Terrestrial Magnetism and Atmospheric Electricity

VOLUME XXI

DECEMBER, 1916

NUMBER 4

PRELIMINARY REPORT ON THE RESULTS OF THE AURORA-BOREALIS EXPEDITION TO BOSSEKOP IN THE SPRING OF 1913. (FIFTH COMMUNICATION.)

BY CARL STÖRMER, *Kristiania*.

1. In this Journal for September, 1913, March and December, 1915, and June, 1916, I published preliminary reports on my aurora-borealis expedition of the spring of 1913. The present communication relates to the material of the last two nights, March 30 and April 1, 1913, comprising about 90 auroral photograms.

Fig. 1 shows the distribution of calculated altitudes of auroras above the surface of the Earth. These altitudes are not as concentrated around the 100 km. level as in the corresponding cases of March 14-15 and 16 to 29, mainly owing to the fact that the auroras of April 1-2 were all very faint and relatively tranquil.

2. I shall now consider some of the photograms taken during the night of March 30 and 31. In accordance with the method previously adopted, the aurora seen from Bossekop was drawn, and a series of points were chosen along its edges and rays; each point was then connected by means of a dotted line with the corresponding position of the same point seen from the other station. The length of this line measured in degrees then gives us the parallax. The computation gave the following altitudes in km.:

No..	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Alt..	120	121	111	108	112	117	122	125	124	123	117	115	127	129	115	113	109

The relatively high position of this aurora is in harmony with its faintness, as compared with the curtains descending to 90-100 km.

The next 4 photograms exhibit the above-mentioned intense development of auroral displays between 10^h 40^m and 10^h 50^m. The first, taken at 10^h 45^m, shows a very pronounced arc near the star Capella. The altitudes in this case are as follows in kilometers:

Number.....	1	2	3	4	5	6	7
Altitude.....	109	107	106	108	104	105	105

FIG. 1.

During the succeeding minutes the arc developed into some of the most splendid curtains that I have ever seen. The intensity was extremely great, and the aurora radiated in various colors, particularly green, white, and red. The altitudes in km. are:

Number.....	1	2	3	4	5	6	7	8
Altitude.....	116	94	93	91	89	97	92	97

As will be observed, the curtain penetrated down to the lower limit of altitude for the auroras observed on our expedition of 1913. Plate XI shows the aspect of the curtain at 10^h 46^m 22^s, exposure 2 sec. Only the lowermost luminous part of the curtain has acted on the photographic plate (Ultra rapid, Hauff, Feuerbach).

The extension in a vertical direction of the most luminous part of the auroral curtain is of fundamental importance in the question of the absorption of the auroral corpuscles in the Earth's atmosphere.¹ A first computation of this vertical thickness in km. gave:

Near point number.....	3	5	7
Thickness.....	27	19	28

At 10^h 46^m 37^s, another photogram (Plate XII) was taken, with an exposure of 2 sec. During the exposure the camera at Bossekop was slightly moved, thus producing double stars; however, the

¹ See P. LENARD: Über die Absorption der Nordlichtsstrahlen in der Erdatmosphäre, Sitzungsberichte der Heidelberger Akademie der Wissenschaften, 1911, and also my Geneva paper: Sur les trajectoires des corpuscles électrisés dans l'espace etc., Archives des Sciences physiques et naturelles, T. XXXII.

Photographed from Store Korsnes.
AURORA, MARCH 30, 10^h 46^m 22^s, 1913.

Photographed from Bossekop.

Photographed from Store Korsnes.
AURORA, MARCH 30, 10^h 46^m 37^s, 1913.

Photographed from Bossekop.

movement was so slight that no appreciable effect was produced in the parallax. The altitudes of the points here are in kilometers:

Number.....	1	2	3	4	5
Altitude.....	99	99	98	97	95

The vertical thicknesses of the curtain's most luminous part are:

Near point number.....	2	3	4	5
Thickness.....	27	28	29	24

I may return later to the consequences of these computations.

For a later stage of the development of the aurora, at 10^h 48^m 12^s, 3 seconds exposure, the following altitudes in km. result:

Number.....	1	2	3	4	5
Altitude.....	99	110	111	102	92

3. I shall mention finally some interesting photograms of the night of April 1-2. During that night the auroras were very faint and tranquil, very different from those, for instance, that occurred on March 14-15. Along the right border of the ray a series of points were chosen, the following altitudes in kilometers being obtained:

Number.....	1	2	3	4	5
Altitude.....	245	222	191	170	153

The corpuscular rays producing the auroral ray had consequently very slight penetrating power, and are probably essentially different from those descending to about 90 kilometers above the ground. As stated before, the aurora on the night in question was very faint and tranquil. For a long period there were only some very faint arcs over the northern sky, and no aurora was visible elsewhere. A photogram of two arcs of this kind, taken at 12^h 05^m, is seen in the plate published in the *Astrophysical Journal*, November, 1913, vol. 38, p. 311. These arcs were so faint that it was just possible to see them, and in consequence the exposure was a very long one—1 minute. The constellation Perseus appeared in the background. I was very curious to see whether these areas lay very high in the air, but on computation it was found that the altitude was not at all unusual. The points selected gave the altitudes in km.:

Number.....	1	2	3	4	5	6
Altitude.....	104	101	94	90	92	92

Because the arcs are very faint and diffuse, the determination of their altitudes and positions is probably somewhat uncertain.

On April 1-2 the display was terminated by a curtain far away in the northwest, lasting from 12^h 43^m until 12^h 46^m. Six successive photograms were taken. The altitudes in km. are:

Number.....	1	2	3	4	5	6
Altitude.....	131	110	117	116	117	114

Along the lower edge was a small luminous border with vertical thickness in km., according to a preliminary computation, as follows:

Near point number.....	3	4	5	6
Thickness.....	12	12	11	12

This thickness is much less than that for the previous cases.

The next photograph was taken at 12^h 44^m, and another at 12^h 44^m 37^s. We have shown in the latter a very characteristic auroral curtain, frequently observed, especially on days of faint and tranquil auroral display. The curtain is folded, and the left portion has its light augmented because we are looking at the curtain tangentially; the altitudes in kilometers are:

Number...	1	2	3	4	5	6	7	8	9	10
Altitude...	161	140	119	109	108	128	104	103	112	120

The vertical thicknesses in kilometers of the most luminous part near the lower border of the curtain are:

Near point number.....	7	8	9
Thickness.....	14	13	14

The next photograph, at 12^h 45^m 04^s, was taken more to the north, with Capella in the background. The altitudes in km. are here:

Number.....	1	2	3	4	5
Altitude.....	124	120	111	114	112

The vertical thicknesses in km. of the most luminous part are:

Near point number.....	2	3	4	5
Thickness.....	10	10	11	10

Two more photographs of the same aurora were taken, namely at 12^h 45^m 22^s and 12^h 45^m 54^s. They gave positions marked on the chart in Fig. 2 as V and VI. For purposes of comparison, two circles with radii of 21° and 22°, respectively, and with their centers on the magnetic axis of the Earth, are drawn on the chart. They represent, as is well known, magnetic parallels, if we drop all the terms, except the first, from the spherical-harmonic series representing the Earth's magnetic potential in space. The relative positions of the auroral curtains with respect to these circles are of theoretical importance, as mentioned in former reports. I shall return to this question in the discussion of the whole material.

FIG. 2.