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Investigation of lunar dusty exosphere during the future Russian lunar missions

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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 magneto tail. 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 lender missions intends for investigation the dynamics of dusty plasma near lunar surface. PmL consists of three parts: Impact Sensor and two Electric Field Sensors.

Dust Experiment goals are:

1) Impact sensor to investigate the dynamics of dust particles near the lunar surface (speed, charge, mass, vectors of a fluxes) a) high speed micrometeorites b) secondary particles after micrometeorites soil bombardment c) levitating dust particles due to electrostatic fields. PmL instrument will measure dust particle impulses. In laboratory tests we used: min impulse so as 7·10-11 N·s, by SiO_2 dust particles, 20-40 m with velocity about 0,5 -2,5 m/s, dispersion 0.3; max impulse was 10-6 N·s with possibility increased it by particles Pb-Sn 0,7 mm with velocity 1 m/c, dispersion 0.3. Also Impact Sensor will measure the charge of dust

particle as far as 10-15 C (1000 electrons). In case the charge and impulse of a dust particle are measured we can obtain velocity and mass of them.

2) Electric field Sensor will measure the value and dynamics of the electric fields near the lunar surface. Two Electric Field Sensors both are measured the concentration and temperature of charged particles (electrons, ions, dust particles). Uncertainty of measurements is 10%. Electric Field Sensors contain of Langmuir probes. Using Langmuir probes near the surface through the lunar day and night, we can obtain the energy spectra photoelectrons in various periods of time.

PmL instrument is developing, working out and manufacturing in IKI. Simultaneously with the PmL dust instrument to study lunar dust it would be very important to use an onboard TV system adjusted for imaging physical properties of dust on the lunar surface (adhesion, albedo, porosity, etc), and to collect dust particles samples from the lunar surface to return these samples to the Earth for measure a number of physic-chemical properties of the lunar dust, e.g. a quantum yield of photoemission, which is very important for modeling physical processes of the lunar exosphere.