Summary of Splinter #1 – Reconnection, turbulence, & waves

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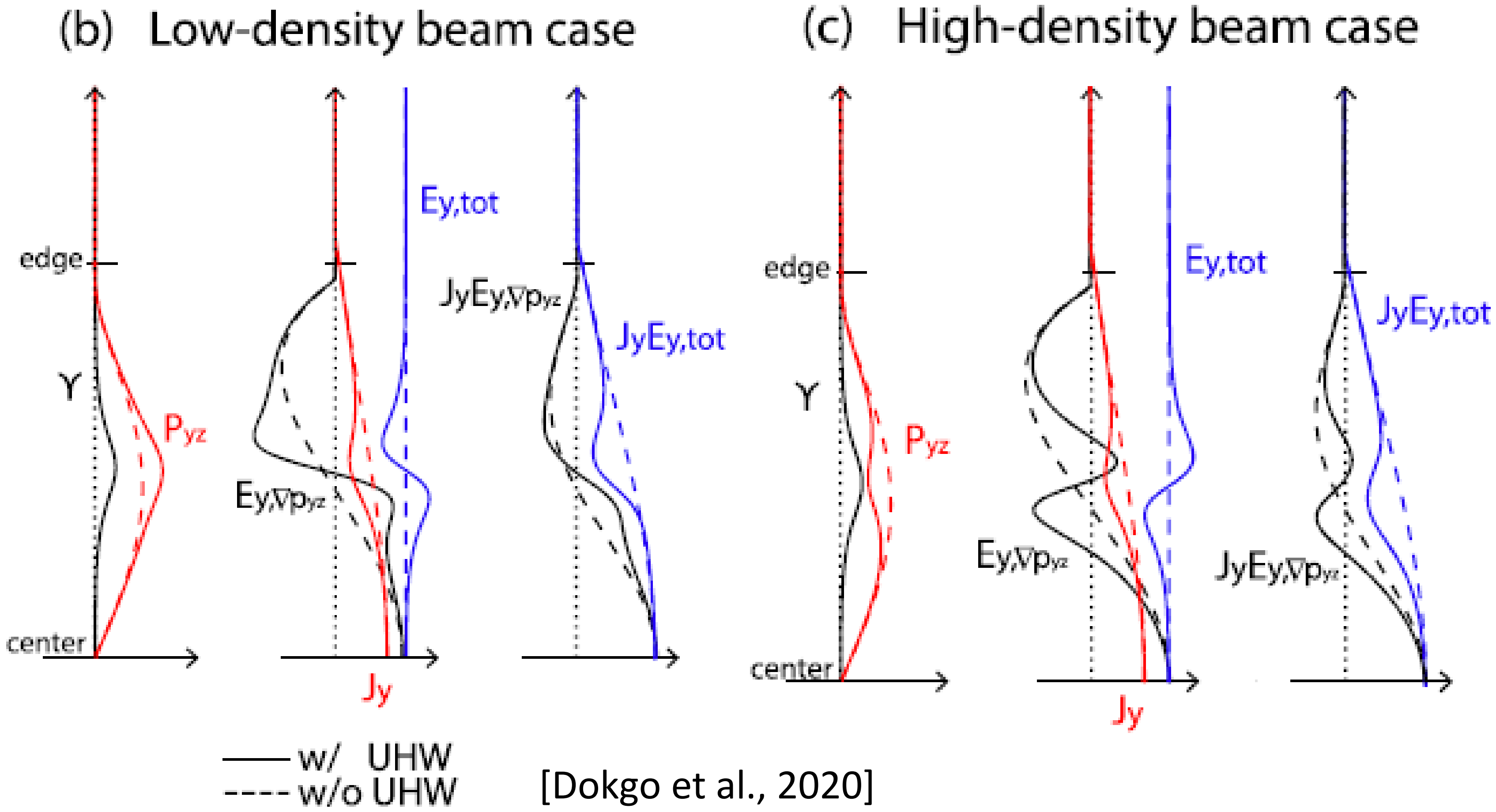
Kyunghwan Dokgo: Energy dissipation via upper hybrid waves



