JOURNAL OF COMPUTATIONAL PHYSICS 86, 256–258 (1990)

Abstracts of Papers to Appear in Future Issues

FAST MOVING SUB-SUBSONIC SHOCKS IN CLOSED-END TUBES. M. Valorani and M. Di Giacinto, *Universita degli Studi di Roma "La Sapienza," Rome, ITALY.*

The problem of the detection, formation and propagation of a fast moving shock in a wholly subsonic environment inside a closed-end tube is solved by a finite-difference integration method belonging to the family of shock-fitting techniques. The shock is fitted by locally combining the method of characteristics with the Rankine–Hugoniot relations, while the regions of smooth flow are solved via a λ scheme. A special attention is devoted to the problems related to shock detection and formation and to the treatment of the reflection of the shock at the boundaries. The pressure oscillation data demonstrate that the shock transition remains sharp and oscillation-free even after many wave cycles. The spectral analysis performed on these data shows that the energy distribution among modes is in good agreement with the analytical solution. These results point out the characteristics of low dissipation and dispersion of the method. For these reasons, the proposed integration technique is particularly well suited for the study of nonlinear axial mode instabilities (usually referred to as "triggered instabilities") in combustion chambers.

GALERKIN SCHEMES AND THE SINC–GALERKIN METHOD FOR SINGULAR STURM–LIOUVILLE PROBLEMS. Mary Jarratt, *Boise State University, Boise, Idaho, USA*; John Lund and Kenneth L. Bowers, *Montana State University, Bozeman, Montana, USA.*

Galerkin schemes for the computation of the eigenvalues of both regular and singular Sturm–Liouville problems are compared to the Sinc–Galerkin method. Contrasted are numerical results as well as qualitative features. The schemes discussed include finite element, spectral, and collocation. The equivalence of the spectral method with sinc basis functions to the sinc-collocation scheme provides this technique with many distinctive features. Highlighted among these features through the course of the computational comparisons is its ease of implementation, its exponential accuracy in the presence of singularities, and its all-around versatility.

BENCHMARKING THE PROPAGATOR METHOD FOR NONLINEAR SYSTEMS: A BURGERS–KORTEWEG–DE VRIES EQUATION. D. G. Cauci, *University of California, Santa Barbara, California, USA*; O. A. Karakashian, *University of Tennessee, Knoxville, Tennessee, USA.*

A new method for solving a generalized Burgers–Korteweg–deVries (BKdV) equation is presented. This new method consists of two symbiotic aspects—analytical and numerical, respectively. The analytical aspect consists of obtaining the propagators—which are the nonlinear analogues of Green's functions—for the BKdV equation, and subsequently using these propagators to obtain the BKdV solution as a fixed-point integral equation. The numerical aspect consists of developing a highly efficient and accurate method for solving this integral equation. Benchmarking comparisons using the Korteweg–deVries and Burgers equations indicate that our new method is efficient, accurate, and robust.

0021-9991/90 $3.00

THEORY OF MULTICOLOR LATTICE GAS: A CELLULAR AUTOMATON POISSON SOLVER. H. Chen, *Los Alamos National Laboratory, Los Alamos, New Mexico, USA*; W. H. Matthaeus, *University of Delaware, Newark, Delaware, USA*; L. W. Klein, *Applied Research Corporation, Landover, Maryland, USA.*

A class of cellular automata models is considered, consisting of a quiescent hydrodynamic lattice gas with multiple-valued passive labels or "colors." Controlled sources of particle color are introduced on the lattice, as are collisions that change individual particle colors while preserving net color. This lattice gas model is shown to be equivalent, in steady state, to a solution to a Poisson equation, with source function proportional to the rate of color introduction and inversely proportional to the intrinsic color diffusivity. The rigorous proofs of the essential features of the multicolor lattice gas are facilitated by use of an equivalent "subparticle" representation in which the color is represented by underlying two-state "spins." Theorems deduced in this way are valid for arbitrary numbers of allowed color values. For example, it is shown that the color diffusivity depends only on the density, for all models of this type. Some preliminary investigations of the efficiency and accuracy of the method are also discussed. Rates of relaxation to the steady state are estimated and schemes for introducing Dirichlet and Neumann boundary conditions are described. Two simple numerical test cases are presented that verify the theory. These results, most of which easily generalize to three dimensions, suggest that a lattice gas of this type may be a useful tool for solution of the Poisson equation.

