Convergence of shearing rate $\omega_{\mathrm{E\times B}}$ with boxsize in gradient driven simulation

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(Dated: 22 November 2022)

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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 $E\times B$ nonlinearty.[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 $\omega_{\mathrm{E\times B}}$ which is the radial derivative of the advecting zonal flow velocity.[4,9] The shearing rate $\omega_{\mathrm{E\times B}}$ is defined as

$$\omega_{\mathrm{E\times B}} = \frac{1}{2}\frac{\partial^2\langle\Phi\rangle}{\partial\psi^2} \tag{1}$$

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 $\omega_{\mathrm{E\times B}} \sim \gamma$,[9,13] where γ is defined as the maximum linear growth rate in the unstable mode. In the discovered zonal flows, also known as $E\times B$ staircase[14], exhibit amplitudes in terms of the $E\times B$ shearing rate satisfying the stabilization criteria.[10,15]

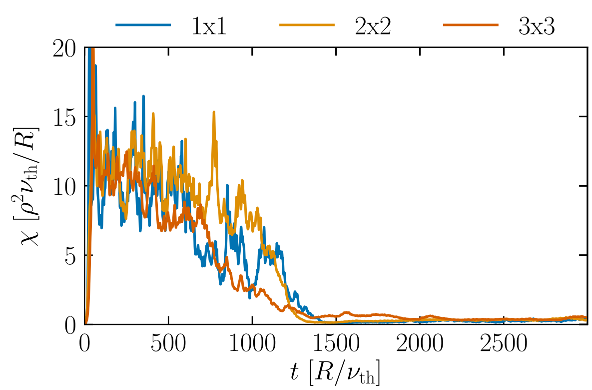


FIG. 1: Test

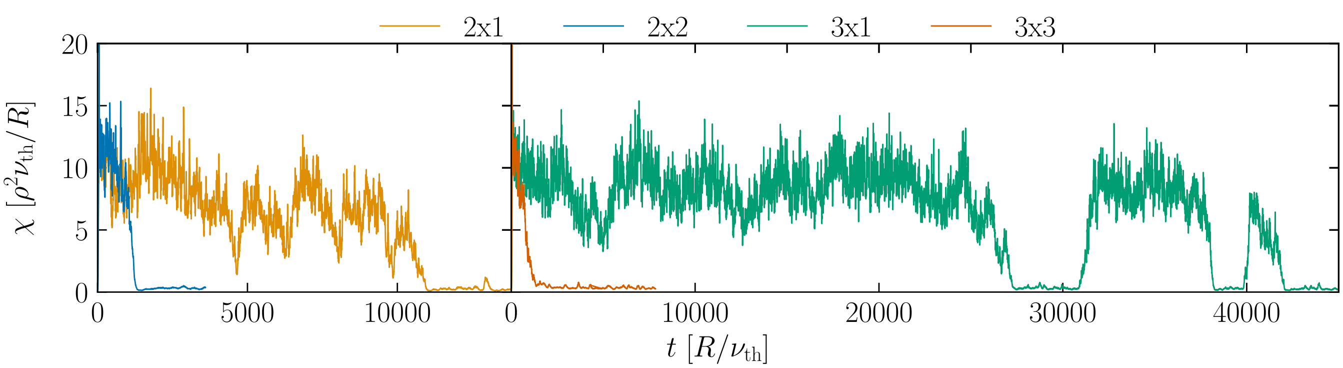


FIG. 4: Test

a) GitHub Repository of this work: https://github.com/ManeLippert/Bachelorthesis-Shearingrate-Wavelength

b) Author to whom correspondence should be addressed: Florian.Rath1@uni-bayreuth.de

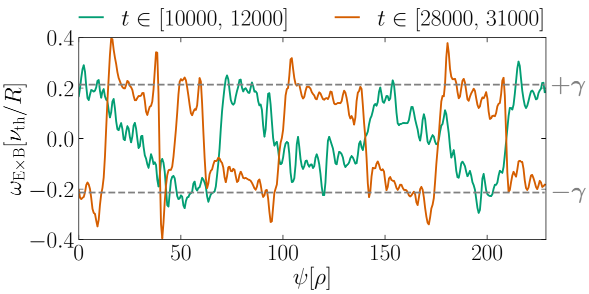
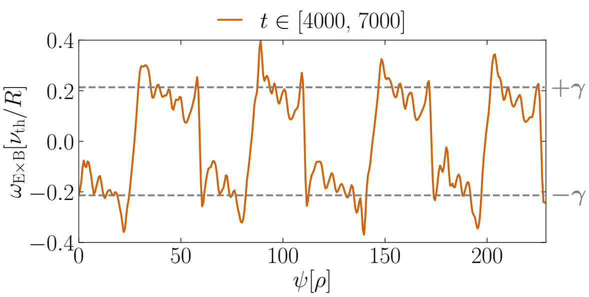


