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ICASE Reports: 1982

- Fix, G. J.: *Phase field methods for free boundary problems.* ICASE Report No. 82-1, January 26, 1982, 18 pages. In book entitled FREE BOUNDARY PROBLEMS, THEORY AND APPLICATIONS, Mario Primicerio and Antonio Fasano, eds., Pitman Series, Research Notes and Math., 1982.
- Gunzburger, M. D. and J. S. Peterson: *On conforming mixed finite element methods for the inhomogeneous stationary Navier-Stokes equations.* ICASE Report No. 82-2, February 1, 1982, 46 pages. Submitted to SIAM J. Numer. Anal.
- Ito, K.: *Regulator problem for hereditary differential systems with control delays.* ICASE Report No. 82-3, February 10, 1982, 31 pages.
- Bayliss, A., C. Goldstein, and E. Turkel: *An iterative method for the Helmholtz equation.* ICASE Report No. 82-4, February 25, 1982, 31 pages. To appear in J. Comput. Phys.
- Harten, A., P. D. Lax, and B. van Leer: *On upstream differencing and Godunov-type schemes for hyperbolic conservation laws.* ICASE Report No. 82-5, March 17, 1982, 58 pages. SIAM Rev., Vol. 25, No. 1, January 1983, pp. 35-62.
- Maestrello, L. and A. Bayliss: *Flow and far field acoustic amplification properties of heated and unheated jets.* ICASE Report No. 82-6, March 17, 1982, 40 pages. AIAA J., Vol. 20, No. 11, November 1982, pp. 1539-1546.
- Pratt, T. W. and G. D. Maydwell: *Experience with the formal semantic definition of HAL/S.* ICASE Report No. 82-7, March 18, 1982, 23 pages. Proc. of Symp. on Compiler Construction, Boston, MA, June 23-25, 1982.
- Rose, M. E.: *A numerical scheme to solve $\text{div } \underline{u} = \rho$, $\text{curl } \underline{u} = \zeta$.* ICASE Report No. 82-8, April 7, 1982, 14 pages.
- Adams, L. and J. M. Ortega: *A multi-color SOR method for parallel computation.* ICASE Report No. 82-9, April 8, 1982, 12 pages. Proc. of the International Conference on Parallel Processing, K. E. Batcher, W. C. Meilander and J. L. Potter, eds., Bellaire, MI, August 1982.
- Daniel, P. L.: *Spline approximations for nonlinear hereditary control systems.* ICASE Report No. 82-10, April 28, 1982, 52 pages. Submitted to J. Optim. Theory Appl.
- Rose, M. E.: *Compact finite difference schemes for the Euler and Navier-Stokes equations.* ICASE Report No. 82-11, April 29, 1982, 12 pages. Submitted to J. Comput. Phys.
- Gottlieb, D. and L. Lustman: *The spectrum of the Chebyshev collocation operator for the heat equation.* ICASE Report No. 82-12, May 14, 1982, 25 pages. To appear in SIAM J. Numer. Anal.
- Gunzburger, M. D., C. H. Liu, and R. A. Nicolaides: *A finite element method for diffusion dominated unsteady viscous flows.* ICASE Report No. 82-13, June 15, 1982, 28 pages. Submitted to Comput. Methods Appl. Mech. Engrg.

- Mehrotra, P. and T. W. Pratt: *Language concepts for distributed processing of large arrays.* ICASE Report No. 82-14, June 16, 1982, 25 pages. Proc. of Symp. on Principles of Distributed Computing, Ottawa, Canada, August 1982.
- Wong, Y. S. and M. M. Hafez: *A minimal residual method for transonic potential flows.* ICASE Report No. 82-15, June 25, 1982, 10 pages. Lecture Notes in Physics, No. 170, E. Krause, ed., Proc. of the 8th Intl. Conf. on Numerical Methods in Fluid Dynamics, Aachen, Germany, June 28 - July 2, 1982, Springer-Verlag, 1982.
- Rosen, I. G.: *Difference equation state approximations for nonlinear hereditary control problems.* ICASE Report No. 82-16, June 30, 1982, 50 pages. To appear in SIAM J. Control Optim.
- Wenzel, A. R.: *Radiation and attenuation of low- and high-frequency waves in a random medium.* ICASE Report No. 82-17, July 9, 1982, 21 pages. To appear in Wave Motion.
- Lakin, W. D. and M. Y. Hussaini: *Stability of the laminar boundary layer in a streamwise corner.* ICASE Report No. 82-18, July 12, 1982, 28 pages. To appear in the Proc. Roy. Soc. London.
- Cox, C. L., G. J. Fix, and M. D. Gunzburger: *A least squares finite element scheme for transonic flow around harmonically oscillating wings.* ICASE Report No. 82-19, July 16, 1982, 28 pages. Submitted to J. Comput. Phys.
- Bayliss, A. and E. Turkel: *The Helmholtz equation for nozzles and underwater acoustics.* ICASE Report No. 82-20, August 2, 1982, 7 pages. To appear in Scientific Computing, R. S. Stepleman, ed., North Holland Publishing Company, 1983.
- Banks, H. T.: *Distributed system optimal control and parameter estimation: Computational techniques using spline approximations.* ICASE Report No. 82-21, August 4, 1982, 7 pages. Invited lecture in Proc. 3rd IFAC Symposium on Control of Distributed Parameter Systems, Pergamon Press, Toulouse, France, June 29 - July 2, 1982.
- Barks, H. T. and J. M. Crowley: *Parameter estimation in Timoshenko beam models.* ICASE Report No. 82-22, August 4, 1982, 30 pages. To appear in J. Astronaut. Sci.
- Turkel, E.: *Progress in computational physics.* ICASE Report No. 82-23, August 5, 1982, 69 pages. To appear in Comput. & Fluids.
- Hussaini, M. Y., T. A. Zang, and M. D. Salas: *Shock-fitted Euler solutions to shock-vortex interactions.* ICASE Report No. 82-24, August 16, 1982, 11 pages. Lecture Notes in Physics, No. 170, E. Krause, ed., Proc. of the 8th Intl. Conf. of Numerical Mathematics in Fluid Dynamics, Aachen, Germany, June 28 - July 2, 1982, Springer-Verlag, 1982.
- Najfeld, I.: *Numerical analysis of Weyl's method for integrating boundary layer equations.* ICASE Report No. 82-25, August 27, 1982, 21 pages. Submitted to the SIAM J. Numer. Anal.

- Banks, H. T., P. T. Daniel, and E. S. Armstrong: *Parameter estimation for static models of the maypole hoop/column antenna surface.* ICASE Report No. 82-26, September 9, 1982, 3 pages. Proc. 1982 IEEE Intl. Large Scale Systems Symp., Virginia Beach, Va., October 11-13, 1982.
- Bokhari, S.: *Finding maximum on an array processor with a global bus.* ICASE Report No. 82-27, September 16, 1982, 28 pages. Submitted to IEEE Trans. Comput.
- Abarbanel, S. S., D. L. Dwoyer, and D. Gottlieb: *Improving the convergence rate of parabolic ADI methods.* ICASE Report No. 82-28, September 20, 1982, 41 pages. Submitted to J. Comput. Phys.
- Ito, K.: *On the approximation of eigenvalues associated with functional differential equations.* ICASE Report No. 82-29, September 23, 1982, 27 pages. Submitted to J. Differential Equations.
- van Leer, B.: *Flux-vector splitting for the Euler equations.* ICASE Report No. 82-30, September 28, 1982, 13 pages. Lecture Notes in Physics No. 170, pp. 507-512, Springer, Berlin, 1982. E. Krause, ed., Proc. of the Intl. Conf. on Numer. Meth. in Fluid Dynamics, Aachen.
- Banks, H. T., I. G. Rosen, and K. Ito: *A spline based technique for computing Riccati operators and feedback controls in regulator problems for delay equations.* ICASE Report No. 82-31, September 29, 1982, 49 pages. Submitted to SIAM J. Sci. Statis. Comput.
- Banks, H. T. and P. L. Daniel: *Estimation of variable coefficients in parabolic distributed systems.* ICASE Report No. 82-32, November 1, 1982, 52 pages. Submitted to IEEE Trans. Automat. Control.
- Tadmor, E.: *The unconditional instability of inflow-dependent boundary conditions in difference approximations to hyperbolic systems.* ICASE Report No. 82-33, November 10, 1982, 22 pages. To appear in Math. Comp.
- Harten, A.: *On a large time-step high resolution scheme.* ICASE Report No. 82-34, November 15, 1982, 20 pages. Submitted to Math. Comp.
- Osher, S.: *Smoothing for Spectral Methods.* ICASE Report No. 82-35, November 16, 1982, 12 pages. Proceedings of Spectral Methods Workshop, SIAM/ICASE, Hampton, VA, August 16-18, 1982.
- Gannon, D. and J. R. Van Rosendale: *Highly parallel multigrid solvers for elliptic PDEs: An experimental analysis.* ICASE Report No. 82-36, November 17, 1982, 38 pages. Submitted to SIAM J. Sci. Statis. Comput.
- Friedland, S. and E. Tadmor: *Optimality of the Lax-Wendroff condition.* ICASE Report No. 82-37, November 23, 1982, 12 pages. To appear in Linear Algebra Appl.
- Gottlieb, D., L. Lustman, and C. Streett: *Spectral methods for two-dimensional shocks.* ICASE Report No. 82-38, November 24, 1982, 25 pages. Proceedings of Spectral Methods Workshop, SIAM/ICASE, Hampton, VA, August 16-18, 1982.

