

Recent Results for Solar-System Tests of General Relativity

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We use the current JPL archive of planetary positional data, along with the data-analysis implementation described by Newhall, Standish, and Williams, to solve for all the conventional parameters included in the JPL planetary ephemerides, plus four more parameters specific to tests of General Relativity. Spacecraft ranging data generated by the Deep Space Network (DSN) for NASA missions, and radar ranging measurements to Mercury and Venus are of primary importance. Venus radar ranging has been calibrated for topography by means of altimetry data from the Pioneer 12 Venus orbiter. Martian ranging data consists of orbiter data from Mariner 9 (1971 to 1972) and Mars Global Surveyor (1998 to 2000), as well as lander data from Viking (1976 to 1982) and Pathfinder (1997). In fitting the data, we weight the separate data sets, except for Mars, such that the assumed standard error for each data set is equal to the RMS residual for that particular set after the fit. For Mars, we use a standard error equal to 5 times the RMS residual for each of the four data sets. This is done to compensate for the systematic error from asteroid perturbations. We interpret the resulting parameter errors after the fit as realistic errors, as opposed to formal errors that would result from setting the Mars standard errors equal to their RMS values. The new values of the PPN parameters β and γ , and the solar gravitational quadrupole moment J_2 , are: $\beta - 1 = -0.0010 \pm 0.0012$, $\gamma - 1 = -0.0015 \pm 0.0021$, $J_2 = (2.3 \pm 5.2) \times 10^{-7}$. The fourth parameter represents a possible time variation \dot{G} in the gravitational constant. It is unchanged from what we reported last year at the Pasadena meeting. We conclude that the orbits of the inner planets are consistent with the Newtonian inverse-square law of attraction and with General Relativity at the post-Newtonian order $O(v^2/c^2)$. This work was sponsored by NASA's Space Astrophysics Research and Analysis (SARA) program and was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA.

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