# Interaction of electromagnetic ion cyclotron waves (EMIC) with the magnetosphere-ionosphere system

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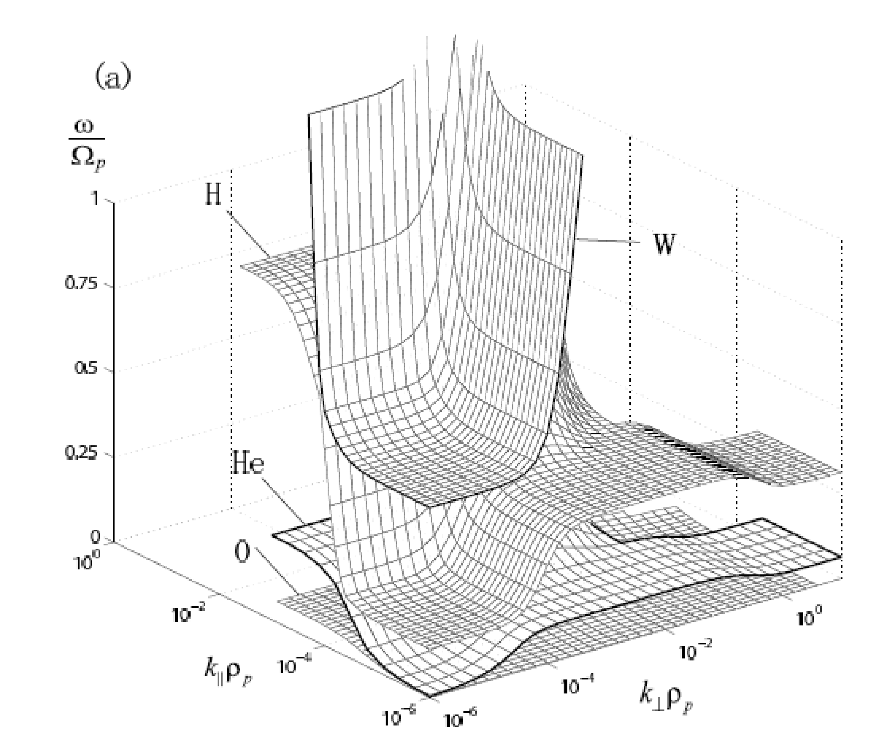
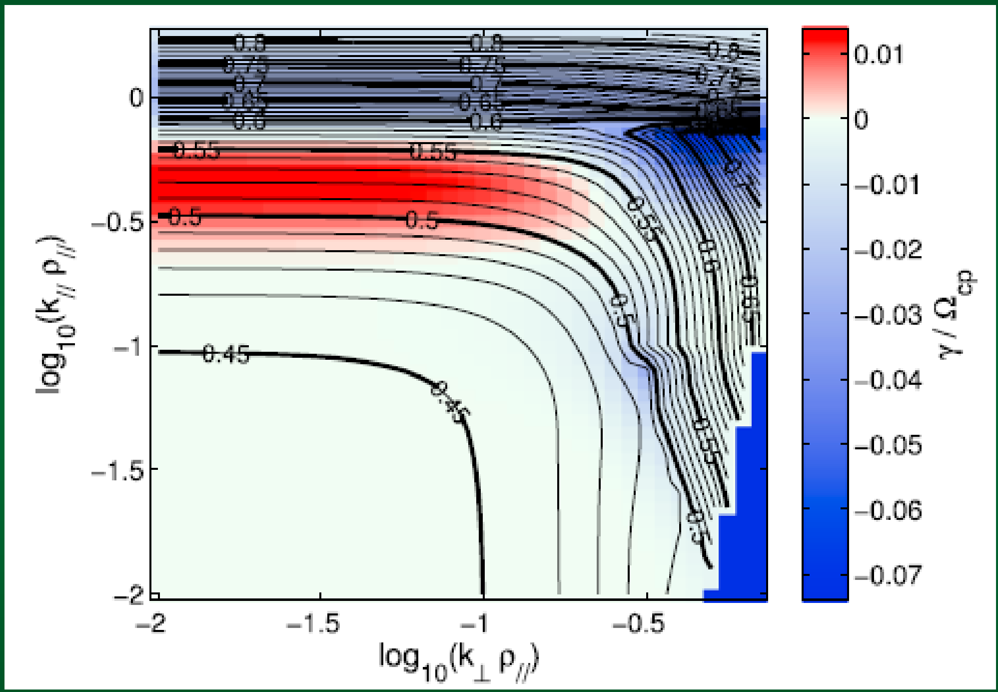
# EMIC affected by the magnetosphere

