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ADAPTIVE TRANSMISSION METHOD FOR COMMUNICATION THROUGH REENTRY PLASMA SHEATH

Abstract

When a spacecraft enters into planetary atmosphere, the tremendous heat converted from atmospheric friction will cause dissociation and ionization of surrounding air molecules, resulting in the formation of the so-called "plasma sheath". Under such circumstances, all the communication, navigation and telemetry signals will be disrupted or at least severely degraded, leading to the well-known "radio blackout" problem.

Since the era of the Apollo program, this problem has attracted much attention over the past decades. Many physical mitigation methods were proposed and some of them have already shown their potential, e.g., aerodynamic shaping, liquid quenchant injection, resonant transmission, electromagnetic windowing. However, all the proposals have their own practical shortages or engineering obstacles, no satisfactory solution has yet been proven, leaving this problem still unsolved as before.

Here we propose a novel method to alleviate the radio blackout problem. Rather than previous physical mitigation methods aiming to reduce the plasma electron density, the adaptive transmission method attempts to communicate at carrier frequency much higher than the plasma cutoff frequency. We use a plasma radio reflectometry to online monitor the plasma electron density, thus estimate the instantaneous channel states and enable adaptive transmission. Numerical simulations are presented and discussed, in order to illustrate the effectiveness of the proposed method.