Percolation transition to turbulence

B. Hof

Institute of Science and Technology, Austria

The transition to turbulence in simple shear flows (e.g. pipe, channel and Couette flow) has remained an open problem for over a century. Typically here turbulence arises despite the linear stability of the laminar flow and results from perturbations of finite amplitude. Turbulence at first appears in the form of localised patches (e.g. puffs, spots or stripes) which coexist with laminar flow, resulting in complex, disordered flow patterns (spatio-temporal intermittency).
Individual turbulent domains can collapse or they can proliferate and seed other patches of turbulence. The time scales on which flows evolve are extremely large and likewise are the relevant length scales. Characterizing the transition process hence requires experiments of very large aspect ratios and extremely long observation times. In detailed experiments and direct numerical simulations of Couette flow we could for the first time determine the critical exponents that characterize this transition and show that it falls into the directed percolation universality class.