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Development of a First-Principles Self-Consistent Core-Pedestal Model and its Application to ITER

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Accurate predictions of fusion performance requires including the strong interplay that exists between core transport, pedestal structure, current profile and plasma equilibrium. An integrated modeling workflow capable of finding the steady-state self-consistent solution to this strongly coupled problem has been developed. The workflow, leverages first principles calculations and does not require prior knowledge of the kinetic profiles. Validation against DIII-D discharges shows that the workflow is capable of robustly predicting the kinetic profiles (electron and ion temperature and electron density) from the axis to the separatrix in agreement with the experiments. Results of a self-consistent optimization of the 15 MA D-T ITER baseline scenario show that controlling the pedestal density and impurity content during ITER operations will be critical to achieve high fusion performance while satisfying the requirements imposed by the density-limit.

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