ACCELERATION OF CONVERGENCE AND SPECTRUM TRANSFORMATION OF IMPLICIT FINITE DIFFERENCE OPERATORS ASSOCIATED WITH NAVIER–STOKES EQUATIONS. M. Saleem. *Department of Mathematics and Computer Science, California State University, San Jose, California 95192, U.S.A.*; T. Pulliam. *Division of Computational Physics, NASA Ames Research Center, Moffett Field, California 94035, U.S.A.*; A. Y. Cheer. *Department of Mathematics, University of California, Davis, California 95616, U.S.A.*

Eigensystem analysis techniques are applied to finite difference formulations of Euler and Navier–Stokes equations in two dimensions. Spectrums of the resulting implicit difference operators are computed. The convergence and stability properties of the iterative methods are studied by taking into account the effect of grid geometry, time-step, numerical dissipation, viscosity, boundary conditions, and the physics of the underlying flow. The largest eigenvalues are computed by using the Frechet derivative of the operators and Arnoldi's method. The accuracy of Arnoldi's method is tested by comparing the dominant eigenvalues with the rate of convergence of the iterative method. Based on the pattern of eigenvalue distributions for various flow configurations, the feasibility of applying existing convergence-acceleration techniques like *eigenvalue annihilation and Relaxation* are discussed. Finally a *shifting* of the implicit operators in question is devised. The idea of *shifting* is based on the power method of linear algebra and is very simple to implement. The procedure of *shifting* the spectrum is applied to ARC2D, a flow code developed and being used at NASA Ames Research Center. When compared to eigenvalue annihilation, the *shifting* method clearly establishes its superiority. For the ARC2D code, an efficiency of 20 to 33% has been achieved by this method.

AN EFFICIENT METHOD FOR COMPUTING INVARIANT MANIFOLDS OF PLANAR MAPS. Dana Hobson. *Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A.*

An efficient method for computing invariant manifolds of mappings in the plane is described and compared to a simple method in common use. The emphasis is on numerically producing smoothly resolved segments of invariant manifolds of arbitrary length while requiring a minimum number of calls to the map itself. A brief estimate of errors is given and applications are discussed. Qualitative and quantitative comparisons between the two methods are made using an example problem. The present method is applied to computing unstable manifolds for the well-known periodically forced Duffing system and the Hénon map (for which the manifold is a strange attractor).

NUMERICAL STUDY OF A SINGULAR DIFFERENTIAL EQUATION RELEVANT FOR THE FINITE β TEARING MODE IN A TOROIDAL PLASMA. M. S. Chu, J. M. Greene, M. Klasky, and M. S. Chance. *General Atomics, San Diego, California 92186-9784, U.S.A.*

The generalized Green's function method proposed by Miller and Dewar and Pletzer for solving the singular differential equation occurring in the finite $\beta$ tearing mode problem has been tested numerically on a model differential equation. This method is compatible with a variational formulation of the problem and gives accurate numerical answers with high powers of convergence with respect to the number of grid points used. When the method is extended to the more physically relevant two-sided problem at moderate pressure gradients, a less stringent condition on the Frobenius expansion is required because the principal value of the otherwise divergent integrals associated with the method is shown to exist.

STABILITY AND ACCURACY OF DIFFERENCING METHODS FOR VISCOPLASTIC MODELS IN WAVECODES. S. A. Silling. *Computational Physics and Mechanics Division, Sandia National Laboratories, Albuquerque, New Mexico 87185, U.S.A.*

The numerical stability and truncation error of a family of differencing schemes for viscoplastic constitutive relations in wavecodes is investigated. A von Neumann stability analysis is performed for a one-dimensional model problem. This analysis identifies two differencing methods that have no restriction on the time step size beyond the usual Courant–Friedrichs–Lewy condition. One of these methods is first-order accurate, and the other is second-order accurate. Implementation of one of these methods in the three-dimensional wavecode CTH is discussed.

A SUITABLE BOUNDARY CONDITION FOR BOUNDED PLASMA SIMULATION WITHOUT SHEATH RESOLUTION. S. E. Parker, R. J. Procassini, and C. K. Birdsall. *Electronics Research Laboratory, University of California, Berkeley, California 94720, U.S.A.*; B. I. Cohen. *Magnetic Fusion Energy Division, Lawrence Livermore National Laboratory, Livermore, California 94550, U.S.A.*

We have developed a technique that allows for a sheath boundary layer *without* having to resolve the inherently small space and time scales of the sheath region. We refer to this technique as the *logical sheath* boundary condition. This boundary condition, when incorporated into a direct-implicit particle code, permits large space- and time-scale simulations of bounded systems, which would otherwise be impractical on current supercomputers. The lack of resolution of the collector sheath potential drop obtained from conventional implicit simulations at moderate values of $\omega_{pe}\Delta t$ and $\Delta z/\lambda_{De}$ provides the motivation for the development of the logical sheath boundary condition. The algorithm for use of the logical sheath boundary condition in a particle simulation is presented. Results from simulations which use the logical sheath boundary condition are shown to compare reasonably well with those from an analytic theory and simulations in which the sheath is resolved.

NUMERICALLY INDUCED PHASE SHIFT IN THE KdV SOLITON. R. L. Herman. *Mathematical Sciences Department, University of North Carolina at Wilmington, Wilmington, North Carolina 28403-3297, U.S.A.*; C. J. Knickerbocker. *Department of Mathematics, St. Lawrence University, Canton, New York 13617, U.S.A.*

When using a finite difference scheme to study the motion of a KdV soliton, a shift in the position of the soliton from the exact solution is detected. In this paper we retain the lowest order terms in the truncation error and treat them analytically as a perturbation of the KdV equation. It is found that perturbation theory can be used to determine the numerically induced shift.

AN ADAPTIVELY-REFINED CARTESIAN MESH SOLVER FOR THE EULER EQUATIONS. Darren De Zeeuw and Kenneth G. Powell. *University of Michigan, Department of Aerospace Engineering, Ann Arbor, Michigan 48109-2140, U.S.A.*

A method for adaptive refinement of a Cartesian mesh for the solution of the steady Euler equations is presented. The algorithm creates an initial uniform mesh and cuts the body out of that mesh. The mesh is then refined based on body curvature. Next, the solution is converged to a steady state using a linear reconstruction and Roe's approximate Riemann solver. Solution-adaptive refinement of the mesh is then applied to resolve high-