Abstracts of Papers to Appear in Future Issues

A VORTICITY–VELOCITY METHOD FOR THE NUMERICAL SOLUTION OF 3D INCOMPRESSIBLE FLOWS. G. Guj and F. Stella. *Dipartimento di Meccanica e Aeronautica. Via Eudossiana 18, 00184 Rome, Italy.*

A new method for the numerical solution of the 3D Navier–Stokes equations written in terms of vorticity–velocity is presented. The advantages of this formulation with respect to primitive variables and vorticity–vector–potential ones are discussed in view of physical as well as engineering applications. A suitable form of the continuum equations, the most appropriate discretization scheme, and variable location in order to guarantee the solenoidality of the velocity and vorticity fields are introduced and justified. A 3D lid-driven cavity problem for $400 \leqslant \mathrm{Re} \leqslant 3200$ is chosen as a test case for comparison and validation purposes. A parallel implementation of the method has been performed on a shared memory architecture mainframe. Speedup results and efficiency considerations are given and discussed.

A SEMI-IMPLICIT SPECTRAL METHOD FOR THE ANELASTIC EQUATIONS. Scott R. Fulton. *Department of Mathematics and Computer Science, Clarkson University, Potsdam, New York 13699-5815, USA.*

This paper describes the efficient and accurate solution of the two-dimensional anelastic equations by a Fourier–Chebyshev spectral method. A fourth-order Runge–Kutta method is used for the time integration, with the diffusion terms treated implicitly and all other terms (including the pressure gradient) treated explicitly. The model is free from aliasing and converges quickly once the solution is resolved. Numerical results are given for nonlinear flow generated by an atmospheric density current.

USE OF A ROTATED RIEMANN SOLVER FOR THE TWO-DIMENSIONAL EULER EQUATIONS. David W. Levy, Kenneth G. Powell, and Bram van Leer. *Department of Aerospace Engineering, University of Michigan, Ann Arbor, Michigan 48109, USA.*

A scheme for the two-dimensional Euler equations that uses flow parameters to determine the direction for upwind-differencing is described. This approach respects the multi-dimensional nature of the equations and reduces the grid-dependence of conventional schemes. Several angles are tested as the dominant upwinding direction, including the local flow and velocity-magnitude-gradient angles. Roe's approximate Riemann solver is used to calculate fluxes in the upwind direction, as well as for the flux components normal to the upwinding direction. The approach is first tested for two-dimensional scalar convection, where the scheme is shown to have accuracy comparable to a high-order MUSCL scheme. Solutions of the Euler equations are calculated for a variety of test cases. Substantial improvement in the resolution of shock and shear waves is realized. The approach is promising in that it uses flow solution features, rather than grid features, to determine the orientation for the solution method.

NUMERICAL SOLUTION FOR THE STEADY MOTION OF A VISCOUS FLUID INSIDE A CIRCULAR BOUNDARY USING INTEGRAL CONDITIONS. S. C. R. Dennis, M. Ng, and P. Nguyen. *Department of Applied Mathematics, University of Western Ontario, London, Ontario, Canada N6A 5B7.*

The problem of determining the two-dimensional steady motion of a viscous incompressible fluid which is injected radially over one small arc of a circle and ejected radially over another arc is considered and examples are given of both symmetrical and asymmetrical flows. The motion is governed by the Navier–Stokes equations and the method of solution is based on the use of truncated Fourier series representations for the stream function and vorticity in the angular polar coordinate. The Navier–Stokes equations are reduced to ordinary differential equations in the radial variable and these sets of equations are solved using finite-difference methods, but with the boundary vorticity calculated using global integral conditions rather than local finite-difference approximations. One of the objects of the investigation is to relate this method to a previous study which did not use integral conditions and also to a recent study which uses an integro-differential method which is different in concept but which also uses integral conditions. A brief review of previous work on the problem is given. Comparisons of present and previous results are excellent.

A NEW FLUX SPLITTING SCHEME. Meng-Sing Liou and Christopher J. Steffen, Jr. *Internal Fluid Mechanics Division, NASA Lewis Research Center, Cleveland, Ohio 44135, USA.*

A new flux splitting scheme is proposed. The scheme is remarkably simple and yet its accuracy rivals, and in some cases surpasses, that of Roe's solver in the Euler and Navier–Stokes solutions carried out in this study. The scheme is robust and converges as fast as the Roe splitting. We propose an appropriately defined cell-face advection Mach number using values from the two straddling cells via associated characteristic speeds. This interface Mach number is then used to determine the upwind extrapolation for the convective quantities. Accordingly, the name of the scheme is coined as the advection upstream splitting method (AUSM). We also introduce a new pressure splitting which is shown to behave successfully, yielding much smoother results than other existing pressure splittings. Of particular interest is the supersonic blunt body problem in which the Roe scheme gives anomalous solutions. The AUSM produces correct solutions without difficulty for a wide range of flow conditions as well as grids.

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