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Edited by T. Rupert Jones
Excerpt
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INSTRUCTIONS.

PART I.—PHYSICAL OBSERVATIONS.

I.—ASTRONOMY.

1. Astronomical Data. (Eclipses of the Sun and Occultations.) By J. R. Hind, F.R.S.

Eclipse of the Sun, 1876, March 25.

In longitude 60° West and latitude 82°, this eclipse commences March 25 at 4^h $12{\cdot}1^m$ local mean time, 139° from the Sun's north point towards the west, and ends at 6^h 8^m. Magnitude of eclipse, 0·67.

For any position not far from the above, the longitude of which is λ (taken *negatively*) and geocentric latitude l, the Greenwich time t, of commencement of the eclipse, may be found from the following formulæ :—

$$\text{Cos}\ \omega = 1{\cdot}11253 - [0{\cdot}19595]\,.\sin l + [9{\cdot}95510]\,.\cos l.\cos(\lambda + 36^\circ\ 19{\cdot}4')$$
$$t = 8^h\ 3^m\ 50^s - [3{\cdot}57030]\,.\sin \omega + [3{\cdot}52333]\,.\sin l - [3{\cdot}76690]\,.\cos l.\ \cos(\lambda - 150^\circ\ 2{\cdot}0'),$$

and applying the longitude expressed in time to t, thus found, the local mean time of first contact is obtained. The quantities within square brackets are logarithms.

The distance of the point of contact on the Sun's limb from his north point reckoning towards the west $= \omega + 29^\circ\ 45'$.

Eclipse of the Sun, 1877, August 8.

In longitude 60° West, and latitude 82°, this eclipse commences August 8 at 12^h $17{\cdot}3^m$ local mean time, 16° from the Sun's north point towards the west, and ends at 13^h 21^m. Magnitude of eclipse, 0·21.

For any position not far from the above, the Greenwich time t of commencement will be found from the formulæ :—

$$\text{Cos}\ \omega = 2{\cdot}52151 - [0{\cdot}22120]\ \sin l + [9{\cdot}93713]\,.\cos l.\cos(\lambda + 289^\circ\ 47{\cdot}1')$$
$$t = 17^h\ 22^m\ 57^s - [3{\cdot}49064]\ \sin \omega - [3{\cdot}30948]\ \sin l - [3{\cdot}73517]\,.\cos l.\cos(\lambda - 26^\circ\ 24{\cdot}9').$$

The distance of the point of contact on the Sun's limb from his north point reckoning towards the west $= \omega - 21^\circ\ 36'$.

Note.—The *north point* is here to be distinguished from the Sun's upper point or vertex.

As an example of the application of the above formulæ of reduction of time of commencement, the calculation may be made for the position assumed in the original calculation upon which the equations are founded, viz., longitude 60° or 4^h West, and latitude (geographical) 82°. To reduce the geographical to the geocentric latitude (l), a correction is to be applied which may be taken from the Table at p. 57 of "Appendices to various "Nautical Almanacs between the years 1834 and 1854;" with argument 82°, this correction is 3·1′ to be subtracted from the geographical latitude, and hence $l = 81^\circ\ 56{\cdot}9'$.

In the case of the eclipse of 1876, March 25, the computation is then as follows:—

Constant	−0·19595
sin l	+9·99570
	−0·19165
No.	−1·55472

Constant	+9·95510
cos l	+9·14633
cos A	+9·96181
	+9·06324
No.	+0·11567
Constant	+1·11253
	+1·22820
	−1·55472
cos ω	−0·32652
or log. cos ω	−9·51391
ω	+109° 3·5′

