Geophysical Research Abstracts
Vol. 18, EGU2016-7103-1, 2016
EGU General Assembly 2016

Next-generation Lunar Laser Retroreflectors for Precision Tests of General Relativity

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Since 1969, Lunar Laser Ranging (LLR) to the Apollo Cube Corner Retroreflectors (CCRs) has supplied almost all significant tests of General Relativity (GR). When first installed in the 1970s, the Apollo CCRs geometry contributed only a negligible fraction of the ranging error budget. Today, because of lunar librations, this contribution dominates the error budget, limiting the precision of the experimental tests of gravitational theories.

The new MoonLIGHT-2 (Moon Laser Instrumentation for General relativity High-accuracy Tests) apparatus is a new-generation LLR payload developed by the SCF_Lab (http://www.lnf.infn.it/esperimenti/etrusco/) at INFN-LNF in collaboration with the Maryland University. With the unique design of a single large CCR unaffected by librations, MoonLIGHT-2 can increase up to a factor 100 the precision of the measurement of the lunar geodetic precession and other General Relativity (GR) tests respect to Apollo CCRs.

MoonLIGHT-2 is approved to be launched with the Moon Express mission MEX-1 and will be deployed on the Moon surface in 2018. MoonLIGHT-2 is also proposed for the Roscosmos mission Luna-27.

To validate/optimize MoonLIGHT-2 for MEX-1, the SCF_Lab is carrying out a unique experimental test called SCF-Test: the concurrent measurement of the optical Far Field Diffraction Pattern (FFDP) and the temperature distribution of the CCR under thermal conditions produced with a close-match solar simulator and simulated space environment.

We perform test of GR with current LLR data and also different GR simulation of the expected improvement in GR test provided by MoonLIGHT-2, using the Planetary Ephemeris Program in collaboration with CfA.

Our ultimate goal is to improve GR tests by a factor up to 100, and provide constraints on the new gravitational theories like non-miminally coupled gravity and spacetime torision.