[Dokgo et al., 2020]

Upper hybrid waves modify $P_{e,yz}$ and E_y, and reduce J_y, leading to reduction of energy conversion J_yE_y

whistler waves

Rick Wilder: observations

- Regions: mainly in the magnetospheric separatrix region, on both closed and open field lines, sometimes deep in the exhaust
- Wave properties: oblique, both away and towards X-line, often associated with bipolar $E_{||}$

Naoki Bessho: simulation, Bg asymmetric Rx

- Regions: magnetospheric separatrix on the side with the strong electron outflow, open field line
- Wave properties: propagating away from the X-line

whistler waves

Rick Wilder: observations

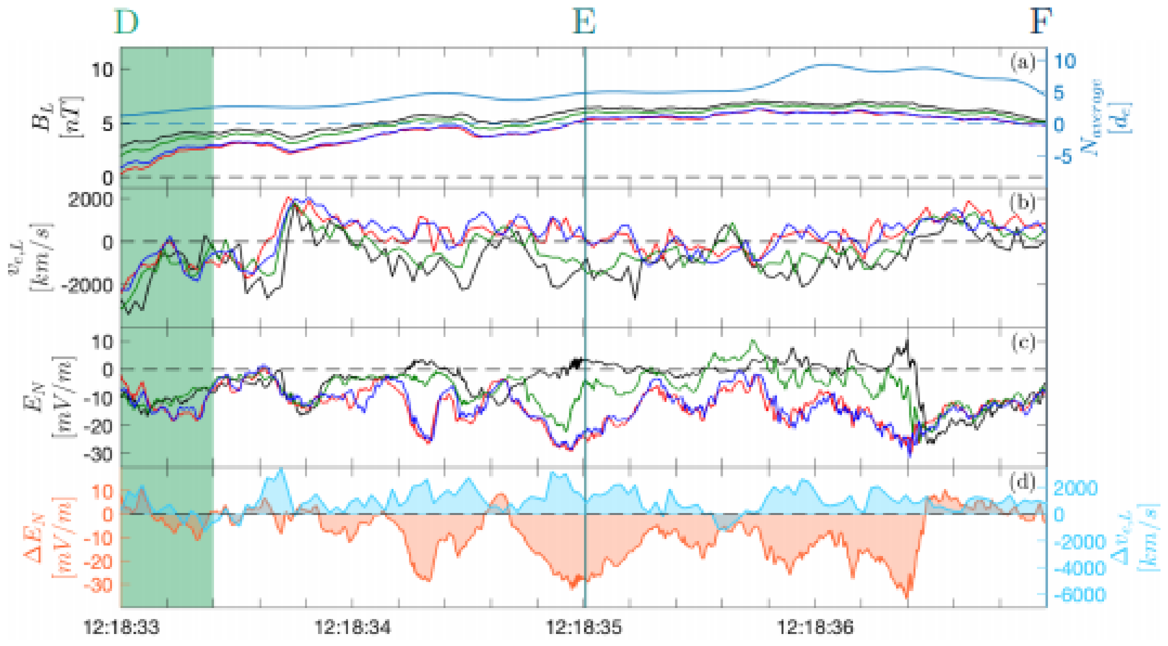
- Electron distributions: anisotropy and beams as possible excitation mechanisms; ‘anomalous resonance’: propagation along the beam
- Wave-particle interaction: plateau near $V_{Ae}/2$ along the propagation direction

