EPSC Abstracts
Vol. 10, EPSC2015-427, 2015
European Planetary Science Congress 2015

Laboratory investigations of electrostatic dust lofting on comet and asteroid surfaces

X. Wang, J. Schwan, H.-W. Hsu and M. Horányi
Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80303, USA (xu.wang@colorado.edu)

Abstract

We conduct laboratory experiments to demonstrate that dust particles (mostly in the form of clumps) as large as > 100 microns are mobilized and lofted on a surface exposed to plasmas. The electric force on a dust particle due to plasma charging is found too small to overcome even the gravitational force. We propose a new so-called "patched charge model". The dust particles can collect secondary electrons (SEs) emitted from their neighbors, creating the patched charge in the shadowed areas of the plasma. The Coulomb force between dust particles is found significant. The total charge and electrostatic force may thus be largely enhanced. The effects of surface roughness and topology are also tested.

1. Introduction

Electrostatic dust lofting has been a long-standing problem that is related to many dust phenomena, including the lunar horizon glow, the dust ponds on asteroid Eros, and the spokes in the Saturn's rings. Recently, the COSIMA instrument onboard Rosetta spacecraft has collected dust particles larger than 50 microns (fluffy and many are the conglomerates of smaller dust particles) coming off Comet 67P /Churyumov–Gerasimenko. It is yet a puzzle how these dust particles are released from the comet surface. Electrostatic dust lofting may be partially responsible for this observation. However, the mechanism of the electrostatic dust lofting still remains a mystery. We conducted laboratory experiments to investigate the dust lofting due to the electrostatic force and its mechanisms.

2. Laboratory experiments

The experiments were performed in a cylindrical vacuum chamber. Plasmas were created by primary beam electrons emitted from a hot filament on the top of the chamber. The dust particles were spread on an electrically floated graphite surface in the center of the chamber. A video camera was used to record the dust moves and hopping trajectories. Various sizes (25 – 70 microns in diameter) and shapes (irregular and spherical) of dust particles were used in the experiments. Potentials above the dust surface were measured.

Our preliminary results showed that the dust particles were moved and lofted when the primary electron energy was 120 eV. The lofted particles were mostly in the form of clumps with the diameter as large as 160 microns. However, set a similar or larger magnitude of the electric field above the dust surface, the dust particles did not move when the primary electron energy was 35 eV. The potential measurements indicate that the SEs were emitted from the dust surface in the former case. It is also known that the SEs emitted from a dust particle can be collected by its neighbors. We propose a new so-called "patched charge model". The bottom areas on a dust particle surface are in the plasma shadow and can collect the SEs emitted from its neighbors while the top area is charged mainly by plasma electrons. The total charge (i.e., the sum of these patched charge) can significantly increase, depending on the surface morphology. The Coulomb force between dust particles was also found significant in addition to the electric force due to the sheath electric field. The total electrostatic force will be largely enhanced. It was also found that the dust particles resting on a rougher surface were lofted more easily.

Acknowledgements

This work was supported by the NASA/SSERVI's Institute for Modeling Plasma, Atmospheres and Cosmic Dust (IMPACT).