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Strategies for Rapid Implementation of Interstellar Missions: Precursors and Beyond (4)

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PERFORMANCE MAP FOR LASER-ACCELERATED SAILCRAFT MISSIONS

Abstract

Breakthrough Starshot is an initiative to explore the Centauri System using laser-accelerated sailcraft. Earlier work yielded point designs for a 0.2 c mission carrying 1 gram of payload and a 0.01 c precursor mission carrying a minimal 6.6 mg payload. The present work maps the wider design space for cost-optimal missions with 0.1 mg to 100 kt payload, 0.0001 c to 0.99 c (6.3 au/y to 63,000 au/y) cruise velocity, and 10 y to 100 y development time.

This mapping is made possible by a simplified system model that swaps numerical trajectory integration for closed-form equations. The new code computes 2-3 orders of magnitude more point designs per unit time than the earlier more general code. Resulting cost-optimal performance maps exhibit a variety of dynamics that can be understood in terms of the limiting (driving) constraint in any given region of the map.

For missions that require only a few gigawatts of laser power or less, an electrical transmission line connected to a regional grid can directly drive the laser instead of, or in addition to, on-site energy storage. This mode of operation has been added to the system model and greatly reduces system cost for some precursor missions.