Paper ID: 18432
student

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Upper Stages, Space Transfer, Entry and Landing Systems (3)

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A STUDY OF REENTRY BLACKOUT ALLEVIATION USING ELECTRON BUNCHING IN THE REENTRY PLASMA LAYER

Abstract

The problem of communications blackout during reentry has plagued atmospheric reentry vehicles since the beginning of human spaceflight. With the retirement of the space shuttles, the resurgence of capsule-like geometries for manned space vehicles, and the growing importance of hypersonic vehicles, the solution to the blackout problem has become a pressing need. Previous research has suggested a wide variety of solutions to this problem including vehicle shape optimization and electromagnetic manipulation of the hypersonic plasma layer. Each solution has its own advantages and shortcomings; thus far, no method has proved viable enough to use on reentry vehicles on a regular basis.

We present a new method for solving the problem of communications blackout during hypersonic flight which involves using plasma instabilities. Plasma instabilities create electron bunching in the plasma layer, forming pockets of low electron density through which radio waves may be transmitted or received. The pockets of low electron density are alternated with pockets of higher than average electron density. We provide a theoretical, linear analysis of this method, followed by results from a multi-species Navier–Stokes simulation of this method around the RAM-C reentry vehicle. We conclude with a plan for experimental verification of the method and the possibility of installing such a system on a reentering spacecraft.