We shall not attempt to describe the Maya chronology. It is a complicated and highly developed system. The larger part of Morley's book is devoted to the description of it. His exposition is admirably clear. No specimens of Maya computation are extant. Maya records contain only the results of computation. It is evident that considerable reckoning is involved in Maya chronology. The Maya had a sacred year of 260 days, an official year of 360 days and a solar year of 365 + days. The fact that $360 = 18 \times 20$ seems to account for the break in the vigesimal system, making 18 (rather than 20) uinals equal to 1 tun. Apparently, the Maya found the lowest common multiple of 260 and 365, or 18,980. In their calendar 18,980 days consituted the "Calendar Round," a period of 52 years which is "the most important period of Maya chronology." Using this period, the Maya developed an elaborate system of counting time, "wherein any date of the Calendar Round could be fixed with absolute certainty within a period of 374,400 years."

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SPECIAL ARTICLES

THE FOCUS OF THE AURORAL STREAMERS ON AUGUST 26, 1916

IN a recent number of SCIENCE[1] the remarkable auroral display of August 26 was described by Professor C. C. Nutting, as observed by him at Lake Douglas in northern Michigan. The phenomenon was reported to have been of unusual intensity and beauty. The appearance of streamers in the southern sky was particularly noted, as well as the fact that the auroral glow prevailed around the entire vault of the heavens, causing the earth to be illuminated without shadows.

This aurora was widespread because it was also seen in northern New York, in New Hampshire, in Nova Scotia, and over the Gulf of St. Lawrence. According to a letter in the current issue of SCIENCE,[2] it was observed as far south as Martha's Vineyard, Mass. In each case the characteristics so well described by Professor Nutting were observed.

It has been reported as far west as Washta, Ia., by F. S. Carrington.[3] In this case the streamers in the northeast passed to the south of the zenith, and the glow in the southern horizon reached to about 30°.

The aurora evidently extended eastward to the British Isles, because a bright display was reported by Mr. W. F. Denning at Bristol, England, from 2 to 4 A.M., August 27. The streamers were observed to an altitude of 70° in the northern sky, and moved rapidly from west to east.[4]

It was seen at Eskdalemuir, Dumfriesshire, from 9 P.M., August 26, to past midnight, accompanied by considerable disturbance of the magnets at the Kew Observatory. The magnetic storm commenced suddenly at 7:45 P.M., August 26. It was observed at Seskin, Waterford, in Ireland, from 10:05 to 10:40 P.M., August 26, the streamers in the northern sky stretching to within 20° or 30° of the zenith.[5]

The aurora was seen on the north shore of Prince Edward Island by the writer, who noted some of its interesting features; among which was the location of the apparent focus of the auroral streamers with respect to some readily identified stars. To this particular attention was paid.

GENERAL FEATURES OF THE AURORA

The writer was on a wide stretch of water and observed the beginning of the aurora, which occurred at 8:15 P.M. Atlantic time, the sky being perfectly clear. The glow at first showed dimly in the southern sky, but rapidly increased in intensity until the entire southern portion of the vault of the heavens was pierced by pale greenish lance-like streamers. Those overhead terminated in a well defined focus, southeast of the zenith, as shown in Fig. 1.

For some minutes there was no evidence whatever of an aurora to the north. Later, streamers rose in that section, and soon the

[1] N. S., Vol. XLIV., October 6, 1916.
[2] N. S., Vol. XLIV., October 20, 1916.
[3] *The Guide to Nature*, November, 1916, p. 191.
[4] *Nature*, Vol. 97, 2444, August 31, 1916.
[5] *Nature*, Vol. 98, 2447, September 21, 1916.

entire sky had the appearance of a luminous umbrella; the well defined center of which was southeast of the zenith. A short time after the commencement of the aurora a band-like corona stretched across the greater portion of the heavens from east to west through the focus, as shown in Fig. 2, and at another time a large irregular corona formed around that region of the sky.

Hampshire. In the report it was stated that the aurora covered the southern sky and that the "umbrella" effect of the streamers showed a center a short distance south of the zenith.

It was seen also by Dr. J. A. Brown, professor of physics in the Syrian Protestant College, Beirut, Syria, who was on a lake in the Adirondacks, N. Y., and who described the display to the writer as a very remarkable one.