	°	′
λ	− 60	0·0
Constant	+ 36	19·4
A	− 23	40·6

λ	− 60	0·0
Constant	−150	2·0
B	−210	2·0

Constant	−3·57030
sin ω	+9·97552
	−3·54582
No.	−3514·2s

Constant	+3·52333
sin l	+9·99570
	+3·51903
No.	+3303·9s

Constant	−3·76690
cos l	+9·14633
cos B	−9·93738
	+2·85061
No.	+ 708·9s
	+ 3303·9
	+ 4012·8
	− 3514·2
	+ 498·6

	°	′
ω	=109	4
Constant	= 29	45
Angle from N. Point at first contact.	=138	49

	H.	M.	S.
or +		8	19
Constant	8	3	50
	8	12	9
Subtract Long.	4	0	0
Local time of commencement	4	12	9

which agrees with the direct calculation.

Occultations.

The list appended includes those stars of the *Nautical Almanac* catalogue, which may possibly be occulted in 82° of north latitude; but in order to ascertain with certainty whether any star is occulted, and the circumstances of the occultation, supposing the position of the point where the observation is to be made approximately known, the formulæ given at p. 134 of *Appendices*, &c., cited above, may be employed. An example of the application of these formulæ for Greenwich is given at p. 145; but to further illustrate the method of computation, the occultation of the planet Mars 1876, January 31, is here calculated for longitude 4h West, latitude 82°.

The following are the circumstances for this position of the principal occultations visible in 1876 and 1877.

		Immersion.			Emersion.		
		H.	M.	°	H.	M.	°
Mars -	1876, Jan. 30–31	23	36	86	0	28	333
Venus -	„ Oct. 13	4	4	12	4	40	294
Regulus	„ Dec. 6	1	57	50	2	47	262
„	1877, Jan. 2	9	52	70	10	46	240
„	„ Jan. 29	21	22	141	21	35	169
„	„ Feb. 26	8	10	95	8	57	214

The above are local mean times, and the angles from N. point are reckoned as usual in the *Nautical Almanac*.

Nautical Almanac Office,
1875, February 10.

J. R. Hind.

OCCULTATIONS of Stars to the 5th magnitude inclusive that may be visible in or near 82° N. Lat. and 60° W. Long.

