GYROKINETIC SIMULATIONS OF TOKAMAK PEDESTALS- PRESENT EXPERIMENTS AND EXTRAPOLATION TO BURNING PLASMAS

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Abstract. Electromagnetic gyrokinetic simulations of transport are reported for the inter-ELM pedestals. For the JET-ILW (ITER Like Wall) pedestal, nonlinear simulations show that Micro-Tearing Mode (MTM) turbulence produces the bulk of the transport in the steep gradient region, and the combination of MTM, electron temperature gradient (ETG), ion-scale electrostatic turbulence and neoclassical transport reproduces experimental power balance across most of the pedestal. Pedestals with $\nu^* < 1$ are often well into the second stability region, so Kinetic Ballooning Modes do not strongly affect pedestal transport- as indicated by previous linear analysis of JET-Carbon cases[1]. A ρ^* scan of ITER-like pedestals is performed, keeping other dimensionless parameters constant. Simulations find gyroBohm scaling of transport in the range of ρ^* of ASDEX/DIIID through low field JET. However, for high field JET and beyond, an insufficiency of velocity shear leads to strong ion scale electrostatic turbulence, and a strong departure from gyroBohm at lower ρ^* such as ITER. Inclusion of Carbon or Nitrogen greatly reduces this turbulence, so that gyroBohm scaling is reestablished through JET, and the departure at ITER is significantly reduced. In addition to low Z impurities, separatrix density is also found to strongly affect pedestal transport, particularly in the regime of insufficient velocity shear. This may provide an explanation for observed deleterious effects of gas puffing. In general, the trends found here may account for observed differences in pedestal behavior in JET-ILW and JET-Carbon. Unstable electrostatic eigenmodes have an unusual structure in the pedestal, and localize where the velocity shear is low for normal aspect ratio (A). However, at low A, eignefunctions peak where shear is strong. To examine the possible ramifications of this, pedestals with parameters of a small, low A fusion device will also be analyzed to see if the qualitative effects above arise as well.

[1]S. Saarelma et. al., Nucl. Fusion **53** 123012 (2013).