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Collision efficiency of rapidly settling particles in a turbulent flow PIJUSH PATRA, ANUBHAB ROY, Department of Applied Mechanics, Indian Institute of Technology Madras, Chennai 600036, India, DONALD L. KOCH, Smith School of Chemical and Biomolecular Engineering, Cornell University, Ithaca, NY 14853, USA — We calculate the collision rate constant of hydrodynamically interacting low inertia spherical particle pairs sedimenting in a homogeneous isotropic turbulent flow in the rapid settling limit where the settling time across a Kolmogorov eddy is short compared with Kolmogorov time scale. Due to the sub-Kolmogorov particle sizes, we approximate the fluid motion in the vicinity of the particle pair locally as a linear flow with a fluctuating velocity gradient that appears from the background turbulent flow. The response of the relative particle position is small over the correlation time of the flow and therefore, a diffusive process characterizes the relative motion with a diffusivity D_{ij}^{H} and the hydrodynamic interactions lead to a net drift, V_i^H , toward small inter-particle separations. The drift-diffusion fluxes are expressed in terms of the velocity gradient auto-correlation function along the settling trajectory and in this particular problem due to rapid settling assumption we are able to relate it with the turbulence energy spectrum. A convection-diffusion equation for pair probability density function, $P(\mathbf{r},t)$, is derived in terms of the hydrodynamic turbulent pair diffusion and drift and then solved numerically to calculate the collision rate constant.

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