Beamed Energy for Ablative Propulsion in Near Earth Space

Grant Bergstue, Optical Science/Electrical Engineering Departments

Overview

Ultra-short optical pulses, when focused, can be used to cause ablation. The ejection of surface material due to ablation creates a small amount of thrust to act on the object. As a means to generate useful levels of thrust, an array of ablative events can be implemented. This array allows the force due to ablation to affect a larger area on the object as well as gives greater control of flight dynamics.

Key Findings

The near vacuum of space provides a favorable environment for the transmission of beamed energy and ultra-short optical pulses. The lack of atmosphere allows longer transmission distances as well as maximum thrust gained from ablation.

\[ F = \frac{2 \cdot P_{\text{avg}}}{v_{\text{ej}}} \]

The equation above gives an approximation of the force exerted on an object through ablation. \( P_{\text{avg}} \) is the average power of the laser and \( v_{\text{ej}} \) is the velocity of the ejected material.

Impact

Developing strategies of beamed energy for ablative propulsion in space could be a new area of focus for space industry. A space based energy infrastructure can also be developed to distribute the beamed energy as needed in near-Earth space. One such strategy modeled by the Laser Science Engineering Group at UAHuntsville uses a specific configuration of satellites to accomplish this.

Explanation

A technique we call Power Encryption can be used to help ensure the safe transmission of the ultra-short optical pulses. By expanding the pulses during transmission, the ablative potential is drastically reduced. Refocusing them at the receiver requires the correct set of optics as well as cooperation to “unlock” the ablative potential of the pulses for thrust generation.

Note: For more information about the energy distribution system, please see Mr. Luke Burgess poster “Energy Infrastructure Arrangement for Near-Earth Space”

Acknowledgements

The author would like to thank Mr. Luke Burgess and Dr. Richard Fork for their work in this research. Thanks to NASA’s Glenn and Marshall Research Centers for providing funding.