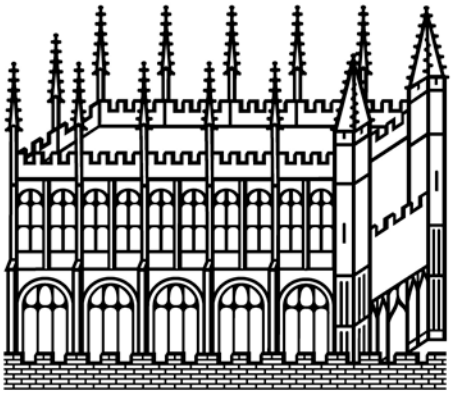

AN ACCOUNT

OF THE

AURORA BOREALIS,

SEEN NEAR CAMBRIDGE,

OCTOBER THE 24TH, 1847:

TOGETHER WITH THOSE OF

SEPTEMBER 21, 1846, AND MARCH 19, 1847,

SEEN

AT THE CAMBRIDGE OBSERVATORY.

WITH TWELVE COLOURED ENGRAVINGS.

BY JOHN H. MORGAN,

OF JESUS COLLEGE, AND LATE OF THE CAMBRIDGE OBSERVATORY,

AND

JOHN T. BARBER,

OF TRINITY COLLEGE, CAMBRIDGE.

CAMBRIDGE:

MACMILLAN, BARCLAY, AND MACMILLAN.

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1847.

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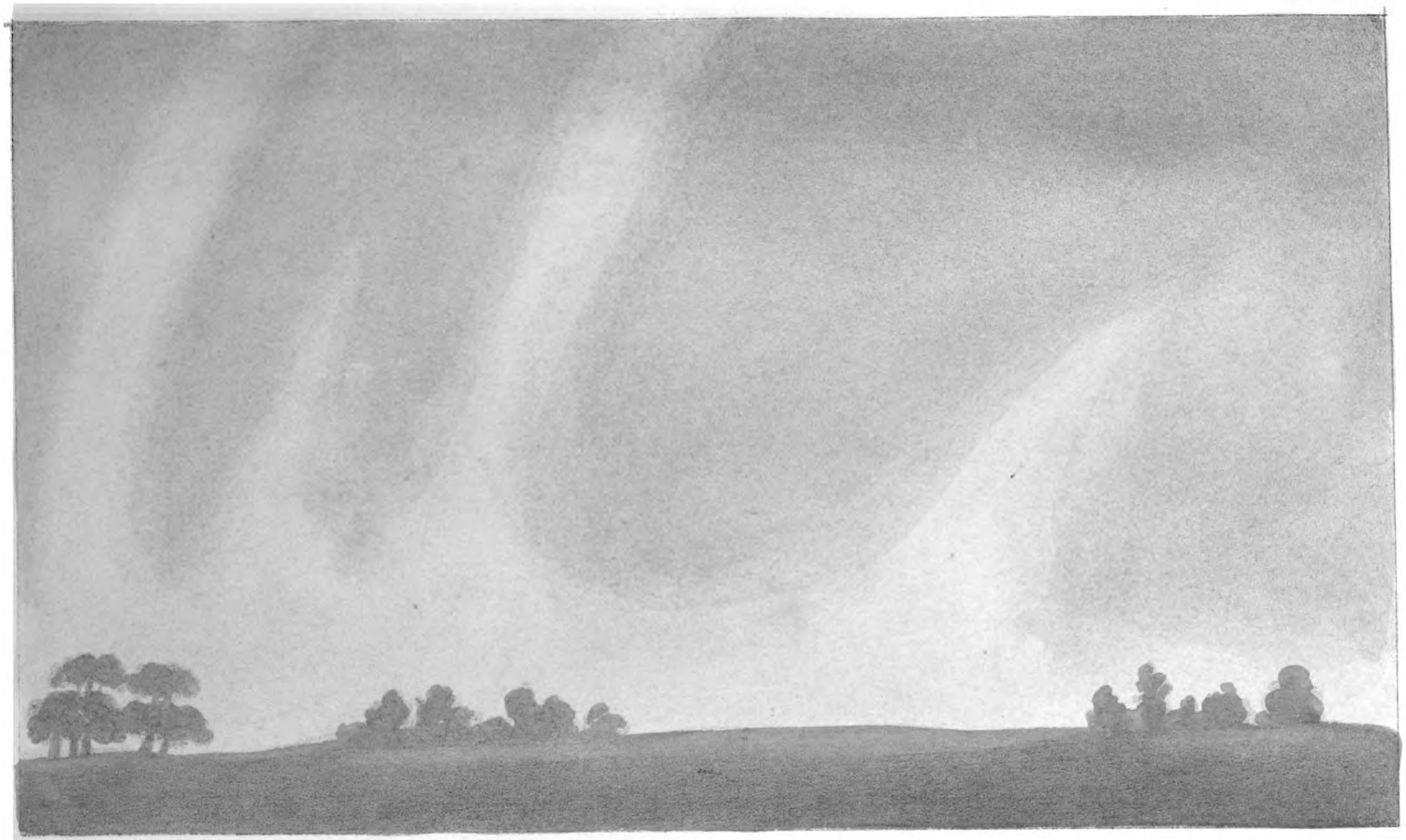
PREFACE.

The little book which is now presented to the public, was principally undertaken to record the particular features of the Aurora of October 24th, 1847; the other observations have been added, that many similar facts which occurred in each might afford a ready comparison for those disposed to consider attentively this beautiful and interesting phenomenon. Some few remarks on the method of observing Auroræ have been appended, that the many industrious meteorologists now rendering their assistance to the science, may have some guide, which, however imperfect, it is hoped will in a measure assist their labours.

PLATE. 1.



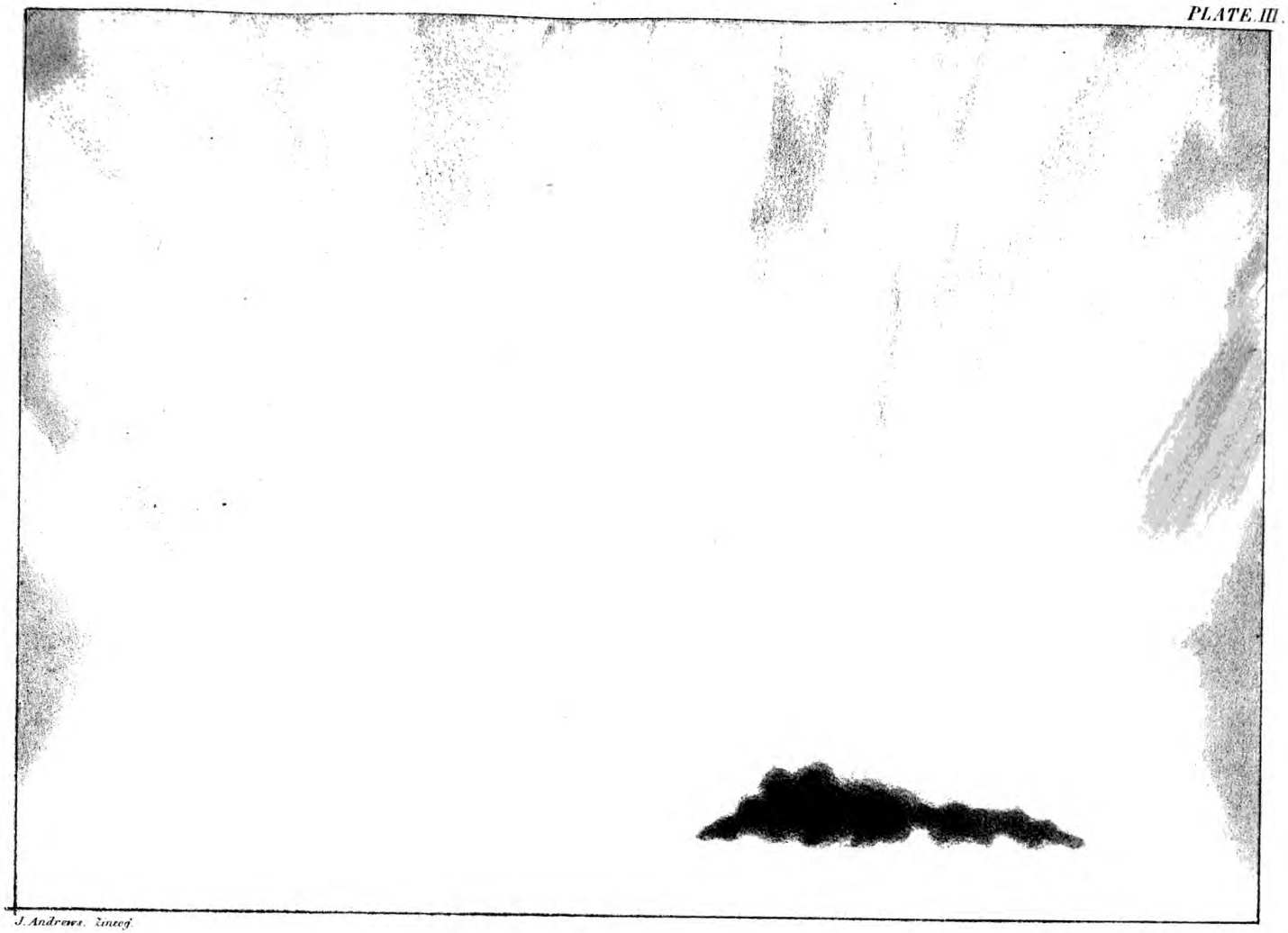
J. Andrews, Zincog.

AURORA BOREALIS, seen Oct^r. 24^th. 1847.

Printed by C. Chabot, Skinner St. Snow Hill.

PLATE .II.

AURORA BOREALIS, seen Oct^{r} 24th 1847.

