the treatment of the periodic boundary conditions. Recent advances to treat singular integrals are employed and extended to our case. The method is tested on simple examples where theoretical results are available. In the static case results are compared with many previous results on periodic arrays of spheres. New results are given in the dynamic case. The scaling behavior for dynamic permeability in porous media is checked and discussed.

SIMULATION OF THE STEADY-STATE ENERGY TRANSFER IN RIGID BODIES, WITH CONVECTIVE/RADIATIVE BOUNDARY CONDITIONS, EMPLOYING A MINIMUM PRINCIPLE. Rogerio Martins Saldanha da Gama, *Laboratorio Nacional de Computacao Cientifica, Rua Lauro Muller 455, 22290 Rio de Janeiro, BRAZIL.*

The subject of this paper is the energy transfer phenomenon in a rigid and opaque body that exchanges energy with the environment, by convection and by diffuse thermal radiation. The considered phenomenon is described by a partial differential equation, subjected to (nonlinear) boundary conditions. It is presented as a minimum principle, suitable for a large class of energy transfer problems. Some particular cases are simulated.

FAST POTENTIAL THEORY II: LAYER POTENTIALS AND DISCRETE SUMS. John Strain, *Courant Institute of Mathematical Sciences, 251 Mercer Street, New York, New York 10012, USA.*

We present three new families of fast algorithms for classical potential theory, based on Ewald summation and fast transforms of Gaussians and Fourier series. Ewald summation separates the Green function for a cube into a high-frequency localized part and a rapidly-converging Fourier series. Each part can then be evaluated efficiently with appropriate fast transform algorithms. Our algorithms are naturally suited to the use of Green functions with boundary conditions imposed on the boundary of a cube, rather than free-space Green functions. Our first algorithm evaluates classical layer potentials on the boundary of a d-dimensional domain, with d equal to two or three. The quadrature error is $O(h^m)+\varepsilon$, where h is the mesh size on the boundary and m is the order of quadrature used. The algorithm evaluates the discretized potential using N elements at $O(N)$ points in $O(N \log N)$ arithmetic operations. The constant in $O(N \log N)$ depends logarithmically on the desired error tolerance. Our second scheme evaluates a layer potential on the domain itself, with the same accuracy. It produces M^d values using N boundary elements in $O((N+M^d) \log M)$ arithmetic operations. Our third method evaluates a discrete sum of values of the Green function, of the type which occur in particle methods. It attains error ε at a cost $O(N^\alpha \log N)$, where $\alpha = 2/(1+D/d)$ and D is the Hausdorff dimension of the set where the sources concentrate in the limit $N \to \infty$. Thus it is $O(N \log N)$ when the sources do not cluster too much and close to $O(N \log N)$ in the important practical case when the points are uniformly distributed over a hypersurface. We also sketch an $O(N \log N)$ algorithm based on special functions. Two-dimensional numerical results are presented for all three algorithms. Layer potentials are evaluated to second-order accuracy, in times which exhibit considerable speedups even over a reasonably sophisticated direct calculation. Discrete sum calculations are speeded up astronomically; our algorithm reduces the CPU time required for a calculation with 40,000 points from six months to one hour.

A FRONT TRACKING METHOD FOR VISCOUS, INCOMPRESSIBLE, MULTI-FLUID FLOWS. Salih Ozen Unverdi and Gretar Tryggvason, *Department of Mechanical Engineering and Applied Mechanics, The University of Michigan, Ann Arbor, Michigan 48109, USA.*

A method to simulate unsteady multi-fluid flows in which a sharp interface or a front separates incompressible fluids of different density and viscosity is described. The flow field is discretized by a conservative finite difference approximation on a stationary grid, and the interface is explicitly represented by a separate, unstructured grid that moves through the stationary grid. Since the interface deforms