RESULTS OF AURORAL SPECTROGRAMS OBTAINED AT TROMSØ OBSERVATORY DURING THE WINTERS 1941—42 AND 1942—43

BY *L. VEGARD* AND *E. TØNSBERG*

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Introduction.

§ 1. In a previous communication (No. 12 in the list of papers) we gave results of a number of spectrograms taken for various purposes in 1940 and 1941, partly at the Auroral Observatory Tromsø, partly at Oslo.

During the following two winter seasons 1941—43 we have obtained a number of interesting spectrograms both at the Auroral Observatory and at Oslo.

In the present paper we intend to deal with the Tromsø spectrograms, those from Oslo will be treated in a subsequent paper.

The Tromsø material falls naturally into the following groups:

A. The group includes three spectrograms taken with a large glass spectrograph (B), the construction of which was described in a previous paper (2 p. 15—17). These spectrograms were taken on Ilf. Selo Crom. plates for the purpose of observing and measuring as many as possible of the weaker lines or bands which appear in the visible region from green to violet.

Reproductions of these spectrograms are shown on pl. 1, Nos. 1, 2, 3. Details with regard to date and time of exposure are given in the explanations to the plates at the end of the paper.

A helium tube containing traces of hydrogen was used for the comparison spectrum.

B. The group includes two spectrograms taken with our glass spectrograph (A) of considerable dispersion (1 fig. 1, pl. IV) on red-sensitive plates for the main purpose of studying the relative intensities of the red OI-lines 6300 and 6364. Reproductions given on pl. I, Nos. 4 and 5.

C. This group includes spectrograms taken with the object of obtaining the negative nitrogen bands with a photographic density suitable for measuring the temperature of the auroral region (ionosphere), and it was of particular interest to obtain spectrograms from the ionosphere when it is still exposed to direct sunlight. The photographic plates ought to be as sensitive as possible in the blue and violet part, and the best we could get to meet these requirements were Ilford Double x-press.

We obtained two spectrograms of sunlit aurorae, one with the large glass spectrograph (A) and one with our large quartz spectrograph (Q) (cf. 2, p. 14). With the latter spectrograph we also took two spectrograms of aurorae under night conditions.

The reproductions of these four spectrograms on pl. II (1, 2, 3, 4) show that on each of them at least one negative nitrogen band appears with suitable density for temperature measurements.

Lines measured in the visible Region from the Spectrograms taken with Spectrograph (B).

§ 2. The spectrograms which were taken with spectrograph (B) (pl. I, Nos. 1, 2, 3) are in most respects similar to some of those given in the papers we published in 1941 (cf. 12, pl. I and 13). The present spectrograms, however, are even more strongly exposed, so as to give the weaker lines with greater density and some weak lines not previously observed also appear. Thus we notice a weak line near the nebular line 5006,8 [O III ($^1D_2$—$^3P_2$)] which within the limits of error coincides with the nebular line 4959, which forms the somewhat weaker component [OIII ($^1D_2$—$^3P_1$)] of the OIII doublet.

On some of the spectrograms given in the previous paper already referred to, the H_β line could be distinctly observed. On the present spectrograms, however, H_β cannot be observed on spectrograms (2) and (3), but is perhaps noticeable on spectrogram (1). Quite near to H_β in the direction of shorter waves a diffuse line or band is now visible.

In the interval between 5000—4000 Å the auroral luminescence contains a very great number of weak lines, and at many places they form more or less continuous bands, where only some of the stronger lines may be distinctly seen and measured. In dealing with the interpretation of the auroral spectrum we must, therefore, take into account that a large number of lines exists, which have not been measured because they are not distinctly separated on the spectrograms.

The lines which were distinctly seen in the visible part of the spectrum, and which were measured, are given in Table I. The first three columns contain wavelength values of the lines observed on the three spectrograms 1, 2 and 3 respectively. The fourth column contains the line previously observed in this spectral region and given in our previous paper (12).

Table I.

Wavelength $j = 2\,s^2\;2\,p$.

From Spectrogr. Pl. I. No. 1.	From Spectrogr. Pl. I. No. 2.	From Spectrogr. Pl. I. No. 3.	From previous measurements	Estimated mean value	Interpretation
5577,35	5577,35	5577,35	5577,3445	5577,345	OI ($^1S_0$—$^1D_2$)
			5472	5472	1 P.G. 9—4
			5456	5456	NII (5454,3)
5436				5436	OI (5436,8; 5435,8; 5435,2)
5415			5415,8	5415,4	
5403				5403	
	5397			5397	
5391				5391	Band with structure OI (5329,6; 5329,0),
		5368	5374	5371	NI 5328,7
			5351	5351	
	5333		5331	5332	
		5315	5307	5311	
5298	5293	5290		5290,3	H_2 (5291,6)
5283			5287	5285	Band with sharp edge (or line) at 5258
5263	5262	5255	5255	5258	
5231,4	5231,7	5228,4	5230,8	5230,6	The sharp lines 5230,6 and 5202,8 approximately coincide with the lines 5229,4 and 5202,9 of
5203,4	5203,6	5202,3	5202,0	5202,9	solid Nitrogen mixed with Neon (N_2-band).
5150,0	5150,5	5150	5155,4	5151,4	
	(5115)	(5123)	(5139)		OI (5130,5)
5072		5088		5080	H_2 (5080,5)
5050	5047	5049		5048,7	He (5047,8), NII (5045,1)
5029		5028	5031	5029,3	H_2 (5030,4)
5006,9	5006,8	5006,2	5006,8	5006,7	OIII ($^1D_2$—$^3P_2$) = Nebul. 5006,9
(4987)?				4987	NII (4987,3)
4975				4975	H_2 (4973,3)
4962 w	(4964) w	4961 w		4961,5	OIII (4958,9) = Nebul.
4942	4942			4942	OII (4943,1, 4941,1)
4936		4933	4935,2	4935	NI (4935,0)
4927,5				4927	H_2 (4928,7), OII (4924,6)
			4916	4916	NI (4915)
4900	4907	4901	4901	4902	OII (4906,9)
4891	4891			4891	OII (4890,9)
4875	4871			4873	OII (4871,6)
		(4866)	4861,5	4861,5	H_β (4861,3) OII (4861,0)
(4855)	4856,5			4856	OII (4856,5)
4834	4837			4835	H_2 (4838)
	4812			4812	NII (4810,3)
4792	4788			4790	NII (4793,7, 4788)
4774	4777	4779	4780	4778	ε, 5—17, NII (4779,7, 4781,2, 4774,2)
4744	4748	4747		4746	OII (4751,3, 4741,7)

