SOLAR-SYSTEM TESTS OF GRAVITATIONAL THEORIES

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Title: Solar-system Tests of Gravitational Theories

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We are engaged in testing gravitational theory, mainly using observations of objects in the solar system and mainly on the interplanetary scale. Our goal is either to detect departures from the standard model (general relativity) – if any exist within the level of sensitivity of our data – or to support this model by placing tighter bounds on any departure from it. For this project, we have analyzed a combination of observational data with our model of the solar system, including planetary radar ranging, lunar laser ranging, and spacecraft tracking, as well as pulsar timing and pulsar VLBI measurements.

In the past year, we have added to our data, primarily lunar laser ranging measurements, but also supplementary data concerning the physical properties of solar-system objects, such as the solar quadrupole moment, planetary masses, and asteroid radii. Because the solar quadrupole moment contributes to the classical precession of planetary perihelia, but with a dependence on distance from the Sun that differs from that of the relativistic precession, it is possible to estimate effects simultaneously. However, our interest is mainly in the relativistic effect, and we find that imposing a constraint on the quadrupole moment from helioseismology studies, gives us a dramatic (about ten-fold) decrease in the standard error of our estimate of the relativistic component of the perihelion advance.

In addition, by considering the contribution of the metric parameters β and γ to the signature of an equivalence principle violation, we have obtained another dramatic (nearly two orders of magnitude) reduction in the standard error for β.

This is the final year under grant NAG5-11455, but we have submitted a proposal to continue this research. In the coming year, we plan to continue adding data to our set, as available. We expect to use these data and improved models to obtain estimates of the gravitational-theory parameters and to publish these results.