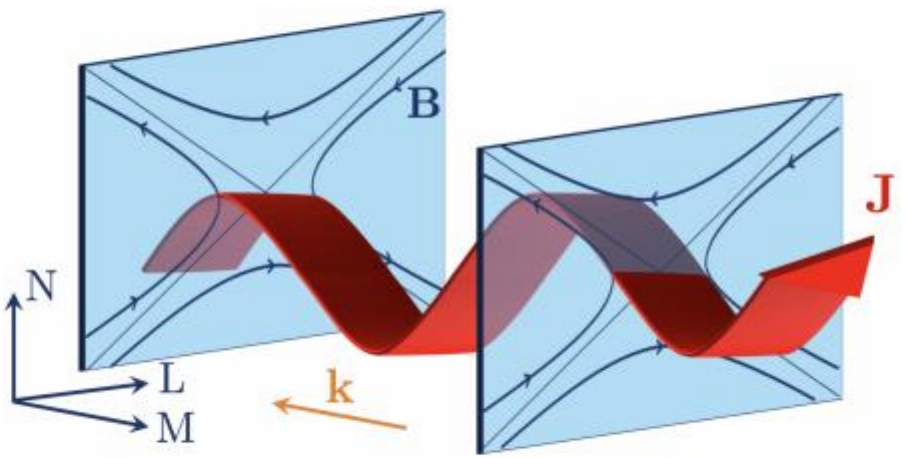
Naoki Bessho: simulation, Bg asymmetric Rx

- Electron distributions: beams with anisotropy and/or nongyrotropy; propagation along the beam, Landau and cyclotron resonance (plus Doppler shift) in effect
- Electron heating occurs, mainly along $T_{e||}$

Giulia Cozzani: EDR with lower-hybrid waves

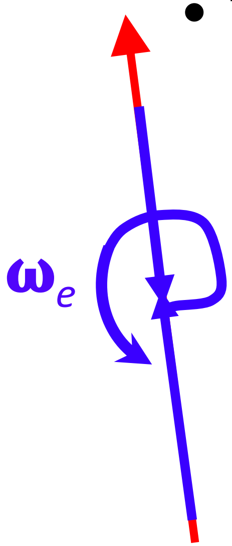
- Magnetotail EDR with electron-scale gradients of fields
- Explained by kinking of the current sheet in the out-of-plane direction, due to the long wavelength mode electromagnetic lower-hybrid waves

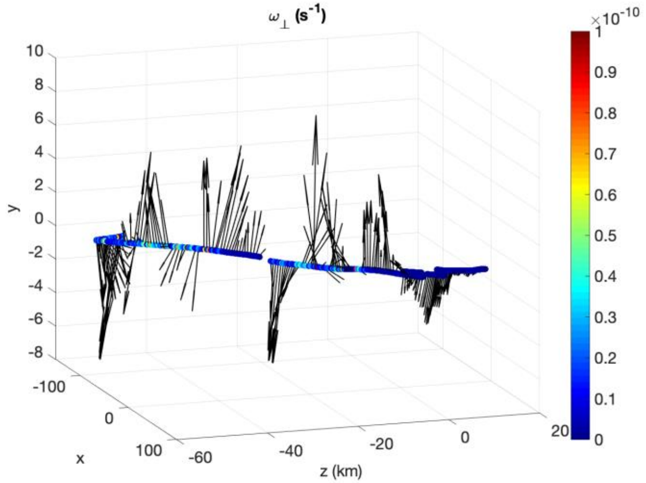




Deirdre Wendel: Dissipation and Angular Momentum in Reconnection

- Deriving from reconnection conditions of loss of field line and flux conservation → vorticity equation constrained by $\nabla \times E_N$
- Generate vorticity null points
- The threshold at vorticity null points to allow electrons/vorticity to escape the same field line: $\left|\frac{c}{2b}\right| > 1$, where $c = \frac{\partial \dot{\varphi}}{\partial z}$, $b = \frac{1}{2}(\boldsymbol{\nabla} \times \boldsymbol{\omega})_z$





