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A Decade of Cassini Radio Science Observations of the Saturn System

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Abstract

The Cassini Radio Science Subsystem (RSS) on board the Cassini spacecraft has returned a wealth of information about the Saturn system during its first decade of observations. The instrumentation is quite versatile, operating in up to three wavelengths simultaneously (S, X, and Ka bands), and tied to a very stable frequency standard either on board or uplinked to the spacecraft from a maser-controlled transmitter as part of the Deep Space Network. Over the course of the mission so far, dozens of occultations by Saturn's rings have been observed, revealing the detailed structure and scattering properties of the rings at sub-km resolution. A companion set of atmospheric occultations by Saturn and Titan have provided detailed vertical profiles of the temperature of the neutral atmosphere and the electron density of the ionosphere, spanning a range of latitudes and a significant fraction of a Saturn season. Operatin in a bistatic mode, the RSS instrument has transmitted signals to the surface of Titan at the specular point such that the reflected signal is received on the earth, revealing the dielectric properties of Titan's surface. Finally, exquisitely accurate measurements of the gravitationally induced Dopper shift of the RSS transmitted signal have provided measurements of the gravitations fields and probes of the internal structure of several of Saturn's major satellites, most notably indicating the presence of sub-surface oceans on both Titan and Enceladus. During the upcoming three-year finale of the Cassini mission, highlights of the remaining RSS science objectives include high-SNR measurements of the rings at their most favorable geometry of the entire Cassini orbital tour, and a set of close orbital fly-bys of Saturn itself, enabling the determination of the planet's gravitational field to an accuracy comparable to that expected for the Juno mission to Jupiter.

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