EPHEMERIS OF THE SATELLITES OF MARS FOR THE OPPOSITION OF 1881.*

BY H. S. PRITCHETT.

Owing to the greater distance from the Earth and the Sun, the present opposition of Mars will not be so favorable as the two preceding ones ; still these distances will be sufficiently small to permit many useful observations of physical phenomena, and, in the case of large telescopes, observations of the satellites. In one respect, the planet is much more favorably situated than in the former oppositions referred to, since it reaches this year a declination of 26° north, and hence will be observed at a much higher altitude. Physical observations, either measures or drawings, by amateur astronomers with good glasses, if carefully made and published, will be useful when finally reduced and compared.

During the last opposition several series of micrometric measures of the diameter of the planet were made by observers with good telescopes which showed curious differences both between themselves and when compared with the results obtained from the heliometer. Some of these measures seemed to show an appreciable flattening at the poles, while others showed no such flattening. It will be interesting to have these measures repeated during the present opposition, with a careful discussion of the sources and effects of personal error.

The satellites were observed last opposition with at least one of the large reflectors, with the great refractor at Washington, with the 15-inch refractor of the Harvard College Observatory, and with the 12¼ inch refractor of the Morrison Observatory, and were seen with other instruments. Before December 1st of this year the satellites will be considerably brighter than when last observed in 1879 with the Harvard College refractor, and also brighter than when last observed with the Morrison Observatory refractor. It seems possible, therefore, that they may be seen this year with telescopes even of moderate size.

The following ephemeris (derived from the elements of Prof. A. Hall, A. N. No. 2394) has been computed at the request of several observers, and will be found convenient for any who may wish to observe these satellites. In connection with the discussion of the relative merits of reflectors and refractors, excited by the observations of these satellites, it may be interesting to many to try if they can see them.

In the case of Deimos, the outer satellite, the ephemeris gives the Washington mean times of the east and west elongations, together with the position-angle and distance at the time of elongation. In the case of Phobos only the times of western elongations are given, as the revolution time is very short and the times of eastern elongations may be obtained by a simple interpolation. The aberration time is not included in the time given, but it may be taken from the table at the end if desired, the effect of the aberration being to make the satellites about five minutes late at each elongation. The relative brightness on different days may be obtained from the same table, taking the brightness on Nov. 20 as unity. As was shown by the observations of 1879, Prof. Hall's elements are very nearly correct, so that the correction to this ephemeris will be quite small.

* Read before the St. Louis Academy of Sciences.

DEIMOS.

DATE.	Direction of Elongation.	Wash. M. T.	Pos. Ang.	Dist.	DATE.	Direction of Elongation.	Wash. M. T.	Pos. Ang.	Dist.
		H. M.					H. M.		
Dec. 5	E	16 33	-----	----	Dec. 22	E	2 2	-----	----
6	W	7 42	-----	----		W	17 10	-----	----
	E	22 50	----	----	23	E	8 19	-----	----
7	W	13 58	-----	----		W	23 26	-----	----
8	E	5 7	-----	----	24	E	14 33	-----	----
	W	20 14	250°.2	52".4	25	W	5 41	-----	----
9	E	11 23	-----	----		E	20 49	-----	----
10	W	2 31	-----	----	26	W	11 57	-----	----
	E	17 39	-----	----	27	E	3 5	-----	----
11	W	8 47	-----	----		W	18 12	-----	----
	E	23 55	-----	----	28	E	9 20	-----	----
12	W	15 3	-----	----	29	W	0 28	-----	----
13	E	6 11	-----	----		E	15 36	-----	----
	W	21 19	249°.7	53".2	30	W	6 44	-----	----
14	E	12 27	-----	----		E	21 52	-----	----
15	W	3 35	-----	----	31	W	13 0	-----	----
	E	18 43	-----	----	Jan 1	E	4 7	-----	----
16	W	9 31	-----	----		W	19 15	245°.9	52".4
17	E	0 59	-----	----	2	E	10 23	-----	----
	W	16 7	-----	----	3	W	1 31	-----	----
18	E	7 15	-----	----		E	16 39	-----	----
	W	22 23	-----	----	4	W	7 47	-----	----
19	E	13 31	-----	----		E	22 55	-----	----
20	W	4 39	248°.5	53".7	5	W	14 3	-----	----
	E	19 47	-----	----	6	E	5 11	-----	----
21	W	10 54	-----	----		W	20 19	-----	----

PHOBOS.

