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THE TEMPERATURE DEPENDENCE OF SOLAR SAIL MATERIALS ON A HELIOCENTRIC DISTANCE

Abstract

We study the temperature dependence of the solar sail materials on the distance from the sun for the heliocentric escape orbits of the solar sail. The main characteristics for the solar sail material are the reflection, absorption and emission of the electromagnetic radiation as well as its thickness. Based on the study given in Refs. 1 for the thickness requirement for solar sail materials and the dependence of the minimum thickness on temperature as well as on the frequency of electromagnetic spectrum of solar radiation we investigate how close to the sun the solar sail could approach to be still functional and accelerate a spacecraft to high cruise speed. Within the standard approach the reflectivity and emissivity of the solar sail material have constant values. As a result the temperature of the solar sail material increases when the solar sail approaches to the sun as $T \sim r^{-1/2}$, where r is the heliocentric distance. In our approach we consider the temperature dependence of the electro-optical parameters of solar sail materials that have implicit dependence on the temperature through the temperature dependence of the electrical conductivity of the solar sail material. It is shown that the temperature dependence of the emissivity and conductivity leads to the dependence of temperature for the solar sail materials approximately as $T \sim r^{-2/5}$ with the heliocentric distance. The developed approach allows us to determine the perihelion of the solar sail orbits based on the temperature requirement for the solar sail materials.

1. R. Ya. Kezerashvili, Acta Astronautica, JBIS **61**, 430-439, 2008. R. Ya. Kezerashvili, Acta Astronautica, **65**, 507-518, 2009. R. Ya. Kezerashvili, G.L. Matloff, Adv. Space Res. **44**, 859–869, 2009.