ACMS Applied Math Seminar

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154 Hurley Hall
3:30 PM – 4:30 PM

Multi-Physics Modeling for Future Propulsion and Power Systems: high-pressure phase separation and plasma assisted ignition

In the development of advanced propulsion and power systems, the growing concerns about emissions & efficiency and the pursuit of high speeds have pushed the systems to operate at extreme conditions. These conditions and the corresponding technical solutions often introduce more physics, which brings new challenges to modeling and simulation. In this presentation, I will talk about two examples of such multi-physics modeling from our recent works: (1) Advanced gas turbines and detonation engines operate at high pressures for high power density and efficiency. At such conditions, the injected multicomponent liquid propellants and fuel-air mixtures often go through transcritical phase change. We developed a CFD framework based on the first-principle vapor-liquid equilibrium (VLE) theory to accurately predict high-pressure phase change, and demonstrated that phase separation can be triggered by either mixing or expansion waves. (2) Plasma assisted combustion (PAC) is a promising technology to enable ignition and stable combustion either at extreme conditions (e.g., high- speed flows in scramjets) or using low-reactivity fuels (e.g., carbon-free ammonia). We developed a series of 0D-3D CFD solvers to model PAC with different levels of fidelity. Using our solvers, we figured out why plasma can surprisingly reduce the NOx emission of ammonia combustion and investigated how turbulence and pulsing frequency affect plasma assisted ignition performance.

The Department of Applied and Computational Mathematics and Statistics

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