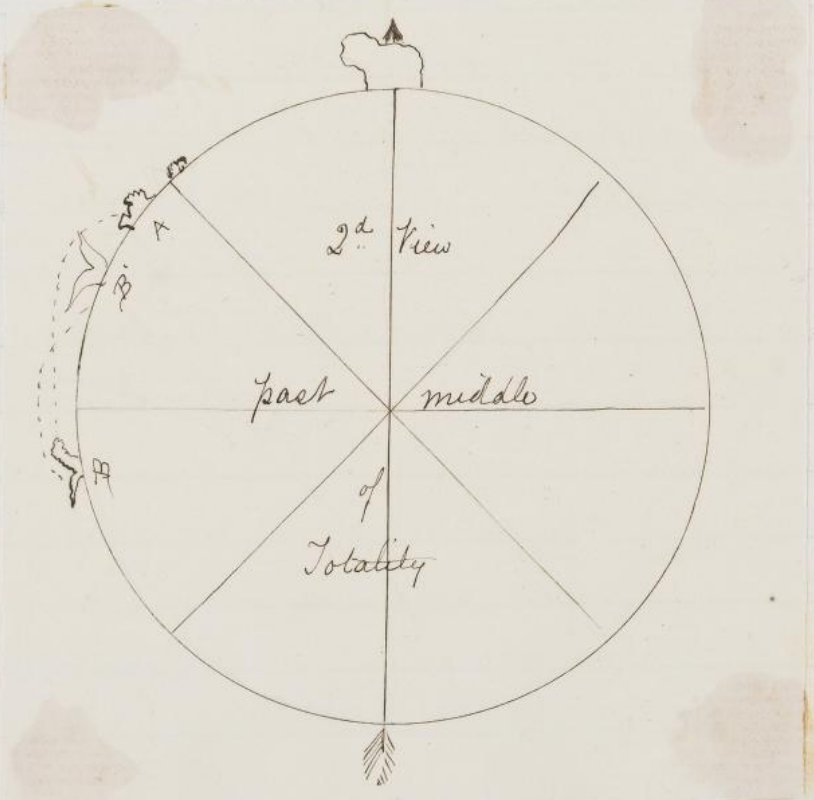
Marquette, Mich.
September 9th/69.

Dear Sir;

Pales send, as you wished, the small diagram of the protuberances, with the changes made in pencil. The dotted lines connect the old positions of the protuberances A & B, with the corrected positions A' & B'

Respectfully Yours
Charles R. Lay

Charles A. Schott Esq.
Coast Survey Office



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Washington. August 19th 1869

Prof. Benj.n Peirce
Supt. U.S. Coast Survey.
Sir:

I respectfully submit the following report of the operations and results of the party under my charge, in execution of your instructions to observe the Solar Eclipse of Aug.t 7th, at some point in the mountains of S. Western Virginia where they would be crossed by the central line of the Eclipse. See appendix, A and B.

On the 25th of July the Party reached Bristol which according to the most authentic maps, was in close vicinity to the line of greatest obscuration; and on the 26th and 27th preliminary observations were taken to ascertain whether the position of the town was correctly laid down. The results being of a satisfactory character, a site for an Observatory, and for observing the Eclipse, was selected; the building put up; and between the 28th of July and the 5th of August, the latitude and longitude of the Station were determined, the former by 12 pairs of stars, and the latter by the transmission of time signals to the Naval Observatory at Washington, on the nights of the 29th and 31st. A third determination of the difference of longitude between the two places was secured on the night following the Eclipse. For the details of this operation, reference is made to the

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Report of Asst. A. S. Mosman, Appendix No. 2.

Bristol is situated between the Cumberland and Alleghany mountains, on the Virginia and Tennessee Railroad, and immediately on the Boundary line, as at present recognized, between Virginia and Tennessee. It may be said to comprise two separate Towns, Bristol in Tennessee and Goodson in Virginia, the Main Street, which alone separates the two, being laid out along the line of the State boundary. The Observatory was erected on a bare ridge lying to the westward of, and adjoining Goodson; about one third of a mile from the Telegraph Office: 320 yds. north of the State line: 82 feet above the railroad track and 1760 feet above the sea. An unobstructed view to the Westward was obtained, and sufficient elevation to command an extensive view of the Surrounding country and mountains. See sketch C, showing the vicinity of Station.

The Zenith Telescope and Transit were mounted on Solid piers composed of brick and cement.

The times of the commencement and end of the Eclipse and of the total phase, were computed for the latitude and longitude of the Observatory, as approximately determined by the 3d of August, using the formulae and tables contained in the "Supplement to the American Ephemeris for 1869." The final reduction of all the observations and comparisons decreased the approximate latitude by 1'. 6" and increased the longitude by 0^{s}. 25.

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A programme of "what to observe" was prepared and arranged in the order in which the phenomena would occur, and special classes assigned to each observer.

As the party was small and organized almost entirely for what may be termed precision, or time observations, many of the physical phenomena usually observed on such occasions, altho included in the programme and more fully explained to those who volunteered or desired to observe them, were not intended to be specially observed, on the ground that if too much duty was imposed on any one observer, none might be thoroughly performed. Hence the examination of the moon's disc, its colors and spots, during the different phases of the Eclipse; the colors exhibited by the corona; the degree of darkness during totality and the changes and gradations in the coloring of the landscape before and after totality; the effect of the observations upon animals, &c, were omitted, or only incidentally observed, for the reason that they could not be properly or reliably attended to without interfering with a more desirable class of observations.

On the afternoon of the 6th of August, the telescopes were placed temporarily in position, and every possible preparation made to secure success in the observations to be taken on the next day.

August 7th, 1869

The telescope used by me was Zentih Telescope, No. 2,

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made by Troughton and Sons. It was mounted on the thick pier, on which it had been employed in the determination of the latitude, the Observatory having been so built that its western end might be removed for observing the Eclipse. The object glass was 3½ inches in diameter; the focal length 54 inches, and the amplifying power about 28 . Box chronometer, Hutton No. 215, running to mean time, was placed close by and the times, as called by me, were noted and recorded by Mr F. W. Perkins, U.S. Coast Survey.

The telescope employed by Asst A. F. Mosman was Recon. Telescope No 14, U. S. C. S., having an aperture of three inches a focal length of 34 inches, and an amplifying power of 40. It was placed just outside the Observatory, at its S.W. corner, in order to be protected from the N.E. wind which was blowing in puffs a short time before the commencement of the Eclipse. The Mosman recorded his own time, using Sid. Chron. Hutton, No. 207.

The telescopes were fitted with eye pieces for direct vision, and provided with diaphragms, in which the circle was divided into octants for the approximate determination of positions of contacts and of spots on the sun.

The time was obtained by transits taken on the evenings of the 6th and 7th of August.

About an hour previous to the commencement of the Eclipse, the different groupes of spots on the sun, were

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plotted on large pasteboard circles divided into octants, and were then lettered so as to secure identity in designations, when noting the times of their immersion and emersion. Each observer was provided with one of these circles on which to sketch and record the position and appearance of the different phenomena observed. See Appendix D.

During the entire partial eclipse, the sun shone with great splendor, so much so that it was necessary to use the darkest screen glass, which, in my case, was of a deep red color. Just before the last contact, however, when the rays appeared to be jumbled, a lighter shade of red was substituted. During totality, the screen was removed. 4h 20m — At this time, cumuli clouds, lying principally along the horizon, covered about three tenths of the sky. The wind was E.N.E. in puffs of moderate strength, say from 10 to 4. The atmosphere was remarkably clear and steady, the trees on the summits of the Alleghany Mountains lying 16 miles to the S.E. being readily distinguished by the bare eye.

Shortly after the commencement of the Eclipse, the wind died away entirely, and the clouds disappeared, and the atmosphere continued until sunset unusually transparent and steady, reminding me of that of California.

The following table will show the computed and observed times of the four contacts.

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Latitude of Observatory ——— 36° 35′ 49.″37 ± 0.″15
Longitude " " ... Br. of Wash.ⁿ — 20ᵐ 32.ˢ75
" " " " " ... — 5ʰ 08′ 11.ˢ25 (12)
Aug. 6th " Corr.ⁿ of m.t. Chron.ʳ No. 215 at 10ʰ.1 — +5ʰ 17ᵐ 54ˢ.99
Aug. 7th " " " " " " " " 8ʰ.3 — + " " 52.26

Contacts	Observed time by Chron.ʳ	Chron.ʳ fast of Bristol m.t.	Bristol m.t. of contact	Computed time of Contact	Diff.ces
1st ext. ontie	10ʰ 01ᵐ 45.ˢ3	5ʰ 17ᵐ 52.ˢ7	4ʰ 43ᵐ 52.ˢ6	4ʰ 43ᵐ 36.ˢ1	+16.ˢ5
1st mner	10 59 13.7	" " 52.6	5 41 21.1	5 41 12.3	+ 8.8
2d "	11 01 45.9	" " 52.6	5 43 53.3	5 43 45.5	+ 7.8
2d ext. ontie	11 54 32.5	" " 52.5	6 36 40.0	6 36 36.8	+ 3.2

The computed times given above are deduced from the results of the final computations of the observations for latitude and longitude. These results show that the position of the Observatory was about four miles to the Northward of the Central line of the Eclipse as projected according to the data supplied by the "Supplement to the American Ephemeris".

4ʰ 43ᵐ 52.ˢ6. Not the slightest sign of the presence or approach of the moon was observed before the contact took place. This may have been due to the dark screen-glass employed.

Nor was the sharp line of the sun's limb in any manner affected by the approach of the moon or at the time of contact. Looking intently at the position angle one-

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puted for the contact, the slightest sensible change was observed to be taking place at a point in the sun's outline, and the time called, tho' I was uncertain at the moment whether I was correct or not. In two seconds after, however, the black line defining the moon's edge had made sensible progress, and continued to advance across the sun's disc without the slightest change or agitation in the outline of the moon, or of the apparently adjoining parts of the sun.

Table showing the times of Immersions of the Solar Spots.

Spots - lettered - see plan of	Time by Chronometer	Chron^{r} fast.	Bristol Mean time
a. penumbra, west line of	10^{h} 24^{m} 19.0^{s}	5^{h} 17^{m} 52.7^{s}	5^{h} 06^{m} 26.3^{s}
a. nucleus - west edge of	" 24 39.4	" " 52.7	" 06 46.7
a. " " - east edge of	" 25 11.8	" " 52.7	" 07 19.1
a. penumbra, east line of	" 25 34.7	" " 52.7	" 07 42.0
b centre of —	" 40 50.7	" " 52.6	" 22 38.1
c " " -	" 43 33.3	" " 52.6	" 25 40.7
f. " "	" 42 47.4	" " 52.6	" 24 54.8
g. " "	" 45 00.6	" " 52.6	" 27 08.0
h " "	" 45 23.5	" " 52.6	" 27 30.9
de " "	" 57 22.2	" " 52.6	" 39 27.6

The following notes were made by me during the intervals

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between the numerous of the spots.

4h 56m. Five perceptible elevations, or irregularities on the moon's edge, situated just below the centre of the arc; closely watched, and found to be steady, and to retain their relative positions

5h 00m. Cusps clearly defined.

5h 08m The limb of moon projected on sun's disc, slightly rolling, and rendering indefinite the elevations previously observed.

5h 10m Cusps sharply defined.

5h 11m Suns rays beaming soft and mild

5h 12m. An apparent purplish tint around edge of moon projected on Sun, giving the appearance of its being shaded off to represent a sphere.

5h 14m. The rolling, or tumultuousness of the limb of the moon increasing, and that of the outline of Sun commenced.

5h 16m. The Suns rays like three is united.

5h 17m. Cusps undisturbed, except by the slight rolling or wavy motion, like that caused by the effect of radiated heat on the outline of a smooth bare hill-but in a very mild degree.

5h 27m Cusps sharply and clearly defined. Long shadows being cast. The summit of the Alleghanies appearing as when lit up by the last rays of the setting sun.

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$5^h\ 30^m$ Cusps very sharp and only slightly affected by rolling.

$5^h\ 31^m$ Cusps as sharp as needles, and appearing to clasp the moon, as if it were the smaller disc. At no time, so far, has the moon been seen projected beyond the sun -

$5^h\ 32^m$ Light fading rapidly away.

$5^h\ 39^m\ 13^s.4$ A cold dark shadow passed over the observatory, very distinctly marked. The time was called as I felt it.

$5^h\ 40^m\ 32^s.4$ Another shadow and a much colder one bounded by, and altho' I was somewhat protected by the observatory, it appeared to strike me plumb-ly - forcibly, rather than to steal softly, quietly by. There was not a breath of air stirring.

$5^h\ 41^m\ 02$ Mr Perkins noted and recorded a third shadow, tho' less distinctly marked, as if they were passing in waves.

Thos D. Watthall Esq. an intelligent gentleman, residing at Bristol, and greatly interested in the subject of the Eclipse, had undertaken, at my request, to note carefully the interval of time between the passage of the dark shadow over the hill, and its arrival, if perceptible on the Summit of the Alleghanies. He reported that he felt the shadow as it passed, and noted 16 seconds of time before its effect was visible on

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the mountains, lying E.S.E. and distant 18 miles.

Just previous to Totality, and when the crescent was dwindling to a mere thread, I raised, for an instant, a marine glass lying by my side and pointed it to the sun, but the light was even then too strong to allow of its use without a screen.

5h 41m 21s.1 - The first inner contact was made and timed with clearness and precision, there being apparently no disturbing or exaggerating causes to affect the outlines of either moon or sun. Their limbs were defined with the utmost clearness to the very moment when the last ray was extinguished.

So soon as the time was called, the marine glass was again raised, and a hurried view taken of the corona, but on catching sight of the solar cloud, the screen glass was instantly removed from the telescope, and the time of totality devoted entirely to the protuberances. See E and F.

The corona appeared to be a broad circular band of silver colored light, with an inner brighter rim, and with rays extending from different points, but very irregular in length and profusion. By far the longest rays were visible about 45° to the left of the vertex, or where the sun disappeared, and their length was estimated at the diameter of the moon. The rays on the opposite side of the circle were the next longest — being about half the length of the first mentioned. The lower left hand quadrant appeared to be comparatively bare.

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At the first glance through the telescope, the large cloud marked C – about 180° from the vertex, attracted attention, and then A and B, the two or three to the right, appearing to be quite small in proportion. The position, shape and dimensions of A, B and C were determined as well as the means at my disposal would allow, and then of D and E; and it was while fixing the position of the last that the emersion was announced by a sudden increase of light, and then a flash, as if before the sun was actually uncovered, a highly luminous body was exposed, sending a flood of light about ½ a second in advance of the sun's rays.

5h 43m 53.3s

The protuberances were of a pink color, varying in shade, and marked, with the exception of D, by smooth, rounded and defined outlines. None were observed on the upper half of the circle, or above a diameter drawn parallel with the horizon. A and B, when first seen, were found to be decreasing and assuming their true form and size just as they were extinguished by the re-appearance of the sun. There were other elevations of the same character, but very low, or close to the dark circumference, presenting the appearance of a broken red line between D and E, which became visible just as the emersion took place. Protuberance C, had two shades of pink, and appeared to be rolled up in itself. It was readily seen with the naked eye. The stem of D I thought at

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one time was separated from the apparent dark edge of the moon, but of this I am not certain.

There was no agitation of, or break in the moon's or Sun's limb either before, at, or after the second inner contact. Both retained their respective outlines as distinct and unbroken as during the partial eclipse.

During totality, a lantern was required to read the Chronometer. The return of light was gradual and without the distinct waves with which the darkness came on.

The times of emersion of the Solar Spots were not obtained with the same precision as those of the immersions. Each Spot had to be clearly recognized before the time could be called, and before some of them could be so recognized, they had been uncovered from one to five seconds.

This Correction was noted in each case, at the time, and applied to the times called and recorded, and was obtained by counting the seconds the Spot apparently moved over the distance it should have retrograded during the same time to have been fairly bisected by the dark line of the moon's limit.

The called times of emersion, thus corrected, are not believed, in any one of those cases, to be over a second in error.

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Table showing the times of emersion of Solar Spots.

Spots - letters, see plan of.	Time by Chronometer	Chronometer fast	Bristol Mean time
a - nucleus - centre of	11h 14m 19.5s	5h 17m 52.5s	5h 56m 27.0
f - centre of	" 32 38.8	" " 52.5	6 14 44.3
g " "	" 34 45.5	" " 52.5	6 16 53.0
b " "	" 36 46.0	" " 52.5	6 18 53.5
b' " "	" 37 47.5	" " 52.5	6 19 55.0
de - north end of	" 50 06.4	" " 52.4	6. 32 14.0
de - south end of	" 50 31.0	" " 52.4	6 32 38.6

The following memoranda were made at the time stated

5h 52m - Cusps sharply defined as during progress of emersion.

5h 59m The moon's limb projected on disc of sun, slightly rolling towards the cusps, while quiet and steady in the centre of the arc -

6h 30m 30s. A low but decided elevation observable on the moon's limb under the upper cusp of sun, close to the point of the cusp. Watched and no change, and not affected by the slight rolling of the moon's outline.

There was no distortion of the cusps at any time during the Eclipse, not even when the sun was close to the horizon; nor was there any agitation of the outlines of sun or moon except within a few seconds of the last contact. This agitation, however, was not at that time sufficient to render them outlines indefinite.

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$6^h\ 36^m\ 40^s$. Just as the moon separated from the Sun, that part of the limb of the Sun where the separation took place appeared to be considerably broken, small pieces of the dark moon, like a broken black line, remaining along the crumbling or dissolving edge of the Sun and presenting the appearance of dark and light spots being interwoven or intermixed, and so distinct was this black, broken line, that I began to doubt whether the separation $6^h\ 36^m\ 50^s.6$ had been completed, and so again called the time when they disappeared.

The Suns limb was then watched and altho' the black spots had gone, the crumbling appearance of $6^h\ 37^m\ 40^s.5$ the Sun's limb, at the locality referred to, continued, and the time again called when the outline had been entirely restored. The sun was then setting in the horizon. There was no phenomenon at all resembling this, the Baily Beads, at any other time.

