AURORAS: SOME RECENT THEORIES.

It has long been known that the compass needle, which usually points northward and is inclined at an angle to the horizon (its dip), is disturbed and oscillates when an aurora is seen in the sky. This common effect led the celebrated Halley in 1714 to hazard the conjecture that the aurora is a magnetic phenomenon. The last few years have seen the equipment of expeditions to Iceland, Finland, and northern America for the principal object of observing the earth's magnetic disturbances. There are two theories on the subject, one due to Prof. Birkeland of Christiania, and the other to Prof. Svante Arrhenius of Stockholm.

It has long been known that violet light rays and the invisible rays of the spectrum beyond the violet, which can be detected by photography, have the property of discharging a negatively electrified body. It is suggested by Prof. Birkeland that the spots on the sun are caused by solar eruptions, or to use a familiar word, volcanoes; and that the sun then emits negatively-charged corpuscles similar to those which are believed to constitute, partly at least, the cathode rays—rays producing those utilized for surgical practice in taking photographs of bones. Prof. Birkeland supposes that such corpuscles are "sucked" into the earth's magnetic poles, giving rise to vortices of electric currents in the upper regions of the atmosphere. It is indeed known that such rays are deviated by a magnet; and also that the presence of large solar spots is always accompanied by magnetic "storms" on the earth and the appearance of frequent and brilliant auroras.

Arrhenius believes that the corpuscles emitted by the sun are not inconceivably minute bodies, but that they have an appreciable size; that they are, let us say, the thousandth of a millimeter, or one twenty-five-thousandth of an inch, in diameter, and that they are expelled from the sun by the repulsive action of light. That light is thus capable of thrusting particles out into space despite the enormous pull of solar gravitation is now conceded. Profs. Nichols and Hull have experimentally proved that light does exert pressure, so that there is nothing inconsistent with Arrhenius's supposition.

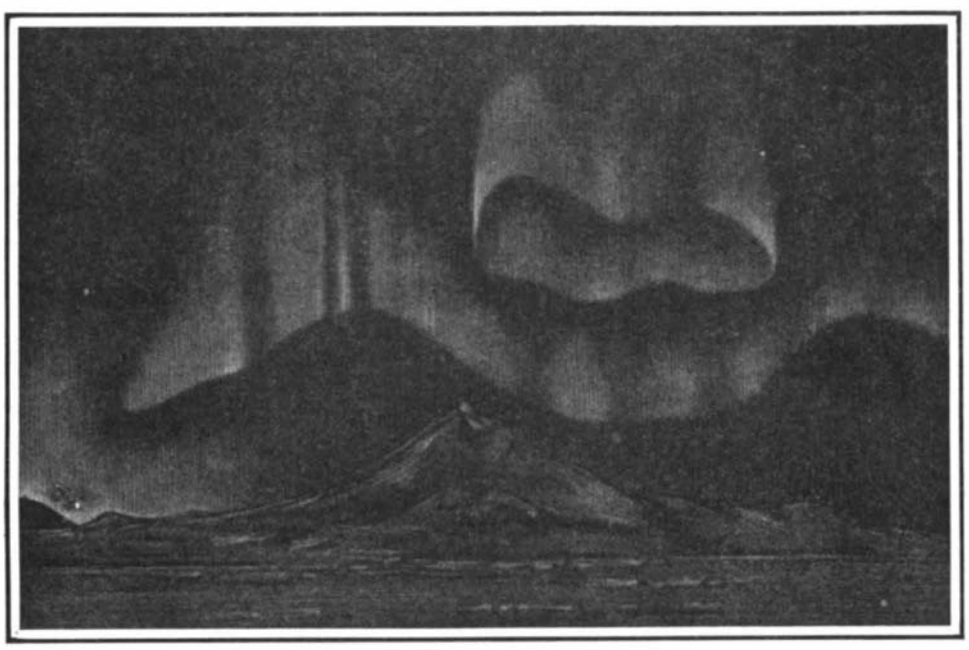
Whether Birkeland or Arrhenius is right, it is likely that negatively electrified gaseous molecules are present in the upper regions of the atmosphere, and it is also likely that these molecules receive their charge most readily where they are most exposed to a vertical sun—that is, at or near the equator. Upper aerial currents, according to Prof. James Thomson, would carry these and other molecules toward the poles. They would move spirally northward and southward with an easterly trend. As they approach the poles their number per unit area will obviously increase; for the terrestrial parallels of latitude decrease in circumference the nearer they are to the poles. It is to be expected that before the actual poles are reached, the potential of the upper air should increase to such an extent as to produce a luminous discharge, in the form of a ring or halo, with the magnetic poles as their centers. It is conceivably this ring which we see as an arch in the sky.

