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Abstracts of Papers to Appear

A Nonlinear Galerkin Method for the Shallow-Water Equations on Periodic Domains. Saulo R. M. Barros* and José W. Cárdenas.† *Departamento de Matemática Aplicada, Universidade de São Paulo, R. do Matão, 1010, 05508-900 São Paulo, Brazil; and †Laboratório Nacional de Computação Científica, Av. Getúlio Vargas, 333, 25651-070, Petrópolis, R. J., Brazil.

A nonlinear Galerkin method for the shallow-water equations is developed, based on spectral transforms. The scheme is compared to a pseudo-spectral Galerkin method. Our numerical results indicate that the nonlinear scheme has the potential advantage of providing similar accuracy at a lower cost than the Galerkin method. The nonlinear method has also less restrictive stability conditions.

A Class of Approximate Riemann Solvers and Their Relation to Relaxation Schemes. Randall J. Le Veque* and Marica Pelanti.† *Department of Applied Mathematics and Department of Mathematics, University of Washington, Box 352420, Seattle, Washington 98195-2420; and †Department of Applied Mathematics, University of Washington, Box 352420, Seattle, Washington 98195-2420.

We show that a simple relaxation scheme of the type proposed by Jin and Xin [*Comm. Pure Appl. Math.* **48**, 235 (1995)] can be reinterpreted as defining a particular approximate Riemann solver for the original system of m conservation laws. Based on this observation, a more general class of approximate Riemann solvers is proposed which allows as many as $2m$ waves in the resulting solution. These solvers are related to more general relaxation systems and connections with several other standard solvers are explored. The added flexibility of $2m$ waves may be advantageous in deriving new methods. Some potential applications are explored for problems with discontinuous flux functions or source terms.

Analysis of Shear Layers in a Fluid with Temperature-Dependent Viscosity. Donald J. Estep,* Sjoerd M. Verduyn Lunel,† and Roy D. Williams.‡ *Department of Mathematics, Colorado State University, Fort Collins, Colorado, 80523; †Mathematisch Instituut, Universiteit Leiden, P.O. Box 9512, 2300 RA Leiden, The Netherlands; and ‡Center for Advanced Computing Research, California Institute of Technology, Pasadena, California 91125.

The presence of viscosity normally has a stabilizing effect on the flow of a fluid. However, experiments show that the flow of a fluid in which viscosity decreases as temperature increases tends to form shear layers, narrow regions in which the velocity of the fluid changes sharply. In general, adiabatic shear layers are observed not only in fluids but also in thermo-plastic materials subject to shear at a high-strain rate and in combustion and there is widespread interest in modeling their formation. In this paper, we investigate a well-known model representing a basic system of conservation laws for a one-dimensional flow with temperature-dependent viscosity using a combination of analytical and numerical tools. We present results to substantiate the claim that the formation of shear layers can only occur in solutions of the model when the viscosity decreases sufficiently quickly as temperature increases and we further analyze the structure and stability properties of the layers.

Implicit Monte Carlo Diffusion—An Acceleration Method for Monte Carlo Time-Dependent Radiative Transfer Simulations. N. A. Gentile. University of California, Lawrence Livermore National Laboratory, Livermore, California 94550.

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Implicit Monte Carlo (IMC) is often employed to numerically simulate radiative transfer. In problems with regions that are characterized by a small mean free path, IMC can take a prohibitive amount of time, because many particle steps must be simulated to advance the particle through the time step. Problems containing regions with a small mean free path can frequently be accurately simulated much more quickly by employing the diffusion equation as an approximation. However, the diffusion approximation is not accurate in regions of the problem where the mean free path is large.

We present a method for accelerating time-dependent Monte Carlo radiative transfer calculations by using a discretization of the diffusion equation to calculate probabilities that are used to advance particles in regions with small mean free paths. The method is demonstrated on problems with one-and two-dimensional orthogonal grids. It results in decreases in run time of more than an order of magnitude on these problems, while producing answers with accuracy comparable to pure IMC simulations. We call the method Implicit Monte Carlo Diffusion, which we abbreviate IMD.

A Vorticity-Based Method for Incompressible Unsteady Viscous Flows. L. Qian and M. Vezza. Department of Aerospace Engineering, University of Glasgow, Glasgow G12 8QQ, Scotland, United Kingdom.

A novel approach is presented, based on the integral form of the vorticity formulation, in which the vorticity transport equation is solved by using the cell-centred finite-volume method, while the velocities needed at the centre of each control volume are calculated by a modified Biot–Savart formula in conjunction with a fast summation algorithm. The vorticity and mass conservation in the flow are guaranteed during the calculation by virtue of the finite volume approach and the method of implementing the boundary conditions at the body surface. As an example, both the early stage development and long term evolution of the flow around an impulsively started circular cylinder are computed using the method. The present results are compared with other numerical and experimental results for the same flow problem and show good agreement.