Date.	Star's Name.	Magnitude.	Local Mean Time of ☌ in R. A. of ☾ and ✱.	Date.	Star's Name.	Magnitude.	Local Mean Time of ☌ in R. A. of ☾ and ✱.
1875.			h. m. s.	1876.			h. m. s.
Sept. 21	136 Tauri	5	11 32 37	Nov. 9	c Leonis	5	21 9 42
Oct. 16	ζ Arietis	4½	6 34 23	29	17 Tauri	4	23 46 26
16	τ′ Arietis	5	9 4 30	30	23 Tauri	5	0 20 22
18	136 Tauri	5	17 48 23	30	η Tauri	3	0 47 4
Nov. 12	ζ Arietis	4½	17 7 15	30	27 Tauri	4	1 26 1
12	τ′ Arietis	5	19 34 13	Dec. 1	136 Tauri	5	22 39 49
15	136 Tauri	5	2 36 23	3	κ Geminor.	3½	14 44 4
20	χ Leonis	5	12 21 59	6	α Leonis	1½	2 8 21
Dec. 10	ζ Arietis	4½	4 33 39	6	ρ Leonis	4	13 27 33
10	τ^1 Arietis	5	7 1 47	27	17 Tauri	4	10 49 5
12	136 Tauri	5	13 42 23	27	23 Tauri	5	11 23 23
15	γ Cancri	4½	3 29 12	27	η Tauri	3	11 50 23
17	χ Leonis	5	19 33 5	27	27 Tauri	4	12 29 45
1876.				29	136 Tauri	5	9 45 32
Jan. 6	ζ Arietis	4½	14 31 24	31	κ Geminor.	3½	1 5 42
6	τ^1 Arietis	5	17 4 27	1877.			
9	136 Tauri	5	1 1 58	Jan. 2	α Leonis	1½	10 34 11
11	γ Cancri	4½	14 36 32	23	ε Arietis	4½	1 26 14
Feb. 2	ζ Arietis	4½	21 42 55	23	17 Tauri	4	20 35 39
5	136 Tauri	5	10 16 10	23	19 Tauri	5	20 43 17
8	γ Cancri	4½	1 20 48	23	20 Tauri	5	20 58 28
Mar. 1	ζ Arietis	4½	3 11 8	23	23 Tauri	5	21 11 6
1	23 Tauri	5	16 6 30	23	η Tauri	3	21 39 1
1	27 Tauri	4	17 15 12	23	27 Tauri	4	22 19 41
3	136 Tauri	5	16 45 45	25	136 Tauri	5	20 52 41
6	γ Cancri	4½	9 47 14	27	κ Geminor.	3½	12 41 18
				29	α Leonis	1½	21 27 30
Oct. 6	17 Tauri	4	6 7 22	Feb. 19	ε Arietis	4½	8 7 24
6	23 Tauri	5	6 42 48	20	17 Tauri	4	3 49 1
6	η Tauri	3	7 10 40	20	19 Tauri	5	3 56 53
6	27 Tauri	4	7 51 21	20	20 Tauri	5	4 12 32
8	136 Tauri	5	7 25 48	20	η Tauri	3	4 54 21
13	ρ Leonis	4	1 49 1	22	136 Tauri	5	5 49 38
13	c Leonis	5	15 7 58	23	κ Geminor.	3½	23 2 33
Nov. 2	17 Tauri	4	13 44 18	26	α Leonis	1½	8 50 24
2	23 Tauri	5	14 18 47	Mar. 18	ε Arietis	4½	13 33 48
2	η Tauri	3	14 45 54	19	17 Tauri	4	9 19 26
2	27 Tauri	4	15 25 29	19	19 Tauri	5	9 27 23
4	136 Tauri	5	13 45 13	19	20 Tauri	5	9 43 8
6	κ Geminor.	3½	7 7 43	19	η Tauri	3	10 25 15
9	ρ Leonis	4	7 37 32	21	136 Tauri	5	12 10 35

OCCULTATION ☌ 1876, JANUARY 31.

Long. 4^h W.

Lat. N. 82° 0′ 0″
Correction −3 7
l 81 56 53

ρ 9·99860
$\cos l$ 9·14633
$\phi^{(1)}$ 9·14493   9·14493
$\cot l$ 9·15063   const. 9·41916
$\phi^{(2)}$ 9·99430 $\phi^{(3)}$ 8·56409

H. M. S.
☾'s R.A. 0 38 41·1
✱'s R.A. 0 39 25·8
time − 44·7
arc − 11′ 10·5′

	H. M. S.
Local sidereal time at Greenwich noon	16 40 14·8
Mars R.A.	− 0 39 25·8
	−7 59 11·0

	H. M. S.
	− 7 59 11·0
T	+ 4 2
	+ 39·8
	− 3 56 31·2
h	− 59° 7·8′

	M. S.
α_1 time	1 51·2
α_1 arc	27′ 48·0″
D ☾'s Dec.	+5° 13′ 50″·8
δ ✱'s Dec.	+4 10 13·3
D−δ	+1 3 37·5
D_1	+14 56·8

P 57′ 23·0″	+3·53694
$\phi^{(2)}$	+9·99430
	+3·53124
cos δ	+9·99885
{	+3·53009
	+56 29·2
+	17·9
	+56 11·3
D−δ	+63 37·5
x	+ 7 26·2
{ α	−11 10·5
	−2·82640
cos δ	+9·99885
{	−2·82525
	−11 8·7
P sin h	−3·47060
$\phi^{(1)}$	+9·14493
{	−2·61553
	−6 52·6
{ y	−4 16·1
	−2·40841
x	+2·64953
tan S	−9·75888
cos S	+9·93817
W	+2·71136
cos[−(S+ι)]	+9·99999
n	+2·71135
Δ′	2·97371
cos ω	+9·73764
c	+3·26589
sin a	−9·92119
	−3·18708
t_1	−0 25·6m
	4 2
	3 36·4
Long.	4 0·0 W
Imm. Jan. 30d	23 36·4 (Loc. Mean T.)
(−ι)	−29·5
ω	+56·9
	−86·4

