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Stochastic Theory for the Clustering of Rapidly Settling, Low-Inertia Particle Pairs in Isotropic Turbulence - I[1] VIJAY GUPTA, SARMA RANI, University of Alabama in Huntsville, DONALD KOCH, Cornell University — A stochastic theory is developed to predict the Radial Distribution Function (RDF) of monodisperse, rapidly settling, low-inertia particle pairs in isotropic turbulence. The theory is based on approximating the turbulent flow in a reference frame following an aerosol particle as a locally linear velocity field. In the first version of the theory (referred to as T1), the fluid velocity gradient tensor "seen" by the primary aerosol particle is further assumed to be Gaussian. Analytical closures are then derived for the drift and diffusive fluxes controling the RDF, in the asymptotic limits of small particle Stokes number ($St = \tau_p/\tau_\eta \ll 1$), and large dimensionless settling velocity ($Sv = g\tau_p/u_\eta \gg 1$). It is seen that the RDF for rapidly settling pairs has an inverse power dependency on pair separation r with an exponent, c_1, that is proportional to St^2. However, the c_1 predicted by T1 for $Sv \gg 1$ particles is higher than the c_1 of even non-settling ($Sv = 0$) particles obtained from DNS of particle-laden isotropic turbulence. Thus, the Gaussian velocity gradient in T1 leads to the unphysical effect that gravity enhances pair clustering. To address this inconsistency, a second version (T2) was developed.

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Sarma Rani
University of Alabama in Huntsville

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