Special
PHYSICAL MATHEMATICS SEMINAR

ON THE THEORY OF SELF-SUSTAINED DETONATIONS

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ABSTRACT:

A self-sustained detonation wave is a shock wave propagating in a reactive medium so that its motion is sustained only by the chemical energy released behind the shock. An important property that distinguishes self-sustained detonations from supported (also called overdriven) detonations is that in the former a sonic locus exists at the end of the reaction zone. The classical theory of Zeldovich, von Neumann, and Doering (ZND theory) of 1940s explains the structure of such detonations assuming the wave is one-dimensional and steady. The sonic condition of unity Mach number in the ZND theory serves as a closure condition necessary to determine the detonation speed. However, since the early 1950s it has been observed that detonations are almost always unsteady and multi-dimensional. A natural basic question arises: What are the closure conditions for such detonations? We propose such conditions for quite general detonation waves with smoothly evolving reaction zone as compatibility conditions in the limiting forward characteristic surface, which defines the sonic locus. Such a sonic locus is an information boundary that isolates the lead shock from the influence of the downstream flow of burnt products. I will discuss how the sonic conditions can be derived from the system of reactive Euler equations and provide numerical illustration of their properties in the simplest case of a pulsating one-dimensional detonation. The sonic conditions can also be used as starting points for various asymptotic analyses. For example, for a slowly evolving weakly curved detonation, one can derive a reduced evolution equation that relates the detonation-shock curvature, speed, and acceleration. Some properties of the evolution equation will be illustrated with an analysis of strong-blast initiation of a gaseous detonation.

MONDAY, MARCH 28, 2005
1:30 PM
Building 2, Room 338

Refreshments at 3:30 PM in Building 2, Room 349.

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