Abstracts of Papers to Appear in Future Issues

AN APPLICATION OF NONLOCAL EXTERNAL CONDITIONS TO VISCOUS FLOW COMPUTATIONS. S. V. Tsynkov. *Department of Applied Mathematics, School of Mathematical Sciences, Tel-Aviv University, Ramat-Aviv, Tel-Aviv 69978, Israel.*

We are looking for a steady-state solution of an external flow problem originally formulated on an unbounded domain. Our case is a 2D viscous compressible flow past a finite body (airfoil). We truncate the original domain by introducing a finite grid around the airfoil and integrate the Navier–Stokes equations on this grid with the help of a finite-volume code which involves a multigrid pseudo-time iteration technique for achieving a steady state. To integrate the Navier–Stokes equations on a finite subregion of an original domain only we supplement the numerical algorithm by special nonlocal artificial boundary conditions formulated on an external boundary of the finite computational domain. These artificial boundary conditions are based on the difference potentials method proposed by V. S. Ryaben'kii. We compare the results provided by the nonlocal conditions with those obtained from the standard external conditions which are based on locally one-dimensional characteristic analysis at inflow and extrapolation at outflow. It turns out that the nonlocal artificial boundary conditions accelerate the convergence by about a factor of 3, as well as allowing one to shrink substantially the computational domain without loss of accuracy.

ACCURATE BOUNDARY CONDITIONS FOR MULTICOMPONENT REACTIVE FLOWS. M. Baum, T. Poinsot, and D. Thévenin. *Laboratoire d'Energétique Moléculaire et Macroscopique, Combustion, Ecole Centrale Paris, Grande Voie des Vignes, F-92295 Châtenay-Malabry, France.*

Procedures to define accurate boundary conditions for reactive flows described by Navier–Stokes equations are discussed. A formulation based on one-dimensional characteristic waves relations at the boundaries, previously developed by Poinsot and Lele for perfect gases with constant homogeneous thermodynamic properties, is rewritten and extended in order to be used in the case of gases described with realistic thermodynamic and reactive models. This kind of formulation appears to be particularly accurate and stable, which is a necessity for non-dissipative codes, in particular for direct simulation of turbulent reactive flows. The simple and solid physical basis of the method is also very attractive and makes it an easy technique to implement in any Navier–Stokes solver. Examples of application in several different computations performed with mixtures of gases and using detailed chemistry and thermodynamic modeling are described. In all cases, acoustic waves, entropy waves, and flames are proved to propagate without perturbation through the boundaries.

VELOCITY BOUNDARY CONDITIONS FOR THE SIMULATION OF FREE SURFACE FLUID FLOW. Shea Chen, David B. Johnson, and Peter E. Raad, *Mechanical Engineering Department, Southern Methodist University, Dallas, Texas 75275-0337, U.S.A.*

Accurate velocity boundary conditions are critical to the successful simulation of free surface fluid flow. It is shown in this paper that previous approaches for the assignment of free surface velocity boundary conditions in marker and cell methods artificially introduce asymmetry and can even cause the simulation to break up. New approaches are presented that improve the accuracy of the treatment of free surface velocity boundary conditions. The significant advantages of the use of these new approaches are demonstrated by simulation results obtained for broken dam and cavity filling problems. The new approaches do not artificially introduce asymmetry. Although symmetry is a useful, tangible indicator, it is shown that the significance of the new approaches extends beyond the elimination of asymmetry. Their use enables the successful simulation of problems with realistic values of viscosity and gravity, problems for which breakup of the solution occurs if previous approaches are employed.

A COMPARISON OF SOME QUADRATURE METHODS FOR APPROXIMATING CAUCHY PRINCIPAL VALUE INTEGRALS. A Natarajan and N. Mohankumar, *Safety Research and Health Physics Programme, Indira Gandhi Centre for Atomic Research, Kalpakkam, India 603102.*

Cauchy principal value integrals are evaluated by the IMT quadrature scheme, which like the TANH quadrature scheme is essentially a trapezoidal scheme, after making a transformation of the variable of integration. Numerical results for some test problems demonstrate that the IMT scheme is superior to the TANH scheme, while both these methods are comparable to, or even better than, the standard methods like the Gaussian or the Chebyshev schemes, in terms of accuracy and simplicity.

FAST FOURIER TRANSFORMS OF PIECEWISE CONSTANT FUNCTIONS. Eugene Sorets, *Department of Mathematics, Yale University, P.O. Box 208283, New Haven, Connecticut 06520-8283, U.S.A.*

We present an algorithm for the evaluation of the Fourier transform of piecewise constant functions of two variables. The algorithm overcomes the accuracy problems associated with computing the Fourier transform of discontinuous functions; in fact, its time complexity is $O(N^2 \log N + NP \log^2 (1/\varepsilon) + V \log^3 (1/\varepsilon))$, where ε is the accuracy, N is the size of the problem, P is the perimeter of the set of discontinuities, and V is its number of vertices. The algorithm is based on the Lagrange interpolation formula and the Green's theorem, which are used to preprocess the data before applying the fast Fourier transform. It readily generalizes to higher dimensions and to piecewise smooth functions.

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