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# DYNAMICS AND STRUCTURE IN A SETTLING SUSPENSION

## Abstract

A dense pack of solid particles can be fluidized by an upward flow of liquid, which counterbalances the gravitational force on the particles. We have recently discovered that the velocity fluctuations in a suspension settling at low Reynolds number are controlled by the macroscopic boundary conditions on the system. For periodic boundary conditions the fluctuations diverge in proportion to the container dimensions, but in batch sedimentation, where the particles settle onto a fixed boundary, the fluctuations saturate to a limiting value as the container gets large.

The qualitative dependence of the velocity fluctuations on the different boundary conditions is not a direct consequence of screening of the hydrodynamic interactions by the walls. Instead, the interfaces between the dense pack, the homogenous suspension, and the supernatent fluid act as sinks for the fluctuation energy, which drains out of the system at a rate that is roughly proportional to the inverse of the cell height. Random density fluctuations convect to one of these two interfaces and are absorbed by the density gradient at the interface. A scaling argument suggests that convection of density fluctuations to the boundaries at the top and bottom of the suspension leads to a new correlation length proportional to the mean interparticle spacing.

It has been suggested that microstructural rearrangements take place in a sedimenting suspension, which screen the long-range hydrodynamic interactions in a rather analogous fashion to the Debye-Huckel screening of macroions in electrolyte solutions, but most theories ignore the role of the macroscopic boundaries. I will present results that demonstrate that there is a qualitative change in the structure factor during the settling process, which is due to the interfaces at the top and bottom of the suspension. For a Poisson distribution of particle positions, such as might be produced by a well-mixed initial condition, the structure factor is non-zero at long wavelengths, indicating that density fluctuations exist at all length scales. In a settling suspension, density fluctuations decay in time to a steady state such that the structure factor vanishes at long wavelengths, and the suspension is therefore incompressible at large length scales.

In this talk I will summarize results from computer simulations of particles settling in a low-Reynolds number regime. The fluid flow is calculated using a lattice-Boltzmann model, which is coupled to the particle dynamics via a no-slip boundary condition on the surfaces of the individual particles. I will compare results for the dynamics and microstructure of settling suspensions with available experimental measurements, and examine current theoretical ideas in the light of these simulations.

**October 22, 2002**
**Barus & Holley, Room 190**
**4:00pm**