AIAA DAYTON-CINCINNATI SECTION

Lunch 'n' Learn
18 September 2026
Thermochemical Non-Equilibrium Hypersonic Flows over Static and Dynamically Moving Rectangular Cavities
Guest Speaker: Mr. Jeremy Redding, AFRL

Abstract: Hypersonic cavity flows arise from a tightly coupled interaction among shear-layer instability, acoustic feedback, shock-wave dynamics, turbulence, and high-temperature gas physics. This presentation examines these interactions across three complementary configurations: a rectangular cavity mounted on a compression ramp, a flat-plate cavity with prescribed lower-wall motion, and a static cavity under canonical external flow. Together, these configurations separate the effects of external compression, geometric forcing, and intrinsic cavity resonance. Particular attention is given to thermochemical non-equilibrium and its influence on acoustic propagation, modal selection, and Rossiter-type oscillations. An effective-speed-of-sound treatment that accounts for translational, rotational, and vibrational energy participation is introduced as a pathway toward a generalized Rossiter formulation spanning subsonic through hypersonic conditions. Time-resolved pressure and flow-field data are analyzed using spectral methods, mode tracking, and coherent structure interpretation to distinguish acoustic resonance from shear-layer dynamics, finite-rate chemistry, and imposed geometric motion. The results clarify how geometry and high-temperature energy exchange modify cavity feedback and provide guidance for predicting and controlling unsteady loads in future hypersonic flight systems.

Biography: Jeremy Redding is an aerospace engineer and computational fluid dynamics researcher whose career is rooted in a lifelong interest in flight, high-speed aerodynamics, and the physical principles governing advanced air and space vehicles. He earned his Ph.D. in Aerospace Engineering from the University of Cincinnati, where his research focused on hypersonic cavity flows, thermochemical non-equilibrium, acoustic feedback, turbulence, and unsteady flow interactions. His experience includes high-fidelity computational simulations, large-scale high-performance computing, CFD method development, and the analysis of complex flow physics using spectral and statistical techniques. Through research collaborations and fellowship work supporting U.S. defense laboratories, he has investigated problems relevant to hypersonic vehicles, boost-glide systems, and high-temperature gas dynamics. His broader interests include aerothermodynamics, turbulence, transport modeling, aeroacoustics, and translating fundamental fluid mechanics into predictive tools for the next generation of flight systems.

Time: *11:45 am*

Location:
China Garden Buffet
112 Woodman Dr.
Dayton, OH 45431

Lunch:
You will be able to purchase the buffet