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A fast lattice Green's function method for solving viscous incompressible flows on unbounded domains SEBASTIAN LISKA, TIM COLONIUS, California Institute of Technology — A novel, parallel, computationally efficient immersed boundary method for solving three-dimensional, viscous, incompressible flows on unbounded domains is presented. The method formally discretizes the incompressible Navier-Stokes equations on an infinite staggered Cartesian grid. Operations are limited to a finite computational domain through a lattice Green's function technique. This technique obtains solutions to inhomogeneous difference equations through the discrete convolution of source terms with the fundamental solutions of the discrete operators. The differential algebraic equations describing the temporal evolution of the discrete momentum equation, incompressibility constraint, and the no-slip constraint are numerically solved by combining an integrating factor technique for the viscous term and a half-explicit Runge-Kutta scheme for the convective term. A nested projection that exploits the mimetic and commutativity properties of the discrete operators is used to efficiently solve the system of equations that arises in each stage of the time integration scheme. Linear complexity, fast computation rate, and parallel scalability are achieved using recently developed fast multipole methods for difference equations. Results for three-dimensional test problems are presented, and the performance and scaling of the present implementation are discussed.

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