Test of vorticity equation terms in MMS and simulations

Matthew Argall

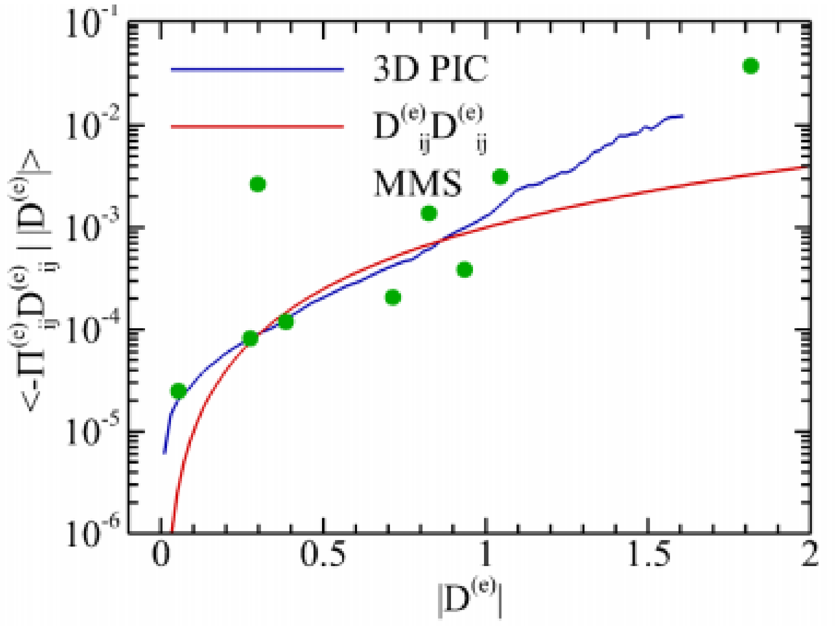
- Velocity-space entropy, a measure of deviation from Maxwellian distribution
- Simulation analysis:
  - ➢Double peaks along N for electrons, parallel anisotropy
  - ➢Single peak for ions, explained with the larger thermal speed than electrons
  - ➢Information loss, depending on grid spacing
- Qualitative and quantitative agreement between the simulation and the tail EDR observation

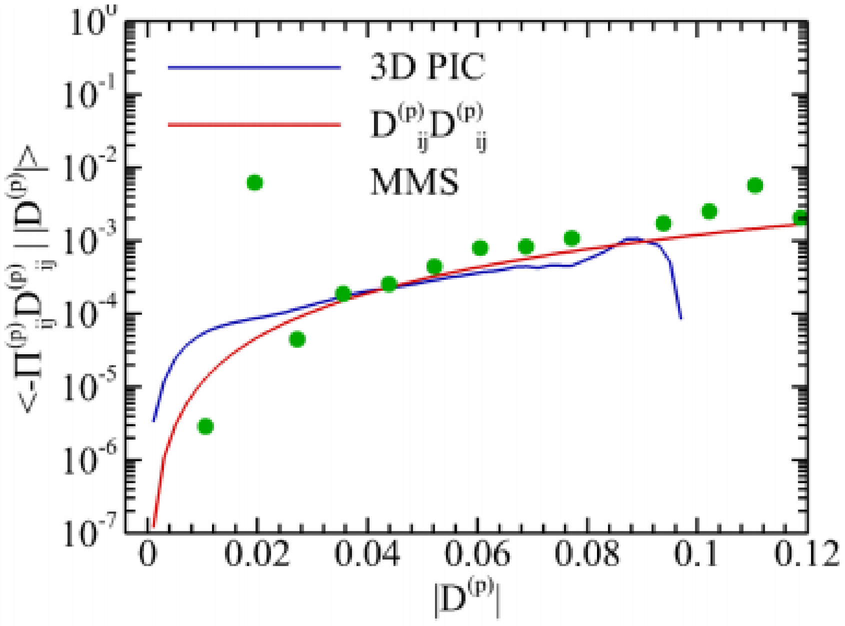
Riddhi Bandyopadhyay: effective viscosity in plasmas

Demonstrate that in plasmas J.E~J^2 and Π_{ij} D_{ij} ~ DijD_{ij}

In collisional media, J = μ E; J.E ~ J^2 Π_{ij} = νD_{ij}; Π_{ij} D_{ij} ~ DijD_{ij}

Evaluate ν, μ for natural systems?





