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Integrated Modeling of Tokamak Experiments with OMFIT

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One Modeling Framework for Integrated Tasks (OMFIT) is a comprehensive integrated modeling framework developed to facilitate the interpretation of today experiments, enable theory validation, and support the design of next step devices. OMFIT is unique in its underlying data structure and grassroots approach. After only two years since the beginning of the project, the framework is now routinely used for frontline scientific research, and has an expanding collection of supported physics codes and workflows, which is driven by a growing number of users.
OMFIT streamlined and increased the scientific throughput of a series of DIII-D experimental data analyses that are tedious, time-consuming, hard to track and error-prone if done manually. These include kinetic plasma equilibrium reconstruction, core and edge stability surveys, and critical-gradient transport studies. The effects on kinetic equilibrium reconstructions of using an exact neoclassical bootstrap current calculation or the approximate Sauter formula were evaluated. Magnetic flutter and neoclassical toroidal viscosity were shown to well describe the effect of resonant magnetic perturbations (RMPs) on edge transport and rotation. A neural-network approach was developed to perform nonlinear multivariate regression of transport fluxes as a function of local dimensionless plasma parameters, and showed excellent quantitative agreement with the DIII-D measurements. The numerical efficiency of the method makes it an ideal candidate for real-time transport simulations.
Concerning predictive transport simulations, OMFIT made possible the design of a workflow that can efficiently find the self-consistent equilibrium and transport solutions by taking advantage of the time-scale separation between transport and current evolution. We found that the feedback between the transport fluxes and plasma equilibrium strongly affects the resulting kinetic profiles and can significantly improve the agreement with the experiments. This technique was validated on DIII-D data used to design baseline and advanced tokamak operational scenarios for both DIII-D and FNSF. Future work in this area of research will focus on including the EPED model in the workflow so to take into account the interplay between edge stability and core transport.

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