PiAI Seminar Series: Physics informed AI in Plasma Science
8:00-9:00, 23 May 2022 (EDT)
14:00-15:00, 23 May 2022 (CET)
21:00-22:00, 23 May 2022 (JST)
Web Seminar

Physics-Informed Dynamic Mode Decomposition

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Data-driven models that respect physical laws are robust to noise, require few training samples, and are highly generalisable. Although the dynamic mode decomposition (DMD) is a principal tool of data-driven fluid dynamics, it is rare for learned DMD models to obey physical laws such as symmetries, invariances, causalities, spatial locality and conservation laws. Thus, we present physics-informed dynamic mode decomposition (piDMD), a suite of tools that incorporate physical structures into linear system identification. Specifically, we develop efficient and accurate algorithms that produce DMD models that obey the matrix-analogues of user-specified physical constraints. We demonstrate the improved diagnostic, predictive and interpretative abilities of piDMD through a sequence of illustrative examples from the sciences. We consider examples from stability analysis, data-driven resolvent analysis, reduced-order modelling, and the low-data and high-noise regimes. In addition, we develop an extension of piDMD that allows the effects of exogenous control variables to be disambiguated from the system dynamics. Finally, we apply piDMD to the nonlinear Burgers' equation by modelling the nonlinear fluctuations as control variables, and accurately identify the linearized spectrum.