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PhD Project Description

Shaking Worlds: Exploring Planetary Quakes and Deep Interiors

Supervisors

Lead Supervisor: Asst. Prof. Doyeon Kim

Co-supervisor(s): TBD based on the specific focus of each PhD project

Research Group

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Project Summary

Understanding what lies beneath the surface of other worlds is one of the most exciting frontiers in planetary science. By listening to how planets and moons "vibrate" and "ring," we can uncover clues about their internal structures, dynamics, and long-term evolution. This is the power of planetary seismology — a field that has transformed our knowledge of the Moon and Mars, and is now expanding across the Solar System.

From the pioneering Apollo lunar seismic experiments (1969–1977) to the recent InSight mission on Mars (2018–2022) and Chandrayaan-3's lunar seismometer (2023), each mission has opened a new window into the deep interiors of planetary bodies. We now stand at the threshold of a second golden age of planetary seismology, with a new wave of missions — including Chang'e-7 (Moon, 2026), Farside Seismic Suite (Moon, 2027), Artemis-3 (Moon, 2027), and Dragonfly (Titan, 2030s) — set to revolutionize our understanding of how planets work from the inside out.

This research theme offers an opportunity to be part of this thrilling era. You will explore the seismic signatures of planetary processes such as landslides, meteorite impacts, tectonic and volcanic activity, and use cutting-edge techniques to image planetary interiors — from the shallow crust to the deep regions near the core–mantle boundary. The project's scope is highly multidisciplinary, combining data analysis, numerical modeling, and mission planning to help shape the future of planetary exploration.

Research Context and Objectives

Please contact Asst. Prof. Doyeon Kim (doyeon.kim@imperial.ac.uk) for details on specific objectives of each PhD project. Projects within this theme may include, but are not limited to, the following: (i) Use existing seismic waveform data from Mars and the Moon to build on and improve previous models, applying quantitative modeling and numerical simulations to explain the observed seismic signals; (ii) Explore how quakes, impacts, landslides, and other dynamic events[5] shape and reveal the inner workings of planets, providing insights into their physical behavior and the global tectonic processes that govern these planetary bodies; (iii) Leverage Earth-based analogs and multi-geophysical approaches by integrating methods such as ground-penetrating radar, seismology, gravity, magnetics, and electromagnetic sounding to strengthen interpretations of planetary structures and processes; (iv) Develop new analytical and computational techniques that can be directly applied in upcoming planetary missions to advance seismic data analysis and interior modeling.

Collaborators and partners on the project:

Collaborations and partnerships will be determined flexibly for each PhD project, depending on the specific research focus and objectives.

Further reading:

Recent example publications from our group related to planetary seismology include:

Charalambous et al., (2025). Seismic evidence for a highly heterogeneous martian mantle. *Science*, 389(6763), pp.899-903. https://doi.org/10.1126/science.adk4292

Kim et al. (2025). A new lunar crustal thickness model constrained by converted seismic waves detected beneath the Apollo seismic network. *Geophysical Research Letters*, 52(13), p.e2024GL114506. https://doi.org/10.1029/2024GL114506

Zhang, et al. (2025). Subsurface dielectric permittivity and structure along Chang'e-4 rover's 42-lunar-day traverse using diffraction focusing methods. *Journal of Geophysical Research: Planets*, 130(9), p.e2024JE008903. https://doi.org/10.1029/2024JE008903

Dahmen, et al. (2024). Revisiting Martian seismicity with deep learning-based denoising. *Geophysical Journal International*, 239(1), 434-454. https://doi.org/10.1093/gji/ggae279

Kim et al. (2023). Structure along the Martian dichotomy constrained by Rayleigh and love waves and their overtones. *Geophysical Research Letters*, 50(8), p.e2022GL101666. https://doi.org/10.1029/2022GL101666

Kim et al. (2022) Surface waves and crustal structure on Mars. *Science*, 378(6618), pp.417-421. https://doi.org/10.1126/science.abq7157

Posiolova et al. (2022) Largest recent impact craters on Mars: Orbital imaging and surface seismic co-investigation. *Science*, 378(6618), pp.412-417. https://doi.org/10.1126/science.abq7704

Stähler et al. (2021). Seismic detection of the martian core. *Science*, 373(6553), pp.443-448. https://doi.org/10.1126/science.abi7730

Knapmeyer-Endrun et al. (2021). Thickness and structure of the Martian crust from InSight seismic data. *Science*, 373(6553), pp.438-443. https://doi.org/10.1126/science.abf8966

Khan, et al. (2021). Upper mantle structure of Mars from InSight seismic data. *Science*, 373(6553), pp.434-438. https://doi.org/10.1126/science.abf2966

Who are we looking for?

We are looking for motivated hard hard-working students with a strong background in earth and planetary sciences, seismology, physics, mathematics, or engineering, and a curiosity to explore how planets work from the inside out. A willingness to learn computational methods as needed. A willingness to learn and apply computational and numerical methods is essential.

Through these projects, candidates will develop advanced numerical modeling and data analysis skills, gain hands-on experience with cutting-edge planetary science tools, and build expertise at the intersection of geophysics and space exploration.

Candidates will be encouraged and supported to present their work at international conferences and publish in high-impact journals, fostering both scientific and professional growth. The projects also offer opportunities for collaboration with other research groups within and beyond ESE, creating a dynamic, interdisciplinary research environment.