Turbulence Studies with the Phase Contrast Imaging in Alcator C-Mod*

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The Phase Contrast Imaging (PCI) diagnostic in Alcator C-Mod is capable of measuring density fluctuations with temporal (10 kHz-5 MHz) and wavenumber (0.5-55 cm^{-1}) resolution. Recent upgrades[1] have enabled the PCI system to localize the short wavelength turbulence in the ETG range and resolve the direction of propagation (i.e., electron vs. ion diamagnetic direction) of even the longer wavelength turbulence in the ITG/TEM range. We have used the upgraded PCI to study turbulence in low density ohmic plasmas, where the ion and electron channels are decoupled. PCI has observed different correlations between the confinement time τ_{kin} and $(\tilde{n}/n)^2$ in linear and saturated regimes. As density increases, the $(\tilde{n}/n)^2$ in the frequency range 20-80 kHz and wavenumber range of 1-5 cm^{-1} decreases in the "linear" ohmic regime (low density, Alcator scaling, $\tau_{kin} \propto n$), whereas it increases in the high density "saturated" ohmic regime. In addition, the $(\tilde{n}/n)^2$ in the frequency range 100-250 kHz are dominated by the mode propagating in the ion diamagnetic direction in both "linear" and "saturated" ohmic regimes and this dominance becomes more apparent as density increases, which might indicate that ITG becomes more significant as density increases. Besides ohmic plasmas, we have also used PCI to study turbulence in ITB plasmas with steep density profiles, where unstable TEM was predicted[2] and previous line-integrated density fluctuation measurements with the conventional PCI showed the similar wavenumber structure as nonlinear GS2 flux tube modeling[3]. In the continued studies, the upgraded PCI has observed an enhanced turbulence in the frequency range of 20-60 kHz after ITB forms. The wavenumber of this enhanced turbulence peaks ~2.5 cm^{-1}, which corresponds $k\rho_s \sim 2.5$ and $\omega_i/2\pi \sim 40$ kHz. PCI has determined that the most intense component of turbulence propagates in the electron diamagnetic direction, suggesting that a dominant TEM mode is observed. Currently, we are carrying out nonlinear global gyrokinetic modeling with GYRO of the above ohmic and ITB plasmas and the experimental measurements will be compared with synthetic PCI diagnostic[4] predictions.

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