MEASUREMENTS OF LUNAR ATMOSPHERIC LOSS RATE, R. R. Vondrak, J. W. Freeman, and R. A. Lindeman, Department of Space Physics and Astronomy, Rice University, Houston, Texas 77001.

The primary method by which the lunar atmosphere is lost from the lunar environment is ionization by solar photons and solar wind followed by acceleration of the ions by the interplanetary electric field. This is an efficient escape mechanism even for those atoms which are too heavy to escape thermally. In this paper we present direct measurements of the loss rate of the lunar atmosphere to the solar wind. These data were obtained by the Suprathermal Ion Detector Experiment (SIDE), one of the ALSEP experiments on the Apollo 12, 14, and 15 missions.

Newly-formed atmospheric ions move under the influence of two electric fields: the interplanetary (solar wind $\vec{v}\times\vec{B}$) electric field and the lunar surface electric field. On the lunar dayside the interplanetary electric field drives approximately 50% of the atmospheric ions into space. Near the terminators the lunar surface potential becomes negative (1), resulting in acceleration and implantation of ions into the lunar surface.

Observations of atmospheric ions by the SIDE detectors have been previously reported (2). The SIDE detectors look radially outward from the lunar surface and, consequently, are able to detect atmospheric ions accelerated by the interplanetary electric field most easily at the sunset and sunrise terminators. Ions are consistently observed at the terminator regions on every lunation, with the three most recurrent ion mass/charge ranges being 20-26, 34-38, and 40-44 amu/q. These heavy ions are thought to be of atmospheric origin because their energy distribution matches that expected from acceleration by the uniform interplanetary electric field of ions originating from neutral atoms distributed exponentially in altitude. A typical atmospheric ion event observed 1.5 days before sunset had an average flux of $\sim 7\times 10^5$ ions/cm^2-sec in the energy range of 10-70 eV/q. The SIDE indicated that these ions had a mass in the range of 20-26 amu/q. Assuming proportionate fluxes over the entire lunar dayside due to interplanetary field acceleration leads to an estimated total atmospheric

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mass loss rate of approximately 5 gm/sec.

This measurement of the atmospheric loss rate can be used to establish constraints on the present source of the lunar atmosphere. Assuming that the lunar atmosphere is in equilibrium requires that the loss rate be balanced by a comparable source rate of ~5 gm/sec. If the source is the solar wind, then at least 1% of the solar wind protons must react chemically with the surface materials to form heavy molecules. If the source is lunar degassing, then the moon is presently about 10^{-5} as geologically active as the earth.

Limits to the size of the lunar atmosphere in the past can be established by computing the expected loss rates of denser lunar atmospheres. This requires consideration of the combined loss rate due to both thermal escape and interaction with the solar wind. By evaluating the minimum loss rate of lunar atmospheres of greater density than at present, an upper limit can be placed on the maximum size of the lunar atmosphere in the past.

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