DATE.	Wash. M. T.	Pos. Ang.	Dist.	DATE.	Wash. M. T.	Pos. Ang.	Dist.
	H. M.				H. M.		
Dec. 2	1 40	251°.5	20".3	Dec. 20	5 51	248°.5	21".5
	9 19	------	----		13 30	------	----
	16 58	------	----		21 9	------	----
3	0 37	------	----	21	4 48	------	----
	8 16	------	----		12 27	------	----
	15 56	------	----		20 6	------	----
	23 35	------	----	22	3 46	------	----
4	7 14	------	----		11 25	------	----
	14 53	------	----		19 4	------	----
	22 32	------	----	23	2 43	------	----
5	6 12	------	----		10 22	------	----
	13 51	------	----		18 1	------	----
	21 31	------	----	24	1 40	------	----
6	5 10	------	----		9 19	------	----
	12 49	------	----		16 58	------	----
	20 28	------	----	25	0 37	------	----
7	4 7	------	----		8 16	------	----
	11 46	------	----		15 55	------	----
	19 25	250°.4	20".9		23 34	247°.3	21".4
8	3 5	------	----	26	7 13	------	----
	10 44	------	----		14 53	------	----
	18 23	------	----		22 32	------	----
9	2 2	------	----	27	6 11	------	----
	9 41	------	----		13 50	------	----
	17 20	------	----		21 29	------	----
10	0 51	------	----	28	5 8	------	----
	8 39	------	----		12 47	------	----
	16 18	------	----		20 26	------	----
	23 57	------	----	29	4 5	------	---
11	7 36	------	----		11 44	------	----
	15 15	------	----		19 23	------	----
	22 54	------	----	30	3 3	------	----
12	6 33	------	----		10 42	------	----
	14 13	------	----		18 21	------	----
	21 52	------	----	31	2 0	------	----
13	5 31	------	----		9 39	------	----
	13 10	------	----		17 18	------	----
	20 49	249°.7	21".3	Jan. 1	0 57	246°.0	21".1
14	3 28	------	----		8 36	------	----
	12 7	------	----		16 15	------	----
	19 46	------	----		23 54	------	----
15	3 25	------	----	2	7 33	------	----
	11 4	------	----		15 13	------	----
	18 43	------	----		22 52	------	----
16	2 23	------	----	3	6 31	------	----
	10 2	------	----		14 10	------	----
	17 41	------	----		21 49	------	----
17	1 20	------	----	4	5 28	------	----
	8 59	------	----		13 7	------	----
	16 38	------	----		20 46	------	----
18	0 17	------	----	5	4 25	------	----
	7 56	------	----		12 4	------	----
	15 35	------	----		19 43	------	----
	23 14	------	----	6	3 23	------	----
19	6 53	------	----		11 2	------	----
	14 33	------	----		18 41	------	----
	22 12	------	----	7	2 20	------	----

DATE.	Brightness.	Semi-diam. Mars.	Aberration Time.
			M.
Dec. 2.0	1.15	7.3	5.3
8.0	1.21	7.5	5.2
14.0	1.24	7.6	5.0
20.0	1.26	7.7	5.0
26.0	1.24	7.7	5.0
Jan. 1.0	1.18	7.6	—5.1

From this it will be seen that Phobos, even on the most favorable date, will be only about 14″ distant from the limb of the planet. In 1877 this satellite was observed with the 12¼ equatorial of the Morrison Observatory when only 7″ distant. In the present opposition the satellite will be much fainter, but on the other hand the brightness of the planet will be considerably diminished. It seems possible, therefore, that this satellite may be seen with glasses of moderate size.

WASHINGTON UNIVERSITY, *Nov.*, 1881.

ELEMENTS OF QUATERNIONS.*

BY A. S. HARDY, Ph. D., Professor of Mathematics, Dartmouth College.

The American press may be expected to teem for the next twenty-five years with elementary treatises on quaternions, and as this work of Professor Hardy's is, we believe, the first of the series, it merits on this account the more attention. The book has a quite neat and attractive exterior, and the mechanical execution is very fair, though a few defects in letter press and engraving are noticeable. The experiment of printing small Alphas with an oblique line through them seems to be a failure. See pp. 45 and 60.

