Short (transverse) scale Drift Alfven Waves (SDAW's) at the magnetopause.

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- Large amplitude ULF waves are often observed at, or near, the magnetopause (Anderson et al.,1982, Rezeau et al.,1986). These waves have been interpreted as KAW's (Rezeau et al.,1993, Stasiewicz et al., 2001, Chaston et al, 2008, 2010…).
- Heated electrons have also been frequently observed near the magnetopause, with sometimes counterstreaming FA features (Hall et al., 1991…).

1- Are electrons heated by the observed waves?

2- How can we explain that electrons interact with waves having A PRIORI a slow phase velocity (~Va<<Ve)?

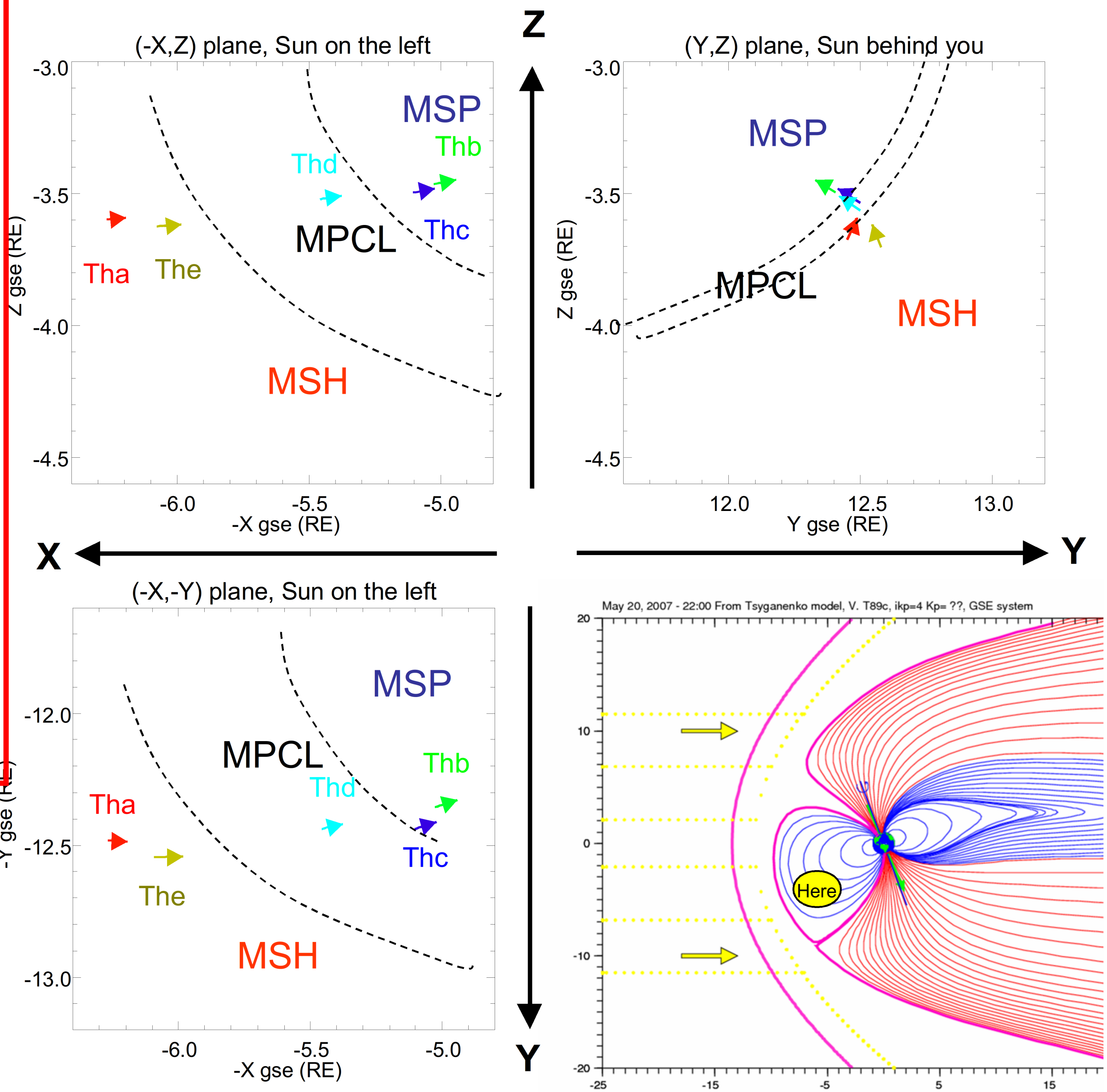
3- What is the generation mechanism of the waves?

