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Abstracts of Papers to Appear

THE RUNGE–KUTTA DISCONTINUOUS GALERKIN METHOD FOR CONSERVATION LAWS. V. MULTIDIMENSIONAL SYSTEMS. Bernardo Cockburn* and Chi-Wang Shu†. **School of Mathematics, University of Minnesota, Minneapolis, Minnesota 55455; †Division of Applied Mathematics, Brown University, Providence, Rhode Island 02912.* E-mail: cockburn@math.umn.edu, shu@cfm.brown.edu.

This is the fifth paper in a series in which we construct and study the so-called Runge–Kutta discontinuous Galerkin method for numerically solving hyperbolic conservation laws. In this paper, we extend the method to multidimensional nonlinear systems of conservation laws. The algorithms are described and discussed, including algorithm formulation and practical implementation issues such as the numerical fluxes, quadrature rules, degrees of freedom, and the slope limiters, both in the triangular and the rectangular element cases. Numerical experiments for two-dimensional Euler equations of compressible gas dynamics are presented that show the effect of the (formal) order of accuracy and the use of triangles or rectangles on the quality of the approximation.

ON THE SCHWARZ ALTERNATING METHOD FOR OCEANIC MODELS ON PARALLEL COMPUTERS. L. Debreu and E. Blayo. *Project IDOPT, Laboratoire de Modélisation et Calcul, BP 53X, 38041 Grenoble Cedex, France.* E-mail: Laurent.Debreu@imag.fr.

In this paper we examine the application of a domain decomposition method to the solution of Poisson and Helmholtz equations often involved in the oceanic models. By studying a theoretical convergence rate of the method in the case of two subdomains (which can be generalized in some extent to the N-subdomains case), we can link some numerical properties of the method to physical features of the model ocean circulation. In particular, the peculiar role of the barotropic mode with respect to baroclinic modes is discussed. The tuning of the different parameters involved in a practical implementation of this Schwarz alternating method is also addressed for the case of a quasi-geostrophic oceanic model. Some CPU-timings are presented. On 16 processors of a CRAY T3D, the parallel code runs as fast as the sequential version does on a CRAY C90.

A CONSERVING DISCRETIZATION FOR THE FREE BOUNDARY IN A TWO-DIMENSIONAL STEFAN PROBLEM. Guus Segal,* Kees Vuik,* and Fred Vermolen†. **Faculty of Technical Mathematics and Informatics, Delft University of Technology, P.O. Box 5031, NL 2600 GA Delft, The Netherlands; †Laboratory of Materials Science, Delft University of Technology, P.O. Box 5045, NL 2600 GA Delft, The Netherlands.* E-mail: c.vuik@math.tudelft.nl.

The dissolution of a disk-like Al_2Cu particle is considered. A characteristic property is that initially the particle has a nonsmooth boundary. The mathematical model of this dissolution process contains a description of the particle interface, of which the position varies in time. Such a model is called a Stefan problem. It is impossible to obtain an analytical solution for a general two-dimensional Stefan problem, so we use the finite element method to solve this problem numerically. First, we apply a classical moving mesh method. Computations show that after some time steps the predicted particle interface becomes very unrealistic. Therefore, we derive a new method for the displacement of the free boundary based on the balance of atoms. This method leads to good results, also, for nonsmooth boundaries. Some numerical experiments are given for the dissolution of an Al_2Cu particle in an $Al{-}Cu$ alloy.

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DISCONTINUOUS GALERKIN FINITE ELEMENT METHOD WITH ANISOTROPIC LOCAL GRID REFINEMENT FOR INVISCID COMPRESSIBLE FLOWS. J. J. W. van der Vegt and H. van der Ven. *National Aerospace Laboratory NLR, P.O. Box 90502, 1006BM Amsterdam, The Netherlands.* E-mail: vegt@nrl.nl.

A new discretization method for the three-dimensional Euler equations of gas dynamics is presented, which is based on the discontinuous Galerkin finite element method. Special attention is paid to an efficient implementation of the discontinuous Galerkin method that minimizes the number of flux calculations, which is generally the most expensive part of the algorithm. In addition a detailed discussion of the truncation error of the presented algorithm is given. The discretization of the Euler equations is combined with anisotropic grid refinement of an unstructured, hexahedron-type grid to achieve optimal resolution in areas with shocks, vortices, and other localized flow phenomena. The data structure and searching algorithms necessary for efficient calculation on highly irregular grids obtained with local grid refinement are discussed in detail. The method is demonstrated with calculations of the supersonic flow over a 10° ramp and the ONERA M6 wing under transsonic flow conditions.

A PARTICLE ALGORITHM FOR LINEAR KINETIC ANALYSIS IN TOKAMAK PLASMAS. Y. Todo and T. Sato. *Theory and Computer Simulation Center, National Institute for Fusion Science, 322-6 Oroshi-cho, Toki, Gifu 509-52, Japan.* E-mail: todo@nifs.ac.jp.

A particle algorithm for linear kinetic analysis in tokamak plasmas is developed. Linear kinetic stability of a tokamak plasma is analyzed as an initial value problem. Particles are used to sample plasma elements along equilibrium characteristics in four-dimensional phase space $(R, z, v_\parallel, \mu)$. Each particle is accompanied with a weight which is a function of the toroidal angle. Integrals in the phase space are evaluated through the weight function and the particle location in the four-dimensional space. Destabilization of an $n = 2$ toroidal Alfvén eigenmode is investigated as a test of the algorithm, and convergence in number of used particle is assessed.