Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

A Fractional-Order Non-Fickian Transport Model For Scalar Turbulence[1] ALI AKHAVAN-SAFAEI, MEHDI SAMIEE, MOHSEN ZAYERNOURI, Michigan State University — Anomalous features such as spotty behavior of coherent vortex structures, ramp-cliff structures and scaling of the structure functions have been shown to be significantly effective on passive scalars mixing and transport in turbulent flows. It has experimentally and numerically been pointed out that such anomalies are imprinted on the statistical features of passive scalar as non-Gaussian statistics, i.e., heavy-tailed and asymmetric distributions. According to the physics, these anomalies are described as non-local phenomena such as long-range interactions in passive scalar properties during the mixing process. We propose a heavy-tailed stochastic transport model which is employing the fractional calculus that intrinsically is designed to consider non-local effects and intermittent behavior. In this talk, we present the Eulerian and Lagrangian implementations of the proposed framework and discuss their numerical considerations. As an important canonical problem, we study the passive scalar mixing on a well-resolved homogeneous isotropic turbulence (HIT) in a periodic computational domain. We show the performance of our stochastic transport model for a variety of Reynolds and Schmidt numbers including a discussion on the statistics of passive scalar and its structure functions.

[1]This work was supported by the AFOSR Young Investigator Program Award (FA9550-17-1-0150), and partially by MURI/ARO (W911NF-15-1-0562) and by ARO Young Investigator Program Award (W911NF-19-1-0444).

Ali Akhavan-Safaei
Michigan State University

Date submitted: 31 Jul 2019 Electronic form version 1.4