Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Directed percolation and puff crystallization near the transition to pipe turbulence[1] HONG-YAN SHIH, Institute of Physics, Academia Sinica and Department of Physics, University of Illinois at Urbana-Champaign, GRGOIRE LEMOULT , Normandie Universit and Institute of Science and Technology Austria, GAUTE LINGA , The Njord Center, University of Oslo and Niels Bohr Institute, University of Copenhagen, MUKUND VASUDEVAN, JOSE M. LOPEZ , BJRN HOF, Institute of Science and Technology Austria, JOACHIM MATHIESEN , Niels Bohr Institute, University of Copenhagen, NIGEL GOLDENFELD, Department of Physics, University of Illinois at Urbana-Champaign — Both theory and recent experiments in a quasi-one-dimensional Couette cell suggest that the onset of turbulence is a non-equilibrium phase transition in the directed percolation (DP) universality class. However, it is not experimentally clear if this universality class applies to pipe flow, where single-puff time scales vary with Reynolds number in a super-exponential way instead of the expected power-law scaling. To see how puff interactions contribute to the critical behavior, we develop stochastic models of puff dynamics by inputting the interaction function measured in pipe experiments, and calculate the phase diagram and critical phenomena. In agreement with renormalization group predictions, we find strong evidence for critical scaling of the turbulent fraction in the DP universality class, with complex crossovers due to finite size effects and the presence of a crystal-like spatio-temporal pattern which results from the repulsion between puffs.

[1]This work was supported by the following grants from the Simons Foundation (Grant number 662985, NG and Grant number 662960, BH)

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Date submitted: 11 Aug 2020 Electronic form version 1.4