PiAI Seminar Series: Physics informed AI in Plasma Science
9:30-10:30, 28 November 2022 (CET)
17:30-18:30, 28 November 2022 (JST)
Web Seminar

"Physics-informed neural networks for synthesizing preferential concentration of particles in isotropic turbulence"

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Cluster and void formation are key processes in the dynamics of particle-laden turbulence. We propose different data driven and physics-informed machine learning techniques for synthesizing preferential concentration fields. The database of direct numerical simulation (DNS) of homogeneous isotropic turbulence with one-way coupled inertial point particles is used to input the enstrophy and particle number density fields. We compare autoencoder, U-Net, and generative adversarial network (GAN) approaches and assess the statistical properties of the generated fields. The results show that the best results, showing clusters and voids, are obtained with GANs. This yields interesting perspectives for reducing the computational cost of expensive DNS computations by avoiding the tracking of billions of particles. We also explore the inverse problem of synthesizing the enstrophy fields using the particle density distribution as the input at different Stokes numbers. Hence, our study also provides perspectives to use neural networks to predict turbulence statistics using experimental measurements of inertial particles.

This work is joint work with S. Jain, K. Matsuda, K. Schneider, J. West and K. Maeda

References : Center for Turbulence Research, Proceedings of the Summer Program 2022, Stanford University, in press.