Paper ID: 31459
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SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration (5)

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RADIO SCIENCE INVESTIGATIONS WITH THE JUNO MISSION

Abstract

Juno is a NASA mission to Jupiter launched in 2011, that will complete 33 high-eccentricity orbits around the gas giant, 25 of which dedicated to the probing of the planet's gravity field. This will be accomplished by utilizing precise Doppler tracking of the spacecraft by the Deep Space Network (DSN), enabled by the onboard Ka-band Translator (KaT) provided by the Italian Space Agency. The instrument is characterized by a frequency stability, measured in terms of Allan deviation, of 4x10-16 at 1000s integration time. The exploitation of a coherent Ka-band radio link (34 GHz uplink, 32.5 GHz downlink) is less susceptible to noise from the inter-planetary plasma. The telecommunication subsystem enables telemetry and commanding operations at X-band via a small deep space transponder, which operates at 7.2 GHz uplink and 8.4 GHz downlink. The simultaneous operation of both X- and Ka-band links allows a cancellation of plasma noise to about 75 The primary observable for the precise reconstruction of the spacecraft trajectory is the spacecraft range rate, relative changes in velocity along the line-of-sight. All Doppler measurements will be carried out in a two-way mode where the microwave signal is transmitted from the ground station utilizing a highly stable frequency standards such as hydrogen masers, received, amplified and coherently re-transmitted back by the on-board transponder to the same station. Expected accuracies on two-way range-rate measurements are about 0.003 mm/s or better, at 1000 s integration time. Of the many antennas of NASA's DSN, only one 34-m station (DSS-25) located at the Goldstone complex (California) is currently equipped for transmission and reception at Ka-band frequencies. Furthermore a water-vapor radiometer-based Advanced Media Calibration (AMC) system was installed near DSS-25 for the calibration of the wet component of Earth tropospheric noise. Numerical simulations of the experiment, entailing the generation of synthetic Doppler data, have been carried out using statistical approaches for the prediction of the expected performances in terms of determination of Jupiter's gravity moments. The least-squares reduction of the data returns an estimate of the coefficients of the spherical harmonics expansion. The accuracies of the gravity reconstruction depend on the number of parameters needed to absorb all the relevant gravity perturbations. The Juno gravity science investigations will address major open questions regarding the deep interior structure of the planet, among which the determination of the core size and the depth of the zonal winds.