NOTES.

The Satellites of Mars.—Prof. Asaph Hall has discovered with the great Washington refractor two satellites to this planet, the outer on August 11, and the inner on August 17. This remarkable discovery was confirmed by Prof. Pickering at Cambridge, U.S., and by Messrs. Alvan Clark at Cambridgeport with the 26-inch refractor just made by them for Mr. McCormick.

From 13 observations of the outer satellite (from August 11 to 20), and from 8 observations of the inner (from August 17 to 20), Prof. Newcomb has computed approximate circular elements of the apparent orbits corresponding to distance of Mars [9·5930] for August 18.

	Outer.	Inner.
Major semiaxis	$82''\cdot5 \pm 0''\cdot5$	$33''\cdot0 \pm 1''$
Minor semiaxis	$27''\cdot7 \pm 2''$	
Pos.-angle of Apsides	$70^\circ, 250^\circ \pm 2^\circ$	$70^\circ, 250^\circ$
Inclin. of true orbit to ecliptic ...	$25^\circ\cdot4 \pm 2^\circ$	
Long. of ascending node	$82^\circ\cdot8 \pm 3^\circ$	
Passage through W. Apsis	Aug. $19^d\ 21^h\cdot7$	Aug. $20^d\ 14^h\cdot3$
Period of Revolution	$30^h\ 14^m + 2^m$	$7^h\ 38^m\cdot5 \pm 0^m\cdot5$
Hourly motion in Areocentr. Long.	$11^\circ\cdot907$	$47^\circ\cdot11$

Thus the outer satellite makes 4 revolutions in $5^d\ 1^h$, whilst the inner makes 3 in $22^h\cdot92$ or $1^h\cdot08$ less than a day. The rapidity of these movements is without precedent; for though Mimas revolves in $22^h\cdot6$, the Saturnian day is less than half this, viz. $10^h\cdot2$, whilst in the case of Mars the day is $24^h\cdot6$, and the outer satellite revolves once in less than a day and a quarter, and the inner $3\frac{1}{4}$ times in one day. The phenomena presented to an inhabitant of Mars must be very remarkable, for the outer satellite will remain above the horizon for two and a half days and nights, and the inner will rise in the west and set in the east twice in the course of the night. The lunar method of determining longitudes must be singularly easy with such a rapidly moving satellite, which is equivalent to the addition of a minute hand to the celestial clock, which, in our case, has to be read by the hour hand alone. But the lunar theory would probably present some difficulties from the large disturbing effect of the protuberant matter at the equator on such a near body.

One important result of the discovery is the determination of the mass of Mars, about which there was previously some uncertainty. Prof. Newcomb makes it 1-3,090,000th of that of the Sun, whilst the value adopted by Le Verrier in his tables is 1-3,000,000th.

The outer satellite has been seen at Paris Observatory with a 10-inch refractor, and at Greenwich several times with the 13-inch equatoreal. Mr. Wentworth Erck also has picked it up with a $7\frac{1}{2}$-inch Cooke. If these satellites have been in existence for ages, it seems strange that they have not been discovered before, especially at the opposition of 1862, when Mars approached the Earth as closely as this year; but it is naturally much easier to see an object that has once been found than to discover it independently. The satellites must be much smaller than any of the minor planets hitherto discovered. Can Mars have picked up a couple of very large meteorites, which have approached him closely? The supposition is highly improbable if the orbits are nearly circular, as the *relative* velocity of the hypothetical meteor must have been only about 1 mile per second at a point close to its perihelion.

Eclipse of the Moon.—Several correspondents have described the phenomena presented on August 23, which were less remarkable than those noted in the eclipse of February 27 last. We have been obliged to defer to our next No. an interesting paper by Mr. Plummer on the relative brightness of the eclipsed and uneclipsed Moon, which shows the exceedingly small portion of light which is refracted into the umbra.

At Greenwich the spectrum was examined with a view to detect traces of the effects of atmospheric absorption, for the only rays which can reach the eclipsed Moon must have passed through a great thickness of our atmosphere, by which they are refracted and scattered. Similar effects and a similar colour would be seen in the case of the Moon as of the Sun at sunset; and when it is considered how very various these latter are, according to the greater or less amount of cloud present, little surprise need be felt at the differences in the phenomena presented in different eclipses. Indeed, as the Sun's rays in the case of an eclipse pass through twice the thickness of air that they do at sunset, the effects might well be exaggerated. Since the maximum radius of the umbra of the Moon is less than 46′, whilst the rays which pass through our atmosphere are deviated through an angle equal to twice the ordinary refraction, which at the horizon is about 35′, a portion of the Sun's light will reach the Moon even in the centre of the umbra, unless it is cut off by clouds all round the edge of the Earth's disk. Now clouds low down will have very little effect; for there is much loss by absorption in the lower strata, and the refraction for rays which pass at a considerable height through our atmosphere will still be sufficient. This limiting height may easily be found by the consideration that the horizontal refraction at that elevation must be just sufficient to bend the rays into the centre of the umbra, *i. e.* through half of 46′ or 23′. Now the refraction at any height above the Earth's surface varies as the density; and the horizontal refraction for a pressure of 30 inches being 35′, the pressure which would give a horizontal refraction of 23′ must be $\frac{23}{35} \times 30$ in. or 19·7 in., corresponding to an altitude of about 11,500 feet.

Considering only rays which pass at this or a greater height through the atmosphere, and taking the case of a central eclipse at mid-totality, the extreme limb of the Sun would be the only part