- Driven by ring current anisotropy
  - although mode conversion is another generation mechanism
- Effects of cold plasma on instability
  - increased instability with cold protons (lowers resonant velocity)
  - decreased instability with addition of heavy ions for frequencies above gyrofrequency of ion (Mace et al., 2011)

# Heavy ions and dispersion surfaces




(Andre, 1985)

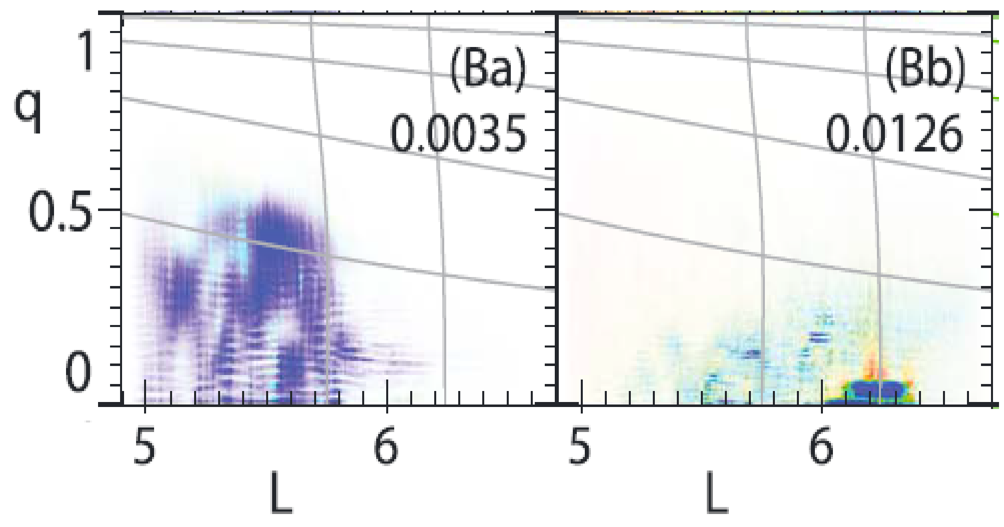
Denton et al. (JGR, 2014)

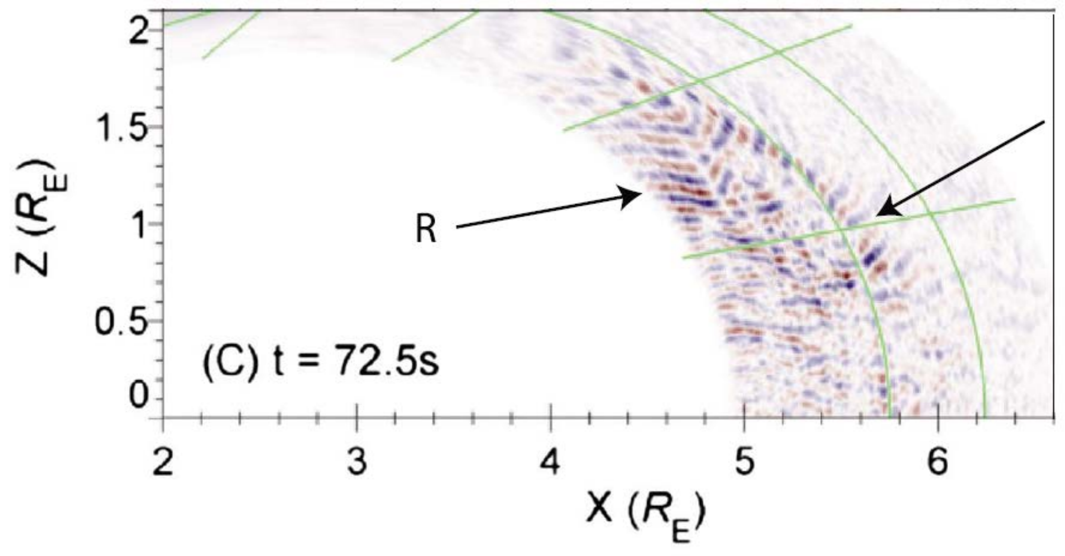
# Effect of plasmapause

- He band waves strongest in plasmasphere
- H band waves much more likely in plasmatrough

$$\frac{\overline{\omega}}{(1-\overline{\omega})^2}\left(\sum_s \frac{\eta_s}{1-\overline{m}_s\overline{\omega}}-1\right)=\frac{1}{\beta_{\|h,e}}$$

