Lastly: the relative visibility of some of the markings changes with their position with regard to the observer. For instance Somnus regio, which was almost invisible when in the centre of the disk, has grown more conspicuous as it has approached the limb. Anteros regio and Adonis regio have similarly become less salient on nearing the central meridian. Other markings under like conditions of position and illumination have not done so, but have remained as evident in the one aspect as in the other or, in Hermione regio, have been less conspicuous on nearing the limb. As of two markings occupying the same part of the disk, Hermione regio and Somnus regio for example, the one will change in one way, the other in an opposite manner, the changes cannot be a matter of obscuration. Secondly as the position of the markings has not shifted with regard to the Sun, the change cannot be intrinsic. It is due probably to a difference in the character of the rock or soil, greater or less roughness for example, in one region than in the other. That in these markings we are looking down on a bare desert-like surface is what the observations imply.

Lowell Observatory, 1896 Oct. 21.

Percival Lowell.

Zusatz. Die von Herrn *P. Lowell* eingesandten Zeichnungen, zu welchen nachträglich noch einige spätere, bis zum 9. November reichende hinzugetreten sind, sind zum grösseren Theil auf den beiliegenden Tafeln wiedergegeben.

Die nicht reproducirten Zeichnungen

Percival Lowell: Sept. 29 $3^h 30^m$ about, Sept. 29 $5^h 12^m$, Oct. 1 $4^h - 4^h 5^m$, Oct. 1 $4^h 16^m - 21^m$, Oct. 3 $2^h 27^m$ to 37^m, Oct. 3 $2^h 45^m - 51^m$, Oct. 5 $1^h 49^m$, Oct. 5 $2^h 47^m$, Oct. 5 $4^h 58^m$, Oct. 7 $3^h 54^m$, Oct. 7 $4^h 50^m - 5^h$, Oct. 8 2^h to $2^h 2^m$, Oct. 8 $2^h 19^m - 25^m$, Oct. 8 $4^h 42^m$, Oct. 9 $1^h 59^m$ to $2^h 28^m$, Oct. 9 $2^h 48^m - 56^m$, Oct. 9 $4^h 50^m - 57^m$, Oct. 9 $5^h 3^m - 8^m$, Oct. 16 $0^h 15^m - 20^m$, Oct. 16 $5^h - 5^h 5^m$, Oct. 17 $3^h 30^m$, Oct. 19 $3^h 25^m - 34^m$, Oct. 19 $5^h 5^m$, Oct. 20 1^h, Oct. 23 $23^h 36^m - 43^m$, Oct. 25 $3^h 45^m$, Oct. 25 $4^h 2^m - 11^m$;

W. L. Leonard: Nov. 4 $4^h 50^m$, Nov. 5 $3^h 20^m - 26^m$, Nov. 7 $4^h 34^m - 40^m$, Nov. 9 $0^h 32^m - 43^m$

stehen den Lesern zur Einsicht zur Verfügung.

Kr.

Libration of Venus and Mercury.

By *Percival Lowell.*

The librations affecting Venus and Mercury are of two kinds: true libration, due to the planet's own motion; and apparent libration, due to the motion of the observer on the Earth. The first kind alone can affect the amount of visible surface presented to him since only libration with regard to the Sun can produce any alteration in the parts of the planet's surface under illumination.

True libration may take place either in longitude or latitude; the former depending upon the eccentricity of the planet's orbit, the latter upon the inclination of the pole of rotation to that orbital plane. The amount of the latter we do not yet know exactly; but from the fact that observations here show no perceptible deviation from what would be the case were the pole perpendicular to the orbital plane, any possible inclination must be small. The libration in longitude is a perfectly definite quantity and amounts in the case of Venus at its maximum, to 47′ of arc; in the case of Mercury to 23° 39′. This is the extreme limit of swaying as the planet moves from apse to apse. As in the succeeding half of the orbit the libration takes place the other way the double of these values, or 1° 34′ for Venus and 47° 18′ for Mercury give the increase of longitudes shown us on either planet. It so happens, therefore, that the amounts disclosed beyond the 180° visible without libration are related in the following easily remembered manner: 47° for Mercury and twice 47′ for Venus.

From this it is evident that we can never see appreciably more than one-half of Venus; while we see in all about five-eighths of Mercury. What is more, we have no reason for supposing, as we have in the case of the Moon, that the hidden portions are like the visible ones. For in the case of the Moon, the Sun which is the great cause of surface changes acts equally on both. This is not the case with Mercury and Venus.

Lowell Observatory, 1896 Oct. 21.

Percival Lowell.

Projections on the Terminator of Mars and Martian Meteorology.

By *A. E. Douglass.*

In this note I desire to call attention to the importance and interest attached to observations upon irrregularities on the terminator of Mars by describing very briefly the observations made at the Lowell Observatory and the meteorological hypotheses which will account for them, and to mention the general conditions under which observations have already successfully been made.

