Journal of Computational Physics **166,** 186–187 (2001)
doi:10.1006/jcph.2001.6693, available online at http://www.idealibrary.com on IDEAL®

Abstracts of Papers to Appear

Simulation of a Waveguide Filter Using Wavelet-Based Numerical Homogenization. Per-Olof Persson* and Olof Runborg.† *COMSOL AB, Tegnérgatan 23, SE-111 40 Stockholm, Sweden; and †Program in Applied and Computational Mathematics, Fine Hall, Princeton University, Princeton, New Jersey 08544.

We apply wavelet-based numerical homogenization to the simulation of an optical waveguide filter. We use the method to derive approximate one-dimensional models and subgrid models of the filter. Numerical examples of the technique are presented, and the computational gains are investigated.

On Consistent Time-Integration Methods for Radiation Hydrodynamics in the Equilibrium Diffusion Limit: Low Energy-Density Regime. J. W. Bates,* D. A. Knoll,† W. J. Rider,‡ R. B. Lowrie,‡ and V. A. Mousseau.‡ *Plasma Physics Division, Naval Research Laboratory, Washington, DC 20375; †Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545; and ‡Computational and Computer Science Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545.

We compare the accuracy of three mixed explicit–implicit schemes for simulating nonrelativistic, radiative hydrodynamic phenomena in the equilibrium diffusion limit. Only the "low energy-density" regime is considered, where it is possible to ignore the effects of radiation pressure and energy density in comparison to the fluid pressure and energy density. The governing equations are then those of compressible Eulerian hydrodynamics with a nonlinear, radiative heat-transfer term appearing in the energy equation. All three finite-volume methods in this study utilize an explicit Godunov method with an approximate Riemann solver to integrate the Euler equations. However, the three differ in their iterative treatment of the radiation diffusion term which is handled in an "operator-split" fashion. In the first method, diffusive effects are computed with a linearized implicit technique that does not converge nonlinearities within a computational time step. In the other two methods, a Jacobian-free Newton–Krylov procedure is used to converge the nonlinearities, and improved accuracy (but not always greater efficiency) is achieved over the more traditional linearized-implicit approach. The two Newton–Krylov methods differ in their order of accuracy in time; one is strictly first-order accurate while the other attempts to achieve second-order accuracy by making use of a predictor–corrector architecture. Several examples are considered to demonstrate the convergence properties of the three schemes, but attention is limited to spherically symmetric problems such as the one-dimensional point explosion.

Three-Dimensional Vortex Methods for Particle Laden Flows with Two-Way Coupling. J. H. Walther* and P. Koumoutsakos.*,† *Institute of Computational Sciences, ETH Zürich, CH-8092 Zürich, Switzerland; and †CTR, NASA Ames 202A-I, Moffett Field, California 94035.

This paper presents a three-dimensional viscous vortex method for the simulation of particulate flows with two-way coupling. The flows are computed using Lagrangian vortex elements advected with the local velocity, while their strength is modified in order to account for viscous diffusion, vortex stretching, and the generation of vorticity induced by the particles. The solid particles move subject to viscous drag and gravity creating vorticity which is discretised using vortex elements. The method adaptively tracks the evolution of the vorticity field and the generation of new computational elements to account for the vorticity source term. A key aspect of the present scheme is the re-meshing of the computational elements in order to adaptively accommodate the production of vorticity induced by the solid particles and to ensure sufficient support for the proper resolution of the diffusion

0021-9991/01 $35.00

equation. High-order moment conserving formulas are implemented that maintain the adaptive character of the method while they remain local in order to minimize the computational cost. These formulas are also implemented in the particle-mesh interpolation of the field and particle quantities in the context of a Vortex-in-Cell algorithm. The method is validated against the results of a related finite-difference study for an axisymmetric swirling flow with particles. The method is then applied to the study of a three dimensional particle blob falling under the effect of gravity. It is shown that drastically different behaviors are found depending on the presence of an initial vorticity field.

Numerical Instabilities in Upwind Methods: Analysis and Cures for the "Carbuncle" Phenomenon. Maurizio Pandol* and Domenic D'Ambrosio.† *Dipartimento di Ingegneria Aeronautica e Spaziale, Politecnico di Torino, Corso Duca degli Abruzzi, 24, 10129 Torino, Italy; and †Aerodynamisches Institut, RWTH Aachen, Wuellnerstr. zw. 5 u. 7, 52064 Aachen, Germany.

Some upwind formulations promote severe instabilities that originate in the numerical capturing of shocks; this is known as the "carbuncle" phenomenon. An analysis of the linearized form of the algorithms is carried out to explain and to predict the generation of such instabilities. The obtained information is then used to design remedies that only slightly and locally modify the original schemes.

Mathematical Modeling of Boson-Fermion Stars in the Generalized Scalar-Tensor Theories of Gravity. T. L. Boyadjiev,* M. D. Todorov,† P. P. Fiziev,‡ and S. S. Yazadjiev.‡ *Faculty of Mathematics and Computer Science, University of Sofia, 1164 Sofia, Bulgaria; †Faculty of Applied Mathematics and Computer Science, Technical University of Sofia, 1756 Sofia, Bulgaria; and ‡Faculty of Physics, University of Sofia, 1164 Sofia, Bulgaria.

A model of a static boson–fermion star with spherical symmetry based on the scalar–tensor theory of gravity with massive dilaton field is investigated numerically. Since the radius of a star is *a priori* an unknown quantity, the corresponding boundary value problem (BVP) is treated as a nonlinear spectral problem with a free internal boundary. The continuous analogue of Newton method (CANM) for solving this problem is applied. Information about basic geometric functions and the functions describing the matter fields which build a star is obtained. In a physical point of view, the main result is that the structures and properties of a star in the presence of a massive dilaton field depend essentially upon both of its fermionic and bosonic components.