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FURTHER PROOF OF THE ROTATION PERIOD OF VENUS.

By Percival Lowell.

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BY

PERCIVAL LOWELL.

Further Proof of the Rotation Period of Venus.

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(*Communicated by the Secretaries.*)

As the importance of the rotation period of the planet *Venus* is fundamental to the physical constitution of that planet's surface, and as the observations here are absolutely conclusive to the effect that the planet rotates once in an orbital revolution, I send the Society a fresh piece of evidence in the matter which to a certain class of minds is likely to have more weight than any number of drawings.

Drawings are not unnaturally open in the minds of the sceptical to a certain doubt. For what one has not seen oneself is always received, if not with disbelief, at least with something bordering on incredulity; for which reason drawings are always looked at somewhat askance, especially if the markings depicted appear to be of an unexpected sort. Only when everybody can see the markings for himself are the drawings credited, and then so far as the detection of the markings goes the thing is ancient history. No new thing ever *is* but always *has been* seen. For the sight is never recognised generally until its first recognition is a thing of the past.

As prefatory to what I am about to give, I may mention four points about the markings which are of importance.

1. The markings seen here differ in kind from previous ones. They are not shadings more or less definite, but perfectly distinct markings. I have seen them when their contours had the look of a steel engraving.

2. They are *invariably* visible. Nothing but a very unsteady air can obliterate them.

3. They have been seen by everyone at the observatory who has made any systematic observations of the planets, Mr. Drew, Miss Leonard, and the writer, as well as by others and the drawings of all the observers agree as well as, if not better than, do their drawings of *Mars*. Up to February 6 the number of drawings was 227, showing a very remarkable accordance.

4. This observatory was founded for the express purpose of getting the best atmospheric conditions, which is by far the most important factor in planetary observations; and what I state of the markings is not surmise, but certainty.

Now although the markings were so distinct as to preclude any possibility of illusion, it is not to be expected that they can

seem so to those who have not observed them. It is therefore advisable to offer evidence which excludes illusion on its face. This is the case with the piece I am now to present.

As a globe turns in consequence of a revolution, orbital or axial, it presents a constantly changing face. On this face any markings must therefore be seen in continually changed positions. If the supposed markings be illusory, the observer of such an illusion must continually be determining unconsciously its position afresh. For such a determination to be performed unconsciously requires—

1. That the observer should estimate unconsciously not a direct quantity but a trigonometric function of the same—namely, the sine of a varying angle, the angular position of the point in question from the centre of the disc.

2. That he should do the like for the sine of a second angle, the angular position of the terminator from the same point.

3. That he should unconsciously combine the two determinations.

It is, I think, evident that such a determination and consequent location would be beyond the automatic possibilities of the most mechanically constituted brain. And this to say nothing of the fact that all the estimates are to be made from the centre of the disc only visible in part; an estimate practically impossible, either unconsciously or consciously.

Lastly, even if the unconscious cerebration should succeed it would speedily be betrayed; for, last but not least, any error it might make—and it would be certain to make some error—would be cumulative. It would increase with the time, for the action, being automatic, would lie beyond the pale of correction. It would gain or lose like a clock when kept under unchanging conditions.

Illusion, therefore, would be quite incapable of producing any nice accordance in the successively observed positions of a point upon a revolving globe. Now it is a very remarkable accordance of the sort which constitutes the fresh evidence of the isochronism of the orbital and axial periods. On measuring the position of *Bilit* on all my drawings made from the time of its first recognition to the close of my observations at Flagstaff, previous to moving to Mexico and tabulating the values, a most interesting result appeared. The measurements were made as follows: First, I measured on the original drawings the relative position of *Bilit* with regard to the limb and the terminator. Then I calculated the position of the terminator theoretically, and then corrected for limit of visibility from my measures of the planet's equatorial and polar diameters. This rendered its position independent of eye estimate. From the two resulting angles I deduced the longitude of *Bilit* on the disc. Now if the axial rotation coincided with the orbital revolution the resulting longitude for *Bilit* should be constant. That it was so, and to a surprising degree of accuracy, the subjoined table will show:—

Venus. Bilit.