Table I (cont.).

Wavelength $j = 2\ s^2\ 2\ p.$

From Spectrogr. Pl. I. No. 1.	From Spectrogr. Pl. I. No. 2.	From Spectrogr. Pl. I. No. 3.	From previous measurements	Estimated mean value	Interpretation
4709,0	4709,9	4709,0	4709,3	4709,3	N. G. 0—2, OII (4710,0)
4651,8	4651,8	4650,3	4652,2	4651,9	N. G. 1—3, OII (4650,9)
4633				4633	NIII (4634,1), NII (4630,6)
4620				4620	NII (4621,4)
4597	4598	4594	4597	4596,5	N. G. 2—4, OII (4596,2)
4571	4574		4572,1	4572,3	H_2 (4572,7)
			4565	4565	NII j(3 $d^3F^0_2$—3 p^1D_2) = 4565
4555,3			4554,2	4554,8	N. G. 3—5, H_2 (4554,2)
4537	4534	4537	4535	4535	ε, 3—15, H_2 (4534,6)
4515				4515	NIII (4514,9)
4508	4505	4510,2	4510,7	4509	NIII (4510,9) N (4507,6) spark line
4487,5	4487,5	4488,4	4487,5	4487,5	N. G. 5—7, NI (4488,2)
4469,0	4468,5		4467,0	4468	OII (4469,4; 4467,8; 4465,4
4450,5	4447,2		4452,5	4451	OII (4452,4)
4437,3	4433,4		4434,3	4435	NII (4432,7)
4427,5	4427,0		4427,8	4427,4	ε, 2—14
4415,3	4415,7	4415,3	4415,2	4415,2	OII (4416,97—4414,89)
			4403,2	4403	N (4401,1) spark line
4397,0	4395,8	4396,5	4395,3	4396	OII (4396,0)
4381			4387	4384	O (4386,3) Geissler tube
			4376,2	4376	OII (4478,4; 4379,6) NIII (4379,1)
4368,3	4368,3	4368,6	4368,3	4368,3	OI (4368,3), OII (4369,3)
4360,3			4362,0	4361	OIII ($^1S_0$—$^1D_2$) = Nebul. 4363,3
4346,5	4345,5	4346,6	4345,6	4345,8	2 PG. 0—4, OII (4345,6; 4347,4)
			4339,7	4339,7	H_γ (4340,5)
4336,7	4335,5	(4332,3)	4333,3	4335	NI (4336,5), OII (4336,9)
4319,8	4320,2	4319,0	4319,1	4319,5	OII (4319,7)
4304,7			4305	4305	OII (4303,8), NI (4305,5)
4293,8	4294,5		4295,1	4294,5	OII (4294,8)
4276	4278	4277	4277,8	4277.8	N. G. 0—1, OII (4275,5)
4236	4236	4236	4236	4236	N. G. 1—2, N (4236,9)
4224,7			4224,5	4224	NI (4223,0), NII (4227,7)
4217,5			4218	4218	ε, 0—12, O (4217,1) G.
4200	4199	4201,7	4199,8	4200	N. G. 2—3, NIII (4200), N (4199,1) G.
			4185,9	4185,9	OII (4185,5)
4178,3		4175	4176,2	4176	H_2 (4177,1), ε. 3—14, NII (4176,1)
4172	4169		4173	4172	OII (4169,2), H_2 (4171,3)
4164		4164		4164	OII (4169)
4141,6	4142,0	4140,6	4140,5	4141	2 P. G. 3—7
4120,1	4120,7	4121,2	4119,7	4120,4	OII (4120,3; 4120,6; 4121,5)
4111,8	4114,0	4113,6		4112	OII (4112,0), NI (4114,0)
4090	4092	4091	4092	4092,8	OII (4092,9—4089,3), 2 P. G. 4—8
4075,8	4075,7	4077	4076	4076	OII = Nebul. 4075,9
4059,0	4059,2	4059,0	4059,1	4059,1	2 P. G. 0—3
4049	4053		4049,2	4050	OII (4048,2)
4040,6	4044,0	4042,1	4042,1	4042,2	NII (4043,5, 4041,3) G, H_2 (4043,6)
4028,0	4026,2	4027,9	4027,5	4027,5	NII (4026,0)
4016,6	4014,2	(4019)?	4011,3	4013	
3997,4	3997,7	3997,7	3997,5	3997,5	2 P. G. 1—4 (NII, 3995,0)
3983,0		3983,8	3981	3982,6	OII (3982,7)
3974,5				3974,5	OII (3973,3)
3963,1			3962,3	3963	OIII (3961,6)
3956,6	3957,0	3957,2	3957,3	3957	NII (3955,9), OII (3954,4; 3954,6)
3942,0	3945,0	3943,7	3942,4	3943	2 P G. 2—5, OII (3945,0)
3914,5	3914,5	3914,5	3914,5	3914,5	N. G. 0—0, OII (3919,3; 3912,0; 3907,5)

The fifth column contains all the lines as yet observed in the spectral region considered between the green line 5577 and the negative nitrogen band 3914.