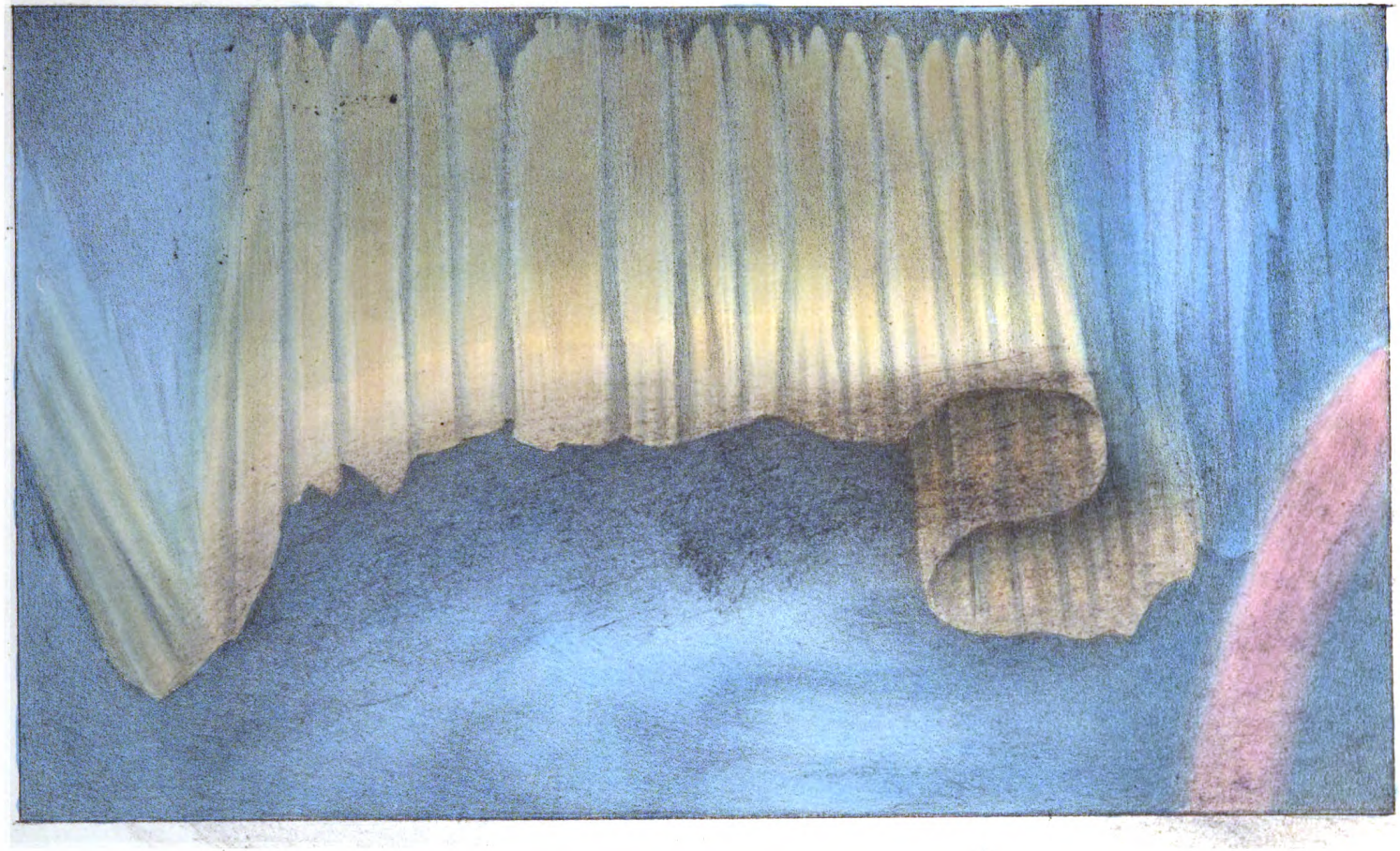


J. Andrews. Lithog.

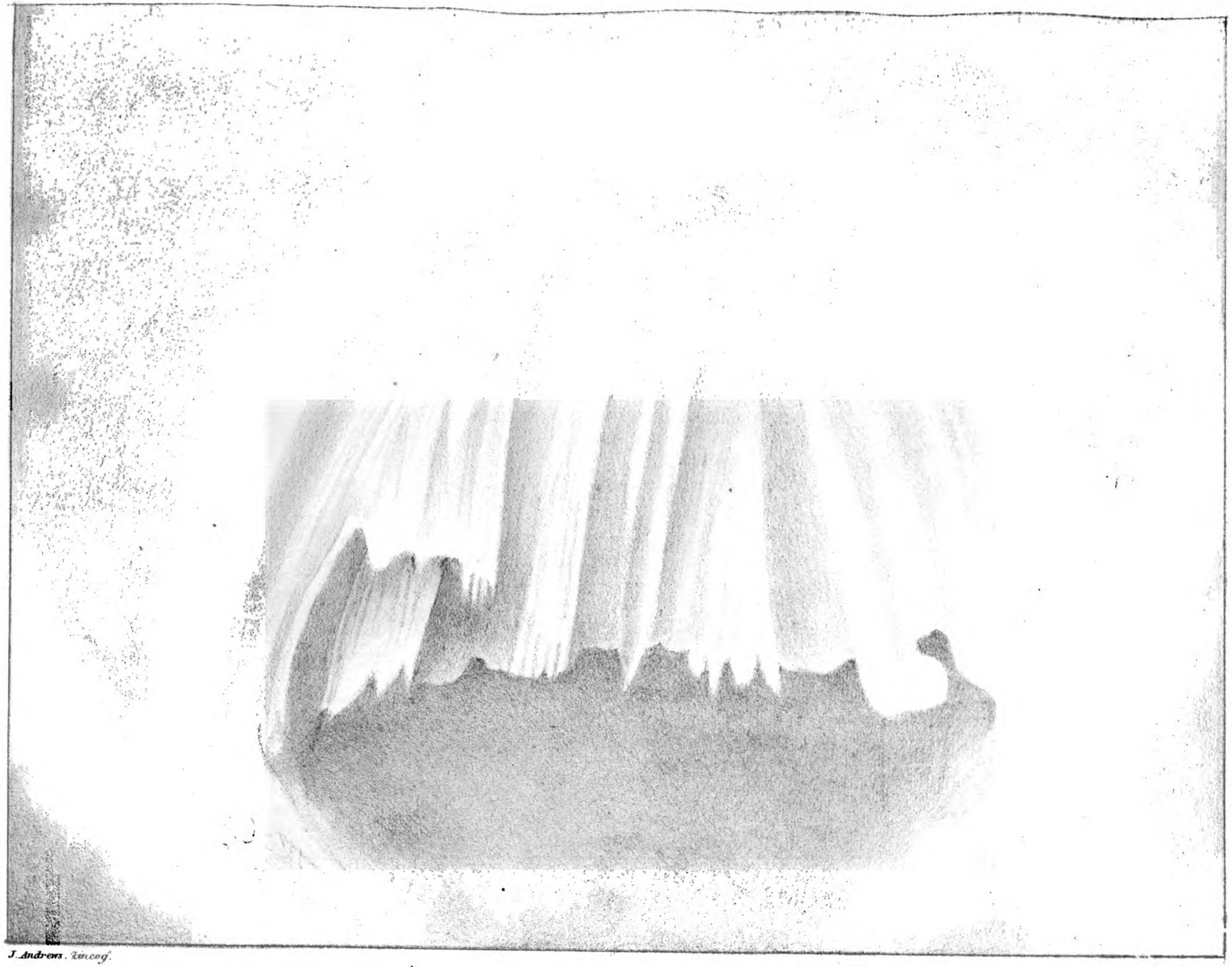
AURORA BOREALIS seen Oct^r. 24^th. 1847.

Printed by C. Hullmandel, Thomas St. Soho.

AURORA BOREALIS seen Oct.r 24.th 1847.

