

Cascade on Kinetic Scales in Two-Dimensional Hybrid Simulations

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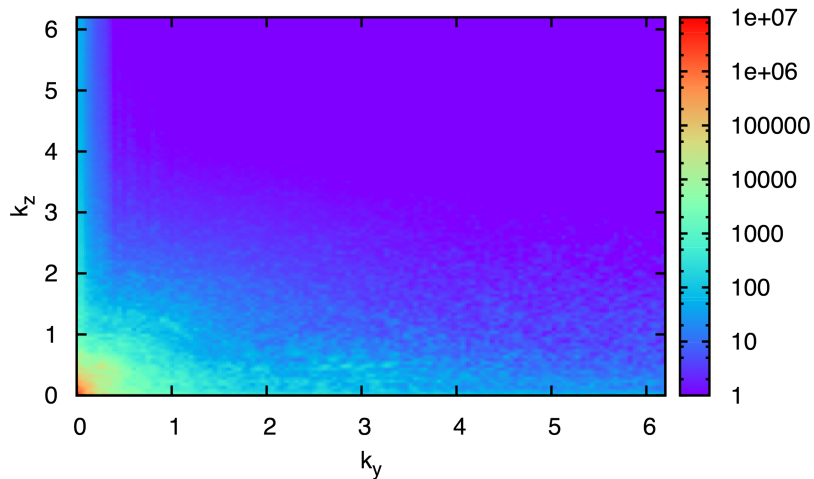
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- $\beta_p = 0.05$
- Box size: 1024×1024 over a spatial size of $250\ell_p \times 250\ell_p$
- 1000 (pseudo-)particles per cell
- superposition of 20 incompressible MHD Alfvén waves following a Kolmogorov spectrum ($k^{-5/3}$) in interval $k = 0.05 \dots 0.2$ for each direction
- 360° covered by 60 steps
- amplitudes correspond to a wave with amplitude $\delta B/B_0 = 0.01$ (Run A) or $\delta B/B_0 = 0.1$ (Run B)
- $dt = 0.01$

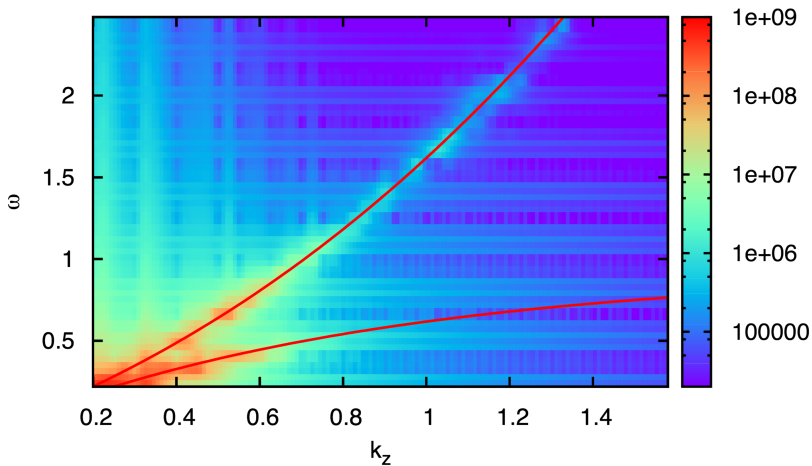
Results Run B

PSD B-field



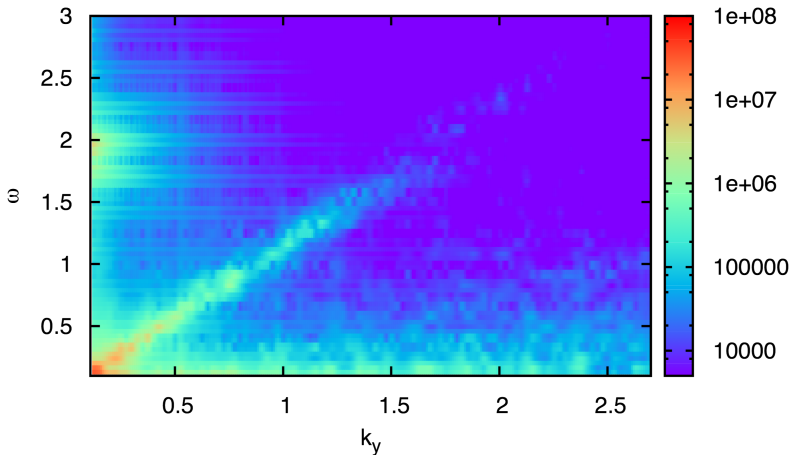
Results Run B

Dispersion, PSD B-field parallel



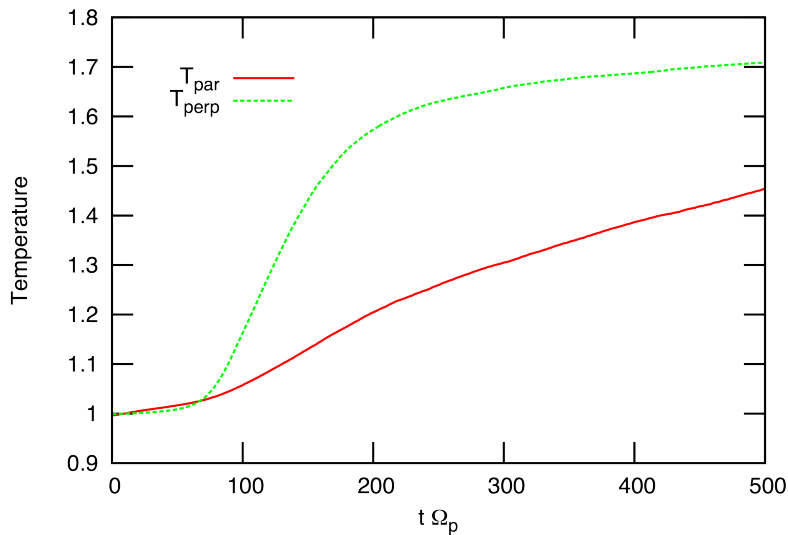
Results Run B

Dispersion, PSD B-field perpendicular



Results Run B

Temperature



Conclusions

- Wave–wave interactions excite normal modes at higher wavenumbers.
- Parallel: L-mode until cyclotron resonance, R-mode continues.
- Density fluctuations are essentially perpendicular.
- Heating and the development of a temperature anisotropy $T_{\perp} > T_{\parallel}$ is observed.
- Quite different from simulations with out-of-plane field → need for 3D simulations