A FAST ADAPTIVE VORTEX METHOD FOR PATCHES OF CONSTANT VORTICITY IN TWO DIMENSIONS. Thomas F. Buttke, *Princeton University, Princeton, New Jersey, USA.*

We present a fast numerical method for solving the incompressible Euler's equation in two dimensions for the special case when the flow field can be represented by patches of constant vorticity. The method is an adaptive vortex method in which cells (vortex blobs) of multiple scales are used to represent the patches so that the number of vortex blobs needed to approximate the patches is proportional to the length of the boundary curve of the patch and inversely proportional to the width of the smallest blob (cell) used. Points along the boundaries of the patches are advected according to the velocity obtained from the approximating vortices.

A NUMERICAL METHOD FOR FINDING THE GROUND STATES OF ONE-DIMENSIONAL SYSTEMS. Kevin Hood, *Université de Sherbrooke, Sherbrooke, Quebec, CANADA.*

Griffiths and Chou introduced a method of effective potentials for finding the ground states of a class of systems that can be described by classical one-dimensional Hamiltonians with nearest neighbor interactions. In practice the effective potentials must be solved numerically by discretization on a grid of N points. Existing algorithms have calculation times that vary as N^2 or worse. We show how this can be reduced to linear in N by means of straightforward optimizations that take advantage of the properties of the effective potentials.

GENERALIZED FLUX-VECTOR SPLITTING AND ROE AVERAGE FOR AN EQUILIBRIUM REAL GAS. Marcel Vinokur, *Sterling Software, Palo Alto, California, USA*; Jean-Louis Montagne, *NASA Ames Research Center, Moffett Field, California, USA.*

The flux-vector splittings of Steger–Warming and van Leer, and Roe's approximate Riemann solver are generalized to arbitrary equilibrium gas laws. Comparisons with other formulations are made.

AN ARTIFICIAL COMPRESSION METHOD FOR ENO SCHEMES: THE SLOPE MODIFICATION METHOD. Huanan Yang, *University of California at Los Angeles, Los Angeles, California, USA.*

A simple and efficient method of artificial compression is introduced. This method is based on a modification of the slopes of the ENO reconstruction and, with the help of suitably chosen parameters, greatly improves the resolution of the contact discontinuities. Numerical examples are provided to test the performance of the method and to give some suggestions as to the choice of the parameters.

A NEW LAGRANGIAN METHOD FOR STEADY SUPERSONIC FLOW COMPUTATION. C. Y. Loh and W. H. Hui, *University of Waterloo, Waterloo, Ontario, CANADA.*

This paper studies the problem of steady two-dimensional supersonic flow of an inviscid compressible fluid using the new Lagrangian formulation of Hui and Van Roessel, in which the stream function and the Lagrangian time are used as independent variables. A shock capturing method is developed by applying the first-order Godunov scheme to the conservation form equations of this formulation. The method is fast and robust. Furthermore, extensive comparisons with exact solutions and with the second order Godunov scheme of Glaz and Wardlaw based on the Eulerian formulation show that the first-order Lagrangian method generally attains the same level of accuracy as the second-order Eulerian method and is even better in resolving slip line discontinuities.

THE MONTE CARLO FLUX METHOD. G. Schaefer and P. Hui, *Polytechnic University, Farmingdale, New York, USA.*

A new computational method—*Monte Carlo Flux Method* (MCF)—is presented, which allows calculating electron distribution functions in weakly ionized gases of stationary molecules subjected to electric and magnetic fields. This method should be equally suited for calculating electron distribution functions in semiconductors. The method utilizes a modified Monte Carlo code to calculate transition probabilities for electrons between phase cells. Transport equations utilizing these transition probabilities are used to calculate steady state and transient distribution functions. Electron generation and depletion processes are easily incorporated. Numerical calculations of space independent electron distribution functions in Nitrogen (N_2) are presented for both steady state and transient conditions and compared with results obtained with *Conventional Monte Carlo* (CMC) calculations. The major advantages of the new method are discussed.

COMPUTATION OF SUPERCONDUCTIVITY IN THIN FILMS. San Yih Lin, *National Chen Kung University, Tainan, Taiwan, REPUBLIC of CHINA*; Yisong Yang, *University of Minnesota, Minneapolis, Minnesota, USA.*

This paper presents a method for computing the physical states in superconducting thin films under the influence of a parallel uniform external magnetic field. The governing equations are the Ginzburg–Landau equations which in general possess multiple solutions and the physical states are those which minimize the total energy. In our approach the energy functional is used to generate a gradient flow and the physical states are obtained in the large time limit. The numerical results completely verify the Meissner effect and the fine structure of the solutions exhibits the occurrence of a symmetric nucleation of superconductivity at intermediate fields.

Printed in Belgium