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SIMULATION OF ION DRAG OVER CHARGED DEORBITING DEPLOYABLES IN REALISTIC ORBITAL CONDITIONS

Abstract

The aerodynamic interaction between a charged body in low earth orbit and the surrounding plasma is fundamentally distinct from neutral aerodynamic interactions. Small charged objects can be seen to experience an ion current and drag force many times greater than would be expected for an uncharged object of the same diameter. Several techniques have been developed to utilise these interactions for active deorbiting and propellant-free orbital control of small satellites. Each of these techniques relies on developing an electric potential on the object with respect to the plasma, thereby increasing drag forces using the greater ion collection of the body.

One specific proposal for generating this drag force is to use charged deployables, providing a propellant-free option for deorbiting and orbital control. Initial investigations show the relationship between the surface charge of these deployables and the subsequent drag forces is complex, and varies with deployable geometry. Additionally, the relationship between the ionospheric composition and these forces is poorly understood for any complex deployable geometry, prompting further investigation. In this work, we showcase a parametric sweep of a range of orbital conditions for a group of deployable devices of varying geometries. Realistic orbital conditions are taken from analytical ionospheric models, and drag forces are predicted using a combination of analytical models and Particle-in-Cell modelling. The ratio of charged to neutral drag, and total drag force over these orbits are used to identify areas in which the use of these charged deployables would be favourable, either for small orbital maneuvers or end-of-life deorbiting. The efficacy of these predictive techniques as mission planning tools for future missions incorporating charged deployables is also investigated.