LUNAR DUST LIFTING EXPERIMENT (LDLE) for ESA Lunar Lander

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We have been developing an experiment entitled Lunar Dust Lifting Experiment for ESA's Lunar Lander. The main purpose of this experiment is to study the lunar dust properties and the mechanisms that charge and transport lunar dust particles. The LDLE consists of two electric field sensors, a cylindrical Field Mill (FM) developed by SPRL/US and a Short Dipole Antenna (SDA) developed by LATMOS/France. These two instruments use different principles to measure electric fields. The FM measures the current between the two sections of a rotating cylinder split into two along its axis, while SDA measures the potentials of two spatially separated electrodes. These two principles of measurements cause differences in performance between the two sensors. The FM is capable of measuring dc electric fields ranging from ~10 to 10^6 V m^{-1}. The SDA is capable of measuring electric fields of up to few tens of kV m^{-1} from dc to few kHz with high sensitivity, about ~4 μV $Hz^{-1/2}$.
The performance of the LATMOS/SPRL LDLE package allows simultaneous measurements of electric fields at few cm above the lunar surface (where electric fields are expected to be of the order of tens of kV m^{-1}) and at few tens of cm (up to few m) above it (where the electric field could be expected much weaker). The SDA's sensitivity to weak signal and quick variations will allow studies of the mass/charge properties of lunar dust particles and the analysis of electrical perturbations associated with dust-dust, dust-electrode and dust-lander impacts.
We plan to validate the LDLE concept during flights with stratospheric balloons in regions with intense and variable electric fields, like those found in auroral regions during the magnetospheric storms.

LDLE : scientific motivations

- Open Questions:

- What are the origins of surface charging?
  - UV solar emissions (dayside) ?
  - difference in thermal velocities of solar wind plasma (night-side) ?
    $V_{Te} >> V_{sw} >> V_{Tp} >> V_{orb}$
  - meteorites ? energetic particles ? gammas? etc.

- Regolith is dielectric (10^{-14} Mo/m) : what are the consequences?
  - non-uniform charge distribution ?
  - charge accumulation at the surface irregularities ?
  - micro-discharges ?
  - electric field which is not perpendicular to the lunar surface ?

- What are the sources of the electric field ?
  - surface charge ?
  - space charge in the Lunar sheath ?
  - charge separation at the terminators ?
  - surface irregularities

- What are the conditions of dust levitation ?
  - local time ?
  - solar activity ?
  - properties, irregularities of surface ?

- What are the dust features ?
  - charge ? size?
  - conditions of levitation ?
  - height distribution ?
  - triboelectric charging ?