The report of Asst. A. J. Mosman is here to annexed. In the two following tables, the times of contacts, immersions and emersions respectively determined by Asst. Mosman & myself & brought together

Contacts	according to R. D. C	according to A. J. M.
1st " outer contact. Eclipse begins	$4^h\ 43^m\ 52^s.6$	$4^h\ 43^m\ 52^s.9$
1st " inner " Totality commenced	$5^h\ 41\ 21.1$	$5\ 41\ 21.4$
2nd " " " " " ended.	$5\ 43\ 53.3$	$5\ 43\ 53.2$
2nd " outer " Eclipse ended.	$6\ 36\ 40.0$	$6\ 36\ 38.2$

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Duration of Totality according to R. D. C. — 2m 32s.2

" " " " " A. T. M — 2m 31s.8

" " " computed ——— 2m 33s.2

Spots &c.	Times of Immersion		Times of Emersion	
	R. D. C.	A. T. M.	R. D. C.	A. T. M.
a'		5h 05m 38s.2		
a2				5h 56m 54s.3
a3		5 06 33.5		
a. west line of penumbra	5h 06m 26s.3			
a. nucleus-west edge	5 06 46.7			
a. " east edge	5 07 19.1			
a. east line of penumbra	5 07 42.0			
a. shadow		5h 06 36s.0		
a. centre of		5 07 35.9 (2)*	5h 56m 27s.0	5 56 23.5
b	5 22 58.1	5 22 54.0	6 18 53.5	6 18 57.1
b'		5 24 20.6	6 19 55.	6 20 04.0 (bad)*
f	5 24 54.8	5 24 54.5	6 14 44.3	6 14 45.8
c	5 25 40.7	5 25 40.3		6 21 12.8
g	5 27 08.0	5 27 09.7	6 16 53.	6 16 52.0
h	5 27 30.9			
de	5 39 29.6	5 39 27.1		
d. north end			6 32 13.9	6 32 13.0
e. south end			6 32 38.5	6 32 43.9

*So marked in the report of Asst. Rosman

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In the report of L. M. Perkins Esq. Aid U.S. Coast Survey, he states that,

"A few minutes before the second contact, the cattle commenced coming home, I could hear the fowls arranging themselves on their roosts in the neighboring trees, and when the extreme darkness of totality fell upon us, the crickets commenced to chirp. The air grew perceptibly cooler, adding to the sensations of awe and admiration which so uncommon a phenomenon naturally produced".

"Mercury, Venus and Saturn were visible, but I looked in vain for stars in any of the northern constellations."

"To the naked eye, and through a marine glass used without shades, the corona was of a white light, and the protuberances of an intense white light and clearly visible to the naked eye. When a very light red shade was used with the marine glass, the protuberances appeared of a yellowish white color.

"After totality, the light seemed to reappear much more rapidly than it had disappeared, the lamps used in reading the chronometer being dispensed with almost immediately after the third contact.

Charles S. Allen Esq. of Philadelphia, who travelled to Bristol for the purpose of observing the Eclipse, reports:

"Of the rose protuberances, the most distinct, was directly opposite the cusps: it continued throughout the period of totality, and was visible to the naked eye. A faint light of

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"a rose color, in the shape of a cone, extended from it toward
"the centre of the moon's disc".

"A rose protuberance on the left or south edge, about
"90° from the vertex appeared at the beginning of totality,
"but soon disappeared. On the north or right edge, 90°
"from the vertex, a protuberance similar to the two others
"appeared near the end of totality. Also, a long forked
"protuberance like two streamers, about 140° from vertex.
"The two last were connected, just before the re-appear-
"ance of the sun, by a row of beautiful rose-colored beads."

In the preceding report, I have confined myself to a mere statement of facts, and description of the phenomena as they appeared to me, deeming any discussion of theories or conclusions by any separate observer, to be both inappropriate and unsafe, until all the proofs and evidence collected, under your direction, shall be brought together, criticized and compared.

I am
Respectfully
Yours
Rich.d D. Cutts.

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Bristol, Tennessee,
Aug.t 8. 1869

Prof.r Benj.n Peirce
Supt U.S. Coast Survey,
Dear Sir,

I beg leave to report that my entire programme for observing the Eclipse of yesterday was successfully carried out. There were three good telescopes in position, accompanied by two box chronometers, one mean time and the other, sidereal, both closely rated. The observations were made at the Observatory, situated on a commanding position, and the principal telescope mounted on a solid pier, constructed of brick and cement. There was not a cloud from the commencement to the end of the Eclipse, to interrupt the view, and the atmosphere was remarkably clear. In fact, so clear and steady was the medium through which we were looking that the phenomena of the Baily Beads, distortion of the cusps &c, usually observed on such occasions and due to the condition of our own atmosphere, were entirely wanting, except that a little before and sometime after the final contact, and when the sun was near the horizon, its limb on both sides of the point where the emersion took place, was somewhat agitated. The contacts were distinct, and their times well determined, as were also the immersion and emersion of the different mon-

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ters of the four groups of Spots on the Sun. The duration of the total phase, as telegraphed last night, through the Observatory at Washington, was $2^m\ 32^s.2$

The Corona was irregular, the rays being much more extended at the point where the Sun disappeared than at other positions on the circumference of the circle.

The protuberances, however, (of different shades of red or pink) attracted attention to the almost exclusion of the corona, and their shapes (in one case very peculiar) dimensions, and changes in height, as they were covered and uncovered by the advancing moon, were sketched and noted.

The Eclipse at Bristol, 1760 feet above the sea, was, in consequence of the unusual clearness of the atmosphere and stillness of the air, strictly, stamly regular and well-defined in all its phases, and only enlivened by the brilliant phenomena exhibited during the shortest two and a half minutes within my recollection.

A full report will be forwarded in a few days, or as soon as the subordinate reports are received.

The latitude and longitude of the Observatory, situated on Lancaster Hill, have been carefully determined by about 12 pairs of stars, and the transmission of time signals to the Naval Observatory at Washington three nights, three having been lost one night during the last ten, on which observations have not been secured by Mr. Rosman. The local time specially for the Eclipse was obtained by the usual star

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transits, on the evenings of the 6th and 7th. These data, principally the latter, were freely given to the different outside observers - some being the representatives of Southern Universities - as they had repaired to Bristol with this expectation, and were, in consequence, entirely dependent on us.

The strength of my own party was increased by the addition to it of Dr. Fisher Longstreth of Phila., Corresponding Member of the Academy, and by others who volunteered to observe, under my direction, special classes of phenomena.

Yours

Respectfully

Yours

Richd. D. Cutts.

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Washington Oct 14. 1869.

Prof Benj Peirce
Supt. U.S. Coast Sy.

Dear Sir-

I forward herewith my report on the Eclipse of Aug 7th being the same that was sent to you on the 19th of August, with the exception of some of the Sketches, topographical &c, including one from Hoeman, which I sent for, and the final results of the obs ns for latitude and longitude of the Stations.

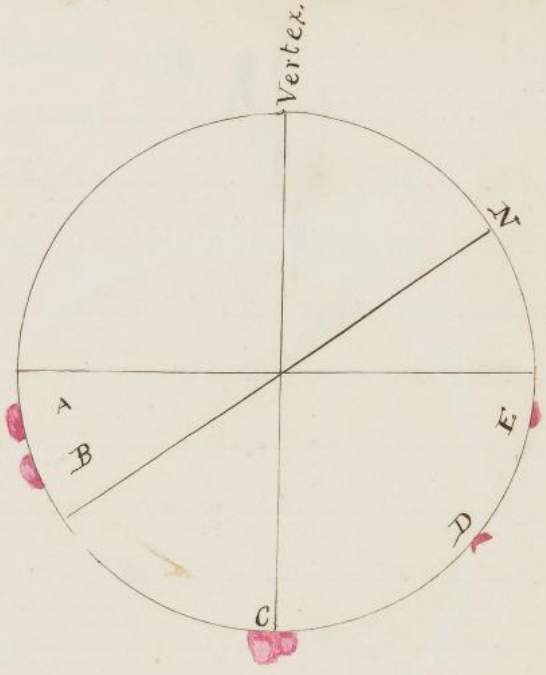
In my report, I stated that there was some doubt about the position of the protuberances D and E. I have taken the liberty of putting them more in accordance with the angles from the vertex assigned them in the Springfield photographs, while, at the same time, I enclose the original sketch of them given to you at the time of the meeting at Salem.

I am respectfully
Yours
Rich d D. Cutts.

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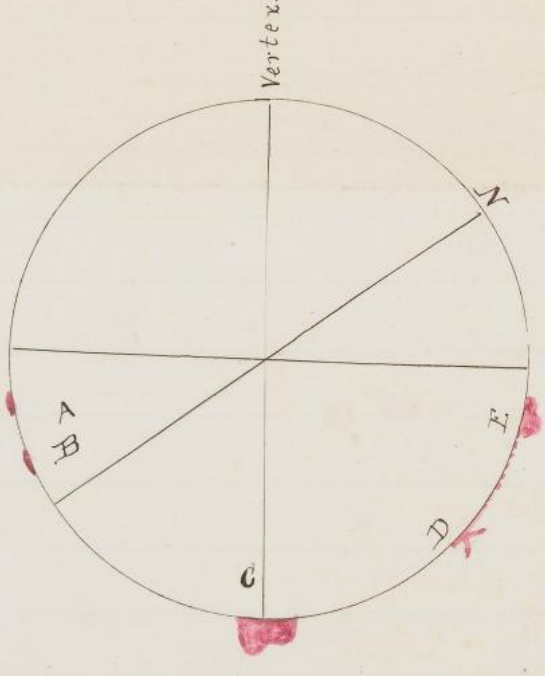
Soon after totality



Estimated greatest altitudes.

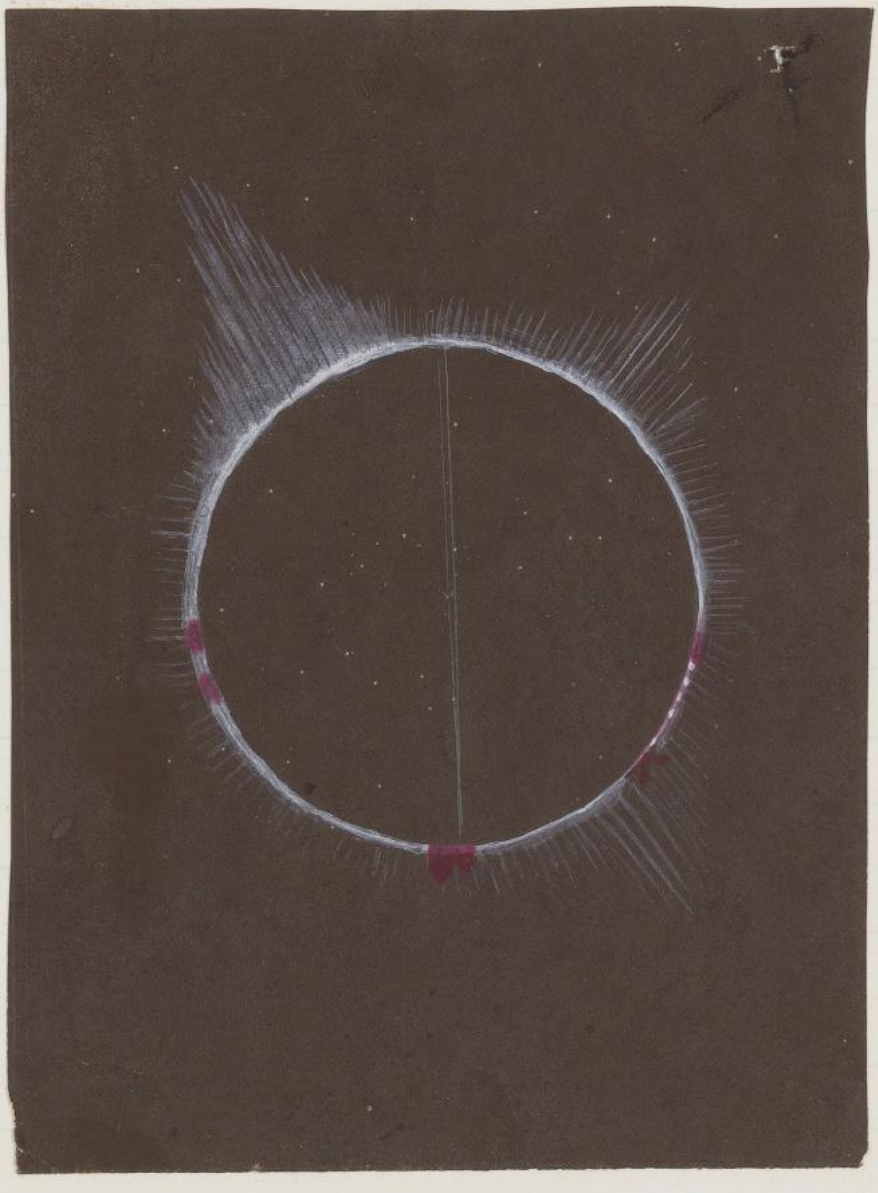
A B E —— 1′ 00″
D —— 1′ 15″
C —— 2′ 00″

Just before emersion



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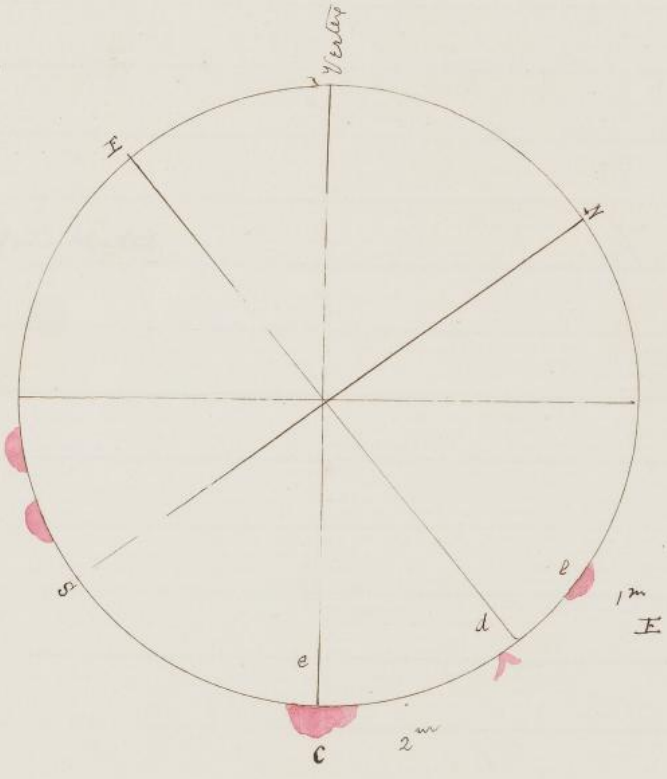


The corona and the protuberances
(Hoar Wang)

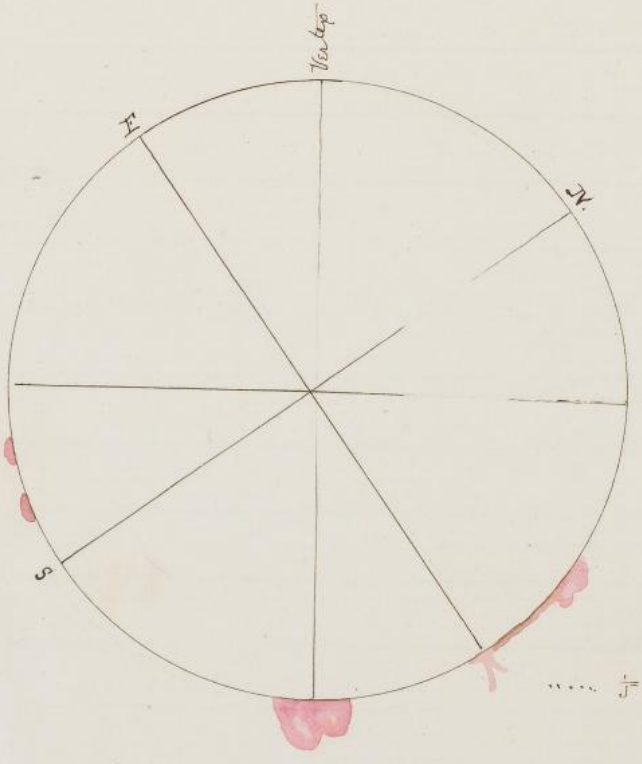
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Soon after totality



Just before emersion

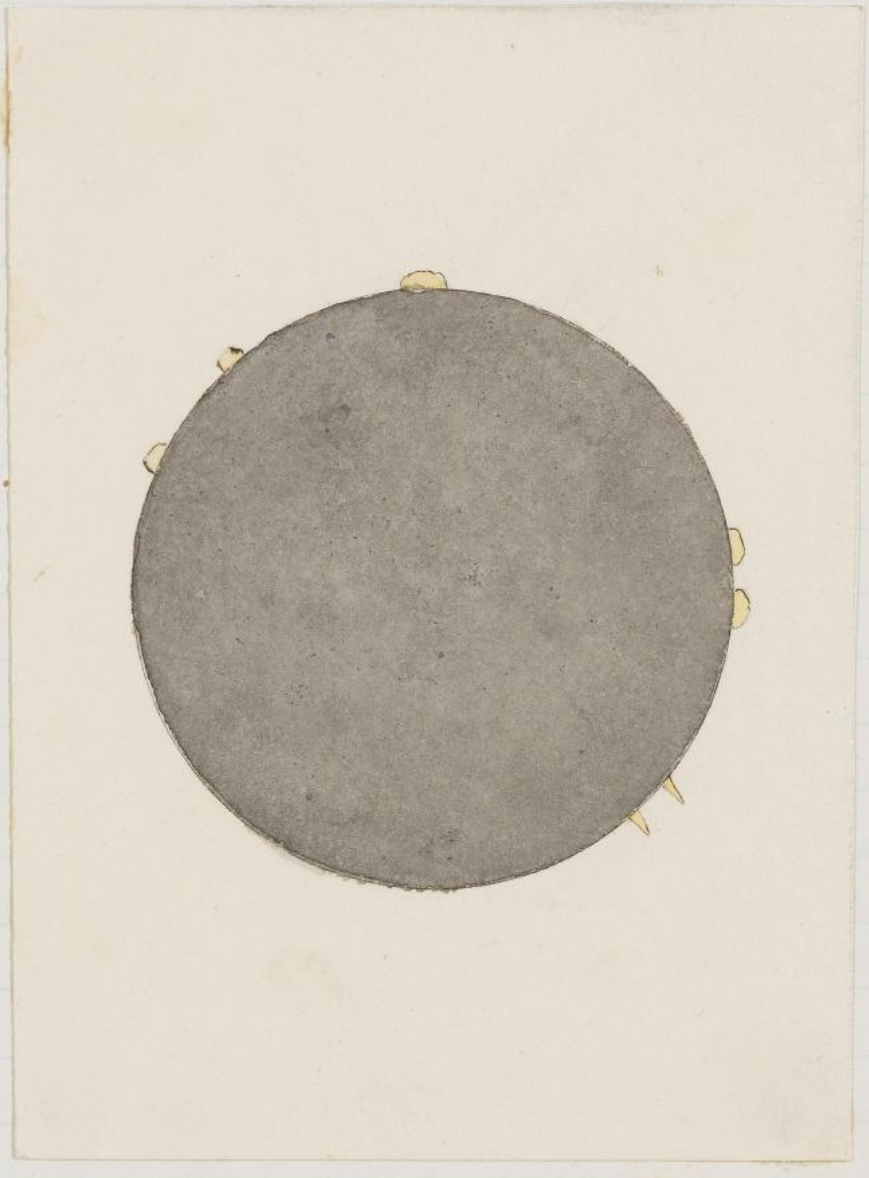


..... ∓ Exaggerated.

