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# Abstracts of Papers to Appear in Future Issues

$\delta f$ AND PARTICLE SIMULATIONS OF PARAMETRIC INSTABILITIES. G. DiPeso and E. C. Morse, *University of California, Berkeley, California, USA*; R. Ziolkowski, *Lawrence Livermore National Laboratory, Livermore, California, USA.*

The $\delta f$ and particle simulation methods are presented and compared for parametric instabilities in a 1D unmagnetized plasma. The $\delta f$ simulation method used here is based on the linearized Vlasov equation. The simulation growth rates from both methods roughly agree with growth rates obtained from a fluid theory. Doubling the number of characteristics in the $\delta f$ simulations does not significantly alter the growth rates. Doubling the number of particles in the particle simulation does alter the growth rates indicating that particle noise is interfering with the physics. The $\delta f$ simulation method was also compared to Vlasov theory for parametric instabilities in a 1D magnetized plasma. The simulations generally agree with the theory.

AN INTERACTIVE APPROACH FOR CALCULATING SHIP BOUNDARY LAYERS AND WAKES FOR NONZERO FROUDE NUMBER. Y. Tahara and F. Stern, *University of Iowa, Iowa City, Iowa, USA*; B. Rosen, *South Bay Simulations, Inc., Babylon, New York, USA.*

An interactive approach is set forth for calculating ship boundary layers and wakes for nonzero Froude number. The Reynolds-averaged Navier–Stokes equations are solved using a small domain with edge conditions matched with those from a source-doublet-Dawson method solved using the displacement body. An overview is given of both the viscous- and inviscid-flow methods, including their treatments of the free-surface boundary conditions and interaction procedures. Results are presented for the Wigley hull, including comparisons for zero and nonzero Froude number and with available experimental data and the inviscid-flow results, which validate the overall approach and enable an evaluation of the wave-boundary layer and wake interaction.

ON THE ACCURACY OF THE SPECTRAL INTERPOLATION METHODS FOR SAMPLED PSEUDOPERIODIC SIGNALS. D. R. Rajaona and P. Sulmont, *Laboratoire d'Hydrodynamique Navale URA 1217 CNRS, ENSM Nantes, FRANCE.*

The accuracy of a spectral interpolation method is studied on sampled pseudoperiodic signals. An attempt is made to compute the accuracy of the characteristics of a particular component in terms of the remaining components contribution. The weighting effect is shown to improve the characteristics computation by reducing the remaining components contribution to an order of $1/N^3$, where $N$ is the number of the samples. The noise effect and the proximity effect are analyzed and the spectral interpolation is compared with a time domain method derived from a Kumaresan Tufts procedure.

A NEW SEMI-IMPLICIT METHOD FOR MHD COMPUTATIONS. K. Lerbinger and J. F. Luciani, *Centre de Physique Théorique de l'Ecole Polytechnique, 91128 Palaiseau Cedex, FRANCE.*

An efficient semi-implicit method for the solution of the nonlinear, three-dimensional, resistive MHD equations is presented. The method is unconditionally stable with respect to the compressional fast magnetoacoustic and shear Alfven waves. The time step is limited instead by the nonlinear physical



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plasma phenomena. Furthermore, the method allows a high spatial resolution. Physically relevant test cases are presented and the feasibility of longtime simulations is discussed.

HIGH-ORDER SPLITTING METHODS FOR THE INCOMPRESSIBLE NAVIER–STOKES EQUATIONS. George M. Karniadakis and Steven A. Orszag, *Princeton University, Princeton, New Jersey, USA*; Moshe Israeli, *Technion-Israel Institute of Technology, Haifa, ISRAEL.*

A new pressure formulation for splitting methods is developed that results in high-order time-accurate schemes for the solution of the incompressible Navier–Stokes equations. In particular, improved pressure boundary conditions of high-order in time are introduced that minimize the effect of erroneous numerical boundary layers induced by splitting methods. A new family of stiffly stable schemes is employed in mixed explicit/implicit time-integration rules. These schemes exhibit much broader stability regions as compared to Adams-family schemes, typically used in splitting methods. Their stability properties remain almost constant as the accuracy of the integration increases, so that robust third- or higher-order time-accurate schemes can readily be constructed that remain stable at relatively large CFL number. The new schemes are implemented within the framework of spectral element discretizations in space so that flexibility and accuracy is guaranteed in the numerical experimentation. A model Stokes problem is studied in detail, and several examples of Navier–Stokes solutions of flows in complex geometries are reported. Comparison is made with the previously used first-order in time spectral element splitting and non-splitting (e.g., Uzawa) schemes. High-order splitting/spectral element methods combine accuracy in space and time, and flexibility in geometry, and thus can be very efficient in direct simulations of turbulent flows in complex geometries.

