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MEC 221

Large Scale Convection in a Well-Stirred Sedimenting Suspension

We consider a suspension consisting of solid particles dispersed in an incompressible viscous fluid. Under various circumstances this mechanical system can be appropriately approximated in different ways. We first consider two important regimes. One occurs when the suspension as a whole is flowing through a structure with a characteristic length much larger than the particle size as is the case for blood flow in the heart. Under these circumstances the suspension can be viewed as an effective Newtonian fluid. The density of the effective fluid is the volume averaged density of the components, and the viscosity of the effective fluid is given in the dilute case by a celebrated formula due to Einstein. The situation where the suspension as a whole is stationary but the solid and liquid phases are separating due to gravity is often modeled as a simple slip between the two phases. Determining the velocity of the slip is then the goal of the analysis which depends significantly on the details of the microstructure. We identify a third regime where a stirring process induces density fluctuations that generate large scale convection cells in the sedimenting suspension. We show that this regime can be modeled as an effective fluid but with a variable density (and viscosity).

Jonathan H. C. Luke was graduated from Rice University in 1982 with a B.A. in Mathematics and Physics. After completing his doctoral work in Mathematics at New York University's Courant Institute for the Mathematical Sciences in 1986, he held post-doctoral positions in the Institute for Mathematics and Its Applications and the School of Mathematics at the University of Minnesota. In 1989, he joined the faculty at the New Jersey Institute of Technology where he has been a Professor of Mathematical Sciences since 2002. Professor Luke's research has ranged over various areas of Applied Mathematics including sedimentation theory, numerical methods for wave propagation and microwave heating. Recently his work has focused again on sedimentation theory where his contributions include variational bounds for the sedimentation speed, convergence of the method of reflections, and divergence and suppression of velocity fluctuations.

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