RESULTS OF THE PHOTOGRAMMETRIC MEASUREMENTS OF THE AURORA BOREALIS DURING THE NORWEGIAN-FRENCH POLAR EXPEDITION TO NORTH-EAST GREENLAND 1938—1939

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Summary. In this paper the visual observations and photographs of aurora made during the Norwegian French Expedition to North East Greenland 1938—39 are given, together with measurements of height and situation of the aurora photographed simultaneously from two stations. The stations in action were: Micardbu (Latitude 77°, 4′.2, Longitude 18° 12′ W Gr.), photographer Mr. Hatlevik, Koldewey (76° 43′.2, 19° 3′.8), photographer Mr. Tillier and the Danish station Mørkefjord (76° 56′.1, 20° 18′.2) photographer Mr. Sølver.

The aurora log of visual observations was made by Mr. Hatlevik at the station Micardbu over the period from November 22, 1938 to March 24, 1939. Photographs of aurora were taken on November 22, December 17, 18, 20, 21, 22, 23, 24, January 9, 14, 15, 18, 19, February 8, 13, 14, 16, 17, 18 and March 12. Usable simultaneous photographs from two stations were taken on December 17, 21, January 9, 14, 15, February 17 and March 12.

In all 92 simultaneous sets were taken, giving height and situation of 391 points of the aurora. In addition to this come 35 extrapolated heights.

The maximum of frequency of all heights is situated near 105 km.

For arcs, the maximum of frequency for the lower border lies between 105 and 110 km.

Much sharper is the frequency maximum of the lower border of bands with ray structure (curtains), near 104 km.

As to rays, the situation is rather variable. The summits, however, lie in general lower than 300 km. No sunlit rays have been measured.

On the whole the distribution of heights is very similar to that observed in Bossekop in Northern Norway.

The direction of auroral arcs has been mapped assuming a reasonable height of the lower border. Comparing this with the direction of the horizontal magnetic force it is seen that the auroral arcs have a tendency to run perpendicular to this direction. The material is, however, rather scanty to draw general conclusions about the direction of the arcs.

A good picture of a corona gave as coordinates of the point of radiation azimuth 33°, east of south, and altitude 80°.7 above the horizon.

PART I

Short Account of Preparations for the Auroral Work.

1. Introduction.

During the spring of 1938 Mr. WILLIE KNUTSEN, member of the Norwegian-French Polar Expedition to North-East Greenland, financed by Comte GASTON MICARD, asked me if I would lend aurora cameras to the expedition and give necessary information on aurora work, as such work was included in the program of the expedition.

As the expedition intended to go so far as to 80° northern latitude, it would be most interesting to get information on height and situation of the aurora so near the magnetic axis of the earth, and I therefore lent two aurora cameras to the expedition of the type used during the polar year and belonging to the International Association of Geodesy and Geophysics; further three pocket spectroscopes and two copies of the photographic atlas of auroral forms with supplements also belonging to the association, and some starmaps.

From the foundation "Det Videnskapelige Forskningsfond av 1919" I obtained a grant of 1500 Norwegian crowns to buy telephones, plates and photographic equipment, and I made an agreement with Willie Knutsen that the collected material should remain at my disposal when he came back to Norway.

From our experience in southern Norway, a large stock of the excellent plates *Agfa Isopan ISS* in sealed iron boxes was secured. These plates, which are very sensible to red and also sensible to the other colors of the spectrum are the best plates I have used for auroral work. They are also very durable; when the expedition came back to Norway I secured the rest of the plates and used them in southern Norway during the following 3 years with great success. Even now, in 1943, they are still usable, but the sensitiveness is reduced to about 0.75 to 0.5 of what it was in 1938.

Before the departure of the expedition I gave Mr. HATLEVIK, who was in charge of the aurora work on the expedition, necessary advice as to the use of the aurora cameras and during some aurora nights in Oslo he and Mr. TILLIER worked with us at our aurora station and gained experience in the choice of time of exposure and handling of the cameras.

In the following the results of the observations and the measurements of the aurora pictures obtained will be given in detail.

2. Mr. Hatlevik's Report.

I asked Mr. Hatlevik to give me a report of his work and so he did in a letter to me dated September 19, 1941. After a short report of the aim of the expedition and the agreement with me he continues:

"The plans of the expedition were briefly to force as far north as possible along the north-east coast of Greenland. A motor sealer — "Ringsel" — of 70 ton was bought, further an aeroplane to be used for observations in the polar ice and for the eventual foundation of a sub-station as far north as possible, and further 48 sled-dogs for transport and sled-excursions along the north coast. A few days before the departure from Norway the aeroplane, however, crashed. One of the telephone transmitters which was preliminarily placed in the aeroplane was destroyed. At the very last moment a new tube and other parts for a new transmitter were secured.

On July 18, 1938, the expedition left Tromsø, and on July 25, after a happy crossing and without special difficulties, we arrived at Eskimonæs in Claveringfjord. On August 7 we reached Danmarkshavn and stayed here till August 24, when at last the ice along the Germanialand sacked. The vessel reached as far as 77° 04′.2 N, where it was again forced to stay on account of the ice. Our little house and food were put on the edge of the firm ice, 2—3 kilometers from the shore, and then the vessel moved southwards and found a very fine winter harbour at the north part of Store Koldewey-Island, 76° 43′.2 N, 19° 3′.8 W. Until the middle of October we were busy with the transport of the equipment and the setting up of the house and radio-masts and the hunting of musk-oxen to provide fresh meat for the winter. The station was named "Micardbu" — and the country is described in the following way in the account of the Danish expedition:

"A waste and barren country, deserted by god and man, vast gray stony surfaces, relieved here and there by a hill. Here and there a decomposed rock, emerging up from the sand, or near the sandy shore some lonely Eskimo-ruins, which make the depressing feeling of death and destruction even more unenduring — thus appears the coast from Kap Bismarck up to the south side of Skjærfjorden."

However, the chief point was that the land was flat with free horizon.

The work was already often disturbed by storm and fog. This was specially true of the sub-station for the photographing of aurora, and after we had determined the position of our vessel we resolved to use it as sub-station. Tillier began to build a new telephone transmitter and prepared to begin the photographic work from the vessel on Koldewey. On November 15 Eigil Knuth, the chief of the Danish Gamma expedition, with base in Mørkefjord (76° 56′.1 N, 20° 18′.2 W) together with Engineer Sølver and the Greenlanders Sakæus and Eli, arrived at Micardbu, on their return from a depot journey. We then agreed to photograph simultaneously from Micardbu, Koldewey and Mørkefjord, as Sølver was in posession of an excellent radio station with telephone transmitter. On November 24 Tillier went southwards to Koldewey to make the radio station there ready and begin the photographic work. On November 30 we got in telephonic connection both with Mørkefjord and Koldewey. We were now ready, but we did not get our first set of pictures with Koldewey before December 17. Our further work will appear from the Aurora log, p. 8.

The first aurora was seen on September 26, at $01^h\ 00^m$, faint rays in the east sky. In the months October, until December 15 we noted aurora at the time of the usual meteorological observations, 01^h, 07^h, 13^h and 18^h G.M.T. (Month schemes of meteorological observations have been given to the Meteorological

Institute, Oslo, and on these the appearance of aurora at the above mentioned times has been added). The last aurora was observed on March 30, faint rays in SE. From December 15 the telegraphist Åmodt and myself shared the watches between us and observed at least every hour. In the dark season I was engaged with the measuring of radiation with Ångström's pyrgeometer, and during this time I obtained rather continuous observations of aurora. In the evening the aurora was strongest and most frequent and we then arranged that we called Koldewey and Mørkefjord at 18^h G. M. T. and had further connection every half hour. Mørkefjord had the receiver continuously directed on Micardbu; we could therefore call at any time. We then watched for aurora several times during the night.

The cold did not disturb the astrocameras, they worked well the whole time. We further arranged a dark room and tentatively developed some plates.

Our clothing was the usual polarfur outfit.

The hut was covered with snow; the mount with the camera was therefore placed at the level of the roof, so that I could speak with Åmodt through the wall. I gave instructions for the photographing in the microphone, Åmodt was inside the hut, noted down and made chronometric observations at the same time as he controlled transmitter and receiver. Åmodt attended to Mørkefjord and Koldewey, and with arranged knocking signals he informed me when Mørkefjord and Koldewey were ready to photograph. In this way I was relieved of both microphone and telephone, and this facilitated the work considerably. The conversation took place in agreement with the following scheme: Micardbu: Description. Plate 1, Picture 1, Vega, Plate 1, Picture 1, Vega, 5 sec. . . ready, 1.5, 2.5. . . . 5.5, finished. How did it go? Hallo, Mørkefjord, come again. Mørkefjord: O. K. Micardbu: Hallo Koldewey, come again. Koldewey: O. K.

Åmodt then received acknowledgement from Mørkefjord and Koldewey, and he knocked signals on the wall to me to be ready.

In favourable weather conditions I used to dictate 6 pictures after each other before Mørkefjord and Koldewey acknowledged, and it proved to be all right.

The most important part of this work of observation was the radio connection, and I will finally account for equipment and connection. On Micardbu we had an American amateur "short-wave" transmitter with an antenna-effect of 50 Watt and with the wave lengths 24—36—48—56—98—108 m. Further we had a converter driven alternating current receiver. This was probably damaged during transport, and the receiving was interrupted by noise from the converter. Tillier constructed a telephone transmitter for Koldewey on wavelength 100 to 180 meters and here he used a common battery receiver. However, Tillier most frequently had to answer by telegraph. He then stood on the roof with telephone and telegraphic key and also photographed. The apparatuses were placed in the radio room. This caused difficulties when they had to be re-adjusted. The transmitter had the effect of 10—15 Watt. Koldewey was out of work during January on account of an accident with the apparatus. Mørkefjord had a P. O. Pedersen's transmitter of 35—40 Watt, and a battery receiver. The telegraphist Bæk took care of the radio connection, and Engineer Sølver took the photographs, by getting orders to photograph direct on the head telephone, and then he gave orders to Bæk to be ready, who then signalized by telephone to Åmodt. The transmitter in Mørkefjord worked on the wave lengths 110—190 meters and very often used 151 or 184 meters.

Short waves from 24 to 108 meters were often disturbed, and there was much fading. The wave lengths of Mørkefjord 151—184 meters proved to be the safest waves we made use of. This agrees with the experience of Christian Jensen during the 4 years he spent at the station of the Danish hunting company Nanok on Hvalrossodden, not far from Mørkefjord. Later Åmodt built a long-wave transmitter, 650—700 meter, which proved to be good for telephoning on the line Micardbu—Mørkefjord—Koldewey.

From this it is seen that all the stations should have been in posession of a telephone transmitter of 20—40 Watt whose wave length could be varied continuously from 150—190 meters, and further a good ship battery receiver. This would probably have secured a good connection between the stations.

The plan was to keep the station Micardbu at work for three years. On account of Comte Micard's illness and other circumstances the expedition was concluded in the summer of 1939 with the departure of the vessel from Greenland August 3, 1939, with the members of the expedition."

3. Engineer Sølver's Report.

I also asked Civil-Engineer S. V. Sølver, who was in charge of the aurora work on the Danish North-East Greenland Expedition 1938—1939, to send me a similar report, and here it is:

"On the departure from Denmark the expedition received from Director D. B. la Cour, Meteorological Institute, Copenhagen, a "P. M. Observations of Aurorae on the Expedition to North-East Greenland 1938—1939."

According to these instructions the observations were to embrace:

Visual observations as a contribution to the statistics of the occurrence of aurorae.

Photographing, in order to make a contribution towards the elucidation of the appearence (structure) of the aurorae and their height above the Earth.

A statement of the work is found below.

The type of camera used was Zeiss' Contax II, in which are inserted strips of perforated kinofilm, 35 mm in breadth, giving room for about 36 exposures of the size 24×36 mm. The shutter is an oil-greased metal-slit shutter. The camera was equipped with an Albada-direct vision view finder, which, when light conditions are dull, is easier to use than a finder mounted in the camera. The lens was a Zeiss Sonnar of a focal length of 5 cm; the largest relative aperture was 1:1.5 and the angle of view, relative to the focal length and the diagonal of the image, was 44°.6; (for the camera of Professor Krogness the angle of view was 58°).

The quality of the lens as well as of the camera was such as to give images sharply defined to the very edge, and the images can in all cases be enlarged up to 30 by 40 cm without loss of sharpness.

When photographing aurorae, the camera was screwed on a ball and socket joint which permitted the camera to be directed towards all points on the sky, and to be secured in all positions by a single movement of a handle. This tilting device was by a specially made reducing thread attached to a theodolite stand of substantial construction. When taking the photographs, the observer usually stood on the roof in order to have an unlimited view of the horizon. The camera was equipped with a cable release.

The type of film used was Agfa Isopan Super Special of the sensitivity of 21/10 D. I. N. At a trial development (made in a Correx-box on Nov. 10, 1938) with Agfa Rodinal, 60 times diluted, the following particulars of the exposures under normal conditions were established (relative aperture 1:1.5 and film, the one mentioned above).

Exposure: 3 sec. The brightest stars recognisable. Sufficient exposure for the stars. Aurorae of the intensity of 2 just visible. (Intensity scale: 0 signifying no aurorae, 4 signifying very bright aurorae.)

Exposure 6—9 sec. Aurorae, intensity 1, are seen faintly, but are sufficiently distinguishable.

Exposure 12—15 sec. Seen through a magnifying glass, the stars near the horizon appear as small strokes, near the north pole of the sky still as dots.

Thus it must be possible to photograph quiet aurorae by means of autochrome films, the sensitivity being 15/10° D. I. N.

In February and March, when the expedition ran short of its stock of the above mentioned type of film, Perutz-Peromnia Umkehrfilms 18/10° D. I. N. were used with unsatisfactory result.

On the expedition's return to Denmark, all not yet developed films were after exhaustive trials developed in Kodak D. K. 20.

Apart from one drawback the above instrument material proved satisfactory: It appeared that the shutter worked inefficiently in severe frost. Already at $\div 20°$ it closed very slowly (1—2 sec.), and at $\div 37°$ C it refused to move altogether.

After a thorough investigation of the camera the manufacturer stated that dust and dirt had entered into the closing mechanism, thereby rendering the oil more viscous; but after the shutter had been cleansed and lubricated, it worked blamelessly at $\div 10°$ C. In order to remedy this defect, it is recommended that a folding mechanism be attached in front of the objective, which can be opened and closed without jarring the camera.

Through conversations with the Norwegian-French Polar Expedition at Micardbu in November 1938 a collaboration was established with the Norwegians for the purpose of determining the height of the aurorae above the earth. It was arranged to take photographs simultaneously from the following three stations:

"Micardbu (Norwegian-French) at the east coast of Germanialand 77° 04′.2 lat. N., 18° 12′ long. West of Greenwich.

Kristen Hatlevik: Photographer.

Telegraphist: Sigbjørn Åmodt.

The winter harbour of the "En Avant" (Norwegian-French) at the Northern point of Koldewey.

76° 43′.2 lat. N., about 19° 03′.8 long. West of Greenwich.

Jess. F. Tillier: Photographer and telegraphist.

"Mørkefjord Station" (Danish) at the South coast of Germanialand, outside the mouth of Mørkefjord.

76° 56′.1 lat. N., 20° 18′.2 long. West of Greenwich.

Svend V. Sølver: Photographer.

Kurt Bæk: Telegraphist.

The three stations form approximately an equilateral triangle, the side of the triangle being roughly 50 km in length.[1]

The two Norwegian stations used Professor Krogness's type of camera with 9 by 12 cm plates, each plate having room for 6 images. At the Mørkefjord station the above described Contax camera was used.

For radio technical reasons the photographing had to be directed from Micardbu. The stations at Micardbu and Mørkefjord were both equipped with small wireless transmitters; thus, Mr. Hatlevik stood at the Micardbu station, a michrophone placed beside the camera, while Mr. Tillier (Koldewey) and myself (Mørkefjord), equipped with headphones, worked our cameras according to his directions. For each plate (6 images) taken at Micardbu a mutual conference was held.

The connection was established on the 150 m-band; but as there were often disturbances, the wave length had to be altered.

The time signal was received from Nauen."

PART II.

Aurora Log and List of Photographs Taken.

4. Detailed Aurora Log Made by Mr. Hatlevik.

During his stay in North-East Greenland Mr. Hatlevik made a detailed log of all his observations and photographs of aurora. This log was sent me in Norwegian, and I have translated it to English in comparing it with the aurora negatives.

The following modifications and corrections have been made:

As the great majority of aurorae had the yellow green colour, his remarks "yellow green" etc. have been omitted except where another colour was mentioned.

The time for the middle of the exposure was often given in half seconds. As this has no importance whole seconds are everywhere given. For the constellations the abbrevations adopted at the International Astronomical congress in Rome 1922 are used everywhere.

When photographs of aurora have been taken the indication of aurora form and situation among the stars have been corrected corresponding to the negative. Instead of the name from the Photographic Atlas "Band with ray structure" (RB) the shorter one "Curtain" has been used. Moreover the short indications HA, HB, etc. from this Atlas are given for each picture in Table 3 (section 6).

As to the headings of the aurora log the following has to be explained:

No. means the number of the plate (first number) and of the picture (second number).

St. means the name of the station: M is Micardbu, K is Koldewey and S is Mørkefjord. If pictures have been taken from two or three stations simultaneously, the letters are combined by dashes.

G. M. T. means Greenwich middle time. From November 22, 1939 to February 13, 1939 5^h inclusive the time is given for the *middle* of the exposure. For the rest, from February 13, 1939, the time refers to the *end* of the exposure. From February 11 all the times have to be corrected according to the comparison between chronometer and radio signals, given from time to time in the log. For instance $18^h + 5^m$ means that 5^m has to be added to 18^h to get correct time.

Exp. means exposure in seconds.

[1] See section 7.

Table 1. *Auroral Log Made by Mr. Hatlevik.*

No.	St.	G. M. T.	Exp.	Remarks
		November 22, 1938.		
1.1	M	19.04.35	7	Double arc under Peg, lower clouds
.2	»	.09.29	10	Double arc between Peg and Altair, clouds SE
.3	»	.19.17	14	Single arc, more feeble, under Peg, clouds SE
.4	»	.21.44	11	Single arc strong, under Peg and and Altair, clouds SE
.5	»	.21 54	10	Feeble rays between Peg and the Pleiades, clouds SE
.6	»	.40.46	6	Single rays, strong light, Saturn
2.7	»	22.14.43	10	Arc and rays, Saturn, taken with two cameras.
.8	»	.20.31	10	Arc in SE with rays, Tau
.9	»	.26.33	10	Arc in SE with rays, Saturn
.10	»	.31.23	10	Arc in SE, Saturn
.11	»	.36.10	8	Rays between Saturn and α Tau
.12	»	.43.27	12	Rays between Ori and Tau
		December 17, 1938.		
1.1	M	20.42.54	10	Ori, Tau
.2	»	.45.42	5	Saturn
.3	»	.46.16	8	Saturn
.4	»	.47.00	6	Cet
.5	»	.50.02	6	Tau
.6	»	.51.32	7	Ori, Cet, Tau, double arc
2.7	K	.54.06	5	Saturn
.8	»	.55.18	10	Tau, Cet
.9	M-K	.56.42	8	Saturn
.10	»	.58.05	12	Ori, Tau
.11	»	.59.42	8	Ori, Tau, Gem
.12	»	21.01.13	8	Ori, Tau
3.13	M	.02.58	6	Ori, Tau, Gem
.14	»	.04.30	8	Gem
.15	»	.05.55	6	Ori, Gem
	»	.34.39		Feeble rays low in S and E
.16	»	.39.42	10	E of Saturn
.17	»	.40.02	10	Ori, Gem, Rays in SE
.18	»	.41.26	10	Cloudlike in S, Saturn
4.19	»	.43.12	8	Cloudlike in S, Saturn
.20	»	.44.49	12	Cloudlike and glow in S. E of Saturn
.21	»	.52.4	10	Cloudlike in S. E of Saturn
.22	»	.53.47	15	Cloudlike in S. E of Saturn
.23	»	.55.32	30	Cloudlike in Ori
.24	»	.57.22	20	Feeble arc between CMi and Ori
5.25	M-K	.59.55	15	Tau, Cet. Diffuse cloudlike band
.26	»	22.01.43	10	Tau, cloudlike band
.27	»	.03.32	8	Ori, cloudlike bits of bands
.28	»	.05.05	9	Ori, Tau bits of bands with rays
.29	»	.08.01	8	CMi, Gem. Diffuse rays
.30	»	.09.56	15	CMi, Gem. Diffuse rays
6.31	M	.12.59	12	CMi rays, glow in S
.32	»	.14.27	12	Rays in E, Arc in Ori
.33	»	.15.49	15	Feeble arc, Ori
.34	»	.17.02	18	Bit of arc CMi, feeble
.35	»	.20.57	12	The same CMi, feeble
.36	»	.22.48	15	The same CMi, Ori feeble
7.37	»	.24.59	8	Stronger, curtain over it, Ori
.38	»	.26.48	4	Fine curtain in S. Cet.
.39	»	.28.05	6	Fine curtain and rays in S. Cet.
.40	»	.29.06	7	Fine curtain and rays Cet, Saturn
.41	»	.30.16	6	Fine horseshoeformed curtain, Cet
.42	»	.31.43	7	The same.
8.43	»	.35.01	7	Arc and rays over it, Ori, Tau
.44	»	.37.15	15	Rays, Procyon
.45	»	.38.46	12	Two arcs, Ori
8.46	M	22.39.59	10	Two arcs Ori, Tau
.47	»	.44.48	20	The same, Ori
.48	»	.46.42	16	The same. Rays in SE, Ori
		23.00.00		Feeble aurora near the horizon
		24.00.00		Aurora spreading on the southern sky from the horizon up to zenith. Arcs, rays and curtains. Strong.
		December 18, 1938.		
	M	01.00.00		Feeble arc through zenith from SW—NE
1.1	»	02.11.33	12	Feeble arc, Gem.
.2	»	.12.58	13	Bands, Ori, Tau
.3	»	.14.06	35	More cloudlike, Tau
.4	»	.15.33	16	Double arc, Ori
.5	»	.16.35	12	Arc, Gem
.6	»	.19.44	14	Rays SW, Ori
	»	.30.00		Aurora disappears
		03.00.00		No aurora. No observ. bef. $6^h\,45^m$.
		06.45.00		Arc SW—NE over zenith, Rays
		07.00.00		No aurora. No observ. before 6.45
		08.00.00		Overcast
		December 19, 1938.		
	M			Overcast
		December 20, 1938.		
	M	00.00.00		Overcast, cloudiness 10
	»	07.00.00		Rays in zenith SW—NE, feeble
	»	08.00.00		Feeble, patches, rays in zenith
	»	09.00.00		Feeble, patches, rays in zenith
1.1	»	10.24.47	14	Rays in zenith UMi. Jellow
.2	»	.26.15	14	Rays in zenith UMi. Jellow
				Rays stronger and disappear
.3		.29.49	30	Patches, rays near zenith UMa, UMi, Dra. Jellow
.4	»	.32.22	22	Rays near zenith UMa. Jellow
.5	»	11.21.40	20	Rays near zenith UMa. Jellow
.6	»	.44.10	30	More diffuse. Jellow
	»	12.00.00		The aurora disappears
	»	13.00.00		Partly overcast
	»	18.00.00		Glow in south
	»	24.00.00		Overcast
		December 21, 1938.		
	M	01.00.00		Overcast (cloudiness 10)
	»	13.00.00		Overcast
	»	18.00.00		Cloudiness 2
	»	20.00.00		Feeble arc low in S
	»	21.00.00		Feeble arc low in S
1.1	M-K	22.52.38	16	Feeble arc low in S Procyon
.2	M-K-S	.54.25	17	Feeble arc with short rays CMi, Ori
.3	»	.55.54	12	Feeble arc Ori
.4	»	.57.03	10	Feeble arc Ori
.5	»	.58.20	10	Feeble arc Ori
.6	»			Rays south of CMi
2.7	M-K	23.06.45	15	Feeble arc in S. Saturn
.8	»	.08.25	16	Feeble arc with patches, Saturn
.9	»	.10.06	22	Feeble rays, Ori
.10	»	.23.27	11	Curtain, Saturn
.11	»	.25.00	10	Strong curtain, Saturn
.12	»	.27.46	14	Arc with rays, Cet
3.13	M	.35.41	18	Arc in S, Ori
		24.00.00		Feeble arc in south

Table 1 (cont.).

