Observations of Wave-Particle Interactions in the Flux Pile-up Region of Asymmetric Reconnection

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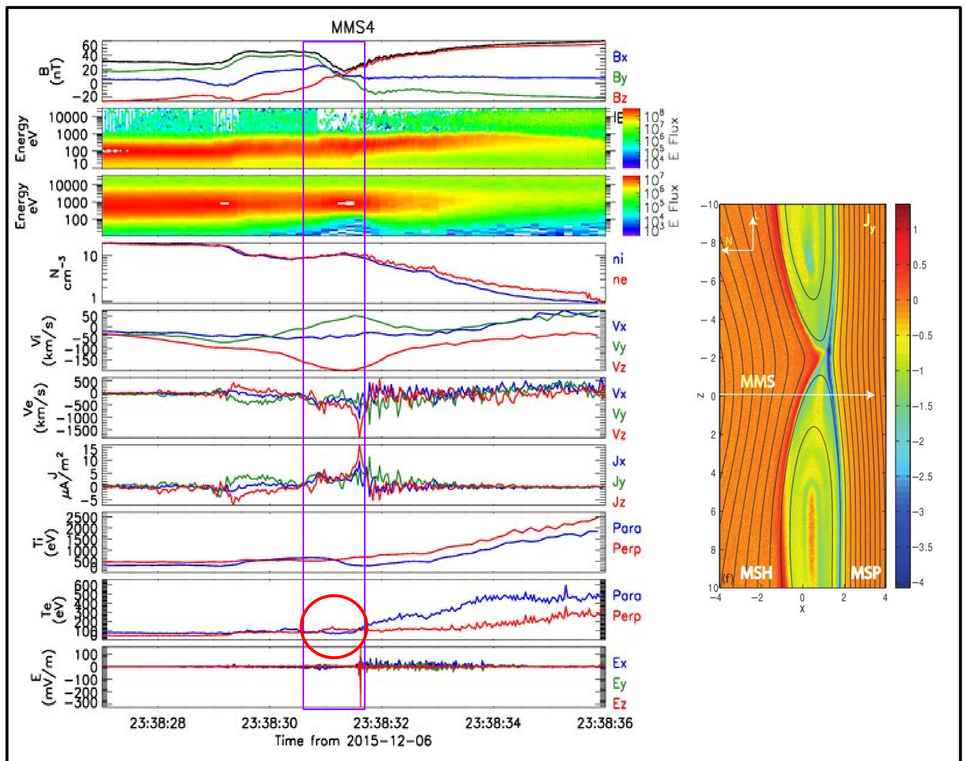
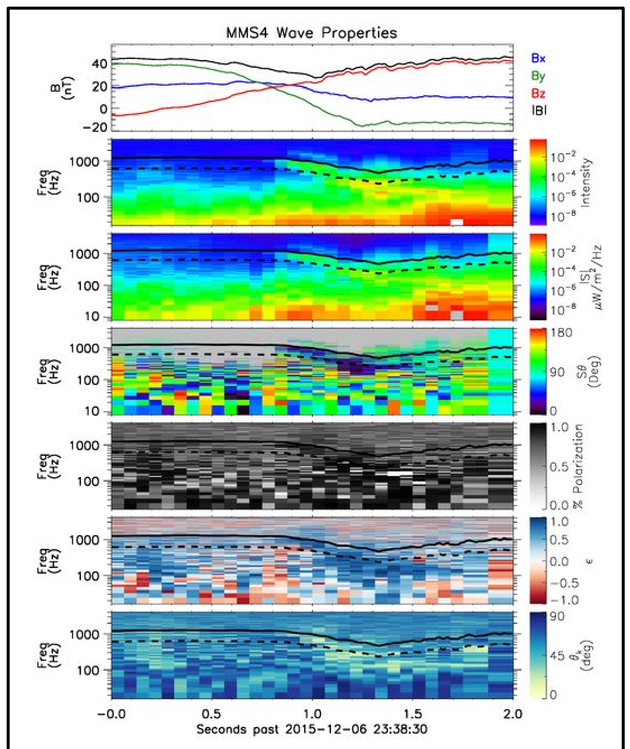
Wave Observations

