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The Orbits of the Regular Jovian Satellites

R. A. Jacobson
Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA
(robert.jacobson@jpl.nasa.gov/Fax:+01-818-354-5904)

Abstract

At the conclusion of the *Galileo* Mission we produced ephemerides for the Galilean and four inner Jovian satellites, Amalthea, Thebe, Adrastea, and Metis [1]. The satellite orbits were determined by fitting a data set that included Earthbased astrometry through 2001 and data acquired by the *Pioneer*, *Voyager*, *Ulysses*, *Cassini*, and *Galileo* spacecraft. The spacecraft tracking data provided additional information on the Jovian system gravity parameters. In preparation for the *Juno* mission currently enroute to Jupiter, we have been developing new ephemerides from updated satellite orbits. As before, the orbits are determined through a comprehensive data fit which also redetermines the gravity parameters and spacecraft trajectories to be consistent with the revised satellite orbits.

Our standard model for the orbits, both satellite and spacecraft, is a numerical integration of their equations of motion. We include the gravitational effects of the point mass mutual interactions of Jupiter, the Galilean satellites, and Amalthea (Thebe, Adrastea, and Metis are assumed to be massless), the effects of an oblate Jupiter, and perturbations from the Sun and planets. For our new orbits we also take into account the effects of tides raised on Jupiter by the satellites. Lainey et al. [4] have pointed out the importance of the tidal accelerations. The spacecraft are also affected by nongravitational forces, e.g., solar radiation pressure, trajectory correction maneuvers. These forces are discussed by several authors [2, 3, 5].

Our current data set is an expansion of that used previously. We have extended the Galilean satellite Earthbased astrometry back to 1891 and forward to 2013 and the inner satellite astrometry back to 1892 and forward to 2002. We added the Galilean satellite mutual events from 2003 and 2009, the Galilean satellite eclipse timings from 1878 to 2013, and the Earthbased radar ranges to Ganymede and Callisto measured in 1992. We also augmented our spacecraft data set with imaging acquired by the *New Horizons* spacecraft when it flew through the Jovian system in February 2007.

In this paper we present the results of our latest determination of the satellite orbits and associated gravity parameters. We compare the orbits and gravity parameters to those that we found previously and our tidal parameters to those of Lainey et al.. We comment on possible future modifications and enhancements before our ephemeris delivery to the *Juno* Project for orbital operations.

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