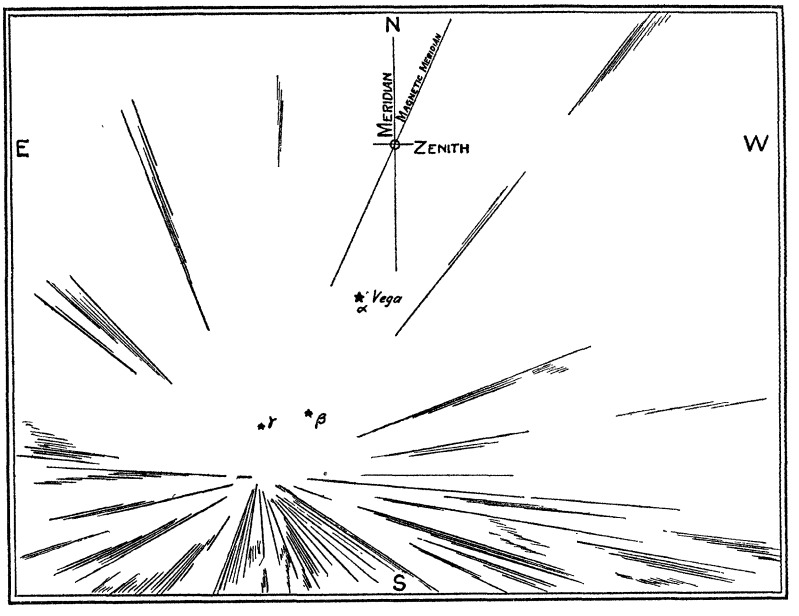

Fig. 1. Auroral focus as it appeared at 8:20 P.M., August 26, at Prince Edward Island. (*The heavens are shown as they appear when facing south and looking at the zenith.*)

The auroral glow showed the very rapid kaleidoscopic changes described by Professor Nutting and the phenomenon was indeed inspiring on account of the unusual grandeur of the display. The color of the streamers as seen from Prince Edward Island throughout the entire evening was pale greenish; almost white, and at no time reddish or the intense light green frequently observed.

The earth appeared as if illuminated by bright moonlight, except the striking effect due to the absence of all shadows, as already reported by Professor Nutting.

The aurora has been reported in a letter to the *Monthly Evening Sky Map* by Mr. Frank C. Porter, who observed it at Ashland, New

His attention was directed to the aurora with special interest on observing the streamers in the southern sky.

The occurrence of the aurora borealis in the southern half of the heavens appears to be an infrequent phenomenon; at least in the temperate zone of North America.

An aurora was observed by the writer some years ago on September 11 at Grand Lake, Maine, which completely arched the southern sky with bright streamers. That display began about eight o'clock in the evening and lasted several hours. At first, no auroral phenomenon appeared north of the zenith, but as the evening advanced a faint glow was seen in the north. Particular note was made at the

time that the streamers in the southern as well as the northern sky appeared to meet a considerable number of degrees to the southeast of the zenith, but the exact location was not observed. One fact of similarity between these two appearances of the aurora in the southern sky was that in both cases the streamers appeared in the southern half of the heavens before any indication of an aurora showed in the north; as if some condition of the atmosphere susceptible to an auroral display had been reached to the south before it has been reached to the north of the point of observation, indicating some progressive change in the atmosphere from south to north.

Professor Nutting, describing the aurora in his article in SCIENCE, states that the "focus of the spectacle was the zenith itself." So it might appear with a casual glance, being near the zenith, and with nothing to mark that point. His paper is mainly concerned with other features of the display and is an excellent description of them, but the position among the stars toward which the streamers converged was evidently not noted.

