Journal of Computational Physics **149,** 198–199 (1999)
Article ID jcph.1999.6189, available online at http://www.idealibrary.com on IDEAL®

Abstracts of Papers to Appear

THE SEMI-LAGRANGIAN METHOD FOR THE NUMERICAL RESOLUTION OF THE VLASOV EQUATION. Eric Sonnendrücker,* Jean Roche,* Pierre Bertrand,† and Alain Ghizzo.† **IECN—Projet Numath, and* †*LPMI, Université Henri Poincaré Nancy 1, 54506 Vandoeuvre-lès-Nancy Cedex, France.* E-mail: Eric.Sonnendrucker@iecn.u-nancy.fr, Jean.Roche@iecn.u-nancy.fr, Pierre.Bertrand@lpmi.u-nancy.fr, Alain.Ghizzo@lpmi.u-nancy.fr.

The numerical resolution of kinetic equations and in particular of Vlasov-type equations is most of the time performed using PIC (particle in cell) methods which consist in describing the time evolution of the equation through a finite number of particles which follow the characteristic curves of the equation, the interaction with the external and self consistent fields being resolved using a grid. Another approach consists in computing directly the distribution function on a grid by following the characteristics backward in time for one time step and interpolating the value at the feet of the characteristics using the grid points values of the distribution function at the previous time step. In this report we introduce this last method, which couples the Lagrangian and Eulerian point of views, and its use for the Vlasov equation and equations derived from it.

AN r-ADAPTIVE FINITE ELEMENT METHOD BASED UPON MOVING MESH PDES. Weiming Cao,* Weizhang Huang,† and Robert D. Russell.‡ **Department of Mathematics and Statistics, Simon Fraser University, Burnaby, Brithish Columbia V5A 1S6, Canada;* †*Department of Mathematics, University of Kansas, Lawrence, Kansas 66045;* ‡*Department of Mathematics and Statistics, Simon Fraser University, Burnaby, Brithish Columbia V5A 1S6, Canada.* E-mail: wcao@cs.sfu.ca, huang@math.ukans.edu, rdr@cs.sfu.ca.

We present an r-adaptive finite element method for solving time-dependent partial differential equations. A moving mesh partial differential equation, or MMPDE, is used to move the (unstructured) mesh in time. A key to the application of the MMPDE to unstructured mesh movement is to define a computational domain and then compute the corresponding computational mesh as the image of an initial mesh on the given physical domain. The finite element discretization of physical PDEs on moving meshes is addressed. Numerical results are presented to demonstrate the capability of the mesh movement strategy and the r-adaptive finite element method. A fully developed r-adaptive finite element method can be expected to be ideally suited to complement the currently popular $h-p$ finite element methods and to provide increased reliability and efficiency for mesh adaptation.

A PROJECTION METHOD FOR LOW SPEED FLOWS. Phillip Colella* and Karen Pao.† **Department of Mechanical Engineering, University of California, Berkeley, California 94720;* †*Scientific Computing Group (CIC-19), Los Alamos National Laboratory, Los Alamos, New Mexico 87545.* E-mail: colella@watt.me.berkeley.edu, kip@lanl.gov.

We propose a decomposition applicable to low speed, inviscid flows of all Mach numbers less than 1. By using the Hodge decomposition, we may write the velocity field as the sum of a divergence-free vector field and a gradient of a scalar function. Evolution equations for these parts are presented. A numerical procedure based on this decomposition is designed, using projection methods for solving the incompressible variables and a backward-Euler method for solving the potential variables. Numerical experiments are included to illustrate various aspects of our algorithm.

0021-9991/99 $30.00

A STAGGERED MESH ALGORITHM USING HIGH ORDER GODUNOV FLUXES TO ENSURE SOLENOIDAL MAGNETIC FIELDS IN MAGNETOHYDRODYNAMIC SIMULATIONS. Dinshaw S. Balsara* and Daniel S. Spicer.† **N.C.S.A., University of Illinois at Urbana–Champaign, Urbana, Illinois 61801; †Code 930, NASA/GSFC.* E-mail: dbalsara@ncsa.uiuc.edu, spicer@gauss.gsfc.nasa.gov.

The equations of magnetohydrodynamics (MHD) have been formulated as a hyperbolic system of conservation laws. In that form it becomes possible to use higher order Godunov schemes for their solution. This results in a robust and accurate solution strategy. However, the magnetic field also satisfies a constraint that requires its divergence to be zero at all times. This is a property that cannot be guaranteed in the zone-centered discretizations that are favored in Godunov schemes without involving a divergence cleaning step. In this paper we present a staggered mesh strategy which directly uses the properly upwinded fluxes that are provided by a Godunov scheme. The process of directly using the upwinded fluxes relies on a duality that exists between the fluxes obtained from a higher order Godunov scheme and the electric fields in a plasma. By exploiting this duality we have been able to construct a higher order Godunov scheme that ensures that the magnetic field remains divergence-free up to the computer's round-off error. We have even presented a variant of the basic algorithm that uses multidimensional features in the flow to design an upwinded strategy that aligns itself with the predominant upwinded direction in the flow. Several stringent test problems have been devised to show that the scheme works robustly and accurately in all situations. In doing so it is shown that a scheme that involves a collocation of magnetic field variables that is different from that traditionally favored in the design of higher order Godunov schemes can nevertheless offer the same robust and accurate performance of higher order Godunov schemes provided the properly upwinded fluxes from the Godunov methodology are used in the scheme's construction.

TIME-DOMAIN DECONVOLUTION REMOVES THE EFFECTS OF NEAR-FIELD SCATTERERS. Thomas M. Roberts. *Air Force Research Laboratory/SNHA, 31 Grenier Street, Hanscom Air Force Base, Massachusetts 01731.* E-mail: tmr@zippy.rl.plh.af.mil.

This paper studies deconvolution algorithms for removing the interference caused by objects near an antenna. Infinitely many time-domain algorithms are considered, the best of which may compete with frequency-domain methods. Special care is taken to find a stable deconvolution algorithm that also accommodates the discontinuity-related numerical noise in standard finite-difference time-domain data.