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Is there universal predator-prey dynamics at the laminar-turbulent phase transition? HONG-YAN SHIH, NIGEL GOLDENFELD, Department of Physics, University of Illinois at Urbana-Champaign — Direct numerical simulation of pipe flow shows that transitional turbulence is dominated by two collective modes: a longitudinal mode for small-scale turbulent fluctuations whose anisotropy induces an emergent large-scale azimuthal mode (so-called zonal flow) that inhibits anisotropic Reynolds stress [1]. This activation-inhibition interaction leads to stochastic predator-prey-like dynamics, from which it follows that the transition to turbulence belongs to the directed percolation universality class [1]. Here we show how predator-prey dynamics arises by deriving phenomenologically an effective field theory of the transition from a coarse-graining of the Reynolds equation. The rigorous mapping between the conserved currents in Rayleigh-Benard convection (RBC), Taylor-Couette and pipe flows [2] suggests that the zonal flow-turbulence scenario might occur in these systems, consistent with observations of zonal flows in two-dimensional RBC [3], and bursts of transitional turbulence in Couette flow that follow the critical scalings of directed percolation [4]. [1] H.-Y. Shih et al., Nat. Phys. 12, 245 (2016). [2] B. Eckhardt et al., EPL 78, 24001 (2007). [3] D. Goluskin et al., J. Fluid Mech. 759, 360 (2014). [4] G. Lemoult et al., Nat. Phys. 12, 254 (2016).

Hong-Yan Shih
Department of Physics, University of Illinois at Urbana-Champaign

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