URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Radio Instrument Package for Lunar Ionospheric Observation: A Concept Study

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The lunar ionosphere is a ~100 km thick layer of electrically charged plasma surrounding the moon, and was identified as one of eight key areas of focus for lunar science by the United States National Research Council in "The Scientific Context for Exploration of the Moon" [1]. While the existence of the lunar ionosphere has been established for decades, its structure, dynamic behaviour, and formation mechanisms remain unresolved due to extremely limited observational capacity and significant discrepancies in existing results [e.g. 2,3]. An enhanced observational picture of the lunar ionosphere and improved understanding of its formation/loss mechanisms is critical for understanding the lunar environment as a whole and assessing potential safety and economic hazards associated with lunar exploration and habitation. To address the high priority need for observations of the electrically charged constituents near the lunar surface, we introduce a concept study for the Radio Instrument Package for Lunar Ionospheric Observation (RIPLIO). RIPLIO would consist of a multi-CubeSat constellation (at least two satellites) in lunar orbit for the purpose of conducting "crosslink" radio occultation measurements of the lunar ionosphere, with at least one satellite carrying a very high frequency (VHF) transmitter broadcasting at multiple frequencies, and at least one satellite flying a broadband receiver to monitor transmitting satellites. Radio occultations intermittently occur when satellite-to-satellite signals cross through the lunar ionosphere, and the resulting phase perturbations of VHF signals may be analyzed to infer the ionosphere electron content and high-resolution vertical electron density profiles. This concept study presents preliminary simulations of crosslink lunar radio occultations, in addition to preliminary system and operational requirements for a potential RIPLIO mission. As demonstrated in this study, RIPLIO would provide a novel means for lunar observation, with the potential to provide long-term, high-resolution observations of the lunar ionosphere with unprecedented pan-lunar detail.

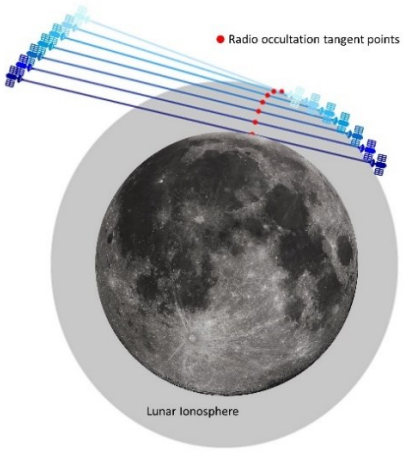

Figure 1. Illustration of a crosslink radio occultation of the lunar ionosphere.

References

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