



The Change in the Mass of the Sun and the Expansion of the Solar System

David E Smith and Maria T Zuber

Massachusetts Institute of Technology, Dept of Earth Atmospheric and Planetary Sciences, Cambridge, United States
(smithde@mit.edu)

As the Sun converts hydrogen into helium by nuclear fusion there is a decrease in the Sun's mass, M and the release of energy through electromagnetic and particle radiation. The continued, steady loss of mass from the Sun results in a reduced gravitational attraction and an expansion of the orbits of the planets. These orbital changes are small, at the level of centimeters/year, but are measureable over a period of several years. Further, if we can measure these changes in planetary motion we might be able to learn about the structure and dynamics of the solar interior. Estimates of solar electromagnetic and particle flux suggest the sun is losing of order 10-13 of its mass/year, corresponding to an increase in the radius of Earth's orbit of 1.5 cm/yr. But the Earth's orbital velocity also decreases and since angular momentum remains conserved, the velocity is further reduced.

There is also the possibility that G changes although neither a change in G or M have actually been measured. G is a scale factor for everything in the solar system whereas M only acts on bodies that are in orbit about the sun, so the orbits of natural satellites of planets are, to first order, independent of the mass of the sun. Thus, lunar laser ranging to the Moon and similar observations of other satellite systems provide a way to separate G and M , opening up the possibility of detecting periodic variations in M and the solar gravitational flattening due, for example, to the solar magnetic cycle. We will discuss experiments to measure the motions of the planets and observational concepts that could lead to making direct observations of the changes in the sun's mass and by implication the processes of the solar interior.