The place of observation where the aurora was observed by the writer was about fourteen miles north of Charlottetown, Prince

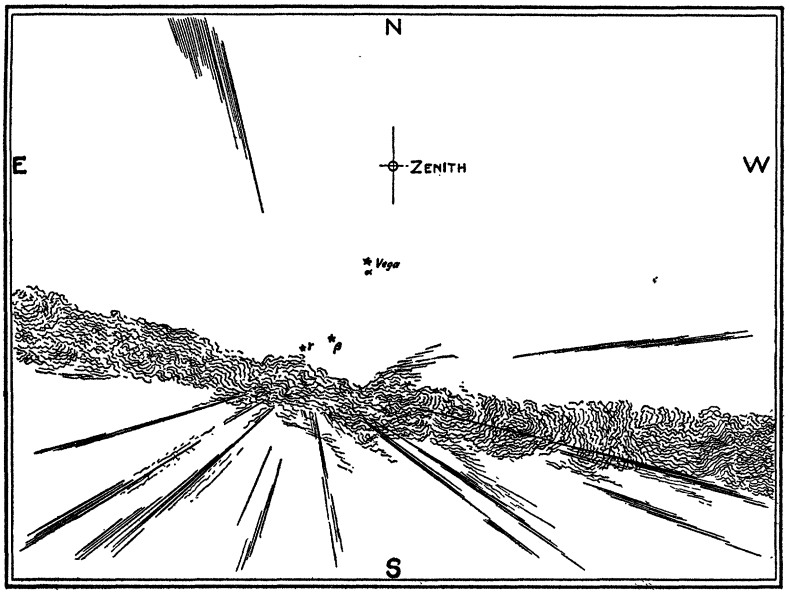

FIG. 2. Auroral corona forming a luminous band across the sky passing through the focus as observed about 8:25 P.M.

THE FOCUS OF THE STREAMERS

The position of the apparent focus of the streamers near the zenith is of special importance owing to the relation of the direction of the streamers to the direction of the lines of force of the magnetic field of the earth. The point of focus was located about two degrees south of the star γ Lyra at 8:20 o'clock Atlantic time. The time was later verified through the local telegraph office. The spot in the heavens could apparently be located within an area of the size of the full moon, which has an angular diameter of about one half degree.

Edward Island, which is at latitude 46° 13′ 58.48″, longitude 63° 7′ 23.64″ according to values provided by the Department of Mines, Canada. The latitude of the place of observation is taken as 46° 26′ and longitude as 63° 8′. Mr. C. S. Brainin, of Columbia University, has kindly computed the position of the zenith with respect to the stars at the time of observation, which gives that point as shown in Fig. 1. The zenith distance of the

auroral focus thus determined is 16° 54′ and the azimuth of that point, 22° 42′ E. The accuracy of the observation, however, can not be considered better than about one degree.

It is of course desirable to compare these values with the magnetic elements of the place of observation.

The Canadian government is now engaged in making a magnetic survey, and has made observations at nearly five hundred stations in Canada, but none recently on Prince Edward Island. Fortunately, the department of terrestrial magnetism of the Carnegie Institution of Washington has been able to provide values for the magnetic declination and inclination at Charlottetown, P. E. I., which were determined in 1908. They are as follows:

Declination 23° 46′.4 W. for the epoch 1908.8
Inclination 74° 59′.3 N. for the epoch 1908.8

Dr. L. A. Bauer has kindly given me the average rates of annual change of both the declination and inclination during the period from 1908 to 1916, as well as the direction of the isogonics and isoclinals for 1916.8, which makes it possible to give the declination at the place of observation as 24° 36″ W., and the inclination 75° 04′ N. A comparison of the focus point of the aurora and the above values is as follows:

Magnetic Field Auroral Focus	Declination, 24° 36″ Azimuth, 22° 42′	Inclination, 75° 04′ Altitude, 73° 06′
Difference.....	1° 54′	1° 58′

While the accuracy of the determination of the auroral focus is only one degree, it is about as close as other determinations. The observation may be unique, owing to the fact that the focus was formed by streamers in the southern as well as in the northern sky, that the point in the heavens was determined from the focus itself, and not from a corona, and at a station as far south as latitude 46°.

Elaborate observations have been made during several Arctic expeditions of the azimuth of the summits of aurora arcs, but there seems to be no definite coincidence between the azimuth measured and the magnetic meridian, the angular differences being often many degrees, sometimes as great as 20° to 40°. No explanation has been given for this anomaly. The corona center has been measured at a number of stations at high latitudes, and as a rule has been found to agree with the magnetic zenith to within about one degree.

At Cape Thorsden (78° 28′ N. Lat.) the mean of a considerable number of observations made the angle between the auroral focus and the lines of the earth's magnetism 1° 7′, the magnetic inclination being 80° 35′, while the coronal center had an altitude of 79° 55′. Somewhat smaller differences have been reported at other far northern stations.