No.	St.	G. M. T.	Exp.	Remarks
		December 22, 1938.		
	M	00.30.00		Feeble arc in S. Feeble patches in W in Leo and under UMa
	»	01.00.00		Feeble patches in S, Ori
	»	.05.00		No aurora
	»	.30.00		No aurora
	»	02.00 00		Feeble arc low in S
	»	.30.00		Feeble arc Ori
3.14	»	.48.45	10	Curtains with fine rays, Ori
.15	»	03.01.05	10	Curtains with fine rays, Ori, Mon, CMi
	»			Glow in E
	»	.30.00		Rays in Ori, stronger aurora near the horizon in S. Patches SW—NE near zenith
	»	.45.00		Feeble bundle of rays in Ori and Leo, and in zenith in the direction SE—NW
	»	04.00.00		Feeble glow low in SW and W
.16	»	.33.00	60	Glow low in SO, Leo
	»	.45.00		Glow low in SO, feeble rays
.17	»	05.16.20	30	Glow low in SO, rays in Hya
	»	.30.00		Glow low in SO
.18	»	.57.45		Glow low in SE under Arcturus
	»	06.15.00		Feeble glow low in E, S and W
	»	06.00.00		No aurora
	»	07.00.00		No aurora
	»	13.00.00		No aurora
	»	14.00.00		Feeble rays in E. Jellow
	»	15.00.00		Feeble rays from Aur, over UMa to Boo. Jellow
	»	16.00.00		Double arc from the horizon in W over the Pleiades, Cas to Altair. Jellow
	»	17.00.00		Strong arcs low in SE
	»	18.00.00		Feeble arcs in SE
	»	19.00.00		Feeble arcs in SE
	»	20.00.00		Feeble glow low in SE to SSW
	»	21.00.00		Feeble glow low in SE to SSW
	»	22.00.00		No aurora
	»	23.00.00		No aurora
	»	24.00.00		No aurora
		December 23, 1938.		
1.1	M	01.18.58	24	Glow round the horizon. Rays in N. Lyr. Her. Dra.
.2	»	.20.36	37	The same
.3	»	.23.31	63	Cloudlike aurora in S, Ori
.4	»	.25.49	21	Cloudlike aurora in N. UMa
.5	»	.30.41	58	Cloudlike aurora Leo
.6	»	.34.06	33	Cloudlike aurora CrB, Her.
	»	02.00.00		Feeble glow along the horizon
	»	03.00.00		No aurora
		04.00.00		No aurora
				Until 7^h no observations made
		07.00.00		Aurora
		08.00.00		No aurora
		09.00.00		Overcast
		24.00.00		Overcast
		December 24, 1938.		
	M	00.00.00		Overcast 10
	»	07.00.00		Cloudiness 3, aurora
	»	08.00.00		No aurora
	»	10.00.00		Feeble rays in zenith. Cloudlike aurora
	M	13.00.00		Feeble yellow rays. Boo, Cyg. UMa.
1.1	»	14.45.02	20	Rays and cloudlike aurora. Boo
.2	»	.45.46	10	Rays and cloudlike aurora. Her
.3	»	.18.36[1]	13	Rays and cloudlike aurora. Boo
.4	»	.46.58	8	Rays and cloudlike aurora. Boo
.5	»	.48.01	24	Long rays, Boo
.6	»	.48.51	10	Glow, Her
	»	15.00.00		The clouds disappear
		16.00.00		More clouds. No aurora
		December 25, 26, 27. 1938.		
	M			Overcast 10
		December 28, 29, 1938.		
	M			Storm, snow fog
		December 30, 1938.		
	M	7.00.00		Rays in zenith from SW to NE
	»	8.00.00		No aurora
	»	9.00.00		No aurora
	»	10.00.00		Overcast
		December 31, 1938.		
	M			Stiff breeze, snow fog
		January 1, 1939.		
	M			The same
		January 2, 1939.		
	M			Overcast 10
		January 3, 1939.		
	M	18.18.15		Feeble rays in zenith from SE—NW
		January 4, 1939.		
	M	01.00.00		Clear weather. Moonlight. No aurora
	»	02.00.00		Clear weather. Moonlight. No aurora
	»	03.00.00		Clear weather. Moonlight. No aurora
	»	07.00.00		No aurora
		January 5, 1939.		
				Aurora not observed before 18^h
	M	18.00.00		Feeble arc in S. Disappears at $18^h\ 15^m$
	»	19.00.00		No aurora
	»	20.00.00		No aurora
	»	21.00.00		Feeble arc in S. Disappears at $21^h\ 30^m$
	»	22.00.00		No aurora
	»	23.00.00		No aurora
	»	24.00.00		No aurora
		January 6, 1939.		
	M	01.00.00		No aurora
	»			Not observed till 7^h
	»	07 00.00		No aurora
				Observation every hour, no aurora before 18^h
	»	18.00.00		Feeble arc in SE and E, low down, disappears at $18^h\ 15^m$

[1] Probably error (46,36).

Table 1 (cont.).

No.	St.	G. M. T.	Exp.	Remarks
	M	19.00.00		No aurora
	»	20.00.00		Feeble arc low in S and SE
	»	21.00.00		Feeble arc low in S and SE
	»	22.00.00		Feeble arc low in S and SE
	»	23.00.00		Feeble arc low in S and SE
	»	24.00.00		No aurora
		January 7, 1939.		
	M	01.00.00		No aurora
	»	02.00.00		No aurora
	»			No observation before 7^h
	»	07.00.00		Cloudiness 8
	»			The rest of the day overcast
		January 8, 1939.		
	M			Overcast
	»	18.00.00		Feeble glow in S. Feeble aurorae low in the southern sky in the evening
	»			
	»			
		January 9, 1939.		
1*.1[1]	M	01.05.34	67	Feeble patches and rays, Vir Com
.2	»	.09.25	50	UMa
.3	»	.10.39	32	Rays, UMa Pulsating patches and rays. Double arc in S.
.4	»	.12.34	35	Arc and luminous patches Ori
.5	»	.14.28	36	Luminous patch, Ori, Gemi, Tau
.6	»	.17.16	65	Too overexposed Ori, Gem, Tau
2*.7	»	.18.48	20	Bands, UMa
.8	»	.20.03	21	Bands, Boo
.9	»	.20.54	15	Bands, Gem
.10	»	.21.54	27	Arc and ray, UMa, corona in zenith, aurora in S, pulsations
.11	»	.24.46	39	Rays, Aur, Per
.12	»	.26.54	54	Bands, UMa
3*.13	»	.31.38	39	Bands, UMa, Cas, Cep.
	»			Aurora now going northwards
.14	»	.38.09	37	Bands, Per, goes southwards with indication of Corona
.15	»	.34.45	37	Rays, Aur, Gem
.16	»	.36.30	39	Rays, UMa
	»			Feeble indication of an arc in W
.17	»	38.59	74	Too overexposed, Gem CMi
	»			Aurora almost gone
.18	»	.41.01	67	Rays, Aur
				Aurora feeble and disappears
	»	02.00.00		Cloudiness increasing. Halo round the moon
	»	03.00.00		No aurora. Observations continue
	»	07.00 00		No aurora before 12^h
	»	12.00.00		Feeble rays in zenith. Direction SW—NE
	»	13 00.00		No aurora
	»	14.00.00		No aurora
	»	15.00.00		Feeble rays in zenith. Direction E—W
	»	16.00.00		Feeble rays in zenith. Direction E—W
	»	17.00.00		Feeble rays in zenith. Direction E—W
	»	18.00.00		Glow over clouds at the horizon in S.
	»	19.00.00		Glow over clouds at the horizon in S.
	M	20.00.00		No aurora
	»	21.00.00		No aurora
	»	22.00.00		Feeble glow in S. Feeble rays in the southern sky
1.1	»	.16.21	31	Arcs, rays over the whole southern sky, Cet
.2	»	.17.56	23	Bands and rays, Ori Tau
.3	»	.19.22	31	Ori, Tau. Strong arc in S. Rays and patches in W
.4	»	.21.32	39	Bands in Leo. In zenith some rays
.5	»	.23.09	37	Arc in south. Aur
.6	»	.24.37	32	Drapery near zenith, Aur Cam
2.7	»	.28.07	20	Drapery near zenith, Aur
.8	M-S	.29.09	15	Draperies SW up to zenith. Tau
.9	»	.30.23	15	Two arcs, Gem, intensity increases
.10	»	.31.25	23	Double arc in SE, Ori, Tau, Gem. Feeble arc in S
.11	»	.32.53	26	Strong pulsations. Patches in SE, arc in S, Gem
.12	»	.34.40	38	Bands, CMi
3.13	»	.38.09	36	Arc, Gem, Aur, Lyn
.14	»	.39.54	40	Arc, CMi
3.15	M	.41.45	51	Feeble double arc in S, rays in zenith, Ori
.16	»	.44.04	53	Arc, feeble glow in W, Ori
.17	»	.46.11	50	Rays in Leo, arc in S. Intensity increases
.18	»	.47.55	27	Curtains, Ori
4.19	M-S	.51.27	43	Arc in S and E, Ori
.20	»	.53.03	35	Bands and curtains, CMi, Gem
.21	»	.54.14	13	Intensity of arcs in S and E increases. Gem
.22	»	.56.07	19	Arcs in Leo
.23	»	.57.17	22	Arc and ray, Gem
.24	»	.58.39	41	Arcs, Ori
*5.25	»	23.02.21	29	Two arcs, Ori
.26	»	.03.25	27	Three arcs, Ori. Arc and rays in S and E, increase
.27	»	.05.01	38	Two arcs, CMi, Gem
.28	»	.06.16	31	Strong arc, Gem
.29	»	.07.34	30	One strong and one feeble arc in Ori
.30	»	.08.45	46	Double arc in S. CMi, Gem
6.31	»	.15.40	37	Gem, strong arc in SE
.32	»	.17.13	38	Feeble, cloudlike, Ori, Tau
.33	»	.18.57	39	Feeble, cloudlike, Gem
.34	»	.20.12	40	Arc, Ori, Tau, Gem
.35	»	.21.39	35	Strong arc in S and SE, feeble arc in SW, CMi, Gem
.36	»	.23.35	36	Very feeble aurora, Arc, Ori
.37	»	.47.38	31	Rays, Boo, CrB, UMa
.38	»	.49.15	31	Rays, Boo, CrB, UMa
.39	»	.50.28	18	Fine curtains, Boo
.40	»	?	25	Rays, Boo, CrB
.41	»	.57.18	18	Rays, Boo, CrB
.42	»	24.00.00	27	Curtain, Boo, CrB
		January 10, 1939.		
	M	01.00.00		No aurora
	»	02.00.00		No aurora
				No observation before 7^h
	»	07.00.00		Only feeble rays in zenith. Cloudiness 3
		January 11, 1939.		
	M	01.00.00		Glow low in S, over a cloud bank
		02.30.00		Glow low in S, over a cloud bank

[1] All pictures 1*.1 to 3*.17 overexposed.

Table 1 (cont.).

No.	St.	G. M. T.	Exp.	Remarks
				No observation before 7^h
	M	07.00.00		No aurora
				No aurora before $15^h\ 30^m$
	»	15.30.00		Feeble arc low in SE. Some clouds
	»	16.00.00		Feeble arc low in SE. Some clouds
	»	17.00.00		Feeble arc low in SE. Some clouds
	»	.30.00		Glow over clouds from α Orionis to Saturn
	»	18.00.00		No aurora
	»	19.00.00		No aurora
	»	21.30.00		Corona, rays in zenith, disappear
	»	22.00.00		Feeble glow low in the sky
	»	23.00.00		Feeble glow low in the sky
	«	24.00.00		No aurora
				January 12, 1939.
	M	01.00.00		Feeble double arc in UMa. Foggy haze
	»			Clouds near the horizon
	»	.30.00		Feeble arc over Ori
	»	02.30.00		No aurora
	»			No observation before 7^h
	»	07.00.00		Cloudiness 7, increasing to 10 at 10^h
	»			
				January 13, 1939.
	M	01.00.00		Variable cloudiness. No aurora seen. Later overcast.
				January 14, 1939.
	M	01.00.00		Overcast, no aurora seen
	»	07.00.00		Overcast, no aurora seen
	»	13.00.00		Cloudiness 3, no aurora
	»	18.00.00		Clear weather, no aurora
	»	19.00.00		Feeble arc low in SE
1.1	M-S	20.08.58	24	Feeble curtain, Peg
.2	»	.12.21	35	Cloudlike in S, Saturn, Psc.
.3	»	.12.51	36	Cloudlike in S, Cet, Ari, Tau
.4	»	.15.26	36	Feeble double arc in S, Ori, Tau
.5	»	.17.09	36	Feeble double arc in Peg, feeble glow in Ori
.6	»	.18.56	49	Feeble double arc, Saturn, Psc.
	M	21.00.00		Feeble arc in S
	«	.45.00		Stronger arc in SE, some rays towards zenith
2.7	M-S	22.10.13	24	Curtain, Leo
.8	»	.11.50	17	Curtain, CMi, Gem
.9	»	.13.08	29	Curtain, Ori, Double arc in SE
.10	»	.14.24	24	Curtain with long rays, CMi, Gem
.11	»	.15.28	12	Fine curtains in S. Ori, Tau
.12	»	.16.32	20	Fine curtains, pulsating, Ori, Tau
3.13	»	.18.31	12	Fine double arc, Ori
.14	»	.19.12	13	Fine arc, CMi, Gem
.15	»	.20.01	16	The same as 3.13. Rays over it, Ori
.16	M	.21.04	24	The same, more feeble, triple arc S—SE
.17	M-S	.22.24	24	Rays, the arcs more diffuse, CMi, Gem
.18	»	.23.41	19	Curtain, rays, Tau, feeble arc in SE, stronger in S
4.19	»	.26.18	16	Two arcs, CMi
.20	»	.27.16	36	Arc, rays, Ori
.21	M	.28.27	18	Arc, CMi, Gem
.22	M-S	.29.36	21	Arc, Ori, Arc in SE, rays in Leo, pulsations Ori
.23	»	.31.17	16	Curtains, Ori
4.24	M-S	22.32.02	17	Arc and curtain, CMi, Gem
5.25	»	.35.48	30	Double arc in S, single in E, Ori Gem
.26	»	.37.25	19	Double arc, ray, Ori
.27	»	.38.31	18	Arc, CMi, Gem
.28	»	.39.39	35	Arc SE, Leo, patches S
.29	»	.46.27	23	Arc and feeble curtains, Ori
.30	»	.49.44	17	Curtain, rays, Ori
6.31	»	.52.26	19	Arcs, Ori
.32	»	.53.20	35	Arcs, CMi
.33	»	.54.21	24	Arcs, Ori, pulsating patches in SE
.34	»	.55.52	23	Arc with rays, Leo, Cnc.
.35	»	.56.51	18	Arc, Leo
.36	»	.57.39	18	Feeble arcs, Ori
7.37	»	23.17.15	32	Bands, Leo, in NE very feeble
.38	»	.21.43	35	Bands, Leo
.39	»	.23.55	27	Feeble curtain, Leo, Com.
.40	»	.27.00	42	Feeble rays, CMi, Cnc, Hya
.41	»	.55.04	24	Fine curtain, CMi, Gem
.42	»	.56.02	25	Cloudlike, Leo
8.43	»	.59.00	12	Fine curtain, CMi, Gem
.44	»	.59.51	25	Arcs, Ori
				January 15, 1939.
8.45	M-S	00.00.32	11	Fine draperies, CMi, Gem
.46	»	.01.33	18	Fine draperies, Leo, Com
.47	»	.02.54	15	Fine arc, Leo
.48	»	.03.38	15	Fine draperies, CMi, Gem
9.49	»	.05.50	20	More diffuse curtains, Leo
.50	»	.06.53	21	More diffuse curtains, Leo, Hya, CMi
.51	»	.07.36	16	Arc with narrow lower border, CMi
.52	»	.08.28	26	The same, Ori
.53	»	.09.19	23	The same, some feeble rays, CMi
.54	»	.10.30	15	The same Hya
10.55	»	.12.42	23	The same, some feeble rays, Leo
.56	»	.13.37	25	The same. Leo
.57	»	.14.42	34	The same. More feeble arc SSE
.58	»	.16.15	36	Lower border double, Ori
.59	»	.20.13	31	Lower border. Arc now diffuse. Glow SSE. Feeble. Rays on northern sky
.60	M	.49.15	40	Arc with rays, Cyg, Lyr.
	»	01.30.00		No aurora
	»	02.00.00		No aurora
	»	.30.00		No aurora
	»	03.00.00		No aurora
	»	.30.00		No aurora
	»	04.00.00		No aurora
	»	.30.00		Cloudiness 9
	»	05.00.00		Cloudiness 10
	»	07.00.00		Faint rays in zenith, clear sky
	»	08.00.00		Faint rays in zenith, clear sky
	»	23.00.00		Feeble arc in SE
				January 16, 1939.
	M	00.00.00		Feeble arc low in SE
	»	00.30.00		Feeble arc in SE
	»	01.00.00		Feeble rays to the left of Ori
	»	.30.00		Feeble rays in Ori and Leo
	»	02.00.00		Arc from Arcturus over Leo
	»	.30.00		No aurora
	»	03.00.00		Faint rays under Cyg
	»	.23.00		Faint rays in Leo
	»	.46.00		No aurora

Table 1 (cont.).

No.	St.	G. M. T.	Exp.	Remarks
	M	04.16.00		Faint rays between Procyon and Regulus
	»	.25.00		Faint rays over the sky from Peg to Cyg
	»	.54.00		Rays under Vega. Feeble patches in zenith
	»	05.00.00		Disappeared
	»	.44.00		Faint rays to the left of Cyg
	»	.59.00		Faint rays between Cas and Cyg
	»	06.32.00		Faint rays between Leo and Cyg
	»	.45.00		Stronger. Leo and Cyg
	»	07.00.00		More feeble
	»	.35.00		Faint rays between Peg and Cyg
	»	.45.00		Faint rays between Peg and Cyg
	»	.55.00		Stronger rays between Peg and Cyg
	»	09.40.00		Rays in Leo
	»	.45.00		Feeble rays under Arcturus
	»	10.05.00		No aurora before $11^h\,30^m$
	»	11.30.00		Feeble rays near Saturn (dawn)
	»	.52.00		No aurora
	»	12.10.00		Feeble rays near Saturn
	»	.23.00		No aurora before 13^h
	»	13.00.00		Faint rays between Cas und the Pleiades
				No aurora before 23^h
	»	23.00.00		Feeble arc between Ori and Aldebaran
	»	.28.00		Feeble glow between Procyon and Regulus
	»	.48.00		Feeble glow low in SE
				January 17, 1939.
	M	00.06.00		Feeble glow in SE
	»	.30.00		No aurora
	»	.43.00		No aurora
	»	.59.00		No aurora
	»			No observations before 7^h
	»	07.00.00		No aurora. Snow fog, gale
	»	13.00.00		No aurora. Snow fog, gale
				January 18, 1939.
	M	01.00.00		Are and rays in S. Snow fog, gale
	»	02.00.00		Arc and rays in S. Snow fog, gale
	»	03.00.00		Arc and rays in S. Snow fog, gale
	»	03.30.00		Luminous belt from Procyon over Cas to Cyg. Patches and rays to the left of Cyg and to the left of Procyon
				No observations till 7^h
	»	07.00.00		Rays in zenith, disappear at $7^h\,30^m$
				No aurora before 21^h
	»	21.00.00		Feeble arc low in SE
	»	22.00.00		Stronger and higher, under Ori
	»	.45.00		Draperies towards zenith, feeble arc in SE. The arc dissolves in rays and draperies in S
1.1	»	.53.21	20	Drapery under UMa
.2	»	.54.05	20	Drapery UMa
.3	»	.55.17	19	Corona, Cam, Polaris
.4	»	.56.24	19	Very fine corona, Cam
	»			Rays and draperies in a zone over the sky from Arcturus over UMa, between Aldebaran and Ari with a strong luminosity west of Mira
1.5	M	22.58.05	13	Fine draperies, Ari, Cet, strong pulsations
.6	»	.59.08	14	Cet. Draperies and rays along the above mentioned zone. Intensity decreases
2.7	»	23.02.36	10	Very fine horseshoeformed curtain. Ori, Tau
.8	»	.03.15	9	The same. Strong aurora in S close to the horizon. Ori
.9	»	.06.37	37	Rays, Aur. Overexposed
.10	»	.08.20	35	Rays, in Leo draperies, feeble rays west of Capella, arcs and rays from Arcturus between UMa and Leo to Gem, upper part of Ori and to the horizon under Mira. The aurora has gone southwards again
.11	»	.11.24	19	Rays, Boo, Com
.12	»	.12.20	15	Curtain Ori, arc from Procyon to Ori, feeble rays in E and glow under the Pleiades. Further feeble rays and arcs from Arcturus through Leo to the belt of Ori and feeble at the horizon under the Pleiades. Feeble arc from Rigel to the horizon under Mira
3.13	»	.27.48	17	Fine drapery to the right of Arcturus
.14	»	.28.46	18	Curtain Leo
.15	»	.29.24	22	Feeble arc with rays, CMi, Gem, Tau. The aurora again higher in the sky, indication of an arc from Arcturus, between UMa and Leo, through Gem and down to Ori. Rays at α Ori. At Deneb bright patches and rays, a broad belt of rays and patches from Arcturus between UMa and Leo to α Ori. Some faint rays from this belt are moving towards zenith
		.32.30		Arc from Regulus to Procyon, the belt of Ori to the horizon. Feeble rays at Arcturus
		.35.00		Some feeble rays towards zenith
		.35.30		The aurora now more diffuse
	»	.52.00		Feeble glow
	»	.53.00		Short arc from Procyon to the belt of Ori, under the Pleiades some dispersed feeble rays and some feeble rays in Aur, CMi, Ori and Tau. Feeble arc from Regulus to Procyon
				January 19, 1939.
	M	00.46.00		Feeble arc from Arcturus to the belt of Ori
	«	01.18.00		The same with a bundle of rays near Ori
	»	.43.00		No aurora
	»	02.10.00		No aurora
	»	.40.00		No aurora
	»	03.20.00		No aurora
	»	.45.00		Feeble rays from CMi to Gem
	»	04.06.00		Rays between Cas and Cyg to UMa
	»	.26.00		Feeble arc in S

Table 1 (cont.).

No.	St.	G. M. T.	Exp.	Remarks
	M	04.50.00		Feeble arc and glow near Procyon
	»	05.15.00		No aurora
	»	.45.00		No aurora
	»	06.05.00		Feeble rays in Leo
3.16	»	07.09.53	27	Feeble rays in Leo
.17	»	.12.02	41	Feeble rays near the pole star
.18	»	.13.46	38	Feeble curtain, Cnc.
	»	08.00.00		No aurora till $20^h\ 35^m$
	»	20.35.00		Glow in Ori
	»	21.53.00		Feeble arc from Leo, under Gem, α Tau to the horizon under Ari
	»	22.27.00		Glow at upper border of clouds in S. Cloudiness 5
				Cloudiness increasing
	»	23.00.00		Cloudiness 10
				January 20, 1939.
	M	00.00.00		Again clear sky
	»	01.00.00		Cloudiness 3
	»	02.00.00		Feeble arc low in S
	»	03.00.00		The same and aurora in zenith in the direction SE—NW
	»			No observations till 7^h
	»	07.00.00		Feeble rays in zenith
	»	08.00.00		No aurora
	»	20.00.00		Overcast
				January 21, 1939.
	M			Overcast
				January 22, 1939.
	M			Overcast
				January 23, 1939.
	M			Overcast
				January 24, 1939.
	M	01.00.00		Cloudiness 2. Gale with snow fog. No aurora. Snow fog till 18^h
	»	18.00.00		No aurora.
	»	19.00.00		Ray, W of Gem
	»			No aurora before 22^h.
	»	22.00.00		Feeble glow at the horizon under Ori
	»	.30.00		Two arcs: one from the horizon under Leo, under Procyon, between the belt of Ori and α Ori to the horizon under Mira. The second in the same direction lower down. Both arcs feeble
	»	.38.00		The arcs dissolve in rays.
	»	23.00.00		The two arcs now consist of patches. No rays.
	»	.05.00		Zone consisting of feeble patches from the horizon in W under Leo and CMi, between the belt of Ori and Rigel down to the horizon
	»	.07.00		Only feeble aurora at Arcturus and Procyon
				January 25, 1939.
	M	00.00.00		No aurora
	»	.30.00		Feeble glow at Procyon. No observation before 4^h
	M	04.00.00		No aurora
	»	07.00.00		No aurora
	»	18.00.00		Overcast
				January 26, 1939.
	M			Overcast
				January 27, 1939.
	M			Variable cloudiness, no aurora
				January 28, 1939.
	M			From 0^h to 3^h, no aurora
	»	07.00.00		Feeble ray in SE
	»	19.00.00		Arc between CMi and Ori, some clouds
	»	20.00.00		No aurora
				January 29, 1939.
	M	00.00.00		Low glow, under Leo. Clouds
	»	.44.00		Low glow, under Leo. Clouds
	»	.50.00		Low glow, under Leo. Clouds
	»	02.00.00		Cloudiness increasing
	»	07.00.00		Overcast
	»	13.00.00		Clear sky
	»	22.05.00		Glow under Leo, disappears $22^h\ 15^m$
				January 30, 1939.
	M			Variable cloudiness
				January 31, 1939.
	M			Variable cloudiness
				February 1, 1939.
	M	01.45.00		Low arc under Arcturus, Leo, Procyon
	»	02.00.00		Higher arc through Arcturus, Leo, Procyon. Feeble
	»	.15.00		The arc has disappeared
	»	04.00.00		Overcast
				February 2, 1939.
	M			Overcast
				February 3, 1939.
	M			Variable cloudiness
				February 4, 1939.
	M			Variable cloudiness
				February 5, 1939.
	M			Variable cloudiness
		19.00		Arc under Leo, Procyon, between the belt of Ori and α Ori, through Saturn. Further aurora over and to the right of Leo. Feeble
		.10		Bundle of rays towards zenith to the left of UMa
				The arc divides
		.15		Some rays in UMa
		.30		Nothing except glow low in SE. Moonlight
				February 6, 1939.
	M			Variable cloudiness
	»	20.10		Arc low under Procyon, between the belt of Ori and Rigel and down to the horizon in S
	»	20.25		The same

Table 1 (cont.).

