NO. 2.

ASTRONOMY

OBSERVATIONS ARRANGED AND REDUCED UNDER THE SUPERVISION

OF

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Instruments. An altazimuth No. 1, made by C. H. G. Olsen, had the horizontal and vertical circles of 21 cm. diameter divided into 10′, two opposite microscopes giving the single seconds. The telescope, with broken optical axis, had an object-glass of 5 cm. aperture and 42 cm. focal length. This instrument, which was originally made for Nansen's Fram Expedition 1893—96, was used by Lieut. Godfred Hansen at the two stations occupied for several months, viz. Gjøahavn on King William's Land 1903—05 and King Point in Alaska 1905—06. Also some observations in Godhavn on the west coast of Greenland in July 1903 were made whith this instrument.

A smaller altazimuth No. 2, also made by C. H. G. Olsen, was used by Lieut. Hansen on boat and sledge expeditions. The telescope had an object-glass of 28 mm. aperture and broken optical axis. The horizontal and vertical circles, of 14.5 cm. diameter, were divided into 20′ and read off by two opposite verniers to half-minutes. It was originally made for Sverdrup's Fram-Expedition 1898—1902.

A still smaller altazimuth by Olsen, originally made for Nansen's expedition to Greenland on 1889, was used by Capt. Amundsen on boat and sledge expeditions. The two circles, of 10 cm. diameter, are graduated to half degrees, two opposite verniers giving single minutes. The telescope, with object glass of 18 mm. aperture and 14 cm. focal length, is placed excentrically (In Nansen's time it had a diopter instead of the little telescope). Capt. Amundsen also used an ordinary sextant.

Chronometers. The Expedition was supplied with 5 box chronometers, designated in the ship's books by A, B, C, D and E. They were placed on the shelf in the aft-cabin in a locker with walls stuffed with reindeer-hair pillows and containing a maximum and minimum thermometer. During the stay in Gjøahavn chronometer D (Kullberg 2480) was sometimes taken ashore and used for absolute magnetic observations, the others were always on board. Chronometer A (Kutter 24) was used for the astronomical observations taken in the neighbourhood of the ship. During the first days in Gjøahavn the observer at the telescope sent electric light signals to the clock-observer, but as difficulties arose with the cable, a snow-hut was built close to the observatory where the clock-observer noted the time by a watch, which was compared before and after with chronometer A. The 3 other chronometers were only used for the daily comparisons.

February 29 1904, the chronometers were removed to the forecabin and placed on a chest. This had a considerable influence on the temperature, as mentioned below. July 25 1905, some days before the departure from Gjøahavn, they were brought back to the old place.

For the boat and sledge expeditions three watches were in use. The observer carried his watch in a little bag on his breast. Before and after and sometimes during the expedition it was compared with chronometer A.

From the results below it will be seen that there were two periods without any determinations of clock-correction, namely (I) December 17 1903—June 23 1904, and (II) August 8 1905—March 16 1906.

Most of the observations in Gjøahavn were taken after the removal of the chronometers to the fore-cabin, namely between June 23 1904 and August 8 1905, with maximum temperatures at about 20° C and minimum temperatures ranging from 0° to 15°. The mean of several equations from this period gave the following expression for the daily rate of chronometer A (i. e. the change in the clock-error A—Local Mean Time):

(1) $$x + 13.25\,y = -1^s.87$$

where y is the temperature-coefficient for 1° C. During the last part of the period I (March 1—June 23 1904) the temperature was so nearly constant (about 13°) that the same value,—1ˢ.87, could be used. This, combined with the observations during December 1903, gave the equation:

(2) $$x - 4.55\,y = -6^s.27$$

The combination of (1) and (2) gives $x = -5^s.15$ and $y = +0^s.247$. This temperature-coefficient is considerably higher than usual for these chronometers, evidently because at low temperature other circumstances than the compensation came into play, which have also given a larger constant term than usual. These values of x and y were used for the calculation of the clock-correction during the period December 17 1903—February 29 1904.

Period II embraces the last days in Gjøahavn, the voyage westwards and the first months at King Point. The combination of the last observation at Gjøahavn (August 8 1905) and the first observation at King Point (March 16 1906), with due regard to the difference of longitude, gave the equation:

(3) $$x + 2.33\,y = -2^s.44$$

which combined with (1) gives:

$$x = -2^s.56 \text{ and } y = +0^s.052$$

These values were used for period II. They are very nearly the same as the values obtained by combination of same observations in Gjøahavn between December 2 and December 17 1903 (with temperatures about zero) and the observations after the removal of the chronometers to the fore-cabin.