- Abarbanel, S. S., D. L. Dwoyer, and D. Gottlieb: *Stable implicit finite-difference methods for three-dimensional hyperbolic systems.* ICASE Report No. 82-39, November 26, 1982, 25 pages. Submitted J. Comput. Phys.
- Hussaini, M. Y. and T. A. Zang: *Iterative spectral methods and spectral solutions to compressible flows.* ICASE Report No. 82-40, November 30, 1982, 30 pages. Proceedings of Spectral Methods Workshop, SIAM/ICASE, Hampton, VA, August 16-18, 1982.
- Geer, J. F. and J. C. Strikwerda: *Vertical slender jets with surface tensions.* ICASE Report No. 82-41, December 16, 1982, 29 pages. Submitted to J. Fluid Mech.
- Taumor, E.: *Skew-selfadjoint form for systems of conservation laws.* ICASE Report No. 82-42, December 23, 1982, 22 pages. Submitted to J. Math. Anal. Appl.

ICASE Reports: 1981

- Van Albada, G. D. and W. W. Roberts, Jr.: *A high resolution study of the gas-flow in barred spirals.* ICASE Report No. 81-1, January 8, 1981, 34 pages. Astrophys. J., Vol. 246, June 1981, pp. 740-750.
- Bauschlicher, C. W., Jr., P. S. Bagus, D. R. Yarkony, and B. H. Lengsfeld, III: *A hybrid method for improving MCSCF convergence.* ICASE Report No. 81-2, January 12, 1981, 19 pages. J. Chem. Phys., Vol. 74, No. 4, February 15, 1981, pp. 2379-2383.
- Fix, G. J., M. D. Gunzburger, and R. A. Nicolaides: *On mixed finite element methods for first order elliptic systems.* ICASE Report No. 81-3, January 15, 1981, 35 pages. Numer. Math., Vol. 37, 1981, pp. 29-48.
- Philips, R. B. and M. E. Rose: *Compact difference schemes for mixed initial boundary value problems - I.* ICASE Report No. 81-4, January 21, 1981, 24 pages. SIAM J. Numer. Anal., Vol. 19, No. 4, August 1982, pp. 698-720.
- Levinson, F. H. and W. W. Roberts, Jr.: *A cloud/particle model of the interstellar medium - galactic spiral structure.* ICASE Report No. 81-5, January 23, 1981, 50 pages. Astrophys. J., Vol. 245, 1982, pp. 465-481.
- Bokhari, S.: *A shortest tree algorithm for optimal assignments across space and time in a distributed processor system.* ICASE Report No. 81-6, January 27, 1981, 24 pages. IEEE Trans. Software Engrg., Vol. 7, No. 6, November 1981, pp. 583-589.
- Gunzburger, M. D. and R. A. Nicolaides: *The computational accuracy of some finite element methods for incompressible viscous flow problems.* ICASE Report No. 81-7, February 3, 1981, 19 pages. SIAM J. Sci. Statis. Comput., Vol. 8, 1982, pp. 167-179. This report is combined with ICASE Report No. 81-23.

- Bayliss, A. and L. Maestrello: *Simulation of instabilities and sound radiation in a jet.* ICASE Report No. 81-8, February 5, 1981, 33 pages. AIAA J., Vol. 19, No. 7, 1981, pp. 835-841.
- Vardi, A.: *A trust region algorithm for equality constrained minimization: convergence properties and implementation.* ICASE Report No. 81-9, February 18, 1981, 35 pages. Submitted to SIAM J. Numer. Anal.
- Anderson, T. A. and J. C. Knight: *Practical software fault tolerance for real time systems.* ICASE Report No. 81-10, March 31, 1981, 39 pages. To appear in Trans. on Software Engrg.
- Van Leer, B.: *On the relation between the upwind-differencing schemes of Godunov, Engquist-Osher and Roe.* ICASE Report No. 81-11, March 16, 1981, 38 pages, NASA CR-165877. To appear in SIAM J. Sci. Statis. Comput.
- Bokhari, S., M. Y. Hussaini, J. J. Lambiotte, and S. A. Orszag: *Navier-Stokes solution of the CYBER-203 by a pseudospectral technique.* ICASE Report No. 81-12, March 27, 1982, 18 pages. Second IMACS International Symposium on Parallel Computation, November 9-11, 1982, Newark, Delaware.
- Davis, S. F. and J. E. Flaherty: *An adaptive finite element method for initial-boundary value problems for partial differential equations.* ICASE Report No. 81-13, March 30, 1981, 42 pages. SIAM J. Sci. Statis. Comput., Vol. 3, No. 1, March 1982, pp. 6-27.
- Hariharan, S. and E. Stephan: *A boundary element method for a two-dimensional interface problem in electromagnetics.* ICASE Report No. 81-14, April 28, 1981, 17 pages. To appear in Numer. Math.
- Malik, M. R., S. Chuang, and M. Y. Hussaini: *Accurate numerical solution of compressible, linear stability equations.* ICASE Report No. 81-15, May 19, 1981, 15 pages. J. Applied Mathematics and Physics (ZAMP), Vol. 33, March 1982, pp. 189-201.
- Banks, H. T. and K. Kunisch: *An approximation theory for nonlinear partial differential equations with applications to identification and control.* ICASE Report No. 81-16, May 20, 1981, 84 pages. SIAM J. Control Optim., Vol. 20, No. 6, November 1982, pp. 815-849.
- Hariharan, S.: *Inverse scattering for an exterior Dirichlet problem.* ICASE Report No. 81-17, May 26, 1981, 23 pages. Quart. Appl. Math., October 1982, pp. 273-286.
- Philips, R. B. and M. E. Rose: *Compact finite difference schemes for mixed initial-boundary value problems - II.* ICASE Report No. 81-18, June 15, 1981, 49 pages. SIAM J. Numer. Anal., Vol. 19, No. 4, August 1982, pp. 698-720.
- Najfeld, I.: *Discrete Fourier transform of vector sets and perturbations of circulant matrices.* ICASE Report No. 81-19, July 17, 1981, 11 pages. Submitted to SIAM J. Algebraic Discrete Methods.

- Bayliss, A. and L. Maestrello: *On the interaction of a sound pulse with the shear layer of an axisymmetric jet. II. Heated Jets.* ICASE Report No. 81-20, July 20, 1981, 34 pages. To appear in *J. Sound and Vibration*.
- Rose, M. E.: *A finite difference scheme for compressible Navier-Stokes equations and a relationship to the Euler equation.* ICASE Report No. 81-21, July 22, 1981, 24 pages. Revised under title *Compact Finite Difference Scheme for the Euler and Navier-Stokes Equations*, ICASE Report No. 82-11.
- Schwartz, J. T.: *Finding the minimum distance between two convex polygons.* ICASE Report No. 81-22, July 30, 1981, 8 pages. *Inform. Process. Lett.*, Vol. 13, Issue No. 4 and 5, 1981, pp. 168-170.
- Gunzburger, M. D., R. A. Nicolaides, and J. S. Peterson: *On conforming mixed finite element methods for incompressible viscous flow problems.* ICASE Report No. 81-23, July 23, 1981, 29 pages. *Comput. Math. Appl.*, Vol. 8, 1982, pp. 167-179. This report was combined with ICASE Report No. 81-7.
- Van Albada, G. D., B. van Leer, and W. W. Roberts, Jr.: *A comparative study of computational methods in cosmic gas dynamics.* ICASE Report No. 81-24, August 3, 1981, 32 pages. *Astronom. and Astrophys.*, Vol. 108, 1982, pp. 76-84.
- Wenzel, A. R.: *Radiation and attenuation of waves in a random medium.* ICASE Report No. 81-25, August 5, 1981, 53 pages. *Acous. Soc. Amer.*, Vol. 71, January 1982, pp. 26-35.
- Banks, H. T.: *A survey of some problems and recent results for parameter estimation and optimal control in delay and distributed parameter systems.* ICASE Report No. 81-26, August 17, 1981, 28 pages. *Proc. of Conference on Volterra and Functional Differential Equations*, VPI & SU, Blacksburg, VA, June 10-13, 1981.
- Bayliss, A. and E. Turkel: *Far field boundary conditions for compressible flows.* ICASE Report No. 81-27, August 25, 1981, 19 pages. *Proc. of the Symposium on Numerical Boundary Condition Procedures*, NASA Ames Research Center, Moffett Field, CA, October 19-20, 1981. *J. Comput. Phys.*, Vol. 48, No. 2, November 1982, pp. 182-199.
- Zang, T. A., Y. S. Wong, and M. Y. Hussaini: *Spectral multi-grid methods for elliptic equations.* ICASE Report No. 81-28, August 31, 1981, 24 pages. *J. Comput. Phys.*, Vol. 48, No. 3, December 1982, pp. 485-501.
- Abarbanel, S. and E. M. Murman: *Stability of two-dimensional hyperbolic initial boundary value problems for explicit and implicit schemes.* ICASE Report No. 81-29, August 31, 1981, 9 pages. *J. Comput. Phys.*, Vol. 48, No. 2, November 1982, pp. 160-167.
- Wong, Y. S. and M. M. Hafez: *Preconditioned conjugate gradient methods for transonic flow calculations.* ICASE Report No. 81-30, September 16, 1981, 22 pages. To appear in book entitled *PRECONDITIONING TECHNIQUES*, D. J. Evans, ed., Gordon and Breach, Ltd., New York, 1982. A version emphasizing applications appeared under title *Conjugate Gradient Methods*

