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Mixing in turbulent channel flow with Lagrangian computations
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Turbulent mixing has been studied because of its importance in transport processes in both nature and engineering [1]. The effects of convection dominate over molecular diffusion, but effects of molecular diffusion are not negligible at molecular scales, and are significant in reacting flows. Several studies have been devoted to molecular mixing in homogeneous, isotropic turbulence. In this study, the effect of anisotropic turbulence, along with that of molecular diffusion, on passive scalar mixing is explored. Simulation of a turbulent channel flow is conducted by direct numerical simulation, followed by Lagrangian tracking of the motion of passive scalars with different Schmidt numbers (Sc) in the flow field. The friction Re is 300 and the Sc ranges from 0.7 to 2,400. Mass markers are released from instantaneous and continuous line sources, located at the center region of the channel to the wall. The combined effects of mean velocity difference, molecular diffusion and near-wall coherent structures lead to the observation of different concentrations of particles at different heights, downstream from the source. Mixing efficiency is quantified by measuring both the intensity and the area of the channel where mixing happens. While results with instantaneous sources demonstrate the physics of mixing, using continuous sources reveals how to control the timing and spatial distribution of the mixing. References 1. Dimotakis, P.E. Annu. Rev. Fluid Mech. 37, 329, 2005 2. Nguyen, Q., Papavassiliou, D.V. Phys. Fluids, 28(12), 125103, 2016 3. Nguyen, Q., Srinivasan, C., Papavassiliou, D.V. Phys Rev E, 91, 033019, 2015

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