Gyrokinetic Simulations of the JET-ILW Pedestal

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Following the installation of an ITER-like wall (ILW), JET has been unable to recover historical confinement levels due largely to a striking change in pedestal structure. Finding a path to overcome this challenge is of utmost importance for both a prospective JET DT campaign (planned for the coming years) and the transition to ITER. We present a gyrokinetic study (using the GENE code) of the transport mechanisms operative in the JET-ILW pedestal. Simulations based on JET-ILW profiles and equilibria quantitatively capture experimental transport levels for a representative experimental discharge and qualitatively recover the major experimental trends. The most important new insight achieved by this study is that the JET-ILW pedestal is susceptible to ion-scale turbulent transport (ITG-like) of a type that is strongly shear-suppressed on smaller machines. Consistent with observations, this transport mechanism is substantially reduced by the presence of a low-Z impurity (e.g., carbon or nitrogen at the level of Z-effective$\sim$2). Our simulations also elucidate the observed degradation of confinement caused by gas puffing. Multiple transport mechanisms, including ITG, ETG, microtearing modes, and neoclassical transport are found to play important roles depending on the pedestal parameters. Kinetic ballooning modes are found (by both gyrokinetics and infinite-n ballooning calculations) to be in a second stability regime. The picture that emerges involves several parameters—notably, ρ^*, Z-effective, pedestal top temperature, and separatrix temperature/density—mediating the relative roles of these transport mechanisms. This study maps out important regions of this parameter space, providing insights that may point to optimal physical regimes that can enable the recovery of good confinement on JET.