Abstract Submitted
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Enhanced diffusivity and skewness of a diffusing tracer in the presence of an oscillating wall[1] RICHARD MCLAUGHLIN, LINGYUN DING, ROBERT HUNT, HUNTER WOODIE, University of North Carolina at Chapel Hill, UNC JOINT FLUIDS LAB COLLABORATION — We examine a passive scalar diffusing in time-varying flows which are induced by a periodically oscillating wall in a Newtonian fluid between two infinite parallel plates. These shear flows yield the generalized Ferry waves which are exact solutions of the Navier-Stokes equations. First, we calculate the second Aris moment for all time, and its long time limiting effective diffusivity as a function of the geometrical parameters, frequency, viscosity, and diffusivity. We show that the viscous dominated limit results in a linear shear layer for which the effective diffusivity is bounded with upper bound $\kappa(1+A^2/(2L^2))$, where κ is the tracer diffusivity, A is the amplitude of oscillation, and L is the gap thickness. Alternatively, we show that for finite viscosities the enhanced diffusion is unbounded, diverging in the high frequency limit. Physical arguments are given to explain these striking differences. Physical experiments are performed in water using Particle Tracking Velocimetry to quantitatively measure the fluid flow. We document that the theory is quantitatively accurate. Further, we show that the scalar skewness is zero for linear shear at all times, whereas for the nonlinear Ferry wave, using Monte-Carlo simulations is non-zero.

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