The height of this aurora may be taken at about sixty-five miles above the surface of the earth, if the results of Carl Störmer's auroral expedition are accepted, as recorded in *Nature*,[6] and reproduced in Fig. 3. Approximately 2,400 of these determinations have been transferred from the chart in Professor Störmer's report and used to make the curve in Fig. 4. It is seen that the maximum height for the aurora according to this set of observations is between 55 and 80 miles.

The position of the auroral focus thus shows the direction of the field of terrestrial magnetism at about sixty-five miles above the surface of the earth.

The lines of force of the earth's magnetism as determined by the auroral focus should curve downward and pierce the earth's crust at about the place of observation, 14 miles north of Charlottetown. It is therefore proper to compare the direction of the magnetic field shown by the auroral streamers with the magnetic declination and inclination at that place. The observed values of both declination and inclination at 65 miles altitude are less than the values at the surface of the earth (each by about two degrees). This is exactly what should be expected since above the surface of the earth the lines of force curve towards the south pole as in the case of any magnet. Assuming the aurora to be at this height, the point on the surface of the earth directly beneath the apparent focus was about 14 miles

[6] *Nature*, Vol. 97, No. 2418, March 2, 1916.

southeast of Charlottetown and on Prince Edward Island at approximately latitude 46° 6′, longitude 62° 53′. The auroral streamers near the zenith may be regarded as approximately parallel and their apparent focus is of course due to perspective.

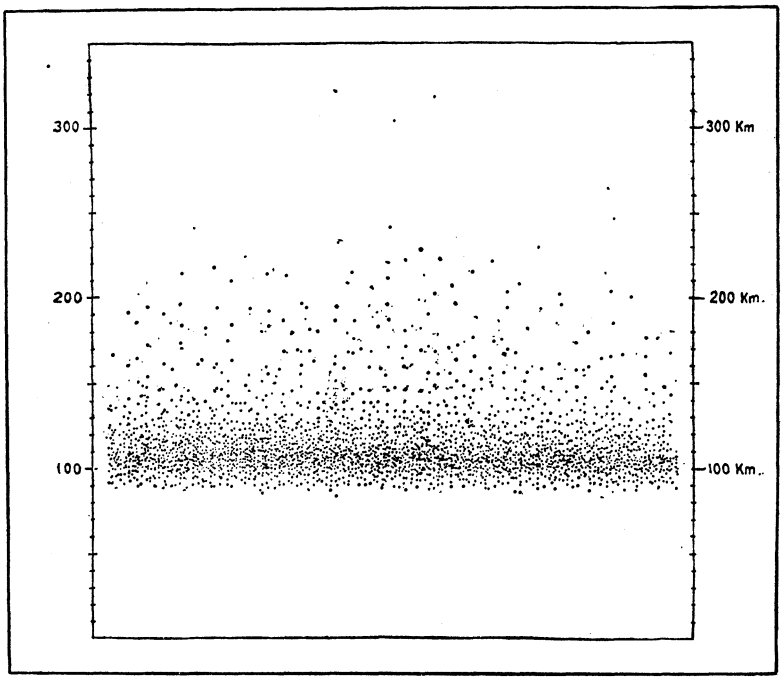

FIG. 3. The altitude of aurora borealis seen from Bossekop during the spring of 1913. Each calculated attitude is marked by a dot and the several hundred simultaneous photographs of aurora from the stations—Bossekop and Store Korsnes—(mutual distance 27½ kilometers) gave about 2,500 determinations of height, which are seen above. (Reprinted from *Nature*.)

HEIGHT OF THE AURORA AND THE METEOR TRAIN ZONE

One of the results of the study of meteor trains has been the discovery of a definite meteor train zone between 50 and 70 miles' altitude. When certain large meteors pass into this zone, a train is observed to remain in the track, apparently composed of self-luminous gas and which frequently remains visible for half an hour. Nitrogen has been found to assume a true phosphorescent state similar to the afterglow of zinc sulphide.[7] It has been observed to remain visible in the laboratory for 20 minutes. There is much evidence in favor of the view that the meteor train is phosphorescent nitrogen and formed in the same zone in the atmosphere which is susceptible to electrical discharges and results in the aurora.