In the last column we have indicated how the observed lines may most probably or possibly be identified with lines of known origin.

Some of the weak lines — especially those which appear close to other lines or bands — cannot be measured with the same accuracy as lines appearing isolated and distinct. In such cases errors amounting to a few Ångstrøm units may be attached to the measurements, and several interpretations may therefore be suggested for such lines.

It appears from the table that the present spectrograms have given about 20 lines not previously observed. On the other hand a few lines previously observed cannot be distinctly seen on the present spectrograms. Among these we notice the lines H_β and H_γ of the Balmer series.

Within the spectral region from infrared to the limit in ultraviolet the total number of lines and bands as yet observed and measured spectrographically amounts to about 170.

Table II.

Oxygen	Number obs.	Nitrogen	Number obs.
OI	8	NI	3
OII	29	NII	13
OIII	4	NIII	1
O[1]	3		

[1] State of ionization not given.

In the column of table I giving the interpretation we notice that the number of lines which may be referred to atomic oxygen and nitrogen is considerably greater than given in earlier papers.

In table II is tabulated the number of auroral lines which are referred to atomic O and N in different states of ionization. The table only contains lines for which we have not been able to find any other reasonable interpretation.

It must be remembered, however, that the number of O- and N-lines which may appear in the auroral spectrum is very much larger than would appear from table II.

Both table I and table II of the previous paper (12) contain a number of lines of which the interpretation is ambiguous owing to the error which may be attached to the wavelength measurements of weak and badly separated lines. This is for example the case with a number of lines which may be referred to atomic O or N. Further some lines from O and N may be masked by the stronger lines and bands of known origin. Finally a good many weak lines appear so close to each other that they are not separated and have therefore not been measured.

For these reasons we have to take account of the possibility that a very considerable number of atomic lines of O and N may appear in the auroral spectrum in addition to those measured and identified.

Wavelength and relative Intensity of the weak Component of the red Doublet OI ($^1D_2$—$^3P_{2,1}$).

§ 3. The spectrograms (Pl. I, Nos. 4 and 5) taken with spectrograph (A) of large dispersion give the components of the red doublet well separated and with a photographic density suitable for intensity measurements. The plate containing the auroral spectrogram was in both cases provided with an intensity scale from a lamp giving a continuous spectrum with known intensity distribution.

The procedure to be followed in the intensity measurements was described in previous papers (cf. paper 12).

In the determination of the wavelength of the weak component OI($^1D_2$—$^3P_1$) we took advantage of our accurate knowledge of the wavelength (6300,30) of the strong component of the red

Table III.

Spectrogram Pl. I	Exposure interval	λ OI ($^1D_2$—$^3P_1$)	I_{6364}/I_{6300}	
No. 4	15/10—20/10 41	6363,5	0,372	a
No. 5	22/10 41—6/4 42	6363,1	0,337	a
	Mean	6363,3	0,355	
From paper (12)	8/11—26/11 40	6364,1	0,385	b
	4/12—9/12 40	6364,3	0,375	b
	27/1—23/2 41	4364,3	(0,317)	b
	25/2—2/4 41	6364,8	(0,287)	b
	Mean of (b)	6364,4	0,341	
	Mean of (a + b)	6364,0	0,347	

doublet and of the strong green line (5577,34). In addition we used as standard one of the red lines (6678 or 6563) of the comparison spectrum. The results are given in table III a.

Table III b gives corresponding results from measurements given in our previous paper (12).

The two spectrograms from January—March 1941 were taken on Ilf. Hyp. Pan. plates, of which the photographic sensitiveness falls off very rapidly in the region of the second weak component, and as stated in the previous paper (12) the intensity values are consequently less reliable. Dropping the two last values of the table III the mean value will be:

$$I_{6364}/I_{6300} = 0{,}365.$$

The observed intensity ratio found experimentally is thus a little higher than the theoretical value $^1/_3$.

The Temperature of the Ionosphere exposed to Sunlight and under Night Conditions.

§ 4. The four spectrograms taken for the purpose of obtaining the negative nitrogen bands with a density suitable for temperature measurements are reproduced on pl. II.

One of these (No. 1) is of special importance, because it corresponds to aurorae exposed to sunlight and was taken with the spectrograph (A), which have a sufficient dispersion to give a good separation of the P- and R-branches.

The other three spectrograms, which were taken with the quartz spectrograph, show a fairly good separation of the R- and P-branches for the band 3914, which in this case is used for the temperature measurements.

The photographic plate containing the auroral spectrogram had also a photographic intensity scale.

The method and procedure adopted in the determination of temperature from the negative nitrogen bands have been dealt with in a number of previous papers (paper 1, 3, 4, 5, 10, 11, 12).

The temperature may either be found from the intensity distribution within the R-branch or from the position of the intensity maximum.

