GOVERNMENT NOTIFICATION.—No. 38.

The following Report from the Director of the Observatory is published for general information.

By Command,

FREDERICK STEWART,
Acting Colonial Secretary.

Colonial Secretary's Office, Hongkong, 29th January, 1887.

REPORT ON THE TIME-SERVICE IN 1886, AND MICROMETRIC MEASURES OF PLANETS.

The transit-instrument was throughout the past year used exclusively for ascertaining the error of the sidereal standard clock. The number of transits observed was 193, and the inclination of the axis was determined 65 times. The azimuthal deviation was whenever necessary corrected by aid of the distant meridian-mark, but this as well as any outstanding error of collimation was eliminated by observing objects very near the zenith,—one passing the meridian south and the other north of the zenith,—and reversing the instrument before the transit of the second star. The inclination cannot be similarly eliminated without using an artificial horizon, but this is not practicable as zenith-stars could not be observed reflected from the mercury,—whence the necessity for levelling every night when transits are secured except occasionally for a few nights, if the temperature is quite constant. The inclination affects the observed clock-error with fully its whole amount, but of course the factor is smaller within the tropics than in a higher latitude.

The sidereal standard clock has been going without interruption since the beginning of September, 1885, since which epoch the case has not been opened nor the hands touched. It is intended that the rate should be altered in another year. The mean daily rates during ten-day periods are exhibited in the following table, where — means gaining rate.

RATE OF SIDEREAL STANDARD CLOCK IN 1886.

Period.		Rate.	Temp.	Bar.	Period.		Rate.	Temp.	Bar.
1886.					1886.				
January	26– 5,	−0s.86	62°.9	30.18	July	4–14,	−2s.78	81°.3	29.72
„	5–15,	0.78	63.1	.12	„	14–24,	2.92	80.2	.63
„	15–25,	0.86	62.9	29.92	„	24– 3,	3.09	82.6	.62
„	25– 4,	0.78	56.2	30.01	August	3–13,	3.24	83.3	.66
February	4–14,	0.55	55.7	.03	„	13–23,	3.28	83.0	.56
„	14–24,	0.58	55.8	.12	„	23– 2,	3.27	80.5	.71
„	24– 6,	0.81	60.1	.01	September	2–12,	3.26	80.3	.71
March	6–16,	1.04	62.4	29.97	„	12–22,	3.23	81.6	.69
„	16–26,	1.28	66.5	.91	„	22– 2,	3.25	79.3	.83
„	26– 5,	1.42	64.8	.92	October	2–12,	3.14	79.2	.80
April	5–15,	1.73	71.5	.82	„	12–22,	3.09	77.2	.88
„	15–25,	1.78	68.9	.83	„	22– 1,	3.11	77.5	.95
„	25– 5,	1.79	70.1	.89	November	1–11,	2.80	72.3	30.03
May	5–15,	1.95	72.9	.79	„	11–21,	2.77	70.5	.00
„	15–25,	2.26	79.2	.79	„	21– 1,	2.55	69.1	.05
„	25– 4,	2.38	78.9	.74	December	1–11,	2.41	64.7	.12
June	4–14,	2.52	80.0	.64	„	11–21,	2.17	62.0	.06
„	14–24,	2.57	79.7	.70	„	21–31,	2.15	60.4	.07
„	24– 4,	2.70	82.9	.70					

The chronometers are compared on Mondays and Saturdays shortly before 1 p. The first named chronometer was used only as a hackwatch. Their daily rates (+ means losing, — gaining rate) were as follows:—

