Lunar Geophysics, Geodesy, and Dynamics

James G. Williams and Jean O. Dickey
Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 91109, USA, James.G.Williams@jpl.nasa.gov, Jean.O.Dickey@jpl.nasa.gov

Experience with the dynamics and data analyses for earth and moon reveals both similarities and differences. Analysis of Lunar Laser Ranging (LLR) data provides information on the lunar orbit, rotation, solid-body tides, and retroreflector locations. Lunar rotational variations have strong sensitivity to moments of inertia and gravity field while weaker variations, including tidal variations, give sensitivity to the interior structure, physical properties, and energy dissipation. A fluid core of about 20% the moon's radius is indicated by the dissipation data. The second-degree Love numbers are detected, most sensitively k_2. Lunar tidal dissipation is strong and its Q has a weak dependence on tidal frequency. Dissipation-caused acceleration in orbital longitude is dominated by tides on earth with the moon only contributing about 1%, but lunar tides cause a significant eccentricity rate. The lunar motion is sensitive to orbit and mass parameters. The very low noise of the lunar orbit and rotation also allows sensitive tests of the theory of relativity. Moon-centered coordinates of four retroreflectors are determined. Extending the data span and improving range accuracy will yield improved and new scientific results.