Fachbereich 4
Produktionstechnik
Maschinenbau &
Verfahrenstechnik

CENTER OF
APPLIED SPACE TECHNOLOGY
AND MICROGRAVITY
ZARM

Fluids and Space Engineering Seminar

Monday, September 3, 2018 at 10:00
Location: ZARM, Room 1730

Prof. James C. Hermanson
Department of Aeronautics and Astronautics, University of Washington

Fuel Droplet Disruption under Supersonic Conditions - Dynamics, Vaporization, and Compression Wave Structure

The disruption of droplets under supersonic conditions was studied in a supersonic wind tunnel. Test liquids were employed with similar physical properties but a range of vapor pressures. The accelerating droplets achieved supersonic velocities relative to the surrounding air, reaching a relative Mach number of as high as 1.8. The droplets were imaged by direct close-up single- and multiple-exposure imaging, schlieren imaging, and Laser-Induced Fluorescence (LIF). Several different droplet disruption modes were observed as the droplets accelerated in the supersonic flow. The low static pressure in the supersonic stream gave rise to superheating of the droplet fluid as the local static pressure became significantly lower than the vapor pressure of the droplet liquid, depending on the test liquid employed. Droplet lifetimes for the most volatile fluid appeared to be shorter due to accelerated vaporization consistent with superheating, though little impact was observed on the droplet velocity and relative Mach number. LIF imaging of the expelled vapor indicated that the more volatile liquid droplets had a higher vaporization rate than non-volatile droplets at all downstream locations, suggesting that droplet superheating does play a role in accelerating the vaporization of supersonic droplets under these conditions. The structure of compression waves in the vicinity of droplets is broadly consistent with those expected for detached bow shock waves in front of a bluff body. The relative droplet Mach numbers, inferred from the Mach angle suggested by the schlieren images, compares favorably with droplet Mach numbers determined previously in this flow configuration.