SIMULATION OF IONISATION DYNAMICS AND ELECTRON KINETICS. R. Marchand and J. P. Matte, *INRS-Energie, Varennes QC, CANADA.*

A simple and efficient scheme is presented for simultaneously solving the ionisation dynamics and the electron kinetic equations. The atomic processes accounted for include collisional excitation and ionisation, dielectronic, and radiative recombination. The integrodifferential equations governing the evolution of the ionisation stages and the electron distribution function are approximated numerically with a Gauss quadrature scheme and finite differences. The result is a set of algebraic nonlinear equations which are solved by iterations.

VECTORISING THE SMOOTH PARTICLE HYDRODYNAMICS B. Haddad, *DAEC and DEMIRM, Observatoire de Paris, F-92195 Meudon principal cedex, FRANCE*; F. Clausset and F. Combes, *DEMIRM, Observatoire de Paris, F-92195 Meudon principal cedex, and Radioastronomie Millimétrique, ENS, F-75231 Paris cedex 05, FRANCE.*

A new method to vectorise the SPH (smooth particle hydrodynamics) code is presented that makes the CPU time grow linearly with the number of particles. This method is presented in 2D, but can be easily extended to 3D, with only 20% increase in memory. One of the main advantages of this hydrodynamical code is that a variable particle size can be used. This implies a variable spatial resolution, particularly useful to sample high density regions, in density-contrasted physical problems.

VERTEX-CENTERED AND CELL-CENTERED MULTIGRID FOR INTERFACE PROBLEMS. M. Khalil and P. Wesseling, *Delft University of Technology, THE NETHERLANDS.*

Cell-centered and vertex-centered multigrid methods for solving interface problems are studied. These methods differ in the location of the nodes in the grids and in the transfer operators. It is shown how

by means of stencil notation a compact and precise description can be given of the transfer and coarse grid operators. A structured FORTRAN description of the fundamental multigrid algorithm with only one goto statement is presented. Numerical results of several test problems with strong discontinuities in equation coefficients are presented. Storage and work requirements are discussed.

A Simple Numerical Algorithm for Elastohydrodynamic Lubrication Based on a Dynamic Variation Principle. R. Verstappen, *University of Twente, THE NETHERLANDS.*

This paper deals with an efficient numerical method for the fully lubricated line contact between a rotating, deformable cylinder and a rigid surface. By exploiting the dynamic variation structure of this non-linear problem the deformation of and the pressure at the free, contact boundary are calculated. The dynamic formulation leads in a natural way to an iterative procedure, where the evolution from one iterate to a subsequent one is governed by a minimization problem. Physically, the Euler–Lagrange equation expresses the fact that the mass has to be conserved. For this reason, in contrast with earlier approaches, mass flux defects do not occur here. The proposed dynamic algorithm starts with the calculation of the lubricated contact between a rigid cylinder and the rigid surface. Then the stiffness of the cylinder is lessened until the desired value is reached, where then the loading on the cylinder is increased by moving it towards the rigid surface. The effort to proceed in time is significantly reduced by preconditioning: the discretized Euler–Lagrange equation is multiplied by an approximation of the inverse of the global operator governing the deflection of the cylinder. In this way, solutions that are comparable to large-time (or super-)computer computations can be calculated on a PC.

## Notes to Appear

On the Monte-Carlo Simulation of Physical Systems. G. K. Savvidy and N. G. Ter-Arutunian-Savvidy, *University of Minnesota, Minneapolis, Minnesota, USA.*

Matrix Generator of Pseudorandom Numbers. N. Z. Akopov, G. K. Savvidy, and N. G. Ter-Arutyunyan-Savvidy, *Yerevan Physics Institute, Yerevan 376306, ARMENIA, USSR.*