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Science and High Accuracy Laser Ranging between the Planets

David E Smith (1), Maria T Zuber (1), Gregory A Neumann (2), Erwan Mazarico (2), and Xiaoli Sun (2)

(1) Massachusetts Institute of Technology, Dept of Earth Atmospheric and Planetary Sciences, Cambridge, United States (david.e.smith@nasa.gov), (2) Solar System Exploration Division, Goddard Space Flight Center, Greenbelt, USA

As we transition from microwave to laser wavelengths the possibilities for improving the measurement of distances within the solar system become realizable. Distance measurements at the centimeter level of accuracy throughout the solar system would enable the refinement of the detailed dynamics of the solar system, including the locations and motions of planets, asteroids and natural satellites. In addition, knowledge of the positions of spacecraft leads to improvement in determining planetary gravity fields and tides, providing information on the interiors of these bodies, their formation, and their evolution. However, these improvements will require the application of newer technologies and refinement of operational procedures that allow refined pointing and timing both on the ground and in space. In addition, increased measurement accuracies will require improved theoretical models of forces and motions, as well as more advanced numerical methods. Progress so far has been slow but the technologies exist on the ground and now must be demonstrated over several AU. Plans and concepts presently being studied suggest we may be on the cusp of a series of experiments and demonstrations that can bring the future of solar system geodesy and geodyamics into reality.