Stochastic Theory for the Clustering of Rapidly Settling, Low-Inertia Particle Pairs in Isotropic Turbulence - II

SARMA RANI, VIJAY GUPTA, 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. In the second version of the theory (T2), the dimensionless strain-rate and rotation-rate tensors “seen” by the primary particle are assumed to be Gaussian distributed, where the strain-rate and rotation-rate tensors are non-dimensionlized using the instantaneous dissipation rate and enstrophy, respectively. Accordingly, closure is again derived for the drift flux driving particle clustering, in the asymptotic limits of Stokes number $St = \tau_p/\tau_\eta \ll 1$, and settling parameter $Sv = g\tau_p/u_\eta \gg 1$. Only the drift flux differs for T1 and T2, while the diffusive flux remains the same. The RDFs for rapidly settling pairs again show an inverse power dependency on pair separation $r$ with an exponent, $c_1$, that is proportional to $St^2$. However, in contrast to T1, the $c_1$ values predicted by T2 show good qualitative and resonable quantitative agreement with the $c_1$ values obtained from DNS of settling particles in isotropic turbulence. Further, the T2-predicted $c_1$ values are smaller than those obtained from DNS of non-settling particles in isotropic turbulence.

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