Wednesday Talk Series

Date: Wednesday, November 26, 2025

Time: 04:00 PM-5:00 PM

Venue: Mithal Hall, Department of Earth Sciences, IIT Roorkee

Adapting Passive Seismic Techniques for the Lunar Data: Autocorrelation, Multi-Component Analysis and Data Constraints.

Speaker: Adityam Rai

Abstract: The deployment of single-station seismometers on Mars (InSight) and the Moon (Chandrayaan-3) requires a shift in methodology from network-based terrestrial seismology to the analysis of data from isolated 3-component (3C) sensors. In these data-starved environments, classical seismic interferometry cannot rely on spatial averaging of the wavefield and must instead depend solely on temporal averaging to retrieve the Green's function. This study presents a methodological framework designed to adapt interferometric techniques to the specific constraints of the lunar environment, which is characterized by sporadic noise sources, extreme thermal cycling, and discontinuous data recordings. The feasibility of retrieving crustal structural information from the ambient noise field recorded by the Instrument for Lunar Seismic Activity (ILSA) onboard Chandrayaan-3 is evaluated. A robust processing pipeline is utilized to mitigate the effects of non-stationary noise and data gaps. Specifically, the potential of Phase Autocorrelation (PAC) to estimate zero-offset crustal reflectivity is investigated, and multi-component cross-correlations (Z-X, Z-Y) are leveraged to constrain shallow regolith properties via Rayleigh wave ellipticity curves. Furthermore, given the extreme diurnal thermal forcing on the lunar surface ($\Delta T > 200$ K), the theoretical and practical detectability of relative velocity variations (dv/v) using Coda Wave Interferometry (CWI) as a proxy for dynamic stress changes in the regolith is assessed. Finally, a validation strategy is outlined that triangulates results from autocorrelation, Horizontal-to-Vertical Spectral Ratios (HVSR), and polarization analysis to distinguish potential subsurface signals from site-specific artifacts.

Keywords: Seismic Interferometry, Phase Autocorrelation, Regolith, Coda Wave Interferometry (CWI)

Brief introduction: Adityam Rai is an MHRD research scholar in the Department of Earth Sciences, IIT Roorkee, working under the supervision of Prof. Simanchal Padhy. He completed his B.Tech in Geoscience Engineering from UPES, Dehradun in 2018, followed by a three-year stint as an oil and gas consultant at L&T, Mumbai. He returned to academia, earning an M.Tech in Earth Sciences (Geophysics) from IISc, Bengaluru in 2023. His doctoral research focuses on monitoring heterogeneous media using passive seismic interferometry in terrestrial and lunar environments.