	+3·53694
cos h	+9·71019
	+3·24713
sin δ	+8·86166
	+2·10879
$\phi^{(1)}$	+9·14493
	+1·25372
	15 39·8
	57 17·7
P	3·53694
const.	9·43677
Δ′	2·97371
S	−29 51·2
ι	+29 30·1
−(S+ι)	+0 21·1
ω	+56 52·1
a	−56 31·0
b	+57 13·2

	+3·53694
sin h	−9·93366
	−3·47060
sin δ	+8·86166
	−2·33226
$\phi^{(3)}$	+8·56409
{	−0·89635
	− 0 7·9
D_1	+14 56·8
x_1	+15 4·7
{ α_1	+27 48·0
	+3·22220
cos δ	+9·99885
{	+3·22105
	+27 43·6
P cos h	+3·24713
	+8·56409
{	+1·81122
	+ 1 4·7
{ y_1	+26 38·9
	+3·20382
x_1	+2·95650
cot ι	+0·24732
cos ι	+9·93969
W	+2·71136
	3·55630
	+6·20735
H	+3·00353
cos ω	+9·73764
c	+3·26589
sin b	+9·92467
	+3·19056
t_2	+0 25·9m
	4 2
	4 27·9
	4 0·0 W
Em. Jan. 31d	0 27·9
(−ι)	−29·5
ω	+56·9
	+27·4

Note.—In this particular example, T ($4^h\ 2^m$) was taken from a previous calculation, but it may be obtained with a sufficient degree of approximation, by the method described at p. 129 of Appendices to the Nautical Almanac.

If the angles from the Sun's vertex are required, the parallactic angles must be computed and applied to the above.

2. SUGGESTIONS for OBSERVATIONS of the TIDES to be made by the NORTH POLE EXPEDITION, by the REV. SAMUEL HAUGHTON, M.D., F.R.S.

I.—SUMMARY OF ARCTIC TIDAL OBSERVATIONS ALREADY MADE.

The tidal wave enters the Arctic Polar Basin by three distinct channels :—

1. By Behring's Strait.
2. By Davis' Strait.
3. By the Greenland Sea and Barentz Sea.

As to the first two of these tidal waves, I can offer some useful observations, but I know little of the third wave, beyond the fact, recorded by Captain Markham, that the tide wave No. 2, entering Smith Sound and Kennedy Channel, meets at Cape Frazer (Grinnell Land), Lat. 80° N. with a tidal wave coming from the north, which I believe to be the wave No. 3, which has travelled round the north coast of Greenland, thus proving it to be an island.

1. *Behring Strait Tidal Wave.*

Observations on this tidal wave have been made at—

1. Port Clarence	-	Captain Moore.
2. Point Barrow	-	Captain Rochfort Maguire.
3. Walker Bay	-	Captain Collinson.
4. Cambridge Bay	-	Captain Collinson.

All these observations lead to the result that this tidal wave is a simple lunar semi-diurnal tide, without any complication of solar or of diurnal tide, which seem, from some unknown cause, unable to enter the Arctic Basin through Behring's Strait, although the diurnal tide is well developed in many parts of the North Pacific Ocean. This tide has been traced eastwards as far as Victoria Strait, where it meets the Davis' Strait tide No. 2, entering Victoria Strait, from the north, through Bellot Strait and Franklin Strait.

[The Franklin expedition perished at the meeting of these two tides, which forms a line of still water and immoveable pack ice. In fact the "Erebus" and "Terror," having become beset in September 1846, were abandoned in April 1848, having moved only 15 miles during the 18 months.]

