Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Data-driven spectral filters for decomposing the streamwise turbulent kinetic energy in turbulent boundary layers WOUTIJN J. BAARS, NICHOLAS HUTCHINS, IVAN MARUSIC, University of Melbourne — An organization in wall-bounded turbulence is evidenced by the classification of distinctly different flow structures, including large-scale motions such as hairpin packets and very large-scale motions or superstructures. In conjunction with less organized turbulence, these flow structures all contribute to the streamwise turbulent kinetic energy $\langle u^2 \rangle$. Since different class structures comprise dissimilar scalings of their overlapping imprints in the streamwise velocity spectra, their coexistence complicates the interpretation of the wall-normal trend in $\langle u^2 \rangle$ and its Reynolds number dependence. Via coherence analyses of two-point data in boundary layers we derive spectral filters for stochastically decomposing the streamwise spectra into sub-components, representing different types of statistical flow structures. It is also explored how the decomposition reflects the spectral break-down following the modeling attempts of Perry *et al.* 1986 and Marusic & Perry 1995. In the process we reveal a universal wall-scaling for a portion of the outer-region turbulence that is coherent with the near-wall region for $Re_\tau \sim O(10^3)$ to $O(10^6)$, which is described as a wall-attached self-similar structure embedded within the logarithmic region.

Woutijn Baars
University of Melbourne

Date submitted: 01 Aug 2017 Electronic form version 1.4