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Decaying turbulence at the laminar-turbulence transition in a pipe[1] NIGEL GOLDENFELD, TSUNG-LIN HSIEH, HONG-YAN SHIH, Loomis Laboratory of Physics, University of Illinois at Urbana-Champaign — As a follow-up to Donnelly's pioneering research on the decay of superfluid turbulence in a pipe, we have studied a different regime: transitional turbulence. Near the onset to turbulence in a pipe, turbulent puffs decay either directly or through splitting, with characteristic time-scales that exhibit a super-exponential dependence on Reynolds number. Using direct numerical simulations of transitional pipe flow, we show that a collective mode, a so-called zonal flow emerges at large scales, activated by anisotropic turbulent fluctuations, as measured in terms of Reynolds stress. This zonal flow imposes a shear on the turbulent fluctuations that tends to suppress their anisotropy, leading to stochastic oscillatory dynamics. These results motivate the proposal that the laminar-turbulence non-equilibrium phase transition can be modeled by an effective theory, usefully thought of as predator-prey dynamics, leading to a predicted universality class of directed percolation.

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