

THE LUNAR IONOSPHERE by J. Benson, J. W. Freeman, H. K. Hills, M. Ibrahim and H. Schneider, Department of Space Physics and Astronomy, Rice University, Houston, Texas 77001.

As our knowledge of the lunar ion environment grows with the help of data from the ALSEP suprathreshold ion detector the complexity of the lunar ionosphere is becoming more apparent. We attempt here to summarize the salient features as we now understand them.

In addition to the extended, albeit transient, ionosphere arising from the ionization of the ambient lunar atmosphere we find the moon surrounded by a number of ion concentration regions or sheaths associated with lunar surface charge regions. These ion sheaths have locations about the moon which show symmetry relative to the line from the moon to the sun. Figure 1 illustrates the positions, surface ion number density and size of these sheaths.

On the dayside of the moon, where the ejection of photoelectrons leaves the lunar surface positively charged (1), there is the widely discussed photoelectron sheath (2) lying within a few meters of the surface.

As the lunar surface potential grows negative approaching the terminator from the dayside (3) we find atmospheric ions forming a tenuous sheath adjacent to the negative surface (4). This sheath extends farther from the surface than the dayside photoelectron sheath and probably also includes a region depleted of solar wind electrons. This is the only large scale region around the moon where the surface potential is negative and the ionizing radiation from the sun has direct access to the atmosphere.

It is also in the terminator region that the SIDE detector look directions and the flow directions of atmospheric ions accelerated by the solar wind $\vec{V} \times \vec{B}$ mechanism occasionally coincide. This makes possible the determination of the extended ionosphere ion scale height, mass composition, number density and ion return rates to the surface due to the $\vec{V} \times \vec{B}$ effect. The calculated ion return rates are of the order of 7 gms/sec (5). This number varies, however, as the atmospheric gas density changes due to solar wind changes and due to gas emanation from the moon.

Moving to the nightside where we expect the surface potential to continue to be negative we find an influx of ions of energy slightly below solar wind energy (6). The flux of these ions is two orders of magnitude below solar wind values. These ions may form the ion sheath for the nightside lunar surface potential. Their ultimate source is probably the solar wind. Figure 1 summarizes the properties of this ion region.

This discussion has been restricted to the moon in the solar wind. In the geomagnetic tail each of these components is altered drastically.

In summary, the moon in the solar wind is surrounded by at least four distinct charge regions. Figure 1 indicates the properties of these regions and their locations. Each of these plays a role in the physics of the lunar environment.

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Figure 1

Figure 1 illustrates the properties of the charge regions surrounding the moon in the solar wind. N_0 is the ion or electron number density at the lunar surface, H is the ionospheric scale height and λ_D is the Debye length or effective electrostatic screening length. The size of the charge regions is not to scale but is indicated roughly by λ_D .

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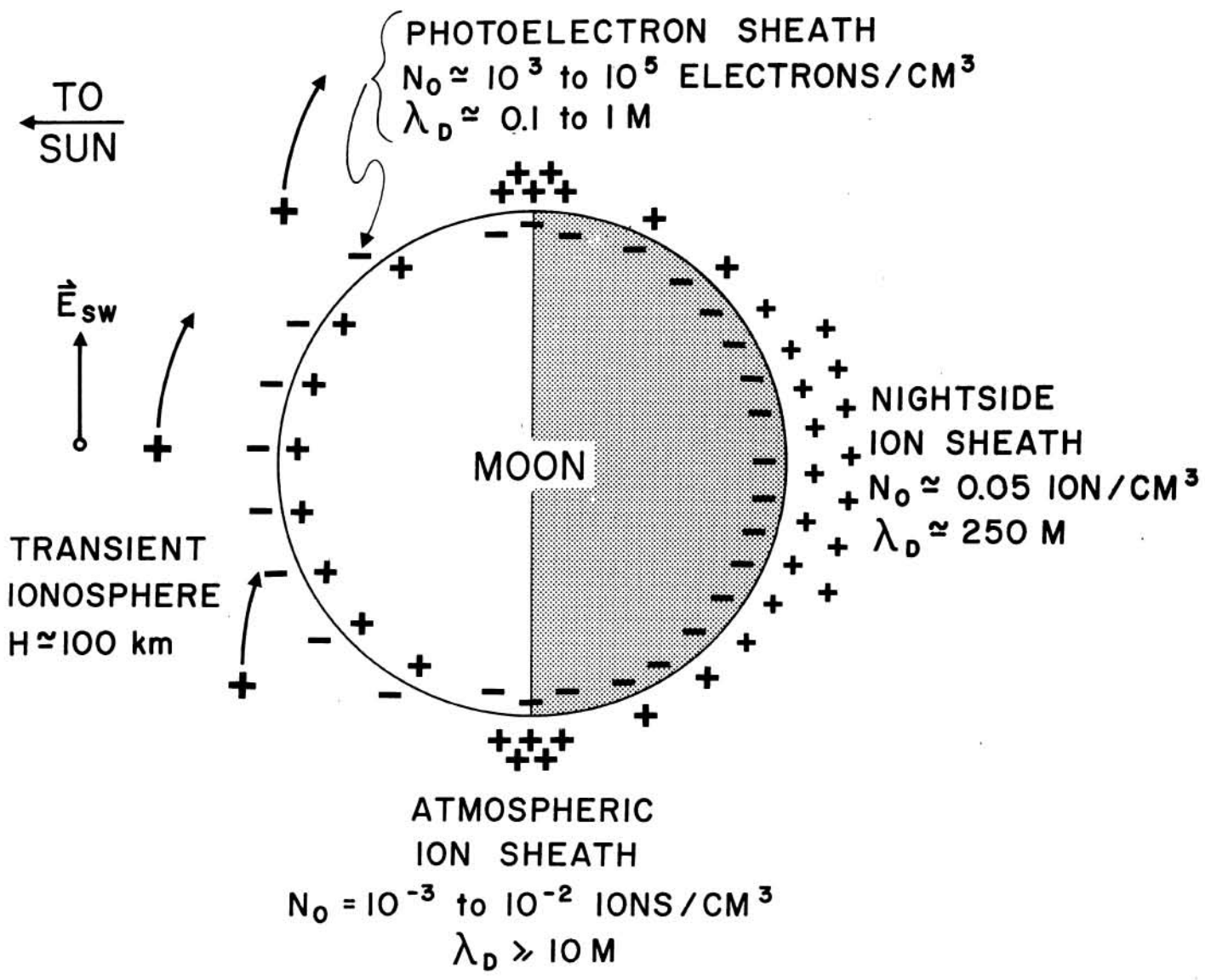


Figure 1