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Abstracts of Papers to Appear

Modeling Three-Dimensional Multiphase Flow Using a Level Contour Reconstruction Method for Front Tracking without Connectivity. Seungwon Shin and Damir Juric. George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, Georgia 30332-0405.

Three-dimensional multiphase flow and flow with phase change are simulated using a simplified method of tracking and reconstructing the phase interface. The new level contour reconstruction technique presented here enables front tracking methods to naturally, automatically, and robustly model the merging and breakup of interfaces in three-dimensional flows. The method is designed so that the phase surface is treated as a collection of physically linked *but not logically* connected surface elements. Eliminating the need to bookkeep logical connections between neighboring surface elements greatly simplifies the Lagrangian tracking of interfaces, particularly for 3D flows exhibiting topology change. The motivation for this new method is the modeling of complex three-dimensional boiling flows where repeated merging and breakup are inherent features of the interface dynamics. Results of 3D film boiling simulations with multiple interacting bubbles are presented. The capabilities of the new interface reconstruction method are also tested in a variety of two-phase flows without phase change. Three-dimensional simulations of bubble merging and droplet collision, coalescence, and breakup demonstrate the new method's ability to easily handle topology change by film rupture or filamentary breakup. Validation tests are conducted for drop oscillation and bubble rise. The susceptibility of the numerical method to parasitic currents is also thoroughly assessed.

Coupling of Fast Multipole Method and Microlocal Discretization for the 3-D Helmholtz Equation. Eric Darrigrand. CEA/CESTA-MAB-LRC-M03, B.P.2, 33114 Le Barp, France; and Université Bordeaux 1, Mathématiques Appliquées, 351 cours de la Libération, 33405 Talence Cedex, France.

We are concerned with an integral method applied to the solution of the Helmholtz equation where the linear system is solved using an iterative method. We need to perform matrix–vector products whose time and memory requirements increase as a function of the wavenumber κ. Many methods have been developed to speed up the matrix–vector product calculation or to reduce the size of the system. Microlocal discretization methods enable one to consider new systems with reduced size. Another method, the fast multipole method, is one of the most efficient and robust methods used to speed up the calculation of matrix–vector products. In this paper, a coupling of these two recently developed methods is presented. This coupling enables one to reduce CPU time very efficiently for large wavenumbers. Satisfactory numerical tests are also presented to confirm the theoretical study within a new integral formulation. Results are obtained for a sphere with a size of 26λ using a resolution based on a mesh with an average edge length of about 2λ, where λ is the wavelength. Results are also given for an industrial test case from Dassault–Aviation, the Cetaf.

Numerical Simulation of Dendritic Solidification with Convection: Two-Dimensional Geometry. Nabeel Al-Rawahi* and Gretar Tryggvason.† *Department of Mechanical Engineering, University of Michigan, Ann Arbor, Michigan 48109-2121; and †Mechanical Engineering Department, Worcester Polytechnic Institute, Worcester, Massachusetts 01609.

A front tracking method is presented for simulations of dendritic growth of pure substances in the presence of flow. The liquid–solid interface is explicitly tracked and the latent heat released during solidification is calculated using the normal temperature gradient near the interface. A projection method is used to solve the Navier–Stokes

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equations. The no-slip condition on the interface is enforced by setting the velocities in the solid phase to zero. The method is validated through a comparison with an exact solution for a Stefan problem, a grid refinement test, and a comparison with a solution obtained by a boundary integral method. Three sets of two-dimensional simulations are presented: a comparison with the simulations of Beckermann *et al.* (*J. Comput. Phys.* **154**, 468, 1999); a study of the effect of different flow velocities; and a study of the effect of the Prandtl number on the growth of a group of dendrites growing together. The simulations show that on the upstream side the dendrite tip velocity is increased due to the increase in the temperature gradient and the formation of side branches is promoted. The flow has the opposite effect on the downstream side. The results are in good qualitative agreement with published experimental results, even though only the two-dimensional aspects are examined here.

Nonlinear Landau Damping in Spherically Symmetric Vlasov Poisson Systems. Claus Heerlein and Günter Zwicknagel. Institut für Theoretische Physik II, Universität Erlangen-Nürnberg, Staudtstraße 7, D-91058 Erlangen, Germany.

The Vlasov Poisson system is a partial differential equation widely used to describe collisionless plasma. It is formulated in a six-dimensional phase space, which prohibits a numerical solution on a complete phase space grid. In some applications, however, spherical symmetry is given, which introduces singularities into the Vlasov Poisson equation. We focus on such problems and propose a stable algorithm using accommodating boundaries. At first, the method is tested in the linear regime, where analytical solutions are available. Thereafter it is applied to large disturbances from equilibrium.

An Implicit Particle-in-Cell Method for Granular Materials. S. J. Cummins and J. U. Brackbill. Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545.

An implicit-in-time method for granular materials is described. The method combines the material point method, a first-order contact algorithm, and a Newton–Krylov equation solver to give improved energy conservation, stabilization of the finite-grid-instability, and the correct description of collisions between grains.