Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Embedding Physics as Hard Constraints in Generative Adversarial Networks for 3D Turbulence[1] DIMA TRETIAK, ARVIND MOHAN, DANIEL LIVESCU, Los Alamos National Laboratory — Generative Adversarial Networks (GANs) have achieved impressive results in the deep learning literature for being able to generate photorealistic 2D images. Among many other neural networks, GANs are now being applied to more complex physical problems, such as turbulence. However, neural networks have become notorious for being physics-agnostic "black boxes." Recent work in enforcing physical laws using augmented loss functions as "soft constraints" show promise, but still suffer from excessive dependence on hyper-parameter tuning and interpretability issues. In this work, we analyze a variety of physics embeddings into GANs for effectiveness and present a novel GANs architecture capable of capturing the statistics of homogeneous isotropic turbulence while also enforcing the zero divergence condition as hard constraint for incompressible turbulence. We evaluate our model's strengths and weaknesses through the use of rigorous physical and statistical diagnostics and discuss future directions for physics-embedded GANs in turbulence.

[1]This work has been authored by employees of Triad National Security, LLC which operates Los Alamos National Laboratory (LANL) under Contract No. 89233218CNA000001 with the U.S. Department of Energy/National Nuclear Security Administration. The study has been supported by LANL's LDRD program.

Dima Tretiak
Los Alamos National Laboratory

Date submitted: 06 Aug 2020 Electronic form version 1.4