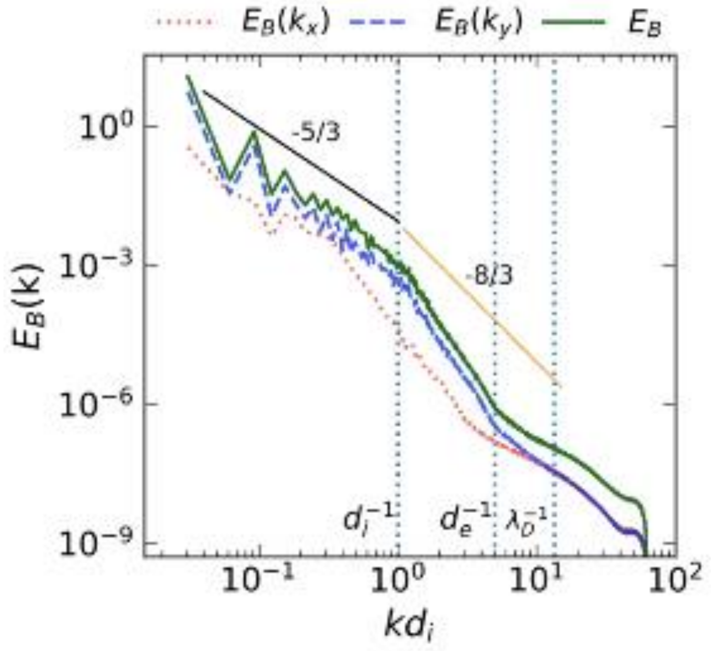
Michael Hesse: Can low-density inflow drive current sheet turbulence?

