Journal of Computational Physics **179,** 346–347 (2002)
doi:10.1006/jcph.2002.7100

Abstracts of Papers to Appear

Interpolating Wavelet-Collocation Method of Time-Dependent Maxwell's Equations: Characterization of Electrically Large Optical Waveguide Discontinuities. Masafumi Fujii and Wolfgand J. R. Hoefer. Department of Electrical and Computer Engineering, University of Victoria, Victoria, British Columbia V8W 3P6, Canada.

Biorthogonal interpolating wavelets have been applied to electromagnetic field modeling through the wavelet-collocation method in time domain, yielding a versatile first-principle algorithm for the solution of time-dependent Maxwell's equations with inhomogeneous media. The resulting scheme maintains high accuracy, while, by virtue of its subgridding capability, significant reduction of the computational expenditure has been achieved. The proposed method has been applied to the analysis of two-dimensional dielectric waveguide discontinuities. Particularly for the modeling of electrically large optical waveguides, where the dimension of the analyzed structure is much larger than the wavelength of the highest frequency content of the transmitted signal, the proposed method has been proven to be highly efficient compared to the standard finite-difference method.

A Particle-Mesh Method for the Shallow Water Equations Near Geostrophic Balance. Jason Frank* and Sebastian Reich.† *CWI, P.O. Box 94079, 1090 GB Amsterdam, The Netherlands; and †Imperial College, Department of Mathematics, 180 Queen's Gate, London, SW7 2BZ, United Kingdom.

In this paper we outline a new particle-mesh method for rapidly rotating shallow water flows based on a set of regularized equations of motion. The time-stepping method uses an operator splitting of the equations into an Eulerian gravity wave part and a Lagrangian advection part. An essential ingredient is the advection of absolute vorticity by means of translated radial basis functions. We show that this implies exact conservation of enstrophy. The method is tested on two model problems based on the qualitative features of the solutions obtained (i.e., dispersion or smoothness of potential vorticity contours) as well as on the increase in mean divergence level.

A Vortex Particle Method for Two-Dimensional Compressible Flow. Jeff D. Eldredge, Tim Colonius, and Anthony Leonard. Division of Engineering and Applied Science, California Institute of Technology, Pasadena, California 91125.

A vortex particle method is developed for simulating two-dimensional, unsteady compressible flow. The method uses the Helmholtz decomposition of the velocity field to separately treat the irrotational and solenoidal portions of the flow, and the particles are allowed to change volume to conserve mass. In addition to having vorticity and dilatation properties, the particles also carry density, enthalpy, and entropy. The resulting evolution equations contain terms that are computed with techniques used in some incompressible methods. Truncation of unbounded domains via a nonreflecting boundary condition is also considered. The fast multipole method is adapted to compressible particles in order to make the method computationally efficient. The new method is applied to several problems, including sound generation by corotating vortices and generation of vorticity by baroclinic torque.

A Direct Simulation Method for Subsonic, Microscale Gas Flows. Quanhua Sun and Iain D. Boyd. Department of Aerospace Engineering, University of Michigan, Ann Arbor, Michigan 48109.

Microscale gas flows are the subject of increasingly active research due to the rapid advances in micro-electro-mechanical systems (MEMS). The rarefied phenomena in MEMS gas flows make molecular-based simulations

0021-9991/02 $35.00

desirable. However, it is necessary to reduce the statistical scatter in particle methods for microscale gas flows. In this paper, the development of an information preservation (IP) method is described. The IP method reduces the statistical scatter by preserving macroscopic information of the flow in the particles and the computational cells simulated in the direct simulation Monte Carlo (DSMC) method. The preserved macroscopic information of particles is updated during collisions and is then modified to include the pressure field effects excluded in the collisions. An additional energy transfer model is proposed to describe the energy flux across an interface, and a collision model is used to redistribute the information after both particle–particle and particle–surface collisions. To validate the IP method, four different flows are simulated and the solutions are compared against DSMC results. The results from the IP method generally agree very well with the DSMC results for steady flows and low frequency unsteady flows ranging from the near-continuum regime to the free-molecular regime.

Stability of Explicit–Implicit Hybrid Time-Stepping Schemes for Maxwell's Equations. Thomas Rylander and Anders Bondeson. Department of Electromagnetics and Center for Computational Electromagnetics, Chalmers University of Technology, S-412 96 Göteborg, Sweden.

An improved version of the stable FEM–FDTD hybrid method [T. Rylander and A. Bondeson, *Comput. Phys. Commun.* **125**, 75 (2000)] for Maxwell's equations is presented. The new formulation has a modified time-stepping scheme and is rigorously proven to be stable for time steps up to the stability limit for the FDTD. The new scheme gives less reflection at the boundary between the structured and unstructured grids than the original formulation. The hybrid method is compared to the FDTD, with staircasing for scattering from a conducting sphere. The discretization errors of the hybrid show quadratic dependence on mesh size, while the scaling is less clear for the FDTD. The FDTD gives errors that are 5–60 times higher than that of the hybrid, depending on resolution and staircasing strategy.