



Inter-satellite Radio Science System for Small Spacecraft

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Future interplanetary space missions will be designed to enable outstanding scientific investigations in the Solar System. Geodetic and geophysical experiments will significantly contribute to the scientific return of these missions by providing unique information on the internal structure of celestial bodies (*e.g.*, planets, moons, and asteroids). An accurate determination of planetary and moons gravity fields is fundamental to retrieve the properties of their interiors, which preserve crucial records of the formation and evolution of the Solar System. Gravity investigations have mainly been conducted through deep space tracking of interplanetary spacecraft. Earth's ground stations (*e.g.*, NASA's Deep Space Network) acquired radio tracking data for navigation and scientific purposes. The processing of these radio science data enabled the estimation of the gravity field of celestial bodies visited by deep space probes. These geophysical results led to important scientific findings. However, an in-depth characterization of planets and moons internal properties will require enhanced accuracies of future gravity measurements.

An alternative approach to map gravity fields consists in precise inter-satellite tracking with dual- or multi-spacecraft configurations. This technique was successfully applied by the dual-orbiter missions Gravity Recovery and Climate Experiment (GRACE), and Gravity Recovery and Interior Laboratory (GRAIL) to retrieve extremely high-accurate measurements of short-wavelength gravity anomalies of the Earth [1] and the Moon [2], respectively. These missions were only focused on gravity investigations since the inter-satellite radio tracking instrumentation significantly limited the available spacecraft mass and power. Therefore, a GRAIL-like mission to survey poorly explored worlds in the Solar System would be feasible with medium-size spacecraft (*i.e.*, ~200-kg mass) only.

This study is focused on a preliminary design of a novel radio science system that allows to collect accurate inter-satellite tracking data between small spacecraft. The components of this instrument are based on the solid heritage of existing technologies developed for deep space tracking. Its compact architecture is well-suited to yield highly accurate radiometric measurements from multidisciplinary missions in the Solar System [3].

References

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