On May 20th, 2007 THEMIS spacecraft bracketed the magnetopause:

- Thb&Thc were on the ***magnetospheric*** side.
- Thd was in the ***magnetopause current layer (CL)***, while
- Tha&The were on the ***magnetosheath*** side.

In the following, we only show Thc, Thd, & Tha.

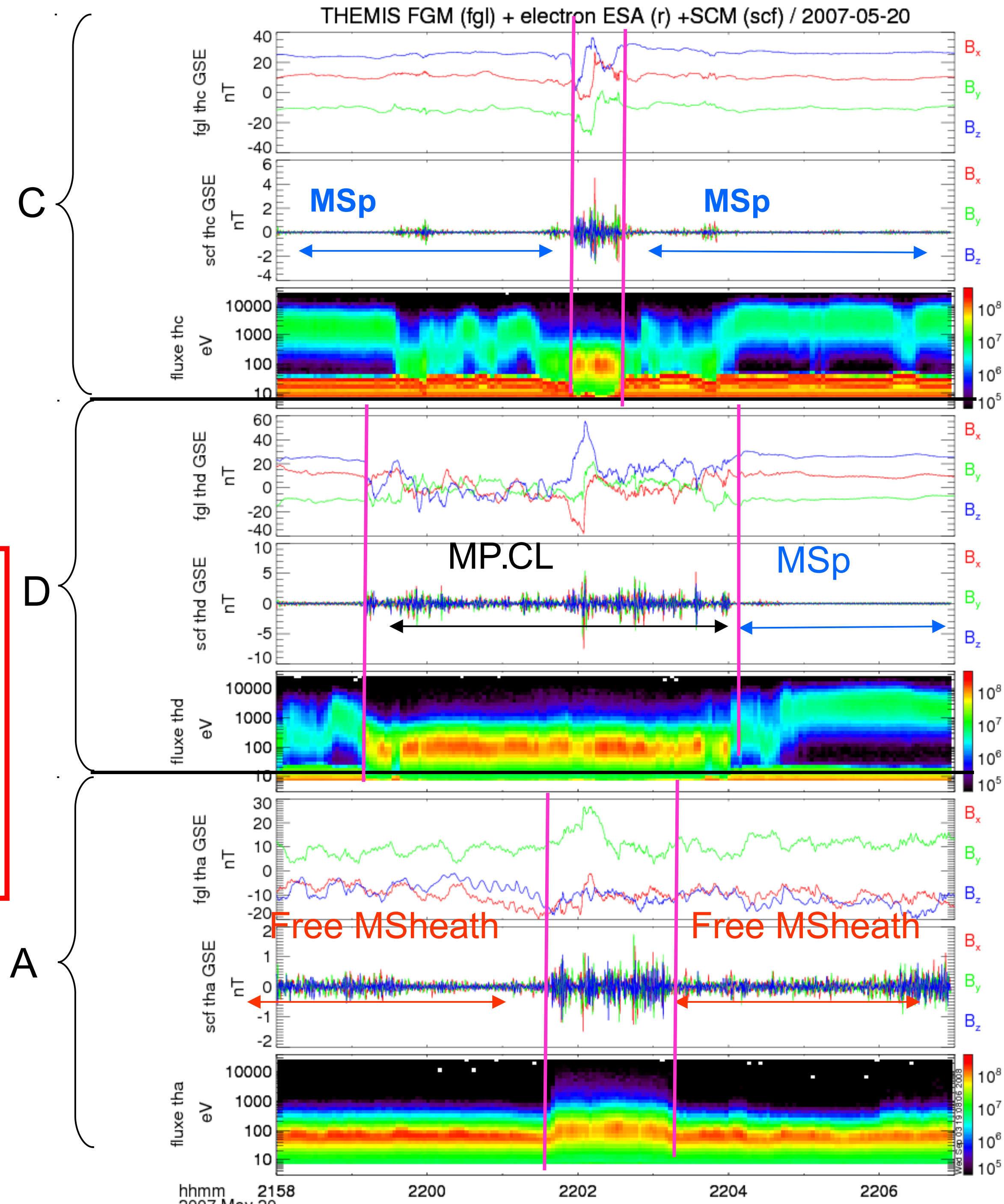
THEMIS Positions - 2007-05-20 / 21:58:00.0 to 22:07:00.0



