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Realtime capable first principle based modelling of tokamak turbulent transport JONATHAN CITRIN, FOM Institute DIFFER, The Netherlands, SARAH BRETON, CEA Cadarache, France, FEDERICO FELICI, Eindhoven University of Technology, The Netherlands, FREDERIC IMBEAUX, JUAN REDONDO, THIERRY ANIEL, JEAN-FRANCOIS ARTAUD, CEA Cadarache, France, BENEDETTA BAIOCCHI, Istituto di Fisica del Plasma, Italy, CLARISSE BOURDELLE, CEA Cadarache, France, YANN CAMENEN, Aix-Marseille Universite, France, JERONIMO GARCIA, CEA Cadarache, France — Transport in the tokamak core is dominated by turbulence driven by plasma microinstabilities. When calculating turbulent fluxes, maintaining both a first-principle-based model and computational tractability is a strong constraint. We present a pathway to circumvent this constraint by emulating quasilinear gyrokinetic transport code output through a nonlinear regression using multilayer perceptron neural networks. This recovers the original code output, while accelerating the computing time by five orders of magnitude, allowing realtime applications. A proof-of-principle is presented based on the QuaLiKiz quasilinear transport model, using a training set of five input dimensions, relevant for ITG turbulence. The model is implemented in the RAPTOR real-time capable tokamak simulator, and simulates a 300s ITER discharge in 10s. Progress in generalizing the emulation to include 12 input dimensions is presented. This opens up new possibilities for interpretation of present-day experiments, scenario preparation and open-loop optimization, realtime controller design, realtime discharge supervision, and closed-loop trajectory optimization.

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