Time & Location: March 19, 2018 at 1:30 PM in Eng 2 202
Title: Theoretical Paschen’s Law Model for Aerospace Vehicles and Validation Experiment

Aerospace vehicles often experience triboelectric charging while traversing the atmosphere. Triboelectric charging occurs when a material come into frictional contact with a different material. Aerospace vehicles often triboelectrically charge due to frictional contact with dust and ice crystals suspended in the atmosphere. Launch vehicles traversing ice clouds in low-pressure atmosphere are especially prone to electrostatic discharge events (i.e. sparks). These conditions are hazardous and affect a rocket vehicle’s launch commit criteria. Engineers for an ARES 1 rocket launch have reported concerns with triboelectric charging over their self-destruct system antenna. This concern was addressed by putting the antenna through harsh conditions in a laboratory environment. The need for laboratory testing could have been avoided if there was a mathematical model to predict these events. These discharge events can typically be predicted by the Classical Paschen’s Law, which relates discharge voltage to pressure, material and distance between the charged and ground surfaces. However, the Classical Paschen’s Law does not capture any aerodynamic considerations such as large bulk flow and compressibility effects. It became apparent that a new model would be needed to predict a discharge voltage with aerodynamic considerations. This research focused on defining a theoretical model and providing experimental data to validate the model. The hypothesis of this work is that charged ions are removed too quickly for enough charge to build up and result in an electrostatic discharge. The wind tunnel testing for this experiment was conducted at the CATER facility. A charged electrode was exposed to flows at Mach numbers 1.5 to 3.5. It was found that the supersonic flow suppressed the electrostatic discharge events. The voltage required for an electrostatic discharge at supersonic conditions increased by at least one order magnitude.

Major: Aerospace Engineering

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Approved for distribution by Kareem Ahmed, Committee Chair, on March 4, 2018.

The public is welcome to attend.