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Route to bacterial swarming[1] XIANG CHENG, YI PENG, ZHENGYANG LIU, University of Minnesota — Collective motions of active fluids such as bird flocks, fish schools and bacterial swarms demonstrate the intriguing emergent behaviors of nonequilibrium systems. While moving independently at low density, active entities in an active fluids move collectively with its neighbors at high density, exhibiting strong orientational order at a scale orders of magnitude larger than the size of individual entities. Although such a disorder-order nonequilibrium phase transition has been previously studied, the detailed kinetics of this transition has not been systematically explored in experiments. Here, using light-controlled E. coli, whose locomotion can be reversibly controlled by light, we experimentally study the kinetic pathway of the swarming transition in 3D bacterial suspensions. The phase diagram of bacterial swarming as functions of bacterial concentration, the velocity of active swimmers and the number fraction of active swimmers are systematically mapped. Moreover, we identify different kinetic pathways for the swarming transition depending on the control parameters. Our results reveal the route to the emergent bacterial swarming and provide new insights into the nonequilibrium phase transition in active fluids.

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