Internship position @ ISAE-SUPAERO

Interacting with diverse planetary surfaces

Internship supervisor: Naomi Murdoch (ISAE-SUPAERO, Toulouse)

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Scientific domains: Planetary science, Geotechnical Engineering, Physics of granular materials

Expected start date: February to May 2024.

Application deadline: Applications will be accepted until the position is filled.

Application process: Candidates should contact the supervisor with a letter of motivation and CV. Please include the contact details of two referees.

Summary: Given the growing number of space missions involving interactions with regolith covered planetary bodies, knowledge about how the extra-terrestrial surface materials behave is increasingly important for robotic and human planetary exploration. Planetary scientists also need this information to correctly interpret the observed behaviour of planetary surfaces. The extra-terrestrial environment provides a significant challenge for understanding the behaviour of granular materials (soils or regolith). The gravitational acceleration varies over several orders of magnitude from Earth to asteroids, the smallest targets of planetary exploration. This changes the weight (normal stress) applied by an object on the planetary surface and influences the behaviour of the grains themselves. Frictional properties (shape and roughness) of surface materials are expected to vary drastically due to the different regolith formation and evolution mechanisms at play: comminution and thermal fracture produce very angular grains whereas aeolian processing and saltation lead to much rounder particles. Differences in grain-grain surface friction, the grains' shapes, geometrical interlocking, and size distribution will all influence the resistance of a grain to movement and affect the behaviour of the material.

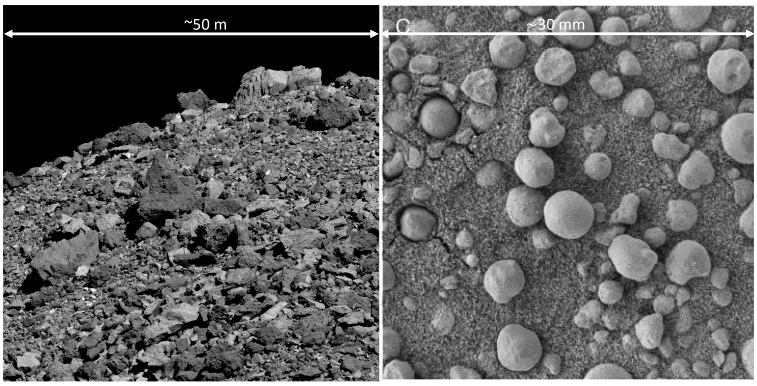

Figure 1. Left - Particles on surface of asteroid Bennu, Image Credits: OSIRIS-Rex/NASA/Goddard Space Flight Center/University of Arizona. Right – Particles on the surface of Mars, Sullivan et al., (2011).

The goal of this internship is to further our understanding of the response of diverse planetary surfaces to dynamic penetration testing. The results are directly relevant to the upcoming ESA Hera and JAXA MMX space missions.

The specific tasks of the internship will be to perform terrestrial gravity penetration experiments and compile a database of experimental data for different surface simulants, to analyse the penetrometer data to determine the influence of surface materials on the penetration behaviour, and to develop a physical model to explain the experimental data. The student is also expected to contribute to the development of future instruments to be used in low-gravity facilities.

The student will be part of the Space Systems for Planetary Applications (SSPA) team at ISAE-SUPAERO. The team is primarily focussed on the development of space missions and the associated technologies for the geophysical exploration of the Solar System.

Figure 2 : The dynamic penetrator that will be used in the laboratory experiments (e.g., Murdoch et al., 2017, 2021).

Desired Profile: Candidates should be in the final year of a Masters degree, ideally in geotechnical engineering, planetary science or physics but other backgrounds will also be considered. The candidates should be rigorous, autonomous and also enjoy working as part of a small team. Previous experience in experimental work would be an advantage.

PhD Opportunity: There is a possibility for the student to continue with a PhD thesis after the internship. The PhD will involve terrestrial and low-gravity experiments using a new facility that is currently under construction at ISAE-SUPAERO, and will also make use of Discrete Element Method (DEM) simulations (e.g., Sunday et al., 2020, 2021, 2022) to complement the experimental analysis.

References: *Murdoch et al., (2017) MNRAS 468, 2, 1259–1272; Murdoch et al., (2021) MNRAS 503, 3460–3471; Sullivan, R. et al., (2011) Journal of Geophysical Research: Planets, 116(E2); Sunday et al., (2020) MNRAS 498, 1062–1079; Sunday et al., (2021), Astronomy & Astrophysics; Sunday et al., (2022), Astronomy & Astrophysics.*