Applied to Transonic Finite Difference and Finite Element Calculations, in the AIAA J., Vol. 20, No. 11, November 1982, pp. 1526-1533.

- Schwartz, J. T.: *Comments on highly reliable software for avionics applications. ICASE Report No. 81-31*, September 23, 1981, 21 pages, NASA CR-165878. Proc. of the National Computer Conference, sponsored by AFIPS, Houston, TX, June 7-10, 1982.
- Banks, H. T. and P. L. Daniel: *Parameter estimation of nonlinear nonautonomous distributed systems. ICASE Report No. 81-32*, October 6, 1981, 5 pages. Proc. of the 20th IEEE Conference on Decision and Control, San Diego, CA, December 16-20, 1981.
- Banks, H. T. and I. G. Rosen: *Spline approximations for linear nonautonomous delay systems. ICASE Report No. 81-33*, October 9, 1981, 60 pages. To appear in J. Math. Anal. Appl.
- Harten, A.: *On the symmetric form of systems of conservation laws with entropy. ICASE Report No. 81-34*, October 15, 1981, 20 pages. To appear in J. Comput. Phys., Vol. 49, No. 3, March 1983.
- Gatski, T. B., C. D. Grosch, and M. E. Rose: *A numerical study of the two-dimensional Navier-Stokes equations in vorticity-velocity variables. ICASE Report No. 81-35*, November 3, 1981, 24 pages. J. Comput. Phys., Vol. 48, No. 1, October 1982, pp. 1-22.
- Rosen, I. G.: *Discrete approximation methods for parameter identification in delays systems. ICASE Report No. 81-36*, November 9, 1981, 67 pages. To appear in SIAM J. Control Optim.
- Fix, G. J., D. N. Lee, and G. Liang: *Stable finite elements for the Navier-Stokes equations. ICASE Report No. 81-37*, November 19, 1981, 11 pages. To appear in Numer. Math.
- Banks, H. T. and J. M. Crowley: *Parameter estimation for distributed systems arising in elasticity. ICASE Report No. 81-38*, December 1, 1981, 20 pages. Invited lecture, NCKU/AAS Symposium on Engineering Sciences and Mechanics, National Cheng Kung University, Tainan, Taiwan, December 28, 1981 - January 1, 1982.
- Gunzburger, M. D. and R. A. Nicolaides: *Stability of Gaussian elimination without pivoting on tridiagonal Toeplitz matrices. ICASE Report No. 81-39*, December 2, 1981, 9 pages. Linear Algebra Appl., Vol. 45, 1982, pp. 21-28.
- Teglas, R. G.: *On the control canonical structure of a class of scalar input systems. ICASE Report No. 81-40*, December 14, 1981, 31 pages. To appear in SIAM J. Control Optim.
- Fix, G. J. and E. Stephan: *Finite element methods of the least squares type for regions with corners. ICASE Report No. 81-41*, December 16, 1981, 15 pages. To appear in Math. Comp.

Gottlieb, D. and L. Lustman: *The DuFort-Frankel Chebyshev method for parabolic initial boundary value problems.* ICASE Report No. 81-42, December 28, 1981, 25 pages. To appear in *Comput. & Fluids*.

ICASE Reports: 1980

Bayliss, A., M. D. Gunzburger, and E. Turkel: *Boundary conditions for the numerical solution of elliptic equations in exterior regions.* ICASE Report No. 80-1, January 11, 1980, 45 pages. *SIAM J. Appl. Math.*, Vol. 42, No. 2, April 1982, pp. 430-451.

Bauschlicher, C. W.: *Singlet-triplet separation in CBr₂.* ICASE Report No. 80-2, January 21, 1980, 11 pages. *J. Amer. Chem. Soc.*, Vol. 102, 1980, pp. 54-92.

Wray, A. and M. Y. Hussaini: *Numerical experiments in boundary layer stability.* ICASE Report No. 80-3, January 22, 1980, 9 pages. AIAA paper No. 80-0275, AIAA 18th Aerospace Sciences Meeting, Pasadena, CA, January 14-16, 1980.

Bauschlicher, C. W.: *Accurate ab initio calculations for the ¹B₁ - ¹A₁ separation in methylene.* ICASE Report No. 80-4, January 23, 1980, 11 pages. *Chem. Phys. Lett.*, Vol. 74, No. 2, 1980, pp. 273-276.

Klopfer, G. and M. Y. Hussaini: *A study of formation of intense shear layers in transitional boundary layers.* ICASE Report No. 80-5, January 31, 1980, 31 pages, NASA CR-165909.

Abarbanel, S. and D. Gottlieb: *Optimal time splitting for two- and three-dimensional Navier-Stokes equations with mixed derivatives.* ICASE Report No. 80-6, February 18, 1980, 43 pages. *J. Comput. Phys.*, Vol. 41, No. 1, May 1981, pp. 1-33.

Strikwerda, J. C. and J. F. Geer: *A numerical method for computing the shape of a vertical slender jet.* ICASE Report No. 80-7, March 24, 1980, 35 pages. *SIAM J. Sci. Statis. Comput.*, Vol. 1, 1980, pp. 449-466.

Bauschlicher, C. W. and I. Shavitt: *A low energy passage for C⁺ + H₂ → CH⁺(¹Σ⁺) + H.* ICASE Report No. 80-8, April 8, 1980, 11 pages. *Chem. Phys. Lett.*, Vol. 75, 1980, pp. 62-65.

Bauschlicher, C. W.: *CI superposition error caused by bond functions.* ICASE Report No. 80-9, April 11, 1980, 9 pages. *Chem. Phys. Lett.*, Vol. 74, No. 2, 1980, pp. 277-279.

Bayliss, A. and L. Maestrello: *The near field interaction between a sound pulse and a jet shear layer.* ICASE Report No. 80-10, April 11, 1980, 10 pages. Proc. of the AIAA 6th Aeroacoustics Conference, June 4-6, 1980, Palo Alto, CA.

Eiseman, P. R.: *Geometric methods in computational fluid dynamics.* ICASE Report No. 80-11, April 18, 1980, 177 pages. Von Karman Institute Lectures, June 1980.

