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Nobody knew turbulent transition could be so complicated

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Explaining the route to turbulence in wall-bounded shear flows has been a long and tortuous journey. After years of missteps, controversies, and uncertainties, we are at last converging on a unified and fascinating picture of transition in flows such as pipes, channels, and ducts. Classically, subcritical transition (such as in a pipe), was thought to imply a *discontinuous* route to turbulence. We now know that this is not the case – subcritical shear flows may, and often do, exhibit *continuous* transition. I will discuss recent developments in experiments, simulations, and theory that have established a deep connection between transition in subcritical shear flows and a class of non-equilibrium statistical phase transitions known as directed percolation. From this we understand how to define precise critical points for systems without linear instabilities and how to characterize the onset of turbulence in terms of non-trivial, but universal power laws. I will discuss the physics responsible for the complex turbulent structures ubiquitously observed near transition and end with thoughts on outstanding open questions.