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SELMA: a mission to study lunar environment and surface interaction

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SELMA (Surface, Environment, and Lunar Magnetic Anomalies) proposed for the ESA M5 mission opportunity is a mission to study how the Moon environment and surface interact. SELMA addresses four overarching science questions:
(1) What is the origin of water on the Moon?
(2) How do the "volatile cycles" on the Moon work?
(3) How do the lunar mini-magnetospheres work?
(4) What is the influence of dust on the lunar environment and surface?

SELMA uses a unique combination of remote sensing via UV, IR, and energetic neutral atoms and local measurements of plasma, fields, waves, exospheric gasses, and dust. It will also conduct an impact experiment to investigate volatile content in the soil of the permanently shadowed area of the Shakleton crater. SELMA carries an impact probe to sound the Reiner-Gamma mini-magnetosphere and its interaction with the lunar regolith from the SELMA orbit down to the surface.

The SELMA science objectives include:
- Establish the role of the solar wind and exosphere in the formation of the water bearing materials;
- Determine the water content in the regolith of the permanently shadowed region and its isotope composition;
- Establish variability, sources and sinks of the lunar exosphere and its relations to impact events;
- Investigate a mini-magnetosphere interaction with the solar wind;
- Investigate the long-term effects of mini-magnetospheres on the local surface;
- Investigate how the impact events affect the lunar dust environments;
- Investigate how the plasma effects result in lofting the lunar dust;

SELMA is a flexible and short (15 months) mission including the following elements SELMA orbiter, SELMA Impact Probe for Magnetic Anomalies (SIP-MA), passive Impactor, and Relaying CubeSat (RCS). SELMA is placed on quasi-frozen polar orbit 30 km x 200 km with the pericenter over the South Pole. Approximately 9 months after the launch SELMA releases SIP-MA to sound the Reiner-Gamma magnetic anomaly with very high time resolution <0.5 s to investigate small-scale structure of the respective mini-magnetosphere. At the end of the mission the passive impactor impacts the permanently shadowed region of the Shakleton crater >10 sec before SELMA and SELMA orbiter flies through the resulted plume to perform high resolution mass spectroscopy of the released volatiles. The data are downlinked to ground and RCS. RCS stays on orbit for 2 more hours to downlink the complete data set.

SELMA orbiter payload include:
Remote sensing instruments
- Infrared and visible spectrometer with spectral range 400 – 3600 nm;
- Wide angle and transient phenomena camera to detect meteoroid impact (>100 g)
- Moon UV imaging spectrometer with spectral range 115 - 315 nm
- ENA telescope with an angular resolution $< 10^\circ$
In-situ instruments
- Lunar ion spectrometer $M/\Delta M > 80$
- Lunar scattered proton and negative ion experiment:
- Lunar electron spectrometer
- Moon magnetometer
- Plasma wave instrument
- Lunar dust detector: M>10-15 kg
- Lunar exospheric mass spectrometer: $M/\Delta M > 1000$

SIP-MA payload includes:
- Waves and electric field instrument
- Impact probe ions and electrons spectrometer
- Impact probe magnetometer
- Context camera
Passive 10 kg copper spherical impactor