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APOLLO: A Comprehensive Test of Gravity via Lunar Laser Ranging¹

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The fundamental incompatibility of quantum mechanics with general relativity together with our well-quantified ignorance of large-scale gravity (dark energy, dark matter) strongly suggests that we intensify our tests of gravity. APOLLO (the Apache Point Observatory Lunar Laser-ranging Operation) is a new project that will bring about order-of-magnitude improvements in testing several fundamental aspects of gravity. Using a 3.5 meter telescope to bounce laser pulses off of the retroreflector arrays left on the moon by the Apollo astronauts, APOLLO is capable of one-millimeter range-precision. By determining the exact shape of the lunar orbit, it will be possible to test the equivalence principle, the time-rate-of-change of the gravitational constant, gravitomagnetism, geodetic precession, and the inverse-square law to at least ten times better precision than currently tested. Details of the technique, millimeter-scale challenges, and performance to date will be presented.

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