Determination of Longitude. Before the departure from Oslo instructions were given for determination of longitude by means of the azimuth of the Moon as observed with the large altazimuth. These instructions have already been published by Kr. Lous: "Determination of longitude by the azimuth of the moon," The Norwegian North Polar Expedition with the "Maud," 1918—1925, Scientific Results, Vol. I, No. 4., and shall therefore not be repeated here.

The astronomical observations have been computed by *Mr. Anton Alexander.* The meteorological data for taking the refraction into account were communicated to him by Mr. *Aksel S. Steen.*

When preliminary values of co-ordinates or of clock-correction had to be assumed, a differential quotient was always computed for application of corrections. The following lists contain Mr. Alexander's final results, but only indications of the observations themselves.

In some cases, during rather long series of observations, the levelling of the instrument seems to have been not quite satisfactory. Some astronomic and geodetic results obtained with the smaller instruments (latitude and longitude and azimuth of some terrestrial marks) on stations in Boothia Felix and King Williams' Land, used for magnetic observations, have been communicated to Mr. Steen and will be found among the magnetic results.

Gjøahavn.

Astronomical Station Uranienborg. (The position of the altazimuth is indicated by Obj. H. and V.).

Latitude.

				Obj.	Alt.	Lat.
1903	November	20.	Altitudes of Polaris	V	69°.8	68°37′ 8″.7
				H	69°.8	37′34″.8
»	»	21.	» » »	H	69°.8	37′29″.5
				V	69°.8	37′50″.0
»	December	2.	Circummeridian altitudes of Jupiter's centre	V	13°.9	37′ 2″.3
				H	14°.0	36′ 4″.3
				H	14°.0	36′23″.7
				V	14°.0	37′ 8″.7
»	»	4.	Meridian altitude of α Persei	V	28°.1	37′32″.6
			» » » η Draconis	H	83°.1	37′32″.4
			» » » α Aurigae	H	24°.5	37′40″.4
»	»	9.	» » » δ Aquilae	V	24°.3	37′15″.7
»	»	9.	» » » Jupiter, upper limb	V	14°.2	36′42″.0
1905	March	19.	Altitudes of Polaris	H	68°.6	37′42″.8
				V	68°.6	37′36″.7

Adopted mean: *68°37′18″.*

Local Mean Time.

Chronometer A = Kutter 24.

					A	A—L.M.T.
1903	December	2.	Altitude of Jupiter's centre	1 H, 1 V	$11^h.5$	$6^h11^m\ 5^s.7$
»	»	16.	» » Cassiopeia	3 V	$9^h.9$	$10^m15^s.1$
»	»	17.	» » »	9 V, 5 H	$10^h.2$	$10^m11^s.6$
1904	June	23.	Altitudes of Sun, lower limb, 5 East, 3 West		$6^h.0$	$5^h58^m52^s.2$
»	»	25.	» » » » » 5 » 5 »		$6^h.0$	$58^m50^s.6$
»	»	29.	» » » upper » 5 » 5 »		$6^h.0$	$58^m43^s.8$
»	»	30.	» » » lower » 5 » 5 »		$6^h.0$	$58^m38^s.2$
»	July	2.	» » » » » 5 » 5 »		$6^h.0$	$58^m35^s.2$
»	»	7.	» » » » » 5 » 5 »		$6^h.0$	$58^m22^s.9$
»	»	23.	» » » » » 5 » 5 »		$6^h.1$	$57^m55^s.8$
»	September	22.	» » Jupiter, upper limb,	4 H, 4 V	$15^h.2$	$55^m46^s.2$
»	October	22.	» » Capella	4 V, 4 H	$12^h.2$	$54^m29^s.3$
»	»	26.	» » γ Andromedae	4 V, 4 H	$11^h.0$	$54^m25^s.2$
»	»	28.	» » β Andromedae	4 H, 4 V	$11^h.7$	$54^m22^s.8$
»	November	19.	» » γ Andromedae	4 H, 4 V	$10^h.6$	$53^m39^s.3$
»	December	15.	» » γ Andromedae	3 V, 3 H	$10^h.6$	$52^m50^s.5$
»	»	17.	» » α Lyrae	4 H, 4 V	$10^h.5$	$52^m43^s.3$
»	»	21.	» » α Persei	4 V, 4 H	$11^h.1$	$52^m39^s.4$
»	»	22.	» » α Persei	4 H, 4 V	$10^h.7$	$52^m37^s.0$
1905	January	16.	» » Capella	4 V, 4 H	$10^h.4$	$51^m58^s.2$
»	»	20.	» » Capella	4 H, 4 V	$10^h.4$	$51^m51^s.7$
»	»	28.	» » Venus lower limb	4 H, 4 V	$13^h.7$	$50^m\ 5^s.3$
»	July	7.	» » Sun, lower limb 7 East, 7 West		$5^h.9$	$47^m19^s.1$
»	»	22.	» » » » » 5 » 4 »		$5^h.9$	$46^m59^s.5$
»	»	25.	» » » » » 12 » 9 »		$5^h.9$	$46^m53^s.4$
»	August	8.	» » » » » 11 » 10 »		$5^h.9$	$46^m33^s.7$

Longitude.

