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Resolving a paradox of anomalous scalings in the diffusion of granular materials[1] IVAN C. CHRISTOV, HOWARD A. STONE, Department of Mechanical and Aerospace Engineering, Princeton University — Granular materials do not perform Brownian motion, yet diffusion can be observed in such systems when agitation causes inelastic collisions between particles. It has been suggested that axial diffusion of granular matter in a rotating drum might be "anomalous" in the sense that the mean squared displacement of particles follows a power law in time with exponent less than unity. Further numerical and experimental studies have been unable to definitively confirm or disprove this observation. We show two possible resolutions to this apparent paradox without the need to appeal to anomalous diffusion. First, we consider the evolution of arbitrary (non-point-source) initial data towards the self-similar intermediate asymptotics of diffusion by deriving an analytical expression for the instantaneous collapse exponent of the macroscopic concentration profiles. Second, we account for the concentration-dependent diffusivity in bidisperse mixtures, and we give an asymptotic argument for the self-similar behavior of such a diffusion process, for which an exact self-similar analytical solution does not exist. The theoretical arguments are verified through numerical solutions of the governing partial differential equations.

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