Astronautical Engineering Seminar

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3:30–4:30 PM
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Ignition Dynamics of Reactive Gaseous Mixtures

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The study of ignition dynamics is important for a wide range of safety, environmental, and transportation applications. This talk presents experimental and numerical investigations of the processes leading to ignition of reactive gaseous mixtures in the presence of ignition sources—specifically, hot surfaces and compressive devices. A novel experimental technique is presented which generates repeatable high-temperature particles that can be injected into a reactive environment. An interferometer that makes use of large-angle dual birefringent prisms performs high-speed temperature imaging of the particle injection and subsequent ignition and flame propagation of the reactive gas. The interferometer is a combination of a differential and Mach-Zehnder interferometer and is highly stable in an infinite fringe configuration. Numerical work analyzes the chemical kinetics of a reactive gaseous mixture adjacent to a hot surface. A simplified expression of the thermal boundary layer growth is presented based on a variation of the Rayleigh problem; the use of a simplified expression rather than three-dimensional calculations allows us to use a detailed chemical kinetic mechanism to simulate the chemistry while still saving on computational cost. Lastly, a novel experiment for compression ignition testing of reactive gas is described. The experiment makes use of a water column rather than a solid piston to compress a pocket of reactive gas. The compression process leads to the formation of a multi-phase mixture consisting of reactive gas, water droplets, and water vapor due to the development of Richtmyer-Meshkov and Rayleigh-Taylor instabilities. Hydrocarbon-air and hydrogen-oxygen reactive mixtures are used in these investigations to simulate potential explosion hazards in the aviation and nuclear sectors.

Stephanie Coronel is a postdoctoral appointee at Sandia National Laboratories working in the Energetic Materials Dynamic & Reactive Science Department. Her research broadly focuses on abnormal thermal response of energetic materials as well as diagnostic development. Prior to joining Sandia, she was a postdoctoral scholar at GALCIT (Caltech). She received her Ph.D. in Aeronautics from Caltech in 2016, where she worked for Professor Joseph E. Shepherd on experimental combustion in the Explosion Dynamics Laboratory. She received her B.S. in Aerospace Engineering from the University of Texas at Arlington in 2009 and an M.S. in Aeronautics from Caltech in 2010. Her Ph.D. research focused on experimental and numerical ignition in thermal boundary layers.

Refreshments will be served prior to the seminar