JOURNAL OF COMPUTATIONAL PHYSICS **143,** 682–683 (1998)
ARTICLE NO. CP986034

Abstracts of Papers to Appear

MARANGONI–BÉNARD CONVECTION WITH A DEFORMABLE FREE SURFACE. K. A. Cliffe* and S. J. Tavener†. **A.E.A. Technology, Harwell Laboratory, Didcot, Oxfordshire OX11 0RA, United Kingdom; and †Department of Mathematics, The Pennsylvania State University, University Park, Pennsylvania 16802.* E-mail: andrew.cliffe@aeat.co.uk and tavener@math.psu.edu.

Computations of Marangoni convection are usually performed in two- or three-dimensional domains with rigid boundaries. In two dimensions, allowing the free surface to deform can result in a solution set with a qualitatively different bifurcation structure. We describe a finite-element technique for calculating bifurcations that arise due to thermal gradients in a two-dimensional domain with a deformable free surface. The fluid is assumed to be Newtonian, to conform to the Boussinesq approximation, and to have a surface tension that varies linearly with temperature. An orthogonal mapping from the physical domain to a reference domain is employed, which is determined as the solution to a pair of elliptic partial differential equations. The mapping equations and the equilibrium equations for the velocity, pressure, and temperature fields and their appropriate nonlinear boundary conditions are discretized using the finite-element method and solved simultaneously by Newton iteration. Contact angles other than 90 degrees are shown to disconnect the transcritical bifurcations to flows with an even number of cells in the expected manner. The loss of stability to single cell flows is associated with the breaking of a reflectional symmetry about the middle of the domain and therefore occurs at a pitchfork bifurcation point for contact angles both equal to, and less than, 90 degrees.

WEIGHTED ESSENTIALLY NON-OSCILLATORY SCHEMES FOR THE INTERPOLATION OF MEAN VALUES ON UNSTRUCTURED GRIDS. Oliver Friedrich. *Institute for Applied Mathematics, University of Hamburg, Bundestrabe 55, Hamburg, 20146, Germany.*

In this paper the weighted ENO (essentially non-oscillatory) scheme developed for the one-dimensional case by Liu, Osher, and Chan is applied to the case of unstructured triangular grids in two space dimensions. Ideas from Jiang and Shu, especially their new way of smoothness measuring, are considered. As a starting point for the unstructured case we use an ENO scheme like the one introduced by Abgrall. Beside the application of the weighted ENO ideas the whole reconstruction algorithm is analyzed and described in detail. Here we also concentrate on technical problems and their solution. Finally, some applications are given to demonstrate the accuracy and robustness of the resulting new method. The whole reconstruction algorithm described here can be applied to any kind of data on triangular unstructured grids, although it is used in the framework of compressible flow computation in this paper only.

A FAST 3D POISSON SOLVER OF ARBITRARY ORDER ACCURACY. E. Braverman,* M. Israeli,* A. Auerbuch,† and L. Vozovoi†. **Technion-Israel Institute of Technology, Computer Science Department, Haifa 32000, Israel; and †School of Mathematical Sciences, Tel Aviv University, Tel Aviv 69978, Israel.* E-mail: maelena@cs.technion.ac.il, israeli@cs.technion.ac.il, amir@math.tau.ac.il, and vozovoi@math.tau.ac.il.

We present a direct solver for the Poisson and Laplace equations in a 3D rectangular box. The method is based on the application of the discrete Fourier transform accompanied by a subtraction technique which allows reducing the errors associated with the Gibbs phenomenon and achieving any prescribed rate of convergence. The algorithm requires $O(N^3 \log N)$ operations, where N is the number of grid points in each direction. We show that

0021-9991/98 $25.00

our approach allows accurate treatment of singular cases which arise when the boundary function is discontinuous or incompatible with the differential equation.

THE PERFECTLY MATCHED LAYER AS AN ABSORBING BOUNDARY CONDITION FOR THE LINEARIZED EULER EQUATIONS IN OPEN AND DUCTED DOMAINS. Christopher K. W. Tam,* Laurent Auriault,* and Francesco Cambuli†. **Department of Mathematics, Florida State University, Tallahassee, Florida 32306-4510; and* †*Dipartimento di Ingegneria Meccanica, Universita degli Studi di Cagliari, Piazza d'Armi, 09123, Cagliari, Italy.* E-mail: tam@math.fsu.edu.

Recently, perfectly matched layer (PML) as an absorbing boundary condition has found widespread applications. The idea was first introduced by Berenger for electromagnetic waves computations. In this paper, it is shown that the PML equations for the linearized Euler equations support unstable solutions when the mean flow has a component normal to the layer. To suppress such unstable solutions so as to render the PML concept useful for this class of problems, it is proposed that artificial selective damping terms be added to the discretized PML equations. It is demonstrated that with a proper choice of artificial mesh Reynolds number, the PML equations can be made stable. Numerical examples are provided to illustrate that the stabilized PML performs well as an absorbing boundary condition. In a ducted environment, the wave modes are dispersive. It will be shown that in the presence of a mean flow the group velocity and phase velocity of these modes can have opposite signs. This results in a band of transmitted waves in the PML to be spatially amplifying instead of evanescent. Thus in a confined environment, PML may not be suitable as an absorbing boundary condition unless there is no mean flow.

ARTIFICIAL BOUNDARY CONDITIONS FOR THE LINEARIZED COMPRESSIBLE NAVIER–STOKES EQUATIONS. II. THE DISCRETE APPROACH. Loïc Tourrette. *Aerospatiale Aircraft Business, A/BTE/EG/AERO, Section 536, B.P. M0142/3, 316 route de Bayonne, 31060 Toulouse Cédex 03, France.* E-mail: Loic.Tourrette@avions.aerospatiale.fr.

In the first part of this paper (*J. Comput. Phys.* **137**, 1, 1997), continuous artificial boundary conditions for the linearized compressible Navier–Stokes equations were proposed which were valid for small viscosities, high time frequencies, and long space wavelengths. In the present work, a new hierarchy of artificial boundary conditions is derived from the so-called "discrete" approach, which consists in working directly on the discretized equations, under the assumption of low time frequencies instead of small viscosities. The discrete artificial boundary conditions are implemented in 1D and 2D model problems and they compare quite well with the continuous artificial boundary conditions. Being self-sufficient by construction, they can be used as numerical boundary conditions and be coupled to schemes having arbitrary stencils.