No.	St.	G. M. T.	Exp.	Remarks
				February 7, 1939.
	M	00.00		From 0^h to $0^h\,5^m$ feeble short arc under Leo
	»	03.05		To $3^h\,8^m$ rays towards zenith between Vega and Arcturus
	»	19.15		Arc of ordinary intensity from the horizon under Mira, between the belt of Orion and Rigel, under Procyon to the horizon to the right of Leo
	»	.30.00		Arc as before, some short pulsations and then again quiet
	»	.40.00		The arc quiet, strongest between Procyon and Ori
	»	.55.00		The arc to the right of Ori has disappeared, feeble double arc between Procyon and Ori
	»	20.00.00		The arc lower, through Rigel to the horizon under Procyon.
	»	.10.00		The arc feeble and disappeared at $20^h\,30^m$
	»	.30.00		Feeble glow under Ori, disappeared at 21^h
				February 8, 1939.
	M			Clear sky
	»	00.00.00		Low arc under Leo and Procyon
		.25.00		Low arc under Arcturus and Leo. Glow low under Procyon
	»	01.00.00		The arc has disappeared
	»	.58.00		Feeble arc under Leo and over the moon
	»	02.15.00		Feeble arc under Leo and Arcturus
	»	.25.00		The arc disappeared
	»	05.47.00		Rays from Peg to Cas
	»	.55.00		Disappeared
	»	.10.00		Some dispersed and feeble rays between Peg, Cas, Cyg to zenith and further through UMa and Leo to the horizon; condense to a continuous bright belt
1.1	»	05.25.10	40	Rays, Leo
.2	»	.26.48	32	Drapery UMa
.3	»	.27.59	34	UMa, more like a band
.4	»	.30.40	36	The same, zenith
.5	»	.33.05	30	Rays to the left of Cyg
.6	»	.35.12	38	Rays, Peg
	»	.40.00		More feeble and only between Peg, Cas and Cyg
	»	.45.00		The aurora gone
	»	22.00.00		Aurora low in S and E
	»	.15.00		Gone
				February 9, 1939.
	M	01.30.00		Feeble glow low under Leo and Arcturus
	»	.45.00		The aurora a little higher with some faint rays
	»	02.15.00		The same under Cyg
	»	.20.00		Diffuse patch under Leo and Arcturus
	»	.25.00		Arc from the horizon under Procyon obliquely up to the lower part of Leo. Gone at $2^h\,40^m$
	»	.25.00		Feeble glow under Leo and Arcturus
	M	03.00.00		Feeble glow under Leo and Arcturus
	»	.10.00		Gone
	»	04.52.00		Aurora over Altair, Vega and Arcturus. Feeble arc at the horizon to the right of the moon
	»	05.05.00		Double arc in the same region, at some places not continuous
	»	.14.00		The arcs dissolve and gather again as a narrow luminosity from ε, γ, δ Cyg through Vega and Arcturus bending down to the horizon to the left of Denebola
	»	.17.00		More feeble
	»	.25.00		Goes now a little under Denebola between UMa and Arcturus and through ε, γ, δ Cyg
	»	.30.00		Only feeble glow left
	»	.32.00		No aurora
	»	.45.00		Aurora from Denebola to UMa
	»	.48.00		No aurora
				February 10, 1939.
	M			Gale and snow fog
	»	01.00.00		Aurora under Procyon, Leo, Boo
	»	05.00.00		Overcast and snow fog
				February 11, 1939. ($12^h+4^m\,48^s$.)
	M			Overcast
				February 12, 1939. ($18^h+4^m\,50^s$.)
	M	02.00.00		Cloudiness 9
	»	03.00.00		Feeble aurora from Deneb to the Polar star to Regulus
	»	.30.00		Dissolves in rays
	»	04.00.00		Feeble rays in the same region
	»	.55.00		Rays and long patches from Peg and Cyg, between Cas and the Polar Star and down to Leo
	»	05.25.00		Arc from the horizon under Regulus and up to Gem. At $5^h\,28^m$ disappeared
	»	05.32.00		Feeble rays between Peg and Cyg
	»	06.00.00		Feeble rays between Peg and Cyg
	»	07.00.00		Rays from NE over zenith to S
	»	08.00.00		Dawn
	»	16.00.00		Overcast
				February 13, 1939.
	M	03.00.00		Cloudiness 5, rays between Gem and Leo, to UMa
	»	04.00.00		No aurora
	»	05.00.00		Gale snow fog. No aurora

In the following notes the time of the *end of the exposure* is given instead of the middle of the exposure as above

1.1	M	20.16.57	37	Bit of an arc, Boo, continues to Peg and Cyg and on the other side to Leo
.2	»	.19.00	37	The same
.3	»	.20.09	39	The same, CnV, Com
.4	»	.21.36	41	Arc with rays, Peg
.5	»	.23.02	47	Arc, Cyg
.6	»	.24.10	37	Rays, Leo
2.7	»	.25.46	34	Rays, Leo
.8	»	.26.52	26	Fine rays, Peg

Table 1 (cont.).

No.	St.	G. M. T.	Exp.	Remarks
2.9	M	20.27.55	30	Fine rays, Cas
.10	»	.29.15	25	More diffuse, resembles a corona, Aur, Cam
.11	»	.29.54	16	More diffuse, Aur, Cam
.12	»	.30.42	18	Fine curtain, Gem, Aurora gone to the S of Peg, Cas, UMa and Leo
3.13	»	.38.55	31	Patches, Leo, UMi and UMa
.14	»	.39.43	28	Diffuse corona, Gem. Aur
.15	»	.40.51	36	Over Capella, nothing on the plate
.16	»	.42.06	31	To the right of Capella
.17	»	.43.07	37	Patches, Per
		.45.00		A feeble patch of the aurora now left at the Pleiades
3.18	»		ca.	Feeble patch in Per
4.19	»	21.12.00	60	Feeble glow in Psc
.20	»		»	Feeble arc, Cet
.21	»		»	Feeble glow with short rays, Ori
.22	»		»	Feeble glow with short rays, Ori
.23	»		»	Feeble rays, Cet
.24	»	.20.00	»	Feeble glow, Psc
	»	.25.00		Glow under Procyon and Leo (clouds)
5.25	»	.36.22	33	Rays, Ori
.26	»	.37.20	30	Rays under Procyon
.27	»	.38.50	33	Rays under Leo
.28	»	.39.50	31	Rays under Leo
.29	»	.40.43	33	Rays under Procyon
.30	»	.41.48	42	Feeble rays, Ori
6.31	»	.44.09	35	Rays, Ori
.32	»	.45.08	33	Rays under Procyon
.33	»	.46.25	50	Feeble rays under Leo
.34	»	.47.45	37	Feeble rays under Leo
.35	»	.48.58	33	Rays, CMi
.36	»	.49.42	26	Fine rays in Ori
7.37	»	.52.25	37	Fine rays in Ori
.38	»	.53.38	35	Rays in CMi
.39	»	.54 31	34	Feeble rays in Leo
.40	»	.55.24	26	Fine rays in Ori
.41	»	.55.59	14	Fine rays in Ori
.42	»	.57.17	19	Fine curtain from CMi to Ori
8.43	»	22.22.20	19	Fine curtain, Ori
.44	»	.23.15	18	Fine curtain, Ori
.45	»	.24.10	18	Fine double curtain, Ori
.46	»	.25.06	17	Fine S formed curtain, Ori
.47	»	.26.21	19	Fine S formed curtain, Ori
.48	»	.27.39	17	Fine curtain, Ori
	«			The aurora disappeared in Ori. Short arc under Procyon and Leo
9.49	»	.30.18	36	Arc under Procyon. Further arc under Leo and rays in Leo
.50	»	.31.31	24	Arc and rays in Leo
.51	»	.32.23	23	Fine rays in Leo
.52	»	.38.48	25	The same
.53	»	.39.49	12	Fine drapery, Procyon
.54	»	.40.08	11	The same from Procyon to Ori; fine, double lower border from Ori to Leo
10.55	»	.49.07	15	Curtain, Ori
.56	»	.49.50	14	Curtain, CMi
.57	»	.50.47	17	Curtain, Leo, now feeble patches in Ori and CMi
.58	»	.51.37	22	The same. The aurora now transforms to more diffuse forms
.59	»	.52.54	37	Feeble curtain in Com and Vir
.60	»	.56.15	40	Stronger again. Arc and some rays, CMi
11.61	M	22.59.17	24	Arc under Leo
.62	»	23.00.08	26	The same, more diffuse
.63	»	.01.37	57	The same, very feeble
.64	»	.19.37	34	Rays, Boo
		February 14, 1939.		
11.65	M	02.50.00		Feedle rays (double exposure) Com Vir
.66	»	.52.00	120	Glow, Com Vir
	»	05.00.00		Some feeble rays from Leo to Cas and in Boo and UMa
	»	.25.00		The same
	»	06.00.00		Feeble rays and cloudlike patches in the same region
	»	06.05.00		Pulsating rays on the southern sky direction to zenith. Northern limitation Denebola, η UMa, the Polar Star
	»	.20.00		Aurora in Cas
	»	.30.00		A few feeble rays in Aql and under Leo
	»	07.00.00		Dawn
	»	19.30.00		Gale and snow fog. Arc under Leo and CMi to Ori. The arc rises and more strong arcs appear
	»	20.00.00		The same
	»	.20.00		Arc under Leo, over Procyon and Ori, then bends down to the horizon. Some lower arcs
	»	.40.00		Gale and snow fog, arc from Leo between Gem and Procyon to Aldebaran. Lower arc through the belt of Orion. Some rays
	»	21.05.00		Gale and snow fog. Strong arcs and draperies under Denebola, through Leo and Gem to Tau. Rays in UMa, more feeble towards W
	»	22.25.00		Only feeble rays to the right of Arcturus
	»	.30.00		No aurora
		February 15, 1939. ($18^h + 5^m$, 1^s)		
	M	01.00.00		Gale and snow fog. Feeble rays under Leo
	»	07.00.00		Rays on the southern sky. Direction towards zenith.
	»	18.30.00		Feeble ray under Gem
	»	.40.00		Long narrow "luminosity" from Gem, Capella to Cas
	»	.45.00		Rays over Ori, strong arc through the belt of Ori. Continues under Procyon and Saturn
	»	19.05.00		Patches in Aur and Tau. Arc from Procyon to α Ori, great activity at the horizon
	»	.25.00		Disappeared. Feeble glow from Cas to UMa
	»	.50.00		Low and short double arc from Ori to Cet. At $20^h\,30^m$ gone
		February 16, 1939 ($12.00 + 5^m\,3^s$).		
	M	01.00.00		Feeble aurora in Cyg. Soon disappeared
	«	.30.00		Feeble aurora in Gem. Soon disappeared

Table 1 (cont.).

No.	St.	G. M. T.	Exp.	Remarks
	M	02.00.00		Feeble aurora in Peg. Soon disappeared
	»	.30.00		Cloudlike patches in zenith. Arc to the left of UMa.
	»	.35.00		Disappeared
	»	03.00.00		Patches in Peg. Soon disappeared
	»	05.55.00		Patch under Leo, gone at $6^h\,5^m$
	»	06.30.00		On southern sky rays with direction to zenith
1*.1	»	.(?)	?	Fine rays, Boo, Vir
.2	»	.(?)	?	Fine rays, CrB
.3	»	.43.41	18	Drapery, Boo, Vir
.4	»	.44.55	17	Rays, CrB, Her, Ser
.5	»	.45.40	20	More diffuse, Her, Ser
.6	»	.(?)		Feeble rays, Ser, Her, Oph
	»	.55.00		The aurora gone
	»	20.15.00		Dawn in NW. Low arc between CMi and Leo. Glow at the horizon
	»	22.25.00		Strong low arcs SE—S, from the belt of Ori under CMi and Leo to the horizon
	»	.45.00		Arcs more feeble
	»	23.05.00		The aurora very faint
1.1	M-S	.15.13	41	Bands at the belt of Ori
.2	M	.55.31	38	Diffuse arc under Denebola
		February 17, 1939 ($18.00.00 + 5^m\,7^s.5$).		
	M	07.00.00		Feeble rays on southern sky. Gone at $7^h\,5^m$
	»	20.00.00		Low arc between Procyon and Leo
1.1	M-S	21.10.50	33	Band near the belt of Ori
.2	M-K-S	.14.48	24	Arcs near the belt of Ori
.3	»	.16.07	23	Arcs under Procyon
.4	»	.17.20	24	The same arcs and some rays, Ori The chronometer $5^m\,8^s$ too slow
.5	»	.18.40	18	Bands and fine rays, Leo
.6	»	.20.03	18	Curtains Leo
2.7	»	.21.51	17	Very fine drapery, Gem
.8	»	.23.20	18	Only some rays left, Gem
.9	»	.24.21	18	Drapery in Tau
.10	»	.25.58	17	Two draperies in Tau
.11	»	.26.58	19	Two curtains in Leo
.12	»	.27.56	9	Very fine curtains, Boo, CVn, Com
3.13	»	.29.48	9	Very fine arc, Aur
.14	»	.30.36	11	Arc, Gem
.15	»	.31.30	17	Fine double arc in Leo
.16	»	.32.15	13	Fine arc in Gem
.17	»	.33.12	10	Irregular bands, Tau
.18	K	.34.05	11	Two fine arcs in Gem. The structure no longer so distinct. Northern limitation Arcturus, UMa, Cas, Peg. In SW the horizon is dark, the lowest arc through the belt of Orion
4.19	M-K-S	.41.03	19	Curtain in UMa
.20	»	.41.53	10	Double band in Leo
.21	»	.46.30	12	Diffuse bands, Procyon
.22	»	.47.33	17	Diffuse bands, Tau
.23	»	.48.25	11	Diffuse bands, Ari
.24	»	.49.15	12	Bands with some rays, Ori, Tau, Gem
5.25	»	.51.40	18	Irregular bands, Tau
.26	»	.52.23	9	Irregular bands, Ori, Tau
.27	»	.53.08	13	Irregular bands Ori, Tau
.28	»	.54.09	18	More cloudlike, Gem
.29	»	.54.56	19	More cloudlike, Tau, Aur
5.30	M-K-S	21.55.41	19	More cloudlike, CMi, Gem
6.31	»	.57.31	12	Arc with some rays, Leo The chronometer is $5^m\,8^s$ too slow.
.32	»	.58.10	11	Arc over Procyon
.33	»	.59.03	18	Bit of broad arc, Tau
.34	»	.59.53	25	Remarkable arc with sawshaped lower border, Gem
.35	»	22.00.53	27	Diffuse bands, Leo
.36	»	.02.02	37	More cloudlike, Ori, Tau, Gem. Aurora almost gone. Very feeble between CMi and Ori
7.37	»	.23.02	30	Diffuse rays, Ori
.38	»	.25.39	12	Arc under Leo
.39	»	.26.31	22	Arc under CMi
		.30.00		The arc now very feeble
		February 18, 1939. ($12^h+5^m\,10^s$).		
	M	01.30.00		Arc of mean intensity under Leo
	»	02.00.00		Feeble patches
	»	03.00.00		Feeble aurora up to UMa
	»	.35.00		In Cyg feeble rays in the direction of zenith. $3^h\,45^m$ disappeared
	»	05.40.00		Feeble rays from Cyg to UMa
	»	.45.00		Arc under Altair. Gone at $5^h\,50^m$
	»	06.10.00		Feeble patches under Vega, Arcturus and Denebola
	»	.15.00		Rays on southern sky with tendency to form two arcs. Direction of rays towards zenith
	»	.25.00		Rays up to Leo
7.40	»	.28.14	44	Rays in Leo
.41	»	.29.37	43	Feeble rays, Lyr
.42	»	.30.53	36	Rays CrB, Boo
	»	.45.00		Feeble rays between Peg and Cyg
*	»	07.00.00		Feeble rays between Peg and Cyg and under Arcturus and Vega Gone at $7^h\,10^m$
	»	07.30.00		Dawn
		14.00.00		Overcast
		February 19, 1939.		
	M			Storm. Overcast
		February 20, 1939.		
	M			Storm
		February 21, 1939.		
	M			Storm
		February 22, 1939.		
				Snow fog and clouds
	M	20.00.00		Feeble arc low in SE, clouds
	«	21.00.00		Feeble glow under Leo
		February 23, 1939.		
	M	05.43.00		Feeble rays from Peg between Cas and Cyg over zenith through UMa
	»	.47.00		Gone
	»	.50.00		Indication of a feeble band from Peg through γ Cyg, Vega and Arcturus. Thin clouds
	»	.55.00		Patches through clouds near the horizon
	»	06.03.00		No aurora
	»	.20.00		Feeble rays in Cas

Table 1 (cont.).

No.	St.	G. M. T.	Exp.	Remarks
	M	06.25.00		Feeble rays over Deneb and Vega to Arcturus
	»	.45.00		Feeble rays from Arcturus to Cas
	»	22.00.00		To $22^h\,45^m$ strong aurora through clouds UMa. Cloudiness 10
				February 24, 1939.
	M	22.00.00		To $22^h\,30^m$ feeble arc under Leo,
	»			some rays going up from it.
				February 25, 1939.
	M	01.57.00		Probably glow low in SE
	»	03.40.00		Feeble rays between Cyg and Arcturus and in Leo
	»	.45.00		Stronger rays from Leo to zenith between Deneb and Arcturus
	»	.55.00		Gone
	»	4.31.00		Faint rays between Arcturus and Leo, direction towards zenith
	»	.45.00		Gone
	»	22.05.00		Strong arc under Arcturus, Leo and Procyon to the belt of Ori. Intensity decreases
	»	23.00.00		Glow under Leo. Gale and snow fog
				February 26, 1939.
	M	21.15.00		Low aurora under Leo and Procyon. Indication of a faint arc with rays along upper border
	»	.40.00		Rays go upwards, towards zenith
	»	22.00.00		Gone
	»	.25.00		Faint low arc in SE
				February 27, 1939.
	M	05.12.00		Very faint rays from the square of Peg through Cas, ε, η, ζ, UMa, between Arcturus and Leo to the horizon. Narrow bundle towards zenith
	«	.20.00		Gone
				February 28, 1939.
	M			Clear sky, no aurora
				March 1, 1939.
	M	05.30.00		Faint rays towards zenith
				March 2, 1939.
	M			Clear sky, no aurora
				March 3, 1939.
	M			Feeble glow in S, probably aurora
				March 4, 1939.
	M	04.00.00		Feeble arc from Arcturus to Vega, gale and snow fog
	»	22.15.00		To $22^h\,25^m$ cloudiness 6, between Arcturus and UMa draperies and indication of a corona in zenith
				March 5, 1939.
	M	05.40.00		Faint rays under and to the right of Arcturus
	M	05.55.00		From the square of Peg through Cas and UMa faint rays are seen
	»	06.02.00		Feeble gray arc from Deneb to Arcturus
				March 6, 1939.
	M			Overcast
				March 7 1939.
	M	21.15.00		To 21.30, low aurora in SE
	«	23.25.00		Low aurora in SE. Faint rays go upwards, clouds
				March 8, 1939.
	M	00.30.00		Broken arc low under Arcturus
	»	.40.00		The arc rises, no aurora under the arc
	»	.50.00		The arc through UMa and over Leo; feeble and disappears at $1^h\,10^m$. Cloudiness rapidly increasing
	»	04.55.00		Cloudiness 7, rays seen at Altair
	»	23.30.00		Feeble arc through Vega and Arcturus
	»	.40.00		Gone
				March 9, 1939.
	M			Some cloudiness, no aurora
				March 10, 1939.
	M			Cloudiness 10, clearing up at 21^h, hazy
	»	22.00.00		Feeble aurora under Leo between clouds
	»	.45.00		Gone
				March 11, 1939.
	M	00.40.00		Diffuse feeble arc from east down to W near the horizon from Leo to Procyon
	»	00.47.00		Gone
	»	01.37.00		Long diffuse patches from Leo over UMa to Peg. At the same time feeble arc of rays from upper part of Peg through Cyg and Lyr; ends under Arcturus
	»	01.50.00		Gone
	»	02.00.00		Feeble band from Ari over Capella to UMa. Cloudiness increasing
	»	.22.00		Faint rays under Gem
	»	.27.00		Faint rays between Leo and Procyon
	»	.35.00		Gone
	»	03.17.00		Faint rays from Peg to Cas and at Arcturus
	»	.27.00		A homogeneous band goes between Arcturus and Denebola through UMa to Cas and further to Peg
	»	.45.00		Very scattered faint rays from Cas to Peg
	»	.55.00		Gone
	»	04.30.00		Scattered rays from Peg to Cas, over UMa and continuing to Cnc and Hya
	»	05.05.00		Scattered faint rays from Leo to UMa
	»	24.00.00		Aurora low in SE among clouds

Table 1 (cont.).

No.	St.	G. M. T.	Exp.	Remarks
		March 12, 1939. ($18^h + 6^m 10^s$.)		
1	M-K	01.14.26	26	Denebola. Photographs spoiled by light on the plate
2	»	.15.34	17	Denebola. Photographs spoiled by light on the plate
3	»	.16.17	13	Curtain. Bootes
4	K	.17.14	22	Arc under Arcturus
5	»	.18.24	26	Arc and rays under Arcturus. Now it becomes overcast
		March 13, 1939.		
	M			Overcast
		March 14, 1939. ($12^h + 6^m 15^s$.)		
	M	01.30.00		Faint rays under Denebola
	»	.55.00		Faint rays under Cas
	»	02.25.00		Faint rays between Aur and Cas up to UMa
	»	02.35.00		Gone
		March 15, 1939.		
	M	02.00.00		Feeble glow low under Leo, rays
	»	.05.00		Gone
	»	.30.00		Feeble scattered rays from Capella over UMa to zenith
	»	03.55.00		Bundle of rays from Cas to Arcturus
	»	03.58.00		Gone
		March 16, 1939.		
	M			Overcast
		March 17, 1939.		
	M			Overcast
		March 18, 1939.		
	M			Some clouds
	»	23.00.00		Feeble arc low under Arcturus and Leo
	»	.15.00		Gone
		March 19, 1939.		
	M			Clear sky, no aurora
		March 20, 1939.		
	M			Clear sky, no aurora
		March 21, 1939.		
	M			Some clouds, no aurora
		March 22, 1939.		
	M			Probably aurora low under Leo through clouds
		March 23, 1939.		
	M			Clear sky, no aurora
		March 24, 1939.		
	M	00.45.00		Diffuse feeble arc in SE
	»	01.05.00		Some feeble rays from the arc towards zenith
	»	.40.00		Feeble diffuse arc over zenith from SW—NE
	»	.55.00		Feeble arc under Leo
	»	02.00.00		Observations concluded

5. Corresponding List of Photographs Taken by Mr. Sølver at Mørkefjord.

Engineer Sølver has sent me the list of the pictures taken simultaneously with Mr. Hatlevik in Micardbu and a translation of this is given in Table 2.

As I also had occasion to study the films in question, the following alterations have been made in Mr. Sølver's list:

The constellations have been added or modified according to inspection of the pictures.

