Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Measurement of Inertial Particle Collision Statistics in Isotropic Turbulence Using 3D Particle Tracking Velocimetry[1] ADAM HAMMOND, ZACH LIANG, HUI MENG, University at Buffalo SUNY — We experimentally investigate the effects of turbulence and particle inertia on three particle collision statistics in particle-laden isotropic turbulence: radial distribution function (RDF), radial particle-pair relative velocity (RV), and for the first time, geometric collision kernel for which RDF and RV are factors. Experimentally obtaining these statistics has been difficult in the past especially as particle separation distance r decreases below the Kolmogorov length scale η to near-contact, where the physics becomes obscure and theoretical models may not hold. Using Shake-the-Box 3D particle tracking, we are able to resolve particle positions and velocities at $r<\eta$, which enables estimations of RDF and RV at near-contact and calculation of the collision kernel. Experiments are performed in a truncated icosahedron isotropic turbulence chamber at ten Stokes numbers $0.2<St<2.3$. The St was changed by varying the fan speed (which also changes $246\leq Re_\lambda \leq 357$) and particle diameter d between 15μm and 45μm. RDF increases as r/η decreases to $O(1)$, and increases with St. RV decreases as r/η decreases until $r/\eta = 1$, recapitulating previous DNS and experimental results (Dou et al, 2018, DOI: 10.1017/jfm.2017.813); however, as $r/\eta < 1$, RV exhibits a sharp upturn. This first simultaneous near-contact estimation of RDF, RV, and collision kernel calculated from real turbulence enables examination of theory and DNS, and may reveal new phenomena not previously accounted for in prior models.

[1]This work was supported by NSF CBET-0967407, and CBET-1828544.

Adam Hammond
University at Buffalo SUNY

Date submitted: 02 Aug 2019 Electronic form version 1.4