Period.		Rate of Chronometer Dent No.			Temperature.	Period.		Rate of Chronometer Dent No.			Temperature.
		39946	40912	40917				39946	40912	40917	
1886.						1886.					
January	4- 9,...	+3ˢ.40	−3ˢ.70	−3ˢ.02	61°	July	5-10,...	+6ˢ.60	−3ˢ.20	−3ˢ.10	81°
„	11-16,...	1.42	4.16	3.02	63	„	12-17,...	7.76	3.38	2.94	81
„	18-23,...	3.78	3.96	2.64	63	„	19-24,...	7.96	3.52	3.20	81
„	25-30,...	3.50	5.24	3.36	60	„	26-31,...	6.74	2.88	3.16	82
February	1- 6,...	2.48	4.12	3.90	54	August	2- 7,...	8.12	3.68	3.32	83
„	8-13,...	4.76	4.72	3.52	56	„	9-14,...	7.78	2.98	3.62	83
„	15-20,...	5.02	4.10	3.52	56	„	16-21,...	7.94	2.96	3.48	83
„	22-27,...	3.22	4.80	3.12	57	„	23-28,...	7.84	3.78	3.56	80
March	1- 6,...	5.34	3.30	4.14	62	„	30- 4,...	7.78	3.58	3.72	81
„	8-13,...	5.04	4.62	4.02	62	September	6-11,...	5.06	4.64	4.78	79
„	15-20,...	5.90	4.00	3.66	66	„	13-18,...	3.02	3.80	3.58	80
„	22-27,...	5.08	4.22	3.68	65	„	20-25,...	2.02	3.76	2.14	81
„	29- 3,...	7.90	4.68	3.64	66	„	27- 2,...	0.54	4.18	3.20	79
April	5-10,...	7.04	3.04	2.82	71	October	4- 9,...	6.02	4.00	2.38	78
„	12-17,...	7.10	3.28	2.78	71	„	11-16,...	5.40	3.50	2.68	78
„	19-24,...	3.72	3.68	2.70	69	„	18-23,...	4.86	3.58	2.78	78
„	26- 1,...	3.64	3.88	2.38	69	„	25-30,...	7.82	3.70	3.32	78
May	3- 8,...	8.60	5.32	2.32	72	November	1- 6,...	1.92	3.60	3.60	72
„	10-15,...	7.40	4.20	2.28	75	„	8-13,...	1.26	4.90	3.00	72
„	17-22,...	5.62	3.18	2.00	80	„	15-20,...	3.14	4.94	2.78	70
„	24-29,...	8.40	3.68	2.14	79	„	22-27,...	5.64	5.36	3.18	69
„	31- 5,...	5.58	3.60	2.22	79	„	29- 4,...	6.36	5.02	3.18	67
June	7-12,...	5.12	2.98	2.56	80	December	6-11,...	8.20	5.34	3.62	63
„	14-19,...	5.76	3.54	2.56	78	„	13-18,...	3.56	5.34	3.92	61
„	21-26,...	7.92	3.82	2.86	82	„	20-25,...	4.46	5.34	4.06	61
„	28- 3,...	8.24	3.54	2.84	83	„	27- 1,...	6.92	7.00	4.08	61

Between the 8th June, 1883, and the same date of 1884, the mean daily rate of Dent 40912 was: +0ˢ.45. In 1885, it was: −1ˢ.88, and in 1886: −4ˢ.06. Between the 8th June, 1883, and the same date of 1884, the mean daily rate of Dent 40917 was: −1ˢ.73. In 1885, it was: −1ˢ.52, and in 1886: −3ˢ.27.

The following table exhibits the errors of the one o'clock signals in 1886, for every day on which the ball was dropped. Whenever the error was less than 0ˢ.15, 0.1 has been entered without sign:—

ERRORS OF TIME BALL IN 1886.

—means too late, + means too early.