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H



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Bristol Penn.
Aug. 9th 1869.

Gen. R. D. Cutts
Assistant U. S. Coast Survey

Dear Sir;

I have the honor to submit the following report of my observations of the Solar eclipse of the 7th instant.

The weather at 4h 30m P.M. was partially cloudy with flying cumuli clouds; Sky 0.3 covered. Wind E. N. E. fine in Strength (on a Scale of ten) Atmosphere very clear and Steady.-

The moons border was not seen before the first contact, nor was there any agitation of the Sun's limb in the region of the contact. Very slight irregularities which looked like mountains were noticed on the moon's edge which was projected on the Sun, as the eclipse advanced.

Moon's edge began to appear tremulous at 14h 17m Sid. T. or 5h 12m M. T. No Spots were observed on the moon. No bright-bands and no illumination of the moon's disc was seen. The cusps appeared very sharp and well defined throughout with no distortions. Sun's edge began to be tremulous at 14h 35m Sid. or 5h. 30m M. T.

No projection of the moon beyond the Sun, and before totality no rapid changes of the crescent, and the time of the first inner contact or beginning of the total obscuration

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was very well marked, quite sharply defined, and very steady.

The advance of the dark shadow was not observed by me.

During totality solar clouds were seen (see sketch) but no corona (probably because out of the field of my telescope) and no clouds till the sun had disappeared.

The two clouds seen near the point where the sun disappeared were long pencil like rays, the others had the appearance of ordinary cumuli clouds; the color of all was a yellowish white and they appeared stationary and very steady during the whole time of observation and disappeared the instant the sun reappeared. See H.

I had no time to examine the space between Mercury and the sun, for the supposed planet, and I saw no stars except Venus as my attention was almost wholly directed to my telescope watching for the instant of the suns reappearance. An increased brightness of the suns limb was noticed about five seconds before emersion, but no flashes or bright rays. No projection of the moon beyond the sun was noticed as the moon receded and the edges of both the sun and moon were remarkably steady and no distortion of either of the cusps was seen.

Moon seemed of a uniform blackness as she receded, very slight inequalities as on advancing were noticed, but no illumination of her disc and no spots on her surface.

The moon was not seen after leaving the sun, but the suns edge in the region of the last contact remained irregular for over a

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minute after the moon had disappeared.

The following are the times of the different contacts and the immersion and emersion of the spots observed by me with Sid. Chron Hutton 207 which was slow 3.s7 and in the next column are the obsers. in Mean Time. The rate of 207 was losing 0.s04 per hour.

The telescope used by me was Rem. Tel. No. 14, U.S. C. S. Aperture three inches. Focal length 2 ft. 10 inches.

Yours respectfully
A. T. Mosman
Assist. Coast Survey

Approx. Longitude +20m 33s from Washington
" Latitude 36° 35' 57"

	Time by Sid. Chron. No 207	Brief Mean Time
First outer contact	13h 49m 40.s5	4h 43m 52.s9
" inner "	14 47 18.6	5 41 21.4
Second " "	14 49 50.8	5 43 53.2
" outer "	15 42 44.5	6 36 38.2

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Solar Spots

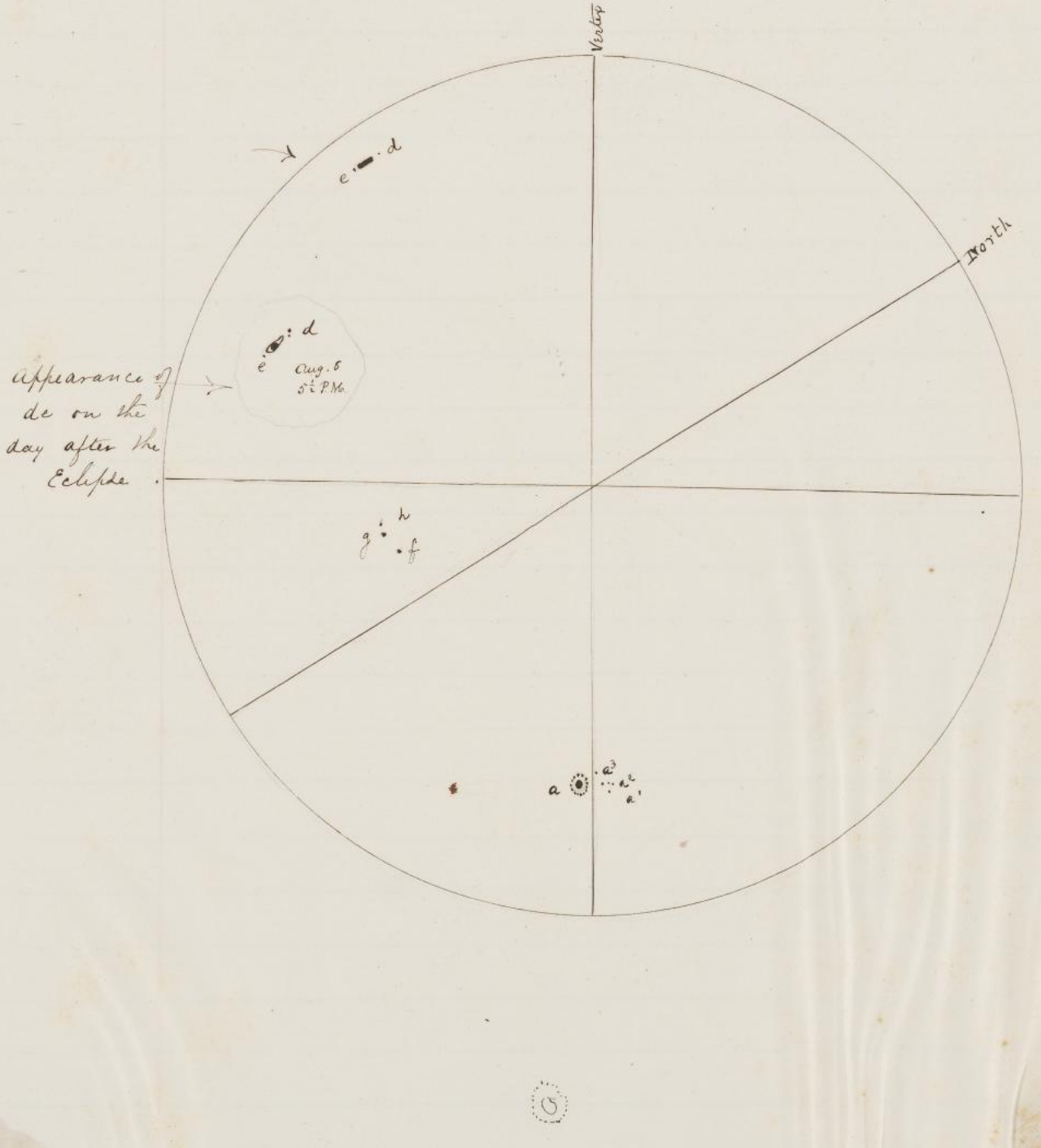
Immersion				Emersion			
	83 Aug 7		m. T.		83 Aug 7		
a'	14 h 11 m	29.5 s	5 h 5 m	38.2 s	a'	—	
a²	—		—		a²	15 2	54.0 5 h 36 m 57.3 s
a³	12	25.0	5 6	33.5	a³	—	—
(a) Shadow	12	27.5	6	36.6			
a	13	27.5	7	35.9	a	15 2	23.5 36 23.5
b	28	48.1	22	54.0	b	25	0.5 6 18 57.1
b'	30	15.0	24	20.6	b'	26	7.5 20.40.3
f	30	49.0	24	37.5	f	20	48.5 14 45.8
c	31	34.9	25	40.3	c	27	22.0 21 18.3
g	33	4.5	27	9.7	g	22	55.0 16 52.0
d	45	24.0	39	27.1	d	38	18.5 32 13.0
e	—		—		e	15 38	49.5 32 43.9

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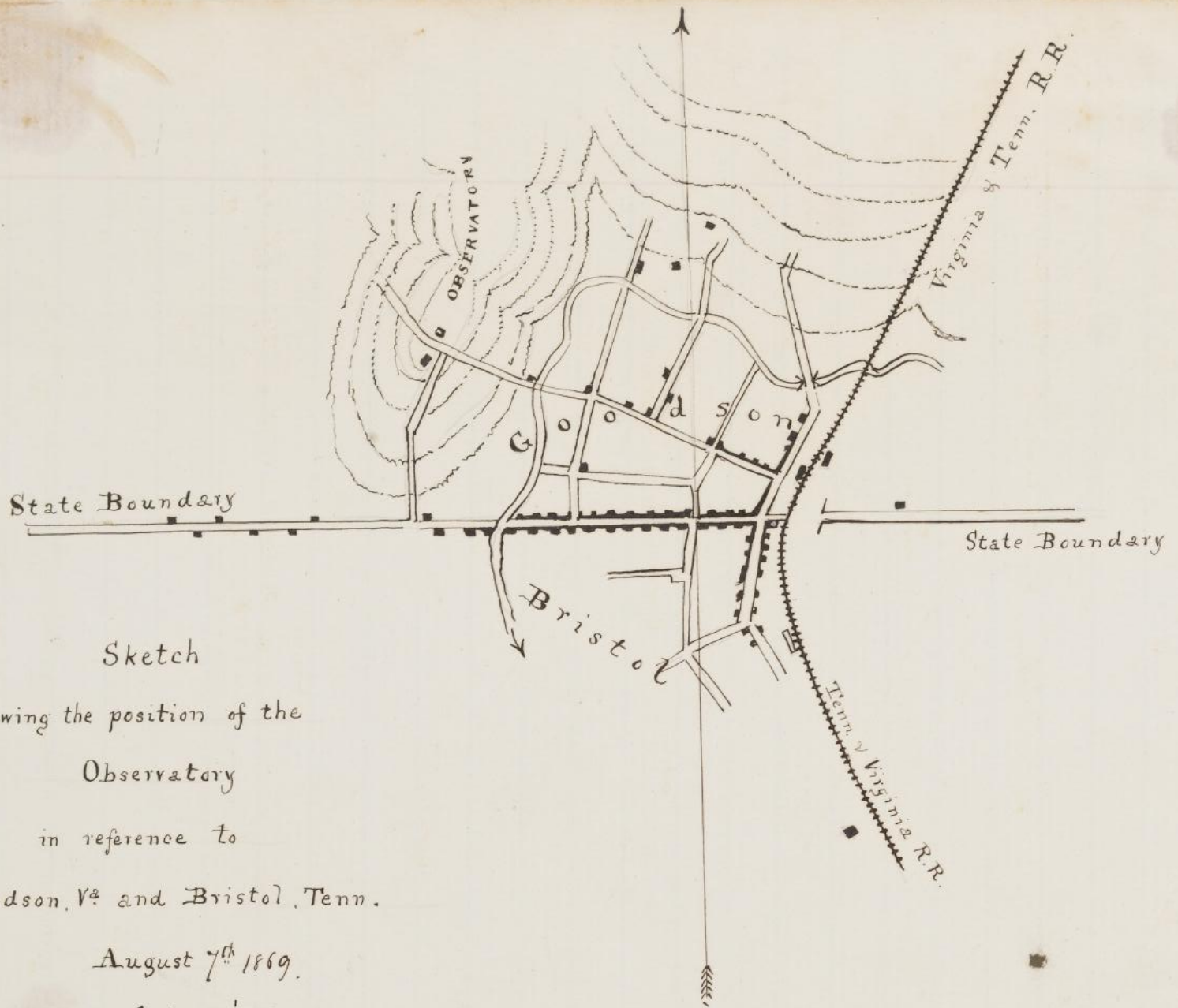
D

Spots on the Sun
as they appeared before the commencement
of Eclipse, Aug 7, 1869



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Sketch

showing the position of the

Observatory

in reference to

Goodson, Va and Bristol, Tenn.

August 7th 1869.

Scale $\frac{1}{10000}$

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B

1
2 000 000.

38°
37°
8.01
6.02
Northern Limit of Total Eclipse. 6.03
Piketon
Wytheville
Abingdon
Bristol
6.03
Central line of Eclipse
6.04
Statesville
Maryantown
Greenville
Ashville
Knoxville
Southern Limit of Total Eclipse.
6.05 P.M.
7
6
5
4

Nautical Miles
10 0 10 20 30 40 50 60 70 80 90 100

State Miles
10 0 10 20 30 40 50 60 70 80 90 100

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Fall River
Sept 2nd /69

Dear Sir;

In accordance with your instructions of June 28th I proceeded to organize an astronomical party to co-operate with a party under the direction of Prof. Joseph Winlock, Director of Harvard Observatory, for the purpose of observing the Solar eclipse on the 7th of August at several of the most favorable points within the limits of the shadow in the State of Kentucky.

Shelbyville, located about thirty miles easterly from Louisville, and near the central line of the shadow, presented many favorable inducements for establishing the principal astronomical station at, or near that place. Besides this, the Honorable Board of Trustees of Shelbyville College, had generously placed their large Equatorial Telescope at the service of Prof. Winlock.

On the 12th of July, I proceeded to make arrangements for erecting the temporary observatories required for making a series of latitude observations, and for sheltering the larger instrument to be used on the 7th of August.

Sub-Assistant F. H. Agnew, having in charge a portion of the astronomical instruments, arrived at Shelbyville on the 16th and Mr F. Blake Jr. Aid in the Coast Survey, reported in person for duty on the 21st

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On the 22nd Prof. Pinlock arrived from Cambridge, and on the following day, made arrangements for dismounting the Shelbyville Equatorial, in the dome of the College Building, and re-mounting it near the Coast Survey Station in the South-western portion of the College grounds. Arrangements were at the same time made for adjusting the Clark Equatorial, which was to be used by Mr. J.A. Whipple of Boston in photographing the phases of the eclipse under the immediate direction of Prof. Pinlock.

On the 24th of July, Mr Blake began a series of latitude observations which he completed on the 3d of August. These consisted of one hundred and sixty five observations upon fourteen pairs of stars, with Zenith Telescope No. 6 C.S. The arc value of one division of the Micrometer was determined from forty observations upon Polaris near Eastern Elongation.

One set of twenty measurements with the micrometer, were made in the usual manner for determining the arc value of the Level divisions.

On the 26th of July, Charles A. Bruce Esq, arrived from Cambridge, and after examining the adjustments of his instrument he proceeded to Bardstown, Ky, and there made observations with the Spectroscope upon the eclipse, the result of which he has reported to Prof. Pinlock.

On the 3d of August, Messrs. George D. and Alvan G. Clark, the well known opticians of Cambridge, reached Shelbyville

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and soon has the large Equatorials in good working order.

On the 5th ult of August, J. A. Whipple Esq. of Boston, joined us at Shelbyville, and with the assistance of Messrs. George D. Clark, Albert Stevens and J. Pendegrast, soon had the photographic apparatus in working order, and all the detail arangements for the photographic operations completed.

For several days immediately preceding the 7th ult of August, the weather was particularly unpleasant, in so much that nothing could be done, by way of adjusting the large instruments, until the morning of the 7th ult when at one o'clock, the heavy clouds began to break, and in a few hours we had a clear, cool atmosphere, and a cloudless sky, which continues until the eclipse observations had been successfully completed. It is perhaps unnecessary to say, that this day proved an unusually laborious one to all the members of the Eclipse party, but it is gratifying to state that the faithful labors of each one, were rewarded by good success.

Spectroscope. As Prof. Winlock will probably soon publish a full report of his Spectroscopic observations on the Solar eclipse, I will only say that he recognized eleven bright lines, whereas, under the most favorable circumstances only five can generally be seen. He used the Shelbyville College Equatorial, having a focal length of ten feet, and aperture of seven and a half inches. The results from his observations will prove a most valuable contribution to science.

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Photography.

Mr. J. A. Whipple of Boston directed the photographic operations, while Mr. George A. Clark of Cambridge, co-operated with him, and had the charge of the Clark Equatorial to which the photographic apparatus was attached. This instrument is seven and a half feet focal length; has an aperture of five and a half inches, and is provided with an excellent clock movement. Fifty good negatives of the eclipse were obtained, three of which were taken during the total phase.

Arangements which require no particular description have been made for recording upon the Chronograph, the time at which each negative was taken.

Lunar contacts and Occultations of Solar Spots.

These were carefully observed by Mr. J. Blake Jr. Aid in the Coast Survey and myself. The instrument used by me for this purpose is an achromatic refractor which was made at Munich and formerly used as a "finder" on the Great Equatorial at Harvard Observatory. Its focal length is forty six inches; aperture three inches, and on this occasion it was used with an amplifying power of thirty.

The telescope was equatorially mounted and firmly adjusted upon a pine post about four and a half feet above the ground, and twenty feet west of the Shelbyville Equatorial, which was used by Prof. Winlock.

