2D Kelvin–Helmholtz Instability with Anisotropic Pressure

Science Question:

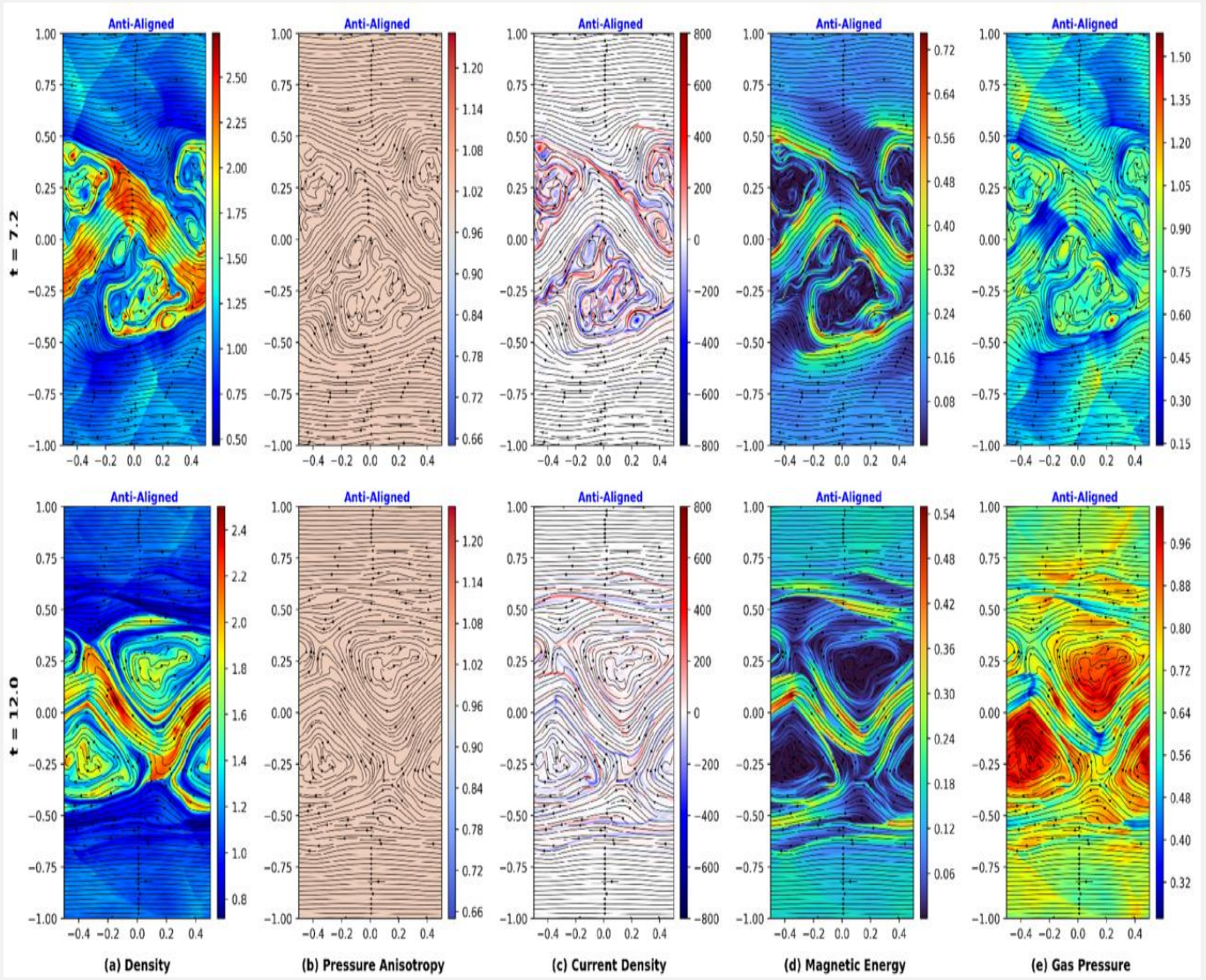
- How does pressure anisotropy modulate the growth of the Kelvin–Helmholtz instability?

Method or approach:

- 2D CGL simulations are performed using a higher-order WENO scheme. In addition, analytical studies are also carried out.
- Smooth ***tanh*** profiles are used for the velocity, density, and magnetic field.

Results and Implications:

- An excellent match between the analytical and numerical growth rates is observed when the instability evolves in the linear regime.
- The largest growth rates and the strongest magnetic effects occur in the MHD limit. In contrast, in the large relaxation-time CGL limit, part of the energy is diverted into generating and maintaining pressure anisotropies, leaving less energy available to bend the magnetic field lines.
- Current densities are highest in the MHD limit, where the largest magnetic islands also form. This indicates that reconnection effects are most pronounced in the MHD limit and are less prominent when pressure anisotropies develop in the CGL limit.
- The intermittencies that develop in the MHD limit are significantly stronger than those observed in the CGL limit.
- These may also impact particle acceleration in CGL versus MHD cases.



Density, pressure anisotropy, current density, magnetic energy, and total gas pressure at early time (t = 7.2, top row) and late time (t = 12.0, bottom row) for the simulation with an anti aligned magnetic field and CGL relaxation time $\tau = 10^{-5}$.

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