PiAI Seminar Series: Physics informed AI in Plasma Science
7:00-8:00, 29 January 2024 (EST)
13:00-14:00, 29 January 2024 (CET)
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Web Seminar

Applications of Artificial Intelligence to Energetic Particle Physics on the DIII-D National Fusion Facility

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Abstract

The success of magnetically confined tokamak fusion devices depends on well behaved populations of fast ions that slow down in the bulk of the plasma. Since resonant fast ions can drive plasma waves unstable and there exists a plethora of diagnostic information at DIII-D, there are opportunities to apply Artificial Intelligence (AI) to mitigate unwanted effects from fast-ion interactions with the plasma and bolster an ignited fusion burn. This talk primarily covers two areas of interest: 1) Machine Learning-based control of Alfvén eigenmodes, and 2) surrogate model development for fast-ion diagnostics. In Area 1, recurrent neural networks are trained to automatically detect five plasma wave instabilities using a labelled database [Heidbrink, et al., NF '20] and CO2 interferometer data [Garcia, et al., NF '23]. The results from a comparison between inputs (single chord and crosspower spectrograms) and another comparison between two different Machine Learning models (Reservoir Computing Network and Long Short-Term Memory Network) achieve high performance (True Positive Rate = 90% and False Positive Rate = 14%). In Area 2, new imaging diagnostic installations at DIII-D including the INPA and IFIDA systems provide valuable

information about the fast-ion distribution function. Post-shot forward modelling can facilitate interpretation of these measurements, but there is a need for in-between shot analysis and real-time predictions of these signals. Here, progress in creating Machine Learning-based surrogate models for accurate fast-ion profile predictions are discussed. This work is supported by the U.S. Department of Energy under DE-FC02-04ER54698, DE-SC0021275, DE-SC0020337, DE-SC0014664, DE-AC0209CH11466, Army Research Office (ARO W911NF-19-1-0045), National Science Foundation under 1633631 and Ghent University Special Research Award No. BOF19/PDO/134.