Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Investigating the dynamics of vorticity and strain rate in compressible turbulent flows NISHANT PARASHAR, SAWAN S SINHA, Indian Institute of Technology, Delhi, MOHAMMAD DANISH, Bennett University, Noida, BALAJI SRINIVASAN, Indian Institute of Technology, Madras — We examine the effect of compressibility on vorticity and strain rate dynamics for compressible turbulent flows. For this, we employ direct numerical simulations of decaying compressible isotropic turbulent flows. A Lagrangian particle tracker is used to identify the influence of compressibility on vorticity-strain rate dynamics. Time correlations between the instantaneous vorticity vector and the strain-rate eigenvector system are calculated using the Lagrangian history of fluid particles. We show that while the statistics obtained are independent of turbulent Mach number, they are found to be significantly influenced by the locally normalized dilatation rate. Further, we study the time correlations conditioned on local flow topologies (based on invariants of the velocity gradient tensor) as well. We find that the influence of dilatation rate is predominantly associated with rotation dominated flow topologies (unstable-focus-compressing and stable-focus-stretching). At last, we provide a physical explanation of all these observations by tracking the moment of inertia and angular momentum history of tetrahedral fluid elements.

Nishant Parashar
Indian Institute of Technology, Delhi

Date submitted: 25 Jul 2019 Electronic form version 1.4