- Fix, G. F. and R. A. Nicolaides: *An analysis of mixed finite element approximations for periodic acoustic wave propagation.* ICASE Report No. 80-12, April 25, 1980, 17 pages. *SIAM J. Numer. Anal.*, Vol. 17, No. 6, December 1980, pp. 779-786.
- Cox, B. and C. W. Bauschlicher: *Surface relaxation and induced stress accompanying the absorption of H upon RE (0001).* ICASE Report No. 80-13, June 4, 1980, 27 pages. *Surface Science*, Vol. 102, 1981, p. 295.
- Lengsfeld, B., J. Jafri, D. Phillips, and C. Bauschlicher: *On the use of corresponding orbitals in calculation of non-orthogonal transition moments.* ICASE Report No. 80-14, June 12, 1980, 26 pages. *J. Chem. Phys.*, Vol. 74, 1982, p. 6849.
- Zang, T. A. and M. Y. Hussaini: *Mixed spectral finite difference approximations for slightly viscous flows.* ICASE Report No. 80-15, June 20, 1980, 6 pages. *Proc. of the 7th International Conference on Numerical Methods in Fluid Dynamics*, Stanford, CA, *Lecture Notes in Physics*, W. Reynolds and R. MacCormack, eds., Springer-Verlag, 1981.
- Eiseman, P. R.: *Coordinate generation with precise controls.* ICASE Report No. 80-16, June 20, 1980, 6 pages. *Proc. of the 7th International Conference on Numerical Methods in Fluid Dynamics*, Stanford, CA, *Lecture Notes in Physics*, W. Reynolds and R. MacCormack, eds., Springer-Verlag, 1981.
- Bauschlicher, C. W., B. Lengsfeld, and D. Yarkony: *On the low lying singlet states of ReO.* ICASE Report No. 80-17, July 14, 1980, 12 pages. *J. Chem. Phys.*, Vol. 73, No. 11, 1980, pp. 5702-5705.
- Bauschlicher, C. W., B. Lengsfeld, and D. Yarkony: *MCSCF for excited states.* ICASE Report No. 80-18, July 14, 1980, 3 pages. *Proc. of the National Resources for Computation in Chemistry Workshop at Lawrence Berkeley Laboratory*, College Station, Texas, 1980.
- Lengsfeld, B. and C. W. Bauschlicher: *On the convergence properties of the density matrix directed general second order MCSCF algorithm.* ICASE Report No. 80-19, July 14, 1980, 5 pages. *Proc. of the National Resources for Computation in Chemistry Workshop at Lawrence Berkeley Laboratory*, College Station, TX, 1980.
- Rose, M. E.: *A unified numerical treatment of the wave equation and the Cauchy-Riemann equation.* ICASE Report No. 80-20, July 14, 1980, 11 pages. *SIAM J. Numer. Anal.*, Vol. 18, No. 2, April 1981, pp. 372-376.
- Bayliss, A. and E. Turkel: *Outflow boundary conditions for fluid dynamics.* ICASE Report No. 80-21, August 7, 1980, 23 pages. *SIAM J. Sci. Statis. Comput.*, Vol. 3, No. 2, 1982, pp. 250-259.
- Nicolaides, R. A.: *Co-energy methods for elliptic flow and related problems.* ICASE Report No. 80-22, August 18, 1980, 20 pages. *Proc. of Elliptic Problem Solvers*, held under auspices of Los Alamos Scientific Laboratory, Santa Fe, NM, June 30-July 2, 1980.

- Brandt, A.: *Multi-grid solvers on parallel computers.* ICASE Report No. 80-23, September 2, 1980, 45 pages. Proc. of Elliptic Problem Solvers, held under auspices of Los Alamos Scientific Laboratory, Santa Fe, NM, June 30-July 2, 1980.
- Abarbanel, S. and D. Gottlieb: *On improving the 2-4 two-dimensional leap frog scheme.* ICASE Report No. 80-24, September 22, 1980, 11 pages. SIAM J. Sci. Statis. Comput., Vol. 1, No. 4, December 1980, pp. 426-430.
- Lin, C. and W. W. Roberts, Jr.: *Some fluid dynamical problems in galaxies.* ICASE Report No. 80-25, October 15, 1980, 36 pages. Annual Review of Fluid Mechanics, Vol. 13, 1981, pp. 33-55.
- Bona, J., W. P. Pritchard, and L. R. Scott: *An evaluation of a model equation for water waves.* ICASE Report No. 80-26, October 16, 1980, 107 pages. Philos. Trans. Roy. Soc. London, Vol. 302, No. 1471, September 1981, pp. 457-510.
- Strikwerda, J. C.: *A time-split difference scheme for the compressible Navier-Stokes equations with applications to flows in slotted nozzles.* ICASE Report No. 80-27, October 20, 1980, 24 pages. Appeared in Parallel Computation, Vol. 1 in Computational Techniques, G. Rodrigue, ed., Academic Press, 1982, pp. 251-267.
- Strikwerda, J. C. and K. R. Bube: *Interior regularity estimates for elliptic systems of difference equations.* ICASE Report No. 80-28, October 21, 1980, 51 pages. To appear in SIAM J. Numer. Anal.
- Anderson, C. and J. F. Geer: *Power series expansions for the frequency and period of the limit cycle of the van der Pol equation.* ICASE Report No. 80-29, October 29, 1980, 29 pages. SIAM J. Appl. Math., Vol. 43, No. 3, 1982, pp. 678-693.
- Eiseman, P. R.: *Coordinate generation with precise controls over mesh properties.* ICASE Report No. 80-30, November 14, 1980, 71 pages. J. Comput. Phys., Vol. 47, No. 3, September 1982, pp. 331-351.
- Eiseman, P. R.: *On the normal stress effects of incompressible non-Newtonian fluids.* ICASE Report No. 80-31, November 14, 1980, 14 pages. J. Franklin Inst., Vol. 312, No. 2, 1981, pp. 109-119.
- McKendry, M. and R. Campbell: *Capabilities for high level languages.* ICASE Report No. 80-32, November 24, 1980, 28 pages.
- Levinson, F. and W. W. Roberts, Jr.: *Insights into the gas dynamics in galaxies via a particle model.* ICASE Report No. 80-33, November 25, 1980, 15 pages. Proc. of the 12th International Symposium on Rarefied Gas Dynamics, S. Fisher, ed., July 7-11, 1980, Charlottesville, VA.
- Gottlieb, D., L. Lustman, and S. A. Orszag: *Spectral calculations of one-dimensional inviscid compressible flows.* ICASE Report No. 80-34, December 4, 1980, 44 pages. SIAM J. Sci. Statis. Comput., Vol. 2, No. 3, September 1981, pp. 296-310.

Vardi, A.: *A trust region algorithm for unconstrained minimization convergence properties and implementation.* ICASE Report No. 80-35, December 4, 1980, 31 pages. Submitted to Math. Programming.

Campbell, R. and P. Richards: *SAGA - A system to automate the management of software production.* ICASE Report No. 80-36, December 16, 1980, 12 pages. AFIPS Conference Proceedings of the 1981 National Computer Conference, Alex Orden, ed., Chicago, IL., May 4-7, 1981, AFIPS Press, Arlington, VA, pp. 231-234.

ICASE Reports: 1979

Harten, A. and H. Tal-Ezer: *On a fourth-order accurate implicit finite difference scheme for hyperbolic conservation laws: I. Non-still strongly dynamic problems.* ICASE Report No. 79-1, January 9, 1979, 46 pages. To appear in Math. Comp.

Rudy, D. and J. C. Strikwerda: *A non-reflecting outflow boundary condition for subsonic Navier-Stokes calculations.* ICASE Report No. 79-2, January 12, 1979, 27 pages. J. Comput. Phys., Vol. 36, No. 1, June 1980, pp. 55-70.

Rauschlicher, C. W.: *The construction of modified virtual orbitals (MVO's) which are suited for configuration interaction calculations.* ICASE Report No. 79-3, January 17, 1979, 14 pages. J. Chem. Phys., Vol. 72, 1980, pp. 880-885.

Rose, M. E.: *An artificial energy method for calculating flows with shocks.* ICASE Report No. 79-4, January 23, 1979, 8 pages. J. Comput. Phys., Vol. 38, No. 1, November 1980, pp. 107-113.

Strikwerda, J. C.: *Iterative methods for the numerical solution of second order elliptic equations with large first order terms.* ICASE Report No. 79-5, February 8, 1979, 24 pages. SIAM J. Sci. Statis. Comput., Vol. 1, No. 1, March 1980, pp. 119-130.

Bayliss, A. and E. Turkel: *Dynamics acoustics for the STAR-100.* ICASE Report No. 79-6, March 7, 1979, 11 pages. Proc. of the 3rd IMACS Intl. Symposium on Computer Methods for Partial Differential Equations, June 20-22, 1979, Lehigh University, Bethlehem, PA.

Bayliss, A. and E. Turkel: *Boundary conditions for exterior acoustic problems.* ICASE Report No. 79-7, March 30, 1979, 6 pages. Proc. of the 3rd IMACS Intl. Symposium on Computer Methods for Partial Differential Equations, June 20-22, 1979, Lehigh University, Bethlehem, PA.

Brandt, A.: *Multi-level adaptive finite element methods: I. Variational problems.* ICASE Report No. 79-8, April 2, 1979, 71 pages. Proc. of the Bat-Sheva Seminar on Finite Elements for Non-elliptic Problems, Tel-Aviv University, Tel-Aviv, Israel, July 1977.

Anderson, T. and P. A. Lee: *The provision of recoverable interfaces.* ICASE Report No. 79-9, April 16, 1979, 14 pages. Digest of Papers, FTCS-9, Madison, WI, June 1979.

