A more detailed account of this work will be published upon its completion.

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NEW MEASUREMENTS OF PLANETARY RADIATION AND PLANETARY TEMPERATURES

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For some years the Bureau of Standards has been conducting investigations of the application of instruments and methods of radiometry to various fields of research. One of the most interesting and useful fields appears to be the application of these instruments to certain astronomical problems.

During the past summer further tests of new radiometric instruments were made at the Lowell Observatory, Flagstaff, Arizona. The outstanding results of this investigation are as follows:

By means of a series of transmission screens of water, quartz, glass and fluorite, the radiation emanating from the planets, e.g., Mars, was separated into spectral components and the radiation intensities determined in the spectral regions of 0.3μ to 1.4μ, 1.4μ to 4.1μ, 4.1μ to 8μ, 8μ to 12.5μ, and 12.5μ to 15μ.

In this manner it was possible to determine the shape of the spectral energy curve of that part of the planetary radiation which is transmitted by our atmosphere and thereby form an estimate of the temperature of the effective radiating surface of the planet.

The 640 inch focus of the 40 inch Lowell reflector, which gave an image of the disk of Mars about 2 mm. in diameter, and thermocouples with receivers 0.23 mm. in diameter, were used in these measurements. This combination permitted the isolation of small areas on the planet's disk, and revealed hitherto unobserved and perhaps unexpected temperature conditions.

Radiometric measurements were made on Venus, Mars, Jupiter, Saturn, Uranus, the Moon and on terrestrial sources.

The results obtained verify our observations of 1922 showing that the planetary radiation emanating from Jupiter and from Saturn, and transmitted by our atmosphere, is very small, while the planetary radiation from Venus, Mars and the Moon is, relatively, very intense.

The planet, Venus, is one of the most interesting cases met with in radiometric observations. The surface of the planet is hidden by clouds, and its period of rotation is undetermined. Hence the thermocouple radiometer appears to be a means of obtaining further information on this question. For it was found that not only does the illuminated crescent show the presence of considerable planetary radiation, but the unilluminated part of the disk also emits a large amount of infra-red rays. This raises the question whether the radiation from the dark side of the planet is owing to a rapid rotation, say one to ten days. If the period of rotation is long (225 days) then it seems necessary to assume that the surface of Venus is still quite warm; although the highly selective condition of the planetary radiation at 8 to 12μ may perhaps be interpreted as owing to radiation of the hot gases convected from the illuminated over the dark part of the planetary surface. However, since this involves distances of 800 to 1000 miles over the surface, it seems difficult to reconcile this assumption with the radiative properties of the gases which probably constitute the atmosphere of Venus.

An interesting and important observation is that the intensity of the radiation emitted from near the south cusp in the present position of the planet, Venus—both for the dark and the illuminated regions—is greater than that emanating from corresponding points near the north cusp. This may be owing to differences in the surface conditions as previously observed on Mars. Then, again, it suggests an effect of insolation due to inclination of the axis of rotation, analogous to seasonal changes on Mars and the earth. Further radiometric observations, at different presentations of the planet's surface to the earth, will be required to test this question. If this is seasonal then it should be possible to establish the position of the axis of rotation of Venus.

The measurements on Mars were made on 24 nights and show that the bright regions are cooler than the dark regions; that the sunrise side of the planet is at a lower temperature than the side under the afternoon sun; and that the polar regions are cold—emitting no planetary radiation, and having temperatures down to perhaps —70°C. The temperature of the dark phase on the sunrise side of the planet is very low, probably down to —60°C.

An estimate of the temperature of the irradiated surface of Mars was obtained by two methods, as follows:

(1) By direct comparison of the spectral components of the planetary

radiation from Mars and the Moon, temperatures were obtained ranging from 5°C for the bright regions to 20°C for the dark regions, and

(2) By a comparison of the observed spectral components of the planetary radiation from Mars with similar data calculated from the laws of radiation of a black body, temperatures were obtained ranging from —15°C for the bright regions to 12°C for the dark regions.

The average of all the measurements gives a black body temperature of 8°C as compared with 18°C obtained by direct calibration against the Moon. As a whole, these temperature estimates are in accordance with other observations on Mars. The measurements indicate that the temperature of the brightly illuminated surface of Mars is not unlike that of a cool, bright day on this earth, with temperatures ranging from 5° to 15°C, or 40° to 60°F.

In the case of Venus and Jupiter the planetary radiation seems to be highly selective, and concentrated principally in the spectral component at $8 - 12.5\mu$. As a result, the infra-red temperatures are so inordinately high that this method of analysis seems impracticable in assigning temperatures, though useful in demonstrating selective emission. The water cell transmissions of Jupiter and Saturn indicate very low temperatures —60° to —80°C.

Uranus does not appear to emit planetary radiation, which is in harmony with other astronomical data.

Among the subsidiary investigations were measurements of the radiation from terrestrial sources such as buildings and distant mountain peaks under solar irradiation.

In connection with the theory of radiation exchanges, planetary radiation and planetary temperatures are discussed. It is shown that the symmetrical thermocouple-radiometer, as used in these investigations, always gives a positive response, whatever the temperature of the planet.

THE NUMBER OF FREE ELECTRONS WITH A METAL

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The question how many "free" electrons there may be within a piece of metal at a given temperature and how this number may vary with the temperature is one of much interest.

If I am not greatly mistaken, some distinguished physicists have entertained the idea that the Boltzmann equation

$$\frac{n}{n_0} = exp\left(-\frac{\phi}{RT}\right) \qquad (1)$$