It is extremely probable that the Behring Strait tidal wave enters Banks' or Maclure Strait and passes as far eastward as the Bay of Mercy, where Maclure's Expedition was abandoned, in 1853, after two years ineffectual attempts to enter Melville Sound from the West. I am persuaded that this failure was due to the meeting of the Behring Strait and Davis' Strait tidal waves at the western outlet from Melville Sound. Unfortunately this important fact cannot be determined with certainty in consequence of the apparent loss of the tidal observations made by Maclure in the Bay of Mercy in 1851–52–53; and by Kellett in Bridport Inlet in 1852–53. If these tidal observations could be discovered they would throw much light on the theory of the tidal motion of this part of the American Arctic Archipelago.

2. *Davis' Strait Tidal Wave.*

This tidal wave is much better known than that of Behring Strait. Observations upon it have been made at—

1.	Fredericksdal -	Missionary Asboe.
2.	Godthaab - -	Dr. Rink.
3.	Holsteinborg -	Director Elberg.
4.	Próven - -	Assistant Bolbroe.
5.	Frederickshaab -	——
6.	Port Leopold -	Sir James Ross.
7.	Bellot Strait -	Sir Leopold McClintock.
8.	Beechey Island -	"Resolute" and "Assistance", "North Star."
9.	Griffith Island -	"Resolute" and "Assistance."
10.	Refuge Cove -	Sir E. Belcher.
11.	Northumberland Sound.	Sir E. Belcher.

This tidal wave, in passing Cape Farewell has a luni-tidal interval of $6^h\ 22^m$, which is increased (Inglefield) to $11^h\ 0^m$ at Upernavik, and to $11^h\ 50^m$ at Van Rennselaer Harbour (Kane). The diurnal element is well developed along the Greenland coast. On reaching the head of Baffin's Bay, the tidal wave moves northward through Smith's Sound, and (according to Captain Markham) meets another tide at Cape Frazer.* The tidal wave flows also through Lancaster Sound to the westward to Port Leopold, where it divides into three branches, through—

a. Barrow Strait (westward).
b. Wellington Channel, Queen's Channel, and Penny Strait (northward).
c. Prince Regent Inlet (southward).

The progress of the tidal waves may be thus estimated by the luni-tidal intervals :—

		H.	M.
(*a*).	Port Leopold - - - -	11	44
	Griffith Island (Admiralty Tide Tables) -	0	15
	Dealy Island (" ") -	1	48
	Bay of Mercy, not given (Admiralty Time Tables).		
	(The range is given at 2 ft. in the Bay of Mercy, and at 4 ft. at Dealy Island; this circumstance, and the presumed difficulty of fixing the time of high water is in favour of the tide at Mercy Bay being the Behring Strait tide.)		
(*b*).	Port Leopold - - - -	11	44
	Penny Strait - - - -	0	15
(*c*.)	Port Leopold - - - -	11	44
	Bellot Strait - - - -	11	48

* Captain Markham's remarks show that the diurnal element is well developed in the tidal wave south of Cape Frazer.

All these tidal waves are complex, and consist of four well marked waves.

1. Lunar semidiurnal.
2. Solar semidiurnal.
3. Lunar diurnal.
4. Solar diurnal.

This tidal wave cannot, therefore, for a moment be confounded with the Behring Strait wave, which is a simple lunar semidiurnal wave.

The western branch moves (as I believe) across Melville Sound, and meets the Behring Strait tidal wave in Maclure Strait. The northern branch proceeds regularly through Penny Strait to lat. 76°, showing no sign of meeting an opposing tide although it would probably meet the Behring Strait tide somewhere about 80°. The southern branch, as I have proved meets the Pacific tide at the north entrance of Victoria Channel, where the Franklin expedition was abandoned. If the statement of the meeting of two tidal waves in Kennedy Channel be confirmed, it will diminish the chance of reaching the North Pole by that route, even though the northern tidal wave be not the Behring Strait wave which is highly improbable.

