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Bacteria Hinder Large Scale Transport in 2D Time-Periodic Flows[1] RANJIANGSHANG RAN, BRENDAN BLACKWELL, QUENTIN BROSSEAU, PAULO ARRATIA, University of Pennsylvania — Understanding mixing and transport of passive scalars in the presence of swimming microorganisms is important to many natural (e.g. algal blooms) and industrial (e.g. biofuel) processes. Here, we experimentally study the mixing of a passive impurity in 2D time-periodic flows that is seeded with different concentrations of swimming E. coli. Dye experiments show that bacteria hinder large scale transport and reduce overall mixing rate, which decreases as bacteria concentration increases. Energy spectra analysis reveals that, at early times, bacteria promote small scale structures by injecting energy at smaller wavelengths. At longer times, we find a substantial energy increase at all wavelengths, suggesting bacteria work against energy cascade. Velocimetry shows that bacteria can attenuate vorticity and systematically decrease the Finite-Time Lyapunov Exponent (FTLE) of the system compared to flows without bacteria at same Reynolds numbers. Overall, our results show that large scale transport and mixing are hindered by the presence of bacteria, despite the formation of small-scale structures locally.

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