On ThA we see that the differential fluxes extend to higher energies, as the s/c approaches the MPCL. While the density is the same as in the free Msheath, Te is larger by a factor 2, @ThA, but also @thD, &ThC

- Magnetosheath electrons are heated in the MPCL, FTE and the adjacent M.Sheath
- e- heating coincides with enhanced magnetic components of ULF waves.

Do waves heat electrons ?



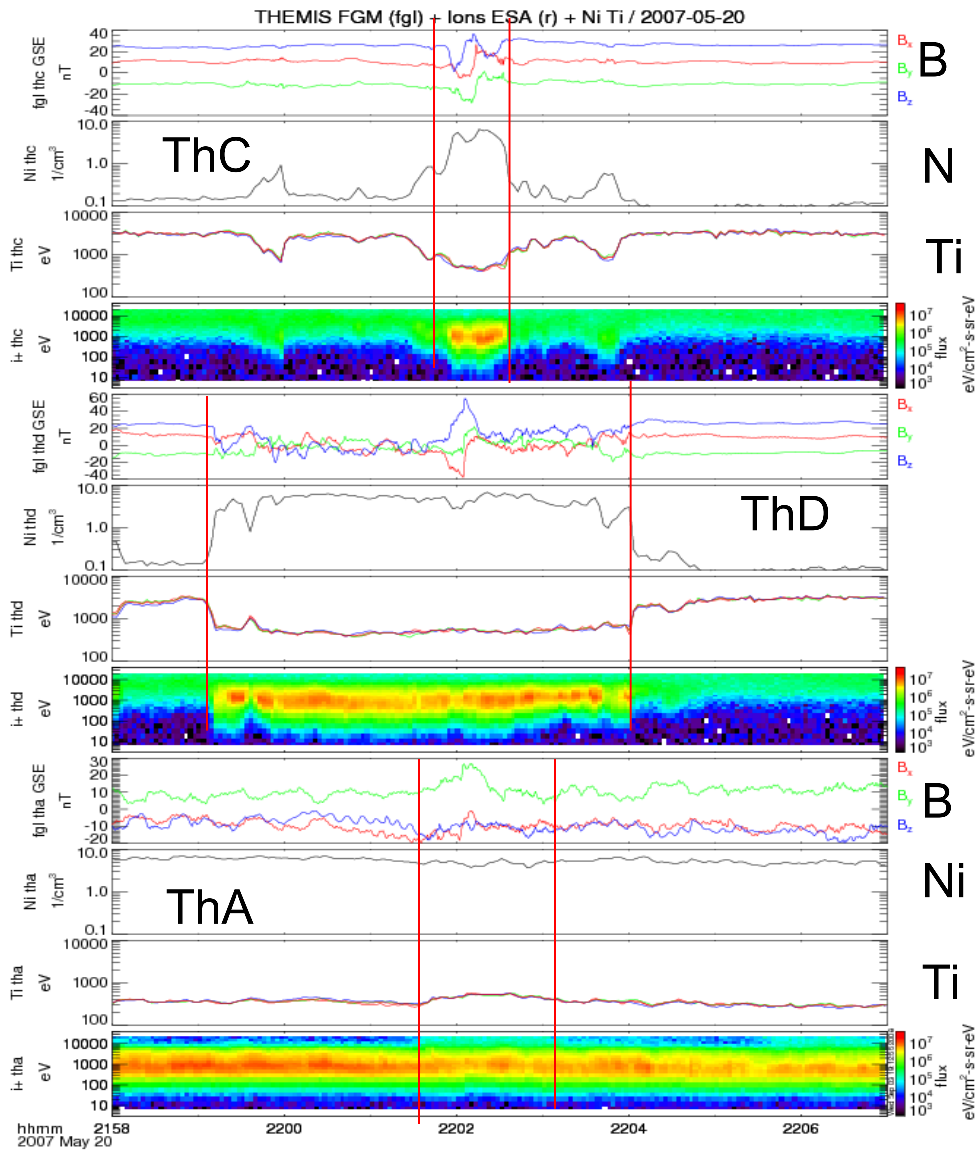
• Magnetosheath ions also penetrate in the MPCL, but their temperature remains about the same. Unlike electrons, ions are not heated.

