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A DISCONTINUOUS *hp* FINITE ELEMENT METHOD FOR DIFFUSION PROBLEMS. J. Tinsley Oden,* Ivo Babuška,† and Carlos Erik Baumann‡. *Texas Institute for Computational and Applied Mathematics, The University of Texas at Austin, Austin, Texas 78712.* E-mail: *oden@ticam.utexas.edu, †babuska@ticam.utexas.edu, and ‡carlosb@ticam.utexas.edu.

We present an extension of the discontinuous Galerkin method which is applicable to the numerical solution of diffusion problems. The method involves a weak imposition of continuity conditions on the solution values and on fluxes across interelement boundaries. Within each element, arbitrary spectral approximations can be constructed with different orders p in each element. We demonstrate that the method is elementwise conservative, a property uncharacteristic of high-order finite elements.

For clarity, we focus on a model class of linear second-order boundary value problems, and we develop *a priori* error estimates, convergence proofs, and stability estimates. The results of numerical experiments on h- and p-convergence rates for representative two-dimensional problems suggest that the method is robust and capable of delivering exponential rates of convergence.

A NOVEL THERMAL MODEL FOR THE LATTICE BOLTZMANN METHOD IN INCOMPRESSIBLE LIMIT. Xiaoyi He, Shiyi Chen, and Gary D. Doolen. *Theoretical Division and the Center for Nonlinear Studies, Los Alamos National Laboratory, Los Alamos, New Mexico 87545.*

A novel lattice Boltzmann thermal model is proposed for studying thermohydrodynamics in incompressible limit. The new model introduces an internal energy density distribution function to simulate the temperature field. The macroscopic density and velocity fields are still simulated using the density distribution function. Compared with the multispeed thermal lattice Boltzmann models, the current scheme is numerically more stable. In addition, the new model can incorporate viscous heat dissipation and compression work done by the pressure, in contrast to the passive-scalar-based thermal lattice Boltzmann models. Numerical simulations of Couette flow with a temperature gradient and Rayleigh–Bénard convection agree well with analytical solutions and benchmark data.

BALANCING SOURCE TERMS AND FLUX GRADIENTS IN HIGH-RESOLUTION GODUNOV METHODS: THE QUASI-STEADY WAVE-PROPAGATION ALGORITHM. Randall J. LeVeque. *Department of Applied Mathematics and Department of Mathematics, University of Washington, Box 352420, Seattle, Washington 98195-2420.* E-mail: rjl@amath.washington.edu.

Conservation laws with source terms often have steady states in which the flux gradients are nonzero but exactly balanced by source terms. Many numerical methods (e.g., fractional step methods) have difficulty preserving such steady states and cannot accurately calculate small perturbations of such states. Here a variant of the wave-propagation algorithm is developed which addresses this problem by introducing a Riemann problem in the center of each grid cell whose flux difference exactly cancels the source term. This leads to modified Riemann problems at the cell edges in which the jump now corresponds to perturbations from the steady state. Computing waves and limiters based on the solution to these Riemann problems gives high-resolution results. The 1D and 2D shallow water equations for flow over arbitrary bottom topography are used as an example, though the ideas apply to many other systems. The method is easily implemented in the software package CLAWPACK.

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GROWING 1D AND QUASI-2D UNSTABLE MANIFOLDS OF MAPS. Bernd Krauskopf* and Hinke Osinga†. *_Theoretical Physics, Free University, De Boelelaan 1081, 1081 HV Amsterdam, The Netherlands; and †The Geometry Center, University of Minnesota, 400 Lind Hall, Minneapolis, Minnesota 55455._ E-mail: *berndk@nat.vu.nl and †hinke@geom.umn.edu.

We present a new 1D algorithm for computing the global one-dimensional unstable manifold of a saddle point of a map. Our method can be generalized to compute two-dimensional unstable manifolds of maps with three-dimensional state spaces. This is shown here with a quasi-2D (Q2D) algorithm for the special case of a quasiperiodically forced map, which allows for a substantial simplification of the general case described in Krauskopf and Osinga (to appear). The key idea is to “grow” the manifold in steps, which consist of finding a new point on the manifold at a prescribed distance from the last point. The speed of growth is determined only by the curvature of the manifold, and not by the dynamics.

The performance of the 1D algorithm is demonstrated with a constructed test example, and it is then used to compute one-dimensional manifolds of a map modeling mixing in a stirring tank. With the Q2D algorithm we compute two-dimensional unstable manifolds in the quasiperiodically forced Hénon map.

A GENERAL CLASS OF COMMUTATIVE FILTERS FOR LES IN COMPLEX GEOMETRIES. Oleg V. Vasilyev, Thomas S. Lund, and Parviz Moin. _Center for Turbulence Research, Stanford University, Stanford, California 94305._

A class of filters for large eddy simulations of turbulent inhomogeneous flows is presented. A general set of rules for constructing discrete filters in complex geometry is given and examples of such filters are presented. With these filters the commutation error between numerical differentiation and filtering can be made arbitrarily small, allowing for derivation of a consistent set of equations for the large scale field. The application of such filters for explicit filtering in large eddy simulations and the issue of boundary conditions for the filtered field are also discussed.