

It is known that radially sheared zonal flows plays a significant role in nonlinear stabilization in tokamak plasmas.¹⁻³ Through advection on the sheared zonal flows the turbulent structure in plasma gets deformed and tilted that causes an $E \times B$ nonlinearity.^{2,4,5} Zonal flows mediate spectral energy transfer to larger radial wave vectors.⁶⁻⁸ The strength of the shearing process is the $E \times B$ shearing rate $\omega_{E \times B}$ which is the radial derivative of the advecting zonal flow velocity.^{4,9} The shearing rate $\omega_{E \times B}$ is defined as

$$\omega_{E \times B} = \frac{1}{2} \frac{\partial^2 \langle \Phi \rangle}{\partial \psi^2} \quad (1)$$

where $\langle \Phi \rangle$ is the zonal electrostatic potential and ψ the radial coordinate that labels the flux surfaces.¹⁰⁻¹² It was shown that the nonlinear threshold for turbulence is directly related to shear stabilization.³ Often the shear stabilization is expressed in the empirical Waltz rule $\omega_{E \times B} \sim \gamma$,^{9,13} where γ is defined as the maximum linear growth rate in the unstable mode. In the discovered zonal flows, also known as $E \times B$ staircase¹⁴, exhibit amplitudes in terms of the $E \times B$ shearing rate satisfying the stabilization criteria.^{10,15}

