

Effects of Upper-Hybrid Waves near the EDR: Change of Pressure Tensor and E field

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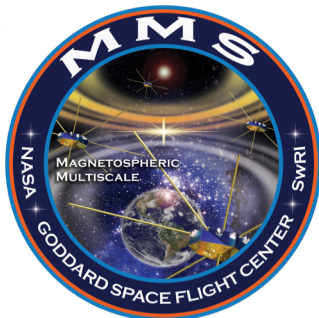
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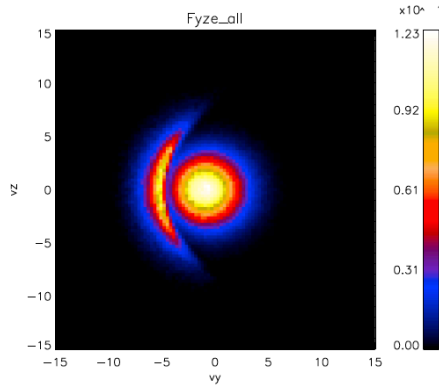
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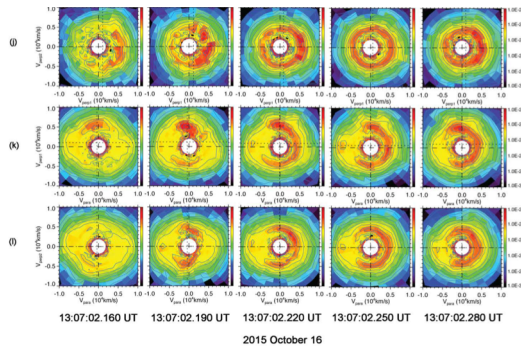


**2020 EGU Online
May 4 2020**

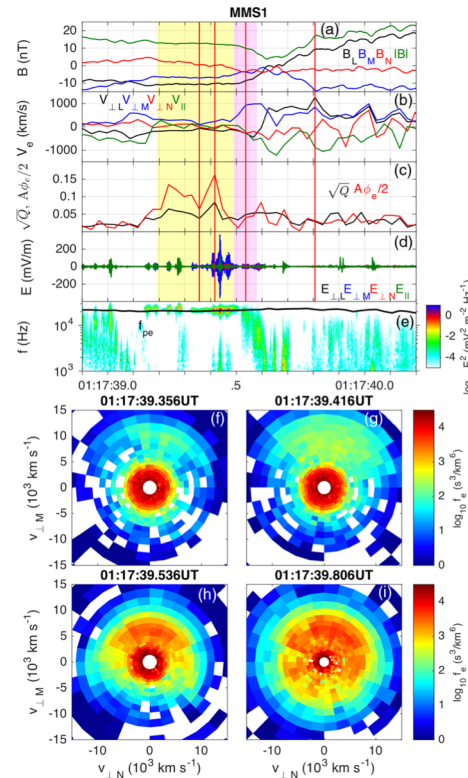




[Hesse et al., 2014, GRL]



[Burch et al., 2016, Science.]



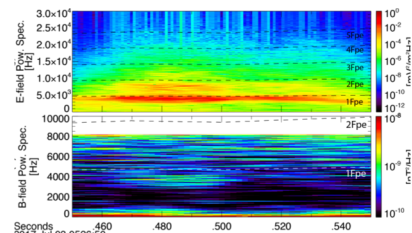
Upper-hybrid waves
[Graham et al., 2017, PRL]

Crescent Electrons

- Near EDRs
- Meandering motion of electron
- Expected by Hesse [2014]
- First observed by Burch [2016]

