Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Amplification and self-attenuation of intense vorticity events in turbulent flows DHAWAL BUARIA, New York University, USA, ALAIN PUMIR, ENS de Lyon, France, EBERHARD BODENSCHATZ, Max Planck Institute for Dynamics and Self-Organization, Germany — Turbulent fluid flows, governed by the incompressible Navier-Stokes equations (INSE), are characterized by intermittent generation of very intense vortical motions over small scales. It is well known that the generating mechanism is vortex stretching resulting from non-linear amplification of vorticity by strain. This interaction is non-local, i.e., depends on the entire state of the flow, and thus is in the way of deriving turbulence theories and in establishing the regularity of INSE. Here, we show results on the contributions of local versus non-local strain to vortex stretching. The local contribution we obtain through the Biot-Savart integral of vorticity in a sphere of radius R, and the non-local contribution is the residue. Analyzing highly resolved numerical simulations of stationary isotropic turbulence up to Taylor-scale Reynolds number of 1300, we show that vorticity is predominantly amplified by the non-local strain, which can be described by linear dynamics. However, as the vorticity is amplified beyond a threshold, the local strain non-linearly acts to counteract this amplification. This self-attenuation mechanism gives support of the regularity of the INSE.

Dhawal Buaria
New York Univ NYU

Date submitted: 03 Aug 2020 Electronic form version 1.4