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ELECTROSTATIC FIELDS IN A DUSTY MARTIAN ENVIRONMENT

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While there have been several studies suggesting the possibility of electrical activity on Mars, to date there have been no measurements to search for evidence of such activity. In the absence of widespread water clouds and convective storm systems similar to those on the earth and Jupiter, the most likely candidate for the creation of electrostatic charges and fields is triboelectric charging of dust, i.e., the friction between blown dust and the ground, and of dust particles with each other. Terrestrial experience demonstrates that electric fields 5–15 kV-m^{-1} are not uncommon in dust storms and dust devils in desert regions, where the polarity varies according to the chemical composition and grain size. Other familiar examples of dusty environments where this charge-separation mechanism operates, sometimes with lethal effect, are in grain elevators where grain-dust explosions occasionally occur, coal mines, factories where metal dust is prevalent, e.g. ammunition factories, and in volcano plumes. Martian dust storms seem unlikely to produce such extreme conditions as these, but simple laboratory experiments have demonstrated that modest electrostatic fields of roughly 5,000 V-m^{-1} may be produced, along with electrical spark discharges and glow discharges, in a simulation of a dusty, turbulent Martian surface environment. While the Viking landers operated for several years with no apparent deleterious effects from electrostatic charging, this may have been at least partly due to good engineering design utilizing pre-1976 electronic circuitry to minimize the possibility of differential charging among the various system components. However, free roaming rovers, astronauts, and airborne probes (e.g. balloons) may conceivably encounter an environment where electrostatic charging is a frequent occurrence, either by way of induction from a static electric field or friction with the dusty surface and atmosphere. This raises the possibility of spark discharges or current surges when subsequent contact is made with other pieces of electrical equipment, and the possibility of damage to modern microelectronic circuitry. Measurements of electrostatic fields on the surface of Mars could therefore be valuable for assessing this danger. Electric field measurements could also be useful for detecting natural discharges that originate in dust storms. This detection could be performed at distances ranging from 10s of km in the case of J-change-like discharge signatures, to planetary distances if there exists a global electrical circuit or Schumann resonance spectrum. Measurement of the horizontal electric (telluric) fields may also yield information concerning the dayside ionospheric convection electric field produced by the interaction of the solar wind with the Martian atmosphere.