AAE FALL COLLOQUIUM SERIES

Detonation Initiation, Propagation, and Failure

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DR. JOE SHEPHERD

C.L. "Kelly" Johnson Professor of Aeronautics and
Professor of Mechanical Engineering
California Institute of Technology

Biography

Joe Shepherd is the C. L. "Kelly" Johnson Professor of Aeronautics and Professor of Mechanical Engineering at the California Institute of Technology in Pasadena, CA. He has been on the faculty at Caltech since 1993 and served on the faculty of Rensselaer Polytechnic Institute from 1986 to 1993. Prior to that, he was a staff member at Sandia National Laboratories from 1980 to 1986. He earned his PhD in Applied Physics from Caltech in 1981, and his BS in Physics from the University of South Florida in 1976.

Joe's research interests have primarily been in the application of molecular and atomic physics, statistical thermodynamics, chemical kinetics, fluid dynamics and solid mechanics to various aspects of combustion, shock and detonation waves, and high-speed flows. His approach is to combine laboratory experimentation using imaging and other optical methods with analytical and numerical studies to obtain fundamental insights into nature and technology.

During his career, he has worked on a number of projects to investigate and improve the safety of nuclear power plants and waste storage or treatment facilities in the United States, Europe, and Asia, including the 1979 incident at Three Mile Island and the 2011 incidents at Fukushima Dai-ichii. His group carried out extensive research on aircraft fuel tank flammability, developing methods of characterizing ignition sources and characterizing explosive events. Researchers in the Explosion Dynamics Laboratory have made fundamental contributions to the study of detonation waves, hypersonic flow, thermal and other ignition processes, and response of piping systems to detonations and shock waves.

Abstract

I will discuss three examples of detonation behavior in homogeneous, premixed gases.

1. Initiation and stabilization of detonations on high-speed projectiles.
2. Initiation of propagating detonations by strong decaying shock waves.
3. Initiation and failure of detonation waves propagating through area changes.

The goal of my discussion is to present some fundamental ideas about the role of unsteadiness and spatial gradients within and behind the reaction zone region. The examples will be illustrated with results from experimental and numerical studies performed in my research group. The unifying theme is the existence of critical levels of unsteadiness and gradients in flow properties that define the boundaries between flow regimes.

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