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Microscopic dynamics and velocity profiles of bacterial superfluids under oscillatory shear XIANG CHENG, SHUO GUO, DEVRANJAN SAMANTA, YI PENG, University of Minnesota, XINLIANG XU, Beijing Computational Science Research Center — Bacterial suspensionsa premier example of active fluidsshow an unusual response to shear stresses. Rather than increasing the viscosity of the suspending fluid, swimming bacteria can self-organize into collective flows under shear, turning the suspension into a "superfluid" with zero apparent viscosity. Although the existence of the bacterial superfluid has been demonstrated in bulk rheology measurements, little is known about the microscopic dynamics of such an exotic phase. Here, by combining sensitive rheology measurements with high-speed confocal microscopy, we study the detailed 3D dynamics of concentrated bacterial suspensions confined in narrow gaps under oscillatory shear. We find that sheared bacterial suspensions in the superfluidic phase exhibit velocity profiles with strong spatial heterogeneity, unexpected from the established hydrodynamic theory of active fluids. We quantitatively explain the observed velocity profiles by considering a balance of active stresses and shear stresses in an ensemble average. Our experiments reveal a profound influence of shear flows on bacterial locomotion and provide new insights to the origin of the unique flow behaviors of active fluids.

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