In the last column "*Remarks*" each picture has been characterized as good, very good, etc. according to the same inspection. For the last film, No. 21, the numbers on the film have been given although they go chronologically in opposite order.

The headings have the following meaning:

M No. means number of picture taken at Micardbu.

Film and *S No.* are the numbers of the film and its pictures.

Exp. is the exposure in seconds.

Const. are the constellations against which the camera was pointed.

Table 2.

Aurora Photographs Taken Simultaneously from Micardbu (M) Koldevey (K) and Mørkefjord (S).

M No.	Film	S No.	Exp.	Const.	Remarks
		December 21, 1938.			
1.2	14	7	15	Ori	The telephone on 36 m very bad. All pictures underexposed
.3	»	8	10	Ori	
.4	»	9	10		
.5	»	10	8	Ori	
.6	»	11	10	Ori	
		January 9, 1939.			
2.8	15	1 A	10	Tau, Ori	Very good
.9	»	2 A	10	Tau, Ori, Eri	Very good
.10	»	3 A	15	Ori	Very good
.11	»	4 A	20	Gem, CMi	Very good
.12	»	5 A	30	Leo, Cnc	Very good
3.13	»	6 A	30	Gem, CMi	Very good
.14	»	7 A	20	Leo, Cnc	Very good
.15	»	8 A	40	Ori	Very good
.16	»	9 A	40	Ori	Very good
.17	»	10 A	40	Leo	Good
4.19	»	11 A	30	Ori	Very good
.20	»	12 A	30	Gem, CMi	Very good
.21	»	13 A	30	Gem	Very good
.22	»	14 A		Leo, LMi	Not usable
.23	»	15 A	15	Gem, Cnc	Good
.24	»	16 A	30	Ori, Tau	Good
5.25	»	17 A	25	Ori, Tau	Very good
.26	»	18 A	20	Ori, Tau	Very good
.27	»	19 A	30	Gem, CMi	Very good
.28	»	20 A	30	Gem	Very good
.29	»	21 A		Ori,Tau,Gem	Very good
.30	»	22 A		Gem, CMi	Good
6.31	»	23 A	30	Gem	Good
.32	»	24 A	30	Ori, Tau	Feeble
.33	»	25 A	30	Ori,Tau,Gem	Feeble
.34	»	26 A	30	Ori,Tau,Gem	Feeble
.35	»	27 A	30	CMi, Gem	Very good
.36	»	28 A	30	Ori	Very good
7.37	»	29 A	25	Boo	Usable
.38	»	30 A	25	Boo CVn	Feeble
.39	»	31 A	15	Boo CVn	Good
.40	»	32	20	Boo, CrB	Good
.41	»	33	15	Boo, CrB	Good
.42	»	34	20	Boo, CrB	Feeble
		January 14, 1939.			
1.4	16	8	30	Ori, Tau	Good
.5	»	9	30	Peg	Too feeble
.6	»	10	30	Leo	Too feeble
2.7	»	11		Leo	Good
.8	»	12	15	CMi, Mon	Very good
.9	»	13	25	Ori	Very good
.10	»	15		Ori	Very good
.11	»	16	15	Ori	Very good
.12	»	17	15	CMi	Excellent
3.13	»	18	12	Ori	Very fine
.14	»	19	10	CMi	Very fine
.15	»	20	12	Ori	Very fine
3.17	16	21	20	CMi, Hya	Very fine
.18	»	22	20	Tau, Eri	Very fine
4.19	»	23	12	CMi	Good
.20		24	30	Ori	Good
.22		25	16	Ori	Good
.23		26	12	Ori	Good
.24		27	12(?)	CMi	Good
5.25	»	28	25	Ori	Good
.26	»	29	15	Ori	Good
.27	»	30	15[1]	CMi, Hya	Good
7.37	»	39	25	Leo, Hya	Good
.38	17	1	30	Leo, Hya	Usable
.39	»	2	30	Leo, Com	Feeble
.40	»	3	30	Hya	Feeble
.41	»	4	20	CMi, Gem	Feeble
.42	»	5	20	Leo	Feeble
8.43	»	6	10	CMi, Hya	Usable
.44	»	7	20	Ori	Good
		January 15, 1939.			
.45	17	8	8	CMi	Good
.46	»	9	15	Leo, Com	Very fine
.47	»	10	12	Leo	Very fine
.48	»	11		CMi, Hya	
9.49	»	12	15	Leo	Feeble
.50	»	13	15	Hya	Good
.51	»	14		CMi, Hya	Good
.52	»	15	20	Ori	Clouds
.53	»	16		CMi, Hya	Good
.54	»	17	17	Hya, Leo	
10.55	»	18	20	Leo	
.56	»	19		Leo, Vir	Good
.57	»	20		Leo	Good
.58	»	21		Ori	Clouds
.59	»	22		Ori	Clouds
		February 17, 1939.			
1.2	21	30	20	Ori	Feeble
.3	»	29	20	C MI	Feeble
.4	»	28	20	Ori	Nothing
.5	»	27	15	Leo	Faint traces
.6	»	26	15	Leo	Faint traces
2.7	»	25	15	Gem, CMi	Faint traces
.8	»	24	15	Gem, CMi	Nothing
.9	»	23	15	Tau	Nothing
.10	»	22	15	Tau	Faint traces
.11	»	21	15	Leo	Too faint
.12	»	20	12	Boo, CnV	Too faint
3.13	»	19	8	Aur, Tau	Too faint
.14	»	18	8	Gem, Aur	Usable
.15	»	17	12		Too faint
.16	»	16	15	Gem	Usable
.17	»	15	8(?)	Tau	Too faint
4.19	»	14	15	UMa	Nothing
.20	»	13	18(?)	Leo	Too faint
.22	»	12	15	Gem	Nothing
.24	»	11	10	Ori	Too faint
5.25	»	10	15	Tau	Usable
.26	»	9		Ori	Faint traces

[1] Pictures Nos. 31—38 not usable on account of foreign light on the film.

6. List of International Signs of the Aurora Forms Photographed From the Norwegian Stations.

In Table 3 we have added a list of the designations of the aurora forms photographed according to the Photographic Atlas of Auroral Forms[1] viz:

HA Homogeneous quiet arcs
HB Homogeneous band
PA Pulsating arcs
DS Diffuse luminous surfaces
PS Pulsating surfaces
G Feeble glow
RA Arcs with ray structure
RB Bands with ray structure (curtains)
D Draperies
R Rays
C Corona
F Flaming aurora.

[1] Photographic Atlas of Auroral Forms and Scheme for Visual Observations of Aurorae, published by the International Geodetic and Geophysical Union, Oslo 1930.

Because the aurora forms merge into one another and as I have not myself seen the photographed forms it was often difficult from the photograph to determine the form.

In the table the first number gives the number of the plate, the second the number of the picture for the stations Micardbu (M) and Koldevey (K).

Table 3. *International Designation of the Aurora Forms Phothographed.*

Nov. 22, 1938, M.		5.29	R	1.5	RA	2.10	RB, DS	6.35	HA, RB	6.34	RA
1.1	HA	.30	RB	.6	HA	.11	RB, DS	.36	HA	.35	RA
.2	RA, RB	6.31	R	2.7	R, DS	.12	RB, DS	7.37	R	.36	RB
.3	RA	.32	HA	.8	R	3*.13	RB	.38	R	7.37	RA, RB
.4	HA	.33	HA	.9	R	.14	RB	.39	RB, R	.38	RB
.5	RB	.34	HA	.10	RB	.15	R	.40	R	.39	R
.6	RA	.35	RA	.11	RB	.16	R	.41	R	.40	R
2.7	HA, R	.36	RA	.12	RA	.17	?	.42	R	.41	D
.8	R	7.37	HA, RB	3.13	HA	.18	R			.42	DS
.9	RA, R	.38	RB			1.1	RA, R	*Jan. 14, 1939, M, S.*		8.43	RB
.10	RA	.39	R, RB	*Dec. 22, 1938, M.*		.2	RB	1.1	RB	.44	RB
.11	RA, RB	.40	RB	3.14	RA	.3	RB	.2	RB, DS		
.12	R	.41	RB	.15	RA	.4	RB	.3	RB, DS	*Jan. 15, 1939. M, S.*	
		.42	RB	.16	G, DS	.5	D, R	.4	RB	8.45	RB, R
Dec. 17, 1938, M, K.		8.43	RA, R	17	R	.6	D	.5	RA	.46	D
1.1	RB?	.44	RA	.18	G, DS	2.7	D	.6	RA	.47	RA
.2	RA	.45	HA, RA			.8	D	2.7	RB, R	.48	RB, R
.3	RA	.46	HA, RA	*Dec. 23, 1938, M.*		.9	RA, HA	.8	RB	9.49	DS
.4	HA, R	.47	HA	1.1	DS	.10	RA	.9	RB	.50	HB, DS
.5	RA, RB	.48	RA	.2	R	.11	PS	.10	RB	.51	RA
.6	HA, RB			.3	DS	.12	RB	.11	RB, R	.52	HA
2.7	RA	*Dec. 18, 1938, M.*		.4	DS	3.13	HA?	.12	RB	.53	RA, R
.8	RA	1.1	HA	.5	DS	.14	HA	3.13	RA	.54	RA
.9	RA	.2	HB	.6	HA, DS	.15	HA, R	.14	RA	10.55	RA
.10	RA	.3	HB			.16	HA, R	.15	RA, R	.56	RA
.11	RA, RB	.4	DS	*Dec. 24, 1938, M.*		.17	RB	.16	HA, RB	.57	RA, HA
.12	RA	.5	HA	1.1	R, DS	.18	RB	.17	R	.58	HA
3.13	RB	.6	R	.2	DS, G	4.19	RA, RB	.18	RB	.59	RA
.14	R, DS			.3	R, DS	.20	RB	4.19	RA, HA	.60	RA, R
.15	RB	*Dec. 20, 1938, M.*		.4	DS, G	.21	D, RB	.20	RA		
.16	RB	1.1	C	.5	R	.22	HA, RA	.21	HA	*Jan. 18, 1939, M.*	
.17	RA	.2	C	.6	G	.23	RA, R	.22	RA	1.1	D
.18	DS	.3	R			.24	RA	.23	RB	.2	D
4.19	R, DS	.4	R	*Jan. 9, 1939, M, S.*		5.25	HA, RA	.24	RA	.3	C
.20	DS	.5	R	1*.1	DS	.26	RA	5.25	RA, R	.4	C
.21	DS	.6	R, DS	.2	DS	.27	RA	.26	HA, RA	.5	D
.22	DS			.3	R	.28	RA	.27	HA	.6	D
.23	DS	*Dec. 21, 1938, M, K, S.*		.4	DS	.29	HA	.28	HA	2.7	RB
.24	DS			.5	DS	.30	HA, RA	.29	RA, RB	.8	RB
5.25	RB, DS	1.1	HA	.6	DS	6.31	RA	.30	RB	.9	R
.26	RB, DS	.2	HA, RA	2*.7	R	.32	DS	6.31	RB	.10	R
.27	RB, DS	.3	HA, R	.8	RB	.33	DS	.32	RB	.11	D
.28	RB, DS	.4	HA, R	.9	RB, DS	.34	HA	.33	RB	.12	RB

Table 3 (cont.).

3.13	D	2.9	R	7.37	R	11.62	HA	1.4	R,HA,HB	5.29	DS
.14	RA	.10	DS, C	.38	R	.63	HA	.5	R, RB	.30	DS
.15	RA	.11	DS, C	.39	R	.64	R	.6	RB	6 31	R, HA
		.12	RB	.40	R			2.7	D	.32	HA
Jan. 19, 1939, M.		3.13	RB	.41	R	*Feb. 14, 1939, M.*		.8	D	.33	HA, RB
3.16	R	.14	C	.42	RB	11.65	R	.9	D, R	.34	RA
.17	R	.17	DS	8.43	RA	.66	G	.10	RB	.35	RB
.18	RB	.18	DS	.44	RA			.11	RB	.36	HA, RB
		4.19	RA	.45	RA	*Feb. 16, 1939, M.*		.12	R, RB	7.37	R
Feb. 8, 1939. M.		.20	RA	.46	RB	1*.1	R	3.13	RA	.38	RA
1.1	R	.21	RA	.47	RB	.2	D	.14	HA	.39	RA, HA
.2	D	.22	RA	.48	RA	.3	D	.15	HA, R		
.3	RB?	.23	RA	9.49	RA	.4	D	.16	HA	*Feb. 18, 1939, M.*	
.4	RB	.24	DS	.50	RA	.5	R	.17	RB	7.40	R
.5	R	5.25	R	.51	D	.6	D	.18	HA	.41	R
.6	R	.26	RA	.52	D			4.19	D	.42	R
		.27	RA	.53	D	*Feb. 16, 1939, M, S.*		.20	RB		
Feb. 13, 1939, M.		.28	RA	.54	D	1.1	HB	.21	RB	*March 12, 1939, M, K.*	
1.1	HA	.29	RA	10.55	RB	.2	DS	.22	HB	1.1	R
.2	HA	.30	RA	.56	RB			.23	RB	.2	R
.3	RA	6.31	RA	.57	RB	*Feb. 17, 1939, M, K, S.*		.24	RB	.3	RB
.4	D	.32	RA	.58	RB			5.25	RB	.4	HA
.5	RB?	.33	RA	.59	RA	1.1	R, HA	.26	RB	.5	R, RB
.6	R	.34	RA	.60	RA	.2	R, HA	.27	RB		
2.7	R	.35	RA	11.61	HA	.3	R, HA	.28	DS		
.8	D	.36	R								

PART III.

The Measurements of Height and Situation of the Photographed Aurorae.

7. Base Lines.

From the observations of Mr. Hatlevik and Sølver the geographical coordinates of the aurora stations were as follows:

Station	Sign.	Latitude N.	Longitude W. Gr.
Micardbu	M	77° 4′.2 ± 0′.1	18° 12′ ± 1′
Koldewey	K	76° 43′.2	19° 3′.8
Mørkefjord	S	76° 56′.1	20° 18′.2

From this the length of base line g and the declination δ_o and time angle t_o of the point where the base line cuts the sky, observed from the main station, were calculated with the following results:

Base line	g	δ_o	t_o
M-K.....	44.77 km	−11°.41	30°.30
M-S.....	54.92 »	— 3°.54	75°.53
K-S.....	39.64 »	7°.93	127°.16

As main stations in the 3 cases were chosen respectively M and K. Fig. 1, drawn from "Report on the Expedition and on Subsequent Work at the Mørkefjord Station", by Eigil Knuth,[1] Fig. 48, shows the situation of the 3 stations.

8. General Remarks on the Work.

The negatives have been measured out by my excellent assistant Olav Egeberg during the years 1940 and 1941. Some of them were dropped on account of too small parallaxe, owing to unfavourable situation of the aurora relative to the base lines. In fact many of the aurorae were too near the point where the direction of base line cuts the sky or too near the horizon. Much longer base lines would have been better for the accuracy of the measurements.

As to the methods used I must refer to earlier papers, in particular to the improved methods published in 1938.[2]

[1] Meddelelser om Grønland Bd. 126, No. 1, Side 159, København 1942.

[2] Carl Størmer: Some Results Regarding Height and Spectra of Aurorae, etc., p. 5—9, Geof. Publ. Vol XII, No. 7, Oslo.

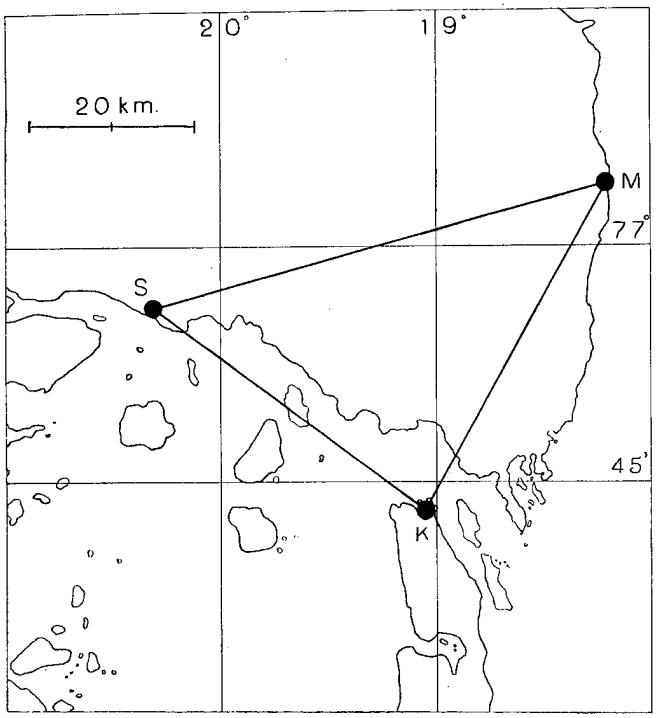

Fig. 1. Geographical position of the aurora stations Micardbu (M), Koldevey (K) and Mørkefjord (S).

9. The Results of the Measurements of Each Aurora Point.

In Table 4 the results of the measurements are given in detail. The headings have the following meaning:

No. is the number of the plate (first number) and picture (second number) according to the notes made at Micardbu.

Point. is the current number of the point of the aurora.

G. M. T. is Greenwich middle time for the middle of the exposure in hours, minutes and seconds.

St. are the stations at the ends of the base line. First letter are the main station, second letter the sub-station.

F is the aurora form measured according to the designations in the Photographic Atlas.

P is the position of the selected point on the aurora. *l* means that the point is *at* the lower border or at the base of a ray, *l'* that it is *near* this border or base; m means that the point is *between* lowest and highest part and h that it is *at* the upper border or at the summit of a ray. h' that it is *near* the upper border or summit.

ε_2 means the angle between the direction from the sub-station to the aurora point and the plane perpendicular to the base line at that point. ε_2 is counted positive on one side of this plane, negative on the other. Calling ε_1 the corresponding angle for the main station the parallaxe p is

$$p = \varepsilon_1 - \varepsilon_2 .$$

See Fig. 2 and the paper in Geofysiske Publikasjoner referred to in the preceding section. In former papers $u_1 = 90° - \varepsilon_1$ and $u_2 = 90° - \varepsilon_2$ were often used instead of ε_1 and ε_2.

p is the parallaxe.

h is the altitude of the aurora point as seen from the main station, a is its azimuth from the same station (reckoned from S positiv westwards and negativ eastwards).

D is the geodetical distance from the main station to the projection of the aurora point on the earth's surface (vertically under).

H is the height of the aurora point.

S. No. means the number of the picture taken at Mørkefjord. All angles are given in degrees, all lenght in kilometers.

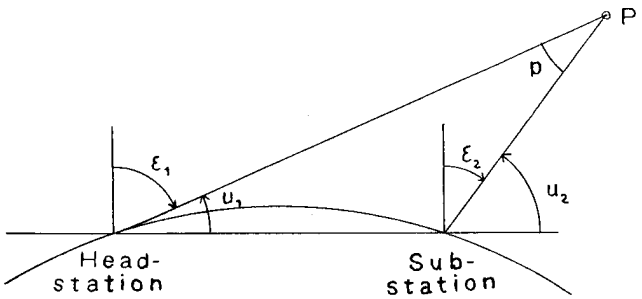

Fig. 2. Definition of angles u_1, u_2, ε_1, and ε_2.

Table 4. *Results of the Measuring of the Simultaneous Pictures.*

No.	Point	G. M. T.	St.	F	P	ε_2	p	h	a	D	H	S No.
						December 17, 1938.						
2.10	1	20.58.05	M-K	RA	l	— 3.3	6.0	14.4	—57.5	407	119	
	2	»	»	»	l	6.8	4.1	7.6	—49.3	606	112	
	3	»	»	»	l	10.5	3.8	7.5	—45.9	648	120	
	4	»	»	»	h	9.4	6.5	19.7	—43.5	300	142	
	5	»	»	»	l	9.6	6.6	15.5	—43.5	365	113	
.11	1	20.59.42	M-K	RB	l	—11.7	4.6	8.5	—67.5	534	103	
	2	»	»	»	l	—10.7	4.6	10.0	—66.7	532	117	
	3	»	»	»	l	-- 9.6	4.9	11.1	—65.2	499	119	
	4	»	»	»	l	— 7.1	5.8	12.5	—61.7	422	109	
	5	»	»	»	l	— 2.3	6.0	13.6	—56.7	410	114	
	6	»	»	»	m	—16.9	4.6	12.8	—73.1	510	139	
5.25	1	21.59.55	M-K	RB	h	35.9	4.6	25.3	—14.3	398	206	
	2	»	»	»	m	37.4	4.9	17.4	—15.4	390	137	
	3	»	»	»	l	37.8	5.0	12.8	—16.0	390	101	
.26	2	22.01.44	M-K	RB	l	34.3	5.8	15.3	—18.5	347	106	
	3	»	»	»	l	29.2	6.2	14.8	—23.6	345	102	
	4	»	»	»	l	23.9	6.1	14.1	—29.4	368	105	
.27	1	22.03.32	M-K	RB	l	7.9	6.3	14.1	—45.7	386	110	
	2	»	»	»	l	10.5	6.2	14.3	—43.0	391	106	
.28	1	22.05.05	M-K	RB	l	21.9	5.0	13.3	—32.7	455	126	
	2	»	»	»	l	15.7	4.9	12.4	—39.2	484	127	
	3	»	»	»	h	21.1	4.9	18.1	—32.9	453	168	
.29	1	22.08.01	M-K	R	h	—14.4	4.1	18.2	—71.4	559	215	
	2	»	»	»	m	—15.5	4.2	14.2	—72.0	557	169	
	3	»	»	»	l'	—16.4	4.3	10.3	—72.7	554	127	
	4	»	»	»	l	—18.3	4.1	9.0	—74.8	578	119	
	5	»	»	»	m	18.1	4.1	12.1	—74.7	570	151	
	6	»	»	»	h	—20.8	4.2	15.8	—77.7	535	177	
	7	»	»	»	l	—21.6	4.4	10.1	—78.0	525	117	
	8	»	»	»	h	— 8.8	5.2	21.4	—64.5	442	194	
	9	»	»	»	l'	—10.1	5.2	15.4	—65.6	459	146	
5.30	1	22.09.56	M-K	RB	h	—30.0	3.3	16.6	—88.3	624	225	
	2	»	»	»	l	—31.6	3.4	11.1	—89.2	617	154	
	3	»	»	»	h	—24.0	4.7	12.8	—81.1	478	128	
	4	»	»	»	l	—25.2	4.1	8.8	—81.7	552	111	
	5	»	»	»	h	—18.6	4.4	21.8	—76.8	497	225	
	6	»	»	»	l	—22.3	4.8	13.6	—78.4	472	134	
	7	»	»	»	l	—20.4	4.3	9.5	—76.6	542	116	
	8	»	»	»	h	—13.4	4.7	22.3	—69.9	477	220	
	9	»	»	»	l	—15.8	4.9	10.7	—71.3	487	112	
	10	»	»	»	h	- 7.8	5.8	26.8	—72.7	380	209	
	11	»	»	»	l	—10.1	6.0	16.0	—74.6	398	129	
						December 21, 1938.						
2.8	1	23.08.25	M-K	R	h	59.3	1.6	12.9	56.0	771	233	
	2	»	»	»	l	60.3	1.9	6.9	56.7	654	114	
	3	»	»	»	l'	63.3	1.7	8.0	53.3	660	129	
2.9	1	23.10.01	M-K	R	m	26.5	3.2	22.1	—27.8	636	303	
	2	»	»	»	l	28.0	3.6	13.9	—27.6	595	179	
2.10	1	23.23.27	M-K	RB	h	57.0	2.7	13.5	56.9	494	140	
	2	»	»	»	l	57.7	2.6	10.8	57.4	509	119	
	3	»	»	»	h	58.1	2.2	16.0	54.8	576	197	
	4	»	»	»	m	59.3	2.2	11.6	55.6	572	146	
	5	»	»	»	l	59.9	2.2	8.2	56.2	569	109	
	6	»	»	»	l	62.7	1.8	6.7	54.2	640	109	
	7	»	»	»	l	63.0	2.2	7.1	53.7	633	112	
2.11	1	23.25.00	M-K	RB	h	58.6	2.3	12.4	56.2	555	149	
	2	»	»	»	m	59.0	2.3	10.5	56.6	555	129	
	3	»	»	»	m	60.0	2.0	8.3	56.5	623	124	
	4	»	»	»	l	66.8	2.2	10.0	48.1	445	95	
	5	»	»	»	l	66.8	1.8	8.1	49.4	548	103	
2.12	1	23.27.46	M-K	RA	l	73.8	1.6	13.0	23.3	429	115	
	2	»	»	»	l	71.6	1.6	12.7	18.8	457	121	
	3	»	»	»	l	70.2	1.9	12.5	16.8	439	114	
	4	»	»	»	l	67.1	2.2	12.0	12.8	437	110	

Table 4 (cont.).

