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Author: Prof. Roman Ya. Kezerashvili
New York City College of Technology, The City University of New York, United States,
rkezerashvili@citytech.cuny.edu

Prof. Vladimir Ya. Kezerashvili
New York City College of Technology, United States, vkezerashvili@citytech.cuny.edu

PROPULSION WITH A SOLAR SAIL ATTACHED TO A SUPERCONDUCTING CURRENT LOOP

Abstract

We present a new idea of the deployment and stretching of the circular solar sail attached to the superconducting current loop. It is predicted that a superconducting current loop can deploy and stretch the circular solar sail membrane [1,2]. The magnetic field induced by the superconducting current loop and elastic properties of a circular solar sail membrane and wire loop are analyzed within a strict mathematical approach based on classical electrodynamics and the theory of elasticity. The formulas for the wire and sail membrane stresses and strains caused by the current in the superconducting wire are derived. The analytical expressions can be applied to a wide range of solar sail sizes. Numerical calculations for the sail of radius up to 60 m attached to a superconducting wire with different engineering current densities and made of Be, Aluminized Mylar, Kapton, CPI membranes of different thicknesses are presented.

Our study reveals that if the sail membrane is coated by heat-sensitive materials that undergo thermal desorption from a solid to a gas phase [3] the sail can be accelerated to the cruise velocity up to 20-40 AU/year. The vicinity of the Kuiper Belt Objects can be reached in less than 1-3 years, while the Sun's gravity focus can be reached in 13-25 years [4]. Our results propose the design and construction of the circular-shaped solar sail of $\sim$ 2,000 m^2 area that can be deployed and stretched by the attached superconducting wire.

References

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