Beam-plasma Interaction

- Crescent and Core
- Large amplitude ES wave
- Thermalize or energize electrons

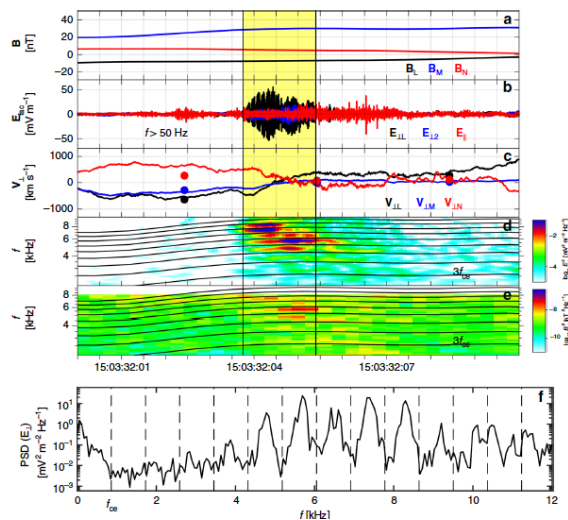
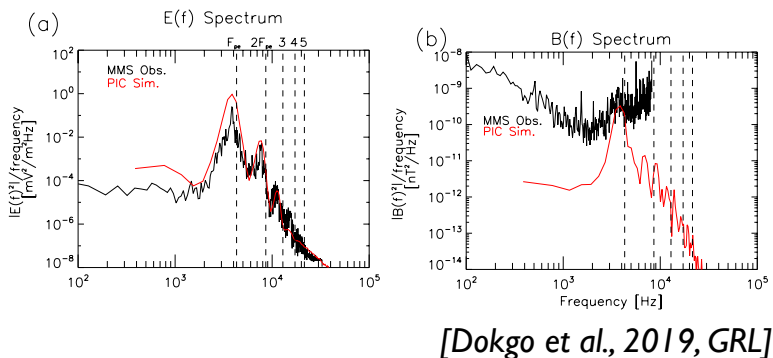


Nonlinear Harmonics and EM radiation

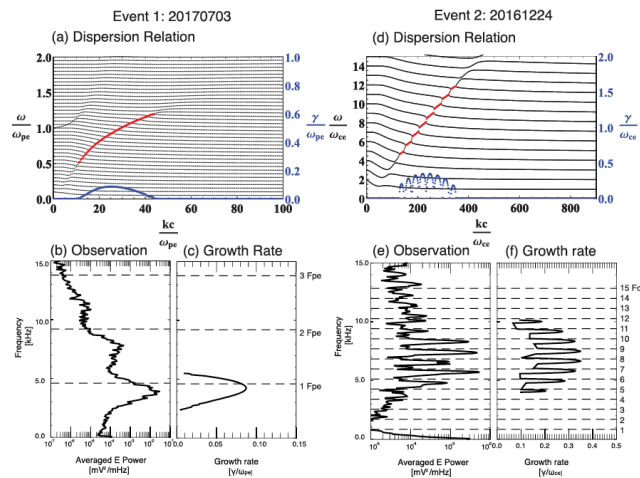
- Nonlinear beam-plasma interaction
- EM Radiation from wave-wave interactions