We cannot think the title happily chosen. There is an incongruity, if not positive impropriety, in assigning to a scant text-book intended for beginners in the class-room a name associated these fifteen years with the great and classic work of Hamilton. This however, is a matter of taste. One of the most important and difficult steps in the logical development of the calculus of quaternions, to which their inventor gave no little attention, is that of assigning a versor power to a vector, or of representing rotation by a symbol that had hitherto been appropriated exclusively to vection or translation. This, in the book before us, is disposed of in a few lines, when, even in a treatise where brevity must be studied, it is well worthy of as many pages. There is, also, throughout the work, an unfortunate fondness for the plane, where quaternions are often at a disadvantage, and where their real power and usefulness cannot be exhibited. The author may have intended to thus avail himself of the student's greater familiarity with the geometry of the plane, while introducing him to a new method; but it ought to be borne in mind that one of the chief claims quaternions have on the teacher of geometry is that they are specially fitted to free the student from the too prevalent restriction of his conceptions to two dimensions. A curious example of this tendency of the book is afforded near the end in applications to loci. Here the author systematically interprets equations as relating to the conic sections, when in reality they frequently relate to quadrics of revolution, the restriction to plane loci having been eliminated in the process of their formation; and when he comes "to transform the proceeding equations into the usual cartesian forms," instead of substituting a trinomial for the variable vector, he imposes a restriction to two dimensions by adopting a binomial, and of course comes out with a plane section in place of the surface itself. Notwithstanding these imperfections, Prof. Hardy has evidently studied his subject and written his book with some care, and with a view to the requirements and opportunities of those for whom it is intended, and it will doubtless prove useful as an introduction to quaternions.

ALEX. S. CHRISTIE.

U. S. COAST & GEODETIC SURVEY,
WASHINGTON, *November* 11, 1881.

* 8°, pp. VIII, 230. Boston, Ginn, Heath & Co., 1881.

LARGE TELESCOPES.

PROFESSOR EDWARD C. PICKERING makes the following suggestion in regard to mounting a telescope on a new plan. He says:—"The small amount of work accomplished with large telescopes has often been the subject of unfavorable comment. This criticism applies with especial force in America, where there are nearly a dozen telescopes having an aperture of a foot or over, besides two of the largest size now in course of construction, and two of twenty-six and twenty-four inches aperture which are unmounted and have been for several years perfectly useless. Among so many it seems as if one might be spared for a trial of the following plan, which, if successful, would produce at a small expense far more work than could be obtained with a mounting of the usual form.

Suppose that the telescope is placed horizontally at right angles to the meridian, and that a plane reflector inclined to its axis by 45° is placed in front of it. This reflector may revolve around an axis coinciding with that of the telescope. Such a mounting has been used in transit instruments, and gives much satisfaction in the meridian photometer of the Harvard College Observatory. The principal difficulty with a large instrument would lie in the flexure of the reflector. This difficulty has, however, been overcome in a great measure in reflecting telescopes by various ingenious devices. In the present case, since the reflector rotates only around one axis instead of two, the problem is much simplified. A slight motion at right angles of perhaps 5° would be a great convenience, as will be shown below, and would probably be insufficient to materially affect the flexure. It may be said that it is more difficult to make a plane surface than one that is curved. But the principal effect of a slight curvature would be to change the focus of the telescope, the aberration being much less than the effect of the varying flexure. Let us admit, however, that the best definition cannot be obtained, in considering the purposes to which such an instrument could be applied without disadvantage.

Many advantages will be apparent on comparing such a mounting with an equatorial. Great steadiness would be secured, since the mirror would be the only portion moved, and this would be placed directly upon a low pier. Instead of a large and expensive dome which is moved with difficulty, the mirror would be protected by a small shed, of which the roof could be easily removed. It would therefore be opened and ready for use in a very short time, and would quickly take the temperature of the surrounding air. The object-glass would be mounted directly upon a second pier, and, as it would not be moved, would be in very little danger of accident. The tube could be made of tin or other inexpensive material, as its flexure is of no importance. It could easily be protected from the changes of the temperature so troublesome in the tube of a large equatorial. If preferred it might even be exhausted of air, or filled with hydrogen, and the effect of the changes of temperature thus greatly reduced.

The eyepiece could be mounted on a third pier, and would be so far distant horizontally from the mirror and object-glass that there is no reason that it should not be inclosed in a room which may be warmed. The comfort in winter of working in a warm room will be appreciated by those who have used a large telescope in a cold climate. The result is sure to be an increased precision in