**Hyper-Mixing in Pure Shear Flows**

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**ABSTRACT:**

In this talk we study mixing in a pure shear flow. We begin by analytically deriving the concentration field for an arbitrary initial condition in an unbounded two-dimensional shear flow. We focus on the solution for a point initial condition and calculate three common measures of mixing: (i) dispersion coefficients, (ii) the dilution index and (iii) the scalar dissipation rate. The main purpose of this note is to illustrate how effective a pure shear is at mixing when quantified by measures (ii) and (iii).

The strong correlation of flow both in the longitudinal and transversal direction implies a hyper-diffusive spreading. This has a dramatic impact on mixing: the dilution index, that quantifies the volume occupied by the plume, increases quadratically instead of linearly for a homogeneous medium, and the scalar dissipation rate decays as t-3, instead of t-2 for homogeneous media. Both these scalings are equivalent to homogeneous systems with four spatial dimensions. Observations for the scalar dissipation rate in d = 2 dimensional heterogeneous velocity fields from simulations and theory do not appear to be able to attain such efficient mixing, which truly highlights how efficient the pure shear flow is at mixing. Thus we term it hyper-dispersive mixing. This phenomenon is expected to occur at small scale in heterogeneous flow fields and can explain the enhanced mixing observed in variable density porous medium flows at low Peclet numbers.