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EFFECT OF SPACECRAFT CHARGING ON PERFORMANCE OF ION ELECTROSPRAY PROPULSION SYSTEMS

Abstract

Ion electrospray thrusters are a miniature type of electric space propulsion that generate thrust on the order of micronewtons. This technology is especially well-suited for small satellites, but can readily be scaled up to provide extremely precise maneuvering for a wide range of spacecraft.

All ion propulsion systems require a neutralizing mechanism to prevent the host spacecraft from accumulating hazardous amounts of charge. The unique ability of electrospray thrusters to produce either polarity of ion can be harnessed for this purpose. Typically, these devices are operated in pairs, with one thruster emitting positive ions and the other negative ions, ideally forming a globally neutral plume. This strategy eliminates the need for an external neutralizer, such as a cathode. However, moderate levels of spacecraft charging are still possible because of minor variations between individual electrospray thrusters. Low-energy ions in the thruster's plume are attracted back to a non-neutral spacecraft, thus producing zero net thrust. It is crucial to quantify the effects of such charging on the effective thrust output of the electrospray system in order to accurately predict in-space performance.

Here, we employ a magnetically-levitated thrust stand to characterize both the thrust output and spacecraft charging behavior induced by an electrospray propulsion system. The thrust stand uses magnetic levitation to suspend a mock-cubesat such that it can rotate freely about its vertical axis. Thrust is deduced from the measured angular position of the spacecraft over time. The testbed is electrically floating such that realistic spacecraft charging is induced while the thrusters are operating. The satellite potential is measured by a non-contact charge sensor. In this work, we perform thrust measurements for thrusters with different firing potentials, emission characteristics, and ion energy distributions, all of which are factors expected to influence spacecraft charging behavior. All experiments will be performed using test facilities and electrospray thruster units available in the Space Propulsion Laboratory at MIT.