• Classical Alfven wave/KAW's Va~100km/sec << Ve cannot heat magnetosheath electrons!

• However Short transverse scales ($k\rho_i >> 1$) Alfven Waves can interact with electrons since:

$$(\omega / k_{//} V_a)^2 = [k\rho_i]^2 (1+T_e/T_i)/(\beta+2)$$

Howes et al.(2008), Sahraoui et al.(2009)



Dispersion relation
1-Homogeneous medium

$(\omega / k_{//} V_a)^2 = [k\rho_i]^2 (1+T_e/T_i)/(\beta+2)$

- From WHAMP (Ronnmark)

We can confirm the dispersion relation above, and estimate the damping rate.

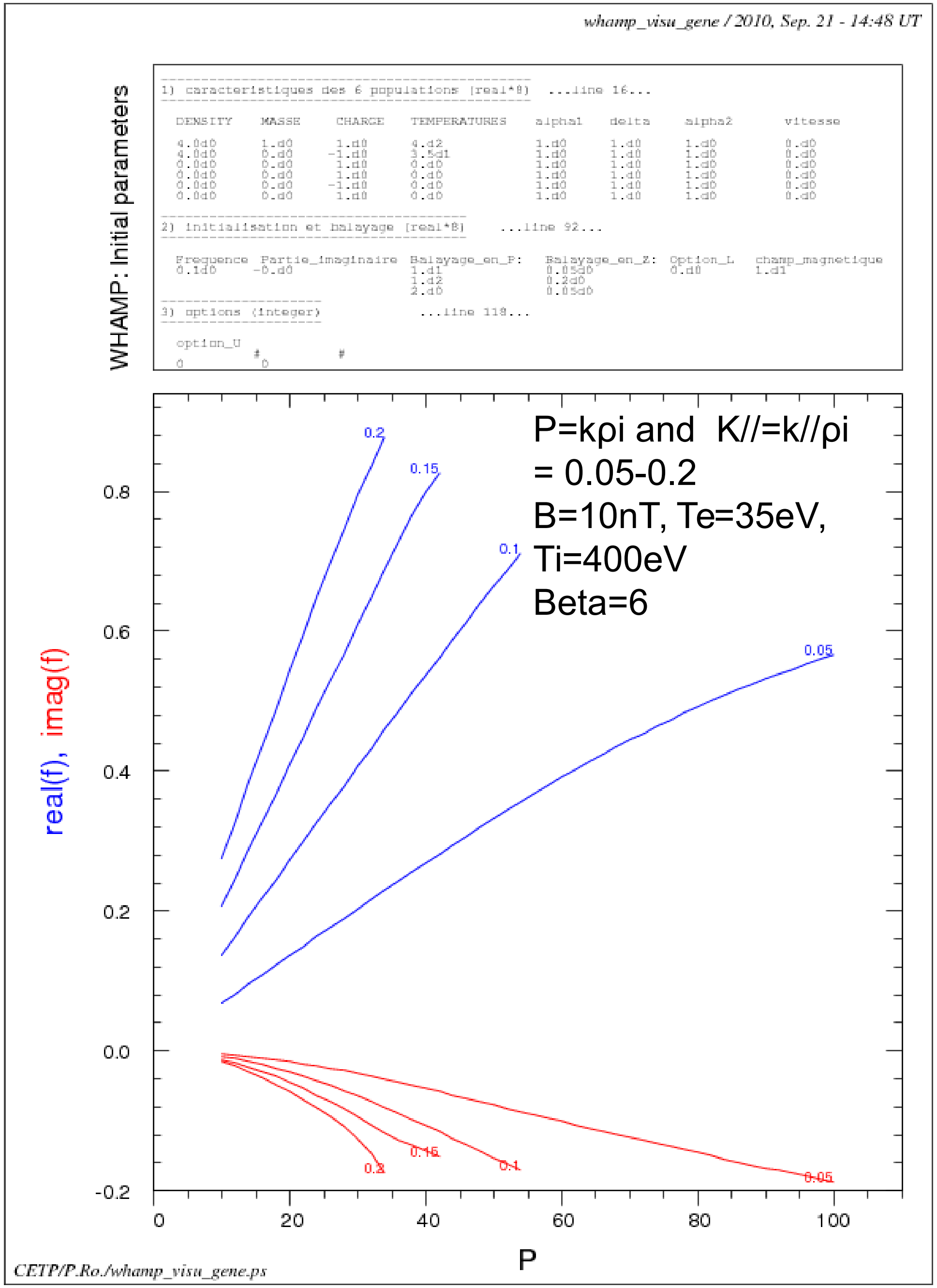
- Blue curves are for normalized frequency, red for damping rate.

- Short transverse scale Alfven waves have large parallel phase velocities and a finite $E_{//}$

$\Rightarrow$heat Magnetosheath electrons

For instance with $K_{//}=0.05$,

$\omega / k_{//} \sim 2400km/s\Leftrightarrow$35eV



Characterization of the waves

MVA calculations

GSE to MVA matrix :

0.379862	-0.184205	-0.906517
-0.413103	0.843046	-0.344412
0.827678	0.505313	0.244145

Eigen values:

253.837311	13.383863	8.928047

$k_\perp \sim k_y$ (azimuthal)

$\delta B_\perp$ Magnetopause

Generation of the waves:

-No thermal anisotropy

-Sharp gradients ⇔drift waves?

Mikhailovskii (1992) has obtained a dispersion relation for short transverse scale AW's valid for a high beta plasma and $k_\perp \rho_i >> 1$. It includes gradB, gradN & gradT. Hence we call it Short scale Drift Alfven Waves (SDAW's). Mikhailovskii shows that SDAW's are unstable for gradTe/gradN<-1.

Sharp antiparallel gradients in Te and N are consistent with the data.

∇ Te

∇ N

∇ B

SDAW's

$k_{//} << k_{\perp}$

$k_{\perp}\rho_i >> 1$

$k_{\perp} \sim k_y$ (azimuthal)

$\delta B \perp$ Magnetopause

Landau damping

$\omega/k_{//} \sim V_e$

$E_{//}$ finite

Electron heating

Questions:

- What is the NL evolution of SDAW's?

- SDAW's have finite E// and $\delta B \perp$ Magnetopause; do they produce small scale turbulent reconnection?