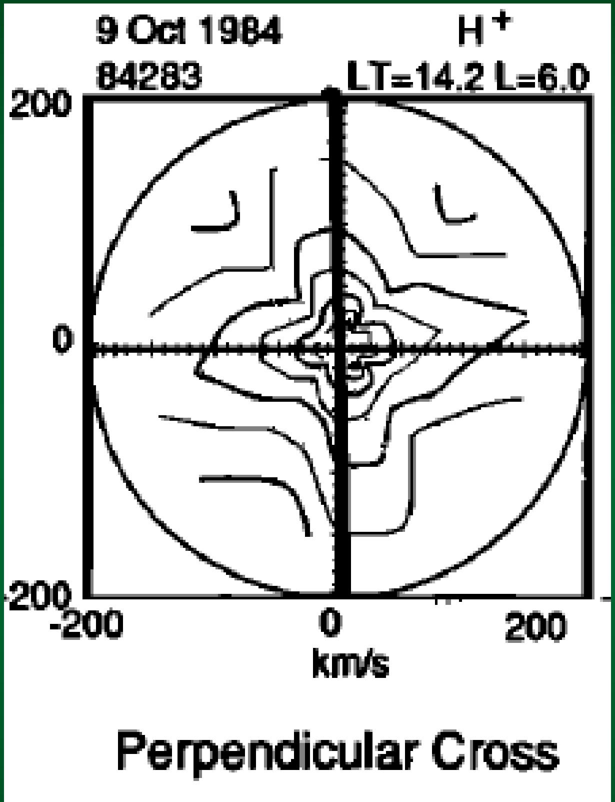
- Plasmapause not a region of preferred growth – though it does guide the waves



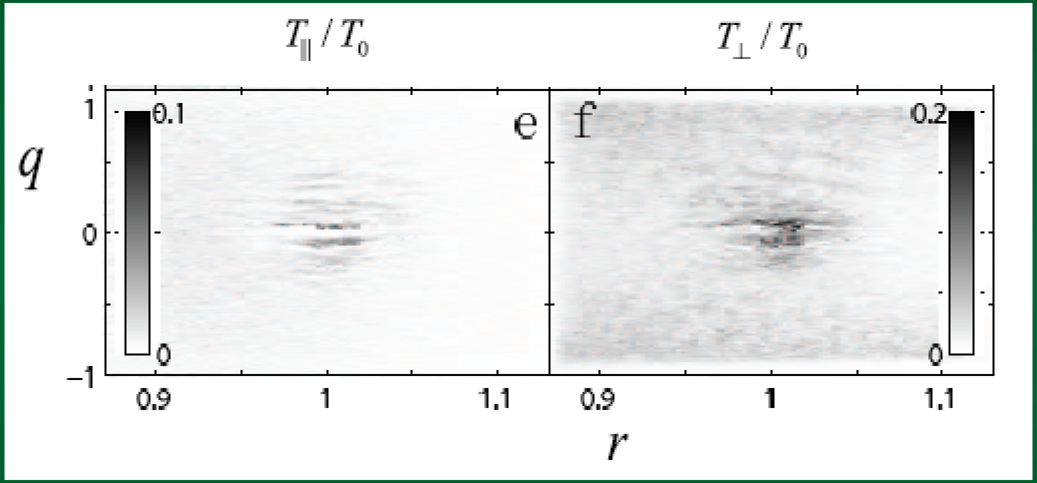




Denton et al. (JGR, 2014)

