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An Immersed Boundary-Lattice Boltzmann Approach to the Direct Numerical Simulation of Complex Particulate Flows BAILI ZHANG, MING CHENG, ZHI SHANG, JING LOU, Institute of High Performance Computing — A three-dimensional momentum exchange-based immersed boundary-lattice Boltzmann method has been developed for solving fluid-particles interaction problems. This method combines the most desirable features of the lattice Boltzmann method and the immersed boundary method by using a regular Eulerian mesh for the flow domain and a Lagrangian mesh for the moving particles in the flow field. The non-slip boundary conditions for the fluid and the particles are enforced by adding a force density term into the lattice Boltzmann equation, and the forcing term is simply calculated by the momentum exchange of the boundary particle density distribution functions, which are interpolated by the Lagrangian polynomials from the underlying Eulerian mesh. This method preserves the advantages of lattice Boltzmann method in tracking a group of particles and, at the same time, provides an alternative approach to treat solid-fluid boundary conditions. Numerical validations show that the present method is very accurate and efficient. The code developed using this approach has been parallelized and allows the direct numerical simulation of fairly complicated phenomena such as three-dimensional particulate flow with very large numbers of particles.

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