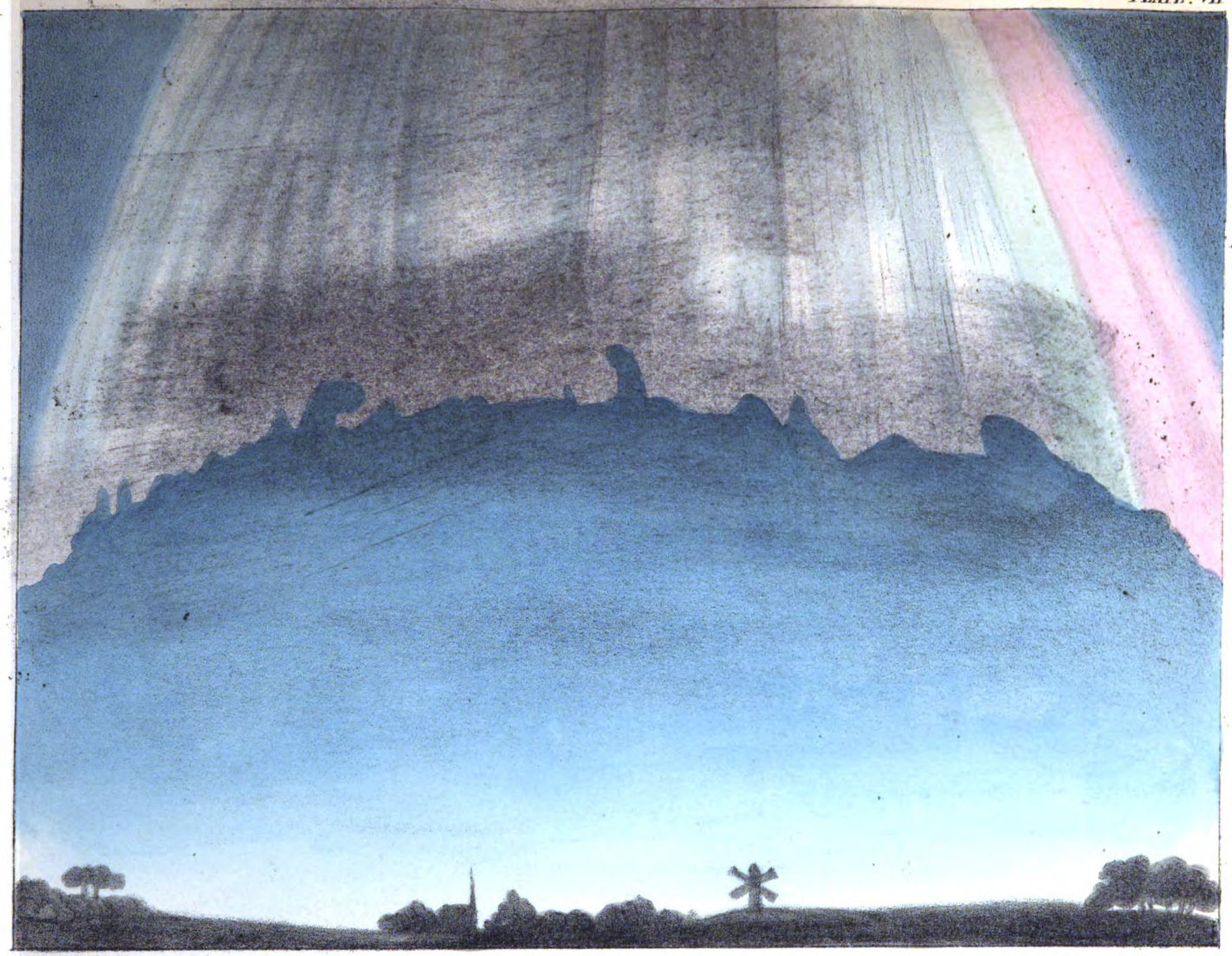


AURORA BOREALIS seen Oct.r 24.th 1847.



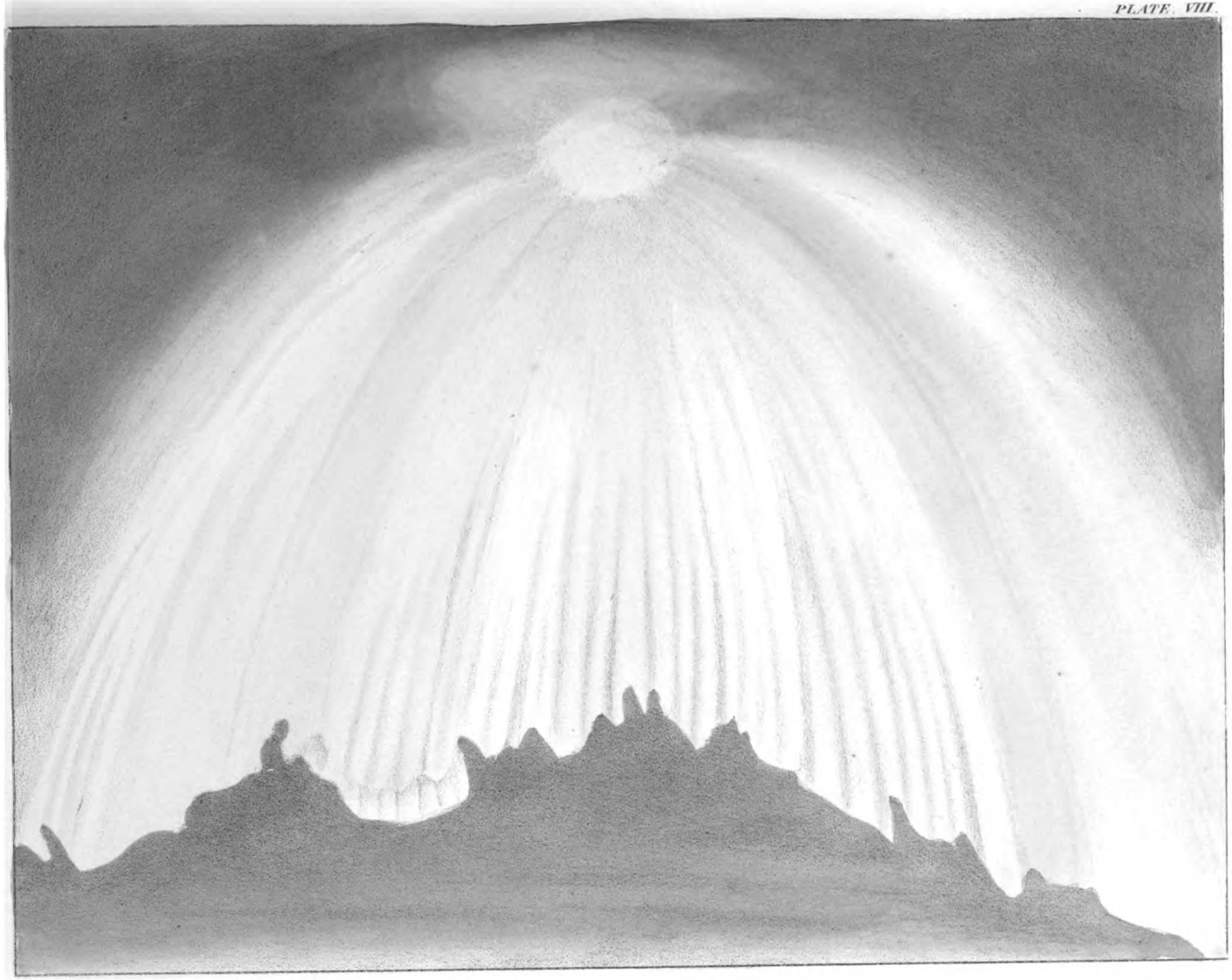
J. Andrews. Zincog.

AURORA BOREALIS. seen Oct^r. 24^th. 1847.



J. Andrews. Zinceg.

AURORA BOREALIS, seen Oct^r. 24^th. 1847.



J. Andrews. Lincoln.

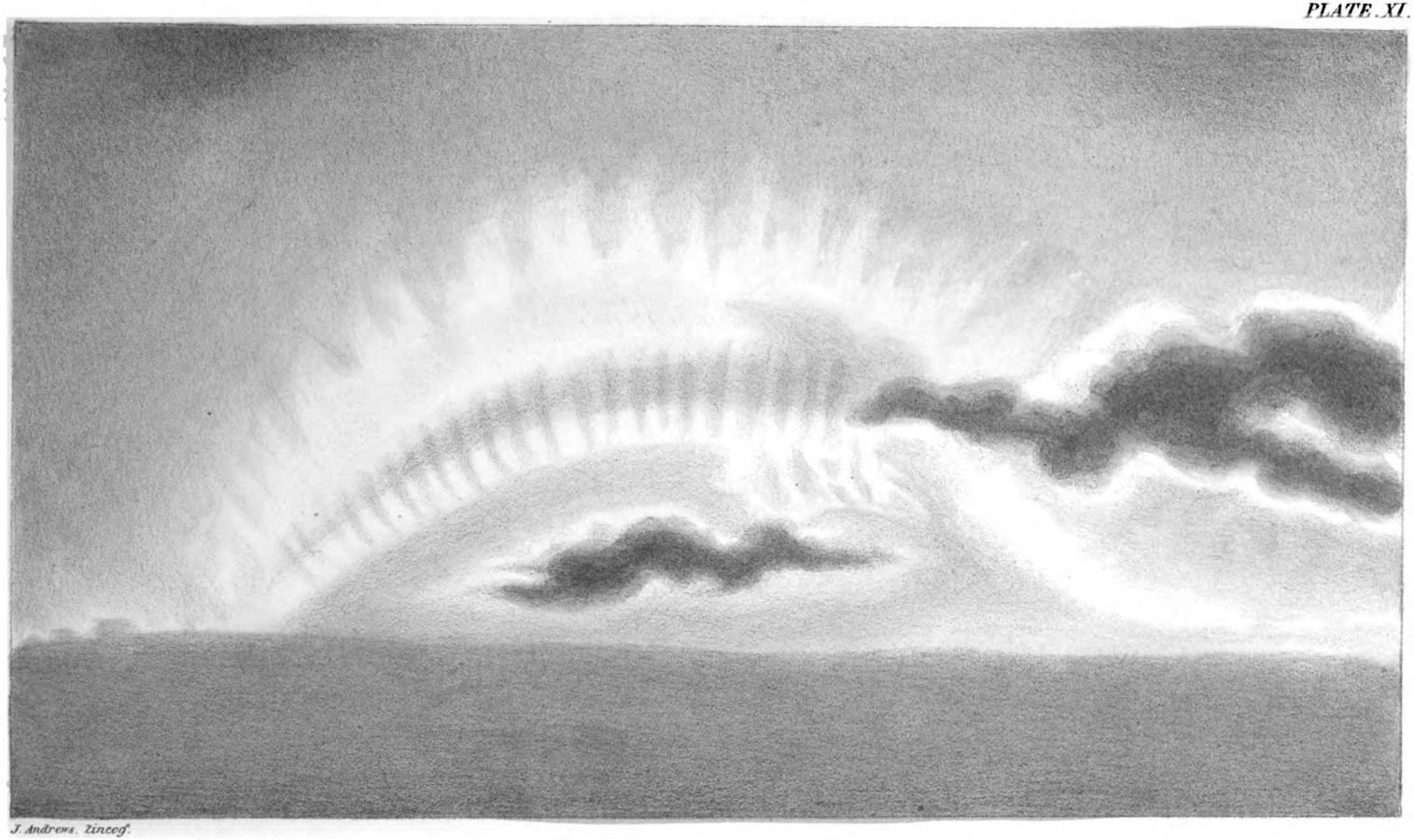
AURORA BOREALIS, seen Oct.r 24th. 1847.

J. Andrews. Zinceg.

AURORA BOREALIS, seen Oct.r 24th 1847.