In the case of a Maxwellian distribution of rotational energy of the molecules the relation between rotational quant number (K) and the corresponding intensity (I_K) is given by the equation:

$$\log_{10}\left(\frac{I_K}{K}\right) = -\varkappa K\ (K+1) \qquad (1\ a)$$

where:

$$\varkappa = \frac{h^2 \log_{10} \varepsilon}{8\pi^2 J.kT} \qquad (1\ b)$$

The moment of inertia (J) of the N_2^+ ion in the upper electronic state is $13{,}4.10^{-14}$ (gr.cm^2). (h) is Plancks and (k) Boltsmans constant.

We determine from the photogram a number of corresponding values I_K and K, and construct the curve $(\log_{10}\left(\frac{S_K}{K}\right) — K\ (K+1))$, which should be a straight line. The slope of this curve gives $\varkappa$ and from (1 b) we find the temperature:

$$T = \frac{1{,}2855}{\varkappa} (K°) \qquad (2)$$

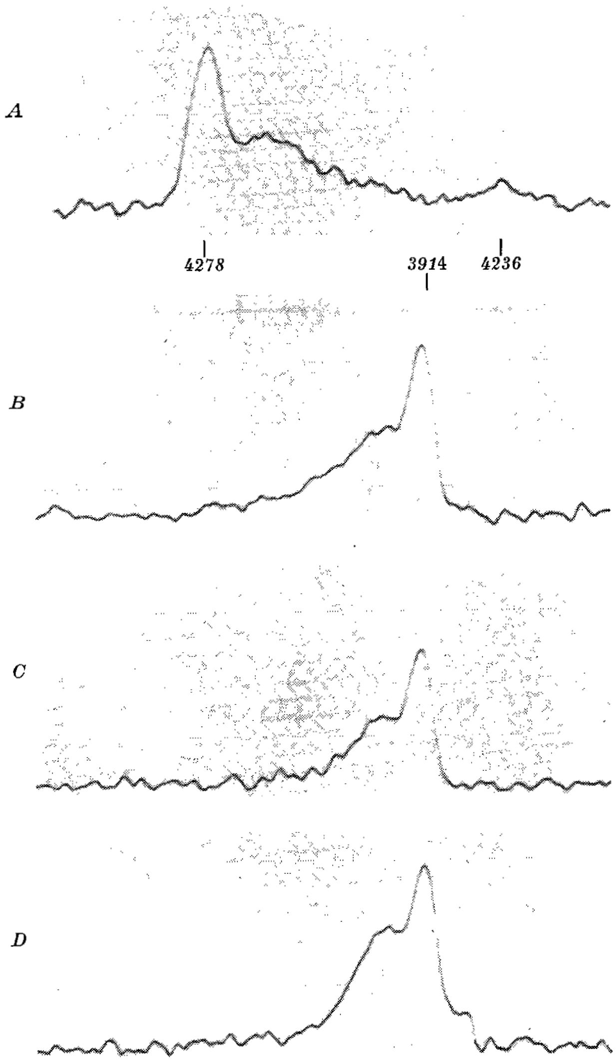

Fig. 1.

Table IV.

Band 4278 from spectrum of Sunlit Aurora taken with spectrograph A. Exposure from 19/10—3/11 1942.

K	I	I'	log. I/K + 2	log. I'/K + 1,5	K (K + 1)
1,14	1,12	0,89	1,99	1,39	2,4
2,35	1,30	1,13	1,74	1,82	7,9
3,44	1,36	1,26	1,59	1,07	15,3
4,48	1,44	1,44	1,51	1,01	24,5
5,45	1,44	1,35	1,42	0,95	35,1
6,37	1,37	1,35	1,33	0,88	47,0
7,21	1,26	1,47	1,24	0,81	59,2
8,04	1,17	1,43	1,16	0,75	72,7
8,88	1,08	1,37	1,08	0,69	87,7
9,65	0,95	1,25	0,99	0,61	102.8
10,39	0,86	1,17	0,92	0,55	118,3
$K_m = 5$, $T_K = 163°$ K			$\varkappa = 6{,}1.10^{-3}$, $T_\varkappa = 211°$ K		
$K'_m = 6$, $T'_K = 230°$ K			$\varkappa' = 4{,}9.10^{-3}$, $T'_\varkappa = 262°$ K		

$T_{mean} = 216{,}5°$ K

Table V.

Temperature of sunlit atmøsphere from Band 3914 taken with quartz spectrograph. Exposure from 15/10—17/11 1941.

K	I	I'	log. (I/K) + 2	log. (I'/K) + 1,5	K (K + 1)
1,80	1,565	1,085	1,940	1,280	5,04
3,55	1,595	1,24	1,653	1,043	16,15
5,10	1,575	1,34	1,490	0,919	31,11
6,60	1,48	1,355	1,351	0,812	50,16
7,95	1,37	1,335	1,236	0,725	71,15
9,25	1,28	1,32	1,141	0,655	94,81
10,50	1,205	1,31	1,060	0,597	120,75
11,65	1,12	1,28	0,983	0,541	147,37
12,70	1,035	1,235	0,911	0,489	173,99
$K_m = 4{,}25$, $T_K = 121°$ K			$\varkappa_1 = 6{,}2.10^{-3}$, $T_{\varkappa_1} = 207{,}5°$ K		
			$\varkappa_2 = 5{,}49.10^{-3}$, $T_{\varkappa_2} = 234°$ K		
$K_m = 6{,}6$, $T'_K = 274°$ K			$\varkappa'_1 = 4{,}86.10^{-3}$, $T^1_{\varkappa_1} = 261°$ K		
			$\varkappa'_2 = 4{,}25.10^{-3}$, $T^1_{\varkappa_2} = 303°$ K		

$T_{mean} = 233{,}4°$ K

If (K_m) is the quant number corresponding to maximum intensity of the R-branch, we deduce a corresponding temperature (T_m) by means of the equation:

$$T_m = 2{,}96\, K_m (2\, K_m + 1) \qquad (3)$$

Temperature determinations from light sources of known temperature (1, 15, 16, 17), carried out

Table VI.

