Sibley School of Mechanical and Aerospace Engineering Colloquium Series

“Towards Realistic Direct Numerical Simulations of Turbulent Combustion”

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Thursday, March 19th, 2015, 4:00 pm | B17 Upson Hall
Refreshments at 3:30, Upson Hall Lounge

Abstract
High Reynolds number reacting flows lie at the heart of energy conversion devices such as IC engines and turbines that are used extensively in the areas of transportation and power generation. Maximizing efficiency while minimizing emissions from these devices necessitates an understanding of the underlying turbulence and thermochemical interactions in fine detail. However, large gaps in our understanding remain, in spite of decades of research. My research attempts to fill this gap in through direct numerical simulations (DNS) that resolve the full range of scales in the flow. I will present results from two recent DNS studies at Sandia. The first study is based on a new engine concept called Homogeneous Charge Compression Ignition (HCCI), with potential diesel-like efficiency and minimal emissions, which relies on volumetric autoignition of the fuel/air mixture. A special feature of these simulations is the use of compression heating through mass source/sink terms to emulate the compression and expansion resulting from piston motion. Detailed simulations were performed with the aim of understanding the role of piston compression heating as well as mixed mode combustion, wherein both premixed flames, as well as autoignition co-exist. The second study is a comparison between a DNS of a temporally evolving planar slot jet flame and experimental measurements within a spatially evolving axisymmetric jet flame with dimethyl ether (DME), a promising alternative fuel. The goal here is to quantify the ability of scalar product imaging in predicting the heat release rate, which is one of the most important quantities of interest in reacting flows, but is challenging to model or measure directly in an experiment. With this aim, joint statistics of OH and CH2O (formaldehyde), which are two key intermediates for this flame, are compared between DNS and experiment. The efficacy of OH/CH2O product imaging as a surrogate for peak heat release rate is investigated. I will conclude with ideas for the direction of future research.

Biographical sketch
Dr. Bhagatwala received his B.S and M.S degrees in Naval Architecture and Ocean Engineering from the Indian Institute of Technology Madras in 2005 where my Master’s thesis was focused on compliant coatings for their potential to reduce skin friction drag. He received his Ph.D. in Aeronautics and Astronautics from Stanford in 2011, working on spherical shock-turbulence interaction and Richtmyer-Meshkov instability in spherical geometry. After his Ph.D., Dr. Bhagatwala joined the Combustion Research Facility at Sandia National Laboratories (SNL) as a postdoctoral research fellow where he is working on petascale simulations of turbulent combustion with application to internal combustion engines and gas turbines. My work at SNL is part of a broader DOE Combustion Energy Frontier Research Center (CEFRC) focused on developing predictive models for 21st century transportation fuels.