

Cornell Fluid Dynamics Seminar Series

Presents

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“Various Scenarios of Flame Acceleration”

12:15-1:15 p.m.

Tuesday, September 29, 2009

178 Rhodes Hall

Pizza and refreshments will be served at noon.

Flame acceleration is an intriguing phenomenon that occurs under various conditions in practical combustion devices. There are three basic combustion configurations which exhibit qualitatively different scenarios of flame acceleration: open-space, closed chamber and open pipe combustion. Flame instabilities and turbulence govern the acceleration of outwardly-expanding flames in an open-space combustion regime, while flame-acoustic interactions and turbulence are dominant for closed chamber combustion. In pipes, on the other hand, the flame acceleration is due to wall friction and built-in obstacles.

In this talk, I will present analytical theories allowing the prediction of various parameters of interest, such as the acceleration rate, the flame speed and shape as well as the flow velocity profile. Our theoretical findings are substantiated by extensive numerical simulations. Flame propagation through a collection of vortices in a pipe will be presented, as well as in a closed chamber of the SI-engine. In a pipe, the turbulent burning rate grows monotonically with the vortex size. In contrast to that, flame propagation in a closed chamber is characterized by the existence of an optimal vortex size that provides the fastest total burning rate. We will further discuss flame-acoustic interactions for the case of a laminar flame propagating toward a closed pipe end. It will be shown that intrinsic flame oscillations, when resonating with acoustic waves, may lead to violent folding of the flame front with a drastic increase in the burning rate.

Finally, I will describe several flame acceleration mechanisms in pipes. The flame interaction with no-slip pipe walls usually leads to a laminar flame acceleration according to the Shelkin mechanism. The presence of built-in obstacles significantly alters the flame acceleration mechanism which is described by the Bychkov scenario and characterized by the extremely fast flame acceleration with the deflagration-to-detonation transition during a short time interval.