Prof. Paulsen divides auroras into two classes. Those of the first class are widely extended, quite steady, and show no streamers. In general, they rise slowly toward the zenith and do not affect the magnetic needle. An aurora of this type usually appears in the form of an arch, or a number of arches. Extended regions of the Arctic and Antarctic sky often glow with a faint light like translucent clouds. Sometimes these luminous masses are so near the ground that they appear in front of hills not more than 1,000 feet high. In northern Finland Paulsen observed the characteristic line of auroras in the spectrum of the light emitted by the air between a spectroscope and a black cloth a few yards distant.

Auroras of the second class are distinguished by characteristic streamers or rays, either sharply separated or blending at the bottom and presenting the appearance of curtains flapping in the wind. The rays are nearly parallel with the dipping needle and when seen in perspective appear to diverge from the center of a radially-striped corona. Auroras of this class are not steady, but are traversed by series of luminous waves. As they rise from the northern horizon, they deflect the needle of the compass to the east, but after passing the zenith they cause a westward deviation. Hence, Paulsen infers that these streamers are only rays in which negative electricity moves downward. Auroras of the first class are more akin to phosphorescence, involving little movement, but the two types often quickly succeed each other.

That there is some connection between auroras and the sun is indicated by the fact that the radiate auroras closely follow the eleven-year sun-spot period. The coronal streamers of an aurora seem to have small velocity in years of minimum spot frequency, and very high velocity in years of maximum activity. Besides the eleven-year period, several others can be traced in auroral phenomena. There is an annual periodicity which Arrhenius explains by his solar dust theory. A period of 26 days seems to affect auroras, terrestrial magnetism, and thunder storms. It has long been ascribed to the sun's rotation. A daily period and one equal to a tropical month (27.3 days) have also been traced, but are difficult of observation.

Antarctic auroral streamers.



Antarctic auroral arc and curtain above, July 5th, 1902, 0 h. 30 m. A. M.

FORMS OF THE AURORA AUSTRALIS.

When the spectroscope is turned on an aurora, a green light is noted. Many other lines have been photographed, but this line is extraordinarily intense, and, indeed, can often be seen when there is no visible aurora, by simply directing a pocket spectroscope toward the north. When first observed, the line was not known to be characteristic of the spectrum of any element. In 1898 Sir William Ramsay announced the discovery of three new ingredients of the atmosphere, to which the names neon, krypton, and xenon were given. The spectrum of neon is characterized by many red, orange, and yellow lines, while that of xenon shows many green and blue lines. The light evolved from tubes containing these gases under low pressure when an electric current of high tension is passed through them is of a corresponding hue. Thus, neon sends out a blended rose or flame-colored light; xenon a sky-blue, while the light of krypton is naturally white, although seen by some people as pale lilac, and by others of a pale green color.

When the wave lengths of the more important lines of krypton were measured, one was found, a very brilliant green line, which had a wave length of 5,570.5. The green line of the aurora to which reference has already been made has a wave length of 5.570 units. The identity of the two is such that Sir William Ramsay has been led to the conclusion that the aurora may be produced by electrical discharges in the upper atmosphere through a gas in which krypton is present in considerable amount. He has calculated the maximum height of an aurora on the supposition that the krypton line is no longer visible when the pressure falls below 0.000035 millimeter, the pressure observed when in a mixture of krypton and helium the green light of krypton becomes faint and almost invisible. From this he concludes that the height of an aurora is about 135 kilometers, or 84 miles. Prof. Birkeland places the altitude at 100 to 200 kilometers, or 62.5 to 125 miles. Hence there is a fair agreement between Ramsay's and Birkeland's estimates, although arrived at by entirely different means.

Whatever may be the cause of the aurora it cannot be denied that the phenomenon is the most beautiful of the earth's frigid zones. Perhaps the most eloquent description of an aurora is that which has been penned by Alexander von Humboldt, which reads as follows:

"Low down in the distant horizon, about the part of the heavens which is intersected by the magnetic meridian (i. e., the point to which the compass-needle is directed), the sky, which was previously clear, is at once overcast. A dense wall or bank of cloud seems to rise higher and higher, and it attains an elevation of 8 or 10 deg. The color of the dark segment passes into brown or violet, and stars are visible through the smoky stratum, as when a dense smoke darkens the sky. A broad, brightly luminous arch, first white, then yellow, encircles the dark segment. . . . The luminous arch remains sometimes for hours together, flashing and kindling in ever-varying undulations before rays and streamers emanate from it and shoot up to the zenith. The more intense the discharge of the northern light, the more bright is the play of colors, through all the varying gradations from violet and bluish-white to green and crimson. The magnetic columns of flame rise either singly from the luminous arch, blended with black rays similar to thick smoke, or simultaneously in many opposite points of the horizon, uniting together to form a flickering sea of flame, whose brilliant beauty admits of no adequate description, as the luminous waves are every moment assuming new and varying forms. Round the point in the vault of heaven which corresponds to the direction of the inclination of the needle, the beams unite together to form the corona—the crown of the northern light—which encircles the summit of the heavenly canopy with a milder radiance and unflickering emanations of light. It is only in rare instances that a perfect crown or circle is formed; but, on its completion, the phenomenon has invariably reached its maximum, and the radiations become less frequent, shorter, and more colorless. The crown and the luminous arches break up, and the whole vault of heaven becomes covered with irregularly scattered broad, faint, almost ashy gray, luminous, immovable patches, which in their turn disappear, leaving nothing but a trace of the dark, smoke-like segment on the horizon. There often remains nothing of the whole spectacle but a white, delicate cloud, with feathery edges, or divided at equal distances into small roundish groups, like cirro-cumuli."

Holes for tree planting have been excavated by the Long Island Railway by blasting with dynamite. Two men can excavate 250 holes per 10-hour day at a cost of about 7½ cents per hole.

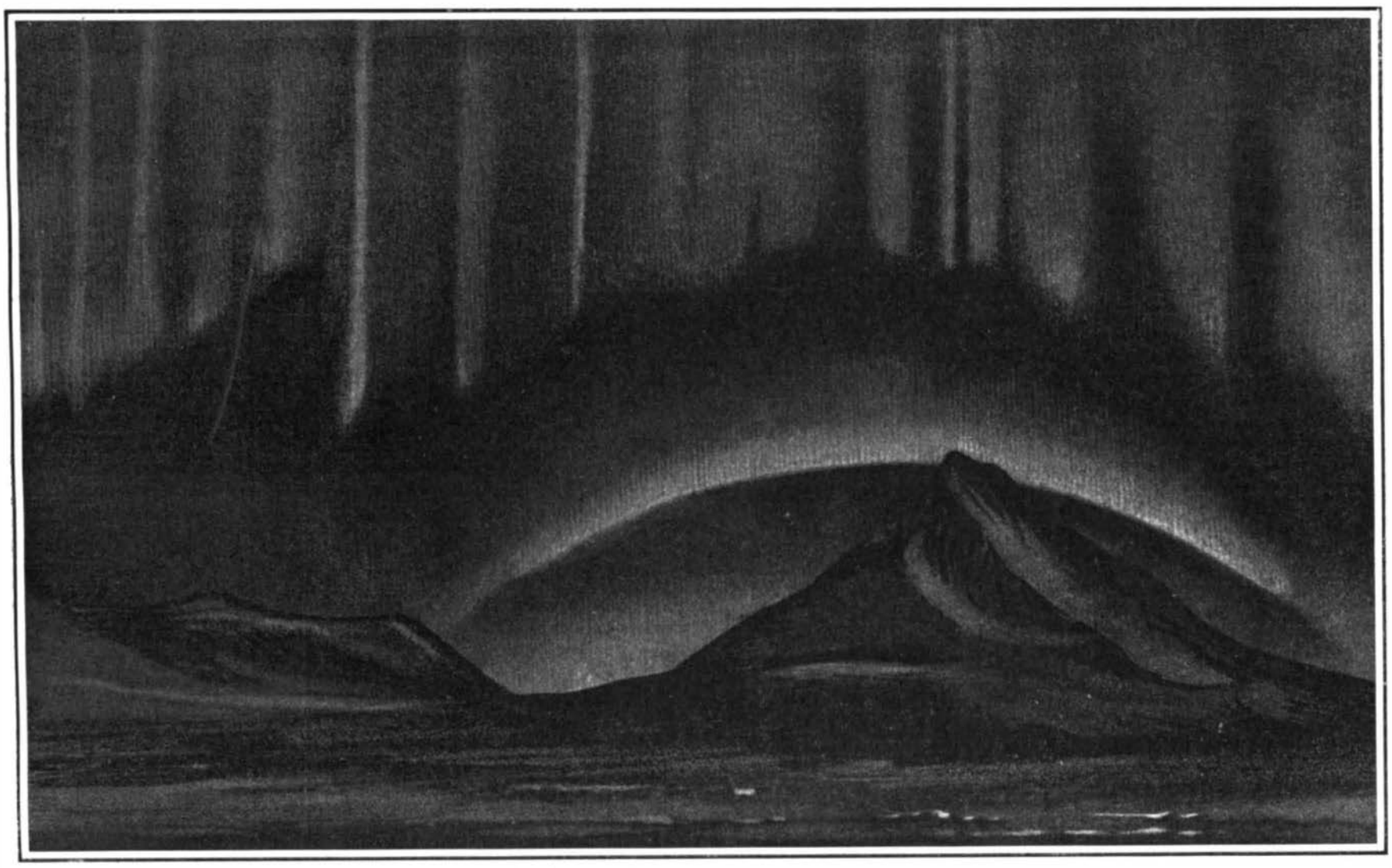
SCIENTIFIC AMERICAN

[Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1909, by Munn & Co.]