Ames Research Center

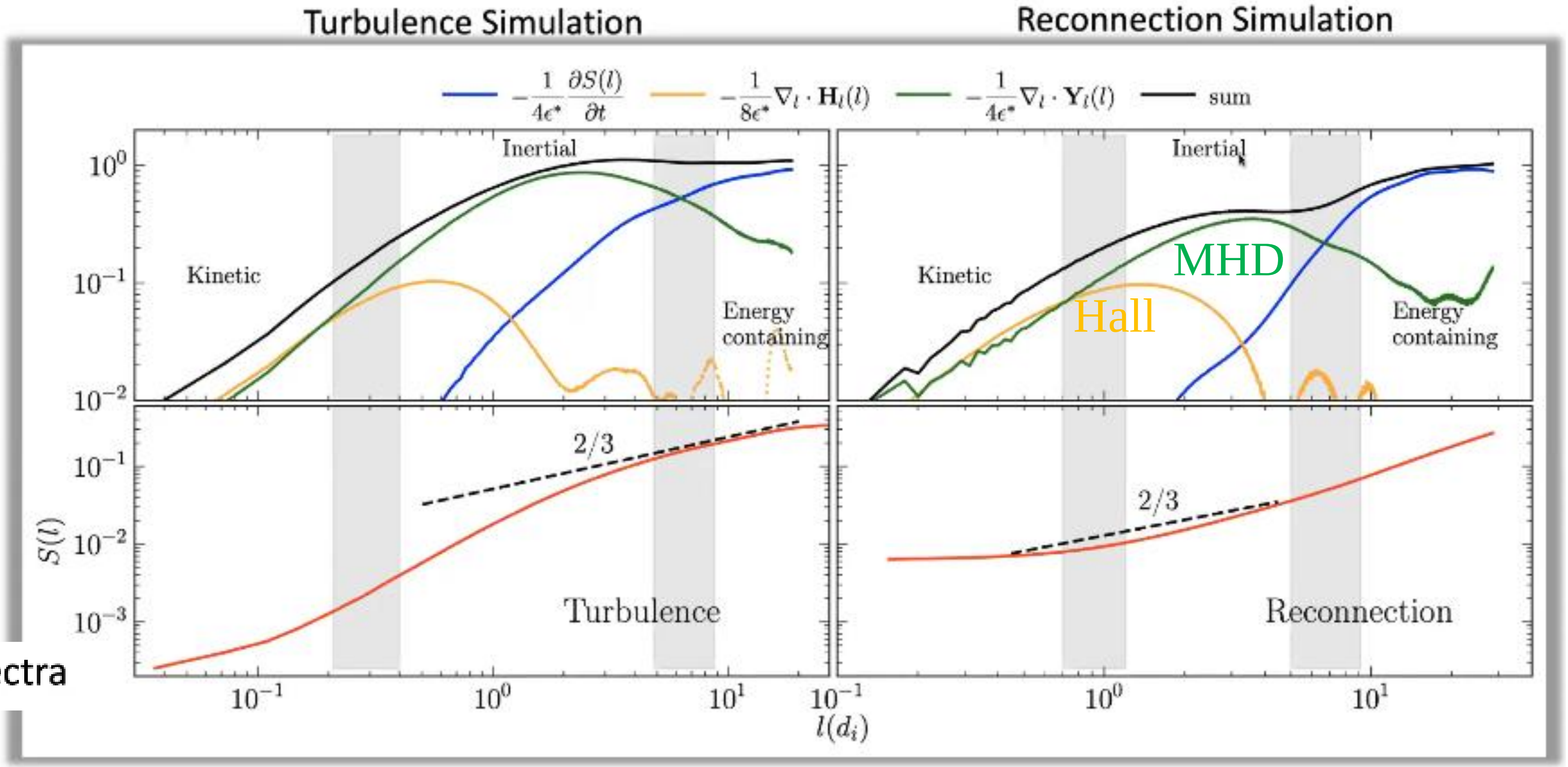
SUMMARY

- Low-density inflow can drive explosive reconnection, with very large electric fields and weak shocks in the outflow
- Reconnection electric fields continue to scale with ~0.1-0.2$v_A B_0$
- Very large electric fields lead to very strong particle acceleration, even for ions
- Simple, low-density inflow drives only limited fluctuations
- Inflow density variations can generate appreciable fluctuations and structure, as magnetic islands. Electric field and current density structures are complex
- Results are promising. Next step: quantify turbulence level

Subash Adhikari: Reconnection as a Turbulence Process



- Laminar reconnection creates -5/3 spectra
- Examine Energy in "lag" space
- Increment $\delta \boldsymbol{u} = \boldsymbol{u}(\boldsymbol{x} + \boldsymbol{l}) - \boldsymbol{u}(\boldsymbol{x})$



Third-order law decomposition of the cascade is similar to standard turbulence

Is there universality between reconnection and turbulence?

Owen Roberts: density spectrum at high frequencies in the turbulent magnetotail

Spectral analysis of a magnetotail event

- Different noise levels for different quantities make comparison difficult
- Density measurement down to 200Hz
- Skewness varies a lot near the characteristic scales of electrons (and protons although time series is too short to resolve protons)
- Kurtosis increases with frequency in all measurements (until we reach noise)
- How to best use this data? Use a longer time interval (prefereable) but other problems arise. Local magnetic field? Throw out density measurements when E is above a certain threshold?

Open questions

- To complete the map of what and how waves are generated in the reconnection context
- To further understand the wave/turbulence effect on particles and reconnection structures
- To pursue the link between reconnection and turbulence
- To solve the ‘dissipation’ problem in reconnection and turbulence