No.	Point	G. M. T.	St.	F	P	ε_2	p	h	a	D	H	S No.
						January 9, 1939.						
2.8	1	22.29.09	M-S	D	l	— 6.3	11.9	18.1	—12.7	249	87	15.1 A
	2	»	»	»	l	— 8.1	11.6	19.6	—11.3	251	95	»
	3	»	»	»	l	— 9.3	11.4	22.0	— 9.1	250	107	»
2.10	1	22.30.23	M-S	RA	l	— 0.3	8.5	14.2	— 6.2	356	101	15.3 A
	2	»	»	»	l	— 8.8	9.7	16.5	—13.7	304	99	»
	3	»	»	»	l	—15.0	9.8	18.5	—20.1	291	105	»
	4	»	»	»	l	4.5	7.8	12.1	— 2.0	389	97	»
	5	»	»	»	l	—18.0	10.0	19.4	—23.2	280	106	»
3.17	1	22.46.11	M-S	RB	m	—70.4	2.7	17.2	—90.1	367	127	15.10 A
	2	»	»	»	l	—74.5	1.6	10.6	—91.3	510	118	»
4.19	1	22.51.27	M-S	RB	h	11.7	6.5	18.0	4.7	443	163	15.11 A
	2	»	»	»	l'	12.9	6.8	11.7	5.7	437	107	»
	3	»	»	»	l	13.5	6.8	11.0	6.2	437	101	»
4.20	1	22.53.03	M-S	RB	m	—20.7	14.0	33.1	—22.5	175	119	15.12 A
	2	»	»	»	l	—21.5	14.2	30.1	—23.0	177	107	»
	3	»	»	»	l	—23.5	13.2	28.0	—26.4	191	107	»
	4	»	»	»	h	—25.4	13.3	30.9	—28.8	182	114	»
	5	»	»	»	l	—26.2	13.5	27.4	—29.0	185	100	»
	7	»	»	»	l	—20.9	9.9	19.5	—36.4	277	106	»
	8	»	»	»	l	—32.0	10.7	22.8	—37.9	229	101	»
	9	»	»	»	l	—25.4	9.0	19.7	—32.2	294	114	»
	10	»	»	»	l	—18.0	9.0	18.2	—24.3	314	112	»
	11	»	»	»	l	— 7.4	9.0	16.3	—13.1	330	107	»
	12	»	»	»	l	—30.4	5.1	8.8	—40.6	520	103	»
4.21	1	22.54.14	M-S	D	h'	—18.9	10.3	39.1	—25.6	219	187	15.13 A
	2	»	»	»	l'	—21.9	12.4	36.2	—25.1	210	108	»
	3	»	»	»	h	—23.9	11.2	35.6	—30.2	206	154	»
	4	»	»	»	l	—26.3	12.4	26.7	—30.2	202	106	»
	5	»	»	RB	l	—41.2	12.0	29.8	—48.8	170	102	»
	6	»	»	»	l	—43.6	12.1	32.2	—52.7	158	103	»
	7	»	»	»	l	—46.9	11.5	32.9	—58.1	155	105	»
	8	»	»	»	l	—48.9	9.2	21.7	—58.0	208	87	»
	9	»	»	»	l	—43.6	9.2	20.9	—51.9	230	94	»
	10	»	»	»	l	—36.8	9.4	19.3	—43.9	251	94	»
4.23	1	22.57.17	M-S	R	h'	—28.2	9.0	38.0	—39.2	237	196	15.15 A
	2	»	»	»	m	—30.4	9.9	33.1	—39.4	226	154	»
	3	»	»	»	l	—33.3	10.8	25.7	—39.8	218	110	»
	4	»	»	RB	l	—37.7	9.7	23.2	—45.3	234	106	»
	5	»	»	»	l	—32.3	10.6	22.7	—38.3	229	101	»
	6	»	»	»	l	—25.9	10.8	21.8	—30.9	241	103	»
4.24	1	22.58.39	M-S	RA	l'	— 0.1	8.1	13.9	6.3	374	105	15.16 A
	2	»	»	»	l	6.4	8.6	14.3	0.8	349	100	»
5.25	1	23.02.21	M-S	RA	l	— 9.0	11.9	20.0	—11.5	243	94	15.17 A
	2	»	»	»	l	— 2.0	12.1	18.9	— 4.0	244	90	»
	3	»	»	»	l	8.0	11.1	17.0	5.6	267	89	»
5.26	1	23.03.25	M-S	RA	l	— 6.5	15.4	35.1	— 3.7	166	121	15.18 A
	2	»	»	»	l	6.8	13.2	17.3	8.0	211	114	»
	3	»	»	»	l	— 7.6	10.5	19.4	— 1.7	279	106	»
	4	»	»	»	l	— 0.2	10.2	18.1	— 4.0	291	104	»
5.27	1	23.05.01	M-S	RA	l	—16.9	16.4	30.5	—15.3	158	97	15.19 A
	2	»	»	»	l	—30.0	15.3	31.4	—31.9	152	97	»
	3	»	»	»	l	—22.9	10.8	21.0	—27.8	249	102	»
	4	»	»	»	l	—25.5	10.2	22.7	—31.4	255	113	»
5.29	1	23.07.34	M-S	HA	l	14.0	8.7	15.2	8.9	335	101	15.21 A
	2	»	»	»	l	— 6.0	12.0	18.4	— 8.4	246	88	»
6.31	1	23.15.40	M-S	RA	l	—17.6	15.1	28.5	—17.9	175	99	15.23 A
	2	»	»	»	l	—27.3	12.7	26.5	—31.0	196	102	»
6.35	1	23.21.39	M-S	RB	h	—18.9	6.2	16.1	—28.0	453	150	15.27 A
	2	»	»	»	l'	—19.5	6.1	12.3	—28.5	466	121	»
7.37	3	23.47.30	M-S	R	l	—57.2	5.4	19.0	—138.7	295	110	15.29 A
	4	»	»	»	h'	—55.2	5.5	25.0	—137.6	291	145	»
	5	»	»	»	l	—64.2	4.9	21.5	—127.4	257	109	»
	6	»	»	»	h'	—61.5	5.2	26.6	—126.4	253	134	»
7.38	1	23.49.15	M-S	R	m	—52.4	5.9	32.9	—135.5	266	182	15.30 A
	2	»	»	»	m	—56.5	5.8	24.0	—137.1	269	127	»
	3	»	»	»	l'	—58.7	5.8	17.5	—138.2	266	90	»

Table 4 (cont.).

No.	Point	G. M. T.	St.	F	P	ε_2	p	h	a	D	H	S No.
7.38	4	23.49.15	M-S	R	h'	—48.2	5.9	39.5	—134.0	263	233	15.30 A
7.39	1	23.50.28	M-S	RB	h'	—63.6	2.8	18.3	—128.1	463	174	15.31 A
	2	»	»	»	m	—65.7	2.5	12.2	—128.8	498	129	»
	3	»	»	»	l'	—67.4	2.0	8.5	—127.8	588	116	»
	4	»	»	»	l'	—69.2	2.4	12.1	—124.7	448	113	»
	5	»	»	»	l	—70.6	2.1	11.4	—123.3	480	116	»
	6	»	»	»	l	—74.0	2.1	13.6	—117.2	396	110	»
	7	»	»	»	l	—74.9	2.2	15.5	—113.2	354	110	»
	8	»	»	»	l	—74.7	2.5	18.0	—107.4	312	111	»
	9	»	»	»	l	—76.5	1.9	12.2	—114.3	374	93	»
7.41	1	23.57.'8	M-S	R	m	—54.3	3.6	22.3	—138.2	458	211	15.33 A
	2	»	»	»	l	—56.7	4.0	11.1	—139.5	420	97	»
	3	»	»	»	m	—59.6	2.4	17.1	—133.3	613	226	»
	4	»	»	»	l'	—61.3	2 1	7.8	—134.7	699	138	»
7.42	1	00.00.24	M-S	R	h	—53.3	4·0	28.9	—135.3	397	239	15.34 A
	2	«	»	»	m	—56.1	3·9	22.1	—136.6	407	182	»
	3	«	»	»	l'	—57.6	3·8	17.1	—137.5	416	144	»
	4	«	»	»	l	—64.9	3·1	13.6	—129.7	413	114	»
						January 14, 1939.						
2.7	1	22.10.13	M-S	R	l	—66.3	4.1	18.9	—83.6	280	105	16.11
2.8	2	22.11.50	M-S	RB	l	—43.0	7.3	15.6	—51.9	300	92	16.12
2.9	1	22.13.08	M-S	RB	l	2.0	6.5	9.7	— 6.2	471	99	16.13
	2	»	»	»	l	2.8	6.5	9.4	— 5.5	472	97	»
	3	»	»	»	l'	— 8.5	5.8	9.1	—17.4	522	107	»
2.11	1	22.15.28	M-S	RB	l	— 2.7	5.6	7.9	—11.8	551	101	16.16
	2	»	»	»	l	6.9	5.7	7.6	— 2.0	530	94	»
	3	»	»	R	l	16.3	5.3	8.4	7.2	540	104	»
2.12	1	22.16.32	M-S	RB	l'	11.2	5.3	10.0	2.1	563	126	16.17
	2	»	»	»	l	10.6	5.4	8.3	1.6	559	108	»
	3	»	»	»	l	9.4	5.6	8.1	0.5	543	102	»
	4	»	»	»	l	— 7.6	7.4	11.2	—14.9	410	95	»
	5	»	»	»	l	12.9	4.9	7.1	— 1.6	613	109	»
3.15	1	22.20.01	M-S	R	l	— 1.5	8.4	16.4	— 7.6	354	116	16.20
	2	»	»	»	m	— 2.0	7.8	24.4	— 8.4	360	178	»
	3	»	»	»	l	— 6.0	8.3	16.1	—12.4	358	116	»
	4	»	»	»	m	— 6.1	7.9	21.5	—12.8	362	156	»
	5	»	»	»	l	— 6.6	8.1	16.1	—13.2	366	119	»
3.17	1	22.22.24	M-S	R	l	—40.3	6.7	16.3	—49.7	369	121	16.21
	2	»	»	»	h'	—36.5	6.1	27.2	—49.3	384	216	»
4.19	1	22.26.18	M-S	RB	l'	—15.2	6.7	13.2	—23.5	485	119	16.23
4.22	1	22.29.36	M-S	RA	l	24.0	4.9	7.6	8.5	574	104	16.25
4.23	1	22.31.17	M-S	RB	l	3.2	4.5	5.7	— 7.0	685	108	16.26
	2	»	»	»	l	18.9	4.8	6.9	9.2	607	106	»
5.26	1	22.37.25	M-S	RA	l	11.1	5.2	6.1	1.7	584	90	16.29
	2	»	»	R	l	0.2	6.3	11.4	— 8.1	482	117	»
5.29	1	22.46.27	M-S	RA	l	11.4	4.7	7.0	1.5	642	115	16.32
7.37	1	23.17.15	M-S	RA	l	—53.0	3.4	9.7	—65.4	539	118	16.39
7.38	1	23.21.43	M-S	RB	l	—62.0	2.6	9.5	—75.4	551	118	17.1
	2	»	»	»	l	—66.3	2.5	9.9	—80.4	490	107	»
7.39	1	23.23.55	M-S	R	l	—74.7	1.5	8.7	—88.3	537	117	17.2
7.40	1	23.27.00	M-S	R	l'	—28.5	5.0	11.7	—38.8	531	135	17.3
	2	»	»	»	l	—28.9	5.2	10.3	—38.9	514	117	»
7.41	1	23.55.04	M-S	D	l	—23.8	10.2	22.9	—29.5	257	116	17.4
	2	»	»	»	l	—17.1	9.6	20.4	—22.7	290	117	»
7.42	1	23.56.02	M-S	DS	l	—38.5	9.5	27.7	—48.0	227	125	17.5
	2	»	»	»	l	—42.5	8.9	23.3	—51.8	236	108	»
	3	»	»	»	l	—47.0	7.2	23.1	—58.8	271	123	»
8.43	1	23.59.00	M-S	RB	m	— 2.1	9.4	27.3	— 6.5	291	160	17.6
	2	»	»	»	l	— 1.9	10.4	19.4	— 5.7	283	107	»
	3	»	»	»	l	—10.2	10.1	20.0	—14.9	285	112	»
	4	»	»	»	l	—15.1	11.5	23.0	—18.7	241	109	»
						January 15, 1939.						
8.45	1	00.00.32	M-S	R	l	1.2	7.3	13.6	— 6.1	413	115	17.8
	2	»	»	»	m	1.5	6.7	20.3	— 6.0	429	179	»
	3	»	»	RB	l	—4.6	7.2	14.0	—12.1	223	119	»

Table 4 (cont.).

No.	Point	G. M. T.	St.	F	P	ε_2	p	h	a	D	H	S No.
8.45	4	00.00.32	M-S	R	l	—16.5	9.5	23.4	—22.4	287	133	17.8
	5	»	»	»	m	1.0	6.1	28.2	— 6.5	437	261	»
8.46	1	00.01.33	M-S	D	l	—58.1	6.6	22.7	—72.8	230	102	17.9
	2	»	»	»	m	—54.6	6.5	28.1	—72.1	235	132	»
	3	»	»	»	m	—52.0	6.6	32.0	—71.5	244	160	»
	4	»	»	»	l	—59.1	6.3	22.1	—74.0	234	101	»
	5	»	»	»	l	—60.8	5.5	20.9	—76.3	257	105	»
	6	»	»	»	m	—57.7	5.8	25.9	—75.5	255	131	»
	7	»	»	»	m	—53.7	6.1	31.6	—74.5	254	165	»
	8	»	»	»	l	—64.3	4.6	18.7	—80.5	278	101	»
	9	»	»	»	m	—61.9	5.0	22.7	—79.9	269	119	»
	10	»	»	»	l	—65.0	4.5	18.3	—81.2	277	99	»
	11	»	»	»	m	—62.4	4.8	22.3	—80.5	277	121	»
8.47	1	00.02.54	M-S	R	h	—47.1	5.9	35.7	—68.6	285	212	17.10
	2	»	»	»	l	—53.4	6.0	26.3	—69.8	274	144	»
	3	»	»	RA	h	—54.8	6.0	23.2	—69.7	273	124	»
	4	»	»	»	l'	—56.2	5.8	20.2	—69.9	270	107	»
	5	»	»	»	h	—44.5	7.8	27.2	—56.8	251	136	»
	6	»	»	»	l'	—46.0	7.9	23.7	—57.0	249	116	»
	7	»	»	»	l	—38.0	10.0	23.2	—45.5	225	102	»
8.48	1	00.03.38	M-S	RB	l	—25.8	10.5	19.8	—31.1	252	96	17.11
	2	»	»	»	l	—21.0	9.5	18.7	—26.8	291	106	»
	3	»	»	»	l	—17.5	8.8	17.1	—23.8	321	109	»
	4	»	»	»	l'	—16.1	8.5	17.5	—22.7	334	116	»
	5	»	»	»	m	—15.6	8.4	21.2	—22.5	330	139	»
	6	»	»	R	l	—13.2	8.4	16.0	—19.8	348	111	»
	7	»	»	»	m	—12.6	7.8	21.9	—19.9	358	157	»
	8	»	»	»	l	— 5.4	7.8	13.8	—12.5	395	111	»
	9	»	»	»	l	1.9	7.0	12.0	— 5.7	434	109	»
	10	»	»	»	h	1.5	6.5	19.1	— 6.3	446	175	»
	11	»	»	RB	m	—17.3	6.1	14.2	—26.4	469	139	»
9.49	1	00.05.50	M-S	DS	l	33.6	8.0	15.2	—42.5	313	94	17.12
9.51	1	00.07.36	M-S	RA	m	— 8.7	6.6	11.2	—17.0	457	109	17.14
9.53	1	00.09.19	M-S	RA	h	1.9	6.8	25.2	— 5.1	407	211	17.16
	2	»	»	»	l'	2.5	7.5	18.0	— 4.3	391	142	»
10.55	1	00.12.42	M-S	RA	l	—52.3	4.1	9.8	—64.0	457	97	17.18
	2	»	»	»	l	—55.0	3.4	8.6	—67.3	517	100	»
10.56	1	00.13.37	M-S	RA	l	—59.9	2.1	5.7	—73.1	735	120	17.19
						February 17, 1939.						
1.2	1	21.19.44	M-K	R	h	48.9	3.8	24.8	1.1	392	198	
	2	»	»	»	l	54.9	3.6	15.5	2.1	389	121	
1.5	6	21.23.29	M-S	RB	l	—46.9	4.7	10.9	—57.8	443	102	21.27
1.5	1	»	M-K	R	m	— 1.4	6.1	30.5	—55.1	350	223	
	2	»	»	»	l	— 3.0	7.2	17.5	—55.8	335	116	
	3	»	»	»	m	— 8.6	5.6	18.6	—63.4	420	158	
	4	»	»	»	l	— 9.3	5.6	15.0	—64.0	429	131	
	5	»	»	RB	l	— 6.0	5.9	12.5	—60.3	417	107	
	6	»	»	»	l	— 3.1	5.5	10.9	—57.8	451	104	
	7	»	»	»	l'	—18.4	4.4	8.6	—74.4	540	105	
1.6	1	21.25.02	M-K	RB	h'	—12.5	4.5	20.3	—68.9	507	214	
	2	»	»	»	m	—13.7	4.8	14.5	—69.6	493	149	
	3	»	»	»	l'	—14.2	5.0	10.7	—69.8	481	110	
	4	»	»	R	l	—16.7	5.6	17.1	—72.0	411	142	
	5	»	»	RB	l	—17.7	5.8	12.5	—72.6	407	104	
	6	»	»	»	m	—11.3	4.8	10.7	—67.1	507	117	
	7	»	»	R	m	—22.3	8.2	21.9	—65.5	264	114	
	8	»	»	»	l	—21.9	7.8	18.9	—65.3	285	106	
	9	»	»	R	h	— 8.7	7.5	32.4	—61.6	270	188	
	10	»	»	»	l	— 9.9	7.9	27.5	—62.6	270	154	
2.7	1	21.26.50	M-K	D	m	25.0	11.6	42.0	— 6.9	131	120	
	2	»	»	»	m	20.6	10.1	49.6	— 8.0	139	169	
	3	»	»	»	l'	23.8	12.3	39.9	—10.2	129	111	
	4	»	»	»	h	14.0	8.5	57.8	—14.1	144	238	
	5	»	»	»	m	16.1	11.6	41.6	—21.7	145	132	
	6	»	»	»	h	10.0	7.5	59.1	—23.6	161	282	
2.8	1	21.28.19	M-K	D	h'	10.6	12.5	40.0	—29.5	152	132	

Table 4 (cont.).

No.	Point	G. M. T.	St.	F	P	ε_2	p	h	a	D	H	S No.
2.8	2	21.28.19	M-K	D	l	10.7	13.7	35.3	— 30.0	149	109	
	3	»	»	»	m	15.2	12.4	39.8	— 23.3	152	130	
	4	»	»	»	l	16.1	13.5	35.3	— 23.1	148	108	
2.9	1	21.29.20	M-K	R	m	64.4	2.6	22.0	35.3	386	171	
	2	»	»	»	m	69.5	2.0	16.9	36.3	431	145	
	3	»	»	»	l	73.0	1.5	13.1	37.2	477	131	
	5	»	»	D	l	71.9	2.0	14.9	24.0	379	113	
	6	»	»	»	l	70.3	2.1	15.3	21.1	390	121	
	7	»	»	»	l	67.9	2.5	15.3	17.2	366	112	
2.10	1	21.30.57	K-M	R	h	—67.7	2.6	22.2	16.7	339	150	
	4	»	»	»	h	—58.2	6.9	38.4	35.5	150	123	
	5	»	»	»	l	—64.1	5.8	31.0	36.9	163	101	
2.11	2	21.31.56	M-K	RB	l	—21.6	13.9	36.5	— 69.9	137	104	
	3	»	»	»	l	—27.5	12.1	32.1	— 78.5	158	102	
2.11	1	»	K-S	RB	l	—60.1	3.9	21.9	— 78.8	265	112	21.21
	2	»	»	»	l	—55.2	4.4	20.6	— 86.4	275	108	»
	3	»	»	»	l	—50.2	4.6	19.1	— 93.2	294	110	»
	4	»	»	»	l	—46.3	4.7	17.5	— 98.2	314	109	»
2.12	1	21.32.59	K-M	RB	m	36.4	7.9	32.1	—117.2	218	143	
	2	»	»	»	l	41.9	7.8	24.6	—118.6	220	105	
	3	»	»	»	h'	41.5	6.0	23.4	—115.1	289	134	
	4	»	»	»	l	44.9	5.7	17.9	—115.8	299	104	
	5	»	»	»	l	45.5	4.9	15.0	—114.4	349	104	
	6	»	»	»	l	56.1	3.9	14.8	—125.1	350	103	
	7	»	»	»	l	54.4	3.3	11.5	—121.0	437	105	
	8	»	»	»	l	49.8	3.1	9.6	—115.4	519	110	
	9	»	»	»	m	42.0	3.3	12.6	—108.2	553	150	
	10	»	»	»	l'	43.4	3.3	9.0	—108.9	550	112	
	11	»	»	»	h	48.9	5.6	21.3	—122.5	276	115	
	12	»	»	»	l	51.0	5.5	18.3	—123.0	275	99	
	13	»	»	»	h	47.7	5.0	19.2	—118.9	320	122	
	14	»	»	»	l	49.4	4.9	16.4	—119.3	322	104	
3.13	1	21.34.51	M-K	RA	l	28.6	16.1	38.9	4.8	110	91	
	2	»	»	»	l	31.4	15.1	38.3	7.5	114	93	
	3	»	»	»	l	34.7	14.1	37.3	11.2	119	94	
	4	»	»	»	l	37.9	13.1	36.2	14.7	124	94	
	5	»	»	»	i	41.3	12.1	34.7	17.9	130	93	
	6	»	»	»	l	46.0	10.3	32.4	21.0	145	95	
	7	»	»	»	l	48.3	9.3	31.4	23.3	155	98	
3.14	1	21.35.38	K-S	HA	l	—49.7	10.0	48.5	— 36.5	98	110	21.18
	2	»	»	»	l	—48.0	10.9	48.0	— 36.2	95	106	»
	3	»	»	»	l	—45.5	11.4	47.4	— 17.8	96	105	»
	4	»	»	»	l	—41.9	11.9	46.3	— 8.3	98	105	»
3.15	2	21.36.29	M-K	HA	l	— 7.4	12.5	30.3	— 54.1	174	106	
	3	»	»		l	—15.2	11.3	27.4	— 64.5	193	104	
	4	»	»		l	—23.5	9.2	23.5	— 76.0	232	117	
	6	»	»		l	— 8.6	13.0	34.3	— 53.6	160	113	
	7	»	»		l	—17.6	12.1	30.3	— 66.5	173	105	
	8	»	»		l	—26.0	10.0	25.3	— 78.0	207	103	
	9	»	»	R	m	—21.7	11.2	42.5	— 74.5	155	147	
	10	»	»	»	l'	—26.1	11.0	36.0	— 79.0	108	127	
3.16	1	21.37.16	M-K	HA	l	29.2	11.1	32.0	— 10.0	170	110	
	2	»	»	»	l	19.2	12.4	32.6	— 21.7	164	109	
	3	»	»	»	l	8.5	12.7	31.8	— 35.0	168	109	
	4	»	»	»	l	29.1	12.5	35.0	— 5.7	146	106	
	5	»	»	»	l	21.8	13.7	35.3	— 14.9	141	103	
	6	»	»	»	l	13.2	14.5	35.0	— 25.8	140	102	
	7	»	»	»	l	5.7	14.0	33.9	— 36.2	151	105	
3.16	1	»	K-S	HA	l	—46.6	9.9	45.4	— 17.2	109	112	21.16
	2	»	»	»	l	—51.8	8.9	42.4	— 29.0	117	108	»
	3	»		»	l	—55.0	7.8	41.2	— 28.5	125	111	»
3.17	1	21.38.15	M-K	RB	l	45.8	9.3	32.5	16.6	161	106	
	2	»	»	»	l	47.8	9.1	32.1	22.4	159	104	
	3	»	»	»	l	54.9	7.1	27.2	23.7	182	98	
	4	»	»	»	l	57.4	6.1	26.3	28.0	201	104	
	5	»	»	»	l	61.7	4.9	25.1	32.4	221	109	
	6	»	»	»	l	62.1	4.4	21.5	39.0	250	105	

Table 4 (cont.).