To avoid using very dark shade glasses, the aperture was

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reduced to one inch, by placing a paper cap over the object glass. Using a Soniden smoke shade, of reduced tint. I directed the telescope upon the sun near the point of the first contact, about one minute before the first contact was recorded. I failed to detect any agitation at all, of the sun's limb, and the first indication of the moons approach was shown by the sun's limb becoming suddenly rough, yet I hesitated to break the chronograph circuit, until I could perceive a slight indentation upon the sun's limb, which I think must have been about five seconds after I first saw the elevated edge of the moon. A few seconds after I had recorded the first contact, Mr. Whipple obtained a good photograph of it, and the exact time was recorded upon the chronograph.

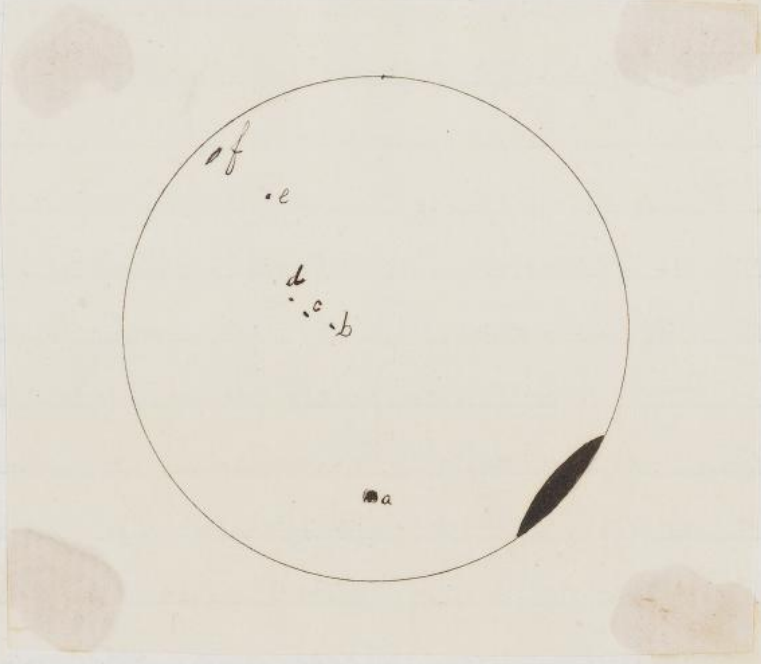
During thirty or forty seconds after the first contact, the moons edge appeared remarkably steady, and sharply defined, its rough outline, resembling very much that of a distant mountain range.

I was unable to discover that the moon projected beyond the sun. About two minutes after the first contact, the edge of the moon became tremulous, and so continued until the end of the eclipse.

The occultation of the solar spots, the approximate relative position of which, are shown in the accompanying rough sketch, were observed in the order as designated by letters.

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Spot (a) being quite large, I observed two contacts of the umbra (first and last) but all other spots were observed at the instant of occultation.

Immediately after recording the occultation of spot (ε) a very light shade glass (London Smoke) was substituted for the dark shade, and the paper cap was removed from the object glass. After the occultation of spot (f) the total phase of the eclipse seemed near at hand, and I watched closely for the first contact. About three seconds before this was recorded, the delicate line of sunlight, suddenly separated into minute fragments, resembling very much, a string of brilliants, which disappeared like snow under a white heat, producing one of the most brilliant and startling effects of the total eclipse.

I have no doubt of the fact, that the dark lines which

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I saw for three seconds before totality, were identical with the elevations that I saw upon the moon at the instant of first contact.

Immediately after I had recorded the first contact of totality, my attention was particularly directed to a large protuberance near the lower, or western edge of the sun. For a few moments, it seemed like a large coral formation tinted with the most delicate pink and red colors. As the eclipse progressed, several of the similar formations appeared at different parts of the limb, all of which, with the corona have been successfully photographed by Mr. Whipple.

During the totality, I made a hasty survey of the heavens in the immediate vicinity of the sun, and also noticed the startling effect upon the landscape produced by the gloomy light from the corona.

The planets Mercury and Venus and the star Regulus were seen without the least difficulty, and yet the degree of darkness during totality was not so great as I had anticipated. I found but little difficulty in reading the notes that I had made in pencil. Others observed near me, were differently affected, and Mr. Blake has stated in his report, that he found great difficulty in reading large print.

I noticed the gradual falling of the temperature during the eclipse and the sudden change of the wind from north east to southeast, but at no time did I feel uncomfor-

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tably cold. According to Mr Lewis record, the change of temperature from the beginning until the close of the eclipse was only seven degrees Fah^{r}.

I was successful in obtaining a good observation of the second inner contact, in other words the last contact of totality, but I failed to see the string of brilliants, (Baily's beads) as I saw them just before the beginning of totality.

About ten minutes after the total phase, I observed a faint object pass across the moon in a south-westerly direction; in a few moments, I saw another, which was soon followed by another in the same general direction; within fifteen minutes, I saw ten of these faint objects pass across the moon. They had the appearance of being meteors, and I am inclined to believe they were. The same phenomenon was observed by Mr Blake and also by Mr. Alvan G. Clark. The wind at that time, was very light from the South east.

As my attention was required for other services, I made no observations upon the solar spots as they reappeared.

The last contact of the moon was satisfactorily observed by Mr. Blake and myself - and in a few hours afterwards, the local time was carefully determined from a series of observations upon Zenith and Circumpolar stars with Transit No. 4. U. S. C. S.

Mr Blake has made a full report of his observations upon the eclipse, and which I have the honor to forward to you.

Professor C. B. Seymour of Louisville had the use of

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a small telescope belonging to the Coast Survey (C.S. No. 24) and made such observations upon the eclipse, as he was able to do. The focal length of the telescope was twenty eight inches; aperture two and a half inches; power forty three. The instrument was provided with a clock-box which Prof. Seymour used in making his observations. I herewith forward to you Prof. Seymour's report of his observations.

Sub-Assistant T. H. Agnew's impaired health prevented him from taking an active part in the Eclipse observations, but he rendered valuable services in attending to the Chronographs, and obtained excellent records of all the observations which were made by Mr. Blake and myself during the progress of the Eclipse.

Meteorological observations were made every fifteen minutes during the progress of the Eclipse, by Robert C. Sevis Esq. of Shelbyville, who also rendered very acceptable services in making arrangements for the eclipse observations.

The Trustees of Shelbyville College placed several rooms in the College Buildings, at our disposal, for storage of the instruments and equipments, and thereby extended every facility in their power to aid the Eclipse party.

To the Rev. Doct. Waller, Doct. Baker, Col. M. C. Taylor, Col. William Winlock, Joseph R. Davis Esq, and R. C. Sevis Esq. We were placed under many obligations for courteous attentions to the eclipse party

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at Shelbyville.

As your instructions contemplated the occupation of one or more stations near the northern and southern limits of the shadow, Falmouth at the North, near the Cin. and Lexington R. R. and Oakland at the South, near the Louisville and Nashville R.R. were considered most favorably located for this purpose, and arrangements were accordingly made for having those stations connected by telegraph for an hour during the eclipse.

John Van Horn Esq. Gen. Supt. of the Western Union Lines, and Mr. William Biggart, Supt. of the Railroad Lines, generously placed their wires at the disposal of the Coast Survey, and cheerfully extended all the telegraph facilities without charge.

The eclipse party at Falmouth was placed in charge of Mr. Arthur Searle of Harvard Observatory, who, on the 5th of August proceeded to complete the requisite arrangements at that place.

Mr. Searle was fortunate in securing the services of several gentlemen at Falmouth, who kindly volunteered to aid him in making observations during the eclipse.

The party was provided with two good telescopes, a clock pendulum, adjusted to sidereal time, two Morse registers, a stop watch and several other smaller instruments. The chief object of the observations near the North and South limits of the shadow was to determine

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the duration of the total phase, and, although Mr. Scales efforts to obtain a good record of his observations upon the Moon registers were not successful, he thinks that the observations made by Capt. W. E. Arnold of Falmouth, who was assisted by two Tally-men Messrs. B. Johnson, and D. Yelton, are worthy of confidence. The times noted by Capt. Arnold gave forty five seconds for the duration of totality, but he thinks that it was a small fraction of a second less. Capt. Arnolds observations were confirmed by Mr. Modena who was assisted by a friend, using an ordinary watch. Mr. Modena thinks that the total phase continued exactly forty five seconds.

The Station is located near the Railroad and west of Watsons Hotel, and was marked by a stake driven into the ground.

Mr. R. N. Grant made observations on the first hill north of Falmouth Station, using a Stop watch, and found the duration of the total phase to be forty one and six tenths seconds. Judge Hudnall observed at the same station, using an ordinary watch, and made the time of totality a small fraction of a second greater than forty one seconds.

At Calamba, a few miles north of Falmouth, the total phase was observed by Mr. D. Codrey Jr. and ascertained to be twelve seconds. Mr. Codrey's observations were timed with an ordinary watch by his father, and Mr. Scale reports that Mr. Codrey will at once mark the point by a stake

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The eclipse party at Oakland, Ky. was in charge of Prof. S.P. Langley, Director Allegheny Observatory, who was assisted by Graham Wilder Esq. and Mr. R. De Bree of Somerville

The station, at which the observations at Oakland were made, is located about half a mile west of the Rail-road Station, at that place, and twenty yards from the track. The point is to be marked by a large stone sunk into the ground. Prof. Langley's party were provided with a good telescope, and a Bond Chronograph regis-ter from the Allegheny Observatory, a Zenith telescope for determining the latitude, a clock pendulum, Pocket chronometer, stop-watch, and other smaller astronomical instruments.

The unfavorable weather before the 7th of August, pre-vented the latitude observations, but it was supposed from the information obtained from the best maps, that the Sta-tion was at least two miles within the shadow. The ob-servations of the totality appear and show that the observers were located just within the shadow.

Prof. Langley's observations were made with a tele-scope having an aperture of three inches, and magnifying power of thirty, and were recorded upon a Bond chrono-graph. These observations show that the duration of totality was one and seven tenths seconds, but Prof. Langley thinks it was not much longer than one second.

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Mr Hilder used a binocular field glass, and his observations were recorded upon a Morse register fillet, and indicate a duration of two seconds. He however remarks in his record, that in his judgment the duration of Totality, could not have been more than three fourths or one second.

Mr De Bree's record was not entirely completed, but in his record book, he remarks, that after recording the first contact on the Morse fillet, he counted one beat of the pendulum, when the Sun reappeared, and he thinks that the duration of the totality did not exceed one second of time. Mr. De Bree used no glass, in observing the contacts.

Prof. Langley remarks in his record that his observers who were stationed at Mr. Luther Carpenter's house, which is located near the railroad, about two miles west and a little South of Oakland, were quite outside of the shadow of the eclipse.

The Coast Survey is under obligations to all the gentlemen who took part in the eclipse observations, at Falmouth and Oakland, — and my thanks in behalf of the Coast Survey are due to John Van Horn Esq, Gen. Supt. Western Union Telegraph, and to Messrs. Carter and Boyle, Telegraph Managers at Louisville.

Mr Albert Stevens of Cambridge performed the duties of Astrician at Shelbyville, in the most faithful and acceptable manner

Very respectfully

Prof Benjamin Peirce
Supt. U.S. Coast Survey

Geo. R. Dean. Assistant

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Boston, Massachusetts
Tuesday, August 24, 1869.

Sir.

I herewith transmit a report of my observations of the total solar eclipse, made on the seventh instant, at the Coast Survey Station, Shelbyville, Kentucky.

Respectfully
J. Blake Jr.
U.S. Coast Survey.

Assistant Geo. W. Dean
U.S. Coast Survey.

Report
On the Total Solar Eclipse of August 7th 1869 as observed at
Shelbyville, Kentucky.

The morning of Saturday, August 7th 1869 opened with a cloudless sky, and throughout the day the atmosphere was of a remarkable clearness. At 5 o'clock A.M. the mercury indicated a temperature of 57° Fahr, it being the lowest reading I had made for at least two weeks. The morning was passed in making the necessary preparations for the afternoons observations. The instrument used by me was the "Bowditch Comet-Seeker", belonging to Harvard College Observatory, the object glass of which is four inches in diameter and three feet in focal length; the power used was 34. This instrument was mounted upon a cedar post about

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Seventy feet South of the observatory, in which were placed the two chronographs and the break-circuit chronometer. The break-circuit key at my instrument and the photographic apparatus attached to the Clark Equatorial, were in one circuit; therefore my observations of contacts and occultations were recorded, by the Harvard Chronograph, upon the same sheet which contains the record of the time at which the several photographs were taken. To facilitate the sketching of the apparent positions of the Solar Spots, I stretched four spider lines across the diaphragm of the comet-seeker, dividing the field approximately into octants. A brass Slide, in which were set a number of colored glasses of different shades, was attached to the eye-piece; and a pasteboard cap, which reduced the aperture to about an inch and a quarter, was placed over the object glass. A chart showing the positions of the planets and constellations at the time of totality, a small sextant, a few sheets of writing paper, and a common watch with which to note approximate times, were the only additional apparatus.

The eye-piece of the comet-seeker is at the extremity of the horizontal axis, and when observing I sat with my face to the North.

The first exterior contact as observed by me is worthless. I was devoting my attention to a portion of the Sun's limb much below the point at which the contact took

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place, and did not break the circuit until some ten or twelve seconds after the time at which Alvan G. Clark Jr. exclaimed, "There it is" I he was looking through the finder of the Shelby Equatorial and was probably the only member of the party who observed this contact. The moon had the appearance of a jet black body projected upon the bright surface of the sun, its edge being slightly irregular.

I am quite confident that the moon's limb was not visible until the contact actually occurred. The moon's disc did not apparently project beyond that of the sun. The accompanying sketch shows the approximate positions of the solar spots, as they appeared through my instrument, just after the first exterior contact.



The first spot [a] was quite large, and in observing it, I made three breaks; one as the moon came in contact with the first edge, a second as it reached the centre of the spot, and a third as the last edge disappeared; I have but little confidence in the observation on the centre. After this occultation had been successfully observed, I could but notice the calmness of the observers,

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and the smoothness with which the different observations were being made.

About twenty-eight minutes before totality, the wind, which had been from the north-east, suddenly ceased; in a few minutes however a breeze sprang up in the south-east, and continued to blow from that quarter during the remainder of the day. At the same time, I noticed that shadows were quite indistinct, that the air was growing chilly and that the sunlight gave a peculiarly gloomy aspect to the landscape.

The remaining spots (b, c, d and e) were small, and but one tap was made on each of them. They remained steady and undisturbed up to the time at which they were occulted.

Thirteen minutes before totality, the air felt quite cold; the sun appeared as a beautiful crescent, while the black edge of the moon seemed to stand out from it, giving one the idea of a stereoscopic picture. The shaking or "running" of the moon's edge seemed to be rapidly increasing. Giving a hurried glance about me, I was struck with the appearance of the trees to the eastward of the tent, and about fifty feet distant; the foliage was of a peculiar color, very similar to that produced by the electric light when displayed at night by Mr. Ritchie of Boston, Mass.

Eight minutes before totality the limbs of the sun and moon were shaking violently, and the sun-light was diminished to such an extent that the faces of the observers

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were of a livid hue, and not unlike that of a corpse.
Facing to the eastward, I saw that the southern edge of my shadow was comparatively sharp and distinct, while the northern edge was ill defined and very faint. The sun was now reduced to an extremely thin crescent, and I began to watch for the first interior contact. A few moments before totality, I noticed a slight agitation in the upper portion of the crescent, which, immediately afterwards broke up into little detached masses of light, of very irregular shapes and sizes, and at unequal distances from each other. This phenomenon, commonly known as "Bailys Beads", lasted but a few moments. These little points of light were rapidly extinguished; and as the last one, with the only remaining ray of sunlight, was cut off, I made a break with the key, the chronographic record of which gives the time of the first interior contact.

With the extinction of that last ray a startling change took place — The corona, of which up to this moment there had been positively no indications, now appeared as an extremely soft white light surrounding the sun, and extending from it, in all directions, to a distance of at least two thirds of its diameter. There was no appearance of rays, nor was there any sparkling light — it had in fact a perfectly dead or "set" look. Its general form was irregular and somewhat similar to that of this rough sketch which is copied from

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the one I made at the time.



Simultaneously with the appearance of the corona, some of the planets and the[illegible] fixed Stars become visible to the naked eye. They did not appear as they ordinarily do at night, but seemed to shine with a very soft and slightly diffused white light. The sky, in the vicinity of the Sun, was not blue as at night, but was of a peculiar milky hue; in the zenith it seemed to be of a purplish tinge and had a more gloomy aspect; the eastern sky was lighted up with a lurid glare, similar to that which sometimes attends an autumnal sunset. I noticed several pink colored protuberances on the apparent right hand limb of the Sun, and one very large one on the lower limb. Like the corona they seemed to be devoid of life. The darkness was so great that it was impossible to distinguish the foliage of trees, a few rods distant, they being visible as dark bodies the outlines of which were projected on the sky. At a distance of about one foot and a half, I was unable to read the names of the planets upon the chart; on referring to it I find they are of this size: -

Venus Mars Mercury.

During the totality I felt quite uncomfortably cold, and was at first very much surprised on finding

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that the mercury has fallen but five degrees. I recollected however that as I had been fully exposed to the sun, in a place where the radiation was very great, it was quite probable that I had experienced a change of temperature which would have caused a thermometer to fall thirty or forty degrees.

After having devoted about two minutes to observations of the general phenomena, I again sat down at the instrument and began to watch for the reappearance of the sun. The edge of the moon surrounding the point at which the emersion was to take place, gradually became brighter and brighter until a single ray of sun light burst forth and a break having been made with the key, the observation of the last interior contact was accomplished.

Some after the reappearance of the sun, my attention was attracted to bright points of light which were from time to time passing across the field. After observing fifteen or twenty of them I concluded: — That they passed between the earth and the dark body of the moon; that they always fell in the same direction, which was from the apparent upper limb of the moon to the horizon; that their paths were straight lines and parallel to each other; that one seen by Mr. A. G. Clark, Jr., through a telescope which was seven feet south and twenty feet east of my instrument, was also seen by myself; and that they were incandescent bodies. In size they were equal to the smallest stars visible through any telescope — about as large as a tenth or

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eleventh magnitude star appears to be in the Harvard Equatorial. As the sunlight increased these meteors ceased to be visible. As I was not looking through the telescope during the total phase I am unable to say whether or not they were then visible.