Beam-mode and Bernstein-mode from agyrotropic electron

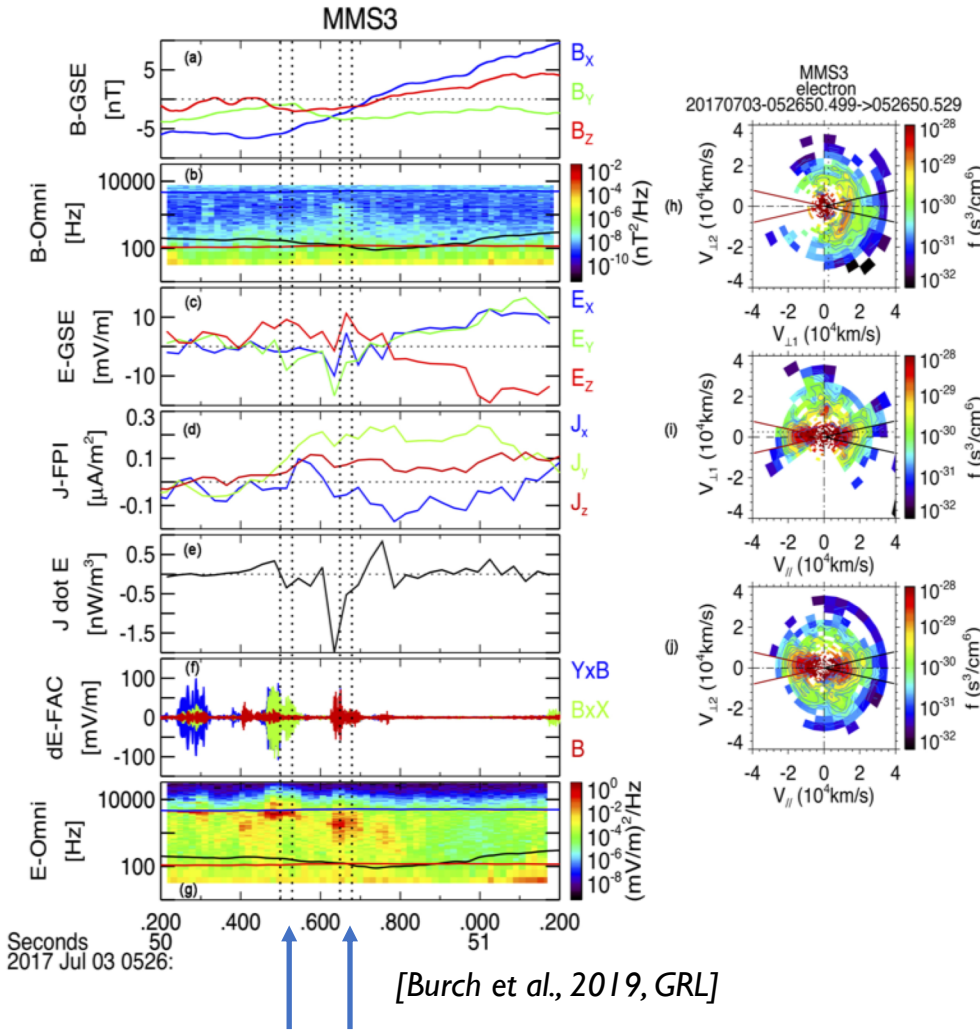
- The same generation mechanism: Interaction between agyrotropic beam and core.



[Li et al., 2020, Nat. Comm.]



[Dokgo et al., 2020, GRL]



Overview

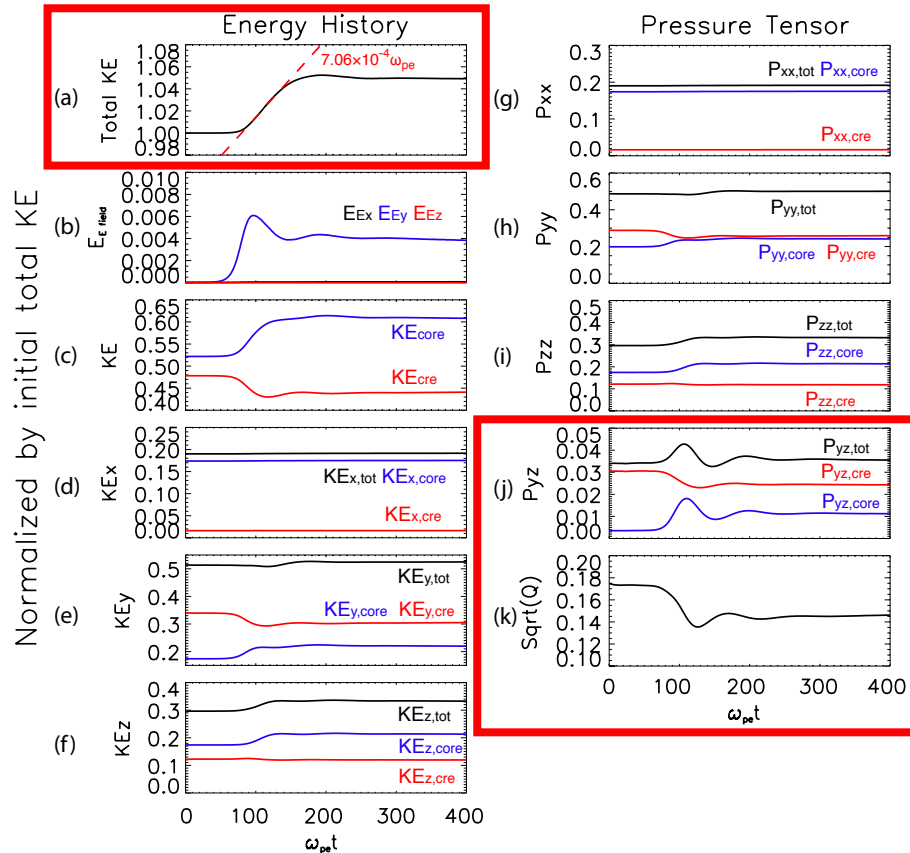
- 2017 July 3rd Event (MMS3)
- UTC 05:26:50.200-51.200, 1sec data

