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USING SOLAR SAILS TO TEST FUNDAMENTAL PHYSICS

Abstract

The motion of the solar sail is determined by the solar radiation pressure as well as the spacetime geometry. We discuss an application of astrodymanics for a solar sail, when general relativistic effects and solar radiation pressure are considered simultaneously and demonstrate the advantages of using solar sail propelled spacecraft to test general relativistic effects compared with more conventional spacecraft. We present deviations from Kepler's third law for heliocentric orbits near the sun. In particular, we consider deviations in the period of circular orbits due to the spacetime curvature near the sun, frame dragging from the rotation of the sun, and the oblateness of the sun. The Poynting-Robertson effect on a nearly-circular heliocentric trajectory of a solar sail is discussed. In addition, for non-Keplerian orbits which are outside of the plane of the sun, we predict an analog of the Lense-Thirring effect for which the orbital plane precesses around the sun. All above mentioned can be tested by a solar sail propelled satellite. We will show that the observation and study of the trajectories of a solar sail by itself provide excellent tests of general relativistic effects and can be new tests of the fundamental principles of general relativity. We may say that Fundamental Physics can be carried out as a passenger activity on space science missions performed by a solar sail propelled satellite. We will also address several fundamental scientific questions: what heats the solar corona and accelerate the solar wind? Where does the solar wind originated? What is the nature of plasma transport and turbulence near the sun?