Professorship of Lunar and Planetary Exploration
TUM School of Engineering and Design
Technical University of Munich

Master thesis/term project

Numerical modelling of water stability and dynamics on the Moon: a physical parameter study

Theoretical / numerical thesis
Start date: As soon as possible

Topic:

The study of volatile elements on airless bodies provides key insights into the formation and evolution of the Solar System. The presence of water on the Moon was confirmed through a variety of remote sensing data, indicating the existence of a lunar water cycle driven by solar wind and impact bombardment, as well as migration and escape mechanisms [1]. We have implemented a solver that solves the equations of heat transfer, mass transfer, and sorption mechanics to study the Moon's diurnal water cycle. With it, we can observe the thermal-pumping effect that drives water migration in lunar soil [2]. The project would involve using this solver to investigate the relationships between various uncertain physical parameters and the water adsorption profile, with the end goal of generating a regional map of adsorbed water on the Moon.

Tasks:

- Thorough literature review of physical parameters, their value ranges, and confidence intervals.
- Sensitivity analysis study of the solver to these physical parameters.
- Implementation of physical tests to make sure that conservation of energy is preserved.
- Processing of LOLA slope dataset.
- Coupling solver results with regional parameters, to generate adsorption lunar maps.
- Optional: Implementation of new modelling components of the solver, and the study of their impact.
- Optional: solver implementation improvements (coupling with implicit libraries, implementing stretched grids. . .)

Requirements:

- Strong programming skills, ideally with experience in HPC and familiarity with the Julia programming language.
- Basic knowledge of numerical programming and differential equations, or a strong interest in learning it.
- Interest in space and planetary scientific research.

Supervisor:

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Bibliography:

[1] Reiss, P. (2024). Exploring the lunar water cycle. Proceedings of the National Academy of Sciences, 121(52), e2321065121.

[2] Schorghofer, N., & Aharonson, O. (2014). The lunar thermal ice pump. The Astrophysical Journal, 788(2), 169.