IAF SPACE POWER SYMPOSIUM (C3)
Space Power System for Ambitious Missions (4)

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POWER REQUIREMENTS AND TECHNOLOGIES FOR GRAM-SCALE INTERSTELLAR SPACECRAFT

Abstract

The Breakthrough Starshot Initiative seeks to develop technologies necessary to enable interstellar exploration using gram-scale space probes accelerated to relativistic velocities by an earth-based laser source. The combination of extremely limited mass budget, long mission duration, and harsh operating environment poses considerable challenges to the development of a power source for such spacecraft. Here, we present the results of an investigation seeking to identify and evaluate the suitability of various power generation and energy storage technologies for the proposed flyby missions. We start by analyzing the mission power requirements, estimating that the spacecraft's power source should provide 20 uW periodically during the 20-year transit phase of the mission, and 1 W peak power during the launch, flyby, and data return phases of the mission, with a total energy budget of 14 kJ. We have evaluated energy scavenging approaches including thin-film photovoltaics and conversion of kinetic energy through interaction with the installer medium. We have also analyzed the viability of various energy storage schemes including chemical, electrical, and nuclear technologies. We will summarize the rankings of these approaches in terms of viability, risk, and technology readiness level, and identify topics for future research and development necessary to realize a viable power source for the interstellar probe missions.