Band 3914 from spectrogram of ordinary aurorae at night taken with a quartz spectrograph. Exposure from 21/11—3/12 1941.

K	I	I'	log. (I/K) + 2	log. (I'/K) + 1,5	K (K + 1)
1,80	1,16	0,805	1,809	1,149	5,04
3,55	1,26	0,975	1,550	0,939	16,15
5,10	1,275	1,085	1,398	0,827	31,11
6,60	1,21	1,105	1,263	0,725	50,16
7,95	1,12	1,090	1,150	0,639	71,15
9,25	1,01	1,045	1,038	0,552	94,81
10,50	0,90	0,98	0,933	0,470	120,75
11,65	0,795	0,91	0,834	0,393	147,37
$K_m = 4{,}6$, $T_K = 140°$ K			$\varkappa_1 = 6{,}7.10^{-3}$, $T_{\varkappa_1} = 192°$ K		
			$\varkappa'_1 = 5{,}85.10^{-3}$, $T'_{\varkappa_1} = 219{,}5°$ K		
$K'_m = 6{,}6$, $T'_K = 274°$ K			$\varkappa_2 = 5{,}2.10^{-3}$, $T_{\varkappa_2} = 249{,}5°$ K		
			$\varkappa'_2 = 4{,}6.10^{-3}$, $T'_{\varkappa_2} = 279°$ K		

$T_{mean} = 225{,}3°$ K

Table VII.

Temperature at Night from Band 3914 taken with quartz spectrograph. Exposure from 18/10—20/10 1942.

K	I	I'	log. I/K + 2	log. I'/K + 1,5	K (K + 1)
1,80	1,405	0,972	1,892	1,233	5,04
3,55	1,47	1,139	1,617	1,006	16,15
5,10	1,495	1,271	1,467	0,896	31,11
6,60	1.39	1,272	1,324	0,785	50,16
7,95	1,22	1,190	1,186	0,675	71,15
9,25	1,07	1,105	1,063	0,577	94,81
10,50	0,94	1,024	0,952	0,489	120,75
$K_m = 5{,}15$, $T_K = 173°$ K			$\varkappa = 5{,}72.10^{-3}$, $T_\varkappa = 224{,}5°$ K		
$K'_m = 6{,}00$, $T'_K = 230°$ K			$\varkappa' = 4{,}78.10^{-3}$, $T'_\varkappa = 268{,}5°$ K		

$T_{mean} = 224{,}0°$ K

at the Physical Institute Oslo with spectrographs of about the same dispersion as that used in the case of aurorae, have shown *that the temperature $T_\varkappa$ within the limit of error gives the correct temperature.*

The temperature T_m deduced from K_m by means of the equation (3) is always somewhat too low. By the determination of T_m from light sources of known temperature the following correction formula was found:

$$(T_m)_{corr.} = 1{,}06\, T_m + 38 \qquad (4)$$

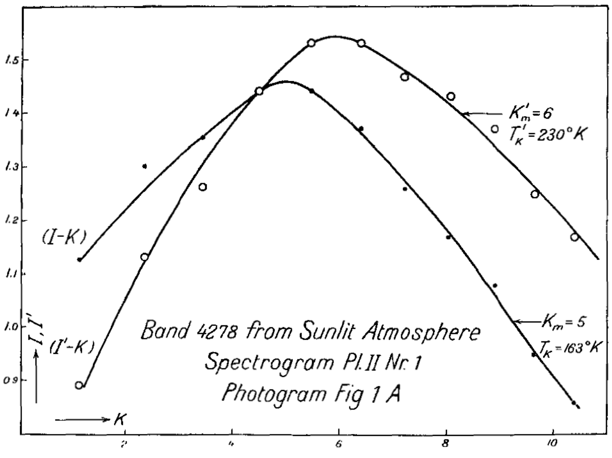

Fig. 2 a.

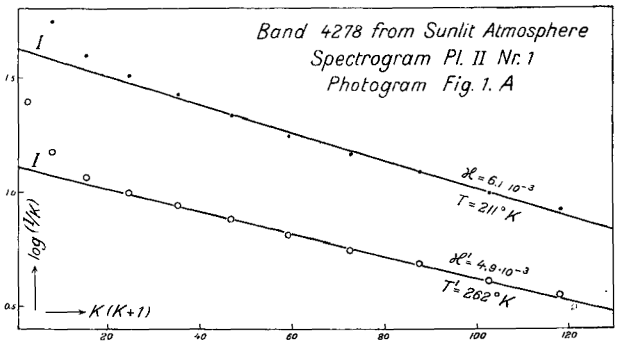

Fig. 2 b.

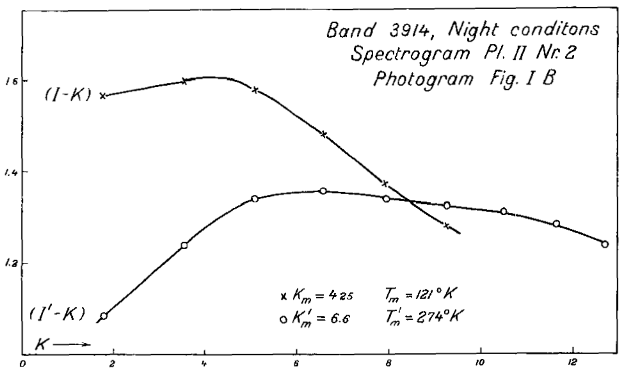

Fig. 3 a.

