PHYSICAL MATHEMATICS SEMINAR

TOPIC: A Numerical Approach for Simulating Two-Dimensional Viscous Incompressible Flows with Interfaces

SPEAKER: Jin Wang
Department of Mathematics
The Ohio State University

Abstract:

Incompressible flows with interfaces occur in a wide variety of physical phenomena and the numerical study of such flows has been a very active area over the past years. Mathematically, the motion of flows is governed by the incompressible Navier-Stokes equations together with the interfacial conditions.

In this talk, we present a new approach to simulate the two-dimensional viscous incompressible flows with interfaces. First we introduce some new coordinates so that the interface is mapped into a coordinate line which enables us to work on a rectangular domain instead of a deformed geometry. Then an iterative approach combined with the backward difference formula is applied to do the time marching. Meanwhile the Fourier transform and the pseudo-spectral technique are applied in the horizontal direction, X, under the assumption that the solutions are periodic in X. Then, we write the semi-discretized equations as a 1st-order ODE system with respect to the vertical coordinate, Z, and an efficient ODE solver is developed to construct the solutions.

As an application of our numerical approach, we study the problem of steady progressive interfacial waves (Stokes' waves). In contrast to all the previous works which were concerned with inviscid fluids, we study the Stokes' waves in the presence of viscosity. Our numerical results show that the effect of viscosities is somehow equivalent to decreasing the value of the expansion parameter in the series expansion of the inviscid Stokes' waves. Our work suggests a new expansion form for Stokes' waves in viscous fluids.

Finally, we mention some new results obtained in our numerical simulations to a more practical problem where a wind is blowing over a progressive water wave and where complicated interactions occur between air and water.

DATE: Tuesday, March 16, 2004

TIME: 2:30 PM

LOCATION: Building 2, Room 338

Refreshments at 3:30 PM in Building 2, Room 349.

Massachusetts Institute of Technology
Department of Mathematics
Cambridge, MA 02139