Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Coherent instability in wall-bounded turbulence M. J. PHILIPP HACK, Center for Turbulence Research, Stanford University — Hairpin vortices are commonly considered one of the major classes of coherent fluid motions in shear layers, even as their significance in the grand scheme of turbulence has remained an openly debated question. The statistical prevalence of the dynamic process that gives rise to the hairpins across different types of flows suggests an origin in a robust common mechanism triggered by conditions widespread in wall-bounded shear layers. This study seeks to shed light on the physical process which drives the generation of hairpin vortices. It is primarily facilitated through an algorithm based on concepts developed in the field of computer vision which allows the topological identification and analysis of coherent flow processes across multiple scales. Application to direct numerical simulations of boundary layers enables the time-resolved sampling and exploration of the hairpin process in natural flow. The analysis yields rich statistical results which lead to a refined characterization of the hairpin process. Linear stability theory offers further insight into the flow physics and especially into the connection between the hairpin and exponential amplification mechanisms. The results also provide a sharpened understanding of the underlying causality of events.

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Date submitted: 31 Jul 2017 Electronic form version 1.4