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Scale selection and feedback loops for patterns in drift wave-zonal flow turbulence

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The scale selection and feedback loops for the formation and sustainment of a mesoscopic profile of staircase structure are investigated for drift wave-zonal flow turbulence. A mean field model based on the Hasegawa-Wakatani system and including the evolution of mean density, mean vorticity and perturbed potential enstrophy (PE), is used. It is found that a quasi-periodic zonal staircase formation follows from self-sharpening of modulation. The principle feedback loop is through the nonlinear dependence of mixing length on electron density gradient, which enters the potential vorticity (PV) gradient, and not on $\vec{E}\times\vec{B}$ shearing. Moreover, the staircase is sensitive to both the drive (production rate of PE and initial density gradient) and damping (flow viscosity and collisional diffusivity) factors. The minimal step scale is selected by competition between the initial density gradient and diffusive dissipation. Finite turbulence spreading is necessary to form the staircase, but moderate enhancement of turbulence spreading tends to wash out the pattern. The staircase retains a memory of its initial scale. Both the mean $\vec{E}\times\vec{B}$ shear and zonal shear affect the staircase evolution. A strong mean shear quenches the pattern by suppressing the drift wave turbulence. The implications of these findings are also discussed.

References

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