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Orbital dynamics of a solar sail accelerated by thermal desorption of coatings

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For extrasolar space exploration, it is convenient to take advantage of environmental effects, such as solar radiation heating, to accelerate a solar sail coated by materials that undergo thermal desorption at a particular temperature, reached at a particular heliocentric distance. This physical process of mass loss can provide additional thrust. We focus on the orbital dynamics of three scenarios that only differ in the way the sail approaches the Sun; in every case once the perihelion is reached, the sail coat undergoes desorption. When the process ends, the sail escapes the Solar System having the conventional acceleration of solar radiation pressure. We compare scenarios in which thermal desorption comes beside traditional propulsion systems, and they are the following:

i. Hohmann transfer plus thermal desorption: The sail is carried as a payload to the perihelion with conventional chemical propulsion by a Hohmann transfer from Earth's orbit to an orbit very close to the Sun (almost at 0.1 AU) and then deployed there.

ii. Elliptical transfer plus Slingshot plus thermal desorption: In this case the transfer occurs from Earth's orbit to Jupiter's orbit where a Jupiter's fly-by leads the sail close to the Sun, where it is deployed.

iii. Two stage acceleration of the solar sail through thermal desorption: The sail has two coats of materials that undergo thermal desorption at different temperatures, so at different distances. The first desorption occurs at the Earth orbit and propels the sail toward the Sun, where the second takes place.

Biography

Elena Ancona is Master of Science in Aerospace Engineering, 2016 from the Polytechnic University of Turin, Italy.

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