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Abstracts of Papers to Appear in Future Issues

NUMERICAL SOLUTION OF THE HELE–SHAW EQUATIONS. Nathaniel Whitaker, *University of Massachusetts, Amherst, Massachusetts, USA.*

An algorithm is presented for approximating the motion of the interface between two immiscible fluids in a Hele–Shaw cell. The interface is represented by a set of volume fractions. We use the Simple Line Interface Calculation method along with the method of fractional steps to transport the interface. The equation of continuity leads to a Poisson equation for the pressure. The Poisson equation is discretized. Near the interface where the velocity field is discontinuous, the discretization is based on a weak formulation of the continuity equation. Interpolation is used on each side of the interface to increase the accuracy of the algorithm. The weak formulation as well as the interpolation is based on the computed volume fractions. This treatment of the interface is new. The discretized equations are solved by a modified conjugate gradient method. Surface tension is included and the curvature is computed through the use of osculating circles. For perturbations of small amplitude, a good agreement is found between the numerical results and linearized perturbation theory. Numerical results are presented for the finite amplitude growth of unstable fingers.

MULTILEVEL MATRIX MULTIPLICATION AND FAST SOLUTION OF INTEGRAL EQUATIONS. A. Brandt and A. A. Lubrecht, *Weizmann Institute of Science, Rehovot, ISRAEL.*

A fast multigrid approach is described for the task of calculating $\int_\Omega K(x, y)\, u(y)\, dy$ for each $x \in \Omega \subseteq \mathbb{R}^d$. Discretizing Ω by an equidistant grid with n points and mesh size h, and approximating the integrations to $O(h^{2s})$ accuracy, it is shown that the complexity of this calculation can be reduced from $O(n^2)$ to $O(sn)$, provided the kernel K is sufficiently smooth. For potential-type kernels, the complexity is reduced to $O(sn \log n)$. Corresponding integral equations can be solved to a similar accuracy with basically the same amount of work, using a special kind of distributed relaxation in a multigrid algorithm. One- and two-dimensional numerical tests, and theoretical derivations of optimal strategies are reported. The method is applicable to the task of multiplying by any matrix with appropriate smoothness properties, including most types of many-body interactions.

INVISCID FLUX-SPLITTING ALGORITHMS FOR REAL GASES WITH NON-EQUILIBRIUM CHEMISTRY. Jian-Shun Shuen, *NASA Lewis Research Center, Cleveland, Ohio, USA*; Bram van Leer, *University of Michigan, Ann Arbor, Michigan, USA.*

Several flux-splitting methods for the inviscid terms of the compressible-flow equations are derived for gases that are not in chemical equilibrium. Formulas are presented for the extension to chemical-nonequilibrium of the Steger–Warming and Van Leer flux-vector splittings, and the Roe flux-difference splitting. The splittings are incorporated in a TVD algorithm and applied to one-dimensional shock-tube and nozzle flows of dissociating air, including five species and 11 reaction steps for the chemistry.

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