Experimental Investigations of Hypersonic Aerodynamics and Hypersonic Propulsion

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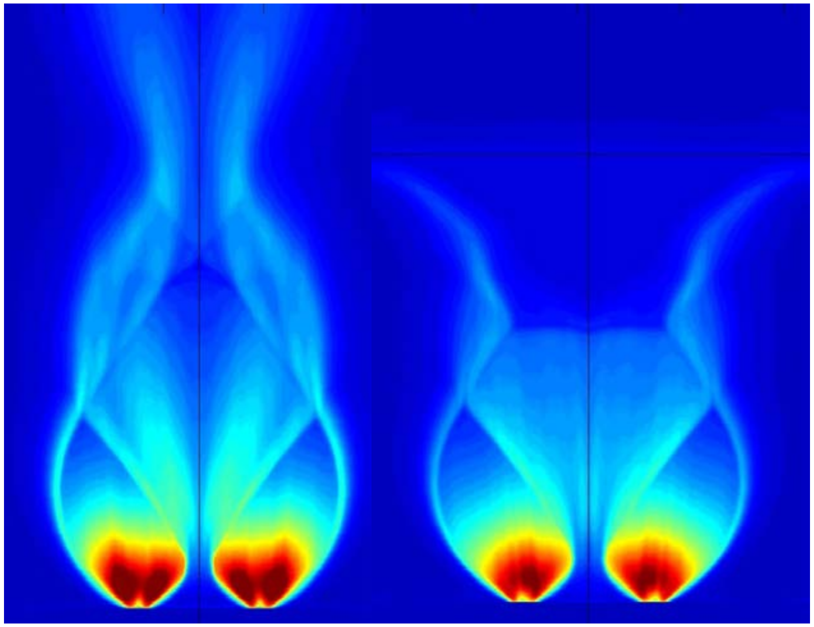


My research interests are hypersonic aerodynamics, hypersonic propulsion and the application of nonintrusive laser-based techniques to flowfield diagnostics. My lab has developed the Planar Laser-Induced Iodine Fluorescence experimental technique for characterizing hypersonic aerodynamic flows. The technique is currently being used to investigate the interaction of hypersonic free jets and the impingement of those hypersonic jet plumes with a solid surface under rarefied flow conditions. Examples of current interest also include the ramjet/scramjet mode transition in hypersonic propulsion systems and the study of planetary entry using retropropulsion and reaction control systems.

"Dedicated to advancing the understanding of the fundamental physics of hypersonic aerodynamics and hypersonic propulsion."

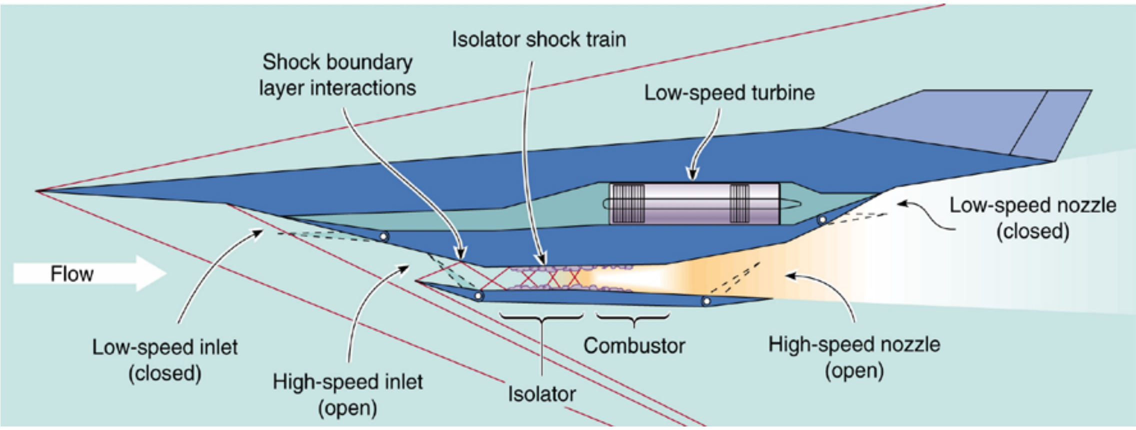
University of Virginia Engineering

Hypersonic Aerodynamics

Damage to spacecraft surfaces can occur when hypersonic retro-rockets are fired close to the surface. Current NASA research studies this interaction using the Direct Simulation Monte Carlo technique, but no experimental data has been available to validate this computational technique. My research group uses a unique hypersonic wind tunnel to produce flows to Mach 16 under rarefied flow conditions. Current measurements, made using Planar Laser-Induced Iodine Fluorescence, study the interactions of multiple free jet plumes and the impingement of those plumes on a surface. With this technique, all the fundamental gasdynamic parameters of the complex hypersonic rarefied flowfields are being made.

Hypersonic Propulsion

For NASA's access to space mission and the Air Force's high-speed atmospheric vehicles, new engines are being developed to propel aircraft to hypersonic speeds. The engines will use a combination of standard gas turbines up to Mach 3 and then ram/scramjets to about Mach 12. A National Center for Hypersonic Combined Cycle Propulsion, led by UVa, conducts experiments and develops computer models to aid in the development of the propulsion systems for these hypersonic flight vehicles.



Retropropulsion for Entry, Descent and Landing into Mars

Supersonic jets are fired forward of a spacecraft in order to decelerate the vehicle during entry into the Martian atmosphere prior to parachute deployment. These retropropulsion jets are positioned off the center of the model in order to preserve the drag of the vehicle that occurs without these jets. Experiments at the UVa Aerospace Research Lab use a hypersonic wind tunnel and a laser-based technique to measure the flowfield surrounding the spacecraft with the retropropulsion jets.

RECENT RESEARCH DEVELOPMENTS

- The interaction of hypersonic jet plumes and the impingement of those plumes on a solid surface is being measured using Planar Laser-Induced Iodine Fluorescence.
- Ramjet/Scramjet mode transition is studied in the UVa supersonic combustion wind tunnel using a variety of laser-based flowfield diagnostics, including tunable diode laser absorption tomography and particle image velocimetry.
- Aerodynamics of hypersonic retropropulsion jets and reaction control systems with spacecraft surfaces is investigated.

RECENT GRANTS

- NASA – Experimental Investigations of Rarefied Gas Dynamics
- NASA/Air Force – National Center for Hypersonic Combined Cycle Propulsion
- NASA – Aerodynamic Interactions of Propulsive Deceleration Jets and RCS Jets on Future HMMES Aeroshells

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