LSU DEPARTMENT OF MECHANICAL ENGINEERING

The Sidney E. Fuchs Seminar Series

3:30-4:30pm, Friday, March 9, 2012

Frank H. Walk Design Presentation Room

Turbulence and Stochasticity in High-Speed Reactive Flows

by **Elaine S. Oran***

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There have been many discussions of turbulence and the fact that it is a stochastic process. There have been significantly fewer discussions of what this means in a practical sense of predictability and the consequences for risk assessment. Now we have begun to address these issues as they arise in energetic reactive flows, in which there are multiple interacting stochastic processes, including flow instabilities, turbulence, many interactions between shocks, flames, and vortices, and the resulting formation of ignition centers (hot spots). The flow that allows us to focus on these issues is the evolution of an initially laminar flame a background medium that may be either quiescent or turbulent. In the first case, we consider a flame propagating down a channel filled with a quiescent, energetic gas and a series of obstacles. As this system evolves, it undergoes flow transitions from subsonic to supersonic, as it simultaneously undergoes transitions among combustion states from a laminar to a violent turbulent flame, and then possibly to the strongest form of combustion, a detonation. This sequence of events and transitions, taken both separately and together, are critical elements of systems ranging from engines to accidental fuel explosions. The second case, where the laminar flame is embedded in a turbulent medium with no solid barriers and no nearby walls, also might occur in accidental explosions or in high-speed engines. In addition, it is important for addressing a fundamental problem in astrophysics: How and why does a deflagration in a type Ia supernova (SNIa) transition to a detonation? SNIa are important because they are the "universal standard candles" of the universe that allow the most reliable measurements of the size and acceleration of the universe. This presentation is illustrated visually by movies made from results of multidimensional, compressible, unsteady, deterministic solutions of the Navier-Stokes equations. In the process of analyzing the dynamic events portrayed in the movie, we have found several surprising properties of the evolving non-equilibrium, non-Kolmogorov turbulence as well as a mechanism for detonations to arise in SNIa.

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