J. Andrews. Lineog.

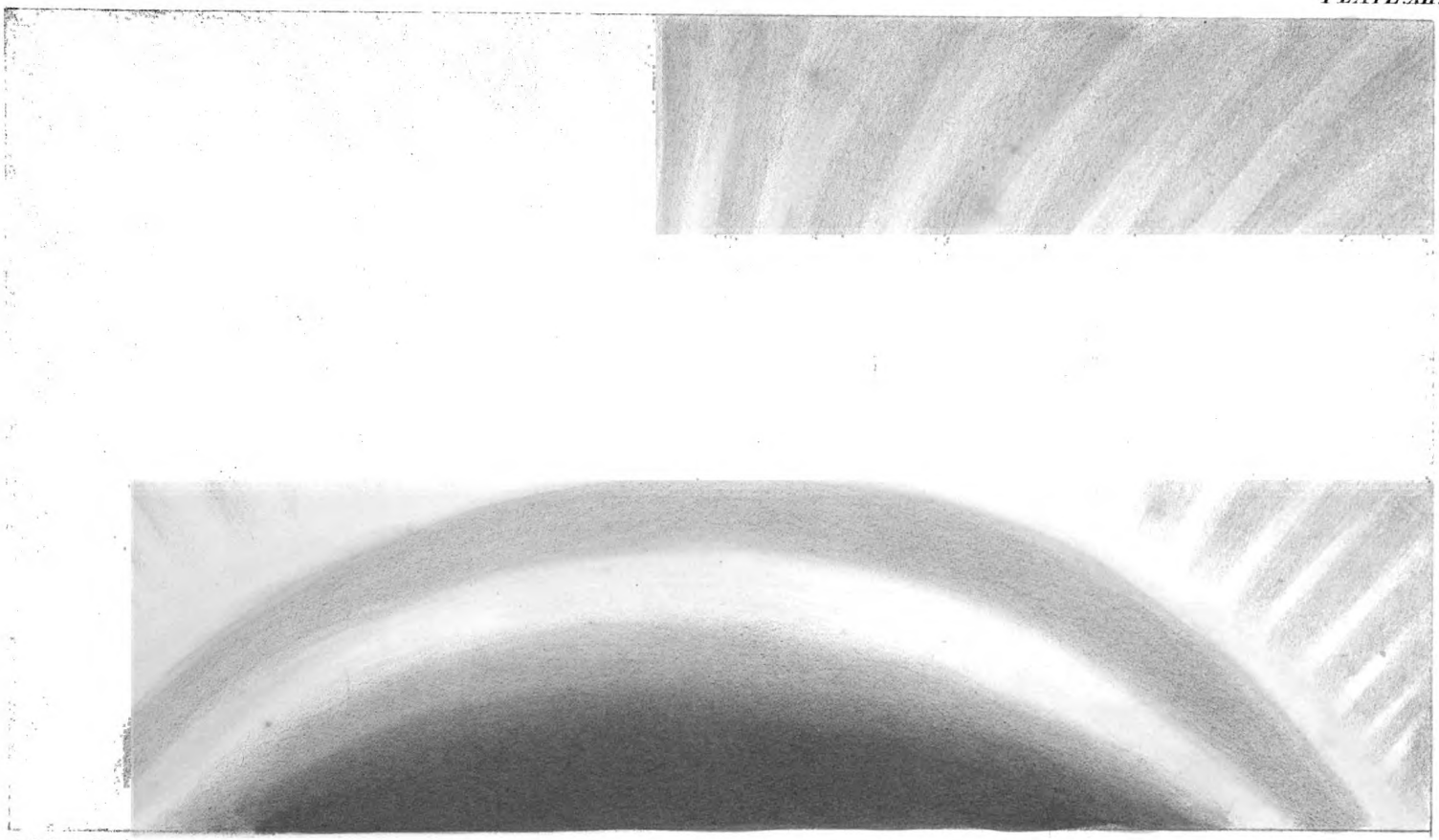
AURORA BOREALIS seen Oct^r. 24^th. 1847.



J. Andrews. Lincoln.

AURORA BOREALIS. seen at the CAMBRIDGE OBSERVATORY. September 21st 1846.

Printed by C. Chabot. Skinner St. Snow Hill.



J. Andrews. Lithog.

AURORA BOREALIS seen at the CAMBRIDGE OBSERVATORY, March 19th. 1847.

THE AURORA BOREALIS

OF

OCTOBER 24, 1847.

BEFORE entering into the detail of the several features of this phenomenon, there is much information to be gleaned by considering the several Meteorological registers of the days before and after the 24th.

From the noon of the 22nd, the barometer had declined rapidly, reading at 3h. P.M. of that day 30·068 in.; on the following morning the reading was very much lower, 29·705 in.; gradually it continued to descend, and at 3 P.M. stood at 29·584 in.; it soon, however, after this began to increase as rapidly, the average reading on the 24th being about the same as on the 23rd, at 9h. A.M., viz:—29·720 inches.

The day previous had been very stormy and wild, from noon until past midnight, rain had been falling in torrents; about 1h. 30m. A.M. of the 24th, the heavens began to clear, and the morning broke beautifully: at 6h. 30m. there was not a cloud to be seen, and the wind blew rather fresh. The day remained fine throughout, though there were many cirro-cumuli clouds occasionally passing. The 25th, continued fine till 11h. A.M., a few cirri clouds then came over and increased in amount as the day advanced. A perfect calm reigned throughout the night.

The following are the readings of the several instruments (indicated by the headings) taken at 9 A.M., and 3 P.M. for the 23rd, 24th, and 25th days of October.

DAY.	BAROM. 9 A.M.	THERM.			BAROM. 3 P.M.	THERM.			Min. Ther.	Max. Ther.
		Att.	Ext.	Wet.		Att.	Ext.	Wet.		
	in.	deg.	deg.	deg.	in.	deg.	deg.	deg.	deg.	deg.
October 23.	29·705.	53·4	57·2	54.7	29·584.	54·7	56·2	55·5	48·6	56·9
„ 24.	29·684.	45·3	46·2	43·2	29·722.	53·1	54·6	50·5	37·9	55·8
„ 25.	29·969.	46·7	45·0	41·3	30·121.	49·2	50·3	45·1	37·2	62·2

The accompanying engravings have been selected from numerous sketches, as presenting the best idea of the several phases of the phenomenon; many more might have been given, but this the extent of the work forbade. The descriptions are not confined

to the mere representations to which they at first refer, but take in every particular which our eyes could compass. We were stationed during the greater portion of the time upon a range of hills, generally known in Cambridgeshire as the "Gog-magog;" from the summit of these, we had a boundless view of the whole heavens, at a distance of four or five miles from the light and smoke of the town of Cambridge, without a single interruption; we systematically observed the marvellous changes, one agreeing to regard more particularly one portion of the heavens, while the other confined his attention to the remaining part; thus we can certainly assert our view to have been as favourable to the giving a perfect record as the rapid changes would permit.

The times given are all true Cambridge mean times, from a watch, afterwards compared with the Observatory Transit clock.

It was 6h. 15m. P.M., when our attention was first directed, as our informant expressed it, to "the reflexion of a fire in the heavens;" probably the appearances might have existed some little time previously, as the sun had sunk below the horizon a sufficient time to have rendered visible, certainly 15m. before, the bright streamers of which Plate I. is a representation; however, we then beheld in the N.W., at an altitude of about 9° from the horizon, a succession of regular bands of faint red light, reaching 45° towards the zenith, and diverging apparently from the magnetic zenith. At this time we did not observe anything more, though the above-mentioned appearances remained: at 6h. 35m. a streamer of the same hue shot up directly N. W. and others between this time and 6h. 43m. were also observed; one particularly at 6h. 50m. of a whitish colour; it had not, however, ascended far before it changed to red, it then gradually faded until no trace of it could be seen. Its position was near δ Ursæ Majoris. Until 7h. 7m. the rays were mostly of a pale white, shooting out in every direction, and succeeding one another rapidly; with a palpitating motion they moved from W. to E. then back again: suddenly a long streamer would dart forth and as suddenly disappear. A faint outline of an arc was seen about 7h. 10m., and the usual dark blue was remarked beneath, in which stars were distinctly seen; this was due North. The Aurora retained the appearance thus described until 7h. 45m., after which time it appeared to diminish in splendour, so much so, that at 8h. nothing of it was to be seen: similar appearances, however, to those just related, were again noticed about 8h. 45m. and very soon after the Aurora was again perfectly developed; the arc now assumed a decided form, and remained, excepting a short interval of 15m., until the phenomenon had disappeared.—9h. 12m. the sky from W. by N. to E., and extending to the zenith, was literally a map of undulating flames, with streamers darting up to the zenith, of red, greenish, yellow and red colours, the arc touched the horizon in the N. W. by W. and N. E. by E. the vertex being situated 10° W. of the astronomical meridian, and at this time *not* on the magnetic meridian. About 9h. 35m. issued a broad band of intense red due E., vertical to the horizon: it gradually approached the planet Jupiter, at that time 7° high, and completely passed over it, diminishing its lustre so much that it became condensed into a well-defined disc, partaking also of the colour of the streamer; this band was afterwards dissipated, having been of a complete crimson upwards of 20m. During the whole of the above time, but one small piece of cumulo-stratus cloud was observed in the S. E., the moon shone

brilliantly, and the atmosphere was clear, though sharp. From 9h. 35m. to 10h. 15m. the sky for several degrees around the astronomical zenith was of the same beautiful red colour so pre-eminently the feature of the whole evening; the greatest brilliancy was centered in the constellation Cassiopeia, from which point the streamers soon began to diverge: this red light had no motion, it appeared to extend over a circular area of 8° radius, the central point being close to α Cassiopeia; two streamers, also of a bright red colour, proceeded from this, one towards the E., which was afterwards united to the one which passed over Jupiter, and another to the N. W., but the latter never reached the horizon, its greatest length being 50 deg.*

Between 10h. 20m. and 11h. 0m. the brilliancy of the scene had greatly decreased, though a new and not less beautiful appearance was observed, a splendid corona around the moon, tints of violet, neutral colours, green and red were seen, though it did not continue brilliant very long.

