The Multidisciplinary Lunar Laser Ranging Experiment

J. G. Williams, P. J. Shelus, D. H. Boggs, J. O. Dickey, J. T. Ratcliff, and J. G. Ries

Jet Propulsion Laboratory, Pasadena, CA 91109
University of Texas at Austin, TX 78712

It has been 30 years since the Apollo 11 landing. Corner-cube retroreflector arrays were carried by the Apollo 11, 14 and 15 flights. A French-built array is on the Soviet rover Lunakhod 2. These retroreflector arrays require no power and are operating normally. Accurate laser measurement of the Earth-Moon separation are regularly made by the McDonald Observatory, Texas and the Observatoire de la Cote d'Azur, France. Analysis of the time-varying round-trip travel time (or the equivalent distance) yields a wealth of information about the Earth-Moon system. The spectrum of variations spans hours to decades.

Analysis of laser ranges to the Moon is utilized for a broad range of investigations: lunar science, gravitational physics, geodesy, geodynamics and astronomy. Unique contributions from LLR include: detection of a molten lunar core; measurement of tidal dissipation in the Moon; an accurate test of the principle of equivalence for massive bodies (strong equivalence principle); and detection of lunar free librations. LLR analysis has provided tests of relativity, measurements of the Moon's tidal acceleration and the Earth's precession, and has provided orders-of-magnitude improvements in the accuracies of the lunar ephemeris and three-dimensional rotation.