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Edge states and the spatio-temporal transition dynamics in a boundary layer driven by free stream turbulence BRUNO ECKHARDT, TOBIAS KREILOS, Philipps-Universitat Marburg, TARAS KHAPKO, PHILIPP SCHLATTER, Linne Flow Center, KTH Mechanics, Royal Institute of Technology, Stockholm, YOHANN DUGUET, LIMSI-CNRS, Universite Paris-Sud, Orsay, DAN S. HENNINGSON, Linne Flow Center, KTH Mechanics, Royal Institute of Technology, Stockholm — We present a cellular automaton model for the transition to turbulence in a boundary layer exposed to free stream turbulence. The model is based on the presence of an invariant flow structure (aka "edge state") intermediate between laminar and turbulent (Phys. Rev. Lett. 108, 044501 (2012)) and replaces the complex initiation of turbulence by a stochastic process with parameters that are related to the properties of the free stream turbulence and the edge state. The model uses a discretization of space and time and includes spanwise and streamwise spreading of a turbulent nucleus. It reproduces the downstream variation of the nucleation rate, the intermittency factor, and the number and widths of turbulent spots, including their variation with the free stream turbulence intensity. The model thus connects the observed characteristics of boundary layer transition with the transition scenario that has been developed for parallel shear flows, such as pipe flow or plane Couette flow.

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