- Harten, A. and H. Tal-Ezer: *On a fourth-order accurate implicit finite difference scheme for hyperbolic conservation laws.* ICASE Report No. 79-10, June 1, 1979, 42 pages. J. Comput. Phys., Vol. 36, 1981, pp. 353-373.
- Raffenetti, R. and D. Phillips: *Gaseous NH_4Cl revisited: A computational investigation of the potential surface and properties.* ICASE Report No. 79-11, June 5, 1979, 28 pages. J. Chem. Phys., Vol. 71, December 1979, pp. 4534-4540.
- Bona, J., W. P. Pritchard, and L. R. Scott: *Solitary-wave interaction.* ICASE Report No. 79-12, June 21, 1979, 10 pages. Phys. Fluids, Vol. 23, 1980, pp. 438-441.
- Dupont, T. and L. R. Scott: *Polynomial approximation of functions in Sobolev spaces.* ICASE Report No. 79-13, June 29, 1979, 48 pages. Math. Comp., Vol. 34, 1980, pp. 441-463.
- Bokhari, S.: *Optimal assignments in dual-processor distributed systems under varying load conditions.* ICASE Report No. 79-14, July 5, 1979, 39 pages. IEEE Trans. Software Engrg., Vol SE-7, November 1981, pp. 583-589 under the title of *A shortest tree algorithm for optimal assignments across space and time in a distributed processor system.*
- Brandt, A.: *Multi-grid solutions to elliptic flow problems.* ICASE Report No. 79-15, July 6, 1979. Proc. of the Conference on Numerical Solution of Partial Differential Equations, Mathematics Research Center, University of Wisconsin, Madison, WI, October 1978.
- Bokhari, S.: *On the mapping problem.* ICASE Report No. 79-16, July 24, 1979, 10 pages. Proc. of the 1979 Intl. Conference on Parallel Processing, Bellaire, MI, August 21-24, 1979, O. Garcia, ed., Wayne State and IEEE, pp. 239-248.
- Gottlieb, D.: *The stability of pseudospectral Chebyshev methods.* ICASE Report No. 79-17, August 6 1979, 24 pages. Math. Comp., Vol. 36, No. 153, January 1981, pp. 107-118.
- Rudy, D. and J. C. Srikwerda: *Boundary conditions for subsonic compressible Navier-Stokes calculations.* ICASE Report No. 79-18, August 6, 1979, 30 pages. Comput. & Fluids, Vol. 9, 1982, pp. 327-338.
- Brandt, A.: *Multi-level adaptive computations in fluid dynamics.* ICASE Report No. 79-19, August 7, 1979, 9 pages. Proc. of the AIAA Computational Fluid Dynamics Conference, Williamsburg, VA, 1979.
- Turkel, E.: *Numerical methods for large-scale, time-dependent partial differential equations.* ICASE Report No. 79-20, August 20, 1979, 136 pages. Computational Fluid Dynamics, W. Kollman, ed., Hemisphere Publishing Corp., Washington, 1980, pp. 128-262.
- Wenzel, A. R.: *Spectral broadening of waves propagating in a random medium.* ICASE Report No. 79-21, September 4, 1979, 37 pages, (a revision of ICASE report No. 78-11). J. Math. Phys., Vol. 21, No. 8, August 1980, pp. 2131-2139.

- Nicolaides, R. A.: *Existence, uniqueness and approximation for generalized saddle point problems.* ICASE Report No. 79-22, September 4, 1979, 22 pages. *SIAM J. Numer. Anal.*, Vol. 19, No. 2, April 1982, pp. 349-357.
- Geer J. R. and J. C. Strikwerda: *Vertical slender jets.* ICASE Report No. 79-23, September 12, 1979, 18 pages. *J. Fluid. Mech.*, Vol. 101, 1980, pp. 53-63.
- Jameson, A. and E. Turkel: *Implicit schemes and LU decompositions.* ICASE Report No. 79-24, September 17, 1979, 23 pages. *Math. Comp.*, Vol. 37, No. 156, October 1981, pp. 385-397.
- Bauschlicher, C. W.: *Improved CI formula evaluation: the elimination of the phase determination level for arbitrarily coupled CSF's.* ICASE Report No. 79-25, September 20, 1979, 5 pages. *International Journal of Quantum Chemistry*, Vol. 19, 1981, p. 649.
- Bayliss, A. and E. Turkel: *Radiation boundary conditions for wave-like equations.* ICASE Report No. 79-26, October 1, 1979, 31 pages. *Comm. Pure Appl. Math.*, Vol. 33, 1980, pp. 707-726.
- Bagus, P. and C. W. Bauschlicher: *Core binding energy shifts for free negative ions of oxygen: 0^0 to 0^m .* ICASE Report No. 79-27, October 8, 1979, 14 pages. *J. Electron Spectroscopy and Related Phenomena*, Vol. 20, 1980, pp. 183.
- Harten, A. and P. D. Lax: *A random choice finite difference scheme for hyperbolic conservation laws (a preliminary report).* ICASE Report No. 79-28, October 12, 1979, 57 pages. *SIAM J. Numer. Anal.*, Vol. 18, No. 2, April 1981, pp. 299-315.
- Hussaini, M. Y., B. Baldwin, and R. MacCormack: *Asymptotic features of shock-wave, boundary-layer interaction.* ICASE Report No. 79-29, October 29, 1979, 14 pages. *AIAA J.*, Vol. 18, No. 8, 1980, pp. 1014-1016.
- Bauschlicher, C. W. and D. Yarkony: *MCSCF wavefunctions for excited states of polar molecules: application to BeO.* ICASE Report No. 79-30, October 30, 1979, 30 pages. *J. Chem. Phys.*, Vol. 2, No. 2, 1980, pp. 1138-1144.
- Maestrello, L., A. Bayliss, and E. Turkel: *On the interaction between a sound pulse with the shear layer of an axisymmetric jet.* ICASE Report No. 79-31, December 19, 1979, 47 pages. *J. Sound Vibration*, Vol. 74, No. 2, January 1981, pp. 281-301.
- Gottlieb, D., S. A. Orszag, and E. Turkel: *Stability in pseudospectral and finite difference methods for variable coefficient problems.* ICASE Report No. 79-32, December 20, 1979, 27 pages. *Math. Comp.*, Vol. 37, No. 156, October 1981, pp. 293-305.
- Bauschlicher, C. W., D. Silver, and D. Yarkony: *An SCF and MCSCF description of the low lying states of MgO.* ICASE Report No. 79-33, December 21, 1979, 16 pages. *J. Chem. Phys.*, Vol. 73, 1980, pp. 2867-2870.

ICASE Reports: 1978

- Gottlieb, D. and E. Turkel: *On time discretizations for spectral methods.* ICASE Report No. 78-1, January 11, 1978, 30 pages. Stud. Appl. Math., Vol. 63, 1980, pp. 67-86.
- Zang, T. A. and F. Hohl: *Computer experiments on the effect of retrograde stars in disk galaxies.* ICASE Report No. 78-2, January 17, 1978, 47 pages. Astrophys. J., Vol. 226, 1978, pp. 521-539.
- Hamlin, G. H., Jr. and T. Crockett: *A microprocessor assisted graphics system.* ICASE Report No. 78-3, January 31, 1978, 14 pages. SIGGRAPH '78 Proceedings, Vol. 12, No. 3, August 1978, pp. 313-317.
- Bauschlicher, C. W. and D. Yarkony: *Electronic structure of CaO: 1.* ICASE Report No. 78-4, February 1, 1978, 29 pages. J. Chem. Phys., Vol. 68, No. 9, May 1978, pp. 3990-3997.
- Korn, D. and J. J. Lambiotte, Jr.: *Computing the fast Fourier transform on a vector computer.* ICASE Report No. 78-5, February 23, 1978, 29 pages. Math. Comp., Vol. 33, No. 147, July 1979, pp. 977-992.
- Abarbanel, S. and D. Gottlieb: *Stability of two-dimensional initial boundary value problems using leap frog type schemes.* ICASE Report No. 78-6, February 28, 1978, 22 pages. Math. Comp., Vol. 33, No. 148, October 1979, pp. 1145-1155.
- Fix, G. J., M. D. Gunzburger, and R. A. Nicolaides: *On mixed finite element methods: III. The grid decomposition property and examples.* ICASE Report No. 78-7, March 9, 1978, 30 pages. Revised under title "On mixed finite element methods for first order elliptic systems," ICASE Report No. 81-3, January 15, 1981, 35 pages. Num. Math., Vol. 37, 1981, pp. 29-48.
- Nicolaides, R. A.: *On finite element multi-grid algorithms and their use.* ICASE Report No. 78-8, March 17, 1978, 17 pages. Proc. of the Conference on the Mathematics of Finite Elements and Applications, Brunel University, England, April 1978.
- Jordan, H.: *A special purpose architecture for finite element analysis.* ICASE Report No. 78-9, March 29, 1978, 30 pages. Proc. of the 1978 Intl. Conference on Parallel Processing, G. Jack Lipovski, ed., IEEE Cat. No. 78CH1321-9C, pp. 263-266.
- Schwartz, J. T.: *Instantiation and decision procedures for certain classes of quantified set-theoretic formulae.* ICASE Report No. 78-10, August 11, 1978, 20 pages.
- Wenzel, A. R.: *Frequency spectra of solutions of stochastic equations with applications to spectral broadening of waves propagating in a random medium.* ICASE Report No. 78-11, August 14, 1978. A revision of this paper appears as ICASE Report No. 79-21, J. Math. Phys., August 1980, p. 2131.