Date.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	...	−1.ˢ0	+0.ˢ5	+0.ˢ3	0.ˢ1	0.ˢ1	+0.ˢ2	...	−0.ˢ2	0.ˢ1	0.ˢ1	−0.ˢ3
2	−0.ˢ4	−1.0	+0.7	+0.5	...	0.1	+0.3	...	−0.2	0.1	−0.2	0.1
3	...	−0.4	+0.9	+0.8	+0.2	+0.2	+0.4	+0.ˢ3	−0.3	...	...	0.1
4	0.1	...	0.1	...	+0.3	+0.2	...	+0.4	0.1	0.1	...	0.1
5	−0.2	−0.2	+0.2	+1.3	+0.2	+0.2	0.1	+0.6	...	0.1	...	...
6	0.1	+1.0	+0.4	+0.9	+0.4	...	0.1	0.1	+0.2	0.1	...	0.1
7	0.1	...	...	0.1	+0.6	+0.4	+0.2	0.1	...	+0.2	...	0.1
8	0.1	0.1	+0.4	+0.4	+0.8	+0.6	+0.2	...	0.1	+0.3	...	−0.2
9	0.1	0.1	+0.6	+0.6	...	0.1	+0.3	+0.2	0.1	0.1	...	−0.4
10	...	0.1	0.1	+0.8	+1.2	0.1	0.1	+0.3	0.1	...	...	0.1
11	0.1	0.1	0.1	...	+1.4	+0.2	...	+0.4	0.1	0.1	...	+0.4
12	+0.2	0.1	+0.2	+0.2	+1.6	+0.3	0.1	+0.5	...	+0.2	0.1	...
13	+0.2	0.1	+0.3	+0.2	+0.5	...	0.1	0.1	−0.3	+0.2	0.1	0.1
14	+0.2	...	...	+0.3	+0.2	...	+0.2	0.1	−0.4	+0.3	...	0.1
15	0.1	+0.2	+0.5	+0.4	+0.4	+0.5	+0.3	...	−0.6	+0.3	0.1	0.1
16	0.1	+0.2	+0.6	+0.5	...	0.1	...	0.1	0.1	+0.4	0.1	0.1
17	...	+0.2	0.1	+0.6	+0.7	0.1	...	0.1	+0.2	...	0.1	−0.3
18	+0.2	+0.4	+0.4	...	0.1	−0.2	...	+0.2	+0.3	0.1	0.1	0.1
19	+0.3	+0.4	+0.7	+0.7	+0.3	−0.3	...	+0.2	...	−0.2	−0.5	...
20	+0.4	+0.4	0.1	+0.8	0.1	...	0.1	0.1	+0.5	−0.3	−0.2	0.1
21	+0.5	...	...	+0.9	0.1	0.1	+0.2	0.1	+0.7	0.1	...	0.1
22	+0.5	+0.6	0.1	+1.0	0.1	+0.2	0.1	...	0.1	0.1	−0.3	0.1
23	+0.5	+0.7	+0.2	...	...	+0.3	0.1	0.1	0.1	+0.2	−0.4	0.1
24	...	+0.8	+0.3	+1.1	0.1	+0.5	0.1	0.1	0.1	...	−0.6	...
25	+0.3	+0.8	+0.4	...	0.1	+0.6	...	0.1	0.1	+0.4	+0.4	...
26	+0.5	0.1	+0.5	...	0.1	+0.7	0.1	0.1	...	+0.6	0.1	...
27	+0.7	0.1	+0.5	0.1	0.1	...	+0.2	0.1	0.1	+0.8	0.1	...
28	+0.9	...	...	0.1	+0.2	0.1	0.1	0.1	−0.2	0.1	...	0.1
29	+1.1		+0.7	0.1	+0.2	0.1	0.1	...	−0.4	−0.2	0.1	0.1
30	0.1		+0.8	0.1	...	+0.2	0.1	0.1	0.1	−0.4	−0.2	0.1
31	...		+0.9		0.1		0.1	−0.2		...		0.1

The probable errors of the signal in the different months of 1886 (with the average percentage of clouded sky added in parenthesis) were as follows:

January 0.^{s}27 (65), February 0.^{s}34 (96), March 0.^{s}36 (92), April 0.^{s}46 (82), May 0.^{s}34 (71), June 0.^{s}22 (76), July 0.^{s}14 (76), August 0.^{s}16 (71), September 0.^{s}20 (51), October 0.^{s}20 (48), November 0.^{s}18 (35), December 0.^{s}13 (31).—The mean of the probable errors was 0.^{s}19 in 1885 and 0.^{s}25 in 1886, and the probable error of the signal during the two past years was therefore about a fifth of a second.