# Off-equatorial heating of heavy ions

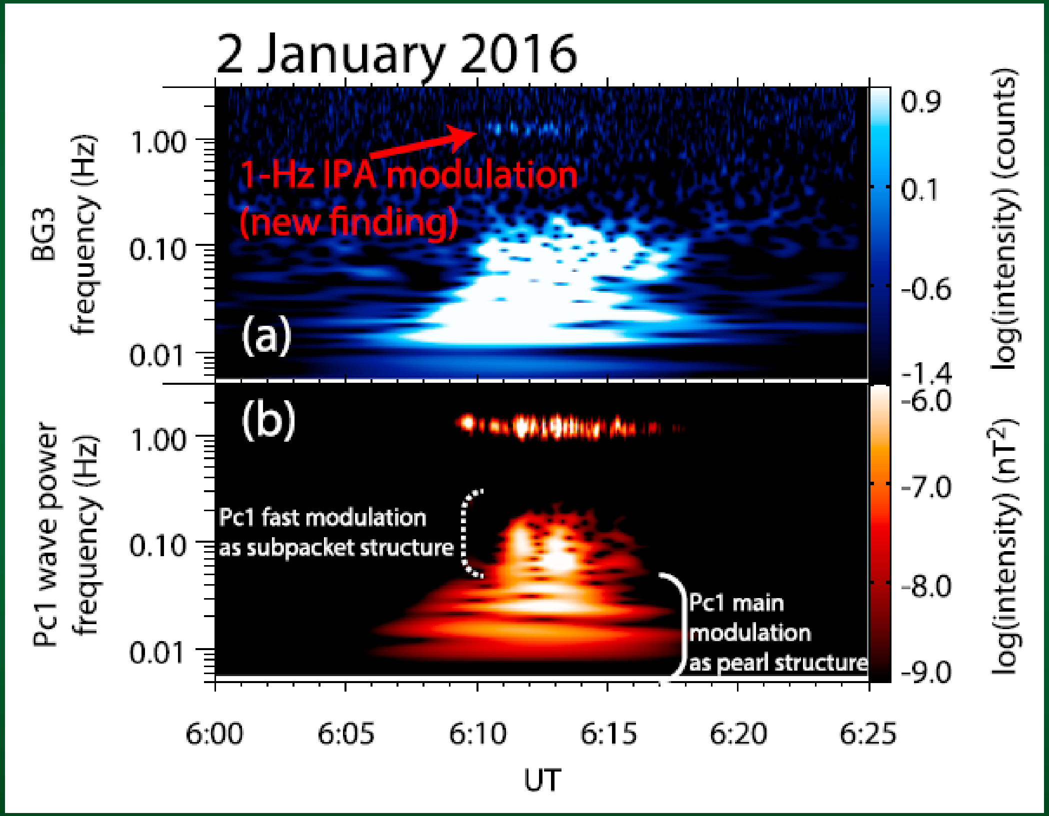


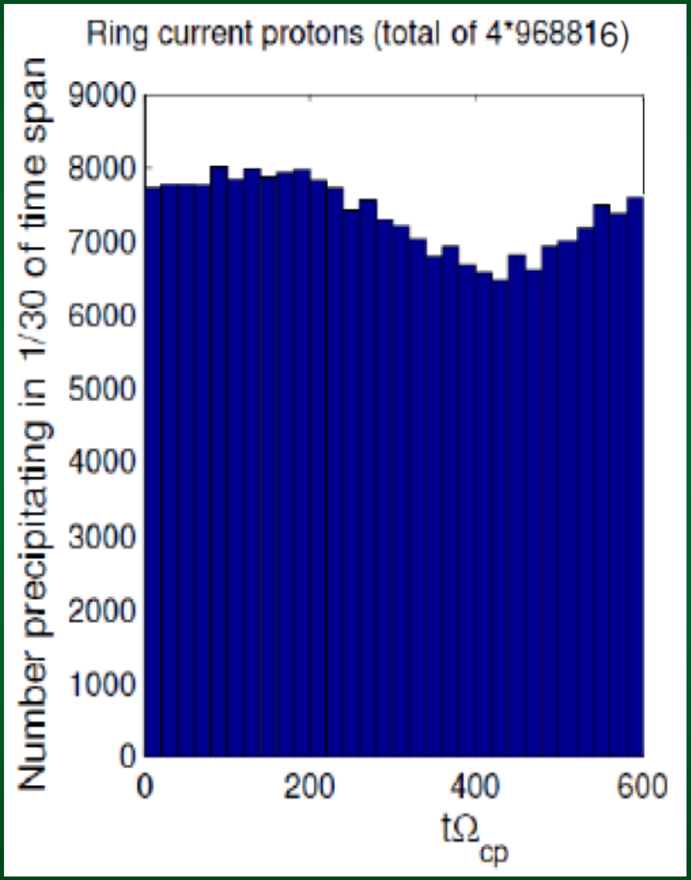

(Fuselier and Anderson, 1996)




(Hu, thesis, 2010)

# Proton Aurora




(Ozaki et al., 2018)

6% loss in 60 s

# Extras

# Dispersion Relation

$$\bar{k}_{\|}^{2} = \bar{\omega}\left(\sum_{s} \frac{\eta_s}{1 - \bar{m}_s \bar{\omega}} - 1\right)$$

$$\left(\frac{1 - \bar{\omega}}{\bar{k}_{\|}}\right)^{2} = \bar{v}_{\mathrm{th}\|h}^{2}$$

$$\frac{\bar{\omega}}{(1 - \bar{\omega})^{2}}\left(\sum_{s} \frac{\eta_s}{1 - \bar{m}_s \bar{\omega}} - 1\right) = \frac{1}{\beta_{\|h,e}}$$

Denton et al. (JGR, 2014)