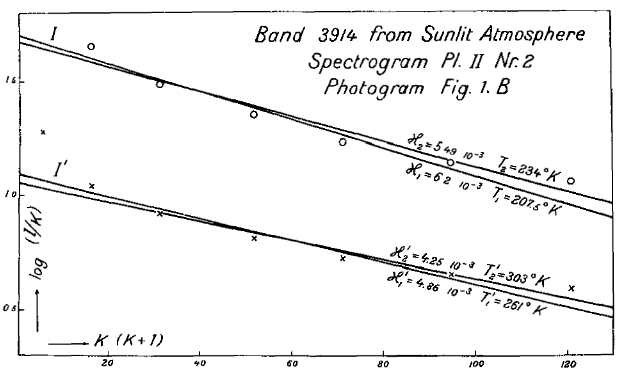

Fig. 3 b.

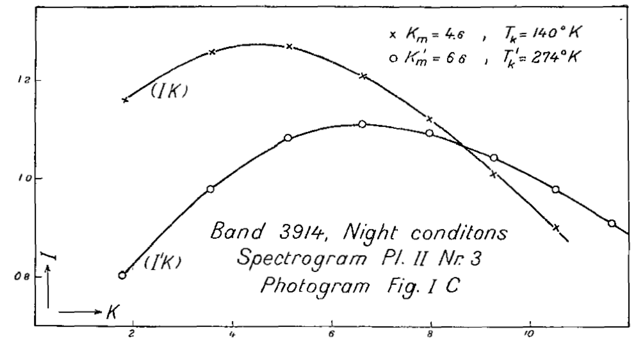

Fig. 4 a.

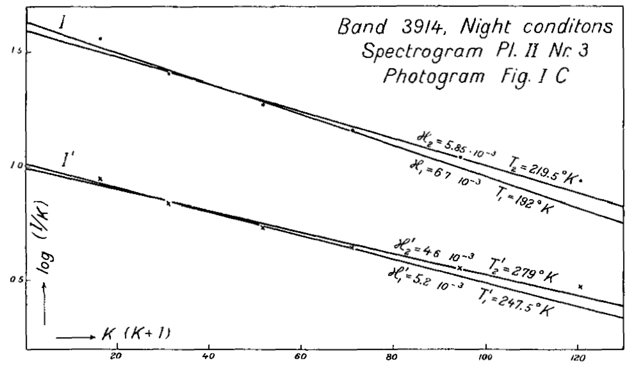

Fig. 4 b.

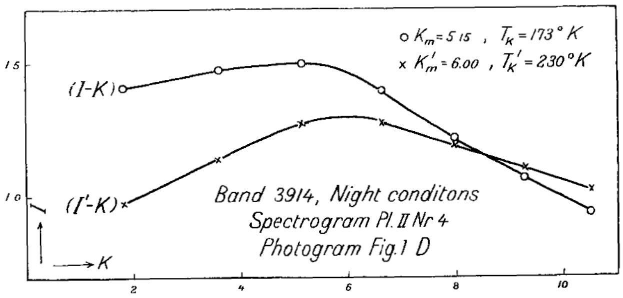

Fig. 5 a.

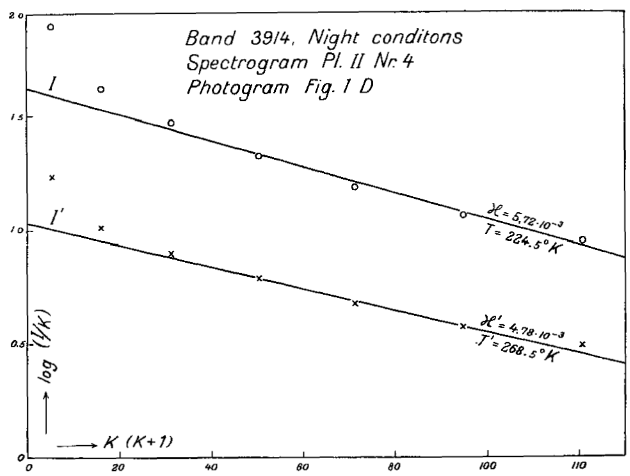

Fig. 5 b.

Table VIII.

From band 4278 taken with spectrograph (A)

Time of exposure	T K°	t c°	Remark
9/10—31/12 1923	241	—32	Vegard; Night Conditions
7/1 —15/1 1924	249	—24	
16/1 —12/4 1924	230	—43	
15/2 —20/2 1933	231	—42	Vegard and Tønsberg
21/2 — 26/2 1933	228	—45	
17/3 — 7/4 1933	218	—55	
3/3 — 23/3 1934	219	—54	
15/10 35—28/3 36	241	—32	
3/12 36—10/4 37	234	—39	
29/11—11/12 1937	216	—57	
8/1 — 9/3 1938	210	—63	
Mean	228,8	—44,2	
19/10— 3/11 1942	216	—57	Sunlit ionosphere

From band 3914 taken with quartz spectrograph (Q) (Vegard and Tønsberg)