At 11h. 5m. a brilliant beam extended to Polaris, and from this time till 11h. 50m. a succession of the most beautiful and varied scenes occurred; a pale orange colour was generally in the zenith, while the E. and W. were scarlet, intensely bright. At the latter time the beams, or rather, as these were, delicate pencils of light, formed into the most natural and graceful folds, exhibiting a complete resemblance to a gigantic curtain being slowly unfolded in the heavens. Plate V. is a very correct representation of the most beautiful one seen at 11h. 55m.; it was raised above the horizon about 12° or 14° and the arrangement of the colours brought it out admirably, the folds lay in the most natural positions, giving it a full and graceful character; happily our artist has succeeded very well with this sketch, for indeed no *description* can convey a fair idea of its beauty.

It was about 11h. 35m. when the Aurora presented the appearance shown in Plate VII.; until this time the beams had principally proceeded from an altitude varying between 10° and 23° above the horizon, being so arranged that their lower portions formed an arc whose vertex was about 22° W. of N.; and therefore the whole segment appeared to be bisected by the plane of the magnetic meridian: it had been observed for some time that this apparent arc, as we may call it, was gradually rising to a higher altitude above the horizon, when, at 11h. 25m., after attaining a height of 38°, it seemed to vanish, and the Aurora was like a band of successive parallel beams of light hanging from the sky, the lower tips of the rays being intensely white in colour, and very much resembling the light of the moon reflected from silver; the Eastern part appeared like a curtain, whilst an undulating motion, propagated through its whole extent in a direction perpendicular to that of the beams, reminded you of the folds of a ribbon gently agitated by the wind; the breadth of this band might be somewhere about 16° and it extended from W. S. W. to E. N. E.; at one time a second curtain of light seemed to fall from the sky and over the former one, but not reaching so far towards the horizon by 5°. All these rays continued rising higher till nearly 11h. 38m. when they darted out in two opposite directions, one towards the horizon, and the other to the magnetic zenith, forming the most beautiful exhibition of Aurora

* See Plate II.

that can possibly be conceived, and considering the latitude, such a one that we may never expect to see again;* for the second† time during the evening a crown was formed near the magnetic zenith, from which all the rays appeared to diverge; their colours were most splendid and of peculiar transparency, especially the red and green, the former being quite like carmine, and the latter that of the pale emerald; the central part of this canopy, or that near the magnetic North, was of a very yellow colour, one streamer being quite like gold; the definition of the outline against the sky was most perfect, and very remarkable, the brilliancy being so great, that notwithstanding the full moon, the reflexion of the Auroral rays was easily perceived from pools of water in the road. It was not long before this magnificent dome of light reached its maximum brilliancy, which took place nearly at 11h. 46m., and in this state it remained till about 12h. 0m., the sky having all this time the appearance of a "cupola on fire;" indeed, no description can give any idea whatever of the phenomenon between the two latter times, to those persons who were so unfortunate as not to witness it. Between 11h. 43m. and 11h. 50m. not the least conspicuous part of this meteor consisted in an enormous sheet of white flame, undulating in a most striking manner, at one time being visible, and the next moment having vanished, appearing to oscillate backwards and forwards from E. to W. and being obscured when it passed behind the scarlet ray in the E.: its breadth was 8° at an altitude of 12°, in form it resembled a pyramid whose vertex was at the centre of the diverging rays. The best illustration of these palpitating motions is that of a large volume of flames rolling in a reverberatory furnace, and indeed, at 9h. 0m. the sky presented very much the same appearance. At the time of the formation of the dome of light, $\beta, \gamma, \delta, \zeta, \delta$ Ursæ Majoris, and α Can: Ven: were frequently rendered invisible on account of the great brilliancy of the phenomenon.

A few minutes before 12h. 0m. the Aurora began to grow less bright, the part which first faded being near the astronomical zenith, and it soon rapidly diminished in splendour, the central rays of the canopy appearing to fall down upon those below them, leaving an open space free from light, while a scarlet ray from the E., and the yellowish white from the S.W. still met near the magnetic zenith as represented in Plate IX.; the tips of the rays at this time were even more intense in brilliancy than before, and their sharp outline contrasted with the sky remarkably beautiful. Just before the appearance of the phenomenon as shown by Plate X., some clouds appeared rather suddenly in the N.E. quarter, below the lower edge of the dome of light; from behind these, rays of white light diverged as from a centre, and their luminosity was so great that the contrast caused the clouds to be of a jet-black colour, though the moon was shining most brilliantly at the time. At 12h. 5m. this magnificent Aurora drew to a close very rapidly, there being at that time nothing more than a red ray in the N.E. and S.W., with occasional streamers shooting up from the N. and N.W. as from an arc, at right angles to the magnetic meridian. At 12h. 15m. only the red rays in the N.E. and S.W. remained, these not being very bright; no more streamers were seen till 12h. 40m. and those which did appear never reached to a higher altitude than 25 deg.; at 1h. 0m. the red ray was still to be seen in the S.W. and a few streamers of a white colour might

* Plate VIII. † The first one appeared between 7h. 7m. and 9h. 15m. nearly.

be perceived until after 2h. 0m, on October 25; at this hour the sky in the N.W. was decidedly bright from Aurora below the horizon. During the whole time that this meteor was visible, the N.E. quarter of the heavens was invariably the most brilliant, and the rays generally extended to the horizon; one which darted up with great rapidity about 11h. 15m. and was of a very white colour, changed to red in half-a minute, and soon became a perfect scarlet or carmine; this ray lasted the longest of any observed, being seen for nearly 25m., the red beams invariably continued longer than any other, and were generally the most brilliant, they did not possess that darting character which characterizes the ordinary class of streamers, which never maintain the same position for many minutes together.

The rays did not diverge from a point, in the strict meaning of the word, but touched the circumference of a circle whose radius was 1°, and did not proceed within it; this extraordinary circular spot remained visible for a considerable time, but was not so perfectly formed after 11h. 35m., as before that hour.

The infrequency of different coloured bands or streamers of Auroral light being observed in these latitudes, renders a few remarks on their formation, relative positions, &c., a matter of some interest. Though the moon maintained her brightness during the whole time, every feature we have recorded was distinct and certain. In the early part nothing but red bands were seen; an interval then elapsed, during which their intensity was not so great; afterwards the whole sky was diversified with white and red ones, the red never appearing anywhere except in the magnetic E. and W.; it was at this time they were observed to palpitate the most. All the bands observed to be red were decidedly of that colour in themselves, since they were frequently seen independently of any other surrounding colour by which, through contrast, they might have been formed. Many decidedly yellow ones were likewise seen, sometimes they even approached to an orange tint, as in the case of the curtain-shaped Aurora; twice only was a greenish tint formed, the brightest one being when the canopy represented by Plate VI. was seen; this band was evidently produced by the contrast of the several colours, it was definite in shape and not more than 1° in width. Most of the white streamers darted up towards the zenith as if they were developed from an apparent arc, the extremities of which rested upon the horizon, and the vertex coincided nearly with the plane of the magnetic meridian; the symmetry of these apparent arcs was frequently broken by some streamers proceeding downwards to the horizon to a greater distance than others, and, when this was the case, they were always unusually bright:* at one time, an entire luminous arc, the altitude of its vertex being 24°, was seen of a muddy white colour, and shortly after its complete formation, a portion of a second one concentric with the primary, and about 3½° higher was seen; it extended in a direction coinciding with that of the principal arc for nearly one-third of its entire length; the diameter of the circle of which these arcs were segments, seemed to be particularly small, and might be about 30°, the sky underneath, instead of being black from contrast, as occurred in the Aurora of March 19, 1847, was particularly white, and seemed more like the hazy cirrus cloud; three times two large globular masses of

* Plate IV.

light were seen under this arc, and remained visible for 1¾m. but re-appeared again soon after; their diameter was 2°.*

The following extracts of observations on the Aurora, from the *Athenæum*, will conclude our information respecting it. We have placed them in this volume that all the observed facts may appear together, and therefore afford one complete record.

Professor PHILLIPS writes in the *Athenæum* as follows:—

"St. Mary's Lodge, Oct. 25, 1847.

"1. In form, this Aurora was composed of narrow beams and irregular expansions of light. When most complete, between 9h. 30m. and 10h. 30m. (York time), the whole of the northern zone from horizon to zenith, and a large segment of the sky south of the zenith, but not reaching to the horizon, were covered by innumerable beams, finely pencilled in white light, and extending upwards from all sides till they reached a point S.S.E. of the zenith, and formed there a crown of many rays and great brightness. At irregular intervals the light was withdrawn from the beams, and again flashed out in new forms; and if the beams were compared to the lines of longitude on a globe, they were often interrupted by continuous bands, like zones of latitude, concentric with the pole of the beams, through which the clear sky was visible. Around the pole, also, was frequently seen a nearly circular space clear from beams.

"2. Irregular expansions of light appeared in two parts of the sky, viz. in the magnetically east and west parts; and these expansions, large and red as the smoke masses over York Minster when it was on fire, were crossed by white narrow beams in great numbers. Several times red beams, 60° in height, rose from the magnetic east; and both on the east and west magnetic lines, but nowhere else, red flashes passed occasionally to the centre of the crown.

"3. This centre of converging rays was easily seen to be about 20° south of the zenith of York; it was also considerably to the east of the meridian, and remained apparently constant for an hour and a half. At 10h. P.M. it was near the star Mirach; at 10h. 20m. appeared pretty exactly to coincide with it; at 11h. was certainly on the east of it. Hence it may be computed that the pole of the auroral beams was in a great circle crossing the meridian of York from about 27° 30′ west of north to 27° 30′ east of south, and distant from the zenith 22° S.S.E. nearly. Now, this point differs from that to which the south pole of the dipping needle points at York only about 2¼° in altitude and 3½° in azimuth. There can be no doubt, then, that this, like other carefully measured auroral exhibitions, was arranged in magnetic lines."

Professor CHALLIS, in the *Athenæum*, says that:—

"Cambridge Observatory.

"The commencement of the Aurora Borealis was noticed as early as six o'clock in the evening. At ten o'clock it had attained great brilliancy, and between the hours of ten and eleven its peculiar phenomena were most distinctly displayed.

* Plate III.