The time between the disappearance of the meteors and the last exterior contact being occupied in writing out notes, no observations of the emersions of the solar spots were attempted.

My work terminated with a very successful observation of the last exterior contact, which was not accompanied by any very striking phenomena. The limbs of the sun and moon showed no signs of distortion up to the instant at which they separated.

In the following table which contains the results of my observations of precision, the Chronometer Times are those which have been read directly from the Chronograph sheet; the Sun Sidereal have been deduced from the Chronometer Times by applying to the latter the Δt computed from time observations made with C.S. Transit No. 6, during the morning preceding, and the evening following, the eclipse.

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Phenomena	Chronometer Times	Sidereal Times	True Mean Times
Exit Ext. Contact	14h 25m 47.00s	13h 33m 55.86s	4h 28m 5.39
Spot a Exit edge	48 50.20	56 57.09	
Spot a Centre	49 5.60	57 14.49	
Spot a Last edge	14 49 15.19	13 57 24.08	
Spot b	15 5 30.68	14 13 39.60	
" c	6 59.46	15 8.38	
" d	8 22.20	16 31.12	
" e	9 39.69	17 48.61	
Exit Int. contact	24 28.81	32 37.75	5 26 37.67
Last " "	15 27 2.80	14 35 11.75	5 29 11.24
Last Ext. "	16 21 2.98	15 29 12.01	6 22 2.66

Duration of Totality 2m 34.00s

F. Blake Jr.

U. S. Coast Survey.

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2 Quincy Street, Cambridge, 1869 Aug. 20.

Professor Winlock, etc, etc.

Sir:

In accordance with your instructions, I have the following account of the observations made by me on August 7.

I was stationed at Bardstown, a small town in Kentucky some what South-West of the Central line of the total eclipse. The totality lasted somewhat longer at Louisville and Danville than it did at Bardstown. The appearances would have been the least at Louisville, and the roof of the Medical College in that City would have afforded a site absolutely free from the serious disadvantage of a crowd of spectators and where the observations would not have been affected by the smoke of the city. But inasmuch as the moon's centre would at the instant of totality be about eight seconds of arc more to the north-east of the sun, as seen at Bardstown than it would be as seen at Louisville, and three seconds of arc more in the direction as seen at Bardstown than it would be as seen at Danville, so that a solar protuberance which at Bardstown should be two or three

Danville was selected before leaving Cambridge on account of its being so near the central line if it should be thought best to separate the party. If I had been sure of clear weather at Shelbyville no other station near the central line would have been occupied.

In selecting Bardstown in preference to Danville, I was influenced mainly by its being more readily accessible. The objections

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minutes high, at Louisville or Danville lose several per cent. of this height, and inasmuch as Shelbyville, where the only other spectroscope in Kentucky (except Dr. Smith's at Bardstown) was to be set up, was so far to the north-east of the central line that it was supposed to be unwise to attempt in that locality to observe on any protuberance upon the south-west limb, Bardstown was selected by you as the proper place for my observations. My special business then, therefore, was to observe the spectrum of any protuberance which might appear upon the south-west limb of the Sun.

I was furnished with an elegant equatorial Telescope ∞ inches clear aperture and focal length. Upon opposite sides of the tube of this telescope and parallel to it, were fixed two brass rods, at the eye-end of the tube and reaching about a foot beyond it. Upon these rods was fixed the spectroscope, and in such a manner that the slit was plainly visible. I found this arrangement ~~of ~~ all that could

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to Louisville was the fear that the proximity of the river and the smoke of the city, might increase the probability of fog or cloudy weather. I knew Bardstown to be one of the pleasantest villages in the state, and Prof. Smith promised to look after the comfort of the party and proposed to observe with it. I made no estimate of the difference in the height of protuberances as seen from the different stations, and took no thought of it, other than that the appearance of a total eclipse might be somewhat different when seen from the central line than from a point as far away from it as Shelbyville. J. W

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be desired. With it, I had little need of a finder. Pieces of white paper were pasted upon the brass work of the slit, to receive the image of the sun, which during totality could not well have been seen upon the polished brass. There was some danger of detaching this paper in opening and closing the slit, and I therefore wished to change the width of the slit as few times as possible during totality. The spectroscope attached to my telescope contained a single flint glass prism and a five-prism direct vision spectroscope screwed in in place of its telescope. There were no means of measuring the positions of the lines. In order to bring different parts of the spectrum into view, it was necessary to unscrew a binding-screw which then left the somewhat heavy arm which carried the direct vision spectroscope entirely loose and then to move this arm with the hand and tighten up the screw. When this was done, the arm would fall a little and it was only by looking at the spectrum and estimating how much the arm would fall, was it possible to set upon any part of the spectrum. During totality there might be no light in the field, if one were to get off of a protuberance and therefore no means of knowing to what part of the spectrum if any the arm was set; if the slit was opened to give full light, the paper pasted on it might become detached and render it impossible to set on a protuberance. There was no clockwork on the telescope, and the observer was in continual apprehension of some disturbance in the crowd of

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mostly ignorant spectators, and therefore, an attempt to move this arm was a thing to be dreaded. On the other hand, it could be so set as to afford a view of the spectrum from its red extremity up to halfway between F and G. Under the circumstances, I would not venture to move it. If I had been alone and consequently at my case I should have done so.

My telescope was pointed for me by Mr. Shaler, the geologist, who generously relinquished his opportunity of witnessing the sublime phenomenon undisturbed, and offered his assistance in the astronomical observations. My telescope was therefore, managed for me with perfect skill and coolness.

Upon the morning of the 6th inst., I set up my instrument and searched for protuberances. I found only one which was upon the following side of the sun and was very yellow; — that is to say, the yellow line near D was relatively very bright in it. Indeed I could not see the F line at all.

On the morning of the 7th I examined the sun with greater care and noted several protuberances (which were afterwards plainly seen at totality) but none of these were so brilliant as the one which had been seen the day before continued to be; and this was now less high, extended over a larger arc on the disc of the sun, and was still more yellow than it had previously appeared.

At the instant of totality my telescope was pointed on this protuberance, and my slit was rather narrow. At that instant, the continuous spectrum vanished, and five lines,

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brilliantly colored, became visible. There were F, b, and the dimmer and broader line say one fourth of the distance from b to D, the well-known yellow line near D, and C. After observing the spectrum of this protuberance at different positions, I looked at the sun, and was pleased to find my conceptions of the shape and color of this protuberance entirely confirmed.

The same glance showed me upon the South-western limb of the sun (where my business chiefly lay) a well-marked rose-colored protuberance. I just observed the spectrum and the red protuberance on the Southern edges and then that of the one just mentioned. I found the spectra of the red protuberances to be alike; they differed from that of the yellow one only in the relative greater brilliancy of the red yellow and blue lines in the former, the faintest green being especially much fainter. I have no doubt, from my previous observations, that the yellow line was also less bright in the red protuberances, but it appeared so bright that I could not perceive ~~that~~ it was less bright than in the yellow protuberance

Mr Shaler then pointed for me in the corona, and I was just opening the slit to get more light when the sun burst forth and put an end to my observations. Two seconds more or a little more privacy would have enabled me to get it.

During the eclipse, the following miscellaneous observations were made by Mr Shaler and me.

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The protuberances were of two distinct kinds. One sort were low, long and yellow; the other high, short and red.

Mr Shaler saw the disk of the sun break into beads at the moment of totality. The appearance lasted only an instant, and seemed as if it were the effect of irregularities of the limb of the moon. About a month before, Mr. Shaler had observed on the limb of the moon, a serrated appearance occasioned by a range of mountains.

Mr Shaler observed that the corona formed a quadrangle with concave sides vertical and horizontal, the latter being the longest. He estimated its mean breadth at 1½ the diameter of the sun. He found that it did not fade gradually away but had a sharply defined edge.

Noticed the following points in reference to colors. While the eclipse was coming on, there was no change in the colors of the landscape or of peoples faces, but the light had a singular theatrical effect owing to the sharpness of the shadows. During totality, the light on the landscape was like the grey of twilight. The moon at this time was not black, but of a deep, dull and somewhat purplish blue, darker than the sky. Mr Shaler confirmed this. The sky was of a dark purplish blue. It was not lighter near the corona. The corona was quite white and not bluish. The yellow protuberances were greenish like the corona and intensely brilliant. The red ones had much the color of the light from Hydrogen in a Geisler tube. Upon the South

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and also (as Mr Shaler says) on the North was a salmon colored light upon the horizon reaching up some five degrees or more. Venus and Mercury looked as white as Vega ever looks.

Mr Shaler says, 'Little effect was visible on animated nature until the last five minutes before Totality, except that the cocks all began to crow, at several points, with the sleepy crow of early morning, and not the exultation of full day. The birds began to make their nesting-cries as the light rapidly waned. Cattle were evidently much alarmed and ran with tails up and heads west across the fields almost in a stampede. At the close of the eclipse, a hen was found with her chickens under her wings. Some months old chickens were seen within ten minutes of the total eclipse quietly feeding. They then disappeared. The crowd was placed at the request of the observers beyond a fence distant about thirty feet from the telescope. At the moment of Totality a hollow sound half of fear, half of admiration, called attention to their faces with dropped jaws and look of horror which were turned towards the wreck of the sun. There is no doubt that exceeding fear took possession of the whole people. The many who were present slipped away quietly; the few who stayed after totality seemed singularly quiet, evidently recovering from a considerable mental shock.

All which is respectfully submitted

Charles S. Peirce.

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Memorandum by Arthur Searle of work done at Falmouth, Kentucky, on August 6 and 7, 1869, with reference to observations of the solar eclipse.

The instruments taken to Falmouth were the Lembones telescope from Harvard College Observatory; the Dollond telescope from St. Pauls church, New York: a pendulum regulated to beat seconds and provided with a break-circuit attachment: two Morse telegraphic registers and reels: three break-circuit keys: and a stop-watch. A second stop-watch meant for the Falmouth station was forgotten and left at Shelbyville.

My instructions were to observe personally the duration of the total phase by means of one of the Morse registers (provided the electrical apparatus could be brought into action before the eclipse), observing the disappearance of the sun with a telescope, its reappearance with the naked eye, and not attempting any estimate of the time by ear, but confining my attention to giving the electrical signals as accurately as possible: to have an observation taken by Mr. West, the Falmouth telegraph operator, of the duration of the total phase, with the office register, by similar signals: and to assign work to any volunteer observers according to my judgment.

I reached Falmouth about 10 A.M. Falmouth time, on August 6. On inquiry, nothing could be heard of Mr Roy, who had been thought likely to be found in Falmouth, and available as an observer: but two gentlemen, Capt. W.C.

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Croze and Capt. W. E. Arnold both civil engineers, kindly volunteered their services which proved of very great value.

Mr. West had received instructions with respect to the proposed observations, and furnished me with every facility for carrying out the plans which had been formed.

The short time remaining before the eclipse made it necessary that the station for the observations should be placed near the telegraph office, in order that Mr. West might have time to make the arrangements required without neglecting his regular business. Leave was therefore at once requested and obtained from the owner of the field on the opposite side of the railroad to erect a small stand there. The stand was put up in the course of the afternoon, an upright case being attached to one end of it for the pendulum, which required protection from the wind and weather as well as from intelligence by bystanders. The boards enclosing it, on one side were fastened by screws, so that it was easily got at when desired. It was set up and partially adjusted before night, but as the workman who was to make a loop in the telegraph line could not do so till morning, it was taken down, and replaced in its box.

Mr. West received the materials for a local battery towards night, and during the evening he continued the connections required for working the three registers with the pendulum and break circuit keys, making a diagram of the positions of the wires, so as to set them up readily the

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next day.

Early on August 7 a loop in the telegraph line was brought to the stand; but Mr. West's regular occupations prevented him from getting the local battery and wire connections set up until near noon; and then the control of the line could not be had for the purpose of experimenting with the pendulum. Shortly before the eclipse, the pendulum was adjusted so far as possible. Its beat seemed somewhat longer than desirable, but further experiments were interrupted by messages upon the line, and soon after by the pendulum from Oakland, which was found to work satisfactorily. Mr. West did not succeed in getting control of the line again for any further adjustment of the Falmouth pendulum, which, as it happened, was not needed, the Oakland pendulum continuing to beat the circuit regularly.

Meanwhile, Messrs. Croze and Arnold had collected several other gentlemen willing to assist in the observations. The telescopes had been placed on the stand early in the afternoon, and the registers and keys were in position, and were found to work promptly. Capt. Croze undertook to use one of the telescopes in connection with the third register. To prevent irregularities in the running of the registers, I had requested Mr. West to provide an assistant for each to keep them working properly; and he assigned this duty to his two subordinates, who were

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used to the management of telegraphic apparatus.
Mr. West managed his own register himself and observed without a telescope. I took the Leuhmus glass, and gave Capt. Crozet the Dolland.

By way of practice, Capt. Crozet and Mr West several times took the interval between signals, given as described hereafter, with their keys and registers and found no difficulty on any occasion in obtaining legible and closely agreeing results. But the observations of the total phase of the eclipse by this method proved almost a complete failure. Mr. West's register seems to have run well, but no signal for the reappearance of the sun can be found on the fillet. The signal may perhaps be coincident with one of the breaks of the Rendulums. Capt. Crozet's register ran very irregularly, as the fillet seems to show, and although it is probable that all the signals are recorded, it is doubtful whether their places can be clearly ascertained. He thinks he gave one tap only for the disappearance of the sun, and for its reappearance (observed with the naked eye) two taps, the second of which is to be preferred. The fillet of my own register was broken, the register stopped, and not started again, several seconds before the total phase began, and my taps, which I think were given as accurately as any I am in the habit of giving on the chronograph key, were not recorded. I did not discover this, of course, until after the total

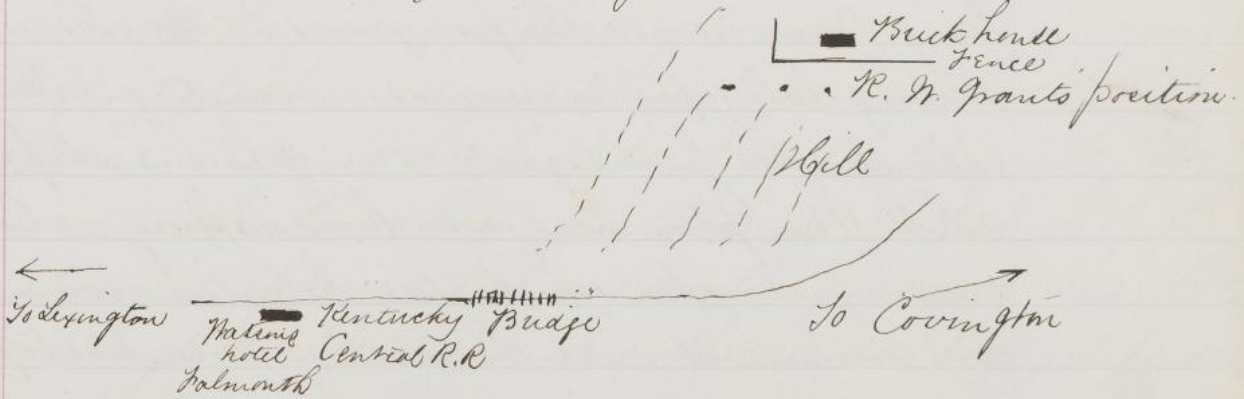
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phase was over, when on inquiry for the electrical records, the facts just stated appeared. We must therefore depend chiefly upon the stop-watch, and upon a tally observation by Capt. Arnold.

The stop-watch had been placed in charge of Mr. R. N. Grant, whom I directed to station himself upon a hill towards Covington, just beyond the railroad bridge, both to obtain an observation near the border of the shadow, and to lessen the chance of confusion, and of interference with the observers by bystanders.

Before leaving the stand, Mr. Grant repeatedly took the interval between signals which I gave him from some distance, with my eye upon my own watch. His results uniformly agreed with mine to the fifth of a second, and I believe his observation to be a very good one. Mr. W. Clarke has promised to see that the place where Mr. Grant stood, is marked by a stake; but it is already indicated by the most northerly of three stumps on the hill close to which he stood. This stump may perhaps be two rods from the fence near it.



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The duration of the total phase at the Grants Station, was (41.6) forty-one and six tenths seconds, as indicated by the stop watch. This observation is confirmed by Judge Hudnall, who took the time by his own watch at the same station, and found it to be 41 seconds, and some fraction (he thought a small one) of another second.

I was fortunate enough to obtain the aid of two gentlemen, Messrs. B. Johnson and D. Yelton, who consented to give up seeing the total phase of the eclipse for the purpose of recording by tally an observation undertaken by Capt. Arnold, at the Stand. The preliminary drill for this observation was as follows. The tallymen were seated facing Capt. Arnold, and at some distance behind them. Signals were given by Mr. Scott, by smartly raising one piece of pasteboard from behind another. Capt. Arnold repeated these signals to the tallymen by rapid gestures of his hand. As the telegraph line was in use for messages when we began our experiments, I counted seconds from my watch for the tally. Both tallymen began recording at the same second, the mark for every fifth second being drawn across the four preceding marks, as usual in keeping tally, for convenience in counting. On receiving Capt. Arnold's first signal, Mr. Johnson stopped his tally while Mr. Yelton went on with his, stopping at Capt. Arnold's next signal, upon which Mr. Johnson resumed his tally, and continued it until the word was given to stop.