It is not at all unlikely that the Behring Strait tidal wave may meet the united Atlantic waves to the north of Greenland, and at this side of the Pole ; in which case it is probable that sledges will do more work than ships.

As it may be of use to determine quickly the character of the tidal wave, I now give a method of doing so.

II.—Method of determining quickly the existence of a Diurnal Tide.

Hourly observations of the height of the tide made for 48 successive hours, will determine accurately the diurnal tide for every hour of the middle 24 hours. Let h_1, h_2, h_3, be three heights of tide separated from each other by intervals of 12 hours, then the diurnal tide, at the period corresponding to the middle observation h_2 is given by the formula :—

$$D=\frac{h_1-2h_2+h_3}{4} \quad (1.)$$

The time selected for making the 48 hours observations should be when the Moon's declination is great (either north or south) because the diurnal tide vanishes with the declination of the Moon or Sun respectively. The expression for the diurnal tide is of the form,—

$$D=M \sin 2\mu \cos (m)+S \sin 2\sigma \cos (S) \quad (2.)$$

Where μ=Moon's declination.
σ=Sun's declination.
m=An angle that goes through all its changes in a lunar day.
s=An angle that goes through all its changes in a solar day.

At the time of equinox $\sigma=0$, and hence the 48-hour observation, if made at this time, and also when $\mu=0$, would show the non-existence of a diurnal tide, although there might be really a large one. The form of equation (2.) shows the reason for directing the observations to be made when the Moon's declination is great.

As a rule the diurnal tide is of considerable amount both lunar and solar, in all the branches of the Davis' Strait tidal wave; and in some cases the solar diurnal tide is actually greater than the lunar diurnal tide.

III.—General Rules for Tidal Observations.

Much valuable time has been often misspent on tidal observations of little value, and great disappointment felt at the small results produced by most laborious and carefully conducted observations; whereas at other stations, a simple month's observations properly made have given results of great value, although the observations themselves did not cost one-tenth part of the labour of other observations which gave but little result.

I offer the following suggestions for tidal observations made for a lengthened period.

1. Hourly observations of height should be made for one month at the times of solstice and equinox.

2. At the intervening periods, in order to save the labour of the observers as much as possible, it is recommended (instead of noting the time and height of high and low water each day) that the height of the tide should be registered every *four* hours of *mean solar time*. This would correspond with the times of striking bells, which would ensure punctuality and accuracy as to the time of observation, and the observation itself could be made in one minute. I should prefer observations made every *four* hours, for this reason among others, that the diurnal and semi-diurnal tides could be at once separated, and discussed independently of each other.

3. The times of observation must be carefully kept to, but whether the exact hours, or a fixed number of minutes after the exact hours, may be decided according to the convenience of the observers.

4. Remark carefully that the times of observation must be according to *mean solar time*, not according to apparent solar time.

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3. Pendulum Observations. By Prof. Stokes, M.A., Sec. R.S.

It must be remembered that pendulum observations are of little value unless very accurately made.

The pendulum station will of course be adjacent to the ship's winter quarters. It must *if possible* be on land, chiefly because the clock's rate at the time of observation must be determined by transits, and we have no guarantee that ice covering the sea, however apparently firm, may not be subject to small motions in azimuth, which would vitiate the transits.

Clear weather should be chosen for the observations, that transits may be observed.

The observers are assumed to be already acquainted with the mode of making pendulum observations, and therefore it will only be necessary to mention some precautions.

It is recommended that great care be taken as to the mode of illuminating the bright patch on the clock-pendulum. Sir George Airy found a gold-leaf surface of an oblique section of a cylinder projecting from the bob towards the observer to be best. The light is then to be lateral, and may be distant.

