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A PARALLEL DAVIDSON-TYPE ALGORITHM FOR SEVERAL EIGENVALUES. Leonardo Borges and Suely Oliveira. *Computer Science Department, Texas A&M University, College Station, Texas 77802.* E-mail: suely@cs.tamu.edu.

In this paper we propose a new parallelization of the Davidson algorithm adapted for many eigenvalues. In our parallelization we use a relationship between two consecutive subspaces which allows us to calculate eigenvalues in the subspace through an arrowhead matrix. Theoretical timing estimates for the parallel algorithm are developed and compared against our numerical results on the Paragon. Finally our algorithm is compared against another recent parallel algorithm for multiple eigenvalues, but based on Arnoldi: PARPACK.

NUMERICAL SIMULATION OF RANDOMLY FORCED TURBULENT FLOWS. L. Machiels and M. O. Deville. *Fluid Mechanics Laboratory, Swiss Federal Institute of Technology, CH-1015, Lausanne, Switzerland.* E-mail: machiels@dgm.epfl.ch.

Several authors have proposed studying randomly forced turbulent flows (e.g., E. A. Novikov, *Soviet Physics JETP*, **20**(5), 1290 1965). More recently, theoretical investigations (e.g., renormalization group) have focused on white-noise forced Navier–Stokes equations (V. Yakhot and S. A. Orszag, *J. Sci. Comput.* **1**(1), 3 1986). The present article aims to provide an appropriate numerical method for the simulation of randomly forced turbulent systems. The spatial discretization is based on the classical Fourier spectral method. The time integration is performed by a second-order Runge–Kutta scheme. The consistency of an extension of this scheme to treat additive noise stochastic differential equations is proven. The random number generator is based on lagged Fibonacci series. Results are presented for two randomly forced problems: the Burgers and the incompressible Navier–Stokes equations with a white-noise in time forcing term characterized by a power-law correlation function in spectral space. A variety of statistics are computed for both problems, including the structure functions. The third-order structure functions are compared with their exact expressions in the inertial subrange. The influence of the dissipation mechanism (viscous or hyperviscous) on the inertial subrange is discussed. In particular, probability density functions of velocity increments are computed for the Navier–Stokes simulation. Finally, for both Burgers and Navier–Stokes problems, our results support the view that random sweeping is the dominant effect of the large-scale motion on the small-scales.

NUMERICAL SCHEMES FOR THE HAMILTON–JACOBI AND LEVEL SET EQUATIONS ON TRIANGULATED DOMAINS. Timothy J. Barth* and James A. Sethian†. **Information Sciences Directorate, NASA Ames Research Center, Moffett Field, California 94035; and †Department of Mathematics, University of California at Berkeley, Berkeley, California 94720.* E-mail: barth@nas.nasa.gov and sethian@math.berkeley.edu.

Borrowing from techniques developed for conservation law equations, numerical schemes which discretize the Hamilton–Jacobi (H-J), level set, and Eikonal equations on triangulated domains are presented. The first scheme is a provably monotone discretization for the H-J equations. Unfortunately, the basic scheme lacks Lipschitz continuity of the numerical Hamiltonian. By employing a "virtual" edge flipping technique, local Lipschitz continuity of the numerical flux is restored on acute triangulations. Next, schemes are introduced and developed based on the weaker concept of positive coefficient approximations for homogeneous Hamiltonians. These schemes possess a discrete maximum principle on arbitrary triangulations and exhibit local Lipschitz continuity of the numerical Hamiltonian. Finally, a class of Petrov–Galerkin approximations is considered. These schemes are stabilized via a least-squares

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bilinear form. The Petrov–Galerkin schemes do not possess a discrete maximum principle but generalize to high order accuracy. Discretization of the level set equation also requires the numerical approximation of a mean curvature term. A simple mass-lumped Galerkin approximation is presented in Section 6 and analyzed using maximum principle analysis. The use of unstructured meshes permits several forms of mesh adaptation which have been incorporated into numerical examples. These numerical examples include discretizations of convex and nonconvex forms of the H-J equation, the Eikonal equation, and the level set equation.

Solving Stiff Differential Equations with the Method of Patches. David Brydon,*,† John Pearson,† and Michael Marder*. **Department of Physics, Center for Nonlinear Dynamics, University of Texas at Austin, Austin, Texas 78712; and †Los Alamos National Laboratory, MS B258, Los Alamos, New Mexico 87545.* E-mail: brydon@lanl.gov or brydon@physics.utexas.edu; pearson@lanl.gov; and marder@chaos.ph.utexas.edu.

We introduce a new method for solving very stiff sets of ordinary differential equations. The basic idea is to replace the original nonlinear equations with a set of equally stiff equations that are piecewise linear, and therefore can be solved exactly. We demonstrate the value of the method on small systems of equations for which some other methods are inefficient or produce spurious solutions, estimate error bounds, and discuss extensions of the method to larger systems of equations and to partial differential equations.

Efficient Pseudospectral Flow Simulations in Moderately Complex Geometries. Costas D. Dimitropoulos, Brian J. Edwards, Kyung-Sun Chae, and Antony N. Beris. *Department of Chemical Engineering, University of Delaware, Newark, Delaware 19716.* E-mail: beris@che.udel.edu.

A computationally efficient pseudospectral method is developed for incompressible flow simulations in two-dimensional geometries involving periodicity in one direction and significant surface deformations. A pseudoconformal mapping is used to map the flow domain into a rectangle, thereby establishing an orthogonal curvilinear coordinate system within which the governing equations are formulated. The time integration of the spectrally discretized, two-dimensional momentum equations is performed by a second-order mixed explicit/implicit time integration scheme. The satisfaction of the continuity equation is obtained through the solution of a Poisson equation for the pressure and the use of the influence matrix technique. A highly efficient iterative solver has been developed for the solution of a generalized Stokes problem at each time step based on a spectrally preconditioned, biconjugate gradient algorithm, which exhibits almost linear scalability, requiring an order $N \log_2 N$ number of operations, where N is the number of unknowns. Numerical results are presented for two-dimensional steady, oscillatory, and peristaltic flows within an undulating channel, which agree well with previous results that have appeared in the literature.