"In this interval streamers rose at all azimuths from W. by S. through N. to E. by N. The aggregrate of these streamers formed a kind of canopy, which covered considerably more than half the celestial vault, the part towards the south being free from auroral light. The streamers did not, as is usually the case, proceed from a luminous arch, but appeared to shoot up either from the horizon or from positions elevated a few degrees above the horizon.

"The beauty of the spectacle was much increased by large patches of a peculiar ruddy colour, more permanent in their character than the streamers, and formed principally in the W. and N.E. quarters of the heavens. The streamers themselves were for the most part white; and were constantly varying in intensity or shifting their positions horizontally, while rapid pulsations were propagated through them in vertical directions. The most remarkable feature of the phenomenon was the distinct convergence of all the streamers towards a single point of the heavens, situated a little to the east of the meridian and to the south of the zenith. Around this point a corona, or star-like appearance, was formed, the rays of which diverged in all directions from the centre, leaving a space about the centre free from light, in which I noticed at one time the rapid formation and disappearance of part of a circular luminous ring. It was easy to fix on the central point. According to an estimate made conjointly by myself and a friend at 10h. 10m., Cambridge mean time, it preceded the bright star Mirach, or β Andromedæ, 10m. in right ascension, and had greater North Polar distance by 20° Consequently, by calculation, its azimuth was 18° 41′ from S. towards E., and its altitude 69° 51′. The azimuth appeared not to vary with the diurnal motion of the heavens. According to the above result, this singular point was situated in or very near a vertical circle passing through the magnetic pole."

Professor CHEVALLIER, in the *Athenæum*, of Nov. 6, makes the following communication:—

"Durham, Nov. 5.

"The Aurora Borealis, which was seen on the evening of Sunday, October 24, in various parts of England, was extremely conspicuous and beautiful in Durham. Bright streamers, some white, others of a light green, were observed shooting upwards from the northern and north-western parts of the sky before half-past six o'clock; and, at intervals, a slight crimson flush was observed alternating with the streamers and diffused over the neighbouring parts of the sky. At this time the sky was perfectly clear, and the moon, then but one day past the full, was shining brilliantly. The stars were distinctly visible through the Aurora.

"Soon after 8 o'clock similar phenomena were observed; but the streamers now rose to a greater height, some attaining even the zenith, and the rose-coloured tinge of the sky was still more remarkable. At 8h. 29m. mean Greenwich time, a faint but sufficiently well-defined corona was formed by the apparent convergence of beams of light to a point about 70° of altitude and 26° eastwards of south, the point to which the

southern end of the dipping needle is here directed. The position of the point was sufficiently well marked by its position with reference to the bright stars α Andromedæ (Alpherat) and β Pegasi.

"But the most brilliant spectacle was presented at 10 o'clock. At that time the whole of the south-western part of the sky was glowing with rose-coloured light, while bright streamers arose from all sides, especially from a little south of west, to a little east of north, passing beyond the zenith, and converging in a flickering corona in the same part of the sky as before, the bright star Mirach (β Andromedæ) forming now nearly the central point. The light of the corona itself was pure white, and appeared to arise from a cloud of extreme tenuity, corruscations or pulses of light undulating continually along the beams which composed it.

"At this time the moon was faintly shaded by a flocky cloud of cirrus, forming a bright halo, varied with prismatic colours about the moon itself.

"The beautiful appearance of rose-coloured light faded away at about 10h. 10m.

"At 10h. 29m., mean Greenwich time, a wreath of Auroræ was observed to form itself into a curve of a hyperbolic form, its convexity being turned to the bright star Mirach. This was immediately followed by a second and third wreath, nearer and nearer to the star; and for an instant by a fourth very fine wreath, and slightly tinged with pink, exactly enclosing the star. These four hyperbolic wreaths continued visible for a very short time. If they should have been noticed elsewhere, and their place in the sky well ascertained, a comparison of such observations would lead to a determination of an interesting question respecting the height of the Aurora at that point.

"Soon after this time the light faded away, but the Aurora was very visible until near midnight, and probably to a still later hour."

The importance and utility of the following communication, with which we have been kindly favoured by JAMES GLAISHER, Esq., of the Royal Observatory, through the permission of the Astronomer Royal, needs no comment; we therefore subjoin it in the original form.

"13, Dartmouth Terrace, Blackheath,
"Nov. 18, 1847.

"SIR,

"The Astronomer Royal having given me permission to send you some account of the great magnetic disturbance on the 23rd, 24th, and 25th ultimo, as requested by you, I beg to send you the following particulars. I regret to say that I have not had time at my disposal to reduce the observations fully, or indeed completely in one instance, therefore both the times and positions are approximate, but they are sufficiently accurate in all cases for your purpose.

"Oct. 22 was distinguished by frequent small disturbances, and the following are the observed west declination as observed on this day. At 11h. 20m. A.M. it was 23° 4′; at 1h. 20m. P.M. it was 23° 10′; at 3h. 20m. it was 23° 3′; and at 5h. 20m., 7h. 20m., 9h. 20m., 11h. 20m. P.M., it was 22° 58′, 22° 57′, 22° 49′, and 22° 55′, respectively.

"On Oct. 23, at 1h. 20m. A.M.; at 3h. 20m. A.M.; at 5h. 20m. A.M.; at 7h. 20m. A.M.; and at 9h. 20m. A.M., the west declinations were 22° 51′, 22° 58′, 22° 54′, 22° 48′, and 23° 4′ respectively.

"Between Oct. 23, 9h. 20m. A.M., and 1h. 50m. P.M., the position of the magnet was constantly changing, and the extreme west declinations were 22° 44′ and 23° 10′.

	h.	m.			
"At	1	51	P.M. the west declination was	23°	11′
	1	54	„ ditto	23	21

"Between 1h. 55m. and 2h. 16m. P.M., the west declination was between 23° 19′ and 23° 31′.

	h.	m.			
"At	2	19	P.M. the west declination was	23°	36′

"Between 2h. 20m. P.M. and 3h. 9m. P.M., the west declination was between 23° 15′ and 23° 37′.

	h.	m.			
"At	3	10	P.M. the west declination was	23°	7′
	3	11	„ ditto	22	57

"Between 3h 12m. P.M. and 7h. 0m. P.M. the west declination was between 22° 46′ and 23° 31′, the magnet having been in these extreme positions several times.

	h.	m.			
"At	7	0	P.M. the west declination was	22°	47
„	7	9	„ ditto	22	39
„	7	10	„ ditto	22	34

"Between 7h. 10m. P.M. and 7h. 42m. the west declination was between 22° 30′ and 22° 57′.

"Between 7 h. 42 m. P.M. and 9 h. 35 m. the west declination was between 22° 48′ and 23° 2′.

	h.	m.			
"At	9	5	P.M. the west declination was	23°	18′
„	10	20	„ ditto	22	44
„	10	50	„ ditto	23	18
„	11	20	„ ditto	22	50

"Between Oct. 23, 11h. 20m. P.M., and Oct. 24, 7h. A.M., the west declination was between 22° 46′ and 23° 14′.

	h.	m.			
"Oct. 24, at	7	0	A.M. the west declination was	22°	33′
„	8	20	„ ditto	22	52
„	9	20	„ ditto	22	55
„	10	20	„ ditto	23	2
„	11	20	„ ditto	23	6

	h.	m.			
"Oct. 24, at	0	20	P.M.	the west declination was.....	23° 8′
„	1	20	„	ditto	23 6
„	2	20	„	ditto	23 13
„	3	20	„	ditto	22 49
„	4	20	„	ditto	23 10

"Between 4h. 20m. P.M. and 6h. 20m. P.M. the changes were large, and frequently the extreme positions between these times were 22° 38′ and 23 12.

	h.	m.		h.	m.					
"Between	6	34	P.M. and	6	46	P.M. the west declinations were	22°	36′ and	23°	13′
„	6	47	„	6	58	ditto	22	12 „	22	38
„	7	0	„	7	7	ditto	22	43 „	22	54
„	7	7	„	8	36	ditto	22	30 „	23	5
„	8	39	„	9	45	ditto	22	46 „	23	8
„	9	45	„	10	32	ditto	22	57 „	23	39

"And between these times several large changes took place. Between 10h. 36m. P.M. and 11h. 29m. P.M. the west declinations were between 22° 48′ and 23° 9′.

	h.	m.			
"At	11	15	P.M.	the west declination was	23° 16′
„	11	35	„	ditto	21 55
"Midnight				ditto	23 21
"Oct. 25, at	0	10	A.M.	ditto	22 34
„	0	20	„	ditto	23 20
„	0	25	„	ditto	22 40
„	0	40	„	ditto	23 39

"Between Oct. 23, 11h. 0m. P.M., and Oct. 24, 1h. 0m. A.M., the changes of position were very large, and very frequent; at times the magnet moved across the field so rapidly, that a difficulty was experienced in following it. After the latter time the change was gradual till

	h.	m.			
"Oct. 25, at	1	35	A.M.	the west declination was	23° 0′
„	2	5	„	ditto	23 30

"And between 2h. 5m. A.M. and 4h. 20m. A.M. there was a constant change of position, both backwards and forwards, but with a continual tendency to decrease the west declination, which was 22° 52′ at the latter time.

"Between 4h. 20m. A.M. and 7h. 20m. A.M. there was a constant change of position, as before, but with a continual tendency to increase the declination, which was 23° 34′ at the latter time.

	h.	m.			
"Oct. 25, at	8	20	A.M.	the west declination was	22° 58′
,,	9	30	,,	ditto	23 22
,,	10	20	,,	ditto	23 8
,,	11	20	,,	ditto	23 8

"Between 11h. 20m. A.M. and 3h. 50m. P.M. small changes of position were very frequent; the extreme positions between these times were 22° 50′ and 23° 26′. Between 3h. 50m. P.M. and 5h. 50m. P.M. the magnet was steady, the west declination being 23° 6′; after this a few changes only took place, and after midnight the disturbance entirely ceased.