As stated in the time-ball notice published in the *Government Gazette* on the 10th January 1885, the ball is not dropped on Sundays or on Government Holidays. On the 30th March it failed at 1 p (clock failing to make contact) but was dropped at 2 p. On the 15th July it failed at 1 p (the telegraph wires being entangled) but was dropped at 2 p. On the 16th, 17th and 19th the ball could not be dropped as the wires were entangled. On the 7th September it failed owing to defective telegraphic connection and also at 1 p on the 8th, but it was dropped by hand at 2 p on the latter date. The ball was dropped by hand from the 9th September till the 2nd November. From the 3rd till the 11th November the signal was not given owing to illness among the staff. Since the 12th November the ball was dropped without intermission by aid of excessive battery-power introduced with the sanction of the Governor.—It is seen, that the time-ball apparatus failed to act only once in 1886, that the telegraphic connection was the cause of failure on 15 days and that the ball was dropped by hand on 47 days. I reported in July the necessity for a new line and this has been approved by His Excellency.

MICROMETRIC MEASURES OF JUPITER.

Epoch.	Pos.	m	n	M.P.	Diameter.		Breadth.		Length.	Obs.—Calc.		
					Equ.	Pol.	Belt	Spot	Spot	Pos.	Equ.	Pol.
1879 August 29,...	335°.65	±0°.17	4	200	...	...	...	...	...	−0°.20	...	...
„ November 24,...	336 .53	.42	5	„	...	...	...	...	...	+ .07	...	...
„ „ 29,...	336 .30	.05	2	„	...	...	...	2″.42	11″.87	− .09	...	...
„ December 19,...	336 .65	.32	4	„	...	...	...	...	...	+ .65	...	...
1880 September 12,...	336 .23	.10	4	„	...	...	...	...	...	+ .25	...	...
„ „ 27,...	335 .25	.30	4	„	...	...	...	3 .39	15 .55	− .49	...	...
„ October 21,...	334 .98	.33	4	„	50″.17	47″.25	9″.13	3 .62	14 .89	− .39	+1″.13	+1″.29
„ „ 23,...	335 .35	.00	3	„	49 .61	46 .84	8 .19	3 .35	15 .79	.00	+0 .68	+1 .00
„ „ 28,...	335 .13	.17	4	„	48 .99	46 .24	8 .48	3 .59	...	− .15	+0 .46	+0 .73
„ November 3,...	334 .47	.13	4	„	49 .35	46 .05	8 .78	...	...	− .75	+1 .39	+1 .03
„ December 1,...	336 .05	.23	4	„	45 .25	42 .23	7 .79	...	...	+ .97	+0 .97	+0 .45
„ „ 3,...	334 .73	.04	4	„	44 .69	42 .38	8 .86	...	...	− .35	+0 .71	+0 .87
„ „ 6,...	335 .37	.17	4	„	43 .54	42 .20	8 .88	...	...	+0 .30	−0 .01	+1 .09
1882 October 26,...	359 .93	.50	4	„	43 .70	41 .09	...	...	...	−1 .57	+0 .61	+0 .46
„ December 7,...	359 .30	.30	4	400	47 .26	44 .43	...	...	...	−0 .54	+0 .14	+0 .29
1883 January 6,...	356 .95	.30	4	200	47 .63	44 .63	...	...	...	−1 .06	+1 .12	+1 .03
„ „ 8,...	354 .45	.70	4	200	47 .41	45 .24	...	...	...	−3 .45	+1 .05	+1 .78
1885 December 27,...	23 .60	0 .91	7	110	...	...	...	...	...	−1 .64	...	...
„ „ 28,...	25 .84	1 .34	8	„	...	...	...	...	...	+0 .62	...	...
1886 April 7,...	24 .40	0 .28	4	„	...	...	...	...	...	−1 .00	...	...