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The whole number of seconds counted from the watch served as a check for the accuracy of the work, which became correct almost every time. Meanwhile, Judge Lee, and Mr. C. A. Vandeloh, endeavored to estimate the fractional part of a second, at which Mr. Scott gave his signals, and their results agreed well together. As soon as the Oakland pendulum could be replaced on the line, the click of the magnet was substituted for my count of seconds; Capt. Crozer and Mr. West began observing and recording Mr. Scott's signals with their registers, as above stated; and I observed by eye and ear. Mr Vandeloh's estimate of fractional parts of seconds agreed well with mine; that the tally record agreed with my silent count of whole seconds; and that both the three registers confirmed these observations. I desired not to fatigue the observers by too frequent a repetition of this work immediately before the total phase; and as the eclipse was already far advanced, I satisfied myself with a few repetitions of the experiment. It was unfortunate that, just as the total phase was about to begin, the train from Lexington drew up at the Station, remained there during the totality, with the passengers shouting, screaming, laughing and talking all the time, and started again as the sun reappeared. Hearing this hubbub, I gave up my tally observations for lost; but after learning the failure of the electrical apparatus, I was doubly pleased to find that although Mr. Yelton, on whom the result chiefly depended,

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had found it very difficult to hear the magnet, and was therefore not so sure of the correctness of his work as he would otherwise have been, there was still very little doubt that by Capt. Arnold's observation the total phase has lasted (45) forty-five seconds. Judge Lee and Mr Vandeloher had been unable to hear the magnet sufficiently well to estimate the fractional parts of seconds, but in any case, some doubt must have existed as to this part of the observation, unless I had asked these gentlemen also to give up during the total phase, and to look only to Capt. Arnold's signals. Capt Arnold himself had considered that it would be safest to confine his attention to giving his signals correctly, and not to attempt to estimate the fraction of a second at which he gave them. He is inclined to think, however, that the interval was really an exact number of seconds, and that if not 45 seconds exactly, it should be considered a little less rather than at all beyond that time.

His observation is confirmed by one taken independently by Mr Woodson, with his own watch, and assisted by a friend upon the platform of the railroad station. Mr Woodson found the duration of the total phase to differ very little, if at all from 45 seconds.

I learn also that Mr. Knight observing from the hotel and that Mr Johnson (father of our Tallyman) observing from his house, somewhat S. E. of the hotel, obtained the

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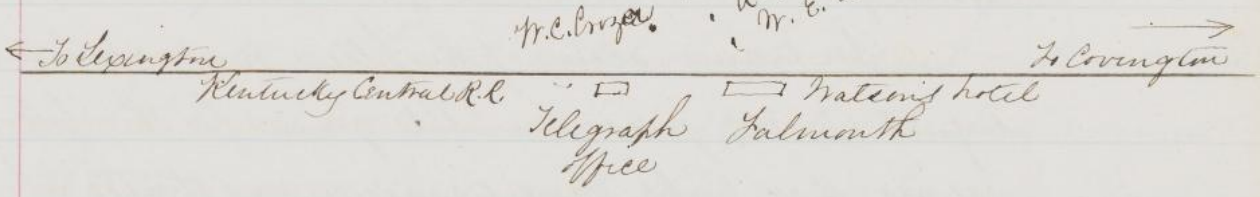
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same result. But as I have not seen these gentlemen, some doubt may exist as to the accuracy of the reports given me of their observations, or of the entire independence of the observations themselves.

The positions of the principal observers are marked by stakes, thus —

The stakes are from two to five feet apart.

The diagram exaggerates their distance



Mr. D. Crozier, Jr. of Catamba, about four and a half miles from Falmouth, informs me that he observed the duration of the total phase at that place to be (12) twelve seconds. His father noted the time with his own watch. Mr Crozier promises to have a Stake set at once where he stood to make this observation.

Two points are reported where the eclipse seemed just to fail of totality: one is John Johnson's house, above Antioch meeting-house, about six miles east of Falmouth: the other is a place known to Mr. A. R. Clarke, about seven miles from Falmouth; but these observations are probably not accurate enough to be of service.

The daily record will be serviceable not only in de-

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nedly exhibiting the length of the total phase, but also in deciphering the fillets from the Mowe regulator; for Mr West thinks that the three regulators were all started very nearly at the same instant; and I gave the signal for the tallymen to begin their record a few seconds after directing the regulators to be started. Mr Johnson's tally comprises 180 seconds; Mr Yeltons 225, with one additional mark, which he is certain he made after Capt. Arnolds signal for the reappearance of the Sun.

An examination of the fillets, made at Cambridge, August 17, 1869, gives some little ground for the following conjectures: that Capt. Crozier's regulator was started about five seconds before Mr. West's; (or that a few marks on Capt. Crozier's fillet belong to one of the previous experiments) that Mr. West's first break failed to be recorded, or coincides with a beat of the pendulum: that about 34 seconds after Capt. Crozier's first break, his regulator began running slow, and two seconds later became almost stationary, and continued so for some three seconds: that it was then started with a jerk which caused the next three or four seconds to be recorded irregularly and in a broken manner: that the first of the two breaks supposed to have been given by Capt. Crozier for the Sun's reappearance was given with hesitation, and appears as two very short breaks upon the fillet: and finally, as the results of the preceding conjectures, that Mr. West's observation

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would make the length of the total phase only about 44.4 seconds, and Capt. Crozet's observations 44.6 seconds. But it is doubtful whether this conjectural result deserves any further consideration.

The stop watch used at Falmouth was compared with the East Clock at Harvard College Observatory, August 20, 1869. and found to gain on that clock (G) two seconds in thirty eight (38) minutes. The clock gained about (0.s02) two hundredths of a second in the same time, if running at its ordinary rate. The stop-watch therefore gains on true mean time 0.s053 in one minute or 0.s038 in two thirds of a minute. This rate agrees closely with that given by G. M. Searle (0.s03 for the duration of the total phase as observed by the stop watch at Falmouth) from comparisons of the same stop watch made by him in New York before the eclipse.

The remaining observations at Falmouth were as follows. The time given is that of my watch (near New York time) Below are comparisons of this watch with chronometer Brodsham 3451, at Shelbyville and with G. M. Searle's watch, which last was fast of Shelbyville mean time $4^m 25^s$ at $11^h 39^m$ P. M. Aug. 5, (or $23^h 39^m$ Aug. 4. astronomical mean time) with a losing rate of 39.1 seconds for that day.

1869 August 5	Brodsham 3451	$11^h 16^m 0^s$
	Watch (A Searle)	2 12 1
1869 August 5	G. M. Searle	$2^h 20^m 0^s$
	A. Searle	3 1 13

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1869 August 5.	J. M. Searle	$3^h\ 52^m\ 0^s.0$
	A. Searle	$4\ 33\ 19.8$
1869 August 5 (astronomical)	J. M. Searle	$18^h\ 57^m\ 53^s.0$
	A. Searle	$19\ 40\ 50.2$
1869 August 6	J. M. Searle	$4^h\ 49^m\ 3^s.3$
	A. Searle	$5\ 22\ 50.0$

Capt. Crozet used the Dollond telescope with a power of 25, throughout the eclipse (except for the reappearance of the Sun.) & used the Lerebours glass (with the same exception as already noted)

Both telescopes had their apertures reduced to about $\frac{3}{4}$ inches by pasteboard caps, until near the total phase. After the total phase, the cap was replaced on the Lerebours telescope, but not on the Dollond.

Eclipse began at $5^h\ 15^m\ 36^s$ (observed W. C. C.)

Light sensibly diminished upon landscape at $5^h\ 46^m$ (A. S.)

Preceding cusp suddenly blunted (soon recovering its sharpness) at $5^h\ 52^m\ 15^s$ (W. C. C.)

Preceding cusp very irregular and even serrated or forked, at the extremity, at $6^h\ 7^m\ 30^s$ (W. C. C. & A. S.)

Limb of the moon decidedly more irregular towards the preceding than towards the following cusp throughout the increase of the eclipse (W. C. C. & A. S.)

Reappearance of large group of spots near the point of the Sun's limb farthest from the Zenith at $6^h\ 30^m$ (W. C. C.)

Reappearance of two small spots, one about $\frac{1}{4}$ of the distance from the extremity of the preceding to that of the following

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cusp, the other about $\frac{3}{4}$ of the same distance, at $6^h\ 36^m\ 33^s$ (W.C.C.)

Group of spots near the following cusp towards the end of the eclipse (W.C.C.)

Eclipse ended at $7^h\ 9^m\ 50^s$ (W.C.C. and A.S.)

Mr. C.A. Wandelohr noted the beginning of the eclipse as apparent to the naked eye at $5^h\ 16^m$: the end of the total phase at $6^h\ 15^m\ 4^s$: the end of the eclipse at $7^h\ 9^m\ 4^s$.

Judge Kendall, at Mr. Grants' station, observed the end (2) of the total phase at $5^h\ 31\frac{1}{2}^m$ by his watch, which was 44^m slow of mine when compared with it at $6^h\ 36^m\ 45^s$

Nothing was seen of "Baily's beads," I believe, by any observer; but the cusp of the sun was broken into several irregular fragments a few seconds before the total phase, according to the observations of Capt. Craven and myself.

During the total phase, no observer used a telescope. A somewhat doubtful observation of red prominences was made to the south of the principal station by Messrs. C.B. Wandelohr and P.F. Bonar, who report that they thought they saw one large prominence on the upper limit of the sun and three smaller ones to the left. Mrs. Arnold saw a "star" under the moon (probably the large protuberance observed there at other stations.)

The corona seems to have presented much the same appearances to all observers, allowing for differences of description. It closely resembled the best published engravings

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of this phenomenon, as I saw it, but no special peculiarities were noticed in it.

Messrs. W. W. Ireland, A. R. Clarke, and W. G. Cooper, and Dr Barlow observed for stars visible during totality; and their observers also reported on the same subject. Their small maps of stars near the sun were used. There seems to be no doubt that Mercury, Venus and Regulus were all visible during the total phase.

Mr. W. G. Cooper describes Regulus as very brilliant, in a written report which I received from him; but the star may have been easily confounded with Venus. Arcturus, Vega and Saturn were distinctly seen by various observers.

Mrs. Murphy saw two meteors during the total phase. The first was traced from a point near the meridian and not far from the zenith towards the southeast: the course of the second was from the northwestern to the southwestern part of the sky.

Mrs. Arnold reports the usual phenomenon of fowls coming to rest during the eclipse.

The diminution of light was not at any time very great. A lantern had been provided for the tally men, but I believe no use was made of it, and the darkness seemed only about equal to what is usual a minute or two after a clear Sunset.

The shadow of the moon was noticed, I understand, by some observers towards the north, but does not seem to have been regarded as a striking phenomenon. The driver of the stage between Eminence and Shelbyville says that it appeared to him no

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more distinct or dark than an ordinary cloud shadow.)

Mr. H. J. Cooper describes the atmospheric effects and the limits of the landscape, as presenting a very beautiful and interesting spectacle.

Mrs. Arnold compared the appearance of the landscape after the total phase to that presenting itself to a spectator just coming out of the Mammoth Cave.

The whole day was unusually bright and clear for the season.

Results of Observations

Duration of total phase at Falmouth station, 45 seconds.
" " " " " on hill N. of Falmouth 41.6 "
" " " " " Catawba 12.0 "

Beginning of eclipse at Falmouth station $5^h\ 15^m\ 38^s$ (by watch of A. Searle)
End of total phase " " " $6^h\ 15^m\ 4^s$ (Same watch)
End of eclipse " " " $7^h\ 9^m\ 50^s$ — " —

Baily's beads not seen. Prominences visible to the naked eye on the upper and lower limbs of the sun (and perhaps on the southern side).

Mercury, Venus, Regulus, Arcturus, Vega and Saturn visible during total phase.

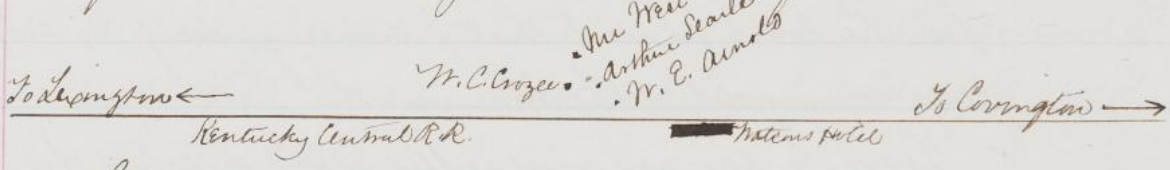
Two meteors during the total phase: point of divergence probably in the north west.

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Results of Falmouth Observations, Aug. 7, 1869

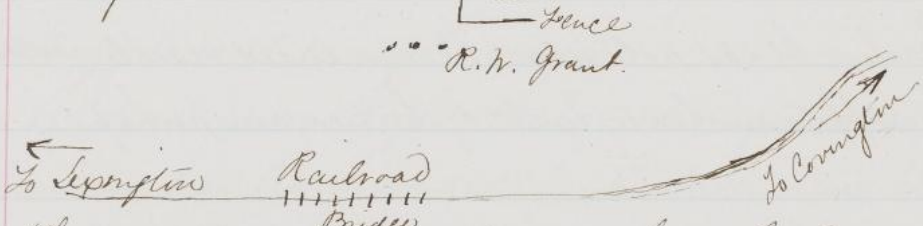
Duration of total phase at Falmouth Station, (45) forty five seconds. This observation was made by Capt. W. E. Arnold of Falmouth, assisted by two Pallymen, Messrs. D. Johnson and D. Yelton. Position of observer marked by a stake: thus:—



The intervals between the stakes vary from two to five feet. Capt. Arnold thinks the time rather less than in excess of 45 seconds.)

Duration of total phase on the first hill to the north of Falmouth Station, beyond the railroad bridge and west of the railroad (41.6) forty one and six tenths seconds. This observation was made with a stop watch by Mr. R. W. Grant.

His position is to be accurately marked by a stake. It is already tolerably well marked by the northernmost of three stumps on the hill.



The stumps may be perhaps two rods from the fence.

Duration of total phase at Catawba (12) twelve seconds. This observation was made by Mr. D. Crozer, Jr. and timed with an ordinary watch by his father. Mr. D. Crozer, Jr. promises to mark his position at once by a stake.

The observation at Falmouth Station is confirmed by

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one made on the platform, close by Mr. Arnold's position, by Mr. Woodson, assisted by a friend, with an ordinary watch. Mr Woodson thinks the total phase lasted just (45) forty five seconds.

Mr Grants observation is confirmed by Judge Kendall, with an ordinary watch, at the same station. He makes the duration of the total phase (41) forty one seconds, and some fraction (he thinks a small one) of the next second.

No results were obtained from the observations attempted with the Moon registers.

Time of eclipse observations, reduced to that of watch carried by Arthur Searle (keeping New York time approximately)

Beginning of eclipse observed by Capt. W. C. Crozer with Dolland telescope, aperture reduced to about $0\frac{3}{4}$ inches power 35

$5^h 15^m 36^s$

Light decidedly diminished at $5^h 46^m$

Preceding cusp of sun distinctly but temporarily blunted at $5^h 52^m 15^s$ [observer W. C. C. with instrument as before]

Preceding cusp decidedly irregular at extremity and even serrated or forked at $6^h 7^m 30^s$

Observed W. C. C. and A. S. the latter with Lerebours telescope.

Reappearance of sun $6^h 15^m 4^s$ observed from near Capt. Crozer's position by Mr. C. A. Mandeloh.

Reappearance of large group of spots near lowest point of sun's limb at $6^h 30^m$. Observer W. C. C., Dollond telescope, full aperture, power 25.

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Watch Compaisons

1869 August 5, Chron. Bodsham 3451		Watch G.M. Seale.
civil time	$9^h\ 28^m\ 30^s$	$11^h\ 43^m$ a.m $46^s.5$
1869 August 7.	$8^h\ 32^m\ 30^s$	$10^h\ 38^m\ 54^s.5$
8	$7^h\ 0\ 0$	$9\ 2\ 8.0$
9	$9^h\ 21\ 0$	$11\ 18\ 6.0$

Results: watch fast $4^m\ 25^s$ 1st Compaisons

$3^m\ 8^s$

$2^m\ 32^s$

$1^m\ 48^s$

1869 August 5 Chron. Bodsham 3451 $11^h\ 16^m\ 0^s$ Watch (A. Seale) $2^h\ 12^m\ 1^s$

Watches of G. M. Seale and A. Seale [Note. Watch of A.

1869 august 5	$2^h\ 20^m\ 0^s$	$3^h\ 1^m\ 13^s.0$ [Seale, probably fast
	$3^h\ 52^m\ 0^s$	$4^h\ 33^h\ 19^s.8$ [Tolerably well until
Aug. 5 [astronomical / mean time]	$18^h\ 57^m\ 53^s$	$19^h\ 40^m\ 50^s.2$ [Round up at $5\frac{1}{2}$ a.m
cr 6	$4^h\ 49^m\ 3^s.3$	$5^h\ 22^m\ 50^s.0$ [Aug. 9. for 6 as shewn by the watch

---

1869. Aug. 9.	$7^h\ 10^m\ 27^s$	$7^h\ 56^m\ 0^s$
	$9\ 10\ 50$	$9^h\ 56\ 10$

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Prof. C. S. Seymour's report.

Aug. 7th 1869.

Immediately before the eclipse seven spots were visible. My watch was not very accurate, so that the times are only approximate.

Spot 2 was large and circular about 135° from the north point and distant half a semi-diameter from the centre.

Spot 1 almost due north of spot 2, about 120° from the north point, quite moderate in size.

Spot 3 about 288° from the north point, not far from the centre, small.

Spot 4 about the same angular distance, and twice as far from the centre.

Spots 5 and 6 were together and about 3 times as far from the centre as spot 3, and very small, about 280° from north point thus ⁄ 3 4 5 6 ⁄

Spot 7 about 286° from north point a longish oval about one eighth of semi-diameter from edge of sun.

At 4h 27m 45s the contact was in a little distance. I failed to see the instant of contact.

4h	49m	0s	Spot 1 disappeared
4	51	3	centre of spot 2 was covered
5	7	30	Spot 3 disappeared
5	8	0	Spot 4 "
5	9	50	Spot 5 "
	10	11	Spot 6 "
	24	30	Centre of Spot 7 "
5	26	20	beginning of total Phase: beads appeared

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on edge of shadow.

5h 28m 50s Total phase just ended; failed to see the instant of end; beads breaking up when just seen.

During the total phase, a kind of luminous irregular twinkling was observed in the dark bay on the paper extending about 45° each side the north point; saw no protuberances on the paper.

