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Collisional Diffusion of Granular Materials: From Creep to Rapid Flow[1] PAUL UMBANHOWAR, Northwestern University, YI FAN, Northwestern University and The Dow Chemical Company, JULIO OTTINO, RICHARD LUEPTOW, Northwestern University — The diffusion of granular material is driven by random collisions between particles and quantified by the diffusion coefficient, D. We computationally study the dependence of D on local shear rate, $\dot{\gamma}$, from the dense flow regime to the creep flow regime in open and closed heap flows. Measurements of D obtained for both geometries, monodisperse and bidisperse systems, various flow rates, and at different streamwise positions collapse onto a single curve when plotted vs. $\dot{\gamma}\bar{d}^2$, where $\bar{d}$ is the local mean particle diameter. In the dense flow regime, where $\dot{\gamma}$ is larger, D is proportional to $\dot{\gamma}\bar{d}^2$, similar to previous studies. However, in the creep flow regime, where $\dot{\gamma}$ is smaller, D is independent of $\dot{\gamma}$. The solids fraction and velocity fluctuations are also constant in this regime. Further study of the effect of gravity on D shows that it determines the transition between rate-dependent and rate-independent regimes and controls the value of D in the creep regime. These results demonstrate that the shear rate is not the relevant time scale in the creeping flow regime.

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