

The Comprehensive Reconstruction of the Cassini Tour, the Orbits of Saturn and its Satellites, and the Gravity Field of the Saturnian System

Robert Jacobson, Duane Roth, Julie Bellerose and William Folkner
Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA, USA
(robert.jacobson@jpl.nasa.gov)

Abstract

We have reconstructed the path of the Cassini space-craft from the time of its insertion into orbit about Saturn to the time of its plunge into Saturn's atmosphere. The reconstruction relies upon a common set of planet and satellite ephemerides and gravity parameters. Our dynamical model includes the gravitational effects of Saturn's rings and of tides raised on Saturn by the satellites. The data set used to determine the Cassini trajectory, the Saturn orbit, the satellite orbits, and the gravity field contains: Cassini Doppler tracking, radiometric range, optical navigation and Imaging Science observations, and very-long baseline interferometry (VLBI), Pioneer 11 Doppler tracking, Voyager Doppler tracking, radiometric range, and optical navigation imaging, Earth-based and Hubble Space Telescope satellite astrometry, satellite mutual events (occultations and eclipses), Earth-based planet and satellite transits, Saturn ring stellar occultations observed from the Earth, with the Voyager 2 Photopolarimeter (PPS), and with the Cassini Visual and Infrared Mapping Spectrometer (VIMS) and Ultraviolet Imaging Spectrograph (UVIS), Saturn ring occultations measured with the Voyager 1 and Cassini Radio Science Subsystem (RSS). In this paper we detail our reconstruction and discuss our findings concerning the masses of Saturn and the satellites, the gravity fields of Saturn, Enceladus, Dione, Rhea, and Titan, and the orientation and precession of Saturn's pole.

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