Towards Highly Accurate Simulations of Chemically Reacting Flows

Abstract: High-speed combustion devices experience a variety of complex and tightly-coupled physical phenomena that render system design analyses extremely challenging. At the heart of these systems, compressible turbulent air streams, often at supersonic speeds, mix with fuel at time scales on the same order of magnitude as the chemical reactions that drive the combustion process. In practical systems, a number of competing effects, such as heat transfer to the combustor walls and the thermochemistry of the fuel source itself, can significantly alter this process, resulting in operational envelopes with enhanced sensitivity to system design. These complexities are hard to reproduce and study experimentally. As such, numerical simulations are an important tool for understanding these high-speed combustion environments. Using these tools in a design environment, however, remains a challenge. First principles simulations can be prohibitively expensive, and reduced-order models can be difficult to design and calibrate. The level of fidelity needed to model such complex flows varies on a case-to-case basis and may not even be known prior to beginning an investigation. Therefore, there is an ongoing need for understanding the fundamental physics associated with these complex combustion environments. This talk will focus on on-going efforts by the Naval Research Laboratory to develop better numerical simulation methods to achieve a more thorough understanding of the complex physics found within high-speed combustion devices.

Bio: Dr. Ryan Johnson is an aerospace engineer from the Naval Research Laboratory (NRL) with expertise in developing various computational tools for modeling transport phenomena and chemically reacting continuum-based physics. He has led the development and support for the Navy’s premier multi-physics solver, the JENRE® code. His current work at NRL focuses on the application and validation of computational tools for high-fidelity simulation of chemically reacting flows with detailed transport in various Navy relevant applications. He has extensive experience in assessing high fidelity models and exploring new numerical techniques that overcome the need for expensive and antiquated CFD methods for transport phenomenal and detailed chemistry. Since coming to NRL, Dr. Johnson has co-authored over 10 peer-reviewed articles, attended over 20 national and international conferences, and authored/co-authored over 50 conference proceedings.

Thursday, March 18th at 4:00 P.M.
Zoom Link: Email eperumala@arizona.edu