The number of readings of the horizontal circle in the two positions of the instrument is given as H and V.

										Long. W. Gr.
1903	December	3.	Moon, preceding limb	2 H	1 V	Jupiter,	Mean of both limbs	1 H	2 V	$6^h23^m11^s.0$
»	»	10.	» following »	1 H	1 V	Venus	—»—	1 H	1 V	$22^m10^s.5$
1904	September	22.	» preceding »	1 H	1 V	Jupiter	—»—	1 H	1 V	$24^m13^s.7$
»	»	22.	» » »	1 H	1 V	»	—»—	1 H	1 V	$23^m38^s.6$
»	October	22.	» » »	1 H	1 V	»	—»—	1 H	1 V	$23^m36^s.8$
»	»	26.	» following »	1 H	1 V	»	—»—	1 H	1 V	$23^m38^s.1$
»	»	28.	» » »	1 H	1 V	»	—»—	1 H	1 V	$24^m12^s.1$
»	November	19.	» preceding »	1 H	1 V	»	—»—	1 H	1 V	$23^m29^s.3$
»	December	17.	» » »	1 H	1 V	»	—»—	1 H	1 V	$23^m54^s.1$
»	»	21.	» both limbs	1 H	1 V	»	—»—	1 H	1 V	$23^m14^s.5$
»	»	22.	» » »	1 H	1 V	α Tauri	—»—	1 H	1 V	$23^m28^s.5$
1905	January	16.	» preceding limb	1 H	1 V	α »	—»—	1 H	1 V	$23^m28^s.0$
»	»	20.	» both limbs	1 H	1 V	Jupiter	—»—	1 H	1 V	$(26^m\ 6^s.6)$
»	»	20.	» » »	1 H	1 V	α Orionis	—»—	1 H	1 V	$23^m40^s.7$

The bracketed first value for 1905 January 20 had required a somewhat doubtful correction to the first circle-reading for the Moon. The mean of the other values is:

Uranienborg $6^h\ 23^m\ 32{,}0^s = 95°\ 53'\ 0''$ West of Greenwich.

King Point.

Latitude.

				Obj.	Alt.	Latitude
1906	February	9.	Altitudes of Polaris	3 V	69°.3	69°6′31″.6
»	»	9.	» » »	3 H	69°.2	7′11″.8
»	March	8.	» » »	3 V	69°.3	7′04″.2
»	»	8.	» » »	3 H	69°.2	6′08″.0
»	»	25.	» » »	3 V	68°.9	6′30″.8
»	»	25.	» » »	3 H	68°.7	6′35°.7
»	April	3.	Meridian altitude of γ Cygn N	H	19°.1	6′56″.9
»	»	3.	» » » η Cancri S	V	41°.6	6′41″.6
»	»	3.	» » » γ Cancri S	V	42°.7	6′31″.4
»	»	3.	» » » ε Hydrae S	V	27°.7	6′34″.9
»	»	3.	» » » ξ Hydrae S	V	27°.2	6′43″.2
»	»	3.	» » » $\varkappa$ Cancri S	V	31°.9	6′26″.6
»	»	3.	» » » o Leonis S	H	31°.2	6′55″.6
»	»	3.	» » » μ Leonis S	H	47°.3	6′61″.6
»	»	3.	» » » π Leonis S	H	29°.4	6′30″.9
»	»	3.	» » » α Leonis S	H	33°.3	6′33″.8
»	»	3.	» » » ξ Cephei N	V	36°.7	6′21″.8

Adopted Mean: *69°6′40″.*

Local Mean Time.

