Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Velocity gradient (VG) decomposition into normal-strain, pure shear, solid-body-rotation tensors: new insights into turbulence VG dynamics RISHITA DAS, SHARATH GIRIMAJI, Texas A&M University — Velocity gradient tensor (VGT, A_{ij}) decomposition into symmetric (S_{ij}) and anti-symmetric (W_{ij}) tensors is unable to segregate the effect of shear present in both the strain-rate and rotation-rate tensors. In this study, an additive decomposition of VGT into normal strain-rate (N_{ij}), solid body rotation (R_{ij}) and pure shear (H_{ij}) tensors, is employed. In this decomposition, shear is clearly demarcated from pure rotation and pure normal strain effects. Then, we use direct numerical simulation data of incompressible forced isotropic turbulence in Taylor Reynolds number range $Re_\lambda \in (200 - 600)$, to examine statistical and dynamical aspects of velocity gradient dynamics. We investigate (i) the probability distribution of the magnitude (Frobenius-norm) of these pure strain, pure shear and solid-body rotation tensors; (ii) the preferential alignment of the axis of solid-body rotation with the normal strain-rate eigenvectors; (iii) the conditional statistics of different VG processes as a function of these tensors; and (iv) intermittency phenomenon. The study develops unique and novel insights into turbulence processes which are not evident from previous VGT decompositions.

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Date submitted: 30 Jul 2019 Electronic form version 1.4