The Gravity Field of the Jovian System and the Orbits of the Regular Jovian Satellites

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In support of the Galileo mission, we have been developing ephemerides of the Galilean and inner Jovian satellites based on numerical integrations of their orbits fit to a variety of Earthbased and spacecraft observations. A necessary byproduct of this effort is improved knowledge of the Jovian system gravity field, the orbit of Jupiter, and the encounter trajectories of the spacecraft. The Earthbased observation set spans the years 1967—2001 and includes: Earthbased astrometry, satellite mutual eclipses and occultations, and satellite eclipses by Jupiter. The spacecraft observations include: Doppler tracking, radiometric range, very-long baseline interferometry, radio occultations, and optical navigation imaging from Pioneer 10, Pioneer 11, Voyager 1, Voyager 2, Ulysses, Galileo, and Cassini. The Pioneer and Voyager data set is the same as that used by Campbell and Synnott (1985 *AJ* 90, 365). We adjusted the satellite orbits, planet orbit, spacecraft trajectories, and gravity field parameters to fit the observations in a least squares sense. We determined the following GM values (units of $km^3 s^{-2}$): (126712763.1 ± 1.0) for the Jovian system, (5959.92 ± 0.02) for Io, (3202.73 ± 0.02) for Europa, (9887.83 ± 0.03) for Ganymede, and (7179.29 ± 0.02) for Callisto. We held the Amalthea GM fixed at 0.5 and assumed the other three inner satellites were massless. The gravitational zonal harmonics of Jupiter are $J_2 = (14735.0 \pm 0.4) \times 10^{-6}$, $J_3 = (0.3 \pm 2.0) \times 10^{-6}$, $J_4 = (-588.9 \pm 3.5) \times 10^{-6}$, and $J_6 = (26.2 \pm 12.5) \times 10^{-6}$, and the sectorials are $C_{22} = (-0.03 \pm 0.06) \times 10^{-6}$ and $S_{22} = (-0.04 \pm 0.05) \times 10^{-6}$. The ICRF right ascension and declination of Jupiter's pole at epoch J2000 are $268°.0573 \pm 0°.0008$ and $64°.4957 \pm 0°.0005$. Our GMs and harmonics are consistent with the ones determined by Campbell and Synnott, but our values have smaller uncertainties. The results on the satellite gravitational harmonics may be found in: Anderson *et al.* 1996 *Nature* 384, 541; Anderson *et al.* 1998 *Science* 281, 2019; Anderson *et al.* 2001 *Icarus* (to appear); Anderson *et al.* 2001 *JGR-Planets* (to appear).