Time of exposure	T K°	t c°	Remark
18/1 — 8/2 1938	230	—43	Ordinary
7/3 — 9/3 1938	216	—57	»
16/10—28/10 1938	210	—63	Lower limit
16/10—28/10 1938	210	—63	Upper limit
5/11 38— 5/1 39	235	—38	Ordinary
21/11— 3/12 1941	225	—48	»
18/10—20/10 1942	224	—49	»
Mean for night aurorae	221,4	—51,6	
26/2 — 2/4 1941	247	—26	Aurorae in sunlight
15/10—17/11 1941	233	—40	
Mean of sunlit aurorae	240	—33	

The individual lines of a rotational band are not separated by the dispersion used. We have previously (4,5) shown how to find an upper limit to the effect of overlapping. From the curves (I′—K) and $\left[\log_{10}\left(\frac{I'}{K}\right) - K(K+1)\right]$, where I′ is an intensity corrected for overlapping, we find new values $\varkappa'$ and K'_m, which by means of equations (2) and (3) give corresponding temperatures $T'_\varkappa$ and T'_m.

Reproductions of the photometer curves of the bands of the four spectrograms are shown in fig. 1. The curves A, B, C, D correspond to spectrograms pl. II, Nos. 1, 2, 3, 4 respectively.

The results of our measurements are given in the tables IV, V, VI and VII and illustrated by the diagrams figs. 2, 3, 4, 5. The diagrams (a) give the curves (I—K) and (b) the curves ($\log_{10}$ I/K—K (K+1)).

Comparing the temperatures obtained for the ionosphere when it is exposed to sunlight with those corresponding to night conditions, the results do not indicate any noticeable difference.

It is quite remarkable that the band 4278, which combines a great dispersion with a very suitable photographic density and which should give the most accurate result, shows the lowest temperature although it corresponds to a sunlit ionosphere.

The temperatures of a sunlit atmosphere, which were given in our previous paper (12), and which were measured from two spectrograms, indicated that the sun's radiation might produce a small increase of the ionospheric temperature, but as the measurements were based on bands taken with the quartz spectrograph of fairly small dispersion the increase is not greater than might be accounted for by errors.

The results of our measurements of the ionospheric temperature by means of negative nitrogen bands of the auroral spectrum are collected in table VIII.

On an average the ionospheric temperature at night as measured from the rotational energy of the molecules should be ÷ 40 to ÷ 50° centigrade or about the same as in the lower part of the stratosphere.

At sunset — when the ionosphere is still exposed to the suns radiation — the temperature is at any rate not essentially higher than during the night.

If we were able to measure the day temperature defined by the rotational molecular energy, it would probably show a somewhat higher value than during the night; but if so the low temperature just after sunset would indicate a very rapid ajustment of the ionospheric temperature.

Our sincere thanks are due to Mr. G. Kvifte for his most able and valuable assistance in connection with the treatment of the observations.

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A. W. BRØGGERS BOKTRYKKERI A/S

Explanation to Pl. I.

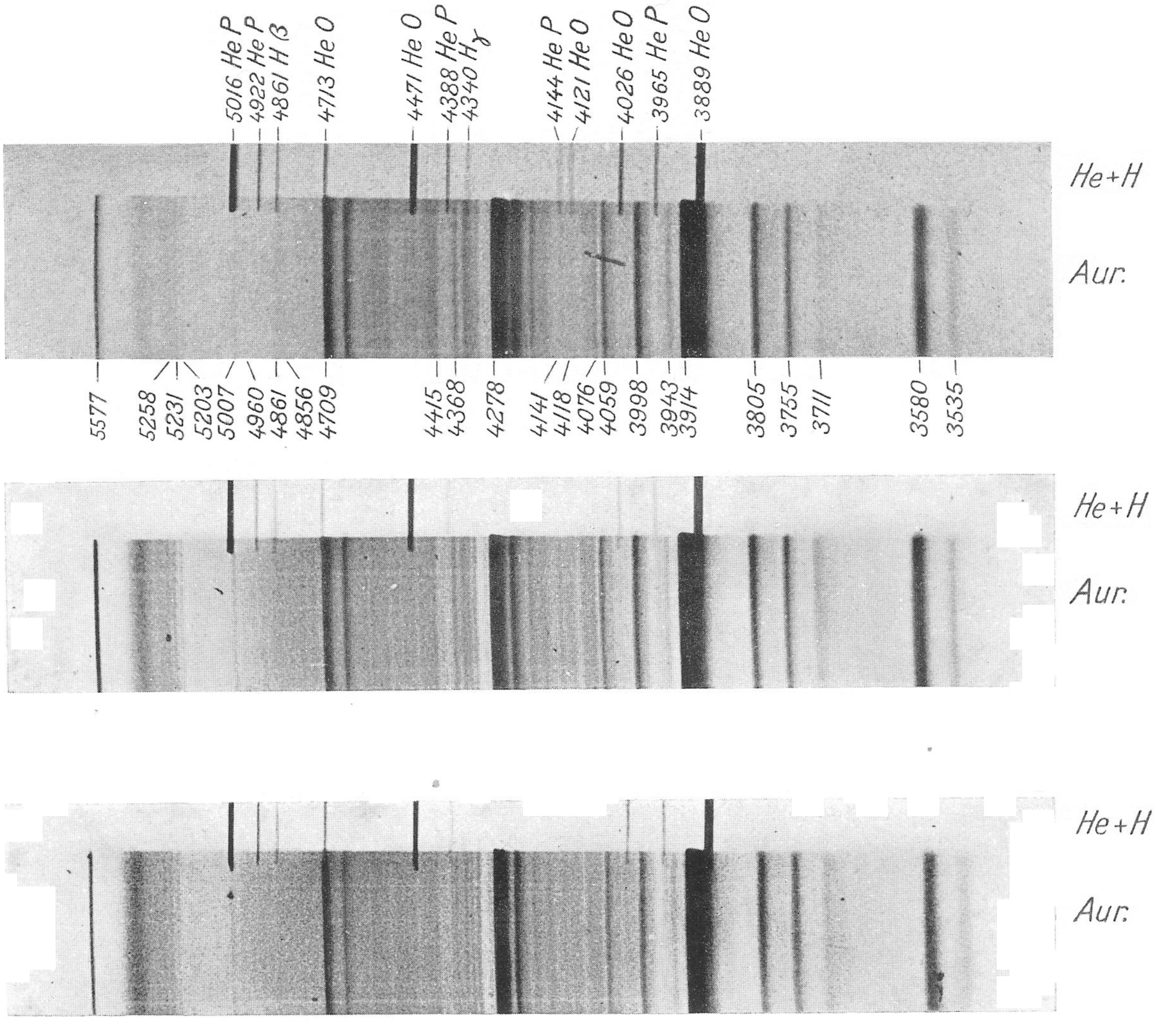
Spectrograms of very long exposure from all sorts of aurorae. Nos. 1, 2, 3 were taken with the glass spectrograph (B) and Nos. 4, 5 with the glass spectrograph (A).