As even an astronomical clock cannot be trusted to go for short intervals of time with a rate equal to its mean rate for 24 hours, it is desirable to take a series of consecutive swings extending over 24 hours, which would have the further advantage that the mean temperature of the pendulum would more accurately correspond to the mean indication of the thermometers. The time chosen for commencement should be about the middle of the time most favourable for transits. As a swing may be expected to last about four hours, and it is sufficient to observe two or three coincidences at the beginning and end of each swing, the observer would have time enough to take transits and to rest in the intervals between observing coincidences. The observer must remember, however, that he is responsible for the number of coincidences that have taken place, and therefore he would do well to take at first, or in preliminary trials, one or two intermediate coincidences, merely as counters not intended for reduction, and not leave off this practice till he has convinced himself that it may be safely dispensed with.

In observing coincidences the observer must, of course, register both the disappearance and the reappearance of the mark. But as it is somewhat perplexing to observe and register four events which succeed one another at intervals of a few seconds, namely, the two disappearances (those of the right and left edges of the mark) and the two reappearances, the observer (unless he can thoroughly depend upon himself to record the four events without confusion) is advised to be careful in the adjustment of the mark and diaphragm, so as to secure the two disappearances or the two reappearances taking place on consecutive seconds even when the pendulum is swinging in the smallest arc that will be observed with, in which case it will, of course, suffice to observe one disappearance and one reappearance for each coincidence.

The barometer and the thermometers hung near the pendulum should be read at the beginning and end of each swing. Should there be much variation of temperature, the thermometers should also be read at noted times once or oftener during the swing. It is to be remembered that what we want to know is, not the exact temperature at the moment of coincidence, but the mean temperature during the swing.

In one of the swings, or, if more convenient, in a preliminary or subsequent special swing taken for this sole object, and in which coincidences need not be attended to, the arc should be carefully observed five or six times distributed over the swing, or, which would probably be found more accurate, the clock times should be noted when the arc attains definite values, beginning with an arc slightly greater than the greatest used for coincidences, and going on till it is reduced to about one-third of its initial value. The barometer and thermometer should be read at the same time. The object of this is to determine the law of decrease of the arc, and thereby render it possible, in the subsequent reduction of the observations for time, to correct for the arc without assuming that it decreases *strictly* in geometric progression.

The geographical position, latitude especially, of the pendulum station must be found, and the height above the sea level. The geological character of the formation on which the pendulum observatory is built should be stated. Should it be found impracticable to erect the observatory on land, it may be built on the ice, provided there be no sensible change of level of the ice, and no motion of any kind, the alteration of which is not extremely gradual, and provided also, that means can be employed for checking the clock's rate by astronomical observations. Should the pendulum be swung on ice, the depth of the sea at the place must be measured.

Twenty-four hours' observation with each pendulum would give an excellent result, provided the weather permit of a trustworthy determination of the clock's rate. The days on which the two pendulums are swung need not be consecutive.

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4. On the DETECTION of METEORIC (COSMICAL) DUST in the SNOW of ARCTIC REGIONS. By PROF. H. E. ROSCOE, F.R.S.

It has been shown by Nordenskiöld* that pure snow collected in the northern regions far distant from any source of dust, contains small black particles left behind when clean snow is melted. These black particles consist mainly of iron, but contain distinct quantities of cobalt, thus proving their non-terrestrial character. It would be very interesting to confirm these observations of the wide-spread depositions of fine cosmical dust by a repetition of the process adopted by Nordenskiöld, which consisted in collecting a large quantity of apparently pure snow, and allowing the same to melt, placing it, for this purpose on a clean sheet, spread out, and arranged so that the water should drain away, leaving the black particles on the sheet. These should then be carefully collected, when the greater part of the snow was melted, by placing the remaining snow in a bottle or glass, and allowing it to melt completely, when the black particles will sink to the bottom and the clear water can be poured off. Or the black particles can

* Poggendorff's Annalen, 151, p. 154.