- Rose, M. E.: *Operator factorizations generalizing the Gauss elimination method.* ICASE Report No. 78-12, August 22, 1978, 10 pages.
- Gottlieb, D., M. D. Gunzburger, and E. Turkel: *Numerical boundary treatment for systems of hyperbolic equations.* ICASE Report No. 78-13, September 7, 1978, 23 pages. *SIAM J. Numer. Anal.*, Vol. 19, No. 4, 1982, pp. 671-697.
- Fung, T., C. Liu, and M. D. Gunzburger: *Simulation of the pressure field near a jet by randomly distributed vortex rings.* ICASE Report No. 78-14, September 8, 1978, 20 pages. *AIAA J.*, Vol. 17, 1979, pp. 553-557.
- Fix, G. J., and M. D. Gunzburger: *On numerical methods for acoustic problems.* ICASE Report No. 78-15, September 13, 1978, 34 pages. *Math. Comput. with Appl.*, Vol. 6, 1980, pp. 265-278.
- Strikwerda, J. C.: *Initial boundary value problems for the method of lines.* ICASE Report No. 78-16, September 27, 1978, 22 pages. *J. Comput. Phys.*, Vol. 34, 1980, pp. 94-107.
- Strikwerda, J. C.: *Time-singular systems of partial differential equations.* ICASE Report No. 78-17, September 30, 1978, 36 pages.
- Brandt, A.: *Multi-level adaptive techniques (MLAT) for singular perturbation problems.* ICASE Report No. 78-18, October 12, 1978, 90 pages. *Proc. of the Conference on Numerical Analysis of Singular Perturbation Problems*, University of Nijmegen, Nijmegen, the Netherlands, May 30-June 2, 1978.
- Turkel, E.: *On the practical use of high order methods for hyperbolic systems.* ICASE Report No. 78-19, November 16, 1978, 39 pages. *J. Comput. Phys.*, Vol. 35, 1980, pp. 319-340.
- Madsen, N.: *Cyclic odd-even reduction for symmetric circulant matrices.* ICASE Report No. 78-20, November 14, 1978, 26 pages. To appear in *J. Linear Algebra and Applications*, June 1983.
- McRae, D. and M. Y. Hussaini: *Numerical simulation of supersonic cone flow at high angle of attack.* ICASE Report No. 78-21, November 15, 1978, 10 pages. *Proc. of the AGARD FDP Symposium on High Angle of Attack Aerodynamics*, Sandefjord, Norway, October 4-6, 1978, (AGARD-CPP 247).
- Bayliss, A. and E. Turkel: *Computation of acoustic waves in a jet.* ICASE Report No. 78-22, December 22, 1978, 32 pages.

ICASE Reports 1977

- Hamlin, G. H., Jr. and C. William Gear: *Raster-scan hidden surface algorithm techniques.* ICASE Report No. 77-1, January 7, 1977, 27 pages. *Proc. of SIGGRAPH '77*, *Computer Graphics*, Vol. 11, No. 1977, pp. 206-213.
- Harten, A.: *The artificial compression method for computation of shocks and contact discontinuities: I. Single conservation laws.* ICASE Report No. 77-2, February 16, 1977, 39 pages. *Comm. Pure Appl. Math.*, Vol. 30, 1977, pp. 611-638.

- Gottlieb, D. and E. Turkel: *On acceleration of MacCormack's scheme.* ICASE Report No. 77-3, March 1, 1977, 7 pages. *J. Comput. Phys.*, Vol. 26, No. 2, February 1978, pp. 252-256.
- Bayliss, A.: *A double shooting scheme for certain unstable and singular boundary value problems.* ICASE Report No. 77-4, March 22, 1977, 16 pages. *Math. Comp.*, Vol. 32, No. 141, January 1978, pp. 61-71.
- Bayliss, A.: *Forced oscillations in quadratically damped systems.* ICASE Report No. 77-5, March 28, 1977, 28 pages. *Comm. Pure Appl. Math.*, Vol. 31, 1978, pp. 69-88.
- Mansfield, L.: *Finite element methods for problems in dynamic elasticity.* ICASE Report No. 77-6, March 29, 1977, 19 pages.
- Ortega, J. M. and R. G. Voigt: *Solution of partial differential equations on vector computers.* ICASE Report No. 77-7, March 30, 1977, 50 pages. *Proc. of the 1977 Numerical Analysis and Computers Conference*, ARO Report No. 77-3.
- Voigt, R. G.: *The influence of vector computer architecture on numerical algorithms.* ICASE Report No. 77-8, March 21, 1977, 17 pages. *High Speed Computer and Algorithm Organization*, D. Kuck, D. Lawrie, and A. Sameh, eds., Academic Press, pp. 229-244.
- Hamlin, G. H., Jr.: *Raster-scan conversion using concurrent microprocessors.* ICASE Report No. 77-9, May 10, 1977, 17 pages. *Proc. of the First Rocky Mountain Symposium on Microprocessors*, August 1977, Fort Collins, CO.
- Hamlin, G. H., Jr. and T. Boardman: *A microprocessor based display controller.* ICASE Report No. 77-10, May 23, 1977, 9 pages. *Proc. of the Intl. Conference on Microcomputers, Minicomputers, and Microprocessors*, Geneva, Switzerland, May 1977.
- Gottlieb, D. and S. A. Orszag: *Theory of spectral methods for mixed initial-boundary value problems, Part II.* ICASE Report No. 77-11, July 21, 1977, 181 pages. Part II of a monograph published by SIAM-CBMS, No. 26.
- Nicolaidis, R. A.: *On multi-grid convergence in the indefinite case.* ICASE Report No. 77-12, July 27, 1977, 7 pages. *Math. Comp.*, Vol. 32, No. 144, 1978, pp. 1082-1086.
- Zang, T. A. and D. Haidvogel: *The accurate solution of Poisson's equation by expansion via Chebyshev polynomials.* ICASE Report No. 77-13, July 28, 1977, 31 pages. *J. Comput. Phys.*, Vol. 30, No. 2, 1979, pp. 167-180.
- Gunzburger, M. D. and R. Plemmons: *Energy conserving norms for the solution of hyperbolic systems of partial differential equations.* ICASE Report No. 77-14, July 29, 1977, 15 pages. *Math. Comp.*, Vol. 33, 1979, pp. 1-10.
- Bayliss, A.: *On the use of coordinate stretching in the numerical computation of high frequency scattering.* ICASE Report No. 77-15, November 14, 1977, 21 pages. *J. Sound Vib.*, Vol. 60, No. 4, 1978, pp. 543-553.

- Fix, G. J. and S. Marin: *Variational methods for underwater acoustic problems*. ICASE Report No. 77-16, August 26, 1977, 44 pages. *J. Comput. Phys.*, Vol. 28, No. 2, August 1978, pp. 253-270.
- Fix, G. J., M. D. Gunzburger, and R. A. Nicolaides: *On mixed finite element methods: I. The Kelvin principle*. ICASE Report No. 77-17, December 28, 1977, 18 pages. Revised under title *On mixed finite element methods for first order elliptic systems*, ICASE Report No. 81-3, January 15, 1981, 35 pages. *Numer. Math.*, Vol. 37, 1981, pp. 29-48.
- Fix, G. J., M. D. Gunzburger, and R. A. Nicolaides: *On finite element methods of the least squares type*. ICASE Report No. 77-18, December 30, 1977, 15 pages. *Comput. Math. Appl.*, Vol. 5, 1979, pp. 87-98.
- Nicolaides, R. A.: *On some theoretical and practical aspects of multigrid methods*. ICASE Report No. 77-19, October 20, 1977, 34 pages. *Math. Comp.*, Vol. 33, No. 147, July 1979, pp. 933-952.
- Brandt, A.: *Multi-level adaptive techniques (MLAT) for partial differential equations: Ideas and software*. ICASE Report No. 77-20, November 20, 1977, 42 pages. Proc. of the Symposium on Mathematical Software III, Mathematics Research Center, University of Wisconsin, Madison, WI, 1977.
- Mansfield, L.: *Finite element methods for nonlinear shell analysis*. ICASE Report No. 77-21, December 9, 1977, 17 pages. *Numer. Math.*, Vol. 37, 1981, pp. 121-131.
- Salas, M. D. and J. Daywitt: *Structure of the conical flowfield about external axial corners*. ICASE Report No. 77-22, November 16, 1977, 9 pages. Presented at the AIAA 16th Aerospace Sciences Meeting, Huntsville, AL, January 16-18, 1978.