					A	A — L.M.T.
1906	March	16.	Altitudes of Jupiter, lower limb	5 H	$17^h.8$	$8^h26^m49^s.9$
			» » » »	5 V	$17^h.8$	$26^m17^s.1$
»	April	3.	Meridian Passage of γ Cygni N	H	$16^h.0$	$26^m\ 8^s.1$
»	»	3.	» » » η Cancri S	V	$16^h.1$	$26^m\ 9^s.5$
»	»	3.	» » » γ Cancri S	V	$16^h.3$	$26^m\ 9^s.8$
»	»	3.	» » » ε Hydrae S	V	$16^h.4$	$26^m\ 9^s.4$
»	»	3.	» » » ξ Hydrae S	V	$16^h.5$	$26^m\ 9^s.9$
»	»	3.	» » » $\varkappa$ Cancri S	V	$16^h.7$	$26^m10^s.6$
»	»	3.	» » » o Leonis S	H	$17^h.3$	$26^m\ 8^s.5$
»	»	3.	» » » μ Leonis S	H	$17^h.4$	$26^m\ 8^s.8$
»	»	3.	» » » π Leonis S	H	$17^h.6$	$26^m\ 9^s.7$
»	»	3.	» » » α Leonis S	H	$17^h.7$	$26^m\ 9^s.0$
»	»	3.	» » » ξ Cephei N	V	$17^h.8$	$26^m\ 8^s.1$
			Mean for April 3		$16^h.9$	$8^h26^m\ 9^s.2$
»	»	26.	Altitude of Jupiter, lower limb	6 V	$18^h.5$	$8^h25^m27^s.0$
»	»	26.	» » » » »	6 H	$19^h.0$	$25^m28^s.0$
»	»	27.	» » » » »	6 V	$18^h.6$	$25^m32^s.6$
»	»	27.	» » » » »	5 H	$18^h.7$	$25^m29^s.8$
»	»	28.	» » Capella	4 V, 4 H	$19^h.5$	$25^m28^s.5$
»	»	28.	» » Jupiter, centre	3 V, 3 H	$20^h.0$	$25^m31^s.7$
»	May	3.	» » Venus, centre	2 H, 2 V	$20^h.2$	$25^m31^s.8$
»	»	4.	» » Sun, upper limb 10 E, 10 W	H	$8^h.4$	$25^m23^s.3$
»	»	7.	» » » » 10 E, 10 W	V	$8^h.4$	$25^m18^s.0$
»	June	19.	» » » » » 7 E, 7 W	H	$8^h.4$	$24^m23^s.5$

Longitude.

							Long. W.Gr.
1906	April	26.	Mean, preceding limb	3 H 3 V	Jupiter, mean of both limbs	2 H 2 V	$9^h13^m31^s.6$
»	»	27.	» » »	2 H 2 V	» —»—	2 H 2 V	$11^m52^s.0$
»	»	28.	» » »	3 H 3 V	» —»—	3 H 3 V	$12^m30^s.2$
»	May	3.	» » »	2 H 2 V	Venus —»—	2 H 2 V	$13^m11^s.9$
»	»	4.	» » »	2 H 2 V	Sun —»—	2 H 2 V	$11^m57^s.5$
»	»	6.	» » »	2 H 2 V	» —»—	2 H 2 V	$12^m14^s.0$

Adopted Mean $9^h12^m33^s = 138°8'.2$ West of Greenwich.

Lieutenant Godfred Hansens's Sledge Expedition to King Haakon VII's Coast.

The following results were obtained by observation of the Sun with altazimuth No. 2, generally three altitudes in each position of the instrument, one set for latitude and one for longitude with several hours interval. In some cases, where one of the co-ordinates had to be assumed, the value is enclosed in brackets.

On some stations the Sun was also observed for determination of the azimuth of a terrestrial mark by means of the horizontal circle, which was utilized for determination of the magnetic declination by means of the compass.

Year	Date		Station	Lat.	Long.W.Gr.	Magn. Decl.	Remarks
1905	April	15.	Cape Crozier	68°59′.7	99°32′.7	—	Azimuth of Mount Rae N 70°42′ W. This was utilized for determination of the latitude of Mt. Rae, where only one set of altitudes of the Sun was observed.
»	»	19.	Mount Rae	69° 3′.5	100° 3′.3	—	
»	May	5.	Camp near Taylor Island	69°14′.1	101°37′.5	—	
»	»	8.	Seal Camp in Albert Edward's Bay	69°37′.1	102°15′.5	—	
»	»	12.	Camp on Collinson Peninsula	(70° 3′)	102° 3′.5	—	
»	»	14.	Cape Jensen	70°18′.7	102°14′.7	55°.7 E	
»	»	20.	Camp between C. Anker and C. Nygaard	70°50′.0	104° 9′.7	—	
»	»	22.	Cape Isachsen	(71° 7′)	104°34′	77°.5 E	
«	»	23.	Cape Mads Wiel	71°15′.5	(104°30′)	—	
»	»	24.	Ice North of Fredrikshald's Bay	71°27′.3	104°30′.0	82°.1 E	
»	»	25.	Camp off Ovidia Hill	(71°50′)	104°44′.0	82°.0 E	
»	»	26.	Cape Geelmuyden	72° 0′.2	105° 1′.7	81°.7 E	
»	June	15.	Princess Ingeborg's Island	68°48′.4	100°38′.7	—	
»	»	17.	Inagsajek Island	(68°58′)	100°19′.5	—	

The watch used on this expedition was compared with chronometer A before and after, with the following result:

			Chr. A.	A-Watch	
1905	April	2.	3^h54^m	$5^h51^m26^s.5$	Mean daily relative rate = + $17^s.21$
»	»	24.	6^h52^m	$6^h15^m17^s$	