Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Revealing self-similar structure with a data-driven wavelet decomposition[1] DANIEL FLORYAN, MICHAEL D. GRAHAM, University of Wisconsin-Madison — A hallmark of turbulence is the range of physical scales it comprises and the cascade of kinetic energy down the hierarchy of scales. Kolmogorov hypothesized the existence of an intermediate range of self-similar scales, and it was later argued that spatial intermittency is a key ingredient accounting for some of the shortcomings of Kolmogorov's theory. Here we describe a method, inspired by wavelets, that adaptively decomposes a dataset into an energetic hierarchy of structures localized in scale and space. We call the resulting basis a "data-driven wavelet decomposition". The method reflects the inherent structure of the dataset it acts on, whether it has no structure, structure dominated by a single scale, or multi-scale structure. In particular, from homogeneous isotopic turbulence data we retrieve spatially localized, self-similar, hierarchical structures. We emphasize that self-similarity is not built into the analysis, rather, it emerges from the data. This decomposition provides a starting point for the characterization of localized hierarchical turbulent structures in a wide variety of fluid flows, which we think of as the building blocks of turbulence.

[1]AFOSR grant FA9550-18-1-0174, ONR grant N00014-18-1-2865

Daniel Floryan
University of Wisconsin-Madison

Date submitted: 30 Jul 2020 Electronic form version 1.4