"The changes of position of the horizontal force magnet were as large and as frequent as those of the declination magnet. The observed range of horizontal force was between 22 and 66 divisions of the scale, where each division corresponds to 0·00023175 parts of the whole horizontal force, and therefore the variation of force was more than one-tenth part of the whole horizontal force. The next reading of the scale was between 53 and 56 divisions, and therefore the great change of force was to diminish the horizontal constant of the magnetic dip. The time of the greatest change in the position of this instrument was at about 10h. P.M. on the 24th.

	h.	m.		div.
"On Oct. 24 at	9	50	the scale reading was	53·8
,,	9	56	ditto	53·5
,,	10	0	ditto	46·5
,,	10	6	ditto	22·0

This magnet was at this time in a position such that it had never been since the establishment of the Magnetic Observatory.

	h.	m.	s.		div.
"On Oct. 24, at	10	6	30	the scale reading was	35·0
,,	7	0		ditto	38·3
,,	7	30		ditto	35·4
,,	7	40		ditto	34·5

and after this time the readings increased, but they did not reach 53 div. till noon on the 25th.

"The changes of position of the vertical force magnet were at no time large, as compared with the change of position of the other two instruments.

"From the preceding account it will be seen that this disturbance seems to have commenced on the 22nd day, and to have continued till after noon on the 25th day. On Saturday the 23rd., the sky was clouded at Greenwich, so that if an Aurora existed, it could not have been seen.

"At Grassmere, Cumberland, the sky was clear, and an Aurora was seen. It commenced about 8h. 45m. and lasted about 40 minutes. The moon was shining brightly

at the time. The sides of the mountains around Grassmere were slightly covered with snow on the morning of the 21st of October, being the first that has fallen here this season.

"The account of the Aurora as seen here on the 24th, I have already sent you.

"The range of the declination magnet during this disturbance was about $1\frac{1}{4}°$, the departure from its mean position being nearly as much on one side as on the other. This disturbance was not so great, as far as the declination magnet is concerned, as that on the 24th of September, but it was much greater with respect to the horizontal force magnet. The motions of both magnets in both disturbances were attended by a peculiar mechanical agitation, and which they only exhibit on rare occasions. It is worthy of remark, that whilst no arch-formation was seen at Greenwich, although the Aurora was most splendid at 10h. P.M. on the 24th, the great change in the position of the horizontal force took place, being many times greater than the changes at this time in the position of the declination magnet, yet on the arch being formed, the great changes took place in the position of the declination magnet, greatly exceeding those in the positions of the horizontal force magnet at the same time."

"I am, Sir,

"Your obedient Servant,

"To Mr. Morgan." "JAMES GLAISHER."

AURORA SEEN AT CAMBRIDGE OBSERVATORY.

SEPTEMBER 21, 1846.

THE beautiful specimen of Aurora Borealis, of which Plate I. is a representation, was seen September 21, 1846, about 7h. 45m. P.M. The vertex of the arc lay directly W.N.W.; in a short time there appeared another, as though it were a reflexion, though it singularly happened to be the most perfect, at the same time that the inner was the brightest. In reference to one another, they were so placed that, if produced, they would have cut. The extreme elevation of the upper arc I consider to have been about 15°. Excepting the appearance of the clouds as represented in the engraving, the sky was quite clear.

I remarked that stars were distinctly visible near and around the phenomenon, though the sky had almost a brownish tint, especially near the horizon. The Aurora as illustrated, lasted only for a short time in character, though the position it had occupied continued to be illumined till midnight by Auroral light.

The singularity of this specimen of Aurora consists in the two arcs *not* being concentric. It has been generally supposed, when two or more have been seen, that the more elevated ones are reflexions of the Aurora Borealis, caused by the light being reflected to the observers by frozen particles; but this argument applies only to phenomena seen during severe frosts. In the present case, as I have before observed, the arcs were apparently *eccentric*. On my attention first being called to this particular, I was inclined to believe the definition of the outer arc to be caused by an intervening cloud, but occasional streamers shooting across the black portion, convinced me this was not the case. The streamers inclined considerably to the West during the whole time, and the portion of the outer arc lay towards that quarter.

With respect to the tint assumed by the surrounding sky—from the undiminished lustre of the several stars seen within the arcs—I am inclined to believe the colour to be only the effect of contrast with the luminous arc; for if this tinted segment were indeed something real, surely they would be rendered indistinct, or at the least, would partake of the colour more or less.

Unfortunately, I have not received any communication concerning this Aurora, and am therefore unable to produce any confirmatory evidence on the peculiarities which I have endeavoured to describe. It would be unsafe to affirm that the hitherto determined fact of these arcs being concentric, is by this single instance disproved, first—because the supposition I have gone upon to explain away its distinction from others, may probably be correct; and secondly, because there seems no reasonable argument to account for the formation of a second arc, other than that already quoted, viz. by the reflexion of the lowest one. The temperature at the time was 50° and the minimum of that day only 48°.

AURORA SEEN AT THE CAMBRIDGE OBSERVATORY,

MARCH 19, 1847.

*This meteor began to be visible a little before the close of twilight: the day had been quite cloudless from sunrise, and the barometer, as also on the preceding day, falling rapidly: about six o'clock in the evening, a bank of clouds (cumulo-stratus) appeared in the western horizon, and gradually rose higher, till they reached an altitude of 20° the wind being then S.S.E.; at 6h. 35m. P.M., this cloud was separated into several smaller parts, assuming the character of cirro-stratus, and all of them moved towards the North, where they disappeared; a bank of cumulo-stratus still remaining on the horizon in the S.W. the whole evening.

As early as 6h. 50m. P.M., it was observed that the sky from W. by S. to N.N.E round by N. was more than usually bright; this was first attributed to the moon and the strong twilight at that hour, but as the brightness of the sky still continued without much diminution, attention was especially directed to this quarter of the heavens for the expected Aurora. At 7h. 26m. the first decisive appearance of this phenomenon was seen in the form of a very black circular segment, each corner of which rested upon the horizon, one in the N.W. by W. the other in the N.E., while the vertex of this dark arc was situated about 7° W. of the astronomical meridian, with an altitude of about $8\frac{1}{4}°$; at first sight it seemed to be a hazy fog or light cloud, but as two stars, α Lyræ, and α Cygni, were soon after seen in the midst of it, there no longer remained any doubt as to its nature: at 7h. 44m. two concentric luminous arcs were formed round this black segment, being most perfect towards the N.E.; in another minute, and almost instantaneously, several streamers shot up to an altitude of 38°, each being at right angles to the parts of the arcs from whence they proceeded; after this, or about 7h. 50m. the black segment below the arcs vanished, but streamers still continued to dart up in great numbers, being mostly of a white colour, a few were pink, and one, which appeared like a sheet of light, had a pulsating motion: those streamers which proceeded from the N.W. and W., after attaining an altitude of about 45° curved towards the South: after 8h. 10m. the streamers were much less numerous, and the arc was no longer seen in the N.W.

8h. 35m. At this hour, there seemed to be an arch forming N. of the astronomical zenith, having the appearance of a faint band, nearly perpendicular to the plane of the magnetic meridian; it remained like this until 8h. 45m., when it appeared to shoot up very suddenly from the W.S.W., passing close to Capella, and through part of the Great Bear. In a few minutes it soon extended across the entire sky to the N.E. by E., passing close to the star Arcturus. "At 8h. $50\frac{1}{2}$m., the lower border passed a very little above γ Orionis, and about as much below Pollux, the upper border passed through Castor: its axis passed also between the stars γ and μ on the feet of the Twins,

* Plate II.

rather nearer to the former than to the other. It terminated at a point between Arcturus and β Andromedæ, distant from the former by about 4-10ths of the interval between the stars. At 8h. 57m. α and γ Orionis were equi-distant from its axis on opposite sides. At 9h. 0m. its upper border was a little below α Orionis, and its lower border as much above δ Orionis. At 9h. 13m. its upper border was as much above δ Orionis, as the lower was below ε Orionis, and the lower border passed midway between ε and ζ Orionis."

"At 9h. 10½m., the lower border just covered δ Orionis, and passed a little above β Canis Minoris. Near the meridian, two stars, γ and δ Cancri, were one on the upper, and the other on the lower border; the breadth measured by the positions of these two stars was 3° 20′, which was nearly the maximum apparent breadth at the time; at 9h. 14½m. it passed entirely below γ and δ Cancri; at 9h. 15½m., it covered the belt of Orion."* The whole arch had a progressive motion to the S.S.E., and appeared to move in such a manner that its vertex was always on the magnetic meridian, or nearly so, the direction of the motion being perpendicular to that meridian: the portion to the S.W. appeared to move more quickly than the remaining part, but it did not extend to the horizon towards the N.E. after 8h. 50m., whereas it appeared to sink below in the S.W. at the time the clouds rose and obscured it, at 9h. 16m. At 9h. 49m., there was a slight break in the clouds, but the bow could not be distinguished. The mean height of this Auroral arch, as determined by Professors Challis and Chevallier, was 177 miles above the surface of the earth. The following are the meteorological observations taken at the Cambridge Observatory, just before and after the appearance of this meteor.

DAY.	BAROM. 9 A.M.	THERM.			BAROM. 3 P.M.	THERM.			Min. Ther.	Max. Ther.
		Att.	Ext.	Wet.		Att.	Ext.	Wet.		
	in.	deg.	deg.	deg.	in.	deg.	deg.	deg.	deg.	deg.
March 18.	29·897.	45·2	48·3	42·4	29·889.	49·9	59·7	46·3	34·3	64·0
„ 19	29·718.	45·1	47·4	41·8	29·660.	50·2	56·9	45·9	33·9	58·0
„ 20	29·548.	48·8	48·9	46·8	29·566.	50·2	56·8	48.6	45·0	61·9

* Communicated by Professor Challis to the *Cambridge Chronicle*, March 27.

APPENDIX.

