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Imaging the onset kinetics of the swarming transition using light-controlled bacteria YI PENG, YISHU TAI, KECHUN ZHANG, XIANG CHENG, Department of Chemical Engineering and Materials Science, University of Minnesota, Minneapolis, MN 55455, USA — Active fluids are a novel class of nonequilibrium soft materials, which are composed of a large number of self-propelled particles. These particles collectively form coherent structures at high densities, as illustrated vividly by the striking patterns of flocking birds, schooling fishes and swarming bacteria. Although the disorder-swarming transition of active fluids has been extensively studied, its very nature is still under heated debate. Here, using an engineered E. coli strain, whose locomotion can be reversibly controlled by light, we experimentally study the onset of the swarming transition of active fluids and explore its kinetic pathway. Particularly, we trigger bacterial swarming using a blue light and image the emergence of the collective structure in concentrated bacterial suspensions. We find a discontinuous jump in the order parameter of the transition and observe a hysteresis in the formation of swarming, which indicate the discontinuous nature. We further investigate the microscopic dynamics in the context of nucleation-and-growth processes and measure the incubation time and the size distribution of nuclei. Our study sheds light on the phase transition of active fluids and the emergent properties of many-body nonequilibrium systems.

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