Event Overview



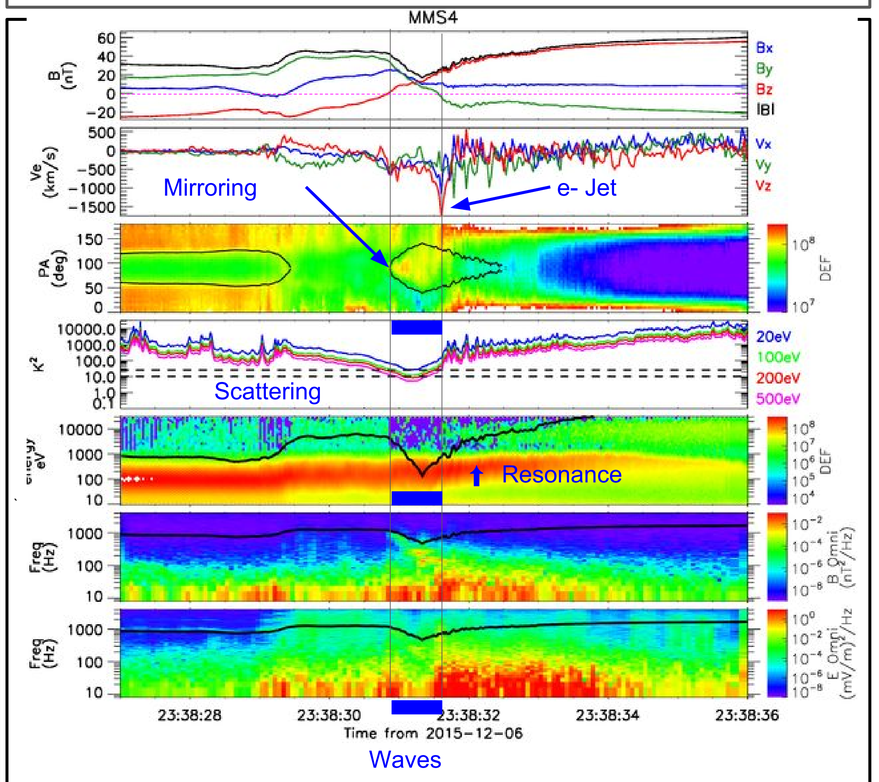
- MMS4 crossed the magnetopause from the magnetosheath to the magnetosphere
  - B_L reverses from negative to positive
  - Density transitions from high to low
- An electron-scale electron jet is embedded within the ion jet
- Electron temperature anisotropy ($T_{e,perp}$/ $T_{e,par}$ > 1) occurs within the current layer

Wave Properties



- Anisotropy leads to wave growth
- Electron whistler waves (f ~ f_{ce}/2)
  - Right-hand polarized
  - Wave-normal angle of ~20°
- Poynting flux directed away from the X-line

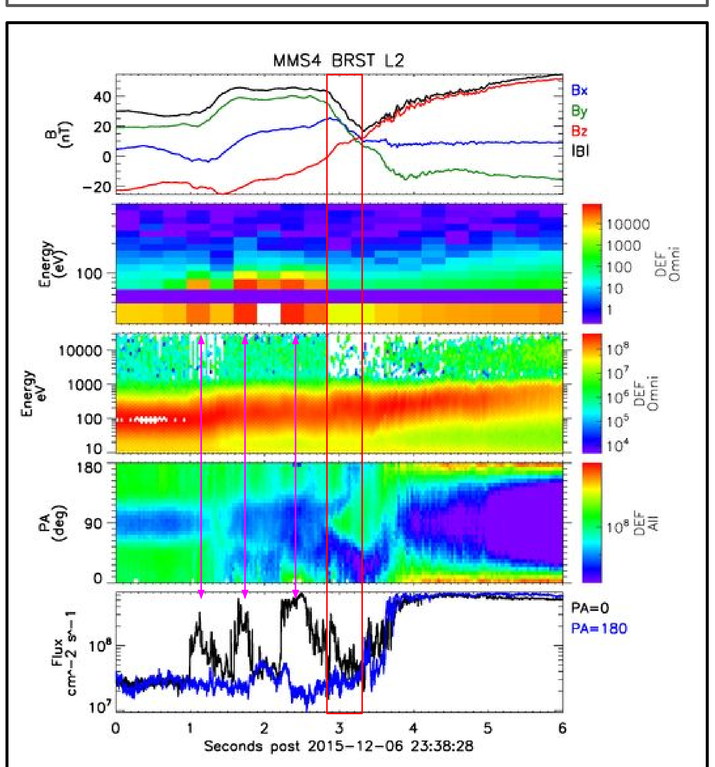
Wave Generation



- Pitch-angle focusing toward 90° at mirror point in 40nT field
- Field line curvature scatters electrons
- Resonant energy dips into bulk energy of the plasma
- Combined result is whistler wave growth