Date.					Longitude, Central Meridian.	Cor. Libration.	Longitude of Bilit from Centre of Disc.	Longitude, Bilit.	Means.	
	h	m	h	m	°	°	°	°	°	°
Oct. 1	4	0–	4	5	31·4	(−·7)	+6·4	37·8	38	37
	4	16–	4	21	31·4	...	+4·3	35·7	36	
3	2	27–	2	37	32·1	...	+4·9	37·0	37	35
	2	45–	2	51	32·1	...	+0·2	32·3	32	
8	2	0–	2	2	34·0	(−·6)	+2·0	36·0	36	36
	2	19–	2	21	34·0	...	+2·5	36·5	36	
	4	42			34·0	...	+2·2	36·2	36	
9	1	59–	2	28	34·4	...	−2·1	32·3	32	34
	2	48–	2	56	34·4	...	+1·0	35·4	35	
	4	50–	4	57	34·4	...	−0·6	33·8	34	
	5	3–	5	8	34·4	...	+0·0	34·4	34	
13	2	55–	3	4	35·9	(−·5)	+0·9	36·8	37	37
14	1	59–	2	12	36·2	...	−0·3	35·9	36	36
	3	13–	3	18	36·2	...	−1·1	35·1	35	
	3	50			36·2	...	+0·3	36·5	37	
15	0	5–	0	14	36·5	...	+0·5	37·0	37	36
	1	0			36·5	...	−3·2	33·3	33	
	2	10–	2	21	36·6	...	+1·2	37·8	38	
	3	48–	3	54	36·6	...	−0·7	35·9	36	
	4	57			36·6	...	+1·0	37·6	38	
16	0	15–	0	20	36·9	...	−4·9	32·0	32	34
	5	0–	5	5	37·0	...	−0·8	36·2	36	
17	3	30			37·3	(−·4)	−3·3	34·0	34	34
19	3	25–	3	34	38·0	...	+1·2	39·2	39	39
	5	5			38·0	...	+0·7	38·7	39	
20	1	0			38·3	...	+1·3	39·6	40	40
23	23	36–	23	45	39·4	...	−2·8	36·6	37	37
25	3	45			40·3	(−·3)	−3·2	37·1	37	37
	4	2–	4	11	40·3	...	−2·4	37·9	38	
28	3	45–	4	0	41·4	...	−4·6	36·8	37	37
	5	0			41·4	...	−4·0	37·4	37	
29	2	59–	3	17	41·7	...	−5·2	36·5	36	36
	4	50–	5	0	41·7	...	−6·0	35·7	36	
31	3	12–	3	32	42·5	(−·2)	−6·7	35·8	36	37
	5	3			42·5	...	−4·0	38·5	39	

Date.	Longitude, Central Meridian.	Cor. Libration.	Longitude of Bilit from Centre of Disc.	Longitude, Bilit.	Means.	
h m h m	°	°	°	°	°	°
Nov. 2 2 58	43·3	...	−5·4	37·9	38	38
3 4 2– 4 10	43·7	...	−4·1	39·6	40	40
4 3 10– 3 16	44·0	...	−6·2	37·8	38	
3 26– 3 37	44·0	(−·1)	−6·0	38·0	38	38
4 58	44·0	...	−5·3	38·7	39	
5 3 32– 3 38	44·4	...	−7·3	37·1	37	37
7 4 40– 4 49	45·1	...	−6·8	38·3	38	38
9 0 30	45·8	...	−9·5	36·3	36	
0 48– 0 54	45·8	...	−8·9	36·9	37	37
1 58	45·8	...	−7·5	38·3	38	

Whence m, the arithmetical mean, $= 36°$; r, the probable error of a single observation, $= 1°·3$; r_0, the probable error of the arithmetical mean $= 0°·2$.

The first column gives the date; the second the longitude of central meridian, the centre of the mean illuminated disc being taken as the zero meridian, and the longitude then corrected for libration; the third, in brackets, the amount of such libration; the fourth, the observed longitude of *Bilit* from the centre of the disc; the fifth, the resulting longitude for *Bilit* from the zero meridian; the sixth, the means.

Now as regards the longitude of *Bilit* on the surface of the planet the determination speaks for itself; but as regards its disclosure of the isochronism of the axial and orbital rotations the evidence it gives is even more conclusive than at first appears. For while it would appear that the longitude of the centre of the disc shifted its position during the observations through 14°·4 (45°·8 − 31°·4), this shift was only the shift of phase (less the libration), the shift as regards the Earth. The shift as regards the Sun, or change in heliocentric longitude of the planet, was in the interval not 14°·4 but 62°; and it is the latter taken in connection with the probable error of the longitude of *Bilit* that determines the degree of coincidence between the axial and orbital revolutions. As the probable error of the longitude of *Bilit* was 0°·2, the probable inaccuracy in the coincidence of the axial and orbital revolutions was therefore less than one three-hundredth of the whole. In other words, this is substantially absolute agreement; for the resulting determination of the longitude of *Bilit* is as close as that of the best observed longitudes on *Mars*.

I may add that observations of *Bilit* up to February 6, the last made, are in accordance with it.

Lowell Observatory, Mexico:
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