The distance of the great ruddy spot from the nearest edge of the belt was measured on October 21st, 1880, as 3″.63, and on October 23rd, as 3″.53. The satellites were measured on November 3rd, 1880, as follows: I 1″.00, II 1″.18, IV 1″.30.

The first column in the table exhibits the epoch, the second the angle of position of the polar axis, the third the average déviation of the single measures from the mean (from which the probable error is easily obtained), the fourth the number of pointings, the fifth the magnifying power, the sixth the apparent diameter of the equator, the seventh the diameter vertical to the latter, the eighth and ninth the breadth of the equatorial belts and the great spot, the tenth the length of the latter when on the central meridian. The eleventh, twelvth and thirteenth columns exhibit the differences between the observed values and those calculated by Marth, in which comparison the phase has been taken into account as usual.

From the differences exhibited in the eleventh column the following normal values of the position angle were obtained: I 1880, July 3rd, 335°.95. II 1882, December 14th, 357°.96. III 1886, February 7th, 24°.56. From I and III the right ascension and declination of Jupiter's North-pole were determined as follows: A.R. 275°4′, Decl. +65°26′ or Long. 330°25′, Lat. +87°34′. Referred to Leverrier's orbit of Jupiter the longitude of the node and the obliquity of the Jovian ecliptic came out as follows: N. 290°31′, ι1°39′. The difference between the position angle II and that calculated from these elements is +2°.94.

When a and d resp. a^1 and d^1 represent the geocentric right ascensions, and declinations of Jupiter at two epochs, A and D the coordinates of his north-pole referred to the terrestrial equator, p and p^1 the observed position angles and i the angle between the Jovian axis, and the plane on which it is projected, perpendicular to the line of vision, we have the well-known equations:

$$\sin D = \sin d \cos i + \cos d \sin i \cos p \qquad (1)$$

$$\cos i = \sin d \sin D + \cos d \cos D \cos (a - A) \qquad (2)$$

$$\sin i = -\cos D \sin (a - A) \operatorname{cosec} p \qquad (3)$$

Eliminating i from (1) by aid of (2) and (3) we obtain:

$$\tan D = \tan d \sin (N - a + A) \operatorname{cosec} N \qquad (4)$$

where: $\tan N = \sin d \tan p$,
and cos N is of the same sign as cos p.
Equating the two equations of the form (4) we obtain:

$$M \sin (N - a + A) = \sin (N^1 - a^1 + A) \qquad (5)$$

where: $\tan d \cot d^1 \sin N^1 \operatorname{cosec} N = M$.
From (5) we obtain:

$$\tan A = \frac{+M \sin (N - a) - \sin (N^1 - a^1)}{-M \cos (N - a) + \cos (N^1 - a^1)} \qquad (6)$$

The value of A is obtained by aid of (6) and D is then obtained from either of the two equations of the form (4).

From the mean of the figures in the sixth and the seventh columns it follows, that the equatorial and polar diameters at the mean distance (5.20273) of Jupiter are 38″.207 and 35″.942 respectively and that the equatorial semi-diameter at the mean distance of the Earth from the Sun is 99″.39. The polar is 0.9407 times the equatorial diameter and the ellipticity $\frac{1}{16.86}$, or about a seventeenth. Its diameter is about 11 times that of the Earth, and as its mass is 309.8 times as large it follows that its density is $\frac{1}{4.3}$ of the mean density of the Earth. It appears therefore that the apparent mean density of Jupiter does not considerably exceed that of water, but of course this includes the no doubt extensive gaseous envelope so that the matter nearer the centre may be much denser.