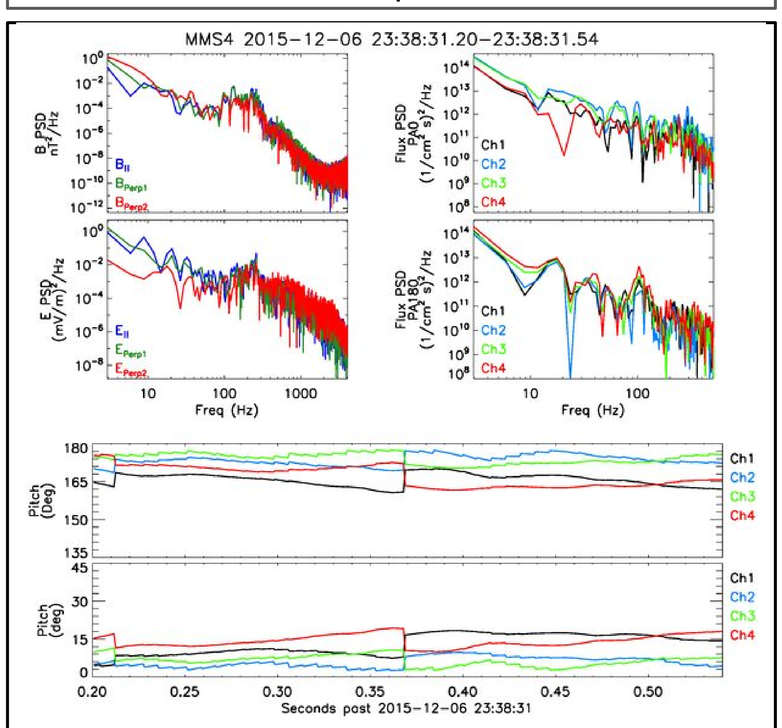
Wave-Particle Interactions

Opening of Field Lines



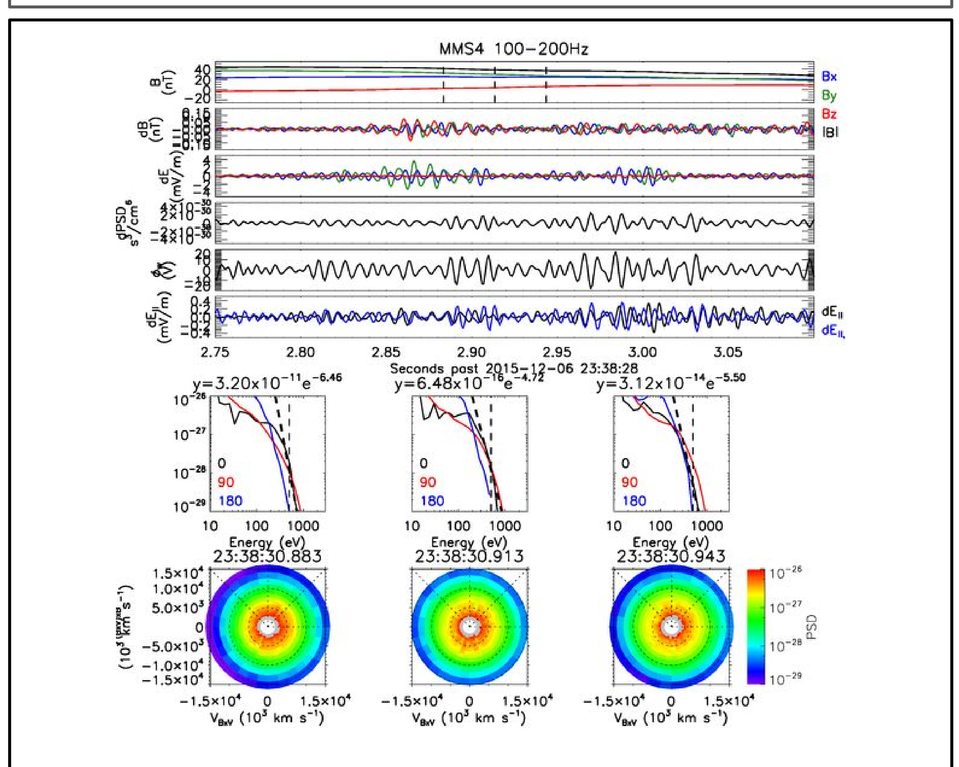
- Magnetospheric plasma is visible in magnetosheath along newly reconnected flux tubes
  - Increase of 500eV, 0° electrons indicate cross to south
  - ~100keV electrons present with whistler waves on separatrix

Power Spectrum



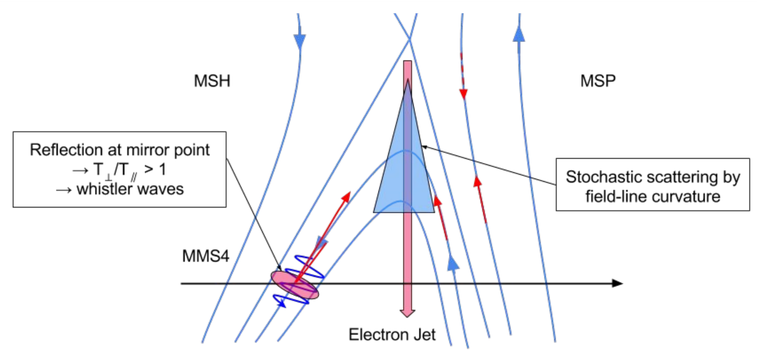
- Magnetic and electric fields show wave power from 100-400Hz
- EDI fluxes modulated from 70-200Hz
  - ~160° PA resonate strongest, in agreement with θ_k

Wave Electric Field



- Parallel-component of whistler waves modulates field-aligned electron fluxes
- Louiville mapping of 500eV fluxes provides wave potential and $E_{||}$
  - ϕ_W ~ 20 V
  - $dE_{||}$ is 10x greater than the measured field (plot is scaled), out-of-phase
  - More careful examination needed

Conclusions



- Inflowing, field-aligned electrons are scattered towards 90° PA by increased field line curvature
- They are then accelerated in the out-of-plane direction by the reconnection electric field
- Upon ejection from the current layer, they re-magnetize and mirror within the exhaust
- Focusing toward 90° PA, among other factors, spurs whistler wave growth

References

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