On raising my eyes to the sun, I saw a red protuberance near the north point, and a large one almost vertically below the sun's centre. Saw Mercury and Venus with the eye. An irregular corona surrounded the sun at totality.

5 41 55 centre of spot 2 reappeared

5 42 0 Spot 1 reappeared

6 4 0 I observed a spot from which the moon's shadow had just passed about 225° from the north point; this I style spot 8. I had not observed it before.

6 5 0 Moon's shadow had just passed spot 3.

6 5 40 Spot 4 reappeared.

6 6 45 Spot 5 reappeared

6 7 15 Moon's shadow has just passed spot 6.

6 18 15 Centre of spot 7 appeared.

6 23 43 Last contact observed.

As nearly as I could approximate, the moon's shadow obscured the sun's centre at 4h 59m 0s and left it at 5h 56m.

But these observations of the centre are only rudely approximate.

These observations were made upon the image of the sun's disk cast through a telescope upon a sheet of paper, on

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which was a circle divided into octants: the lines in the telescope cast a shadow falling exactly on the lines on the face dividing the octant.

C. B. Seymour.

Dear Sir:

On the 3d of August, I left Louisville with Mr. Graham Wilder, arriving at Oakland, the same day. It is a Station on the Louisville & Nashville Road, with only one or two houses in the vicinity, and no telegraph office within ten miles.

No buildings be accessible near the track, I had two small sheds, each about 8 ft. by 10, moved into the field bordering the Rail-road to a site which commanded a fair view Westward. No entirely satisfactory site was procurable. We made these sheds water tight as far as we could, and by Thursday evening (the 5th) had mounted in them the instruments.

These consisted of a C. Survey Zenith Telescope, loaned by Mr. Dean which I mounted, but unfortunately could not use, both the nights of the 5th and 6th being rainy; of a Chronograph and a Telescope of about 3 in. aperture which I brought from Pittsburgh, of a Morse register and a pendulum, beating sidereal seconds, with a stop watch, and the necessary batteries etc.

Mr. Wilder brought with him a good pocket chronometer, made by Riardon of London, but we were without the local time.

All these except the Zenith Telescope were placed in the shed looking West, the Site of which is carefully marked, and

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described in a memorandum placed in the charge of the Coast Survey.

The telegraph operator, Mr. De Bric, arrived Friday afternoon and connected one station with the main lines.

The spare time was occupied in practising the Observers, by noting the times between various signals made at irregular intervals for the purpose, and in trying to procure and instruct amateur Observers in noting times by their watches, the latter with poor success.

On the afternoon of the 7th, one isolated station was the resort of all the inhabitants of the adjoining country, white and black, who crowded around the shed, interrupted the view, and proved a great annoyance.

A special train from Bowling Green, brought since hundreds more who arrived upon the ground and within the enclosure, just before totality, very opportunely, with a brass band.

Our arrangements were as follows.

The pendulum broke the circuit, on the Chronograph, Morse Register, and Main line. I observed immediately in front of the shed, using the telescope of say 3 in. 30 diameters, magnifying power, recording on the Chronograph. Mr Wilder near me used a good field glass, and the Morse Register. Mr De Bric naked eye and Register, the latter being instructed to count the beats audibly, between internal contacts, as a safeguard in case the register failed.

We were expecting about 30 seconds totality from the presumed latitude of Oakland. The phenomenon of the Baily's

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Beads was so unusually protracted as to prepare me for the conclusion that we were much nearer the edge than I had expected, but the almost instantaneous reappearance of the light took me by surprise.

All the records of our observations were placed in charge of Mr Dean, by me, when I left Somerville and I take the following figures from memory. —

S. P. Langley (from Chronograph)	duration of totality	1.s75
G. Wilder (from Morse Tellet)	" " "	2.s05
— De Brie	" " " " "	" (conjectured) 1.s

I saw the light dwindle to a star like speck, which hung on the limb about a second after the rest went out, (and which was due, as I conjecture from its distinctive appearance to a lunar cleft.) as this was disappearing I struck the key and removed my eye from the telescope, but saw an almost simultaneous burst of light from the sun, and signalled again, after looking once more through the instrument.

I have no doubt, that in my case, the 1.s75 is a sufficiently large estimate.

Mr. Wilder who like myself was expecting a longer interval, is satisfied that his (2.s05) is too large. Mr De Brie struck once coincidently with Mr. Wilder, and as he says, had no time to strike again, before the sun reappeared.

If under these circumstances, it be permitted, as I think it may, to correct the record from one's impressions noted at the time, I should say that there was an instant of undoubted

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totality, lasting perhaps one second, but not in any case more, and that the only circumstance affecting the estimation which might increase it, was that the light apparently shone, as I have stated, through a lunar cleft, for an instant, after the limb, properly speaking, had covered the sun.

In view of this, I think that the time totality lasted not less than $^{s}.5$ nor more than 2^{s}. and that a mean of these times should be taken on the basis of computation.

It is evident that we were placed almost precisely on the edge of the shadow, and in further confirmation of this, a reliable observer, Mr. Strange, who, at my request, stationed himself at the house of Luther Carpenter, described as near the Rail-road, two miles West and half a mile South, found the eclipse partial only, the light being too dazzlingly bright to gaze fixedly on, even at the greatest obscuration.

I have been thus prolix in describing the circumstances under which the contacts were noted, as we were fortunate in being nearer the edge of the shadow than we could have designedly ventured, and it may be hoped, successful in fixing its limit with precision. If this be the case, I shall feel in a large measure, compensated for the loss of a view of the general phenomena of the eclipse: of which I saw necessarily little. I omitted to state that all the contacts were similarly recorded, on the Chronograph and reduced to the time by the Riardon Watch.

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I had a light darkening glass, before my eye, through which I noted what follows, in the very brief time presented.

On the left, or Eastern limb of the Sun (with direct vision) were three prominent flames. The upper about 55° from the vertex was larger, more diffuse, softer in outline and pale in color, than the two lower, suggesting a different constitution (?). Of these two the lower was about 10° above the last point where the light lingered. A group of prominences, low and prolonged, seemed to be on the right of the sun. The Corona was very notably different from my anticipations, being, visible through the darkening glass as a halo close to the Sun, whence radiated, a number of brushes of pale light, some about the Solar diameter (perhaps less) in length, not noticeably curved, and suggesting at the time a comparison with the Auroral Streamers; though by this I do not mean to necessarily imply apparent motion. In one particular I was fortunate as a spectator.

The "Baily's Beads" so called, were seen for 15 seconds or more. They were long and thin, rather than points of light, apparently moved with the moon, "went out" very much like sparks upon the edge of a piece of rough paper, and if a very deliberate view, where there were lenses, enables me to form any confident opinion, I should say were unquestionably the effect of the inequalities of the moon's outline exaggerated by irradiation; at least they presented precisely the appearance we might expect this to cause.

I am, Sir
Very Resp[t] Yours.
S. P. Langley

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Shellyville, S, Aug, 1869.

My Dear Sir:

Through the glass you so kindly furnished me I was enabled to view the Corona which shot forth most beautiful rays of light, in height perhaps = 1/3 diameter of the moon

I noticed three red flames the most brilliant was on the upper edge, and appeared like a jet of molten metal — its height was not equal to 1/10th of the diameter of the moon — it may have been more than 1/20th — just before the totality, I looked for the Baily Beads, but did not recognize them — the limb of the sun lost however its clean cut appearance, and seemed like strata irregularly superimposed — this however might be a defect of vision — certainly I did not see any resemblance to beads — At the time of totality, it was quite easy to read fine print at half the distance required in day light. It required close attention to read the second hand of my watch — The gloomy aspect of the heavens cannot be compared with any appearances we are accustomed daily to witness.

Mercury and Venus and some of the fixed stars were brilliant, and added much to the beauty and grandeur of the scene —

Thanking you for the very great pleasure we have enjoyed

I remain

Your friend

J J Bowditch

Prof. Newlock.

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Shelbyville, 8 Augt 1869

My Dear Sir,

In reply to your enquiry, I have to say that I observed the total eclipse yesterday chiefly through one of Clark's admirable navy glasses, of two inch aperture, fixed upon a firm post on the top of the college building, and occasional glances with the naked eye.

With the naked eye, the corona appeared like a ring of great brilliancy, encircling the moon, gradually decreasing in brightness, with its distance from the edge of the moon, and fading away so as to be lost at about the distance of half a diameter. In brilliancy it exceeded that of a full moon, and its appearance was just what would have suggested to early observers, an extensive atmosphere to the moon, illuminated in proportion to its density.

But through the glass, to which I gave most attention, the appearances were very different. The corona spread widely in rays of very unequal length, the longest of which certainly extended more than a diameter from the moon. My daughter who was observing with Lincoln's Comet Seeker, says a diameter and a half. These rays generally diverged from the common centre of the moon, though there were some deflections. They were thrown out in four great pencils or cones of irregular size, connected by shorter rays - forming a continuous halo of rays. The largest was on the upper left hand limb.

Along the edge of the moon, numerous tongues and

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beads of intense concentrated light were distributed, but my attention was so much occupied by the corona, and one of these tongues, that I am unable to depict them particularly. This one, which exceeded all others in size and brilliancy, was almost exactly on the lower limit of the moon, and resembled a fountain of molten metal, rising in the centre to a height of about 1/20 of a diameter, and flowing over on each side in the form of two arches. It was of an intense white light like that of Sirius.

As the moon passed over the disk of the Sun, I noted the time of its contact with several spots, the record of which I enclose, though I presume you have them more accurately taken with the larger glass.

I cannot close this, without expressing my very cordial thanks for all the kindness you have extended to us by which we have been able to witness this most interesting phenomenon to so much advantage; and to the good people of Shelbyville who have so courteously attended you; and congratulating you on the rare opportunity which a kind Providence has extended to us.

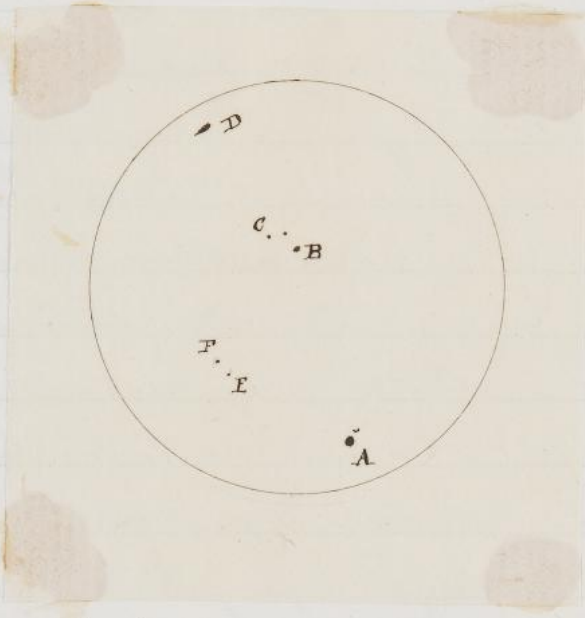
Very truly Yours

J. J. Daniell

Prof. Joseph Winlock

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Contact with Spot A	5. 46. 25
A entirely obscured	5. 47. 08
Contact with B	6. 03. 15
" " C	6 05 47
" " F	6. 07. 10
" " D	6. 20 05
A reappears	6. 35. 30
A entirely uncovered	6. 35. 58
D reappears	7. 13. 35

This is the time of my watch, set to Boston time, which according to Mr. Dean, as corrected this morning is 53' 33 fast of Shelbyville.

7th Aug. 1869.

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Cambridgeport, Aug 21st 1869

When arangements were being made for observing the total eclipse of the Sun, Aug. 7th 1869, I was invited by Prof. Winlock, to join his party, and assist them in their work.

For this purpose I arrived at Shellyville Kentucky, Aug 2nd. The time previous to the eclipse, was employed in setting up and adjusting the instruments which were to be used.

Prof. Winlock had attached to the Munich equatorial of 7½ inches aperture belonging to the Shellyville College, his spectroscope for observing the protuberances, and the finder of the instrument was assigned to me, we having previously adjusted it, so that the cross lines would very accurately coincide with the slit of the spectroscope. After the first contact, which I had the good fortune to detect at the instant, nothing of especial interest followed, till the sun was about half covered.

At this point, Prof. Winlock, while looking through the finder which I had relinquished for an instant, discovered numerous small objects crossing the field of the telescope in straight lines, which he called meteors; he called my attention to them, and I saw them distinctly, and observed about twenty.

I have listened with interest to the various surmises as to what they were, as it has been suggested by some one of our party, that they were insects in the air, but this seems improbable to me, for has they been insects, some of them would have crossed the field in curved lines, and it is my belief that they were meteors.

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I had entertained some fear that the light might be insufficient during totality, to enable me to see the cross lines, and asked the opinion of others, and we came to the conclusion that the corona would illuminate them sufficiently, but on the instant that the Sun was obscured the lines were lost to view; upon mentioning the fact to the Professor, he responded quick as thought, "take off the cap"; accordingly the dark glass was removed, and all was right, and I had a fine view without harm to my eyes with 1½ inch of aperture.

I observed radial lines in the largest protuberance which was situated near the base of the Sun, and to which my attention was mostly devoted.

On the side, were two or more horn like protuberances, which extended twice the distance beyond any of the others.

The number, strength and location of the protuberances, as well as the inequalities of the corona, are admirably given in a fine photograph executed by Whipple of Boston, at Shelbyville, while the eclipse was total.

The instrument used was an equatorial telescope, 5¼ inches aperture, West focus, manufactured by Clark & Sons, and supplied with a good driving clock regulated by Bond's Spring governor. No drawing, painting or description in words could answer the purpose of this photograph.

Alvan G. Clark.

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Caldwell, Warren Co. N.Y. 1869 Aug 17.

Dear Sir;

I send ym the following note of my obsevations during the eclipse.

My measurement of its duration by the stop-watch was 2m 34.s 0 but I am not inclined to give any weight whatever to this, being of the opinion that both beginning and end were observed several seconds too late, my attention being distracted by watching the movement of the shadow. This I saw immediately before the totality as a dark-red tinge on the low haze or thick air, in the north-western horizon; shortly before the end its limits were plainly visible on the sky, the boundary between the dark and light being about thus



About a minute or so before the totality I saw the complete disc of the moon, with the incipient corona in the form of short brushes of light perpendicular to the limb, and about 2' or 3' in length apparently equably distributed. I do not notice whether these increased in length before the total obscuration, and am not sure whether I saw them with the naked eye or opera-glass. This last was a binocular marine glass furnished by Asst. G. W. Dean, of the largest possible diameter.

The corona which appeared at the total obscuration, and did not so far as I noticed, change its shape subsequently, was prolonged in four directions, at least such is my impression; these directions being vertical and horizontal, or nearly so. Its length

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in these directions was about equal to the diameter of the moon, its shortest length about one third of this, I should say; and it appeared to me decidedly in the form of rays, not of concentric rings as described, & believed, by Mr. Frankenstein.

I did not notice any protuberance immediately, but the eclipse had not lasted more than half a minute probably, when I noticed without specially looking for it, and I think with the naked eye, the principal protuberance, apparently directly below. It appeared to me of a yellow color and it was not till toward the close of the eclipse that it seemed to assume a deeper or reddish tinge. I should call this color pink properly. Half a minute or perhaps more before the close of the eclipse, another appeared about ten degrees as I should say below the extreme right hand limit of the moon, but I did not notice any marked color in this, and did not look at it closely: in fact, I did not examine the other attentively, being too much engaged in looking for planets.

I did not see any stars except Venus, Mercury and Regulus: the two first were of course very conspicuous during the whole of the totality. I am not sure whether I saw the latter with the naked eye or not. The darkness was not so great as to need the lantern which I had prepared for examining my chart of the heavens. Some gentlemen at my side whom I requested to note what stars they saw, reported what evidently from their position, must have been Arcturus, Vega and Saturn.

Neither the beginning nor the end of the eclipse seemed to me

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to produce a very marked change in the amount of light, especially the former, and I did not notice the edge of the shadow moving over the landscape, though my position, on the roof of the Court house was quite a high one, and commanded a fine view. My attention was however somewhat distracted by the sun itself.

I think that if there had been any stars as bright, or within a quarter of a magnitude as bright as Regulus between that star and Mercury and within three degrees of the ecliptic (at least in the northern side,) I should not have failed to see them. I did not however see γ Leonis, or any of the other stars of that constellation. I had a spy-glass of about 1½ inches aperture, but did not use it much during the totality.

The birds about the building were apparently quite excited during the totality, and flew about wildly.

A gentleman whom I met at Louisville reported that he had seen a prominence, (I believe the principal one immediately below) at Shelbyville, Indiana, where the eclipse was total.

Is it not possible that the prolongations of the corona have some connection with the prominences? They seem to correspond with them in position.

Yours very truly

G. M. Searle

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Passaic, New Jersey
Sep. 1st 1869

To T. L. Conrad,
Prof. Physical Science,
Penna. College Gettysburg, Pa

Dear Sir:—

I will endeavor to give you a more definite description of the general appearance of the total eclipse, than any thing I have yet seen, by combining my report of Aug. 9th to Dr. E. S. Crozier, Sec. Soc. Nat. Hist. New Albany, Ind., with the descriptions in the Independent of Aug. 19th by Rev. T. H. Innes at Springfield, Ill., "not two miles from the central line", and by other members of one party at New Albany, where one point of observation was about 2 miles north of the central line, on a knoll 240 feet above low water, with a clear horizon of about 60 miles radius, from N. 10° E to 30° E or 140 degrees.— From this point, the Ohio River, with New Albany and Jeffersonville on the north, and Portland and Louisville on the South, was in full view.

As the eclipse increased, the atmosphere appeared to have a greenish hue. This I suppose to be a deception arising from the greenish hue of all objects that contained yellow, as buildings in cities, the naked ground, and the faces of the company. All remarked the sickly appearance of faces, and the deep green of the foliage. The same effect, but in a greater degree, is produced by the blue flame of burning alcohol.

During the total eclipse there was 1/8 or 1/10 diameter of the sun,

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a bluish white circular corona surrounding the moon;* and beyond this corona, rose rays from the centre, projecting beyond the moon in the direction of the motion or ecliptic, about three-fourths of the diameter of the moon, and nearly the same at right angles to that direction, the whole forming nearly a square, with the sides vertical and horizontal. Then from the centre of the upper side, undulations flashed to the left, resembling the convections of an ordinary aurora, passing from the centre to the angle in about half a second. Color of the sun.