No.	Point	G. M. T.	St.	F	P	ε_2	p	h	a	D	H	S No.
3.17	7	21.38.15	M-K	RB	l	59.3	4.6	20.1	46.5	263	104	
	8	»	»	»	m	63.3	3.1	20.7	40.9	340	141	
	9	»	»	»	l	66.2	2.9	17.5	41.1	335	117	
	10	»	»	»	h'	38.0	10.0	40.9	38.9	150	135	
	11	»	»	»	l	44.0	9.5	35.0	40.1	158	114	
	12	»	»	»	h	48.6	6.9	32.1	42.5	205	135	
	13	»	»	»	l	52.8	7.0	27.1	43.1	195	105	
4.19	1	21.46.01	K-M	D	m	24.4	13.6	48.8	—131.4	113	130	
	2	»	»	»	l	32.5	14.7	39.5	—134.0	113	96	
	3	»	»	»	m	27.5	10.5	46.9	—126.2	146	160	
	4	»	»	»	l	37.9	12.3	34.0	—129.4	136	94	
	5	»	»	»	m	23.2	12.3	47.6	—121.3	138	143	
	6	»	»	»	m	30.0	13.3	39.2	—123.7	129	108	
4.20	2	21.46.56	M-K	RB	l	3.8	11.6	27.3	— 42.9	195	104	
	3	»	»	»	l	— 1.3	10.0	22.1	— 50.8	235	101	
	4	»	»	»	l	— 4.6	8.3	18.3	— 56.4	289	103	
	5	»	»	»	l	— 9.6	8.3	18.4	— 61.6	285	103	
	6	»	»	»	l	—12.4	7.6	15.8	— 65.2	315	98	
	7	»	»	»	l	—15.4	6.8	14.2	— 69.1	348	99	
	8	»	»	»	l	2.4	15.5	35.4	— 38.2	134	98	
	9	»	»	»	l	— 2.0	12.3	27.9	— 48.6	182	100	
	10	»	»	»	l	— 6.9	9.0	18.3	— 58.0	265	94	
4.21	1	21.51.32	M-K	RB	h	33.7	10.8	30.9	— 5.3	168	104	
	2	»	»	»	h	31.3	10.1	27.7	— 11.9	190	104	
	3	»	»	»	h	31.9	6.2	21.3	— 18.9	321	136	
	4	»	»	»	m	33.7	5.8	18.5	— 18.1	342	126	
	5	»	»	»	h	26.5	7.0	20.2	— 24.3	303	121	
	6	»	»	»	m	27.7	6.5	17.5	— 24.2	328	114	
	7	»	»	»	l	30.9	5.6	16.2	— 22.1	372	121	
	8	»	»	»	l	29.1	5.2	14.3	— 24.8	411	120	
4.22	1	21.52.32	K-M	HB	l	—38.3	9.6	34.1	— 25.9	171	120	
	2	»	»	»	m	—39.5	9.0	40.3	— 19.8	165	145	
	3	»	»	»	m	—43.5	9.0	34.1	— 18.5	169	119	
4.24	1	21.54.17	M-K	RB	l	53.7	4.5	18.1	3.1	315	112	
	2			»	l	60.7	3.8	18.3	11.9	308	111	
	3			»	m	66.4	1.5	13.1	17.0	628	245	
	4			»	m	70.0	1.3	14.1	17.5	636	197	
	5			»	m	66.9	1.5	18.6	18.7	613	245	
	6			»	m	70.0	1.3	15.3	19.2	631	211	
	7			»	l	70.1	2.6	14.9	21.0	320	95	
	8			»	l	69.6	2.8	16.4	23.7	302	98	
5.25	1	21.56.39	M-S	RB	l	34.5	6.3	13.6	27.7	395	110	21.10
	2	»	»	»	m	34.1	7.0	15.1	28.3	355	108	»
	3	»	»	»	m	33.3	7.1	16.7	28.0	351	117	»
	4	»	»	»	l	32.6	8.6	19.4	29.7	288	109	»
	5	»	»	»	l	31.9	10.2	21.9	31.8	241	103	»
	6	»	»	»	l	34.0	10.9	23.5	35.7	218	100	»
	7	»	»	»	l	36.8	11.5	23.4	39.9	200	90	»
	8	»	»	»	m	42.2	7.1	20.2	39.4	304	121	»
	9	»	»	»	l	43.4	6.9	18.3	39.5	311	112	»
	10	»	»	»	m	35.7	6.4	16.3	29.7	378	124	»
6.31	3	22.02.33	M-K	RB	l	—17.1	8.6	21.1	— 69.4	263	108	
	4	»	»	R	h'	1.0	9.6	31.7	— 47.7	223	145	
	5	»	»	»	l	0.7	11.4	26.9	— 47.8	199	105	
	6	»	»	»	h	— 4.3	10.3	34.2	— 53.1	203	143	
	7	»	»	»	l'	— 4.8	10.8	30.2	— 53.3	202	123	
6.32	2	22.03.13	M-K	HA	l	47.9	5.9	21.3	— 0.2	268	112	
	3	»	»	»	l	40.4	6.8	21.1	— 8.4	265	109	
	4	»	»	»	l	33.7	7.5	20.9	— 15.5	262	107	
6.33	1	22.04.02	M-K	HA	l	62.9	4.1	22.7	26.1	258	115	
	2	»	»	»	l	65.5	3.6	21.7	32.8	271	111	
	3	»	»	»	l	66.0	3.3	18.7	38.5	295	108	
	4	»	»	R	l	62.0	4.8	22.6	34.4	229	101	
6.34	1	22.04.48	M-K	RA	l	46.0	7.8	26.6	3.1	201	105	
	2	»	»	»	l	43.3	8.0	26.6	— 0.1	206	108	
	3	»	»	»	l	39.0	8.5	27.8	— 4.0	205	113	
	4	»	»	»	l	38.1	8.1	26.7	— 6.7	220	116	

Table 4 (cont.).

No.	Point	G. M. T.	St.	F	P	ε_2	p	h	a	D	H	S No.
6.34	5	22.04.48	M-K	RA	l	34.1	8.5	27.6	— 9.6	217	119	
	6	»	»	»	l	34.5	8.1	25.1	—12.1	233	116	
	7	»	»	»	l	31.0	8.4	25.8	—15.6	233	118	
	8	»	»	»	l	30.7	8.2	23.0	—17.7	245	110	
6.35	1	22.05.47	M-K	RB	l	12.7	7.7	17.1	—39.3	307	103	
	2	»	»	»	l	6.5	7.3	15.8	—46.2	331	104	
	3	»	»	»	l	0.0	6.8	14.2	—52.6	362	103	
	4	»	»	»	h	—13.1	7.1	18.4	— 67.3	328	120	
	5	»	»	»	l	—13.1	7.1	15.8	— 67.3	333	104	
						March 12, 1939.						
1.3	1	01.22.21	M-K	RB	h	3.7	9.1	25.7	—45.9	250	127	
	2	»	»	»	l'	3.9	9.0	23.3	—46.0	257	118	

10. Remarks on the Height Measurements. Some Selected Sets.

It is necessary to make some supplementary remarks on the measurements in Table 4. These are given below for each date chronologically. The Plate and Picture numbers are the same as in Table 1.

December 17, 1938.

2.10 Points 1, 4 and 5 give the best results.

2.11 Points 2, 3, 4 and 5 the best ones.

5.28 Rather diffuse pictures.

January 9, 1939.

2.8 Point 1 doubtful.

2.10 Points 1, 2 and 4 the best ones.

4.21 The lower border of the lowest band diffuse and difficult to measure (points 8, 9, 10 and 11).

6.31 Very diffuse and doubtful.

6.37 The rays were difficult to identify.

January 14, 1939.

4.19 Very diffuse and difficult to measure.

7.39 Doubtful.

January 15, 1939.

10.56 As an error in p of 0°.1 makes an error of 9 km in H, the measure is doubtful.

February 17, 1939.

1.5 The measurement of the heights of point 6 with base line M-S and base line M-K differed only 2 km.

3.14 Points 2, 3 and 4 better than Point 1.

3.15 Points 3, 4, 7 and 8 the best ones.

We have not found it necessary to reproduce pictures or sketches of all the photographs taken. A selection is made only among the best and most characteristic ones. Here they are:

Date	Pict.	No.	G. M. T.	Sketch	Picture	N
December 17, 1938	M	5.30	22 09 56	Fig. 3	Plate 1,1	a
» » »	K	«	»	»	» 1,2	
January 14, 1939	M	2.12	22.16.32	»	Plate 1,3	b
» » »	S	16.17	»	»	» 1,4	
January 14, 1939	M	3.17	22.22.24	»	Plate 1,5	c
» » »	S	16.21	»	»	« 1,6	
January 15, 1939	M	8.46	00.01.33	»	Plate 2,1	d
» » »	S	17.9	»	»	» 2,2	
January 15, 1939	M	8.48	00.03.38	»	Plate 2,3	e
» » »	S	17.11	»	»	» 2,4	
February 17, 1939	M	2.12	21.32.59	»	Plate 2,5	f
» » »	K	»	»	»	» 2,6	
February 17, 1939	M	3.13	21.34.51	Fig. 4	Plate 3,1	g
» » »	K	»	»	»	» 3,2	
February 17, 1939	M	6.34	22.04 48	»	Plate 3,3	h
» » »	K	»	»	»	» 3,4	

On each sketch the outlines of the aurora as seen from the main station and some easily recognisable stars are marked. From each selected point a broken line is drawn to the corresponding situation of the same point as seen from the substation, thus giving the parallaxe.

The corresponding pictures are reproduced on Plates 1—3 after enlarged copies from the original negatives. On the pictures with the Astrolens the stars often show 4 rays very useful for finding the optical center and for distinguishing stars from faults in the plate.

The geographical situations are seen in Fig. 5, all points belonging to the same set of pictures being enclosed in a broken line; the letters a, b, c, ... h under the heading N are joined to these lines.

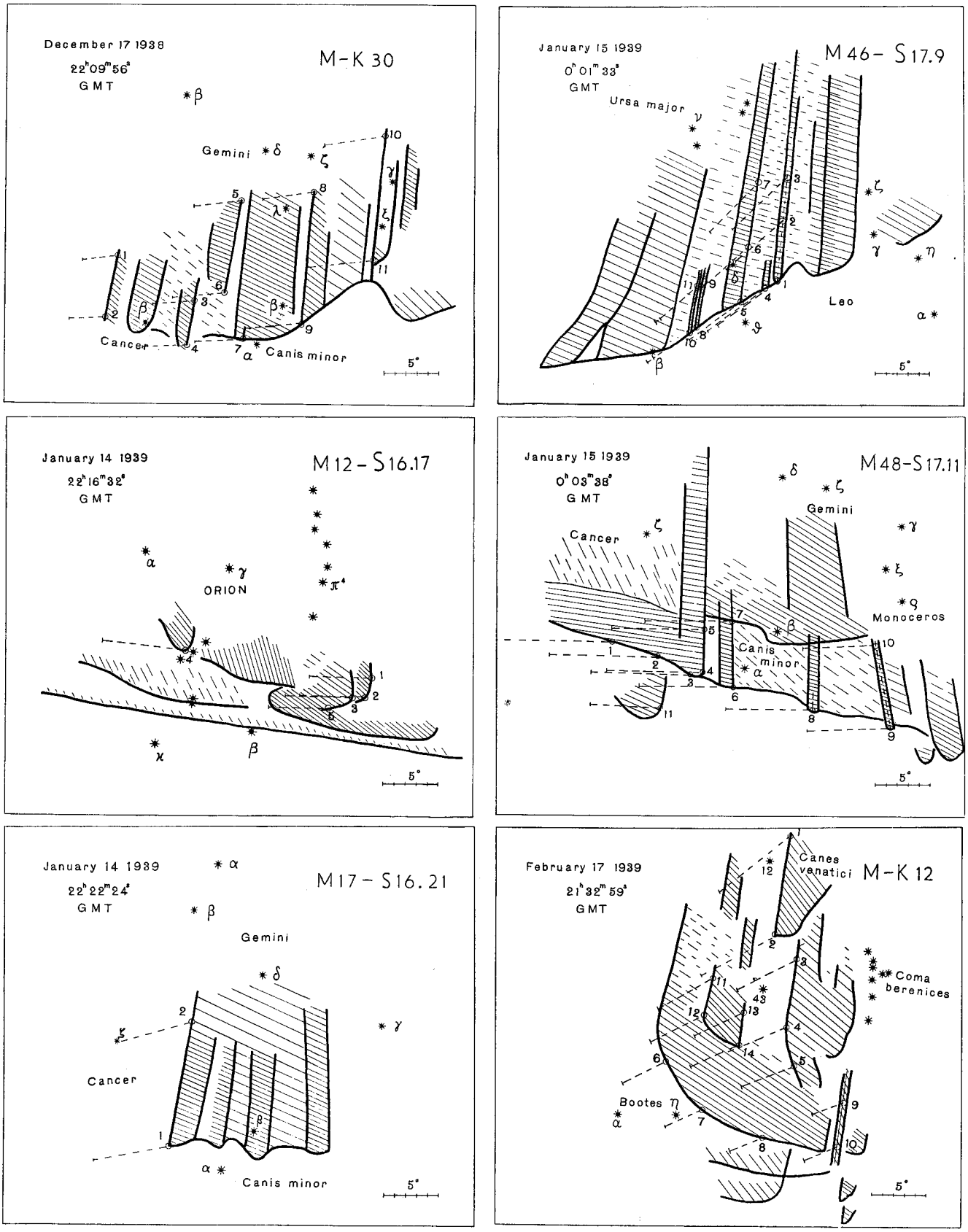

Fig. 3. Sketches of selected aurorae.

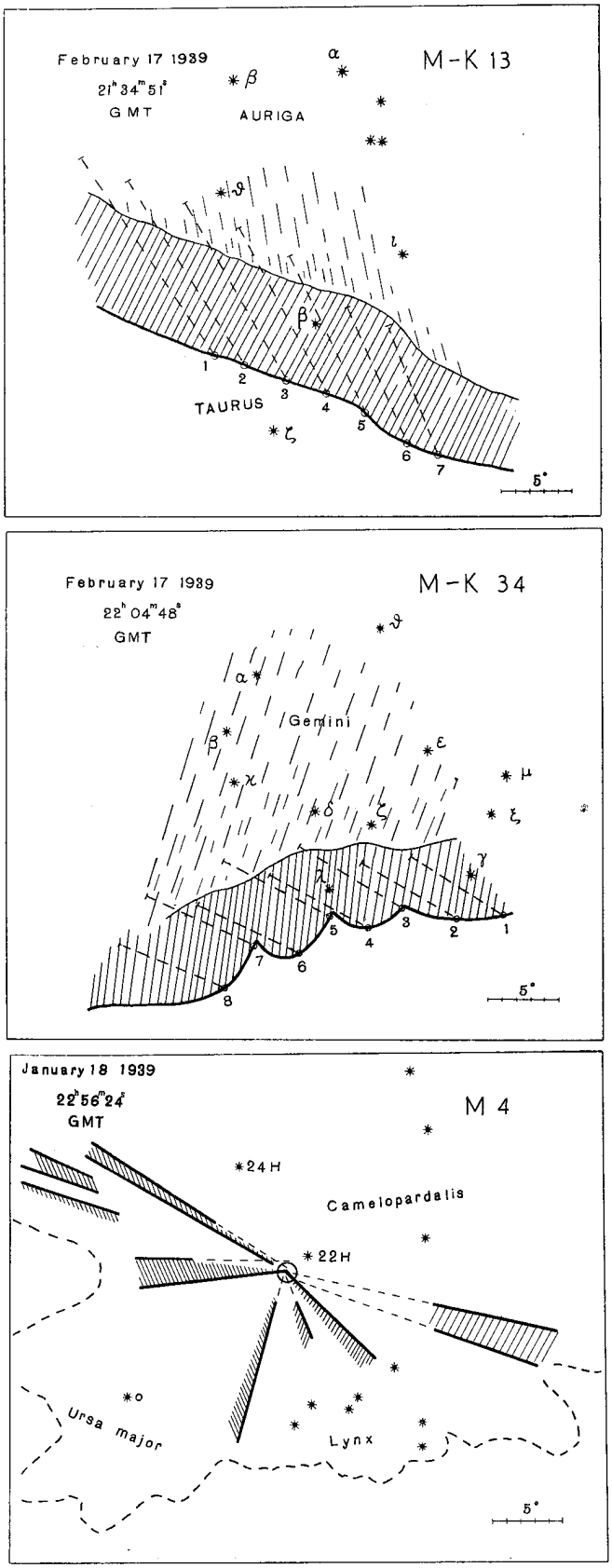

Fig. 4. Sketches of selected aurorae.

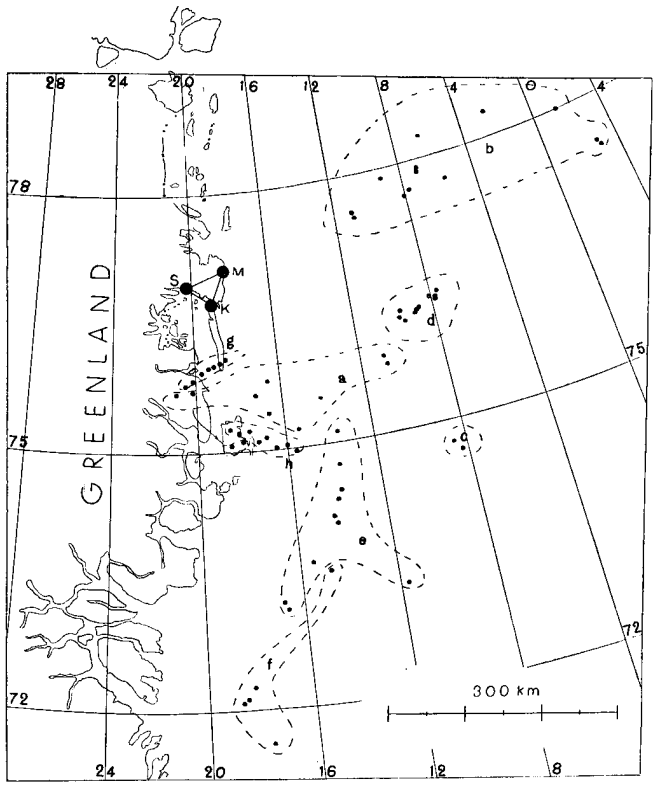

Fig. 5. Geographical positions of the measured points of the selected aurorae.

Table 5.

Results of the Extrapolation to Find Highest and Lowest Points of Aurorae.

No.	St.	F	P	H	No.	St.	F	P	H
January 9, 1939.					*January 15, 1939.*				
4.21	M	R	>1	239	8 45	M	R	<1	108
»	»	»	<2	96	8.46	M	D	>3	277
4.23	M	R	>1	221	8.47	M	RA	<4	96
4.24	M	RA	<1	100	»	»	»	<6	109
6.35	M	RB	<2	110	8.48	M	RB	>7	300
7.37	M	R	<3	106	9.51	M	RA	>1	114
»	»	»	>4	230	»	»	»	<1	104
»	»	»	>6	169	*February 17, 1939.*				
7.38	M	R	>4	261					
7.39	M	RB	<4	107	1.2	M	R	>1	250
7 42	»	R	<4	103	1.5	M	R	>1	287
January 14, 1939.					»	»	RB	<7	100
					1.6	M	RB	<3	103
2.9	M	RB	<3	100	2.7	M	R	>2	211
2.11	M	R	>3	137	2.12	K	RB	>1	212
3.15	M	R	>2	212	»	»	»	>9	218
»	»	»	>4	189	4.19	M	D	>1	192
3.17	M	R	>2	246	»	»	»	>5	133
8.43	M	RB	>1	260	6.31	M	R	<7	112
					March 12, 1939.				
					1.3	M	RB	<2	114

11. Supplementary Measurements of Highest and Lowest Points of the Aurora.

In a series of cases the chosen points were not at the lowest or at the highest parts of the aurora, but it was not difficult by extrapolation to find the height of these parts. For rays we have used the method given in a paper from 1926.[1] In Table 5 the results are seen: Here >1 means the summit over point 1, and <2, the base under point 2 etc.

[1] Carl Størmer: Resultats des mésures photogrammetriques etc. § 3, Geofysiske Publikasjoner, Vol. IV, No. 7, Oslo 1926.

PART IV.

General Results of the Measurements.

12. Statistics of the Heights Measured.

In Table 6 we have from Tables 4 and 5 given the number of cases for each given height in order to have an illustration of the frequency of the different heights.

Table 6.

Frequency of the Heights of Measured Aurora Points.

H	N	H	N	H	N	H	N	H	N
87	2	123	3	159		194	1	229	
88	1	124	3	160	3	195		230	1
89	1	125	1	161		196	1	231	
90	4	126	3	162		197	2	232	
91	1	127	6	163	1	198	1	233	2
92	1	128	1	164		199		234	
93	4	129	4	165	1	200		235	
94	9	130	2	166		201		236	
95	5	131	3	167		202		237	
96	4	132	3	168	1	203		238	1
97	6	133	2	169	3	204		239	2
98	5	134	3	170		205		240	
99	6	135	3	171	1	206	1	241	
100	8	136	2	172		207		242	
101	12	137	2	173		208		243	
102	10	138	1	174	1	209	1	244	
103	15	139	3	175	1	210		245	2
104	19	140	1	176		211	4	246	1
105	17	141	1	177	1	212	2	247	
106	15	142	3	178	1	213	1	248	
107	12	143	3	179	2	214	1	249	
108	13	144	2	180		215	1	250	1
109	17	145	4	181		216	1		
110	14	146	2	182	2	217		260	1
111	8	147	1	183		218	1	261	2
112	13	148	2	184		219			
113	6	149	3	185		220	1	277	1
114	12	150	1	186		221	1	282	1
115	5	151	1	187	1	222		287	1
116	11	152		188	1	223	1		
117	10	153		189	1	224		300	1
118	5	154	4	190		225	2		
119	11	155		191		226	1	303	1
120	6	156	1	192	1	227			
121	10	157	1	193		228		376	1
122	1	158	1						

The heights over 150 km belong for the most part to points on rays and are therefore very dispersed.

For heights less than 150 km we have made the following summations in order to eliminate as much as possible the accidental errors:

1°. The sum of cases for 85, 86, 87 km, for 88, 89, 90 km and so on.

2°. The sum of cases for 86, 87, 88 km, for 89, 90, 91 km and so on.

3°. The sum of cases for 87, 88, 89 km, for 90, 91, 92 km and so on.

Writing each sum in the same line as the second of the 3 heights we get the following table.

Table 7.

Frequencies for 3 and 3 Consecutive Heights.

km	Sum 1	Sum 2	Sum 3	km	Sum 1	Sum 2	Sum 3
86	2			109			44
87		3		110	39		
88			4	111		35	
89	6			112			27
99		6		113	31		
91			6	114		23	
92	6			115			28
93		14		116	26		
94			18	117		26	
95	18			118			26
96		15		119	22		
97			15	120		27	
98	17			121			17
99		19		122	14		
100			26	123		7	
101	30			124			7
102		37		125	7		
103			44	126		10	
104	51			127			10
105		51		128	1		
106			44	129		7	
107	40			130			9
108		42		131	8		

Table 7 (cont.).

km	Sum 1	Sum 2	Sum 3	km	Sum 1	Sum 2	Sum 3
132		8		142			7
133			8	143	8		
134	8			144		9	
135		8		145			8
136			6	146	7		
137	4			147		3	
138		5		148			3
139			5	149	5		
140	5			150		6	
141		5					

In Fig. 6 the corresponding curves are superimposed giving a fairly good impression of the situation of the bulk of the measured aurora points.

For comparison we have made the same additions for groups of 5 heights associating each sum to the third of the heights (the height in the middle).

We then get the following Table 8.

The 5 frequency curves superimposed give a still finer impression of the distribution of the aurora points. Maximum of frequency about 105 km, very nearly the same as for aurora observed in Bossekop[1] and Haldde[2] during 1913—1914. See Fig. 7.

[1] CARL STØRMER: Rapport sur une expédition d'aurores boréales à Bossekop et Store Korsnes pendant le printemps de l'année 1913, Geofysiske Publikasjoner, Vol. 1, No. 5.

[2] L. VEGARD and O. KROGNESS: The Position in Space of the Aurora Borealis. Observations Made at the Haldde Observatory 1913—14, Geof. Publ. Vol. 1, No. 1.

