

# **Excitation of Zonal Flow by Intermediate-Scale Electron Temperature Gradient Turbulence in Tokamak Plasmas**

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On the basis of gyrokinetic theory, we derive nonlinear equations for the zonal flow generation in intermediate-scale electron temperature gradient (ETG) turbulence (with wavelength much shorter than the ion Larmor radius but much longer than the electron Larmor radius) in nonuniform tokamak plasmas [1]. Both the spontaneous and forced generation of zonal flows are kept on the same footing. The resultant Schrödinger equation for the ETG amplitude is characterized by a Navier-Stokes type nonlinearity, which is typically stronger than the Hasegawa-Mima type nonlinearity resulting from the fluid approximation. The physics underlying the three stages of zonal flow generation process is clarified, and the role of parallel mode structure decoupling is discussed. It is found that zonal flows can be more easily excited in the intermediate-scale ETG turbulence than in the short wavelength regime. This finding offers a plausible explanation for recent multi-scale gyrokinetic simulations.

## **References**

- [1] Haotian Chen, Stefan Tirkas and Scott E. Parker, Excitation of Zonal Flow by Intermediate-Scale Toroidal Electron Temperature Gradient Turbulence, Nucl. Fusion, 2021 (accepted).