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Abstracts of Papers to Appear

ROBUST NUMERICAL SIMULATION OF POROSITY EVOLUTION IN CHEMICAL VAPOR INFILTRATION. I. TWO SPACE DIMENSION. Shi Jin,* Xuelei Wang,* Thomas L. Starr,† and Xinfu Chen.‡ **School of Mathematics, Georgia Institute of Technology, Atlanta, Georgia 30332; †Department of Chemical Engineering, University of Louisville, Louisville, Kentucky 40292; and ‡Department of Mathematics, University of Pittsburgh, Pittsburgh, Pennsylvania 15260.*

A numerical method is presented for describing pore structure evolution during chemical vapor infiltration densification and other gas–solid reactions involving growth of porous solids. Our method uses the level set equation of the Eulerian formulation coupled with a boundary value problem of the Laplace equation. It allows robust numerical capture of topological changes such as merging and formation of pores during the process. An efficient numerical method for the detection of the inaccessible pores is introduced for models in the kinetic limit, where the front speed is constant. Numerical examples show that this model will accurately predict not only the residual porosity, but also the precise close-off time, location and shape of all pores.

COMPUTATIONAL HARMONIC ANALYSIS FOR TENSOR FIELDS ON THE TWO-SPHERE. Peter J. Kostelec,* David K. Maslen,* Dennis M. Healy, Jr.,† and Daniel N. Rockmore.* **Department of Mathematics, Dartmouth College, Hanover, New Hampshire 03755-3551; and †Mathematics Department, University of Maryland, College Park, Maryland 20742-4015.*

In this paper we describe algorithms for the numerical computation of Fourier transforms of tensor fields on the two-sphere, S^2. These algorithms reduce the computation of an expansion on tensor spherical harmonics to expansions in scalar spherical harmonics and hence can take advantage of recent improvements in the efficiency of computation of scalar spherical harmonic transforms.

A SPECTRAL VANISHING VISCOSITY METHOD FOR LARGE EDDY SIMULATIONS. G.-S. Karamanos and G. E. Karniadakis. *Division of Applied Mathematics, Brown University, Providence, Rhode Island 02912.*

A new simulation approach for high-Reynolds-number turbulent flows is developed, combining concepts of monotonicity in nonlinear conservation laws with concepts of large-eddy simulation. The spectral vanishing viscosity (SVV) is incorporated into the Navier–Stokes equations for controlling high-wavenumber oscillations. Unlike hyperviscosity kernels, the SVV approach involves a second-order operator which can be readily implemented in standard finite element codes. In the work presented here, discretization is performed using hierarchical spectral/hp methods accommodating effectively an *ab initio* intrinsic scale separation. The key result is that monotonicity is enforced via SVV leading to stable discretizations without sacrificing the formal accuracy, i.e., exponential convergence, in the proposed discretization. Several examples are presented to demonstrate the effectiveness of the new approach including a comparison with eddy–viscosity spectral LES of turbulent channel flow. In its current implementation the SVV approach for controlling the small scales is decoupled from the large scales, but a procedure is proposed that will provide coupling similar to the classical LES formulation.

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IMPROVED THIN TUBE MODELS FOR SLENDER VORTEX SIMULATIONS. Omar M. Knio* and Rupert Klein.† *Department of Mechanical Engineering, The Johns Hopkins University, 3400 N. Charles Street, Baltimore, Maryland 21218-2686; and †FB Mathematik & Informatik, Freie Universität Berlin, Arnimallee 2-6, D-14195 Berlin, Germany.*

This paper explores three numerical schemes for efficient simulation of slender vortex filaments. The schemes defeat the spatial and temporal stiffness of the equations of motion by only requiring adequate resolution of the filament centerline and by allowing large integration time steps. In order to capture the self-induced filament velocity correctly, the first scheme uses an explicit velocity correction method and the second scheme relies on a logarithmic extrapolation of two velocity predictions, while the third scheme employs a local refinement algorithm. The performance of the three schemes is contrasted in light of unsteady computations of a perturbed vortex ring with small core to radius ratio.

LOADING AND INJECTION OF MAXWELLIAN DISTRIBUTIONS IN PARTICLE SIMULATIONS. K. L. Cartwright,* J. P. Verboncoeur,† and C. K. Birdsall.† *Air Force Research Laboratory, Kirtland AFB, New Mexico 87117-5776; and †Electronics Research Laboratory, University of California, Berkeley, California 94720.*

Existing and new particle loading and injection algorithms for particle simulations are analyzed to determine numerical accuracy and computational efficiency. Emphasis has been placed on loading and emission of Maxwellian, drifting Maxwellian, and cutoff Maxwellian velocity distributions. Once a velocity distribution has been inverted for loading or injection, time-centering of the position and velocity is necessary in order to maintain second-order accuracy. Here, the accuracy of these methods is determined and compared to three analytic test cases with spatially varying, time-dependent, and time-independent electric fields in a homogeneous magnetic field and a self-consistent crossed-field diode. The initial push is shown to be important in calculating the correct electric field at the boundary where particles are injected, in relaxing constraints on the time step, and in providing reliable field fluctuations due to particle statistics.