LETTERS TO THE EDITOR

ASTRONOMY

Possible Luminescence Effects on Mercury

A GROWING body of evidence leads to the conclusion that luminescence effects occur on the lunar surface. Large intensity fluctuations on the Moon have been observed photographically by Kopal and Rackham[1], spectroscopically by Spinrad[2], and photometrically and polarimetrically by Gehrels *et al.*[3]. If the luminescence phenomena are induced by the solar wind (see Nash[4]), we might do well to look to other bodies in the solar system, which are similarly unprotected by an atmosphere, for evidence of luminescence.

Fluctuations in the intensity of portions of the surface of the planet Mercury were recorded by Antoniadi[5–7], who regarded the apparent obscuration of dark areas as the result of variable cloud cover. From his extensive observations with the 33-in. Meudon refractor, Antoniadi concluded that the density and extent of the 'clouds' varied with the changing distance of Mercury from the Sun, probably reaching maximum at perihelion and minimum after aphelion.

The newly derived rotation period of Mercury reported by Pettengill and Dyce[8] casts some doubt on the long-term changes reported by Antoniadi because his conclusions were based on the assumed 88-day period. Antoniadi[5] also noted, however, that changes occur on Mercury in a few tens of hours, and these cannot be simply explained in terms of the shorter rotation period. Other observers have also reported short-period changes on Mercury[9].

In the interval 1958–64, I made an extensive series of observations of Mercury with telescopes up to 82 in. in aperture. Visual studies of Mercury are difficult owing to the proximity of the planet to the Sun, but my observations generally confirm that variations in the intensity of certain of Mercury's markings can occur in a matter of several hours or days.

Fig. 1 shows four drawings of Mercury made in a nine-day period in 1963. Drawing *A* was made with a 36-in. reflector and the remainder with a 12-in. reflector, all in fairly good seeing conditions. Between the first and last drawings in Fig. 1, a darkening at the south cusp is apparent. Later drawings made as the crescent waned show the south cusp darkening further until it was the darkest region on the planet. The apparent change in the interval of three days between *A* and *B* may be related in part to the higher resolving power of the 36-in. telescope used for *A*.

The great similarities between the Moon and Mercury that have been pointed out by many investigators and the probable luminescence phenomena on the Moon may make it possible to interpret changes on Mercury as the effects of luminescence of the surface materials.

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[6] Antoniadi, E. M., *J. Brit. Astron. Assoc.*, **45**, 256 (1935).
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[9] McEwen, H., *J. Brit. Astron. Assoc.*, **45**, 240 (1935).

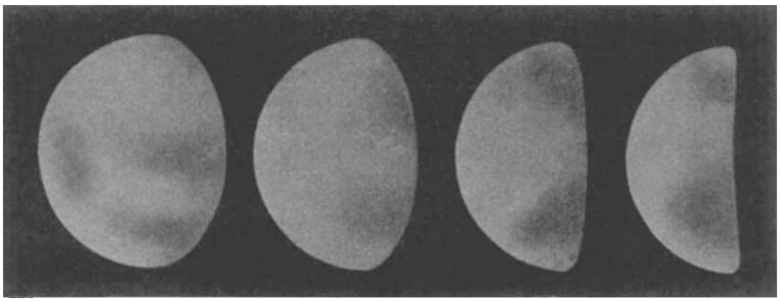

Fig. 1. Four drawings of Mercury. *A*, April 12, 1963, 2200 U.T.; *B*, April 16, 1963, 2030 U.T.; *C*, April 20, 1963, 2330 U.T.; *D*, April 21, 1963, 2330 U.T. South is at the top

GEOPHYSICS

Night-time Electron Temperatures in the Upper *F* Region

SATELLITE observations indicate that night-time electron temperatures in the upper *F* region are larger than the neutral gas temperatures. Willmore[1] estimates that an energy input $Q/n_e = 1{\cdot}5 \times 10^{-5}$ eV sec^{-1} is required at 650 km to maintain the temperature difference, and he suggests that bombardment by electrons of kilovolt energies might provide a suitable source. This communication shows that his suggestion is consistent with an upper limit on the precipitated flux of fast electrons set by optical observations[2].

The rate of electron heating due to bombardment by fast electrons is:

$$Q = p \frac{\mathrm{d}E}{\mathrm{d}x} v n_{ef} \text{ eV cm}^{-3}\text{ sec}^{-1} \qquad (1)$$

where $\mathrm{d}E/\mathrm{d}x$ is the energy loss in eV per cm path, p is the fraction of this loss converted to kinetic energy of the ambient electrons, and v is the velocity and n_{ef} the number density of the fast electrons. The energy loss due to collisions of fast electrons, of energy E eV, with ambient electrons is[3]:

$$\left(\frac{\mathrm{d}E}{\mathrm{d}x}\right)_e = \frac{2 \times 10^{-12}}{E} n_e \text{ eV cm}^{-1} \text{ for } E > 3 \text{ eV}$$

Using (1) and (2) and taking $p = 1$, $Q/n_e = 1{\cdot}5 \times 10^{-5}$ and $E = 10^3$, Willmore[1] obtained:

$$v n_{ef} = 7 \times 10^9 \text{ cm}^2\text{ sec}^{-1}.$$

The precipitated flux of fast electrons is:

$$J = \frac{1{\cdot}6 \times 10^{-12}}{\varphi} E v n_{ef} \text{ ergs cm}^{-2}\text{ sec}^{-1} \qquad (3)$$

where the factor $1{\cdot}6 \times 10^{-12}$ converts eV to ergs and where φ is equal to 1 if the fast electrons are incident vertically and all effects of the magnetic field are neglected. With $\varphi = 1$, $E = 10^3$ and $v n_{ef} = 7 \times 10^9$ we obtain $J = 10$ ergs cm^{-2} sec^{-1}. This cannot be correct, since[2] the optical observations of N_2^+ emissions indicate that J cannot exceed some 10^{-2} ergs cm^{-2} sec^{-1}. We consider two effects which greatly reduce the value of J which is consistent with the suggested mechanism of ionospheric heating.