EDR features

- Electron perp. Temp. increase
- Discrepancies between bulk electron velocities and $E \times B$
- Finite $J \cdot E'$
- Crescent-shape electron distribution

Strong E-field perturbations

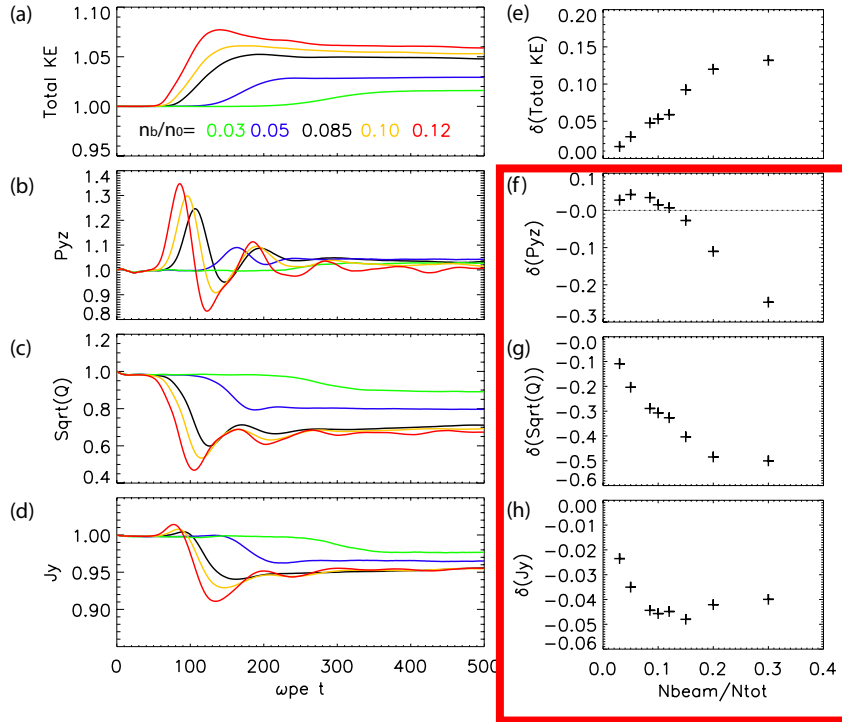
- Max. amplitude : ~ 150 mV/m
- Frequency : $\sim F_{pe}$ (~ 4 kHz)



[Dokgo et al., in prep.]

Time history of Energy and Pressure tensors

- The increase rate of electron kinetic energy agrees with the MMS observation measured by $J \cdot E'$
- P_{yz} increases due to the core population.
- $\text{Sqrt}(Q)$ decreases
- P_{yz} and $\text{Sqrt}(Q)$ can be changed oppositely.

