FINAL REPORT

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Accomplishments

The purpose of the research was to continue developing an understanding of electrostatic phenomena in preparation for any future flight opportunities of the EGM experiment, originally slated for a 2004 Space Station deployment. Work would be based on theoretical assessments, ground-based lab experiments, and reduced-gravity experiments.

The ability to examine dipoles in the lab proved to be elusive, and thus, effort was concentrated on monopoles –how materials become charged, the fate of the charge, the role of material type, and so forth. Several significant milestones were achieved in this regard. In regard of the dipoles, experiments were designed in collaboration with the University of Chicago school district who had access to reduced gravity on the KC-135 aircraft. Two experiments were slated to fly last year but were cancelled after the Columbia accident. One of the experiments has been given a second life and will fly sometime in 2005 if the Shuttle flights resume. There remains active interest in the question of electrostatic dipoles within the educational community, and experiments using magnetic dipoles as a substitute are to be examined. The KC-135 experiments will also examine dispersion methods for particles as a verification of possible future techniques in microgravity.

Both laboratory and theoretical work established a number of breakthroughs in our understanding of electrostatic phenomena:

1) Triboelectric experiments on a wide variety (over 100) types of materials yielded a model of charge exchange and has enabled the explanation of net charge on triboelectrically-charged natural particulate clouds.

2) An alternative model to tribocharging will be shortly proposed for dust clouds. Currently, the tribocharging model is popular, but has a significant number of unanswered issues. Combined aerodynamic and electrodynamic models are pending publication with Bill Farrell and other colleagues.

3) A model has been developed that provides an excellent explanation for the cohesion of microgravity aggregates even after they were observed in USML to survive long after the charge dissipation period. This is the subject of a paper being submitted to *Geophys. Res. Lett.* Further insights into electrostatic behavior of grains in microgravity is also submitted to *Geophys. Res. Lett.*, and is currently under review.

4) Experiments were conducted to elicit information about Coulombic friction, but the tribocharging method employed proved too weak to establish meaningful results. Serendipitously, this led to a realization that there may be a threshold for tribocharging, or at least a very non-linear relationship between tribocharging kinetic energy and the magnitude of the resulting charge.

5) A model has been developed that explains compressive stresses caused by electrostatic forces in a closed vessel containing like-charged monopolar particulate material.

6) A fundamental issue in electrostatics is the magnitude of "pull-off" forces between two charged surfaces. An experimental method of determining this using the coefficient of restitution of materials has been proposed and is being followed up by research at a New Zealand university.

The concepts evolved in items 1, 2, 3, and 6 are to be submitted for publication in 2005.

Publications

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