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Abstracts of Papers to Appear

GAS-KINETIC SCHEME FOR MULTIMATERIAL FLOWS AND ITS APPLICATION IN CHEMICAL REACTIONS. Y. S. Lian and K. Xu. *Mathematics Department, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China.*

This paper concerns the extension of the multicomponent gas-kinetic BGK-type scheme to chemical reactive flow calculations. In the kinetic model, each component satisfies its individual gas-kinetic Bhatnagar–Gross–Krook (BGK) equation and the equilibrium states of both components are coupled in space and time due to the momentum and energy exchange in the course of particle collisions. At the same time, according to the chemical reaction rule one component can be changed into another component with a release of energy. The reactant and product may have different ratios of specific heats. The BGK scheme basically uses the collisional Boltzmann model to mimic the numerical dissipation necessary for shock capturing. The numerical dissipation is controlled by the particle collision pseudo-time τ. In the resolved viscous calculations, there is a direct relation between the physical viscosity coefficient and the particle collision time. Many numerical test cases presented in this paper validate the gas kinetic approach in the application of multicomponent reactive flows.

ON THE STABILITY OF THE FINITE-DIFFERENCE TIME-DOMAIN METHOD. Rob F. Remis. *Laboratory of Electromagnetic Research, Centre for Technical Geoscience, Delft University of Technology, Mekelweg 4, 2628 CD Delft, The Netherlands.*

In this paper we give a necessary and sufficient condition for stability of the finite-difference time-domain method (FDTD method). This is an explicit time-stepping method that is used to solve transient electromagnetic field problems. A necessary (but not a sufficient) condition for its stability is usually obtained by requiring that discrete Fourier modes, defined on the FDTD grid, remain bounded as time stepping proceeds. Here we follow a different approach. We rewrite the basic FDTD equations in terms of an iteration matrix and study the eigenvalue problem for this matrix. From the analysis a necessary and sufficient condition for stability of the FDTD method follows. Moreover, we show that for a particular time step the 2-norm of the FDTD iteration matrix is equal to the golden ratio.

SPECTRAL ELEMENT METHODS FOR AXISYMMETRIC STOKES PROBLEMS. M. I. Gerritsma* and T. N. Phillips.† **Faculty of Aerospace Engineering, Delft University of Technology, Kluyverweg 1, 2629 HS, Delft, The Netherlands; and †Department of Mathematics, University of Wales, Aberystwyth SY23 3BZ, United Kingdom.*

The approximation of the Stokes problem in axisymmetric geometries using the spectral element method is considered. The presence of the volume element *rdrdz* in the weak formulation of the problem is shown to be a potential source of difficulty. The discrete equations associated with nodes on the axis of symmetry can lead to a degeneracy in the global system of equations. This difficulty is resolved by incorporating the factor r into the weight function for spectral elements adjacent to the axis of symmetry and using appropriate basis functions in these elements in the radial direction. Properties of the Jacobi polynomials are used to construct the elements of the modified method. Numerical results are presented that demonstrate some of the features of the proposed approach.

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FREE VIBRATION ANALYSIS OF CURVILINEAR QUADRILATERAL PLATES BY THE DIFFERENTIAL QUADRATURE METHOD. C. Shu,* W. Chen,* and H. Du.† *Department of Mechanical and Production Engineering, National University of Singapore, 10 Kent Ridge Crescent, Singapore 119260; and †School of Mechanical and Production Engineering, Nanyang Technological University, Nanyang Avenue, Singapore 2263.*

A methodology is developed for applying the differential quadrature (DQ) method to the free vibration analysis of arbitrary quadrilateral plates. In our approach, the irregular physical domain is transformed into a rectangular domain in the computational space. The governing equation and the boundary conditions are also transformed into relevant forms in the computational space. Then, all the computations are based on the computational domain. As compared to the approach proposed by Bert and Malik the present approach requires much less computational effort and virtual storage. In addition, the present work uses a simple and convenient way to implement clamped and simply supported boundary conditions. An exact mapping technique is used to perform the coordinate transformation in this study. Some numerical examples are provided to show the computational efficiency of the present scheme.

THE CONTINUOUS GALERKIN METHOD IS LOCALLY CONSERVATIVE. Thomas J. R. Hughes, Gerald Engel, Luca Mazzei, and Mats G. Larson. *Division of Mechanics and Computation, William F. Durand Building, Stanford University, Stanford, California 94305-4040.*

We examine the conservation law structure of the continuous Galerkin method. We employ the scalar advection–diffusion equation as a model problem for this purpose, but our results are quite general and apply to time-dependent nonlinear systems as well. In addition to global conservation laws, we establish local conservation laws which pertain to subdomains consisting of a union of elements as well as individual elements. These results are somewhat surprising and contradict the widely held opinion that the continuous Galerkin method is not locally conservative.