Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

**Fractional physical-inform neural networks (fPINNs) for turbulent flows**[1] FANGYING SONG, GUOFEI PANGE, Division of Applied Mathematics, Brown University, CHARLES MENEVEAU, Mechanical Engineering, Johns Hopkins University, GEORGE KARNIADAKIS, Division of Applied Mathematics, Brown University — We employ fractional operators in conjunction with physics-informed neural networks (PINNs) to discover new governing equations for modeling and simulating the Reynolds stresses in the Reynolds Averaged Navier-Stokes equations (RANS) for wall-bounded turbulent flows at high Reynolds number. In particular, we develop a simple one-dimensional model for fully-developed wall-turbulence that involves a fractional operator with fractional order that varies with the distance from the wall. We use available DNS data bases to infer the function that describes the fractional order, which has an integer value at the wall and decays monotonically to an asymptotic value at the centerline. We show that this function is universal upon re-scaling and hence it can be used to predict the mean velocity profile at all Reynolds numbers. We also extend the fractional RANS for fully-developed turbulent channel flow to a turbulent boundary layer and infer the fractional order in the wake region.

[1]This work is supported by the DARPA-AIRA grant HR00111990025.

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Date submitted: 27 Jul 2019 Electronic form version 1.4