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Some Constraints on Generation of Poloidal Shear Flow.

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Electrons:

$$\omega = \omega_k + \delta\omega_{\mathrm{NL}},$$

$$\omega_k = \omega_p + \frac{3}{2} k^2 T_e / m,$$

$$\delta\omega_{\mathrm{NL}} = \frac{1}{2}\omega_p \, \delta n / n,$$

Ions :

$$\Omega^2 = k^2 T_e / M + \delta_{\mathrm{NL}},$$

Nonlinearity is coming from $(V_e \nabla)V_e$ in electron equations of motion (and taking V_e as $\mathrm{eE}/\mathrm{m}\,\omega$ while $\omega = \omega_{\mathrm{p}}$) and can be reduced to a kind of additional pressure :

$$\delta\Omega_{NL}^{2} = \frac{E^2}{8\pi n M}.$$

$$(\omega - \omega_p)\delta E = \frac{1}{2}\omega_p E \, \delta n / n,$$

$$(\partial^2 / \partial t^2 - T_e / M)\delta n = 1 / 8\pi M \, \frac{\partial^2}{\partial x^2} E \delta E$$

$$\omega = \omega_{\mathrm{p}} + i\nu, \qquad \Omega = \Omega_s + i\nu,$$

$$\nu^2 = \frac{1}{16}\omega_p \omega_s E^2 / 4\pi n T$$

$$\left(\partial^2/\partial t^2 - T_e/M\right)\delta n = 1/8\pi M \, \frac{\partial^2}{\partial x^2} E\,\delta E,$$

$$\omega = \omega_{\mathrm{p}} + i\nu, \qquad \Omega = \Omega_s + i\nu,$$

$$\nu^3 = \left(\frac{1}{16\pi n M} \omega_p E^2 \right)^{1/3}$$

$$\omega_d \Rightarrow \omega_d^{'} + \omega_{c.c.},$$

1. $\omega_{\mathrm{c.c.}}$ small compared to ω_{d}

2. Dissipation brings imaginary part greater than 3 - wave resonance mismatch

Arbitrary strong dissipation but only in one mode (e.g. in drift mode) does not eliminate instability, only reduces its growth rate.

Poloidal zonal (Shear) flow is a particular case of Convective Cells (c.c.)

$$k_y = 0,\ \ k_x \neq 0$$

$$x \leftrightarrow r \text{ (in cilindrical geometry)}$$

If poloidal shear flow supresses drift mode microturbulence, is there mechanism to switch it on and off?

Standart Theory:

Parametric generation of polodal shear flow by Drift mode is unstoppable,

Thus the "Predator-Pray" scenario is unavoidable with improved confinement.

Experiment:

There are regimes of improved confinement but not universal; within the same regimes there might be zones of significantly lower microturbulence (areas of "Transport Barriers")

Computational:

See both cases

Suggested Model
(Dissipation in both resulting modes)

Drift Mode:

- Consider scenario of Non-linearly Saturated Drift Microturbulence (as starting point before it start interacting with zonal flow)
- Imaginary part of damping is of the order of real part

Zonal Flow mode:

- Include "primordial" damping due to turbulent viscosity provided by

Initial Drift Mode

Turbulence