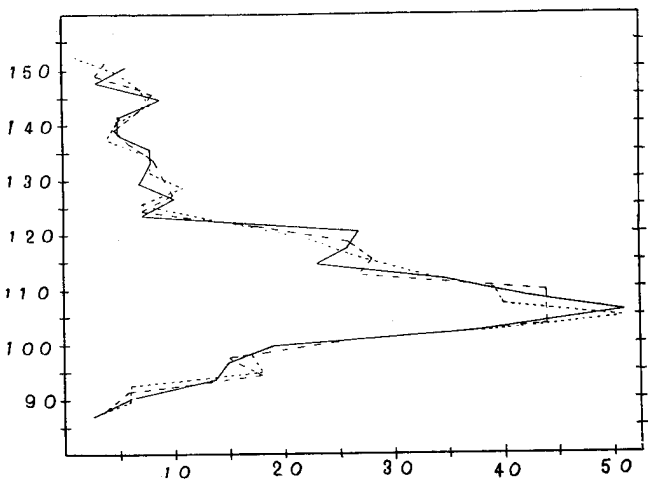

Fig. 6. Frequency curves of the measured aurora heights, taken 3 and 3.

Table 8.

Frequencies for 5 and 5 Consecutive Heights.

Km	S 1	S 2	S 3	S 4	S 5
87	4				
88		8			
89			9		
90				8	
91					11
92	19				
93		20			
94			23		
95				28	
96					29
97	26				
98		29			
99			37		
100				41	
101					51
102	64				
103		73			
104			76		
105				78	
106					76
107	74				
108		71			
109			54		
110				65	
111					58
112	53				
113		44			
114			47		
115				44	
116					43
117	42				
118		43			
119			42		
120				33	
121					31
122	23				
123		18			
124			11		
125				16	
126					14
127	15				
128		16			
129			16		
130				13	
131					14
132	13				
133		14			
134			13		
135				11	
136					10
137	10				
138		8			
139			7		
140				9	
141					11
142	10				
143		13			
144			14		
145				12	
146					9
147	9				
148		8			
149			7		
150				6	

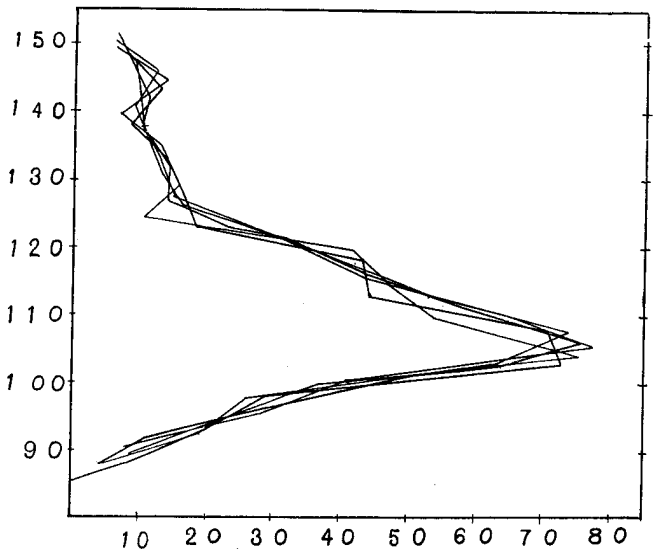

Fig. 7. Frequency curves of the measured aurora heights, taken 5 and 5.

In the next section we shall consider the lower border of some of the most frequent aurora forms, which give more interesting results.

13. Frequency of Heights of the Lower Border of Prominent Forms.

On account of the long exposure for most of the aurora pictures it was difficult on the negatives to distinguish between the homogeneous arcs (HA) and arcs with ray structure (RA), because the last form often looks homogeneous because the rays have moved during the exposure.

In the frequency studies we have therefore combined the two forms and have studied the frequency of the heights along the lower border, taken in groups of 3 as in the foregoing section.

In Fig. 8 the results are seen. Most of the heights fall between 100 and 120 km.

Much more pronounced is the distribution of the form "Bands with ray structure" (Curtains), called RB.

In Fig. 9 the result of the enumeration of 3 and 3 heights of lower border is seen.

For rays, isolated or associated with curtains or arcs we have only a scanty material. We have therefore preferred to use another representation as follows.

As abscissa we have written date and number of each set where rays have been measured. The points of the same ray have been given by small streaks combined by a full line; extrapolated points along the rays are marked by small circles. If the ray stretches more downwards or more upwards than the measured point this has been indicated by a broken line with an arrow.

Some of the rays lie rather outside the main bulk But this is probably due to the small parallaxe, with corresponding doubtful measurements.

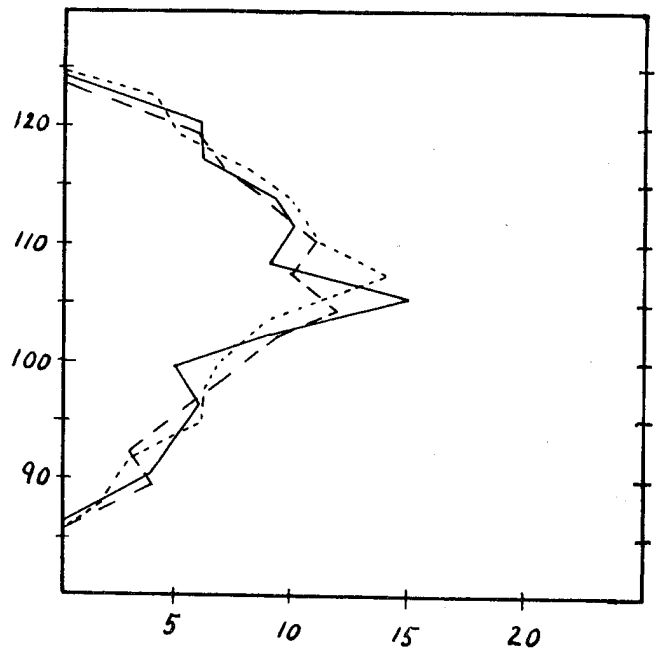

Fig. 8. Frequency curves for heights of auroral arcs.

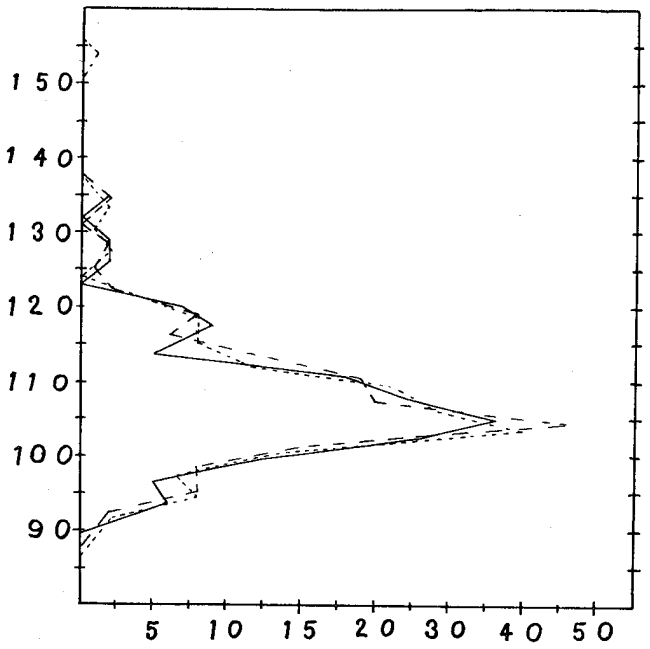

Fig. 9. Frequency curves for heights of bands with ray structure (curtains).

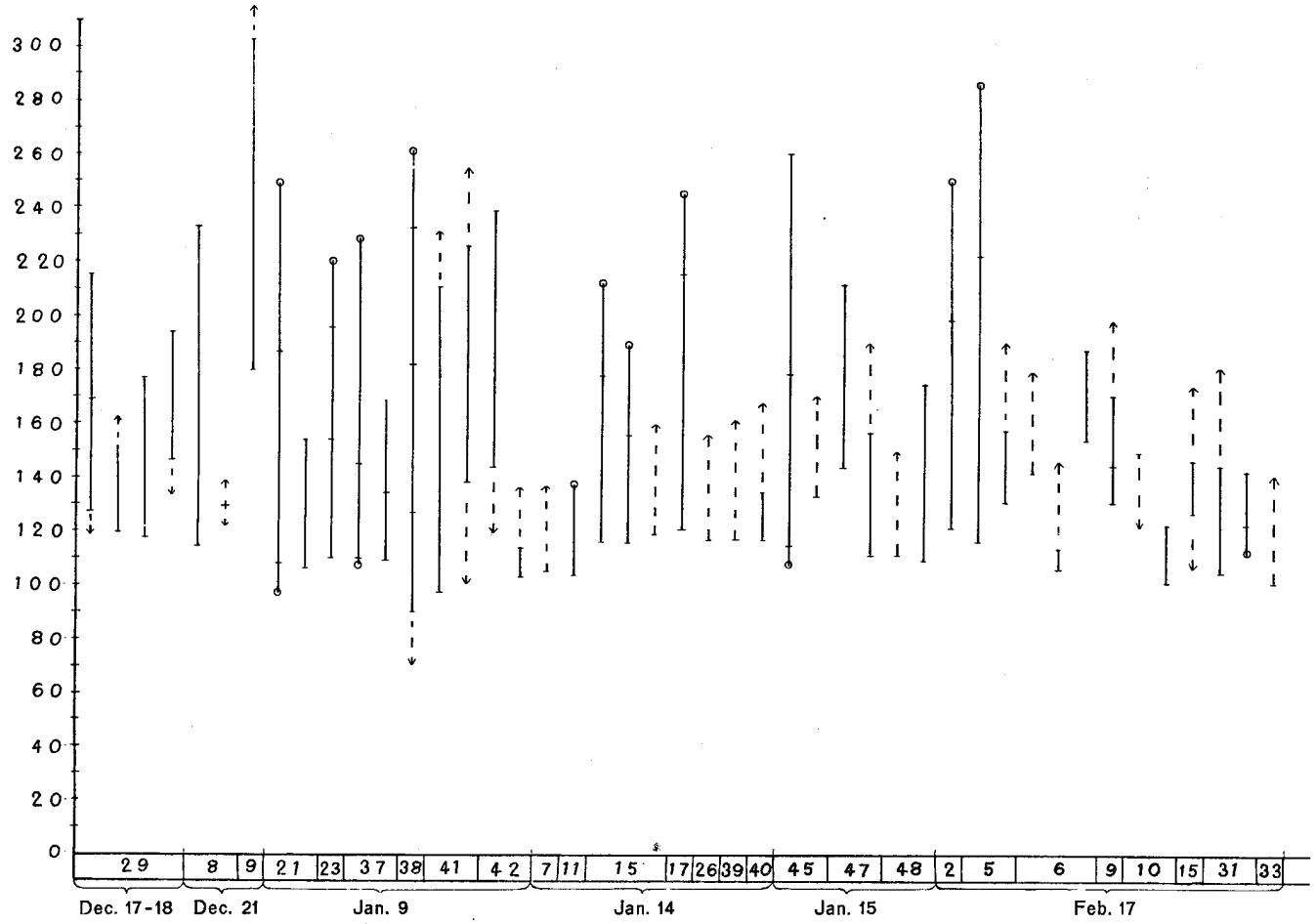

Fig. 10. Position in the atmosphere of the measured aurora rays.

In Fig. 10 the diagram is seen.

On the whole, the situation of the rays is very similar to the corresponding one observed in Bossekop. No sunlit rays seem to have been measured and the extraordinary heights observed for rays in southern Norway in the same years 1938—39 have not been found here.

14. Geographical Situation of All the Points Measured.

In Fig. 9 we have marked the vertical projection of all aurora points measured, on a map of North Eastern Greenland.

Most of the aurorae have been observed in south east and the distribution of the points seems to run parallel to the aurora zone farther south.

15 Direction of Aurora Arcs.

As all evidence from measurements of aurora arcs in the earth's shadow point to the fact that the height of the lower border is constant along the arc we only need to assume a reasonable height for this lower border to find the geographical situation of the arc.

From the statistics of homogeneous arcs (HA) and arcs with ray structure (RA) we have seen that the bulk of the heights are distributed between 100 and 120 km. We have therefore plotted the geographical situations corresponding to

$$H = 110 \text{ km.}$$

If we had supposed $H = 100$ or $H = 120$ km it would only have the effect that the arcs were displaced parallel to themselves and the main direction of the arcs would only be slightly altered.

As best photographs of homogeneous arcs we have chosen 26 pictures; in Table 9 the results are given. Here PN means picture number, GMT Greenwich middle time, h, a, and D as usual altitude, azimuth and geodetical distance from the station to the projection of the aurora point, H being supposed equal to 110 km. The results are found graphically. CN means current number.

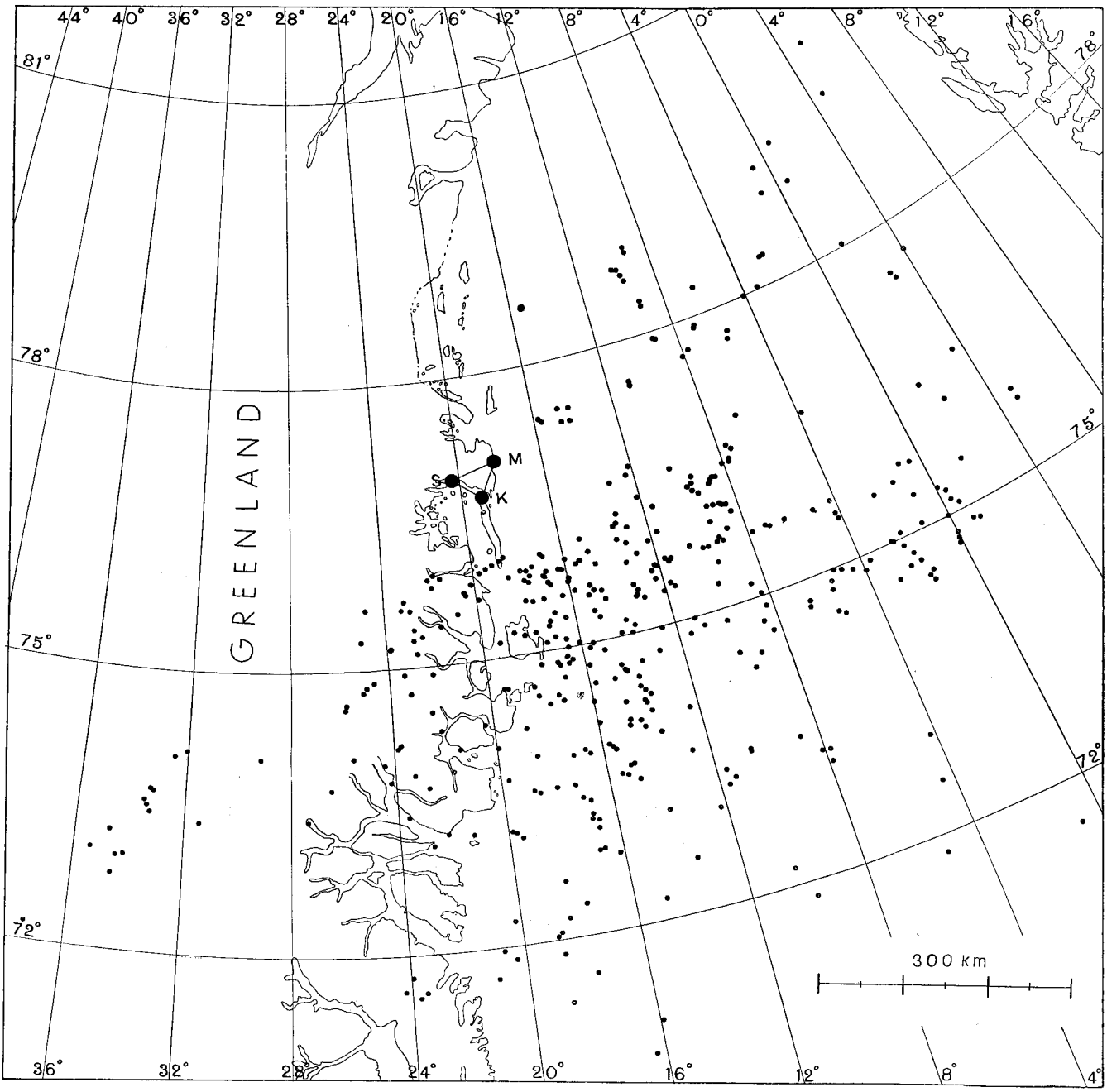

Fig. 11. Geographical positions of the measured aurora points.

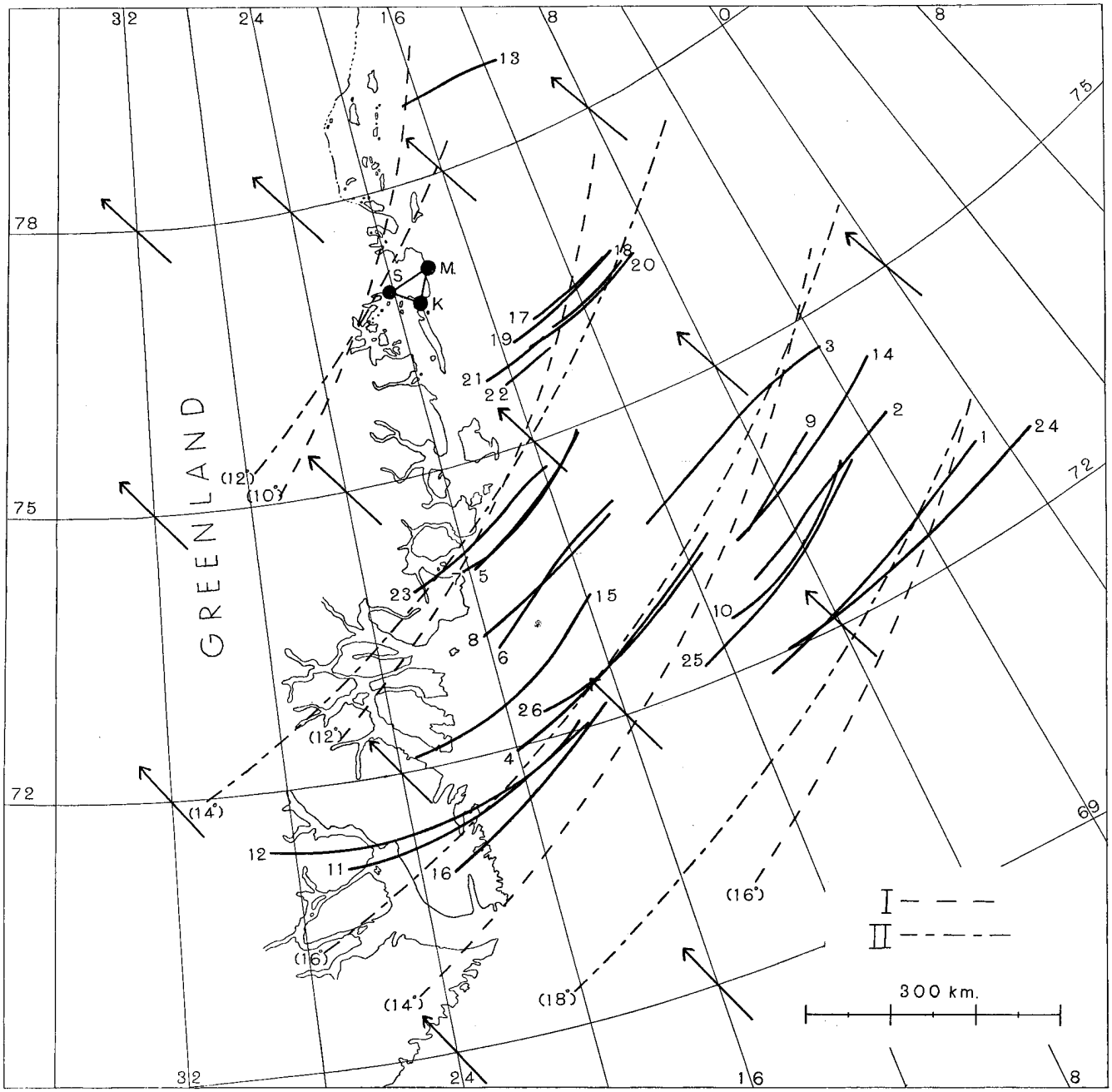

Fig. 12. Directions of selected homogeneous auroral arcs, whose lower border is supposed to be 110 km over the earth. (See also section 10.)

Table 9. *Homogeneous Arcs with Assumed Height of 110 km, Used to Find the Direction of Arcs.*

Date	PN	G. M. T.	Point	h	a	D	Remarks	CN	Date	PN	G. M. T.	Point	h	a	D	Remarks	CN
Dec. 17	M 6	20.51.32	1	7.1	— 24	622	Lower arc	1	Feb. 13	M 62	23.04.49	1	10.6	—32	483	Very diffuse	14
»	»	»	2	7.1	— 32	622	—»—		»	»	»	2	10.4	—42	489		
»	»	»	3	6.9	— 40	633	—»—			»	»	3	9.9	—52	505		
»	»	»	4	6.6	— 48	648	—»—		»	»	»	4	9.3	—62	527		
»	»	»	5	6.1	— 56	675	—»—		Feb. 17	M 2	21.19.44	1	12.4	—10	427	Upper arc	15
»	M 32	22.14.27	1	9.3	— 30	529		2	»	»	»	2	10.9	— 2	473	—»—	
»	»	»	2	9.3	— 38	529			»	»	»	3	9.6	6	515	—»—	
»	»	»	3	9.0	— 46	537			»	»	»	4	8.1	18	571	—»—	
»	»	»	4	8.4	— 56	565			»	»	»	5	8.8	— 6	548	Lower arc	16
Jan. 9	M 14	22.39.54	1	13.7	— 24	394	Lower arc	3	»	»	»	6	6.9	6	633	—»—	
»	»	»	2	13.8	— 34	391	—»—		»	»	»	7	5.5	14	707	—»—	
»	»	»	3	13.5	— 44	399	—»—		»	M 15	21.36.29	1	37.4	—46	139	Upper arc	17
»	»	»	4	12.9	— 52	415	—»—		»	»	»	2	33.7	—58	159	—»—	
»	»	»	5	11.0	— 62	469	—»—		»	»	»	3	30.3	—68	181	—»—	
»	M 16	22.44.05	1	8.2	6	573	Lower arc	4	»	»	»	4	26.2	—78	214	—»—	
»	»	»	2	9.3	— 4	527	—»—		»	»	»	5	33.0	—48	163	Lower arc	18
»	»	»	3	10.2	— 12	496	—»—		»	»	»	6	29.3	—60	188		
»	»	»	4	10.9	— 20	473	—»—		»	»	»	7	24.4	—76	230		
»	»	»	5	11.5	— 30	453	—»—		»	K 15	21.36.29	1	42.6	—52	117	Upper arc. The same aurora from the other station	19
»	M 29	23.07.34	1	15.3	8	358	Upper arc	5									
»	»	»	2	17.7	— 4	314	—»—										
»	»	»	3	19.9	— 16	282	—»—		»	»	»	2	38.0	—64	136		
»	»	»	4	21.4	— 26	262	—»—										
»	»	»	5	11.5	6	453	Lower arc (weaker)	6	»	»	»	3	33.0	—76	163		
»	»	»	6	13.8	— 4	391	—»—		»	»	»	4	24.0	—90	234		
»	»	»	7	15.3	— 14	358	—»—		»	»	»	5	33.1	—50	132	Lower arc	20
»	»	«	8	15.8	— 22	347	—»—		»	»	»	6	33.5	—64	161		
»	M 34	23.20.12	1	15.3	10	358		7	»	»	»	7	27.8	—76	200		
»	»	«	2	16.8	0	330			»	»	»	8	21.9	—88	256		
»	»	»	3	18.3	— 8	305			»	M 16	21.37.16	1	35.7	—10	149	Upper arc. The same aurora as M 15 and K 15	21
»	»	»	4	19.8	— 16	283											
»	»	»	5	21.8	— 26	258											
»	M 36	23.23.35	1	12.0	8	437		8	»	»	»	2	35.5	—24	150		
»	»	»	2	13.4	0	402											
»	»	»	3	14.5	— 10	375			»	»	»	3	35.0	—32	152		
»	»	»	4	15.3	— 20	358			»	»	»	4	33.4	—44	161		
Jan. 14	M 21	22.28.27	1	10.5	— 34	486		9	»	»	»	5	32.8	—16	165	Lower arc	22
»	»	»	2	10.6	— 42	481			»	»	»	6	32.7	—30	166		
»	»	»	3	10.5	— 50	486			»	»	»	7	31.6	—40	172		
»	M 27	22.38.31	1	8.9	— 24	544		10	Jan. 9	S 15.7	23.02.21	1	15.7	10	350	The following on films from Mørkefjord	23
»	»	»	2	8.8	— 32	549											
»	»	»	3	8.9	— 40	544			»	»	»	2	17.9	— 4	312		
»	»	»	4	9.1	— 48	534			»	»	»	3	19.9	—16	283		
Jan. 15	M 52	00.08.28	1	5.5	24	708	Feeble	11	»	»	»	4	20.5	—28	274		
»	»	»	2	6.2	16	668			Jan. 14	S 16.12	22.11.50	1	7.0	—34	629	Very fine picture	24
»	»	»	3	7.4	6	608			»	»	»	2	6.2	—46	669	See Plate 4	
»	»	»	4	8.5	— 4	559			»	»	»	3	5.3	—56	717		
»	M 58	00.16.15	1	5.5	32	708	Feeble	12	»	»	»	4	4.5	—64	770		
»	»	»	2	6.0	22	679			»	S 16.30	22.36.31	1	8.1	—56	578		25
»	»	»	3	6.7	14	644			»	»	»	2	8.2	—46	573		
»	»	»	4	7.4	6	608			»	»	»	3	8.3	—36	569		
»	»	»	5	8.5	— 2	559			»	»	»	4	8.2	—26	573		
Feb. 13	M 1	20.21.33	1	22.1	—144	254	One of the few aurorae on the northern sky	13	Jan. 15	S 17.10	00.09.19	1	10.8	—36	476	See Plate 4	26
									»	»	»	2	10.5	—26	486		
»	»	»	2	25.1	—154	224			»	»	»	3	9.9	—16	506		
»	»	»	3	27.3	—162	204			»	»	»	4	9.5	— 6	520		
»	»	»	4	29.1	—172	190											

On the map Fig. 12 the geographical situation of the measured arcs is seen. I am sorry that so few arcs were observed in W and N, and that the same arc was not photographed successively along its whole extent; if so, the results would have been much better.