ICASE Reports: 1976

- Hamlin, G. H., Jr.: *Configurable applications for satellite graphics*. ICASE Report No. 76-1, January 2, 1976, 20 pages. Proc. of the Third Annual Conference on Computer Graphics Interactive Techniques and Images Processing, Vol. 10, No. 2, July 1976, pp. 196-203.
- Sherman, S. and R. Brice: *I/O buffer performance in a virtual memory system*. ICASE Report No. 76-2, February 2, 1976, 24 pages. Proc. of the Fourth Symposium on the Simulation of Computer Systems, Vol. 4, August 1976, pp. 25-35.
- Gunzburger, M. D.: *On the stability of Galerkin methods for initial-boundary value problems for hyperbolic systems*. ICASE Report No. 76-3, February 20, 1976, 25 pages. *Math. Comp.*, Vol. 31, No. 139, July 1977, pp. 661-675.
- Wenzel, A. R.: *A note on wave propagation over an impedance boundary*. ICASE Report No. 76-4, February 20, 1976, 6 pages. Accepted by the Journal of the Acoustical Society of America but withdrawn.

- Raffenetti, R. C. and M. D. Gunzburger: *A note on the application of the finite-difference boundary value method to the calculation of Born-Oppenheimer vibrational eigenvalues for the double minimum $E, F^1 \Sigma^+$ state of the hydrogen molecule.* ICASE Report No. 76-5, February 25, 1976, 5 pages.
- Sherman, S. and R. Brice: *Performance of a database management system with partially locked virtual buffers.* ICASE Report No. 76-6, February 27, 1976, 15 pages. ACM Trans. on Database Systems, Vol. 2, No. 2, June 1977 under the title *An extension of the performance of a database manager in a virtual memory system using partially locked virtual buffers.*
- Gear, C. William: *The stability of numerical methods for second order ordinary differential equations.* ICASE Report No. 76-7, March 16, 1976, 14 pages. SIAM J. Numer. Anal., Vol. 15, No. 1, February 1978, pp. 188-197.
- South, J. C., Jr. and A. Brandt: *Application of a multi-level grid method to transonic flow calculations.* ICASE Report No. 76-8, March 19, 1976, 29 pages. Proc. of the Project SQUID Workshop on Transonic Flow Problems in Turbomachinery, Monterey, CA, February 11-12, 1976, pp. 180-207, Hemisphere Publishing Company.
- Brice, R. and S. Sherman: *Empirical comparison of partitioned and non-partitioned buffer management in virtual memory system.* ICASE Report 76-9, March 25, 1976, 14 pages. EURO CAMP Conference Proceedings, Computer Performance Evaluation, Online, Middlesex, England, September 1976, pp. 1-16.
- Fix, G. J. and M. D. Gunzburger: *Downstream boundary conditions for viscous flow problems.* ICASE Report No. 76-10, April 7, 1976, 27 pages. Comput. Math. Appl., Vol. 3, 1977, pp. 53-63.
- Kleinstein, G. and M. D. Gunzburger: *Frequency modulation at a moving material interface and a conservation law for wave number.* ICASE Report No. 76-11, April 20, 1976, 24 pages. J. Sound Vib., Vol. 48, No. 2, 1976, pp. 169-178.
- Gottlieb, D. and M. D. Gunzburger: *On the matrix equations $AH + HA = A^*H + HA = I$.* ICASE Report No. 76-12, April 21, 1976, 6 pages. J. Linear Algebra and Applications, Vol. 17, 1977, pp. 277-282.
- Mastin, C. W. and J. F. Thompson: *Transformation of three-dimensional regions onto rectangular regions by elliptic systems.* ICASE Report No. 76-13, April 26, 1976, 21 pages. Numer. Math., Vol. 29, 1978, pp. 397-407.
- Mastin, C. W. and J. F. Thompson: *Elliptic systems and numerical transformations.* ICASE Report No. 76-14, May 25, 1976, 19 pages. J. Math. Anal. Appl., Vol. 62, No. 1, January 1978, pp. 52-62.
- Gunzburger, M. D. and G. Kleinstein: *On the mathematical conditions for the existence of periodic fluctuations in nonuniform media.* ICASE Report No. 76-15, May 26, 1976, 28 pages. J. Sound Vib., Vol. 48, No. 3, October 1976, pp. 345-357.

- George, J. Alan, W. G. Poole, Jr. and R. G. Voigt: *A variant of nested dissection for solving n by n grid problems.* ICASE Report No. 76-16, June 1, 1976, 22 pages. *SIAM J. Numer. Anal.*, Vol. 15, No. 4, August 1978, pp. 662-673.
- George, J. Alan, W. G. Poole, Jr., and R. G. Voigt: *Analysis of dissection algorithms for vector computers.* ICASE Report No. 76-17, June 8, 1976, 58 pages. *Comput. Math. Appl.*, Vol. 4, 1978, pp. 287-304.
- Kleinstejn, G. and M. D. Gunzburger: *Applications of the wave number jump condition to the normal and oblique interaction of a plane acoustic wave and a plane shock.* ICASE Report No. 76-18, July 1, 1976, 23 pages. *J. Sound Vib.*, Vol. 53, No. 3, 1977, pp. 417-433.
- Turkel, E.: *Extrapolation methods for dynamic partial differential equations.* ICASE Report No. 76-19, July 6, 1976, 27 pages. *Numer. Math.*, Vol. 29, No. 3, 1978, pp. 269-285.
- Raffenetti, R. C., K. Hsu, and I. Shavitt: *Selection of terms for a CI wavefunction to preserve potential surface features.* ICASE Report No. 76-20, July 8, 1976, 21 pages. *Theoretica Chimica Acta*, Vol. 45, 1977, pp. 33-44.
- Wenzel, A. R.: *Propagation of sound in turbulent media.* ICASE Report No. 76-21, July 15, 1976, 9 pages. *Proc. of the 13th Annual Meeting of the Society of Engineering Science*, Hampton, VA, November 1-3, 1976.
- Cline, A.: *Several observations on the use of conjugate gradient methods.* ICASE Report No. 76-22, August 10, 1976, 30 pages.
- Boardman, T.: *A microprocessor architecture for digital device implementation.* ICASE Report No. 76-23, August 12, 1976, 16 pages. *Proc. of the AFIPS 1977 National Computer Conference*, Dallas, TX, June 1977, pp. 201-205.
- Mansfield, L.: *Mixed finite element methods for elliptic equations.* ICASE Report No. 76-24, August 18, 1976, 11 pages. *Comput. Math. Appl.*, Vol. 7, 1981, pp. 59-66.
- Fix, G. J.: *A mixed finite element scheme for transonic flows.* ICASE Report No. 76-25, August 26, 1976, 39 pages. *Numer. Math.*, Vol. 28, 1977, pp. 259-271.
- Fix, G. J. and M. D. Gunzburger: *On least squares approximations to indefinite problems of the mixed type.* ICASE Report No. 76-26, August 30, 1976, 39 pages. *Intl. J. Numer. Methods Engrg.*, Vol. 12, 1978, pp. 453-469.
- Brandt, A.: *Multi-level adaptive solutions to boundary value problems.* ICASE Report No. 76-27, August 30, 1976, 102 pages. *Math. Comp.*, Vol. 31, No. 138, April 1977, pp. 333-390.

- Trivedi, K.: *Prepaging and applications to the STAR-100 computer.* ICASE Report No. 76-28, August 30, 1976, 20 pages. High Speed Computer and Algorithm Organizations, D. Kuck, D. Lawrie, and A. Sameh, eds., Academic Press, pp. 435-446.
- Wenzel, A. R.: *A note on the forward-scatter approximation.* ICASE Report No. 76-29, October 4, 1976, 4 pages. J. Acous. Soc. of Amer., Vol. 61, No. 3, March 1977, pp. 882-883.
- Gottlieb, D. and E. Turkel: *Boundary conditions for multi-step finite difference methods for time dependent equations.* ICASE Report No. 76-30, September 13, 1976, 25 pages. J. Comput. Phys., Vol. 26, No. 2, February 1978, pp. 181-196.
- Bucy, R., K. Senne, and H. Youssef: *Pipeline parallel and serial realization of phase demodulators.* ICASE Report No. 76-31, November 22, 1976, 67 pages. Proc. of Conference on Stochastic Control, 1976.
- Gottlieb, D. and S. A. Orszag: *Numerical analysis of spectral methods for mixed initial boundary value problems.* ICASE Report No. 76-32, November 26, 1976, 89 pages. Part I of the monograph published by SIAM - CBMS, No. 26.

