Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Fine-scale dynamics of bubble induced turbulence with and without breakup and coalescence IMMANUVEL PAUL, Stanford University, BRUNO FRAGA, University of Birmingham, MICHAEL DODD, Stanford University, CHRIS LAI, Las Alamos National Laboratory — We study bubble induced turbulence (BIT) through a swarm of air bubbles rising in a vertical column. We consider two types of bubbles: one without and another with breakup and coalescence. The immersed boundary method is used to model the bubbles without breakup and coalescence while the volume of fluid is utilized for the other case. The void fraction of air bubbles is 0.5% at the start in both the simulations. We focus on the quasi-steady stage of the temporal evolution of the BIT. For this stage, we also note the -3 slope in the energy spectrum as reported in the experiments. We further explore the fine-scale turbulence dynamics by studying the evolution equation of the velocity gradient tensor (VGT) in Q-R space. We observe an entirely different conditional mean trajectories (CMT) of R and Q in both the BIT simulations. Here, the trajectories no longer spiral towards the origin as in the case of the homogeneous isotropic turbulence. Rather, the CMTs evolve to a particular line on the right branch of D=0 line leading to divergence in finite time. This is accompanied with the larger magnitude of the pressure Hessian term compared with all other terms in the VGT evolution equation.

Immanuvel Paul
Stanford University

Date submitted: 01 Aug 2019 Electronic form version 1.4