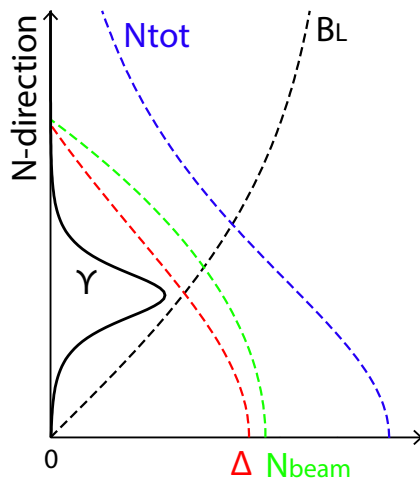


[Dokgo et al., in prep.]

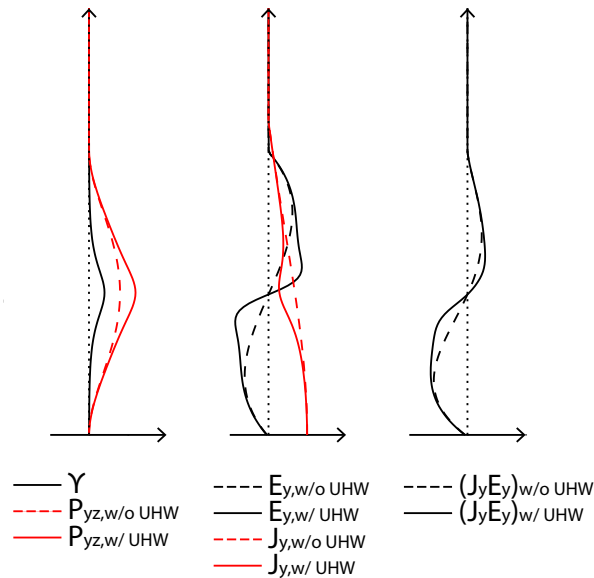
More runs using various beam densities

- Change of P_{yz} depends on the beam density.
- $N_{beam} < 0.13$: P_{yz} increase
- $N_{beam} > 0.13$: P_{yz} decreases
- Current J_y decreases as a result of beam-plasma interaction