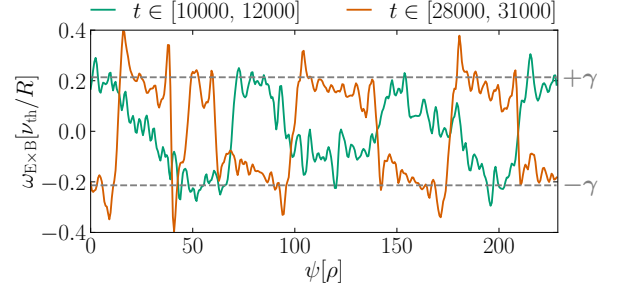


FIG. 2: Test

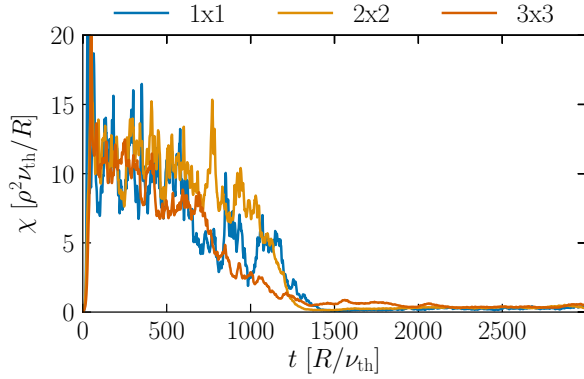


FIG. 1: Test

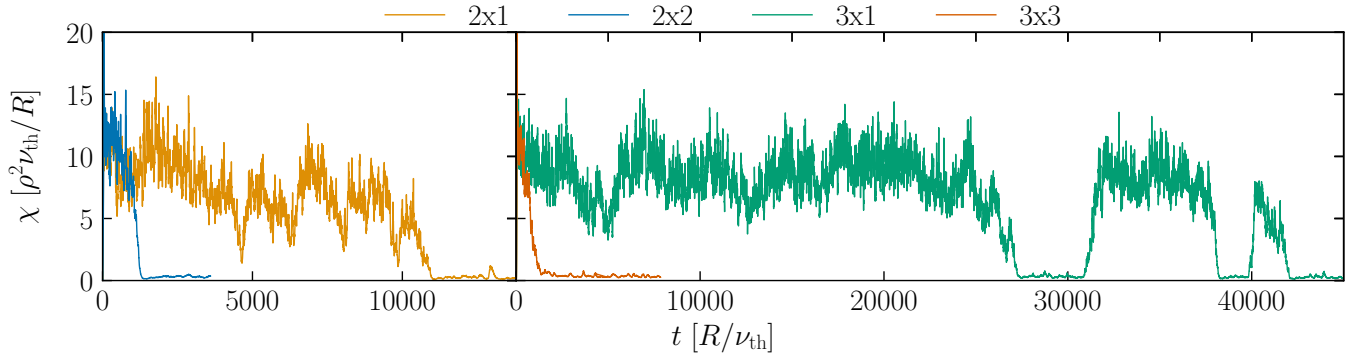


FIG. 4: Test

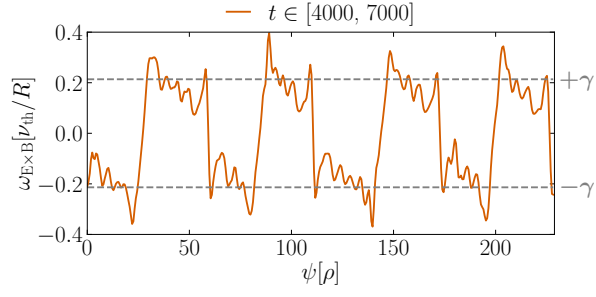


FIG. 3: Test

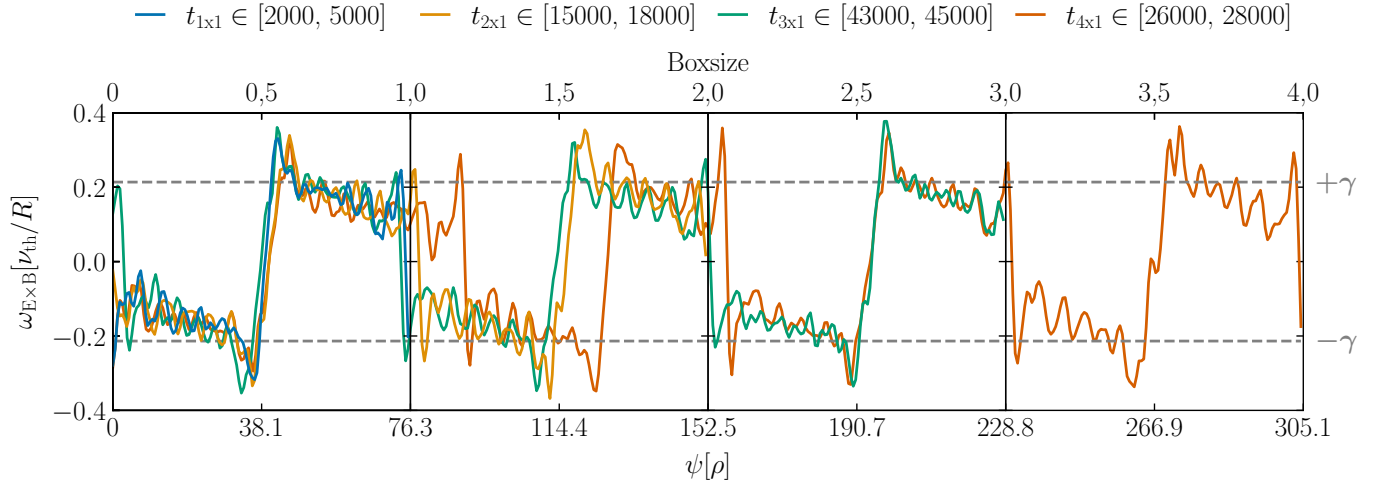


FIG. 5: Test

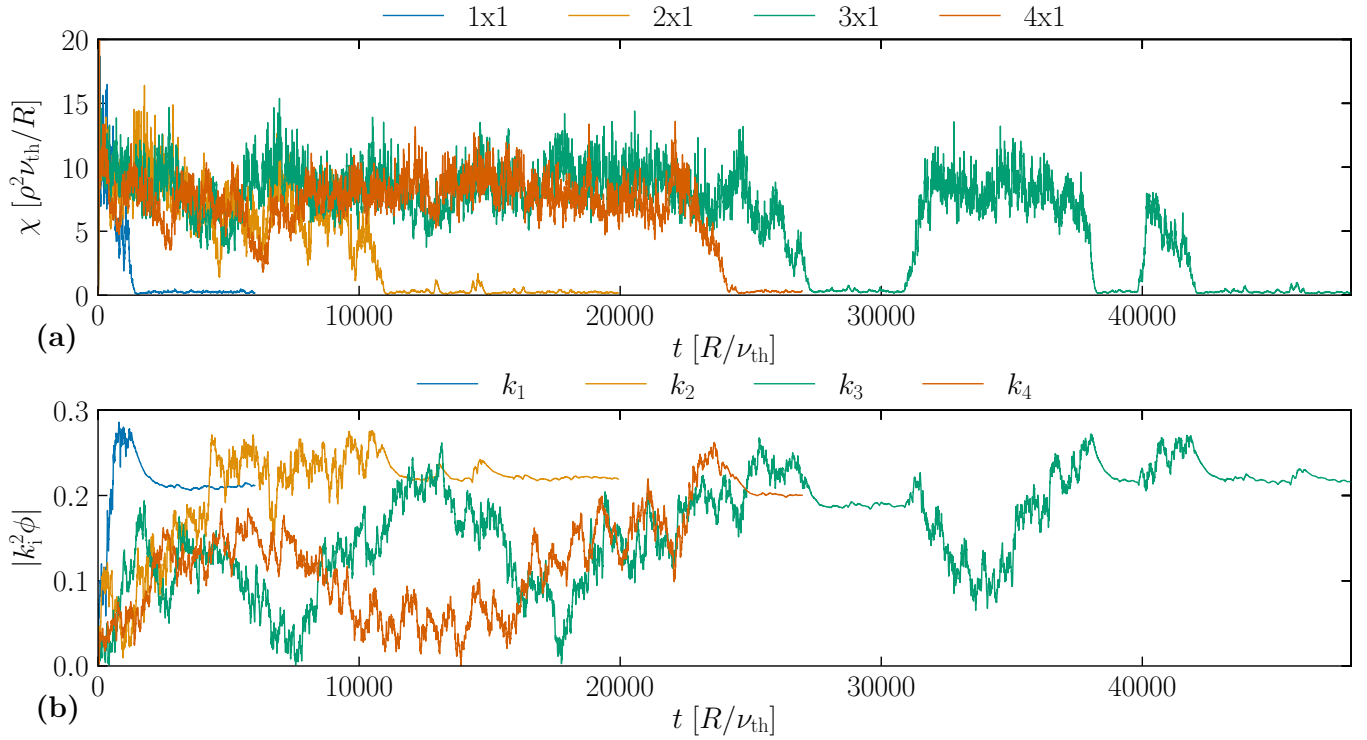


FIG. 6: Test

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

	Counter		Words	
	1 Col	2 Col	1 Col	2 Col
Words			269	
Figure	3	4	200	400
Table	0	0	13	26
Table Row	0	0	5	13
Eq Row	0	0	7	13
Pages			3	
Total			2469	
Remain			1031	

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