Photoelectric Charging by Ultraviolet Light of a Lunar Dust Simulant in a Microgravity Environment

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Abstract

A microgravity experiment to test the electrostatic behavior of a lunar dust simulant being charged through the photoelectric effect will expand understanding of the charging characteristics of dust particles and may lead to a possible mitigation solution. With a design based upon Robert Millikan's oil-drop experiment, this experiment is designed to observe the interactions of a lunar dust simulant without the conflicting effect of a dominant gravitational force. The dust particles will be charged by means of a lamp capable of photon energies necessary to emit electrons by the photoelectric effect. In the presence of an axial electric field, the photo-electrons and charged dust will be attracted to opposing sides of a capacitor and the net charge over time as well as physical trajectories of the particles can be determined.

Experiment

One of the unexpected obstacles of the Apollo Missions was the presence of abrasive and adhesive lunar dust. Due to such factors as plasma electrons, bombardment from solar winds, and photoelectrons, the lunar dust (regolith) is charged. The purpose of this experiment is to better understand the charging of a lunar dust simulant due to an easily reproducible means of charging, the photoelectric effect.

Test Objectives:
1. To determine the net charge acquired by silica dust particles over time evolution due to electron emission from the photoelectric effect, under controlled experimental conditions.
2. To qualitatively observe the interactions between particles of a charged lunar dust simulant in microgravity.
3. To determine the effect of particle size in relation to net charge acquired.

Hypotheses:
1. Silicon dust particles will exhibit a charging effect when exposed to ultraviolet light containing sufficient minimum photon energy corresponding to the work function for the compound.
2. The rate of charging over time evolution will be constant due to the photoelectric effect being almost instantaneous, but the rate of acceleration of the particles will increase as greater charge is accumulated.

Experiment Apparatus:

Need for Microgravity:
1. Experiments on earth would require an unsafe voltage to balance the force of gravity with an electromagnetic force.
2. Microgravity environments better model conditions of dust interaction on lunar, Martian, and other sub-earth-gravity environment surfaces.

Results:

Unfortunately due to budget constraints, NASA was unable to allow the normal number of proposals to be accepted, meaning the experiment wasn’t performed.

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