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# Abstracts of Papers to Appear

*An Essentially Nonoscillatory High-Order Padé-Type (ENO-Padé) Scheme.* Zhiping Wang and George P. Huang. Department of Mechanical Engineering, University of Kentucky, Lexington, Kentucky 40506-0108.

A new, essentially nonoscillatory high-order Padé-type (ENO-Padé) scheme has been developed by incorporating the ENO interpolation algorithm into the cell-centered Padé scheme. The scheme is designed to eliminate the nonphysical oscillatory behavior of the Padé scheme across discontinuities and to improve the performance of the ENO scheme in smooth regions. The main features of the ENO-Padé scheme are illustrated by the solution of the scalar transport equation, while the extension of the method to the solution of compressible flow equations is also demonstrated. A number of numerical test cases, including two scalar-transport problems and three compressible flows, are used to compare the performances of the ENO-Padé scheme against other available schemes, such as upwind-biased, Padé, and ENO schemes. The numerical results show that the ENO-Padé scheme is an excellent compromise of the available schemes for resolving profiles over flow discontinuities while maintaining accurate flow structures in smooth regions.

*An Adaptive Higher Order Method for Solving the Radiation Transport Equation on Unstructured Grids.* A. Dedner* and P. Vollmöller.† *Institut für Angewandte Mathematik, Universität Freiburg, Germany; and †Max Planck Institut für Aeronomie, Katlenburg, Lindau, Germany.

A new class of solution methods based on a short-characteristics approach embedded in the finite element framework for the solution of the radiation transport equation is developed and tested. The order of convergence and the error to runtime ratio are determined in numerical tests. Furthermore, the efficiency of the scheme is demonstrated in the case of a challenging problem from the field of solar physics. A quantitative comparison with other methods, based either on the characteristics or on the finite element approach, is carried out. This emphasizes the efficiency and accuracy of our method. Two different adaptation mechanisms are studied: grid adaptation and local variation of the order of the scheme.

*A Moving Mesh Finite Element Algorithm for Singular Problems in Two and Three Space Dimensions.* Ruo Li,*,† Tao Tang,† and Pingwen Zhang.* *School of Mathematical Sciences, Peking University, Beijing 100871, People's Republic of China; and †Department of Mathematics, The Hong Kong Baptist University, Kowloon Tong, Hong Kong.

A framework for adaptive meshes based on the Hamilton–Schoen–Yau theory was proposed by Dvinsky. In a recent work (2001, *J. Comput. Phys.* **170**, 562–588), we extended Dvinsky's method to provide an efficient moving mesh algorithm which compared favorably with the previously proposed schemes in terms of simplicity and reliability. In this work, we will further extend the moving mesh methods based on harmonic maps to deal with mesh adaptation in three space dimensions. In obtaining the variational mesh, we will solve an *optimization problem* with some appropriate constraints, which is in contrast to the traditional method of solving the Euler–Lagrange equation directly. The key idea of this approach is to update the interior and boundary grids simultaneously, rather than considering them separately. Application of the proposed moving mesh scheme is illustrated with some two- and three-dimensional problems with large solution gradients. The numerical experiments show that our methods can accurately resolve detail features of singular problems in 3D.



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*A Two-Level Time-Stepping Method for Layered Ocean Circulation Models.* Robert L. Higdon. Department of Mathematics, Oregon State University, Corvallis, Oregon 97331-4605.

This paper describes a numerical method with two time levels for solving partial differential equations that represent layered models of ocean circulation. The method is designed to be used with a barotropic–baroclinic splitting that separates the fast and slow motions into subsystems that are solved by different techniques. With this method, some of the dependent variables are predicted and then corrected. After the initial prediction steps, all steps involve centered differencing and averaging about the midpoint of the time interval in question. The Coriolis and pressure terms are evaluated at the same time levels to avoid a first-order truncation error in the geostrophic balance between those terms. Compared to the three-level leapfrog method that is widely used in geophysical fluid dynamics, the present method does not admit a computational mode, and the maximum permissible time step is at least twice as large. In addition, with the two-level method it is possible to use a nearly nonoscillatory advection algorithm to solve the equations for mass and momentum. In a simple test problem, the present method gives less phase error than the leapfrog method and two other methods, and it does not give any amplitude error. The differences are especially large when compared to the leapfrog method. The two-level method also gives good results in a nonlinear test problem involving vanishing layers at the top and bottom of the fluid domain and an interface moving along sloping bottom topography.

*An Iterative Substructuring Method for Coupled Fluid–Solid Acoustic Problems.* Jan Mandel. Department of Mathematics and Center for Computational Mathematics, University of Colorado at Denver, Denver, Colorado 80217-3364; and Department of Aerospace Engineering Science and Center for Aerospace Structures, University of Colorado at Boulder, Boulder, Colorado 80309-0429.

A fast parallel iterative method is proposed for the solution of linear equations arising from finite element discretization of the time harmonic coupled fluid–solid systems in fluid pressure and solid displacement formulation. The fluid and the solid domains are decomposed into nonoverlapping subdomains. Continuity of the solution is enforced by Lagrange multipliers. The system is augmented by duplicating the degrees of freedom on the wet interface. The original degrees of freedom are then eliminated and the resulting system is solved by iterations preconditioned by a coarse space correction. In each iteration, the method requires the solution of one independent local acoustic problem per subdomain and the solution of a global problem with several degrees of freedom per subdomain. Computational results show that the method is scalable with the problem size, frequency, and the number of subdomains. The method generalizes the FETI-H method for the Helmholtz equation to coupled fluid–elastic scattering. The number of iterations is about same as for the FETI-H method for the related Helmholtz problem with Neumann boundary condition instead of an elastic scatterer if enough coarse space functions are used. Convergence behavior is explained from the spectrum of the iteration operator and from numerical near decoupling of the equations in the fluid and in the solid regions.