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Control-oriented Current Profile Modeling with Physics-Based Neural Network Accelerated Models for Temperature Transport

Content

Model-based control methods that incorporate control-oriented models for the current profile evolution have typically relied on numerous limiting assumptions to include plasma temperature transport dynamics [1]. The evolution of tokamak current diffusion is largely dependent on the plasma resistivity profile, which is primarily a function of plasma temperature. More general transport models such as TGYRO or the quasilinear version TGLF are prohibitively expensive to evaluate for control purposes (requiring many CPU hours). However, recent work has shown success with the use of neural networks to emulate the electron heat and particle fluxes computed by TGLF [2]. The neural network models can be evaluated on the order of CPU-microseconds enabling the possibility of real-time simulations for profile control purposes. In this work, a model for plasma electron transport based on the electron heat flux profile computed by the TGLF neural network is integrated into the control-oriented transport code COTSIM (Control-Oriented Transport Simulator), eliminating the need for empirical correlations for the electron temperature.

[1] Ou Y., T.C. Luce, E. Schuster, et al.," Towards model-based current profile control at DIII-D," Fusion Eng. Des., 82, 1153, 2007.

[2] O. Meneghini, S. Smith, P. Snyder, et al., "Self-consistent core-pedestal transport simulations with neural network accelerated models," Nuclear Fusion, vol. 57, no. 8, p. 086034, 2017.

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