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Abstracts of Papers to Appear in Future Issues

DISCRETIZATION OF FREE SURFACE FLOWS AND OTHER MOVING BOUNDARY PROBLEMS. K. N. Christodoulou and L. E. Scriven. *University of Minnesota, Minneapolis, Minnesota 55455, USA.*

A system of elliptic partial differential equations and boundary conditions has been developed for generating boundary-fitted finite element discretizations of two-dimensional free and moving boundary problems. Terms in the differential equations are scaled for dimensional homogeneity and adjustable weighting of orthogonality, smoothness, and concentration of the coordinate mesh they govern. Grid points become finite element nodes mapped isoparametrically or subparametrically from a simple or patched computational domain. Concentration terms contain control functions and parameters that influence node spacing along each coordinate independently; overall control is by patchwise parameters and functions. Successful selection of these to follow deforming flow regions is straightforward and is illustrated by analysis of steady and transient slide coating flows.

ON THE ERRORS INCURRED CALCULATING DERIVATIVES USING CHEBYSHEV POLYNOMIALS. Kenneth S. Breuer and Richard M. Everson. *Brown University, Providence, Rhode Island 02912, USA.*

The severe errors associated with the computation of derivatives of functions approximated by Chebyshev polynomials are investigated. When using standard Chebyshev transform methods, it is found that the maximum error in the computed first derivative grows as N^2, where $N+1$ is the number of Chebyshev polynomials used to approximate the function. The source of the error is found to be magnification of roundoff error by the recursion equation, which links coefficients of a function to those of its derivative. Tight coupling between coefficients enables propagation of errors from high-frequency to low-frequency modes. Matrix multiplication techniques exhibit errors of the same order of magnitude. However, standard methods for computing the matrix elements are shown to be ill-conditioned and to magnify methods, the errors are found to be most severe near the boundaries of the domain, where they grow as $(1-x^2)^{-1/2}$ as x approaches ± 1. Comparisons are made with the errors associated with derivatives of functions approximated by Fourier series, in which case it is reported that the errors only grow linearly with N and are evenly distributed throughout the domain. A method for reducing the error is discussed.

NUMERICAL EVALUATION OF AIRY FUNCTIONS WITH COMPLEX ARGUMENTS. R. M. Corless, D. J. Jeffrey, and H. Rasmussen. *University of Western Ontario, London, Ontario, Canada.*

We present two methods for the evaluation of Airy functions of complex argument. The first method is accurate to any desired precision but is slow and unsuitable for fixed-precision languages. The second method is accurate to double precision (12 digits) and is suitable for programming in a fixed-precision language such as FORTRAN. The first method uses the symbolic manipulation language Maple to evaluate either the Taylor series expansion or an asymptotic expansion of each function. The second method extends an idea of J. C. P. Miller to the complex plane. It uses the first method to obtain a grid of points in the complex plane where the functions are known to high precision and then uses Taylor series from these base points. The resulting algorithm is accurate and efficient.

VORTICITY ERRORS IN MULTIDIMENSIONAL LAGRANGIAN CODES. John K. Dukowicz. *Los Alamos National Laboratory, University of California, Los Alamos, New Mexico 87545, USA*; Bertrand J. A. Meltz. *Centre d'Etudes de Limeil-Valenton, B.P. 27, 94195 Villeneuve Saint-Georges Cedex, France.*

We investigate the apparent paradox, as exemplified by the well-known Saltzman test problem, of multidimensional lagrangian codes experiencing mesh tangling when computing one-dimensional irrotational flows. We demonstrate that the cause is the generation of spurious vorticity, or vorticity error, by a nonuniform mesh. Based on this, we investigate two methods of constructing improved lagrangian vertex velocities by removing, or filtering out, this spurious vorticity, rather than by the more common practice of introducing artificial viscosity. The first method reconstructs the velocity from the known flow divergence and from the true vorticity computed by means of a transport equation. The second method, which is much simpler and more efficient, subtracts a divergence-free correction from the velocity, such that the resulting velocity possesses the correct vorticity. We then successfully apply this method to solve a two-dimensional shock refraction problem, a problem which exhibits nonzero intrinsic vorticity.

SIMULATION OF ROLLUP AND MIXING IN RAYLEIGH–TAYLOR FLOW USING THE TRANSPORT-ELEMENT METHOD. Anantha Krishnan and Ahmed F. Ghoniem. *Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA.*

The vortex method is extended to obtain solutions of the variable density vorticity transport equation in cases when vorticity is generated by the action of gravitational body forces as well as inertial baroclinic effects. The convection of a scalar, in this case density, is simulated using the transport-element method. Similar to the vortex method, this is a grid-free, Lagrangian field method in which scalar gradients are transported along particle trajectories while being modified according to the distortion of the flow map. Results are obtained for a Rayleigh–Taylor flow evolving by the action of gravity on a finite temperature gradient. The numerical solution is validated by comparing the growth rate of small perturbations to the results of the linear stability analysis of this flow. Numerical solutions within the nonlinear range are analyzed to study the effect of density ratio on the rollup of the vorticity layer and the mixing which follows this process.

ABSORBING BOUNDARY CONDITIONS FOR FREE SURFACE WAVES. J. E. Romate. *Delft Hydraulics, P.O. Box 152, 8300 AD Emmeloord, The Netherlands.*

In this paper the use of absorbing boundary conditions is investigated for the numerical simulation of gravity waves on an incompressible, inviscid fluid in three dimensions. A review of existing methods is given for

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