Mr. Phillips, of York, preluded his communication to the *Athenæum*, on the Aurora Borealis of Oct. 24, with the following remark:—"Thinking it probable that we may have a grand auroral season, and that by recording *concisely* those features of the "northern lights" which really bear on the physical theory of their origin, you may not unworthily occupy from time to time a few columns of the *Athenæum*." * * * This has been so directly followed by many displays of Aurora, and the circumstances that have preceded them have been so very similar, that the accompanying general remarks will, perhaps, prove of additional interest to the reader.

On Nov. 1, about 7h., P.M. a faint appearance of Aurora was seen in the N.N.W., it remained merely as extra light in that quarter during the night. At 10h. 45m., P.M. one slightly coloured streamer shot up from the N.W. by N. The mean reading of the barometer on this day was 30·350 in.; attached thermometer 56°, the max. and min. thermometers 60° 9 and 49° 2 respectively.

The next Aurora was seen on Nov. 19, at Cambridge, by Mr. Barber; of which the following notes will convey some idea.

At 8h. 36m. (mean Cambridge time), perceiving that the magnetic needle was very considerably disturbed, and suspecting that an Aurora was the cause, I went to examine the sky towards the N.W., and saw a streamer of a dull red colour exactly N. 23° W. which reached to an altitude of 45° on the magnetic meridian; at the same time there appeared to be considerable haze near to the horizon, which, being fringed with the red light of the Aurora, gave to it a very curious colour, resembling the intermixture of orange and red in the solar spectrum; several other streamers soon appeared, attaining an average altitude of 38°; they appeared to proceed from behind the haze during the whole time that they remained visible, and no appearance of an arc was seen at all.

This lasted more or less until 8h. 55m., when the meteor suddenly assumed so glaring an appearance, that it seemed as if the phenomenon was to be of more than usual brilliancy; at this hour the sky was perfectly crimson between N.W. and N. 55° E.: at 8h. 56m. a bright sheet of red rose in the N.E., being about 12° broad and 30° high: at 9h. 0m. it attained its maximum brightness, being equal to the celebrated Aurora of the 24th of October, but it only remained in this state for 4m.: during this time *(i.e.)* between 8h. 56m. and 9h. 4m., the oscillations of the needle were greatest, and appeared to commence about 48 seconds before the streamers were visible; and when they became brightest the needle was nearly stationary, but deviated to the E. of the magnetic meridian: 9h. 10m. a streamer passed through δ and ζ Ursæ Majoris, being 2° broad and reaching to an altitude of 30°; this suddenly disappeared at 9h. 12½m., being unlike the former ones, and also those of the 24th of October, which always lasted for some time.

A few streamers and sheets of flame continued to be seen till 9h. 24m., when they gradually faded, and no re-appearance of red light was noticed, though the N.N.W. horizon was unusually bright till past 1h. A.M. of the 20th. The oscillations of the needle still, however, continued, the deviation being mostly towards the E. The colour of the upper portion of these rays was of that remarkable transparency and brightness, so conspicuous in the meteor of October 24, but presented a striking difference in the length of time they remained visible; possessing more of the shooting character which is generally observed in the white streamers. Two currents existed in the atmosphere when the Aurora was visible, the lower being S. and the upper, from an observation of a cloud which passed over the moon, N.E. The sky was generally very clear, and a sharp frost from sunset to about 4h. A.M., when it became cloudy.

Again, at 4h. A.M. of December 1, an Aurora appeared in the N. and N.E., it afterwards extended to N.W. and E. appearing at 4h. 15m. like a rose-coloured sunrise, extending to an altitude of 20°; about the same time there were two streamers in the N.E. by N. also of a rose colour; the tint of these varied considerably, sometimes being very bright and at others faint. This phenomenon remained visible until twilight; the sky during the whole time was beautifully clear, the wind was from the W.S.W. but not very strong, and the temperature was low.

Early in the evening of the following day (December 2), a very brilliant Aurora was seen, though it was very indistinct at intervals, by black cumulo-stratus clouds interrupting the view. The phenomenon consisted principally of streamers, generally white, with a tint of yellow: some of them near the N. were 10° and 12° in breadth, they shot up to an altitude of 50°: one red ray about 11h. was seen through α and β Ursæ Majoris. From 11h. to 11h. 12m. large sheets of light seemed to rise up from the horizon to an altitude of 8°, extending from N.N.W. to N. by E.; they seemed very much like sheet lightning. The Aurora was principally confined to W.N.W. and N.N.E., and at 11h. 56m. was entirely concealed by very dense clouds. The wind was supposed to come from W.S.W.

The last Aurora we have observed was that on the evening of Dec. 19. The sky during the day had been mostly covered with cloud, and at 7h. 15m. P.M. a slight rain fell. At 10h. 0m., and, indeed, for some time previous, a well-defined halo was seen around the moon, and at 10h. 5m. the North was first seen to be brilliantly illuminated with auroral light: at the time mentioned, the rays were principally about 8° from the horizon, and extended from N.N.E. to N.N.W. in one long line, like a curtain of a pale yellow; here and there cirrus clouds broke the continuity of it, but as they slowly moved away, the parts became visible. The height of these streamers was about 2°; immediately above this line, and directly N., there was a constant palpitating motion, which at each vibration ascended towards the zenith, about half a degree at a time, while the base of the streamers continued to increase, and the other extremity to decrease. In less than a minute they had gained the circumference of the lunar halo; some went beyond this, and met in the magnetic zenith, while others seemed to have abruptly broken off. The zenith was now intensely red, so deeply coloured that the stars were of the same hue. At 10h. 20m. the phenomenon had attained its greatest brilliancy, and was then very similar to the representation given in Plate II. of the Aurora of Oct. 24. Nearly W. there was a broad band of red, about N. 20° W. there was a sharply defined white

one, passing completely to the zenith, and about N. 15° W. commenced the first streamer of a number making in form a fan-like shape, the breadth of which was about 10°. Most of the streamers composing this form met at a point in the magnetic zenith. At 10h. 23m. the whole began to fade rapidly, and at 10h. 25m. there was nothing remaining but a faint red colour in those parts where it had been observed during the whole time. A bank of cumulo-stratus clouds, about 5° in height from the horizon, extended to N. from E., and great patches of cirrus and cirro-cumulus were scattered about.

It is worthy of remark, that the generality of the phenomena of which we have in this little book made mention, took place after heavy falls of rain and great depressions of the barometer, *i. e.* when the atmospheric electricity was most active; but soon before the meteor appeared the mercury rapidly ascended. This particularly applies to the Auroræ of Oct. 24 and Dec. 19, and as the following registers of rain, temperature, and atmospheric pressure, before and after the days on which we have observed these meteors may prove interesting, we here subjoin them.

The meteorological observations applying to the Auroræ of Sept. 21, 1846, March 19, and Oct. 24, 1847, have been given in their proper places, the amount of rain registered as having fallen on Oct. 23, was 0·881 in., on Sept. 21, 1846, and March 19, 1847, there was no rain preceding or for some time after, but on Nov. 18, there was ·072 in.; on Dec, 1, 2, and 19, there was ·059, ·127, and ·409 in. respectively.

9 A.M.							3 P.M.					
Day of Month. 1847.	BAROM.	THERMOMETERS.					BAROM.	THERMOMETERS.			Direct. of Wind.	Amount of Rain.
		Att.	Ext.	Wet.	Min.	Max.		Att.	Ext.	Wet.		
	in.	deg.	deg.	deg.	deg.	deg.	in.	deg.	deg.	deg.		in.
Dec. 18	29·547	49·4	47·1	45·9	45·1	48·5	29·411	48·2	46·1	45·1	S.	
„ 19	·492	44·9	39·3	38·9	31·9	45·1	·509	46·1	42·2	40·9	N.E.	·409
„ 20	·770	43·2	38·4	37·2	34·8	50·3	·749	43·1	38·2	36·9	N.	

ON THE METHODS OF OBSERVING THE AURORA BOREALIS.

To be enabled to arrive at any conclusions concerning the origin and nature of this meteor, it is absolutely necessary to make accurate observations upon it. These will principally consist in the places of the most striking part of the phenomenon, referred to the fixed stars, together with the time at which the observation was taken. Should two observers, at a distance from each other, direct their attention to the same part of the Aurora, these would determine its height above the earth's surface. As, however, it is generally rather difficult to guess what part would be most likely to be observed by another person, it might be better to take more observations, both in number and of different parts of the Aurora. Such an appearance as a corona, appearing so distinct and for so long a time together as on the 24th of October, 1847, is a most desirable point for observers to direct their attention to, or indeed any other point which does not possess a rapid motion; secondly, in observations of the magnetic needle, which is always considerably disturbed in these latitudes before the meteor commences to be visible. One of two things is evidently the cause of this disturbance; either that the electricity giving rise to the Aurora directly affects this instrument, or that the intensity of the earth's magnetism is constantly varying during its visibility. M. Arago remarks, that the needle at Paris has been disturbed by an Aurora below the horizon, but whose existence is known from the observations of the polar navigators. This raises a *primâ facie* presumption in favour of the latter hypothesis. Probably, this point might be determined by making use of an astatic needle, which is uninfluenced by the earth's magnetism, but affected by a current circulating above it. The intensity of the atmospheric electricity is also a point worth attending to, but does not appear to have been tested by any observer at present; meteorological observations are also likely to disclose new facts, particular attention being paid to the wind, and whether two or more currents exist in the atmosphere at the time. It might also be desirable to measure the lengths of the streamers, when, if the height be known, the depth of the stratum of electricity passing towards the magnetic equator would also be known approximately, since the streamers are always parallel to the dipping needle. As it appears highly probable that the Aurora is becoming more frequent than formerly, these remarks just mentioned may be either proved or not within a short time: however, the extension of our knowledge with regard to terrestrial magnetism and electricity will soon be so far advanced as to take a place with any of the other sciences, and the theory of the Aurora determined with as great correctness as that of the heavenly bodies.

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ERRATA.

Page 4, line 23, dele last δ, and read the word "and" before ζ

Page 13, head line, insert "the" before Cambridge

Page 13, line 1, for Plate I. read "Plate XI."

Page 14, in note, for Plate II., read "Plate XII."