HEAT FLOW BETWEEN SPECIES IN ONE-DIMENSIONAL PARTICLE PLASMA SIMULATIONS. William S. Lawson, *Courant Institute, New York University, New York, New York, USA*; Perry C. Gray, *Dartmouth College, Hanover, New Hampshire, USA.*

The rate of heat flow from one one-dimensional particle species to another is studied using the theory worked out by Eldridge and Feix. Assuming initial Maxwellian distributions, some approximate formulas are derived which, though still somewhat complex, should be of use to simulators. The results of the theory are tested via simulation using a standard code. The results indicate that heat flow between species is often quite rapid when the real (not necessarily the intended) temperatures are different and is, therefore, a serious hazard. Reducing the number of grid cells per Debye length does not seem to reduce the rate of heat flow significantly over the range of grid cell sizes considered. In two and three dimensions the same effects exist, but the magnitudes of the effects are not calculated here.

ITERATIVE SOLUTION OF NAVIER–STOKES DUAL VARIABLE DIFFERENCE EQUATIONS. George Mesina, *EG&G, Idaho National Engineering Laboratory, Idaho Falls, Idaho, USA*; Charles Hall, *Institute for Computational Mathematics and Applications, University of Pittsburgh, Pittsburgh, Pennsylvania, USA.*

The dual variable transformation applied to implicit finite difference approximations of the Navier–Stokes equations reduces the number of unknowns by a factor of three, removes the pressures from the discrete equations, and produces velocities which satisfy the discrete continuity equation exactly. New iterative methods for the solution of the unsymmetrical dual variable system are developed and are proven to converge for a large class of problems. These iterative methods involve a sequence of discrete Laplacian systems whose solutions converge to the solution of the dual variable system. They take advantage of the special structure of the dual variable coefficient matrix, are very fast compared to the direct methods currently used, are less memory intensive, and can be more easily vectorized and parallelized.

MULTI-SCALE PARTICLE-IN-CELL PLASMA SIMULATION. A. Friedman, S. E. Parker, and S. L. Ray, *Lawrence Livermore National Laboratory, University of California, Livermore, California, USA*; C. K. Birdsall, *Electronics Research Laboratory, University of California, Berkeley, California, USA.*

We describe a form of self-consistent particle-in-cell (PIC) plasma simulation which is applicable to strongly inhomogeneous systems involving a wide range of space and time scales. In this *multi-scale* method, the plasma particles in each region of phase space are advanced using a step size appropriate to that region, as determined by accuracy considerations. While the necessity of a self-consistent field may seem to require processing of all particles in synchrony, the method overcomes that difficulty. This is accomplished by means of implicit PIC techniques, interpolating grid quantities in time to obtain the source contributions from groups of particles not advanced during the current step. For suitable problems (those in which fine space-time resolution is needed only in isolated spatial regions), most of the particles are not processed on any given step. Thus, major gains in efficiency over conventional simulations may be realized. In this paper we describe the method and the beginnings of our investigations into its feasibility.

DIFFERENCE FORMULAS FOR THE SURFACE LAPLACIAN ON A TRIANGULATED SURFACE. Geertjan Huiskamp, *Laboratory of Medical Physics and Biophysics, University of Nijmegen, THE NETHERLANDS.*

Different approximating expressions for the surface Laplacian operator on a triangulated surface are derived. They are evaluated on a triangulated spherical surface for which the analytical expression of the