

ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics - Part 1 (3)

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EFFECT OF A DRAG FORCE DUE TO ABSORPTION OF SOLAR RADIATION ON SOLAR SAIL
ORBITAL DYNAMICS**Abstract**

It is well known that the reflected, absorbed and emitted portions of the solar electromagnetic radiation can be used to propel a solar sail, due to the force from the electromagnetic pressure. What is less known is that the absorbed portion of the radiation induces a drag force on the solar sail, thereby diminishing its tangential speed relative to the sun [1]. This drag force is associated with the Poynting-Robertson effect, which was predicted by Poynting in 1904 for small spherical dust particles.

We consider the Poynting-Robertson effect, on various types of trajectories of solar sails. Since this effect occurs at order v/c , where v is the tangential speed relative to the sun, it can dominate over other special relativistic effects which occur at order v^2/c^2 . For a solar sail directly facing the sun in a bound heliocentric orbit, the Poynting-Robertson effect decreases its orbital speed, thereby causing it to slowly spiral towards the sun. For escape trajectories, this diminishes the cruising velocity, which can have a cumulative effect on the heliocentric distance. We also consider this effect for non-Keplerian orbits in which the solar sail is tilted in the azimuthal direction. Due to the Poynting-Robertson effect, a non-Keplerian orbit of a solar sail exhibits oscillatory behavior in the polar direction. While in principle the drag force could be counter-balanced by an extremely small tilt of the solar sail in the polar direction, periodic adjustments are more feasible.

References

- [1] R. Ya. Kezerashvili, J. F. Vazquez-Poritz, *Advances in Space Research* **46** (2010) 346–361.