FIG. 2: Test



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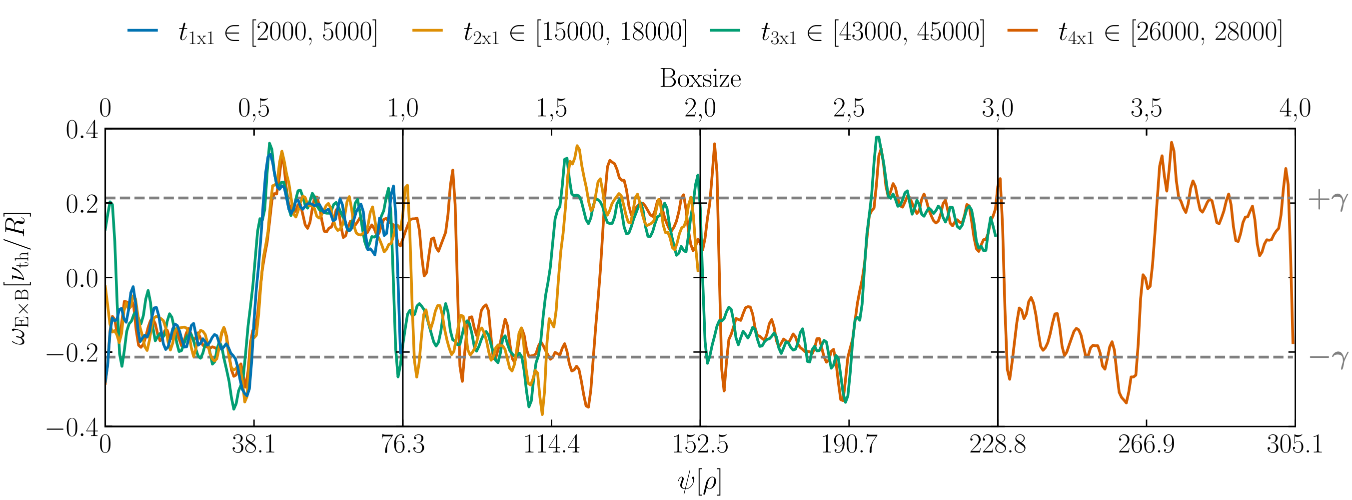

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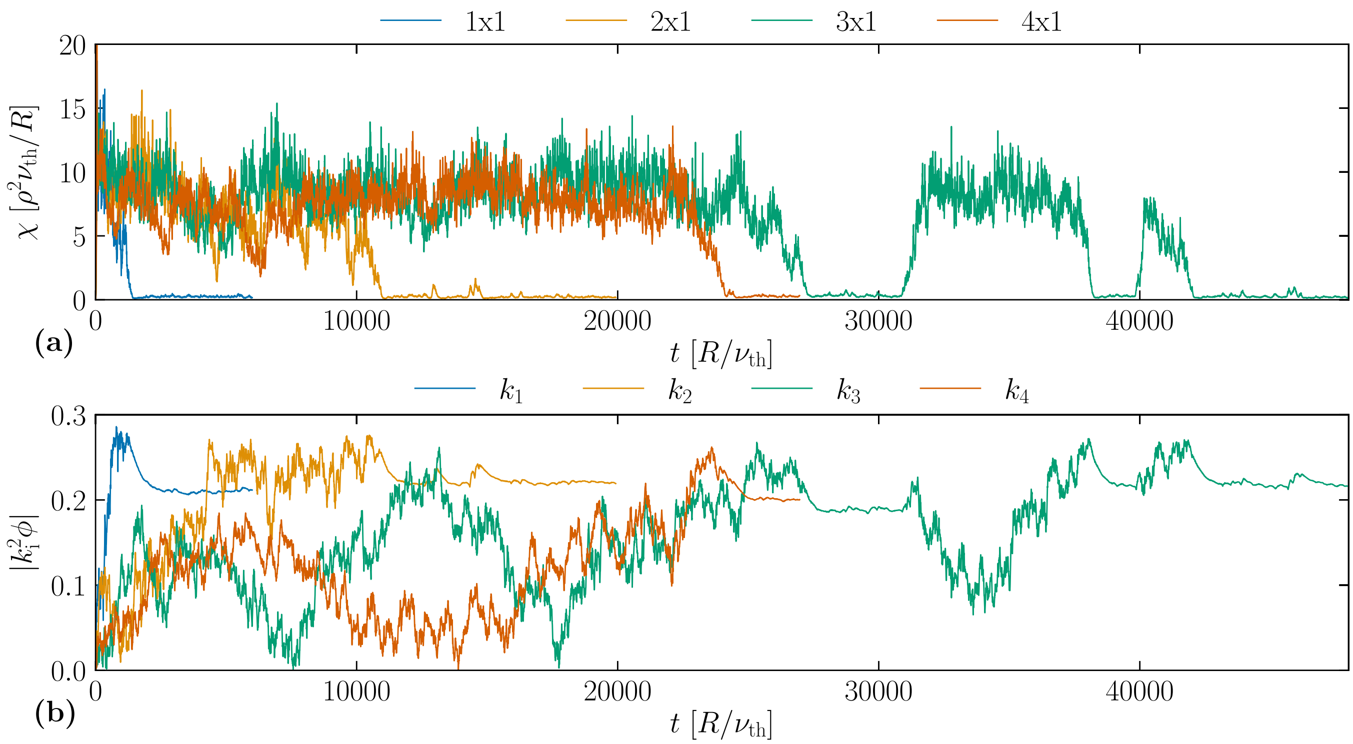

FIG. 6: Test

DATA AVAILABILITY

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

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