

Numerical SPIS-Dust Modelling of Plasma – Lunar Lander Interactions

I.A. Kuznetsov¹, A.V. Zakharov¹, E. Seran², S.L.G. Hess³, F. Cipriani⁴, G.G. Dolnikov¹, A.N. Lyash¹, I.A. Shashkova¹

1 Space Research Institute of the RAS, Moscow, Russia, email: kia@iki.rssi.ru

2 Laboratoire Atmospheres, Milieux, Observations Spatiales, Paris, France

3 French Aerosp. Lab., ONERA, Toulouse, France

4 ESTEC/TEC-EES, Noordwijk, The Netherlands

Abstract

One of the complicating factors of the future robotic and human lunar landing missions is the influence of the dust. Meteorites bombardment has accompanied by shock-explosive phenomena, disintegration and mix of the lunar soil in depth and on area simultaneously. As a consequence, the lunar soil has undergone melting, physical and chemical transformations.

Recently we have the some reemergence for interest of Moon investigation. The prospects in current century declare USA, China, India, and European Union. In Russia also prepare two missions: Luna-Glob and Luna-Resource. Not last part of investigation of Moon surface is reviewing the dust condition near the ground of landers. Studying the properties of lunar dust is important both for scientific purposes to investigation the lunar exosphere component and for the technical safety of lunar robotic and manned missions.

The absence of an atmosphere on the Moon's surface is leading to greater compaction and sintering. Properties of regolith and dust particles (density, temperature, composition, etc.) as well as near-surface lunar exosphere depend on solar activity, lunar local time and position of the Moon relative to the Earth's magnetotail. Upper layers of regolith are an insulator, which is charging as a result of solar UV radiation and the constant bombardment of charged particles, creates a charge distribution on the surface of the moon: positive on the illuminated side and negative on the night side. Charge distribution depends on the local lunar time, latitude and the electrical properties of the regolith (the presence of water in the regolith can influence the local distribution of charge).

On the day side of Moon near surface layer there exists possibility formation dusty plasma system. Altitude of levitation is depending from size of dust particle and Moon latitude. The distribution dust particle by size and altitude has estimated with taking into account photoelectrons, electrons and ions of solar wind, solar emission. Dust analyzer instrument PmL for future Russian lander missions intends for investigation the dynamics of dusty plasma near lunar surface. PmL consists of three parts: Impact Sensor and two Electric Field Sensors.

One of the tools, which allows to simulate the dust emission from the Moon and asteroids, its transport, deposition and its interaction with a lander, is the SPIS-DUST (Spacecraft Plasma Interaction Software) code which based on Particle-in-Cell (PiC) method.

This paper presents first results of SPIS-DUST modelling of the interaction between the lunar plasma environment, regolith and a lander. The model takes into account the geometry of the Luna-Glob lander, the electric properties of materials used on the lander surface, as well as Luna-Glob landing place. Initial conditions were chosen based on the current theoretical models of formation of dusty plasma exosphere and levitating charged dust particles.

Acknowledgements

This work was supported by the Russian Scientific Foundation (the grant № 17-12-01458).