Journal of Computational Physics **164,** 238–239 (2000)
doi:10.1006/jcph.2000.6619, available online at http://www.idealibrary.com on IDEAL

Abstracts of Papers to Appear

Vortex Methods for High Resolution Simulations of Viscous Flow past Bluff Bodies of General Geometry. P. Ploumhans and G. S. Winckelmans. *Center for Systems Engineering and Applied Mechanics, Department of Mechanical Engineering, Université Catholique de Louvain, Belgium.*

Recent contributions to the 2-D vortex method are presented. A technique to accurately redistribute particles in the presence of bodies of general geometry is developed. The particle strength exchange scheme (PSE) for diffusion is modified for particles in the vicinity of the solid boundaries to avoid a spurious vorticity flux during the convection/PSE step. The scheme used to enforce the no-slip condition through the vorticity flux at the boundary is modified in a way that is more accurate than in the previous method. Finally, a mapping of the redistribution lattice is also used, in order to perform simulations with non-uniform resolution. In that case, the PSE is still done in the physical domain, using a symmetrized, conservative scheme. The quadratic convergence of this scheme is proved mathematically, and numerical tests are shown to support the proof. These elements are all validated on the benchmark problem of the flow past an impulsively started cylinder. High-resolution, long-time simulations of flow past other bluff bodies are also presented: the case of a square and of a capsule at angle of attack.

Application of Double Fourier Series to the Shallow Water Equations on a Sphere. Hyeong-Bin Cheong. *Department of Environmental Atmospheric Sciences, Pukyong National University, 599-1 Daeyeon-3-dong Nam-gu, Pusan 608-737, Korea.*

The spectral transform method with the double Fourier series as orthogonal basis functions as in Cheong (*J. Comput. Phys.* **157**, 327, 2000) is extended to the solution of the shallow water equations on a sphere. A spectral filter which mimics the implicit diffusion process with the third-order Laplacian operator is applied to the spectral components of predicted variables in order to prevent aliasing error or nonlinear instability. For a predicted variable the spectral filter needs only about $76N^2$ operations, with N being the zonal and meridional wavenumber truncation. The use of the filter even at every time-step does not deteriorate the computational efficiency of the double-Fourier-series model, because of the availability of FFT. The filter requires additional memory for only $6N^2$ elements, so the total memory space of $O(N^2)$ is sufficient in the present model. Along with the incorporation of the polar filter, the semi-implicit time-stepping procedure contributes to a significant increase in the time-step size. A standard test set proposed by Williamson *et al.* (*J. Comput. Phys.* **102**, 211, 1992) is used to evaluate the errors associated with the new method at various resolutions. It is shown that as a whole the accuracy of the method is comparable to that of the spherical harmonics model (SHM); the present method provides more accurate time-integration for some cases but not for other cases. A time-integration far beyond the period specified in the standard test set also illustrates almost the same accuracy as that given by the SHM. The efficiency of the method relative to that of the SHM appears from the resolution of 256×128 transform grids, and the gain becomes significant for the resolutions higher than 512×256. The computational efficiency is expected to increase further with an improved algorithm for FFT. The test results suggest that the new method could be extended to three-dimensional numerical models describing weather prediction.

Acceleration of Lattice-BGK Schemes with Grid Refinement. Olga Filippova and Dieter Hänel. *Institute of Combustion and Gasdynamics, University of Duisburg, D-47048 Duisburg, Germany.*

The LBGK method with local grid refinement has been shown to be an efficient and accurate tool for the simulation of incompressible, viscous flows over complex geometries. In the present study a further improvement

0021-9991/00 $35.00

of this concept is proposed which allows the use of smaller amount of time steps on refined grids without impairing the spatial or temporal accuracy. This extension of the LBGK method has been proved by analytical and numerical investigations. The gain in computational time was found to be significant.

LATTICE BGK MODEL FOR INCOMPRESSIBLE NAVIER–STOKES EQUATION. Zhaoli Guo,* Baochang Shi,† and Nengchao Wang. *National Laboratory of Coal Combustion, *Department of Computer Science, and †Department of Mathematics, Huazhong University of Science and Technology, Wuhan 430074, People's Republic of China.

Most of the existing lattice Boltzmann BGK models (LBGK) can be viewed as compressible schemes to simulate incompressible fluid flows. The compressible effect might lead to some undesirable errors in numerical simulations. In this paper a LBGK model without compressible effect is designed for simulating incompressible flows. The incompressible Navier–Stokes equations are exactly recovered from this incompressible LBGK model. Numerical simulations of the plane Poiseuille flow, the unsteady 2-D shear decaying flow, the driven cavity flow, and the flow around a circular cylinder are performed. The results agree well with the analytic solutions and those of previous studies.

COMPUTER-AIDED SERIES EXPANSION FOR THE PHONON SELF-ENERGY. R. G. Della Valle* and P. Procacci.† *Dipartimento di Chimica Fisica e Inorganica, Università di Bologna, Viale Risorgimento 4, I-40136 Bologna, Italy, †Università di Firenze, Dipartimento di Chimica, Via Gino Capponi 9, I-50121 Florence, Italy.

In this paper we discuss an algorithm for the calculation of the temperature-dependent anharmonic correction to the phonon spectrum in atomic and molecular crystals. We show how the equation of motion method can be used to compute corrections of arbitrary perturbation order to the phonon self-energy. Complete analytical expressions up to order λ^6 are obtained, as an application of the method.