PiAI Seminar Series: Physics informed AI in Plasma Science
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Web Seminar

Physics-informed neural networks modeling of turbulent natural convection

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Turbulent natural convection is a spontaneous physical process present in many natural systems as well as in engineering applications, such as passive cooling. The continued increase of supercomputing power has enabled the DNS of highly turbulent flows, resolving the entire array of scales at very high Rayleigh number. But it involves such a computational effort in terms of degree of parallelism, CPU resources and storage capacity that it will eventually entail strong restrictions on the spatial / temporal accuracy of the stored data and will therefore hamper its analysis.

In our work, we explore two types of neural networks (DNN and CNN), both physics-informed, to reconstruct flow fields from partial data. First, we propose new simple strategies to improve accuracy and optimization convergence of PINNs surrogate modeling with the sole knowledge of the temperature field with the purpose of inferring the hidden flow field. Second, we compare auto-encoder and U-Net to reconstruct the temperature field from synthetic PIV data or shadowgraphs. This study is to be seen in the light of the difficulties of experimental measurements of the temperature field in turbulent flows.

References: D. Lucor, A. Agrawal and A. Sergent, "Simple computational strategies for more effective physics-informed neural networks modeling of turbulent natural convection", J Comp. Phys., 456, 111022, 2022