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Scale-invariant transition from turbulent to coherent flows in 3D confined active fluids. KUN-TA WU, JEAN BERNARD HISHAMUNDA, DANIEL T.N. CHEN, STEPHEN J. DECAMP, Department of Physics, Brandeis University, YA-WEN CHANG, ALBERTO FERNANDEZ-NIEVES, School of Physics, Georgia Institute of Technology, SETH FRADEN, ZVONIMIR DOGIC, Department of Physics, Brandeis University — Far-from-equilibrium, kinesin-driven active microtubules (MT) consume ATP and form extensile bundles. The bundles provide active stress, driving background fluids. Here we found that confining these fluids in a toroid triggers a transition from turbulent to coherent flow. The criterion for the transition is the aspect ratio of the toroid's channel cross-section, disregarding its absolute size. The underlying mechanism for such scale-invariant transition remains unclear. To gain insight, we measured the profiles of fluid flows as well as MT nematic order parameters when in coherent and incoherent states. We found that such flow transition is accompanied with a formation of MT nematic layer wetting the boundaries, while MT structure remains disordered in the bulk, indicating that such a coherent flow is a surface-driven phenomenon. In particular we found that the layer thickness is increased with the local shear rate of background fluid flow, reinforcing the connection between the surface layer and fluid motion. Our finding paves the path to outlining principles of interaction between active particles and fluid flows as well as the coherent transition caused by their collective dynamics.

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