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The Impact of Nitrogen Seeding on Turbulent Transport in Ohmic Plasmas in Alcator C-Mod and Gyrokinetic Simulations[1]

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Nitrogen seeding experiments performed on the Alcator C-Mod tokamak demonstrated that main ion dilution can decrease turbulence driven transport in both the low-density linear (LOC) and high-density saturated (SOC) ohmic confinement regimes. The seeding was observed to reduce the density fluctuations in the region of $r/a > 0.75$, and increase the inverse ion temperature gradient scale length (a/L_{Ti}) without increasing the gyrobohm-normalized energy flux (Q_i/Q_{GB}), which indicates either an increase in the critical ion temperature gradient or a decrease in the stiffness of the ion transport. The nitrogen seeding also caused the intrinsic core toroidal rotation to reverse direction in SOC plasmas, causing the rotation profiles to become LOC-like. Simulations with the nonlinear gyrokinetic code GYRO (with $k_\theta \rho_s \leq 1$) showed that main ion dilution reduced the ion transport both by decreasing the stiffness and by increasing critical gradient. In LOC plasmas main-ion dilution primarily increased the critical gradient, while in SOC plasmas it primarily decreased the stiffness. A quantitative comparison between the local GYRO energy flux and the experimental energy flux showed agreement at $r/a = 0.8$ (where the turbulence is strongly unstable) in both the ion flux and the electron flux in the LOC regime. In the SOC regime the GYRO ion flux shows an underprediction relative to experimental flux measurements while the electron flux shows agreement between experiment and GYRO. At $r/a = 0.6$ (where the turbulence is marginally stable) local GYRO over predicts both the ion and the electron energy fluxes relative to experiment. When global effects are taken into account at $r/a = 0.6$, the GYRO and experimental ion energy fluxes agree, but the electron energy fluxes are under-predicted. This may indicate the importance of high-k (with $k_\theta \rho_s \geq 1$) electron modes that were not included in the simulations.

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