IAF SPACE PROPULSION SYMPOSIUM (C4)
New Missions Enabled by New Propulsion Technology and Systems (9)

Author: Prof. Harijono Djojodihardjo
Indonesia

PARAMETRIC STUDY OF SOLAR ELECTRIC SAIL THRUST MODELING UNDER SOLAR WIND VARIABILITY AND UNCERTAINTIES

Abstract

The development of Solar Electric Sailing introduced by Janhunen in 2004 for interplanetary travel, which uses the natural solar wind dynamic pressure for producing thrust for a spacecraft by Coulomb interaction, has gained significant progress in theoretical, laboratory and experimental fight tests. The E-sail configuration, which comprises a number of long, thin, conducting and centrifugally stretched tethers kept in a high positive potential by an onboard electron gun, is here utilized as a baseline. Guided by the interest to look into the plausibility of Electric Sailing Spacecraft for interplanetary travel, and capitalizing on various approaches and results presented by leading researchers, the present review and study is founded on a synthesized Electric Sailing Spacecraft thrust model from carefully selected model judged from the Solar Wind Physics and Characteristics, Variability and Uncertainties. The intrinsic variability of the solar wind properties results in perturbations of the solar wind dynamic pressure that has the same order of magnitude as their mean value. To account for such a problem, the solar wind dynamic pressure recently statistically modelled as a generalized Polynomial Chaos analysis and the sail grid voltage varied as a function of the instantaneous value of the solar wind properties is utilized. In the process, the variability of solar wind field in the Solar System and influence of solar wind field fluctuations on solar electric sail thrust for various solar electric thrust modeling is considered, taking into account rationale and results from recent studies. Then a parametric study is carried out to investigate the heliocentric interplanetary trajectories of the baseline Electric Sailing Spacecraft under selected solar wind conditions.