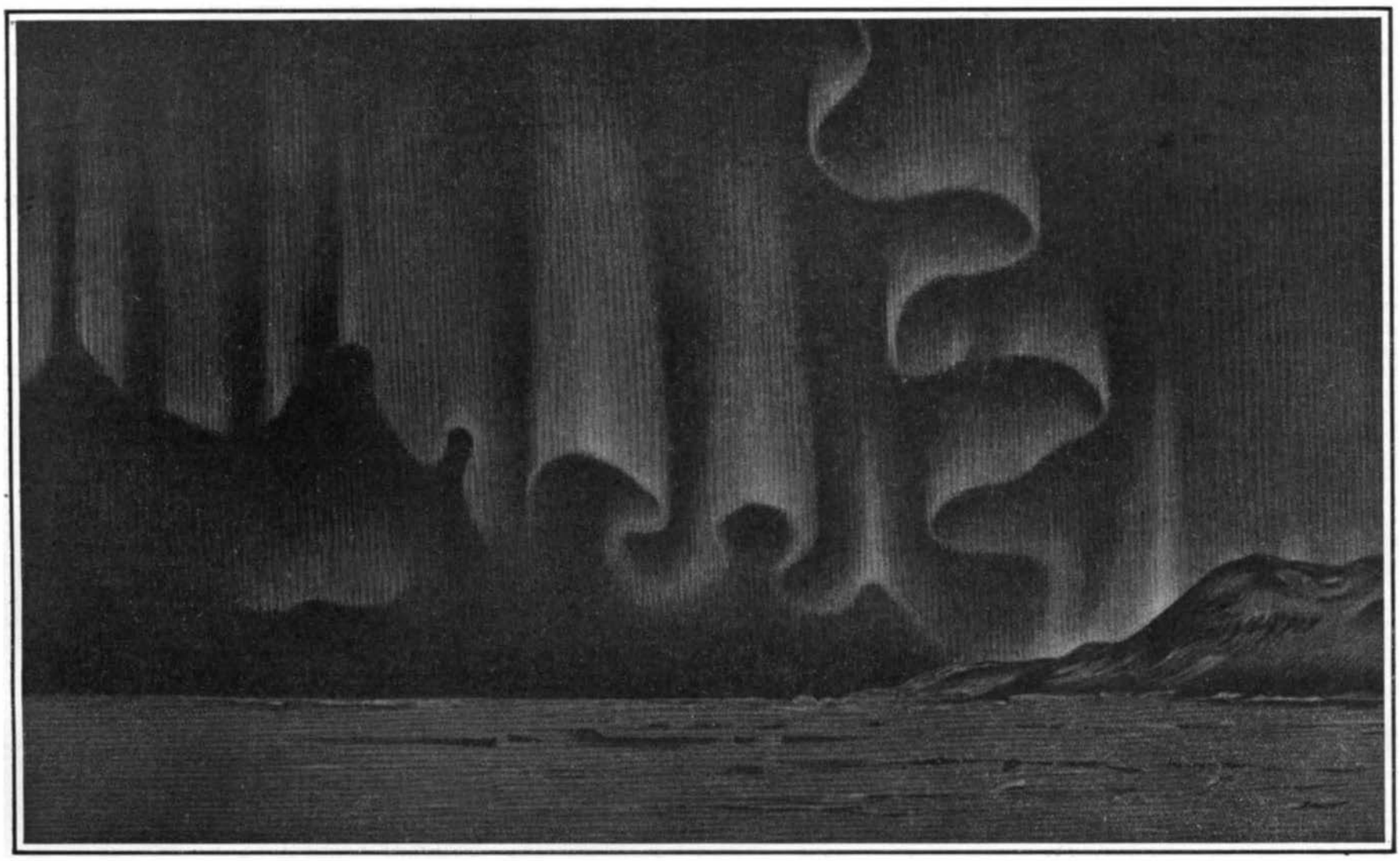
Vol. C.—No. 23.
ESTABLISHED 1845.

NEW YORK, JUNE 5, 1909.

10 CENTS A COPY
$3.00 A YEAR.



Double auroral arc with vertical rays in the upper arc (August 29th, 1902, 2 h. A. M.) as seen within the Antarctic Circle.



Study of an auroral curtain made on July 5th, 1902 (1 h. A. M. to 2 h. A. M.) during the National Antarctic Expedition (1901).

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FORMS OF THE AURORA AUSTRALIS.—[See page 424.]