MICROMETRIC MEASURES OF SATURN.

Epoch.	Pos.	m.	n.	M.P.	Ring—Diam.		Planet.			Obs.—Calc.		
					Ext.	Cass.	Int.	Equ.	Pol.	Pos.	Ext.	Int.
1879, Jan. 3,	+4°.37	±0°.17	4	200	39″.12	...	...	17″.48	16″.00	+0°.04	+0″.54	...
„ „ 4,	4 .25	.20	4	600	...	...	...	...	...	−0 .07	...	...
„ „ 14,	4 .89	.14	4	200	37 .26	...	...	17 .53	16 .81	+0 .63	−0 .65	...
„ „ 15,	4 .14	.24	4	„	37 .75	...	...	17 .08	16 .66	−0 .11	−0 .12	...
1880, Oct. 21,	0 .11	.00	2	„	46 .39	39″.35	30″.87	19 .31	19 .12	−1 .39	+1 .33	+0″.90
„ „ 23,	1 .32	.23	4	„	46 .91	...	30 .78	19 .93	18 .88	−0 .20	+1 .88	+0 .83
„ „ 28,	1 .20	.20	4	„	46 .72	...	30 .80	19 .53	18 .90	−0 .35	+1 .76	+0 .89
„ Nov. 3,	1 .37	.15	4	„	46 .22	39 .37	30 .78	19 .58	18 .85	−0 .24	+1 .38	+0 .98
„ Dec. 1,	+1 .10	.20	4	„	44 .59	37 .90	30 .44	19 .11	18 .33	−0 .70	+1 .02	+1 .46
1882, Oct. 27,	...	...	...	„	46 .66	39 .87	...	20 .30	...	...	+0 .91	...
„ Dec. 5,	...	...	...	300	46 .92	40 .64	...	19 .40	...	...	+1 .25	...
„ „ 7,	...	...	...	200	47 .26	40 .41	...	19 .65	...	...	+1 .66	...
1883, Jan. 8,	−2 .50	.25	4	„	45 .56	...	...	18 .17	...	−1 .03	+1 .81	...
1885, Dec. 23,	6 .42	.28	4	340	...	...	...	...	...	+0 .28	...	...
„ „ 27,	7 .97	0.50	3	„	...	...	...	...	...	−1 .30	...	...
„ „ 28,	8 .50	1.27	6	600	...	...	...	...	...	−1 .83	...	...
1886, Apr. 5,	−7 .31	0.70	7	110	...	...	...	...	...	−0 .79	...	...

The first column exhibits the epoch. The second, third, fourth and fifth columns are arranged as in the previous table. The sixth to the tenth columns inclusive exhibit the external diameter, the diameter of Cassini's division, the internal diameter of the Ring and the equatorial and polar diameters of the planet. The three last columns exhibit the differences between the observed values and those given in the *Nautical Almanac* for the position of the semi-minor axis and the external and internal diameters of the Ring.

From the measures the following proportions between the different diameters and the external diameter of the Ring were obtained: Ext. 1.0000, Cass. 0.85434, Int. 0.66573, Equ. 0.42733, and the proportion between the polar and the equatorial diameter of the planet 0.95992 and the ellipticity $\frac{1}{24.95}$. The dimensions at the mean distance (9.5388) of Saturn are: External diameter of Ring 40″.28, Cassini's division 34″.42, Internal diameter 26″.82, Equatorial diameter of the planet 17″22 and Polar 16″.53. The equatorial semi-diameter at the mean distance of the earth from the Sun is 82″.11. Its diameter is about $9\frac{1}{3}$ times that of the Earth and as its mass is 102.7 times as large it follows that its density is $\frac{1}{7.9}$, or about $\frac{1}{8}$, of the mean density of the Earth.

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Hongkong Observatory, 8th January, 1887.