DEPARTMENT OF PHYSICS AND PHYSICAL OCEANOGRAPHY
PHYSICS 495 RESEARCH PROJECT

"Modeling Fluid Flow with Lattice-Gas Cellular Automata"

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Abstract

The flow of fluids historically presents one of the greatest challenges in classical physics. The governing equation of motion in fluid dynamics, the Navier-Stokes equation, is inherently non-linear and thus limited to few exact solutions. Numerical techniques are therefore required to gain insight into many fluid dynamics problems. Most computational fluid dynamics methods rely on solving the Navier-Stokes equation through numerical approximation. An alternative method has been devised using the concept of cellular automata, a particular type of model where individual cells in a grid are updated in discrete time steps according to simple local rules governed by the states of neighboring cells. These so called Lattice-Gas Cellular Automata methods have been shown to simulate the Navier-Stokes equation in the macroscopic limit.

In this talk I will derive an exact solution of the Navier-Stokes equation for a simple fluid flow and, after a brief introduction to the concept of cellular automata, explain how I was able to simulate this flow in Matlab using a simple square grid Lattice-Gas model. Discrepancies associated with the square grid and how they are corrected by extension to a hexagonal grid will be discussed, and examples of more complex fluid flow simulations using Lattice-Gas models will be shown.

Friday, April 24, 2009
2:00 PM
DeLoach Hall, Room 212

Refreshments served at 1:45