Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Transport and Dynamics of Swimming Microorganisms in Time-Periodic Flows[1] RANJIANGSHANG RAN, BOYANG QIN, BRENDAN BLACKWELL, PAULO ARRATIA, University of Pennsylvania — Microorganisms often need to navigate through complex flow environments to successfully feed and reproduce. Examples include algae in oceans and lakes, bacteria in gastrointestinal tracts, and during the production of food and vaccines. Here, we experimentally investigate the transport and mixing of swimming E. coli in two-dimensional time-periodic flows using particle tracking velocimetry and dye mixing experiments. Mixing is assessed by computing stretching fields and finite-time Lyapunov exponents (FTLE) from experimentally measured velocity fields. Velocimetry data shows that bacteria lowers the peak velocity and vorticity of the flow. This result is a function of bacteria concentration and flow geometry; that is, flow separatrices hinder mixing compared to passive particles likely due to bacteria trapping. Stretching fields show that bacteria shorten the average wavelength of Lagrangian coherent structures (LCSs). Overall, mixing can increase or decrease by the addition of active particles (i.e. swimming bacteria) but there seems to be a non-trivial dependence on Reynolds number, path length, flow geometry, and bacteria volume fraction.

[1]This work is supported by NSF-DMR-1709763

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Date submitted: 01 Aug 2019 Electronic form version 1.4