ICASE Reports: 1975

- Fix, G. J.: *Finite elements and fluid dynamics.* ICASE Report No. 75-1, February 1, 1975, 48 pages. Proc. of the First Intl. Symposium on Computational Methods in Nonlinear Mechanics, Springer-Verlag Lecture Notes, T. Oden, ed., Vol. 461, 1975, pp. 47-70.
- Gunzburger, M. D., C. Liu, and L. Maestrello: *Simulation by vortex rings of the unsteady pressure field near a jet.* ICASE Report No. 75-2, February 12, 1975, 7 pages. Progress in Astronautics and Aeronautics, I. Schwartz, ed., MIT Press, Vol. 33, 1976, pp. 47-64.
- Basili, V. and J. C. Knight: *A language design for vector machines.* ICASE Report No. 75-3, February 18, 1975, 14 pages. Proc. of the Conference on Programming Language and Compilers for Parallel and Vector Machines, SIGPLAN Notices, Vol. 10, No. 3, March 1975, pp. 39-43.
- Raffenetti, R. C.: *Optimal even-tempered Gaussian atomic orbital bases: first row atoms.* ICASE Report No. 75-4, February 25, 1975, 12 pages. Proc. of the Intl. Journal of Quantum Chemistry, Symposium No. 9, 1975, pp. 289-295.
- Gottlieb, D. and B. Gustaffson: *Generalized DuFort-Frankel methods for parabolic initial-boundary value problems.* ICASE Report No. 75-5, February 27, 1975, 32 pages. SIAM J. Numer. Anal., Vol. 13, No. 1, March 1976, pp. 129-144.
- Knight, J. C., W. G. Poole, Jr. and R. G. Voigt: *System balance analysis for vector computers.* ICASE Report No. 75-6, March 21, 1975, 25 pages. Proc. of the ACM National Conference, October 1975, pp. 163-168.

- Hardgrave, W. T.: *Set processing in a network environment.* ICASE Report No. 75-7, March 31, 1975, 43 pages. Proc. of the ACM/NBS 15th Annual Technology Symposium, June 1976 under the title *Set Processing: A tool for data management.*
- Hardgrave, W. T.: *Accessing technical data bases using STDS: A collection of scenarios.* ICASE Report No. 75-8, April 16, 1975, 84 pages.
- Crane, H., Jr., N. Gibbs, W. G. Poole, Jr. and P. Stockmeyer: *Matrix bandwidth and profile reduction.* ICASE Report No. 75-9, April 14, 1975, 19 pages. ACM Trans. Math. Software, Vol. 2, No. 4, December 1976, pp. 375-377.
- Hirsh, R., B. Pitts, and M. Wolfshtein: *Second order non-iterative ADI solution of nonlinear partial differential equations.* ICASE Report No. 75-10, May 12, 1975, 7 pages. Computer Methods for Partial Differential Equations, R. Vichnevetsky, ed., Proc. of AICA Intl. Symp. on Computer Methods for Partial Differential Equations, Lehigh University, Bethlehem, PA, June 1975, published by AICA, 1975.
- Atias, M., M. Wolfshtein, and M. Israeli: *A study of the efficiency of various Navier-Stokes solvers.* ICASE Report No. 75-11, May 12, 1975, 10 pages. Proc. of the AIAA Second Computational Fluid Dynamics Conference, Hartford, CT, June 1975.
- Gottlieb, D. and B. Gustaffson: *On the Navier-Stokes equations with constant total temperature.* ICASE Report No. 75-12, June 2, 1975, 33 pages. Studies in Applied Mathematics, Vol. 55, 1976, pp. 167-185.
- Stone, H.: *Sorting on STAR.* ICASE Report No. 75-13, June 5, 1975, 32 pages. Trans. Software Engrg., Vol. 4, No. 2, March 1978, pp. 138-146.
- Cline, A.: *The transformation of a quadratic programming problem into solvable form.* ICASE Report No. 75-14, August 11, 1975, 14 pages.
- Gerhart, S.: *On the relationship between structured programming and correctness proofs.* ICASE Report 75-15, August 13, 1975, 26 pages. Infotech State of the Art Report; Structured Programming, 1976, pp. 229-242.
- Ghil, M.: *Initialization by compatible balancing.* ICASE Report No. 75-16, August 22, 1975.
- Boisvert, R. and W. G. Poole, Jr.: *An interactive graphics package for the automatic node renumbering of finite element matrices.* ICASE Report No. 75-17, September 24, 1975, 10 pages. Proc. of the Applications of Computer Graphics in Engineering Conference, October 1975, pp. 605-614.
- Abarbanel, S.: *The slow recirculating flow near the rear stagnation point of a wake.* ICASE Report No. 75-18, September 29, 1975, 13 pages.
- Turkel, E.: *Composite methods for hyperbolic equations.* ICASE Report No. 75-19, September 29, 1975, 33 pages. SIAM J. Numer. Anal., Vol. 14, No. 4, September 1977, pp. 744-759.

- Sherman, S. and R. Brice: *Experiments concerning buffer management in a virtual memory system.* ICASE Report No. 75-20, October 6, 1975, 36 pages. ACM Trans. Database Systems, Vol. 1, No. 4, December 1976, pp. 317-343 under title *Performance of a database manager in a virtual memory system.*
- Abarbanel, S. and D. Gottlieb: *A note on the leap-frog scheme in two- and three-dimensions.* ICASE Report No. 75-21, October 30, 1975, 6 pages. J. Comput. Phys., Vol. 21, No. 3, 1976, pp. 351-355.
- Gottlieb, D. and E. Turkel: *Dissipative two-four methods for time dependent problems.* ICASE Report No. 75-22, October 30, 1975, 40 pages. Math. Comp., Vol. 30, No. 136, October 1976, pp. 703-723.

Earlier ICASE Reports

- Fix, G. J.: *Finite element approximation of ocean circulation problems.* SIAM J. Appl. Math., Vol. 29, No. 3, November 1975, pp. 371-387.
- Gunzburger, M. D., C. Liu, L. Maestrello, and L. Ting: *Sound propagation through a real jet flow field with scattering due to interaction with turbulence.* J. Engrg. Math., Vol. 10, No. 6, July 1976, pp. 47-64.
- Lambiotte, J. J., Jr. and R. G. Voigt: *The solution of tridiagonal linear systems on the CDC STAR-100 computer.* ACM Trans. Math. Software, Vol. 1, No. 4, December 1975, pp. 308-329.
- Gibbs, N., W. G. Poole, Jr. and P. Stockmeyer: *An algorithm for reducing the bandwidth and profile of a sparse matrix.* SIAM J. Numer. Anal., Vol. 13, No. 2, April 1976, pp. 236-250.
- George, J. Alan: *A negative result on sparse matrix splitting in the context of Gaussian elimination.* SIAM J. Numer. Anal., Vol. 13, No. 6, December 1976, pp. 846-853.
- Rosenbaum, J.: *Conservation properties of numerical integration methods for systems of ordinary differential equations.* J. Comput. Phys., Vol. 20, No. 3, March 1976, pp. 259-267.
- Poole, W. G., Jr. and R. G. Voigt: *Numerical algorithms for parallel and vector computers: An annotated bibliography.* Comput. Rev., Vol. 15, No. 10, October 1974, pp. 379-388.
- Heller, D.: *Some aspects of the cyclic reduction algorithm for block tridiagonal linear systems.* SIAM J. Numer. Anal., Vol. 13, No. 4, September 1976, pp. 484-496.
- Cline, A.: *A descent method for the uniform solution of overdetermined systems of linear equations.* SIAM J. Numer. Anal., Vol. 13, No. 3, June 1976, pp. 293-309.

Swint, E. and D. Yen: *Periodic solutions in a class of nonlinear dual-mass systems*. Proc. of the First Intl. Symposium on Computational Methods in Nonlinear Mechanics, COMPUTATIONAL METHODS IN NONLINEAR MECHANICS, University of Texas, Austin, TX.

Sherman, S., J. Howard, Jr., and J. C. Browne: *Trace driven studies of deadlock control and job scheduling*. Springer-Verlag Notes in Computer Science, Vol. 26, 1975, pp. 386-395.

Hardgrave, W. T: *Positioned versus keyword parameter communication*. SIGPLAN Notices, Vol. 11, No. 5, May 1976.

Poole, W. G., Jr., N. Gibbs, and P. Stockmeyer: *A comparison of several bandwidth and profile reduction algorithms*. ACM Trans. Math. Software, Vol. 2, No. 4, December 1976, pp. 322-330.

Other Reports by ICASE Personnel

Bokhari, S., M. Y. Hussaini, and S. Orszag: *Fast orthogonal derivatives on the STAR*. Comput. Math. Appl., Vol. 8, No. 5, 1982, pp. 367-377.

Salas, M. D., T. A. Zang, and M. Y. Hussaini: *Shock-fitted Euler solutions to shock-vortex interactions*. Lecture Notes in Physics No. 170, Springer, Berlin 1982, E. Krause, ed., Proc. of the Intl. Conf. on Numer. Meth. in Fluid Dynamics, Aachen.

Salas, M. D., C. R. Gumbert: *Non-unique solutions to the transonic potential flow equation*. AIAA Technical Note (NASA).

Bayliss, A., L. Maestrello, and E. Turkel: *Simulation of the fluctuating field of a forced jet*. Lecture Notes in Physics No. 170, Springer, Berlin 1982, E. Krause, ed., Proc. of the Intl. Conf. on Numer. Meth. in Fluid Dynamics, Aachen.

Zang, T. A. and F. Hohl: *Computer experiments on the effect of retrograde stars in disk galaxies*. Astrophys. J., Vol. 226, December 1978, pp. 521-539.

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