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22nd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Interactive Presentations - 22nd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (IP)

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IMPROVING PARTICLE TRACKING IN PLUME-REGOLITH INTERACTIONS USING SLOTTED PLATES

Abstract

With several countries planning missions to the moon, understanding plume-regolith interactions is vital for the operation and safety of lunar landers. Retro rockets cause the lunar surface material to be ejected at high-speed, having a sand blasting effect that can damage equipment such as photovoltaic cells or the landing craft itself. Previous research using PIV (Particle Image Velocimetry) systems to track the ejected particles (Particle Trajectory Mapping) in a vacuum are hindered by the amount of regolith that is displaced by the nozzle flow, which blocks the PIV camera and prevents individual particles from being identified. This means only the initial moments after impingement may be studied. The current research focuses on a method of reducing the amount of regolith ejected, allowing a longer timescale to be captured by the PIV system after jet impingement.

A tray filled with lunar regolith simulant (glass bubbles of 40 micron diameter) to a depth of 7 cm was placed under a thruster nozzle in vacuum chamber. Air was removed to provide near-vacuum conditions. A simple convergent-divergent nozzle was used with an exit diameter of D=8.9 mm, heated to 900 K for Reynolds number similitude, which provides an exit Mach number of 6.6. The nozzle exit was positioned at a height of 4D above the regolith bed and flow was provided from a pressurised nitrogen container.

To reduce the amount of regolith ejected, a circular steel plate 2mm thick, with a diameter of 380 mm, was placed on the regolith bed. The plate had a slot of 250 mm in length cut along the central axis. Three test plates were investigated with 1, 2 and 3 mm width slots. The slot is aligned with the PIV laser sheet, which is in turn aligned with the central axis of the nozzle. This allows the impingement with and ejection of the regolith to be captured on this plane, as regolith is only ejected through the slot. This reduces the volume of ejected regolith and increases the time before the PIV camera is obscured. The jet was operated for 1 sec for each experimental run with a background pressure of 1 Pa and a stagnation pressure at the nozzle throat of 1 MPa. Particle velocities were compared to that of previous work, along with the maximum time that can be captured before the PIV camera is obscured.