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Self-Regulation of Trapped Electron Mode Turbulence via Density Zonal Field

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Trapped Electron Mode (TEM) turbulence significantly influences transport properties in magnetically confined plasmas, impacting the confinement of tokamaks. Zonal flows are pivotal in turbulence saturation[1], especially for the Ion Temperature Gradient (ITG) modes, but it is revealed that for high temperature gradients relative to density gradients, zonal flows have a minimal role in stabilizing TEM turbulence[2,3,4]. Instead, density zonal fields are proposed as the primary mechanism for TEM turbulence saturation[3,4]. The aim of this study is to elucidate the self-regulating saturation mechanisms of TEM turbulence to enhance plasma confinement and improve the efficiency of fusion devices.

Our approach begins with analyzing the drives of micro-instabilities, such as temperature and density gradients, by examining the stability diagram derived from the linear dispersion relation. This analysis focuses on local micro-instabilities rather than large-scale turbulent structures. We then constructed the quasilinear evolution equations for density and temperature by making use of the linear response and the dispersion relationship.

Our findings are expected to highlight the role of density zonal fields in TEM saturation, offering insights into effective turbulence suppression strategies. This understanding is crucial for optimizing plasma confinement and enhancing the performance and stability of fusion reactors.

References

[1] P. H. Diamond, S. I. Itoh, K. Itoh, T. S. Hahm, *Plasma Phys. Control. Fusion* **47**, R35-R161 (2005)
[2] T. Dannert, F. Jenko, *Phys. Plasmas* **12**, 072309 (2005)
[3] D. R. Ernst, J. Lang, W. M. Nevins, M. Hoffman, Y. Chen, W. Dorland, S. Parker, *Phys. Plasmas* **16**, 055906 (2009)
[4] J. Lang, Y. Chen, and S. E. Parker, *Phys. Plasmas* **15**, 055907 (2008)