R009-20
A 会場 ： 11/25　 AM1（9:15-10:45）
10:00〜10:15:00

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Ray Tracing for Titan's Ionospheric Occultation of Saturn Radio Emissions: Implications for JUICE Mission

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Titan possesses a highly variable and complex ionosphere influenced by both solar radiation and interactions with Saturn's magnetosphere. While previous estimates of Titan's ionospheric electron density have been derived from radio occultation and in situ measurements, photoionization by solar UV radiation is considered the dominant ionization mechanism. The accumulation of new observational data is expected to further advance our understanding of its detailed structure and temporal variability.

Yasuda et al. (2024) proposed a new method for deriving ionospheric electron densities of planetary satellites using planetary auroral radio emissions. This method was successfully applied to Galileo Plasma Wave Investigation (PWS) data of Jovian radio emissions, providing new insights into the ionospheric structures of Ganymede and Callisto, both of which have tenuous neutral atmospheres.

In this study, we extend this method to Titan, which has a dense atmosphere, by analyzing the occultation of Saturn Kilometric Radiation (SKR) using data from the Cassini Radio and Plasma Wave Science (RPWS) instrument. The SKR emission was modeled using Exoplanetary and Planetary Radio Emission Simulator (ExPRES) developed at Paris Observatory, and the propagation paths of the radio waves were computed with ray tracing simulations.

As a result, we successfully constrained both the peak electron density and the width of Titan's ionosphere from data acquired during the Cassini Titan-15 (T15) flyby. The peak densities were estimated to be 3200 cm^{-3} on the dayside and 1090 cm^{-3} on the nightside, consistent with previously reported day-night asymmetries. Additionally, by comparing the frequency range of the observed SKR with ExPRES model predictions, we provided a new constraint on the beaming angle of Saturn's radio emissions.

The polarization data from RPWS played a critical role in this analysis. It not only allowed us to constrain the beaming angle, but also enabled us to determine whether the radio sources were located in Saturn's northern or southern hemisphere. This represents a major advancement over previous applications to Jovian satellites based on Galileo observations, which lacked polarization measurements. Since the upcoming JUICE mission will carry the Radio & Plasma Wave Investigation (RPWI) instrument with polarization capabilities, our methodology can be directly applied to future Jupiter Icy Moons Explorer (JUICE) observations.

We are currently extending this analysis to other Titan occultation events. This study highlights the potential of planetary auroral radio emissions as a new diagnostic tool for probing the ionospheres of icy moons and contributes to the development of observation strategies for the JUICE mission.