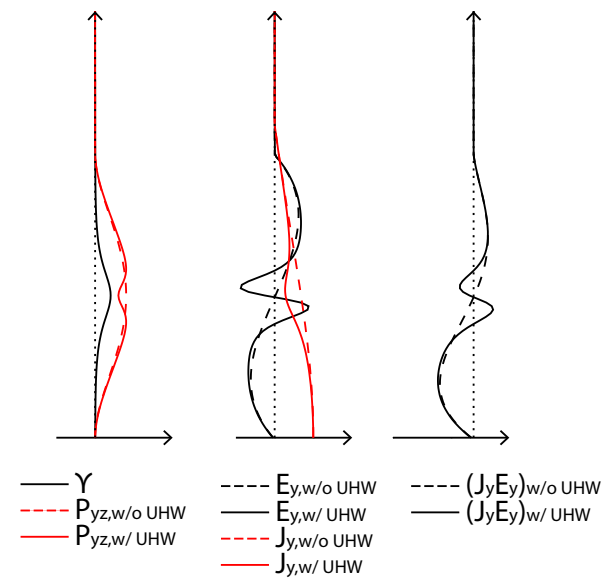
(a) Profiles of Plasma Parameter



(b) Weak case



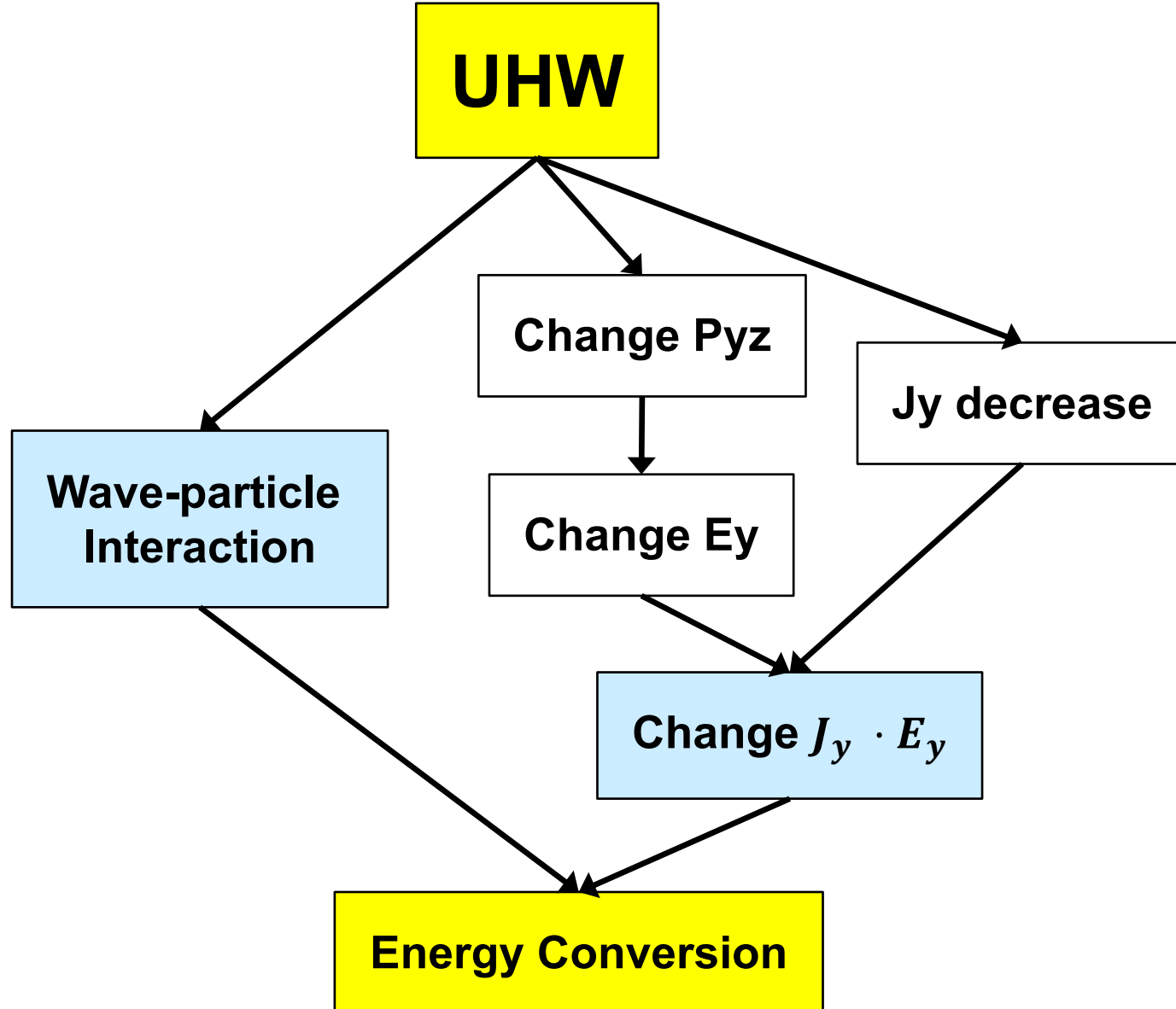
(c) Strong case



[Dokgo et al., in prep.]

Schematic diagram of plasma profiles w/ and w/o UHW

- Weak beam case: E_y field can be enhanced
- Strong beam case: Reversal of E_y field can be formed



- We Performed 2D PIC simulation for the generation of upper-hybrid waves near the EDR
- Electron energization (heating) rate via wave-particle interaction agrees with the MMS observation measured by $J \cdot E'$
- The gyrotropy factor $\text{Sqrt}(Q)$ and current J_y decreased as a result of wave activity.
- Off-diagonal pressure tensor P_{yz}
 - increased when $N_{\text{beam}} < 0.13$
 - decreased when $N_{\text{beam}} > 0.13$
- **These changes of parameter can affect $J_y \cdot E'$ near the EDR**

Thank you