AN ITERATIVE METHOD TO SOLVE THE NONLINEAR POISSON'S EQUATION IN THE CASE OF PLASMA TANGENTIAL DISCONTINUITIES. M. Roth and J. Lemaire, *Institute for Space Aeronomy, Brussels, BELGIUM*; A. Misson, *Ecole Polytechnique de Lausanne, Lausanne, SWITZERLAND.*

In order to determine the electric potential in collisionless tangential discontinuities of a magnetized plasma, it is required to solve a nonlinear Poisson's equation with sources of charge and current depending on the actual potential solution. This nonlinear second-order differential equation is solved by an iterative method. This leads to an ordered sequence of nonlinear algebraic equations for each successive approximation of the actual electric potential. It is shown that the method holds for transitions with characteristic thicknesses (D) as thin as five Debye lengths (λ). For smaller thicknesses, when D shrinks to 3λ or less, the method fails because in that case the iteration procedure does no longer converge. Numerical results are shown for an ion-dominated layer ($D \sim 10^2$–$10^3\lambda$), as well as for two electron-dominated layers characterized by $D \approx 5\lambda$ and $D \approx 2.5\lambda$, respectively. In all cases considered in this paper, the relative error on the electric potential obtained as a solution of the quasi-neutrality approximation is of the order of the relative charge density. When the method holds, each successive approximation reduces the relative error on the potential by roughly a factor of 10. For space plasma boundary layers, the quasi-neutrality approximation can be used with much confidence since their thickness is always much larger than the local Debye length.

SPLITTING OF INVISCID FLUXES FOR REAL GASES. Meng-Sing Liou, Bran van Leer, and Jian-Shun Shuen, *NASA Lewis Research Center, Cleveland, Ohio, USA.*

Flux-vector and flux-difference splittings for the inviscid terms of the compressible flow equations are derived under the assumption of a general equation of state for a real gas in equilibrium. No unnecessary assumptions, approximations, or auxiliary quantities are introduced. The formulas derived include several particular cases known for ideal gases and readily apply to curvilinear coordinates. Applications of the formulas in a TVD algorithm to one-dimensional shock-tube and nozzle problems show their quality and robustness.

MULTIGRID AND DEFECT CORRECTION FOR THE STEADY NAVIER–STOKES EQUATIONS. Barry Koren, *Centre for Mathematics and Computer Science, Amsterdam, THE NETHERLANDS.*

Theoretical and experimental convergence results are presented for nonlinear multigrid and iterative defect correction applied to finite volume discretizations of the full, steady, 2*D*, compressible Navier–Stokes equations. Iterative defect correction is introduced for circumventing the difficulty in solving Navier–Stokes equations discretized with a second- or higher-order accurate convective part. By Fourier analysis applied to a model equation, an optimal choice is made for the operator to be inverted in the defect correction iteration. As a smoothing technique for the multigrid method, collective symmetric point Gauss–Seidel relaxation is applied as the basic solution technique: exact Newton iteration applied to a continuously differentiable, first-order upwind discretization of the full Navier–Stokes equations. For non-smooth flow problems, the convergence results obtained are competitive already with those of well-established Navier–Stokes methods. For smooth flow problems, the present method performs better than any standard method. Here, first-order discretization error accuracy is attained in a single multigrid cycle, and second-order accuracy in only one defect correction cycle. The method contributes to the state of the art in efficiently computing compressible viscous flows.

A NUMERICAL INVESTIGATION INTO THE STEADY FLOW PAST A ROTATING CIRCULAR CYLINDER AT LOW AND INTERMEDIATE REYNOLDS NUMBERS. D. B. Ingham and T. Tang, *University of Leeds, Leeds, ENGLAND.*

Numerical solutions have been obtained for steady uniform flow past a rotating circular cylinder. Results are presented for Reynolds numbers, based on the diameter of the cylinder, 5 and 20 and the

rotational parameters, α, in the range of $0 \leqslant \alpha \leqslant 3$. To avoid the difficulties in satisfying the boundary conditions at large distances from the cylinder a new numerical technique is introduced. Further, series expansion solutions are obtained which are valid at small values of α, but the results are found to be applicable over a wide range of values of α. The calculated values of the drag and lift coefficients and the general nature of the streamline patterns are in good agreement with the most recent time-dependent calculations performed by Badr and Dennis.

AN EXPLICIT FINITE-DIFFERENCE SOLUTION TO THE WAVE EQUATION WITH VARIABLE VELOCITY. Alvin K. Benson, *Brigham Young University, Provo, Utah, USA.*

An explicit method is formulated for solving the scalar wave equation using finite differences in isotropic, inhomogeneous media. Extrapolation from the known grid-plane to the unknown grid-plane is in *depth* so that the final result represents an image of the medium's true spatial structure. This image is often used to predict favorable locations for drilling into the earth. This paper determines equations for the depth differencing coefficients and the lateral differencing coefficients of a polynomial series solution to the wave equation.

PSEUDO-SPECTRAL SOLUTION OF NONLINEAR SCHRODINGER EQUATIONS. D. Pathria, *University of Waterloo, Waterloo, Ontario, CANADA*; J. Ll. Morris, *University of Dundee, Dundee, Scotland, UNITED KINGDOM.*

We compare four pseudo-spectral split-step methods for solving a class of nonlinear Schrödinger (NLS) equations. The importance of observing the L^2 invariance of the continuous problem is demonstrated through numerical experiments. The best performance is obtained by transforming the given equation to an NLS equation where two of the coefficients satisfy a simple algebraic relationship. The problem can be solved efficiently in terms of the new variables, and the l^2 norm of the computed solution is time-invariant.

Printed in Belgium