David E Smith, Maria T Zuber, Antonio Genova

Can Planetary SLR Measure the Expansion of the Solar System?

It has been suggested that the mass (M) of the sun and the gravitational constant (G) may both be changing which would affect the scale of the solar system. The sun is continually converting hydrogen to helium and the resulting loss of mass is estimated to be or order 10-13/yr. Further, it is suggested that G might also be decreasing, possibly as a result of the expansion of the universe, at ~10-12/year. These rates of change of the solar GM will be having a significant effect on the orbital motions of all the masses in the solar system at levels we can now measure. Although these changes are estimated to be decimeters/year, they represent the best tool to measure the changes in solar system. Further, laser ranging to spacecraft in Mars and lunar orbits, and to a spacecraft en route to Mercury have demonstrated the technology. A suggested rate of change of GM of 10-12/year would change the positions and orbits of the planets by hundreds of thousands of kilometers over a billion years interfering with the resonant relationships of many planets and their satellites. The change in GM is most easily accomplished by measuring the change in the distances between planets. Measurements between landers on widely separated planets might appear the easiest but for gaseous planets, such as Jupiter, it would need to be to a spacecraft in orbit. The measurements, technically feasible, would be difficult but the knowledge of whether the size of the solar system is changing would be a significant accomplishment with possibly important implications for the solar system's past and future.