TEXAS TECH UNIVERSITY
Department of Mechanical Engineering

ME SEMINAR SERIES IN SPRING 2014

Shock Driven Hydrodynamic Instabilities: Experiments, Simulations, and Applications

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Date: February 3, 2014 (Monday)
Time: 2:00pm-3:00pm
Venue: PE 121
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Abstract: The Richtmyer-Meshkov instability (RMI) is a hydrodynamic instability driven by the interaction of a shock wave with a density perturbation such as a fluid interface. Scientific interest in this instability has been driven by its role in astrophysical phenomena and inertial confinement fusion, which will be explored in this talk. A computational and experimental study of the RMI will then be presented for an inclined interface perturbation. The computational work is composed of simulation studies of the RMI performed using the Arbitrary Lagrange Eulerian (ALE) code called ARES developed at Lawrence Livermore National Laboratory. These simulations cover a wide range of Mach numbers (1.2 to 3.5), gas pairs (Atwood numbers 0.23 to 0.95), inclination angles (30° to 85°), and explore various perturbation types (both inclined interface and sinusoidal). These simulations show that a distinct transition in growth regimes for the RMI occurs as the inclination angle passes 75°, where the initial conditions transition from the nonlinear to the linear regime. The experimental portion of this work was conducted using the Texas A&M University Fluids Mixing Shock Tube Facility, completed in May of 2012. This facility employs optical diagnostics for measuring density and velocity fields simultaneously using the planar laser induced fluorescence and particle image velocimetry techniques. The development of this new experimental shock tube facility and the diagnostic systems will be described briefly. A series of experiments using a 60° inclination and various gas pairs and incident shock strengths will be presented. These experiments show the development of secondary instabilities and a decay of the organized structures into a turbulent state at late times after reshock. By using various initial conditions it can be seen that the interface retains a memory of its initial conditions even after reshock for many cases. The experimental results will be compared with simulations to evaluate the ARES code abilities in this flow regime. Finally, the talk will conclude with a brief discussion of other fluids experiments being developed in the author's lab which explore the Rayleigh-Taylor instability, Rayleigh-Bernard convection, and super-critical fluid heat transfer characteristics.

Speaker Bio: Dr. Jacob A. McFarland is a visiting assistant professor at Texas A&M University and a former Red Raider. He received his PhD from Texas A&M in mechanical engineering where he studied hydrodynamic instabilities. He received his Master's degree from Virginia Tech in mechanical engineering where he studied the aerothermodynamics of steam turbines. Before this, he attended Texas Tech and graduated in mechanical engineering. He also worked at Lawrence Livermore National Laboratory as part of the high energy density physics program where he used highly parallel computational hydrodynamics codes.