MATHEMATICS DEPARTMENT
North Carolina State University

SPECIAL SEMINAR

Monday, February 10, 2003
2:35 p.m. 330 Harrelson Hall

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"A rigorous perspective for large eddy simulations of turbulent premixed flames"

The flamelet regime of turbulent premixed combustion is by definition where both the reaction is much faster than the turbulence and the flame thickness is smaller than the Kolmogorov scale. The flame front is hence a moving interface separating burned and unburned gas. The principle role of turbulence, in this case, is to wrinkle the front at small scales, which results in a speed enhancement for the large scale flame.

We introduce a new perspective for large eddy simulations (LES) of premixed flames by using a rigorous-asymptotic approach through a simplified-idealized case with a synthetic turbulent-like flow field varying on two length scales, the integral scale and a subgrid-turbulent scale, both larger than the flame thickness. The turbulent combustion speed enhancement, in the asymptotic limit, is given through an effective Hamiltonian that solves a nonlinear eigenvalue problem (the cell-problem).

I start my talk by presenting a new method for computing effective Hamiltonians. The method is robust, efficient, and second order accurate for smooth data. This method is then used to build up an asymptotic flamelet library as a subgrid model for LES. Numerical results where the LES calculations are validated by direct numerical simulations are provided and unambiguous answers to some important practical issues are obtained. The important issue of speed enhancement versus turbulent kinetic energy scaling laws is also addressed and some new results are obtained. In particular, the bending effect (well known in the combustion community) is clearly and quantitatively identified for the first time, in the case of a time-dependent shear layer.

Joint work with Anne Bourlioux and Andrew J. Majda.

Dr. Khouider is a candidate for a faculty position.

Tea will be served in HA 243 at 3:30 p.m.