Pedestal Fueling Simulations with a Coupled Kinetic Plasma - Neutral Transport Code onto the NSTX Vessel Walls[1]

D. P. Stotler, C. S. Chang, D. Battaglia, and B. LeBlanc

Princeton Plasma Physics Laboratory, Princeton University, P. O. Box 451, Princeton, NJ 08543, USA

An improved understanding of core plasma fueling and H-mode pedestal formation is critical to ensuring that ITER will achieve its objectives. Relevant neoclassical effects in a separatrix geometry with steep plasma gradients, including ion orbit loss near the X-point and radial orbit excursion across the pedestal, have been examined previously with the XGC0 code [1]. XGC0 integrates the Hamiltonian guiding center equations of motion for particles and solves self-consistently for the radial electric field and resulting rotation profiles. Realistic transport studies can be carried with the inclusion of anomalous transport effects via random walk, although the long-term development objective is to determine turbulent fluxes from a gyrokinetic turbulence code. To date, applications of XGC0 include computation of the bootstrap current in the pedestal and an examination of the pedestal buildup due to recycling [1]. The simplified 2-D Monte Carlo neutral transport model used in those calculations has been replaced with one based on DEGAS 2 [2], allowing a more accurate and flexible representation of atomic physics processes, including molecules, as well as a more realistic treatment of particle-material interactions. In particular, the mesh used in XGC0 - DEGAS 2 fills completely the simulated vacuum vessel so that the neutral source due to recycling is determined directly from the fluxes of XGC0 to material surfaces, and both evolve consistently during the simulation. A secondary benefit of a common mesh in XGC0 - DEGAS 2 is that it permits an unambiguous assessment of volumetric mass, momentum, and energy conservation in the neutral-plasma exchanges. Third, synthetic diagnostics for filterscopes and other neutral based diagnostics can be developed for use with DEGAS 2 to facilitate comparisons with experimental data.

A possible mechanism for a particle pinch that could contribute to the pedestal buildup was proposed in [3], motivated in part by some initial XGC0 - DEGAS 2 simulations. In this paper, we will present more detailed XGC0 - DEGAS 2 pedestal fueling calculations based on NSTX discharges. In particular, we will assess recycling resulting from X-point ion orbit loss. The anomalous transport coefficients in XGC0 will be adjusted to match the radial plasma profiles of those discharges. However, limitations on the present XGC0 - DEGAS 2, including a 1-D, radially varying plasma potential and fixed charge state impurities, prevent a comprehensive match to experimental data.

[1] C. S. Chang, S. Ku, and H. Weitzner, Phys. Plasmas **11**, 2649 (2004).
[2] D. P. Stotler and C. F. F. Karney, Contrib. Plasma Phys. **34**, 392 (1994).
[3] W. Wan et al., Phys. Plasmas **18**, 056116 (2011).

[1]This work supported by U.S. DOE Contract DE-AC02-09CH11466.