16. The Direction of the Arcs Compared with the Corpuscular Theory of the Aurora.

The direction of the auroral arcs round the magnetic axis of the earth is of great interest in connection with the corpuscular theory of the aurora.[1] Some explanations may be necessary.

For the magnetic field of the earth in space we adopt two approximations; in both the magnetic field is approximated by the field of a dipole within the earth with fixed direction.

In the *first* approximation the dipole lies in the earth's center and its axis cuts the northern hemisphere at a point with coordinates: Northern Latitude 78° 32′ and Longitude West of Greenwich 68° 48′. In the *second* approximation the dipole is placed in the so called *magnetic center* of the earth with its axis parallel to the axis in the first approximation. For details we refer to the papers given below.[2]

Now, if electric corpuscles come from the sun towards the earth and strike the upper atmosphere as an aurora, according to the theory the zone of precipitation will have a tendency to come down between two surfaces of revolution very near each other and having the magnetic axis as axis of revolution. Near the earth these surfaces lie very near a surface of revolution obtained by rotating a *line of magnetic force* round the magnetic axis. In polar coordinates this line has the equation

$$r = c.\cos^2\psi,$$

c being a constant and can easily be drawn. (See Fig. 13.)

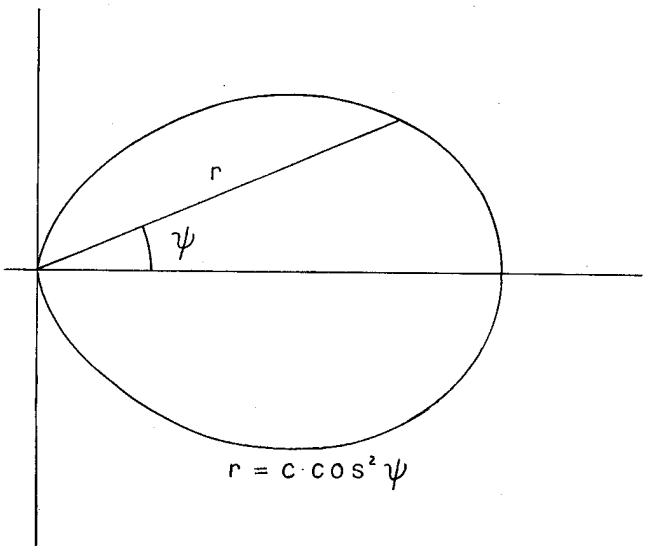

Fig. 13. Line of magnetic force of the dipole.

In the first approximation this surface of revolution cuts the surface of the earth in a circle.

In the second approximation, where the dipole lies excentrically to the center of the earth, the line of intersection is not a circle but a curve of higher degree, which can be found by a rather troublesome calculation. All the necessary formulae can be found in the paper in Astrophysica Norvegica referred to above.

If we give c a series of values we find a series of curves giving approximately the theoretical directions of the auroral arcs. We shall not give the calculations here; they have been made by my assistant Miss Julie Kjennerud after my instruction.

On the map Fig. 12 the results are seen. The lines of intersection corresponding to the first approximation are marked with I, those corresponding to the second approximation by II; in parentheses the angular distances from the magnetic axis are given in degrees.

We have also marked the direction of the magnetic horizontal force as arrows, taken from magnetic maps lent to us by Norges Sjøkartverk.[1]

As seen from this, the direction of the auroral arcs is nearly perpendicular to the direction of magnetic force. As to the lines I and II mentioned above, the lines I deviate rather much from the arcs. The lines II, however, agree better.

But as the material is rather scanty this result must only be considered as preliminary.

---

[1] Carl Størmer: On the Trajectories of Electric Corpuscles in Space under the Influence of Terrestrial Magnetism Appl'ed to the Aurora Borealis and to Magnetic Disturbances, Archiv for Mathematik og Naturvidenskab, § 5, Vol. XXVIII, 1906, and Über die Probleme des Polarlichtes, § 15 and § 16, Ergebnisse der kosmischen Physik. Vol. I, Leipzig 1931.

[2] Adolf Schmidt: Der magnetische Mittelpunkt der Erde und seine Bedeutung, Gerlands Beiträge zur Geophysik, Vol. 41, 1934, and Carl Størmer: On the Trajectories of Electric Particles in the Field of a Magnetic Dipole etc. § 2, Astrophysica Norwegica, Vol. II, No. 4, 1936.

[1] I am indebted to the director Rolf Kjær for lending us these maps.

17. Point of Radiation from a Picture of a Corona.

I am sorry that only one picture was taken of a corona where the point of radiation of the aurora rays could be determined safely.

The picture was, however, a very fine one, reproduced on Plate 4. It was taken by Mr. Hatlevik from the station Micardbu on January 18, 1939, at $22^h\,56^m\,24^s$ GMT, exposure 19 seconds.

On Fig. 4 is seen the sketch from the negative. The coordinates of the point of radiation were found to be

Altitude $80°.7 \pm 0°.4$
Azimuth $-33°.0 \pm 4°$ (to the E of S).

No determination of the magnetic inclination was made at Micardbu. The azimuth is in rough coincidence with the declination 30° 22′ West, showing that the projection of the aurora rays on the earth's surface falls near that direction.

18. Some Interesting Single Pictures of Selected Aurorae.

On Plates 11 to 13 we have reproduced a series of single pictures of fine aurorae. They are in chronological order:

M 1.1, December 20, 1938, $10^h\,24^m\,47^s$, Plate 4.

This was taken by Mr. Hatlevik from Micardbu. Rays are seen near magnetic zenith forming a part of a corona. The stars β and γ UMi and α, η, ζ, φ, 24 and ϰ Dra are easily recognisable.

S 16.12, January 14, 1939, $22^h\,11^m\,50^s$, Plate 4.

This is a very fine arc taken from Mørkefjord by Mr. Sølver. Its direction is also marked on Fig. 10 as No 24. The star Procyon with β CMi over it is seen over the arc.

S 17.10 January 15, 1939, $00^h\,09^m\,19^s$, Plate 4.

Also a very fine arc taken from Mørkefjord by Mr. Sølver. Marked on Fig. 10 as No. 26. The stars in Leo major, in particular α (Regulus), η, γ, ζ, μ and ε are easily seen.

M 1.4. January 18, 1939, $22^h\,55^m\,17^s$. Plate 4.

Fine corona, taken from Micardbu by Mr. Hatlevik immediately before the photograph mentioned in the preceding section. The same stars as on that picture.

M 8.45. February 13, 1939, $22^h\,28^m\,55^s$. Plate 4.

This fine picture is of arcs with ray structure in south with the constellation Orion, taken by Mr. Hatlevik from Micardbu.

19. Acknowledgements.

Before ending this report I want to express my hearty thanks to the following persons and institutions:

To the Norwegian French expedition, in particular to Comte MICARD and Mr. WILLY KNUDSEN for permission to use the aurora negatives taken during the expedition.

To the leaders of the "Dansk Nordøstgrønlands Ekspedition 1938—39", EBBE MUNCK and EIGIL KNUTH for permission to use the aurora films taken simultaneously in Mørkefjord, and to Engineer S. V. SØLVER for sending me these films and necessary information about them.

To the foundation "Det videnskabelige Forskningsfond av 1919" for grants in connection with the measurement of the aurora negatives.

To Mr. HATLEVIK for excellent work during the expedition, and for detailed reports sent me of his aurora observations and photographs.

To my assistant OLAV EGEBERG for the measuring of all the plates, and to Mr. ØSTVOLD, Mr. STORDAL and Miss KJENNERUD for assisting me in measuring plates and in preparing tables and drawings.

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Printed, April 18th, 1944.

EXPLANATION OF THE PLATES

Pl. 1. 1: Aurora, Dec. 17, 1938, $22^h\,09^m\,56^s$ GMT photographed from Micardbu (Hatlevik).

Pl. 1. 2: The same photographed simultaneously from Koldewey (Tillier).

Pl. 1. 3: Aurora, Jan. 14, 1939, $22^h\,16^m\,32^s$ GMT, photographed from Micardbu (Hatlevik).

Pl. 1. 4: The same photographed simultaneously from Mørkefjord (Sølver).

Pl. 1. 5: Aurora, Jan. 14, 1939, $22^h\,22^m\,24^s$ GMT, photographed from Micardbu (Hatlevik).

Pl. 1. 6: The same photographed simultaneously from Mørkefjord (Sølver).

Pl. 2. 1: Aurora, Jan. 15, 1939, $00^h\,01^m\,33^s$ GMT, photographed from Micardbu (Hatlevik).

Pl. 2. 2: The same photographed simultaneously from Mørkefjord (Sølver).

Pl. 2. 3: Aurora, Jan. 15, 1939, $00^h\,03^m\,38^s$ GMT, photographed from Micardbu (Hatlevik).

Pl. 2. 4: The same photographed simultaneously from Mørkefjord (Sølver).

Pl. 2. 5: Aurora, Feb. 17, 1939, $21^h\,34^m\,s$ GMT, photographed from Micardbu (Hatlevik).

Pl. 2. 6: The same photographed simultaneously from Koldewey (Tillier).

Pl. 3. 1: Aurora, Feb. 17, 1939, $21^h\,32^m\,59^s$ GMT, photographed from Micardbu (Hatlevik).

Pl. 3. 2: The same photographed simultaneously from Koldewey (Tillier).

Pl. 3. 3: Aurora, Feb. 17, 1939, $22^h\,04^m\,48^s$ GMT, photographed from Micardbu (Hatlevik).

Pl. 3. 4: The same photographed simultaneously from Koldewey (Tillier).

Pl. 4. 1: Auroral corona, Jan. 18, 1939, $22^h\,55^m\,17^s$ GMT, photographed from Micardbu (Hatlevik).

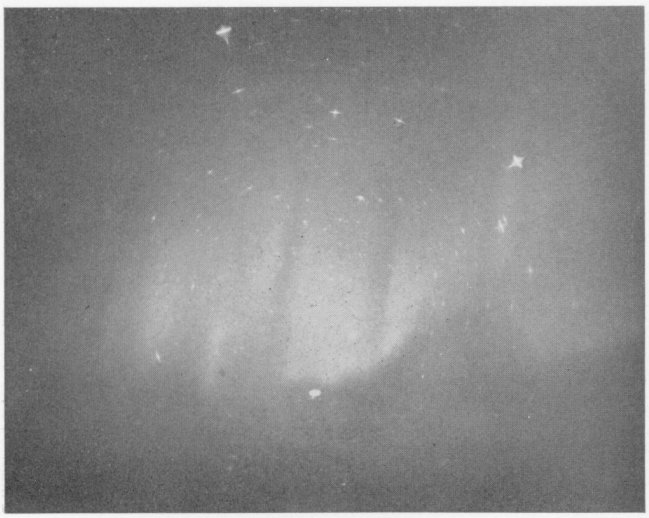
Pl. 4. 2: The same corona at $22^h\,56^m\,24^s$, from the same station (Hatlevik).

Pl. 4. 3: Aurora, Dec. 20, 1938, $10^h\,24^m\,47^s$ GMT, photographed from Micardbu (Hatlevik).

Pl. 4. 4: Aurora, Jan. 14, 1939, $22^h\,11^m\,50^s$ GMT, photographed from Mørkefjord (Sølver).

Pl. 4. 5: Aurora, Feb. 13, 1939, $22^h\,28^m\,55^s$ GMT photographed from Micardbu (Hatlevik).

Pl. 4. 6: Aurora, Jan. 15, 1939, $00^h\,09^m\,19^s$ GMT, photographed from Mørkefjord (Sølver).



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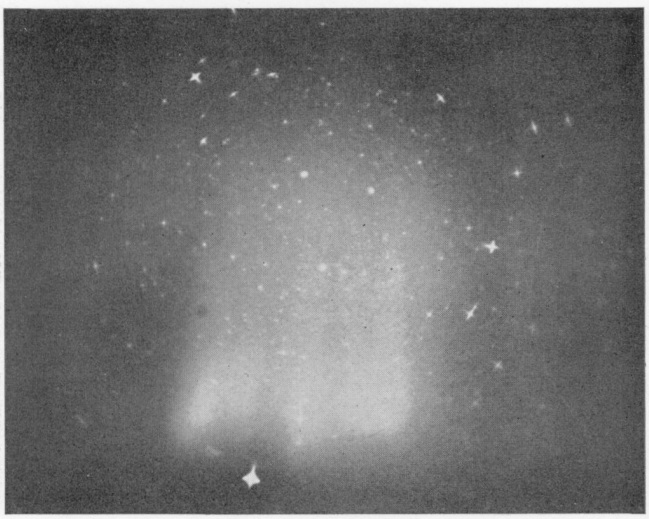

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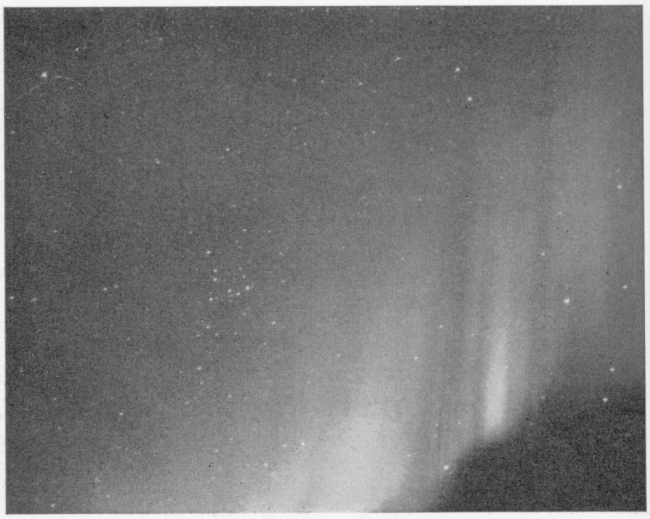

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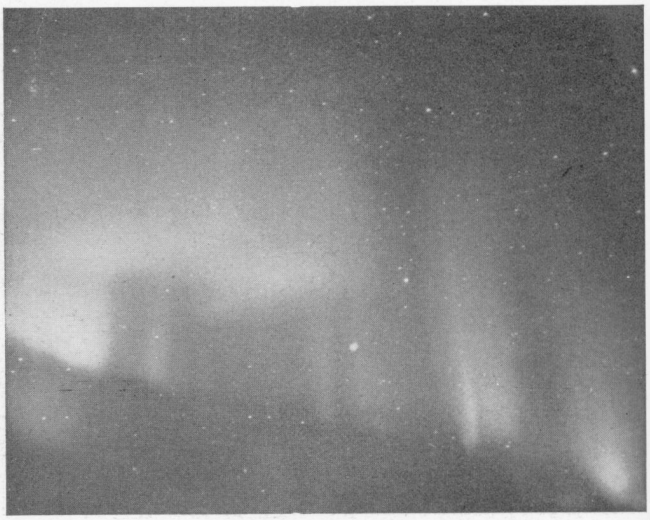

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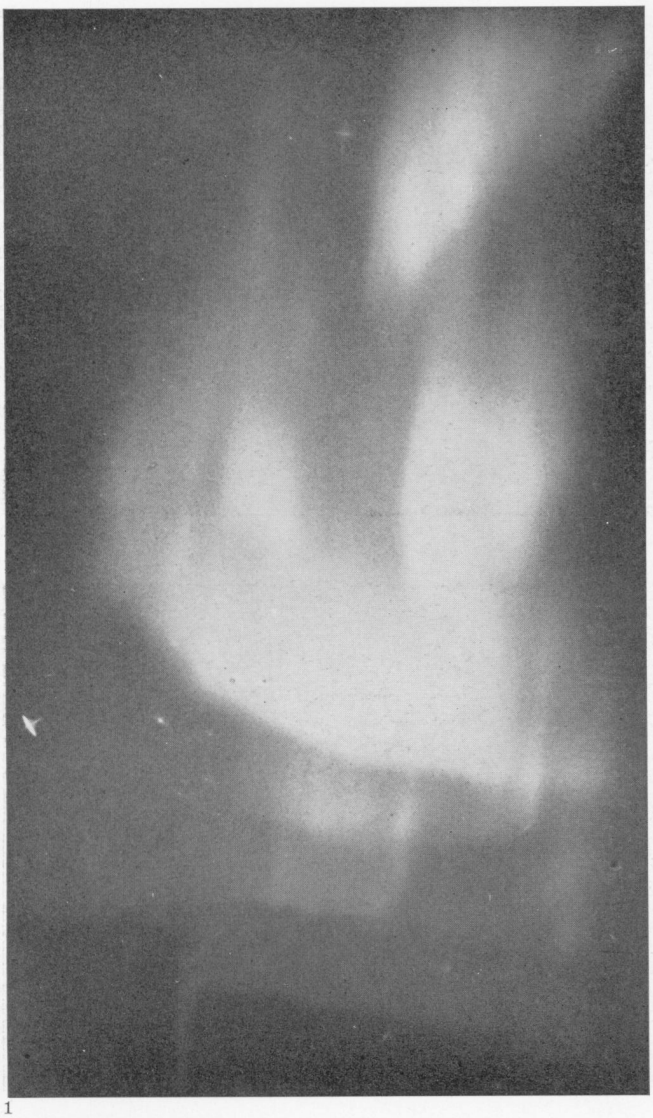

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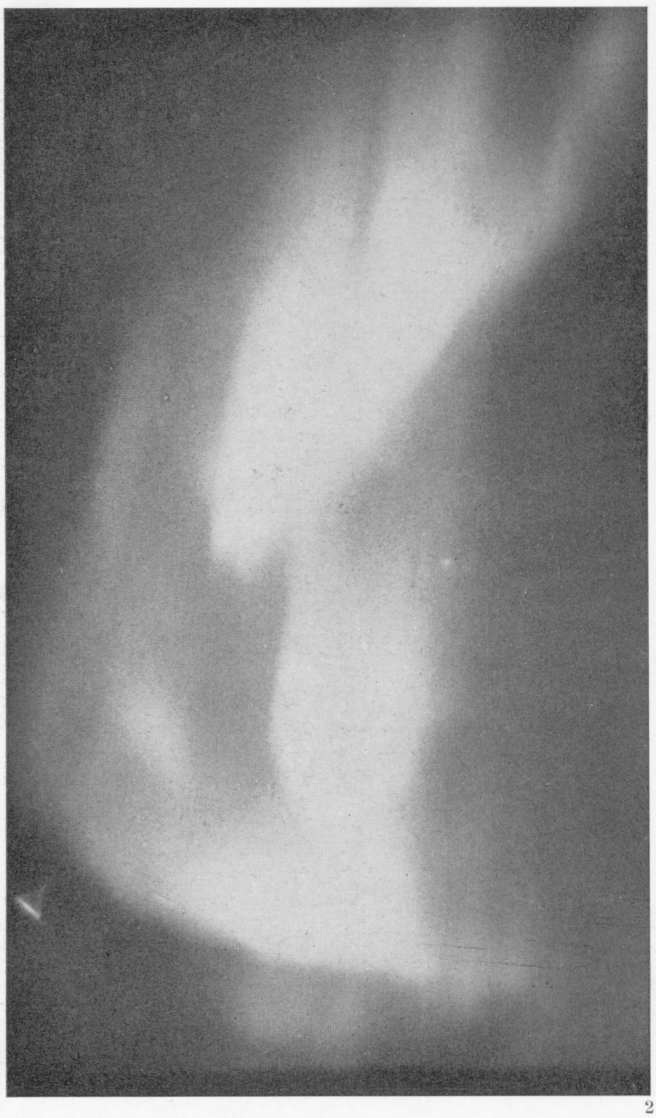

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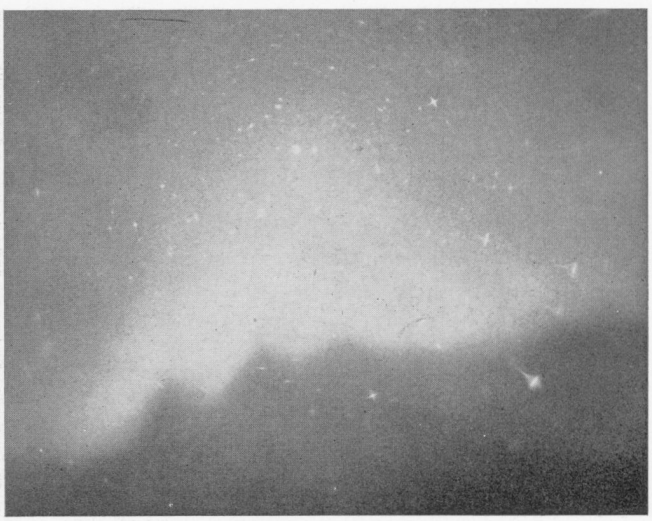

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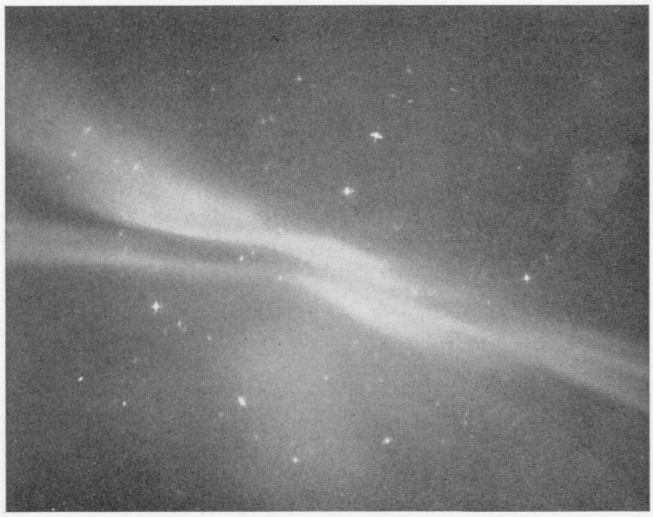

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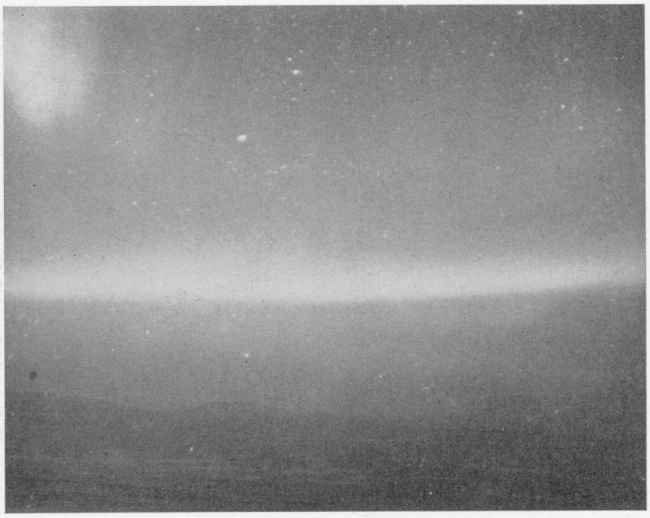

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