Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

The role of hydrodynamic instability in the turbulent propagation of premixed flames FRANCESCO CRETA, MOSHE MATALON, NAVIN FOGLA, University of Illinois at Urbana-Champaign — We investigate the role of hydrodynamic instability in the wrinkled flamelet regime of turbulent combustion, where the turbulence scale is large compared to the flame thickness and the intensity small compared to the laminar flame speed. To do so we use the Michelson-Sivashinsky equation suitably forced by a noise term, representing the turbulent field, whose intensity and spatial auto-correlation function can be fully controlled. We study the effects on the turbulent propagation speed of turbulence intensity, integral scale and of a parameter measuring the degree of hydrodynamic instability. We find two different behaviors depending on the stability of the planar front. If the planar front is hydrodynamically stable we find a quadratic dependence of the turbulent speed on intensity, modulated by a linear dependence on the instability parameter. If the planar flame is unstable, the basic state is corrugated and the scaling law is more complex, revealing a certain resilience of the flame to turbulent perturbation. We also observe, both for stable planar and corrugated flames, the existence of an intermediate integral scale at which the turbulent speed is maximized. For vanishing integral scales the flame surface becomes fractal and a limiting fractal dimension was established. Two-dimensional flames exhibit polyhedral-cellular structures similar to those observed in experiments.

Francesco Creta
University of Illinois at Urbana-Champaign

Date submitted: 28 Jul 2010 Electronic form version 1.4