Abstract Submitted
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Meso-scale turbulence in living fluids[1] JORN DUNKEL, DAMTP, University of Cambridge, RIK WENSINK, CNRS, Universite Paris-Sud 11, SEBASTIAN HEIDENREICH, Physikalisch Technische Bundesanstalt Berlin, KNUT DRESCHER, Princeton University, RAY GOLDSTEIN, DAMTP, University of Cambridge, HARTMUT LOEWEN, Heinrich Heine Universitat Duesseldorf, JULIA YEOMANS, University of Oxford — The mathematical characterization of turbulence phenomena in active non-equilibrium fluids proves even more difficult than for conventional liquids or gases. It is not known which features of turbulent phases in living matter are universal or system-specific, or which generalizations of the Navier-Stokes equations are able to describe them adequately. We combine experiments, particle simulations, and continuum theory to identify the statistical properties of self-sustained meso-scale turbulence in active systems. To study how dimensionality and boundary conditions affect collective bacterial dynamics, we measured energy spectra and structure functions in dense Bacillus subtilis suspensions in quasi-2D and 3D geometries. Our experimental results for the bacterial flow statistics agree well with predictions from a minimal model for self-propelled rods, suggesting that at high concentrations the collective motion of the bacteria is dominated by short-range interactions. To provide a basis for future theoretical studies, we propose a minimal continuum model for incompressible bacterial flow. A detailed numerical analysis of the 2D case shows that this theory can reproduce many of the experimentally observed features of self-sustained active turbulence.

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