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Precision tests of General Relativity and Gravitation by Lunar Laser Ranging

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Lunar Laser Ranging (LLR) to the Apollo retroreflectors on moon over the past four decades has provided some of the best experimental tests of Gravitation and General Relativity. The history and technology of the Lunar Laser Ranging Retroreflectors (LLRR) deployed during the Apollo 11, 14 and 15 missions and the ranging program will be briefly described. The results of the LLRR program have produced some of the best validations of the theory of General Relativity and of the properties of Gravity. The discovery of Dark Energy has stimulated the development of a new set of alternate theories that modify or replace General Relativity. On the other hand, the LLR results evaluating the limits on the violation of the Strong Equivalence Principle and the change of the Gravitational Constant with Time and Space, for example, provide powerful constraints on these various new theories. Further, when combined with the results of other experiments, strong limits on some of the fundamental ideas in cosmology are achieved.
While the Apollo retroreflectors are still operating, over the past four decades the technologies deployed on the lunar laser ranging ground stations have improved the ranging accuracy for a single photo-electron by more than a factor of 200. Thus the retroreflector arrays deployed during the Apollo missions now limit the single photo-electron range accuracy. The new results for General Relativity and Gravitation that could be accomplished by a next generation retroreflector that supports 1 mm ranging will be described.

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