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OUROBOROS, AN UNDERGRADUATE DESIGN AND ANALYSIS OF A HALL THRUSTER FOR SMALL-SAT APPLICATIONS

Abstract

OUROBOROS is a student-led project at the University of Alabama in Huntsville to design and test a Hall thruster for small satellite applications. Established in 2024, the project provides hands-on education and training for undergraduate and graduate students in electric propulsion, fostering skill development and advancing Hall thruster research.

ORB-1-D1 is the team's first prototype thruster. The device employs electromagnets that enable in-situ modification of the magnetic field topology. The thruster is magnetically shielded, reducing erosion of the discharge channel and extending its operational lifespan. This enhances efficiency and durability, which enables more sustainable and adaptable mission profiles and reduces satellite waste and on-orbit debris.

A current limitation to the longevity of Hall thrusters is the lifetime of the neutralizer. ORB-1-D1 features a center-mounted glow discharge cathode, a simpler, cheaper alternative to previously-flown heater-keeper and heaterless hollow cathodes, which has been tested in laboratory environments but is currently unproven in space. Our research explores its viability and hopes to advance the technology, investigating options for performance improvements to enable competition with traditional hollow cathodes.

Another prohibitive limitation for Hall thruster users is propellant cost and availability. The ORB-1-D1 thruster uses argon and krypton instead of the traditionally-used xenon, enhancing sustainability and drastically reducing propellant costs for small satellite constellations by easing demands on the world's xenon supply.

ORB-1-D1 is set to be hot fired by May 1, 2025. The long-term aim of the project is to develop a Hall thruster to be used as a research platform for investigating phenomena such as plasma instability, magnetically-lensed thrust vectoring, alternative discharge channel materials, and additive manufacturing of thruster components. OUROBOROS also seeks mutually beneficial collaborations with other research projects and organizations to enable novel research and expand the use of EP technology for in-space applications.