Multi-field/Multi-scale Turbulence Response to Electron Cyclotron Heating of DIII-D Ohmic Plasmas

G. Wang,[1] W.A. Peebles,[1] T.L. Rhodes,[1] J.C. DeBoo,[2] G.M. Staebler,[2] J.C. Hillesheim,[1] Z. Yan,[3] G.R. McKee,[3] C.C. Petty,[2] W.M. Solomon,[4] K.H. Burrell,[2] E.J. Doyle,[1] A.W. Leonard,[2] L. Schmitz,[1] M.A. VanZeeland,[2] A.E. White[5] and L. Zeng[1]

[1]Physics and Astronomy Department and PSTI, University of California, Los Angeles, California
[2]General Atomics, P.O. Box 85608, San Diego, California
[3]University of Wisconsin-Madison, Madison, Wisconsin
[4]Princeton Plasma Physics Lab, Princeton, New Jersey
[5]Massachusetts Institute of Technology, Cambridge, Massachusetts

ABSTRACT

A diverse multi-field/multi-scale core (ρ~0.5-0.8) turbulence response to electron cyclotron heating (ECH) of DIII-D Ohmic plasmas is reported for the first time. Long wavelength (low-k) electron temperature ($\tilde{T}_e/T_e$) and high-k density turbulence levels ($\tilde{n}_e/n_e$) are observed to strongly increase during ECH. In contrast, low-k and intermediate-k $\tilde{n}_e/n_e$ showed little change, whereas the cross-phase between local low-k electron temperature and density fluctuations ($\alpha_{n_eT_e}$) was significantly modified. The increase in the electron thermal diffusivity determined from power balance is consistent with the increased turbulent transport correlated with the measured increases in low-k $\tilde{T}_e/T_e$ and high-k $\tilde{n}_e/n_e$. Linear stability analysis using the trapped gyro-Landau fluid (TGLF) model indicates an enhanced growth rate for electron modes (e.g. trapped electron mode, TEM) at low-k consistent with the observed modifications in $\tilde{T}_e/T_e$ and $\alpha_{n_eT_e}$. TGLF also predicts an increase in high-k electron mode growth rates for normalized wavenumbers $k_\theta\rho_s > 7$, where electron temperature gradient (ETG) modes exist which is consistent with the observed increase in high-k $\tilde{n}_e/n_e$ turbulence.

PACS Nos.: 52.25.Fi, 52.35.Qz, 52.35.Ra, 52.55.Fa