45f A Numerical Solution for the Anomalous Sedimentation of a Small Brownian Sphere in a Vertical Cylinder of Periodically Varying Radius

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We consider the long-time asymptotic transport of a small Brownian sphere that is sedimenting through a viscous fluid within an infinite vertical cylinder whose radius changes periodically and abruptly between two values. Use of generalized Taylor dispersion theory gives rise to a set of steady-state differential equations that govern the long-time mean velocity. We prove these equations possess a unique solution. Finite difference discretization of all governing equations and boundary conditions, except for the normalization condition, leads to a homogeneous system of equations that possesses an infinite number of solutions. Application of the normalization condition selects the particular solution of the set that satisfies all conditions. Despite the absence of classical wall effects, the long-time mean velocity of the particle through the pore is generally less than the Stokes sedimentation velocity that applies at every point within the fluid. This anomalous behavior could be used to enhance force-driven separation of Brownian particles that possess identical Stokes velocities but different diffusivities. Furthermore, this numerical approach may be applied to similar problems.