In the opposition of 1894, the south pole of the planet was turned well towards us and we recorded nearly eight hundred irregularities of which some three hundred and fifty were projections. The frequent continuance of projections for several hours at the same latitude followed by an entire absence on the next night of any sign of a projection in that locality, lead us to believe that they are due to clouds forming at greatly varying altitudes, at or very near the moment of the departure of sunlight. Their form then is that of a bank whose upper surface touches the ground at the sunset line and which extends toward the night side continuously in a nearly horizontal direction, straight away from the sun, becoming higher and higher as it gets farther from the terminator. Whether, toward the outer extremity, the under surface of the cloud bank reaches the ground or not it is of course impossible to say. From certain special observations it seems probable that at very low altitudes this condensation can take place at least half-an-hour before sunset, also that occasionally clouds last over night and appear on the sunrise terminator as cloud-masses at considerable altitude and separated from the surface, as if the lower masses of vapor had been precipitated. In the special case to which I have reference apparently the same vapor mass came to the sunrise terminator on two successive mornings. On the first morning it had an altitude of fifteen miles above the surface and on the second morning was only eight miles high, had changed some ten degrees of latitude, and was more spread out in longitude. The average vertical height of the top of the sunset cloud-bank observed in the month of July and August, 1894, was 4.4 miles. Upon the sunrise terminator in the following December, January, and February, it was 3.4 miles.

Upon investigating the distribution of projections in latitude we found a very marked accumulation of them between latitudes 40° and 50° south, which it seems best at present, at least, to associate in some way with the heat-equator of the planet. The season on Mars was just before the middle of the southern summer, and on a planet which has no oceans and is largely desert the heat-equator must sway much farther from the geographical equator than on the Earth, and reach its greatest distance more promptly. It is therefore reasonable to suppose that this maximum of vapor at about latitude —43° corresponds to our equatorial rainy belt which moves north and south with the sun. The concentration of cloud at this latitude during the months of July and August, 1894, would be sufficient to cover the zone between —40° and —50° to a mean depth of 2.1 miles. The cloud masses between —60° and +50° if spread evenly over the entire zone between those latitudes would produce a mean depth of 1800 feet. The sunrise terminator was less carefully observed but its quantity was only about one-third of this.

A certain class of projections of great height and appearing to extend well beyond the true limb appeared upon the terminator in the vicinity of either cusp.

The depressions which constituted the remainder of the eight-hundred irregularities and which were usually, but not always, over the dark markings, seem best explained by attributing them to the character of the surface, that is, to its lack of reflecting power under certain conditions; the frequent absence of the depressions being due to the presence of haze in the air, or mist condensing towards nightfall from that moisture which is usually assumed to exist in greater quantity in the dark regions than in the light.

The conditions under which these observations were made, consisted in, first, an atmosphere through which the limb and terminator could be seen as distinct lines. This great number was observed through a telescope of 18 inches aperture and 315.5 inches focus and almost entirely with a $^1/_2$ inch eye-piece giving a power of 617. A few were seen with a power of 420 ($^3/_4$ inch eye-piece). Unless the atmosphere is sufficiently good to allow the use of a power of 500 or 600 to advantage, probably very little can be done. During the chief part of the observations the diameter of the planet was between 11″ and 17″ and the phase angle — the angle at Mars between the Earth and Sun — was 37° to 47°. When this angle was less than 37° the number of irregularities decreased very rapidly.

In the present opposition of 1896 the north pole is turned slightly towards us and we have observed a line of conspicuous projections on the southern edge of the north polar white zone, that is, in general between latitudes +40° and +50°. The polar cap may be seen as a minute spot on the southern edge of this white zone. The white zone not being the polar cap, has therefore not been explained with certainty but this appearance of projections on its sonthern edge indicates that aqueous vapor is present in it. It seems probable that the white zone is a region so cold that clouds can form in large quantities in the daytime but that along its northern boundry the aqueous vapor requires the actual departure of sunlight before there is sufficient cold to produce condensation.

In this general view of Martian meteorology the function of convectional action seems to be to raise aqueous vapor up into the air but not by this means to produce clouds to any great extent in the daytime as on the Earth. This to some degree is what we should expect because the atmosphere on Mars decreases in density on ascent with only one-third the rapidity of our own. The strong convectional currents near the heat-equator raise the vapor which in the southern summer is derived from the melting of the south polar cap. In the late southern autumn (of the present opposition) this has not been observed to nearly so great an extent either owing to its approach to the southern cusp or because of an actual decrease in the water supply; while on the other hand we do get a cloud sheet stretching north from latitude +50° and on the southern edge of this enough moisture and yet enough heat to produce condensation and yet limit it to the time of sunset.

Such in brief is the present stage of the study of irregularities on the Martian terminator and our understanding of their significance. We hope that their importance in the investigation of meteorology upon a neighboring planet will incite all those who can spare the time to attempt something in this interesting subject.

Lowell Observatory, Flagstaff, Arizona, 1896 Oct. 22. *A. E. Douglass.*