Several of our party agreed as to the square form, but differed as to the convections. I am inclined to the opinion that this square was in the atmosphere of the earth, and caused by electricity as an ordinary aurora. The angles of the square corresponding with the line of motion, and at right angles to the same, may arise from the general law, that a magnetic current is always at right angles to a current of electricity. The apparent radiation may have been the effect of perspective.

Mr Winer did not observe the circular corona within the square, but says: "This corona did not form a perfect circle, but was rather rhomboidal in its shape, owing to the greater length of rays at four points, corresponding very nearly to the four principal points of the compass. The greatest length of the corona was in the direction of the ecliptic".

This agrees with my own description of the aurora, excepting that

* The corona was about 1/8 or 1/10 of the diameter of the sun. The color of the aurora was about the same as that of the sun. B. Apthorp.

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He says nothing of flashes of light. But a gentleman who saw the partial eclipse at New York, informs me that he distinctly saw flashes of light, but could not distinguish the aurora. I am positive that there were flashes as described. There may have been seen at other places. I kept my eye fixed on this point only, to be certain of the fact, as other matters required attention, and the total eclipse lasted only two minutes and 15 seconds.

Again:- During the total eclipse, the light reflected from the atmosphere about 50 miles to the North, had the effect of a hazy half twilight; while that from the South about 90 miles distant, appeared as the last rays of twilight. According to my recollection, these partial twilights were segments of circles; that at the North rising to about 30 degrees, and that at the South about 5 degrees. They were striped horizontally with different colors. The prevailing color was orange deadened by the haze. The remainder of the Sky had not the transparent appearance of a dark night, but appeared to be obscured by a black fog, composed of moisture and smoke, like that of London or Pittsburgh. This was deepest in the direction of the deepest shadow N.W. and S.E.

Mr. Clarkson, editor of the Iowa State Register, says in his report: "A sombre curtain was falling from the hazy heavens — a strange mist, like the smoke of Indian Summer made moist. When the totality was half elapsed, the horizon at the North and North west, was tipped in beautiful orange." Mr. Wines says "the air was copper-colored, the grass and foliage dark blue." And subsequently,

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"the sky was dark as in a storm".

The position of Mr. Clarkson is not given; but I infer that he was near the northern limit of totality, where the mist of Indian Summer, intervening for a short distance between him and the illuminated atmosphere on the North, did not obscure the "beautiful orange" on that side; but the mist of 140 miles on the opposite side, made the southern illuminated atmosphere invisible, as he does not refer to it.

We had a deeper shadow on the North, being 50 miles from the northern limit, and 90 miles from the southern limit. I designate the appearance of the partial twilight, as "orange deadened by haze"; and that at the South was most deadened. Mr. Times, at 70 miles from the southern limit, says, "the air was copper colored." This, I understand to signify, that the arcs on the North and South were orange-colored, obscured by a dark haze; while the remainder of the "sky was dark as in a storm". Because such was the fact with us; and if the air was copper-colored, the grass and foliage could not be "dark blue, or deep green", as was the fact. The cause of this green or blue tint became obvious during the total eclipse, when it became evident that the corona or delicate photosphere surrounding the stronger light of the sun, has a bluish tint Hence, the peculiar tint in all eclipses when the central light of the sun is partially shut out, and blue predominates.

With us the sky was cloudless, excepting the dark haze during the eclipse. This I attribute to the temporary condensation of moisture caused by the reduction of temperature below the dew

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point. Our standard thermometers from the Smithsonian Institution gave the maximum 75°.5 at 3 P.M. in the shade; and thence, continued to fall to 64°.5 at 7 P.M. The solar thermometer indicated 89°.2 at 3 P.M; 68°.7 during the total eclipse from 5:20 to 5:30; and 71° at 6:20 P.M. and then continued to fall. The wet bulb thermometer gave 58° as its minimum, at 5:40 P.M. Hence at the minimum, the temperature was 10°.7 degrees above the dew point, at the place of observation. This, however was near the earth previously heated by the sun, and then radiating the accumulated heat, so that, immediately at the point of observation, there was no haze.

But I suppose, that at a comparatively short distance above, the temperature was below the dew point, and even looking downwards from the knob towards the cities, the atmosphere appeared hazy.

We made no photometric observations, and I have no definite opinion as to the depth of shadow. But on Aug. 10th I inquired of Mr. Rothrock at Wyandotte Cave, 30 miles west of New Albany, and nearly on the central line, and he said: "It was much darker than at full moon. The chickens near the coop appeared to be distressed. I endeavored to see how they acted, but could not distinguish them. There is no difficulty in seeing them by moonlight."

We could perceive no effect on the needle of an ordinary Surveyors compass. We could distinctly see the red flame projecting beyond the moon, and Mercury, Venus and some bright stars.

Had the darkness been simply the absence of light in a transparent atmosphere, I suppose we could have seen many more stars.

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I presume you have received a copy of the New Albany Daily Ledger, of Aug. 9th, containing the minute details of the telescopic, barometric, and thermometric observations by different members of one party, including my own report, hastily prepared for immediate printing, upon which I have herein enlarged in order to compare my observations with those made elsewhere, and especially for the purpose of calling your attention to the "nearly square" or rhomboidal" aurora. I am convinced that this was in our atmosphere. I can conceive no physical reason why this form should be attached to the Stationary Sun, and with the greater diagonal in the direction of the motion of the moon. Nor can it be attached to the moon, or it would be brighter at other times if permanent; and the accidental position of the earth behind the moon at that moment, would be no obvious reason for its instant appearance and disappearance. But the flashes of light determine the question in my mind, and prove the aurora to be within our own atmosphere. Hence, in making experiments to ascertain the nature of the "red hydrogen flame", the question will be complicated by the three different lights — the red — self-luminous? the circular corona — self-luminous? and the rhomboidal aurora — self-luminous?

I find from conversations, that is not generally known, that during all partial eclipses of the sun, the shadows of all leaves and the like indicate the eclipse, as if a circular piece had been cut out of the edge of each leaf. During an annular

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eclipse also, the image of each object is surrounded by a penumbra or halo, in the ratio of an eighth an inch to the foot of distance of the shadow; or at an angle of 32 minutes, equal to the angular diameter of the sun.

Since the above was written, I notice in a report of the proceedings of the American Association for the promotion of Science, at Salem, Mass., Aug. 23d, that Prof. Peirce remarked that "the corona might be merely an auroral phenomenon; might consist of meteors shot out from the sun; or might be caused by the sun's atmosphere reflecting the intensely hot liquid masses below it. It was a very difficult subject. He had come there prepared to maintain the meteoric theory; but what he had heard had rather shaken his confidence in it; and he was now inclined to think the auroral was the simplest explanation. The nebular hypothesis was, in his opinion, not well founded."

Now, no one in this convention of the Association appears to have drawn a distinction between the corona surrounding the sun, and the aurora in our atmosphere. Perhaps with them the aurora overpowered the corona. I am confident that I saw them both, as described; and no one had a better opportunity for observation than I had. Nor is Prof. Peirce's hypothesis of reflection satisfactory, because the blue tint of the corona differs from the direct light of the sun. So far as that it always differs in the same manner, because partial eclipses have the same effect on colors, as I can certify from frequent observations. — Whatever this corona may

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be, I can suppose it produces the appearance of the immense willow leaves discovered by Nasmith, arranged systematically over the surface of the sun, and, as it were, hedging the chasms of the dark spots; for the exterior of the circular corona was not a uniform circle, but appeared indefinitely wavy and transparent; and hence, each wave would act as lens to focalize the rays.

Again, the report of the Scientific Association at Salem continues: "Several astronomers testified to having seen meteors passing over the black surface of the moon, between the cusps of the sun. As this phenomenon was seen at several places, by different individuals, no other explanation than the above seems to be admissable; though the first gentleman who mentioned the matter, believed it to have been caused by midges."

Now, I suppose there to have been neither meteors nor midges, but in the eye itself when fatigued by long intent observation, as I have experienced myself. The position is remarkable — "between the cusps; and seen at different places in the same position"; while the parallax would place the same meteor in different positions.

I have met with no reported observations on the Zodiacal light. I saw none, unless the rhomboidal aurora, or the circular corona be the central portion of it sufficiently strong to be perceptible in the presence of the other light, and to penetrate the haze which I suppose, must have intervened, although there was no such appearance.

Or if it were not for the electric flashes, I might suppose

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the rhomboidal aurora to have been local, and dependent on the hygrometric condition of the air near the observer; and the apparently diverging rays to have been actually parallel, as we frequently observe at sunset near the sun, and occasionally opposite the sun, parallel streaks of reflected light apparently diverging or converging, from the effect of perspective. Nor am I certain that electric flashes would be inconsistent with auroras as local as rainbows. Hence I am prepared to hear very different accounts of this aurora from different places.

Very Respectfully
B. Apthorp

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The Great Eclipse of August 7, at Hanover College Ind.

That great event was anticipated by those persons who were interested in matters astronomical with a lively feeling, careful preparations having been made for accurate and detailed observations. Different points were examined beforehand in reference to selecting the most favorable positions for observing all the important phenomena of the eclipse. That selected was in the College Campus, South of the College building, from which the hills South of the Ohio river for eighteen miles, were in full view, and the most prominent points of the north bank for the same extent, for a view of a still wider region of scenery; and as the best position for observing the sweep of the shadow, the cupola of the building was occupied.

The morning of Saturday was employed by the observers in locating their instruments and completing their arangements for full observations. The night previous, observations had been made for the purpose of correcting their times. The records of the barometer and thermometer were begun at two o'clock p.m. Saturday.

Shortly before the time for the beginning of the eclipse, the different observers took their seats at the instruments. By this time numbers of intelligent citizens from the neighboring villages, from Madison, and some from Ohio and other more distant places were gathering, near.

The instruments in use were a Standard thermometer; a

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first-class aneroid barometer, adjusted to a standard mercurial barometer; three refracting telescopes; one three inch aperture, equatorially mounted; one two-and-a-half inch aperture, on altitude and azimuth stand; one two inch aperture, on altitude and azimuth stand.

The astronomical corps consisted of the following gentlemen.

S. H. Thomen, A. M. Prof. of Astronomy and Mech. Phil. in charge of the two inch refractor.

J. H. Thomen, A. B. in charge of the two-and-a-half inch refractor.

O. Mulvey, M. S. in charge of the three inch equatorial.

G. D. Archibald, D. D. observing sweep of the shadow.

Rev. Heber Gill, A. B. recorder of observations.

H. N. Wiley, A. B. recorder of observations.

E. H. Allison, recorder of observations.

J. C. Eastman, A. B. in charge of the time.

G. N. Bean, in charge of barometer and thermometer.

The observations recorded are as follows:

Time-	Barom.	Ther.	Wind, direction & strength.
2h.	29.12	73°	breeze, N.E.
" 20m	29.12	73° 25'	" "
" 40m	29.115	72° 75'	" "
3h.	29.127	73°	" "
" 20m.	29.123	74	" "
" 40m.	29.12	73° 25'	" "
4h	29.12	73°	" "

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Time	Barom.	Ther.	Wind, direction & strength
4h 10m	29.11	73°50	breeze, N.E.
" 20m	29.11	73°	" " "
" 25m 45s	29.11	73°	" " "
	[First contact]		
" 30m	29.11	73°	light " " "
" 36m 25s			

[Sphericity of moon first noticed on eastern limb, which was then observed until the appearance of Baily's beads.]

" 40m	29.11	73°	light " " "
" 50m	29.11	72°50	" " " "
" 53m			

[By this time there was a perceptible diminution in the strength of the light]

5h	29.09	72	light " " "
" 2m			

(A further perceptible reduction of light.]

" 9m

[Still further perceptible reductions of light.]

" 10m	29.09	71°50	Stng " N.E.E.
" 20m	29.09	70°50	light " " " "
" 23m			

[Venus visible; getting darker rapidly]

" 24m 44s	29.09	70°	calm

[Beginning of totality]

" 26m 58s	29.07	70°	light " " "

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[End of totality.]

Time	Barom.	Ther.	Wind direction and Strength.
5h 30m.	29.06	70°	light wind N.E.E.
" 40m.	29.05	69°50	" " " " "
" 50m.	29.05	69°75	" " " " "
6h	29.03	69°50	" " " " "
" 20m.	29.03	69°50	" " " " "
" 21m. 5s	29.03	69°50	" " " " "

[Last contact]

The sky was entirely free from clouds during the whole afternoon, with the slightest possible haze or bluish smoke. Just previous to totality, the sky at the west, below the sun, was reddish yellow, growing more yellow towards the south. During totality to the north and northeast it was quite dark, almost black (seemed opaque as no stars were visible there.) For sometime before, and whilst totality lasted, the faces of bystanders, and other light-colored objects had a greenish yellow color; the leaves looked yellow. After totality objects generally just seemed pale, without any color, as though they were lighted with a faint white light, the light growing gradually stronger till the end of the eclipse. A number of persons remarked the light was stronger just after the close of totality than previous to the beginning of it. This effect was doubtless caused by the pupils of the eye having dilated in the darkness.

Baily's Beads were seen only at the cusps, and not ne

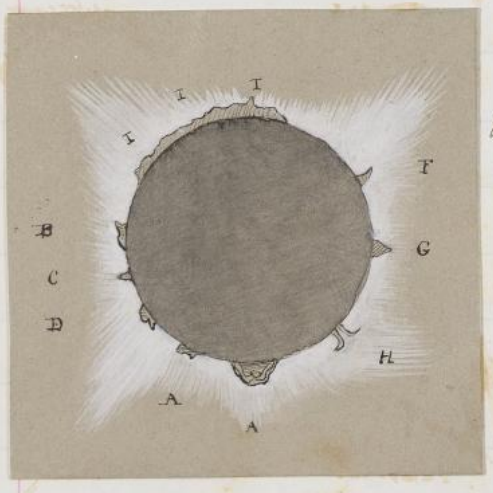
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the centre of the crescent; those near the extremities being smallest, those more remote seeming elongated: they dropped off in successions very rapidly; there was no distortion of the cusps.

During totality, the following heavenly bodies were seen Mercury, Venus, Saturn, Arcturus, Lyra, Antares, Altair and Benetnasch. Some claim to have seen more, but the above are all that were recognized by the observers.

No bodies were discovered between the Sun and Mercury. The sweep of the shadow was distinctly observed; it was first noticed on the west hills, some two miles below the College, travelling rapidly towards Madison; when totality arrived, the hills back of Madison, about four miles above, were yet in sunlight; in a few seconds they, too, were in darkness. When the shadow returned, the Madison hills were again lighted, whilst the observers were still in the gloom. In a few seconds it swept swiftly by, and down the river for fourteen miles, when it was lost to view on the land, but was visible for several seconds after in the air, sweeping to the southeast. The flame protuberances were just observed just at the commencement of totality, and at the place of the first inner contact.



Just at this moment, the excitement was so intense that the observers were slightly thrown off their guard; the time, however, was very carefully noted,

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though the shapes of the smaller flames were not; but to the recollection of one observer they were jagged and almost a continuous chain to the southeastern limit, (see diagram) those to the right being highest - III. The flame A was seen instantly after totality; B C D and E rising almost simultaneously, and immediately after A. Then as the moon swept across F and G, and then H, rose in extremely rapid succession.

The flames A H and G were plainly visible to the naked eye, though of course their shapes were not. A was much the broadest of any one flame seen; in fact, it seemed as if it were made of three flames, folded one upon another, with some shorter ones in front of them. This was perhaps a little higher than H. But the most remarkable were those two designated H; these were closely scrutinized; they rose to the same height, with parallel sides, and their tops turned in opposite directions, at a sharp right angle; they were perfect duplicates one of the other, with the exception of their tops being turned in opposite directions. The color of the flames were thought to be of a more reddish purple than rose color by some of the observers; by others, more of a bluish-rose tinge. The flame A continued visible for full eight seconds after totality terminated.

The following contacts with the moon's limb, with well marked solar spots, were observed: [see diagram]

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Time.

4h. 47m 31s. Right hand spot [group 1.]

" 48m 42s Largest spot (group 1); just contact of penumbra.

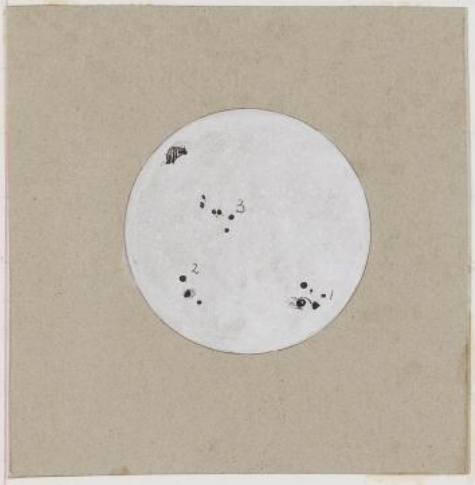
" 49m 15s Largest spot (group 1); second contact of penumbra, or just covered.

5h 9m ..... Immersion of left hand spot (group 2)

" 23m ..... Last spot covered, a large one, (marked 3)

6h 4m 8s .... Emersion of left hand spot (group 2)

" 16m 55s Last spot uncovered (3 in diagram)



From July 27th to the 30th the magnetic needle lost two minutes of variation, since then there has been no change.

From the time, the round appearance of the moon was just seen, until totality ensued, numerous white objects, supposed to be swallows, were observed passing over the eastern limit of the moon in a general direction from north to south.

Quite a number of swallows, chirping mournfully, flew to the College building to roost. It is also reported that some of the chickens which went to roost did not come down again when the eclipse ended. Others did come off again.

Whilst totality lasted, the excitement was very great; everybody seemed enraptured and anxious to see all the different phenomena visible. Just at commencement, there

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was one burst of applause, which increased till the sun shone forth again, though nearly every one was unconscious of any one making a noise but himself. One observer even forgot to remove the dark glass from his telescope; nevertheless he made excellent use of this time. The time keeper forgot to note the minute of the end of totality, but recorded the seconds carefully.

It was a glorious sight, one never to be forgotten.

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