No.	Duration of Exposure	Effective Time of Exposure	Sort of photogr. Plate
1	$^{14}/_{10}$—$^{20}/_{10}$ 1941	17 hours	Ilf. selo. Crom.
2	$^{6}/_{11}$ 41— $^{6}/_{2}$ 42	28 »	—»—
3	$^{13}/_{10}$ 42— $^{8}/_{4}$ 43	27 »	—»—
4	$^{15}/_{10}$—$^{20}/_{10}$ 41	14 »	Agfa spektral rot rapid
5	$^{22}/_{10}$ 41— $^{6}/_{4}$ 42	33 »	—»—
Comparison spectrum helium mixed with hydrogen			

Explanation to Pl. II.

The spectrograms were taken on Ilf. double x-press plates. No. 1 with spectrograph (A), Nos. 2, 3, 4 with the quartz spectrograph (Q).

No.	Duration of Exposure	Effective Time of Exposure	Remarks
1	$^{19}/_{10}$— $^{3}/_{11}$ 1942	$3^1/_2$ hours	Aurora in sunlight
2	$^{15}/_{10}$—$^{17}/_{11}$ 41	$1^1/_2$ »	—»—
3	$^{21}/_{11}$— $^{3}/_{12}$ 41	$1-1^1/_2$ »	Night conditions
4	$^{18}/_{10}$—$^{20}/_{10}$ 42	$2^1/_4$ »	—»—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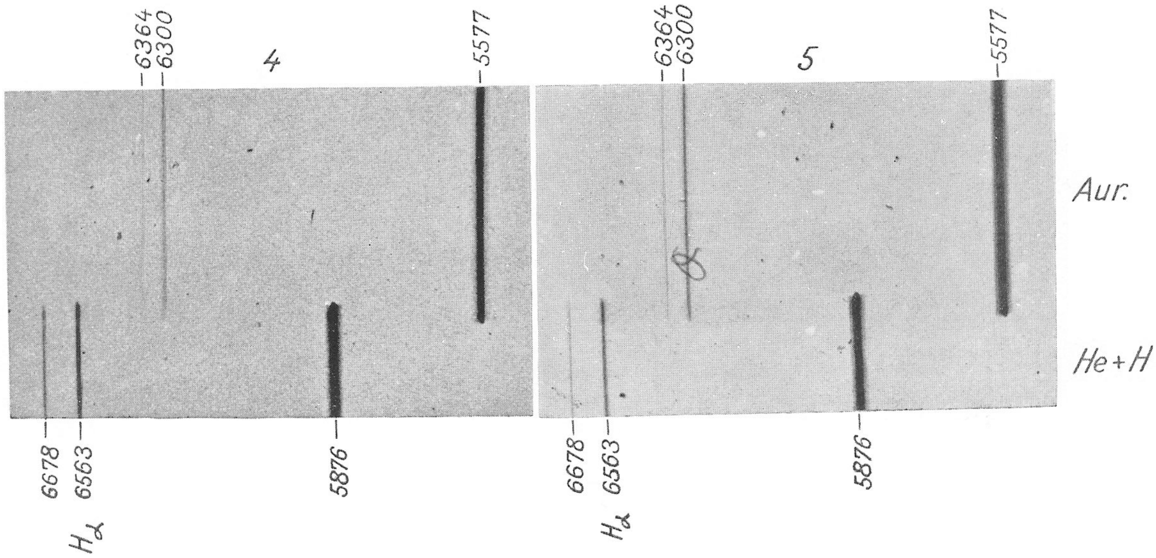
4922 He P
4861 H β
4713 He O
4471 He O
4388 He P
4340 H γ
4144 He P
4121 He O
4026 He O
3965 He P
3889 He O
He+H
Aur.
5577
5258
5231
5203
5007
4960
4861
4856
4709
4415
4368
4278
4141
4118
4076
4059
3998
3943
3914
3805
3755
3711
3580
3535
He+H
Aur.
He+H
Aur.


6364
6300
4
5577
6364
6300
5
5577
Aur.
He+H
6678
6563
5876
Hα
6678
6563
5876
Hα

No. 2.