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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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TEMPERATURE RESTRICTIONS FOR MATERIALS USED IN AEROSPACE INDUSTRY FOR THE NEAR-SUN ORBITS.

Abstract

For near-Sun missions, the spacecraft approaches very close to the Sun and space environmental effects become relevant. Strong restrictions on how close it can get are given by the maximum temperature that the materials used can stand in order not to compromise its activity and functionalities. The temperature of an object in space depends on its optical properties: reflectivity, absorptivity, transmissivity, and emissivity. Usually, it is considered as an approximation that the optical properties of materials are constant. However, emissivity depends on temperature. The consideration of the temperature dependence of emissivity and conductivity of materials used in the aerospace industry leads to the conclusion that the temperature dependence on the heliocentric distance is different from the case of constant optical properties [1]. Particularly, taking into account that emissivity is directly proportional to the temperature, the temperature of the object increases as $r^{-2/5}$ when the heliocentric distance r decreases. This means that the same temperature will actually be reached at a different distance and, eventually, the spacecraft will be allowed to approach closer to the Sun without compromising its activities. We focused on the most common materials in aerospace structures and find perihelion of the near-Sun orbits based on their temperature restrictions. Our analysis can be extended to all kinds of composite structures and materials, once their optical properties - in particular emissivity - are defined.

References:

1. R. Ya. Kezerashvili, Space exploration with a solar sail coated by materials that undergo thermal desorption, Acta Astronautica 117 (2015) 231-237.