Subject offered for a contract starting October 2017

SUBJECT TITTLE: ***Probing planetary regoliths via infrared thermal sounding: the case of Saturn's satellites, Mercury and Lunar polar deposits.***

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Host lab/ Team : : **IPGP- Planétologie comparée et Sciences Planétaires – UMR71**

Financing: Doctoral contract with teaching assignment

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Presentation of the subject: (1 or 2 pages)

Atmosphereless planetary surfaces, like skins, are revealing by their current state, physico-chemical processes in play at various space and time scales. Cosmic grinding by meteoritic bombardment, which has been generating several tens-meter-thick regoliths since 4.6 Gyr, does not erase, still, neither the scars of radiation and bombardments of highly energetic particles, which shape the structure of regoliths at centimeter or decimeter depths nor those of geological phenomena which have been acting recently or much further away in the past. The exploration of our Solar System over the last decade has gathered a wealth of unique data on these surfaces, that of Mercury, of the Moon, of small bodies, dwarf planets, asteroids, or of satellites of the giant planets. These surfaces have been observed with unprecedented spatial resolution, from the topographic to the mesoscopic scales, over a wide range of wavelengths.

In particular, infrared spectrometers, detecting part or most of their thermal emission have been systematically put onboard spacecraft such as Lunar Reconnaissance Orbiter, Dawn, Cassini or Rosetta. The temperature measurements over diurnal, seasonal cycles, or even during eclipses, can help probing the surface at different depths. The way temperatures change with time help us understanding the thermo-physical properties of the regolith. Typical depths range from millimeters or centimeters for Saturn icy satellites to few tens-of-cm scales for lunar or hermean regoliths. Thermal sounding is then perfectly adapted to study the depths impacted by space weathering or subsurface layers of ice.

We have recently proposed a model of heat transfer in planetary regoliths (Ferrari et Lucas 2016) which yields, from those thermal cycles, the regolith properties within the probed skin depths, such as porosity, grain sizes, quality of contacts, or even the ice phase. It is also able to reproduce the small thermal inertias observed in the Solar System with a normal porosity as expected in grains pilings. It has shown also that radiative conductivity can be prominent in icy regoliths, even at low temperatures.

It is proposed here to follow an approach combining analysis of thermal data, thermal modelling, and model inversion to study two questions, dealing with different phenomena and surface types, either icy or rocky: analyzing thermal anomalies observed by the CIRS-Cassini spectrometer on the surface of the saturnian icy satellites and the thermal signature of subsurface icy polar deposits in the permanently shadowed areas at Mercury and Moon poles, with the help of the LRO-Diviner data and in the perspective of the next first orbital insertion of a thermal spectrometer, MERTIS, onboard the Bepi-Colombo spacecraft. In the first case, we'll aim at constraining with diurnal (a day or so) and seasonal cycles (2004-2017), together with some eclipses (hours long), the regolith properties of the thermal anomalies observed on the leading faces of Mimas, Dione and Rhea. It will give indications on the actual consequences (sintering of grains, decreasing porosity, change in ice phase, etc) of the bombardment of these specific faces by energetic electrons embedded in the Saturn magnetosphere. In the second case, DEMs of the polar regions of Mercury and the Moon will be coupled with this model in order to test whether it is able to explain the very low thermal inertias observed there or to estimate the impact subsurface water ice layers on thermal cycles that will be observed at these high latitudes.