Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Universal separation scaling for vortex reconnection in classical and quantum fluids[1] JIE YAO, FAZLE HUSSAIN, Texas Tech Univ — Reconnection plays a significant role in the dynamics of plasmas, polymers and macromolecules, as well as in numerous laminar and turbulent flow phenomena in both classical and quantum fluids. Extensive studies in quantum vortex reconnection show that the minimum separation distance between interacting vortices follows a $\delta(t) \sim t^{1/2}$ scaling. Due to the complex nature of the dynamics (e.g. the formation of bridges and threads as well as successive reconnections and avalanche), such scaling has never been reported for (classical) viscous vortex reconnection. Using direct numerical simulation of the Navier–Stokes equations, we study viscous reconnection of slender vortices, such as colliding vortex rings, orthogonal vortex tubes, and trefoil knotted vortex. For separations that are large compared to the vortex core size, we discover that $\delta(t)$between the two interacting viscous vortices surprisingly also follows the 1/2-power scaling for both pre- and postreconnection phases. The prefactors in this 1/2-power law depend not only on the initial configuration but also on the vortex Reynolds number (or viscosity). Our finding in viscous reconnection, complementing numerous works on quantum vortex reconnection, suggests that there is indeed a universal route for reconnection – an essential result for understanding the various facets of the vortex reconnection phenomena and their potential modelling, as well as possibly explaining turbulence cascade physics.

[1]The computaional resources are provided by Texas Tech University HPCC and TACC Lonstar and Frontera.

Jie Yao
Texas Tech Univ

Date submitted: 02 Aug 2020 Electronic form version 1.4