Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Lattice Boltzmann Model for Two-Dimensional Flow of Immiscible Fluids between Closely-Spaced Plates ALEX FORE, ROBERT SEKERKA, MICHAEL WIDOM, Carnegie Mellon University — We formulate a Lattice Boltzmann (LB) model for simulation of two-dimensional flow of nearly-immiscibile fluids between closely spaced parallel plates. We treat displacement of a more viscous fluid by a less viscous fluid, as in a Hele-Shaw cell. The nearly two dimensional flow leads to the well-known Saffman-Taylor instability. We use a binary (A-B) LB model to simulate the problem. We account for the effects of the thin dimension between the plates via a drag force that we obtain by averaging the equations of motion over the thin dimension. We consider the A-B solution to be a regular solution with a strongly repulsive potential and use the effective potential method, consistent with equilibrium thermodynamics, to model non-ideal solutions. To control the viscosity of each phase we use a mixing rule for the relaxation time that depends linearly on mole fraction. We use a gradient energy on the mole fraction to attain control over the interface width and surface tension. We use this model to simulate viscous fluid displacement in a rectangular Hele-Shaw cell. Preliminary results display the Saffman-Taylor instability which we compare with a classical linear stability analysis. We have also observed time development of nonlinear fingering patterns.

Alex Fore
Carnegie Mellon University

Date submitted: 16 Nov 2006