In Fig. 4, curve *A*, the heights of 2,400 observations of the aurora made by Carl Störmer's expedition are shown. Curve *B* shows the heights of the middle portion of 30 meteor trains, and curve *C* gives the heights of the lower ends of 21 meteor trains.

The initial intensity of gas phosphorescence has been found to be proportional to the third power of the gas pressure;[8] hence it is to be expected that meteor trains would show a predominance at slightly lower elevation than the aurora, as indicated in Fig. 4.

[7] C. C. Trowbridge, *Phys. Review*, Vol. XXVI., June, 1908.

[8] C. C. Trowbridge, *Phys. Rev.*, Vol. XXXII., February, 1911.

It is thus evident that there is a zone in the atmosphere susceptible to electrical conductivity beginning at about 50 miles from the surface of the earth as shown by both the auroral height determinations and those of focus of the aurora of August 26 were at a height above the earth's surface not far from sixty to sixty-five miles.

C. C. Trowbridge
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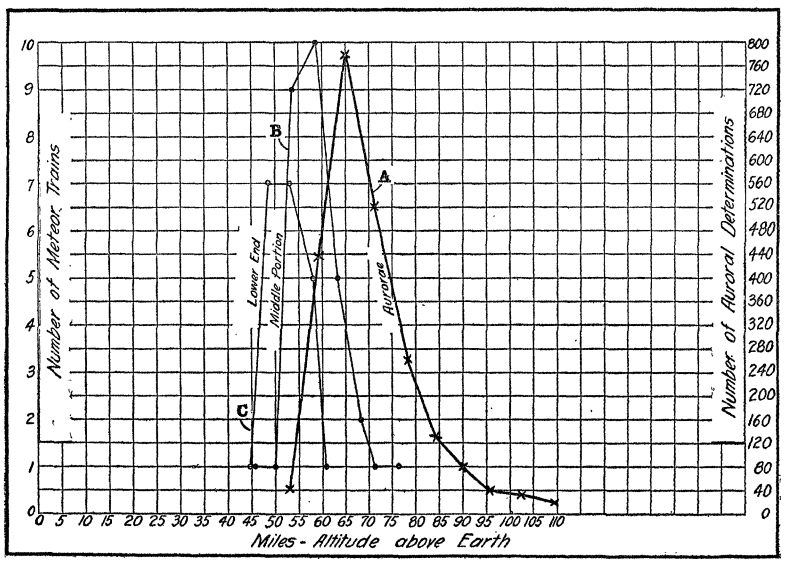

Fig. 4. Comparison of the heights of the aurora, determined by Carl Störmer's expedition at Bossekop during the spring of 1913, and the heights of meteor trains. In both cases the altitudes were determined by triangulation from two stations.

Curve *A*—2,400 determinations of the heights of the aurora.

Curve *B*—the heights of the middle portion of 30 meteor trains.

Curve *C*—the heights of the lower end of 21 meteor trains.

the meteor trains. The conducting layer in the earth's atmosphere which has been much discussed by those interested in the propagation of long electric waves is usually given as at an altitude of 35 to 40 miles by various writers on wireless telegraphy, as based on some theoretical deductions of Professor J. J. Thomson. The results given above seem to show that the main conducting layer of the atmosphere is considerably above the altitude heretofore accepted, and is at a height of from 50 to 70 miles.

The general agreement between the recently determined values of auroral heights and the altitude limits of the meteor train zone shown in Fig. 4 is very significant, and there is thus good evidence that the streamers forming the

THE NINETEENTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY

The nineteenth meeting of the American Astronomical Society was held in the Sproul Observatory of Swarthmore College, Swarthmore, Pennsylvania, on August 30 to September 2, 1916. This was the first meeting held east of the Allegheny Mountains since 1911, intervening meetings having been held in Pittsburgh, Cleveland, Atlanta, Evanston, and San Francisco.

It has been the policy of the society for some years past to hold its meetings at some one of the active observatories of the country. Astronomers are dependent, in a considerable measure in the nature of their contributions, on the equipment of their various observatories, and for a large part on the character and size of the telescope. It is, therefore, always of interest in the meetings to