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How hairpin vortices emerge from exact invariant solutions TOBIAS M. SCHNEIDER, EPFL Lausanne, MIRKO FARANO, PIETRO DE PALMA, Politecnico di Bari, JEAN-CHRISTOPH ROBINET, Arts et Metiers ParisTech, STEFANIA CHERUBINI, Politecnico di Bari — Hairpin vortices are among the most commonly observed flow structures in wall-bounded shear flows. However, within the dynamical system approach to turbulence, those structures have not yet been described. They are not captured by known exact invariant solutions of the Navier-Stokes equations nor have other state-space structures supporting hairpins been identified. We show that hairpin structures are observed along an optimally growing trajectory leaving a well known exact traveling wave solution of plane Poiseuille flow. The perturbation triggering hairpins does not correspond to an unstable mode of the exact traveling wave but lies in the stable manifold where non-normality causes strong transient amplification.

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