THEMIS observations of kinetic ballooning/Interchange instability signatures before substorm onset

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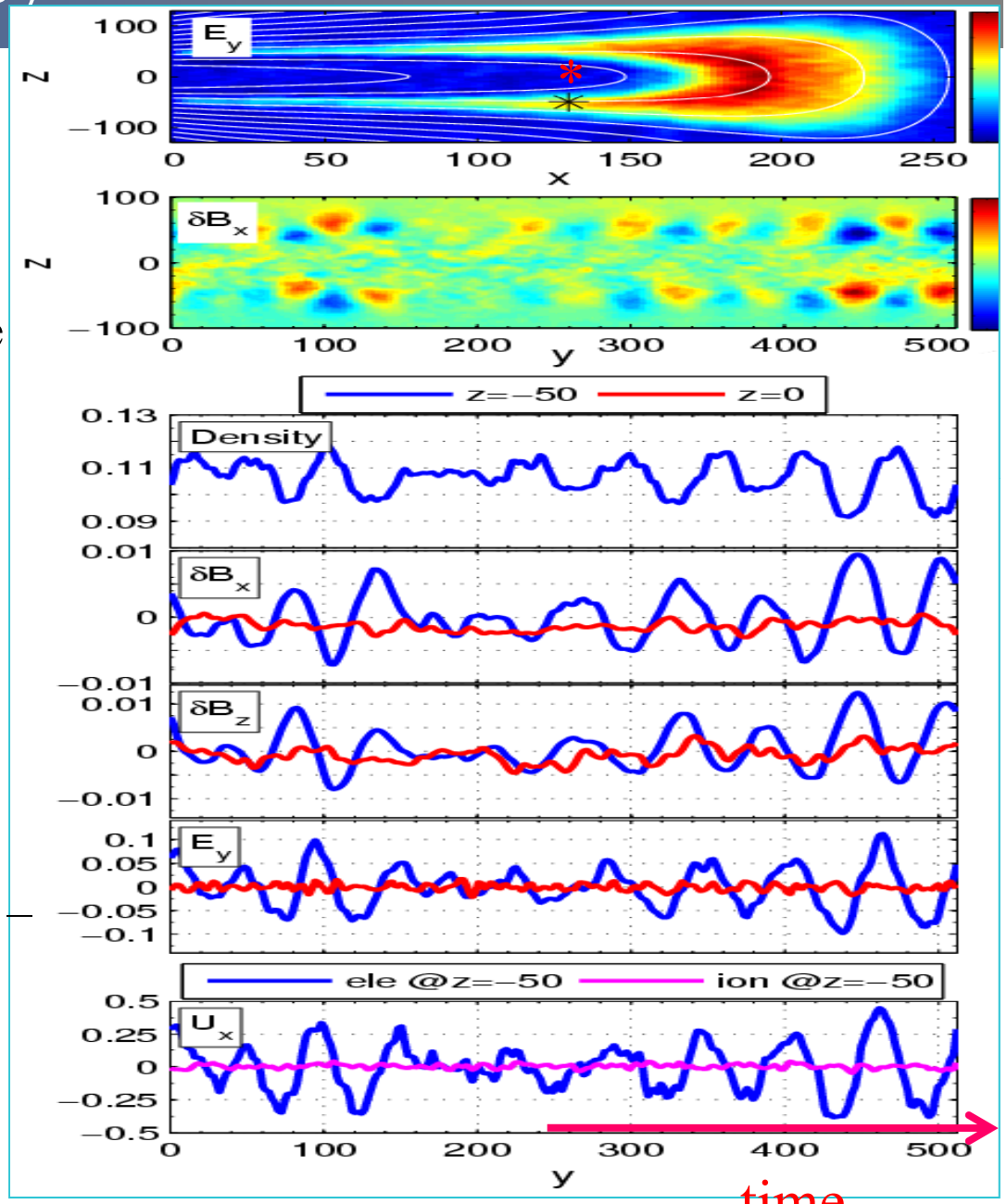
Kinetic BIC instability

Pritchett and Coroniti (2010, 2011) PIC modeling ➔

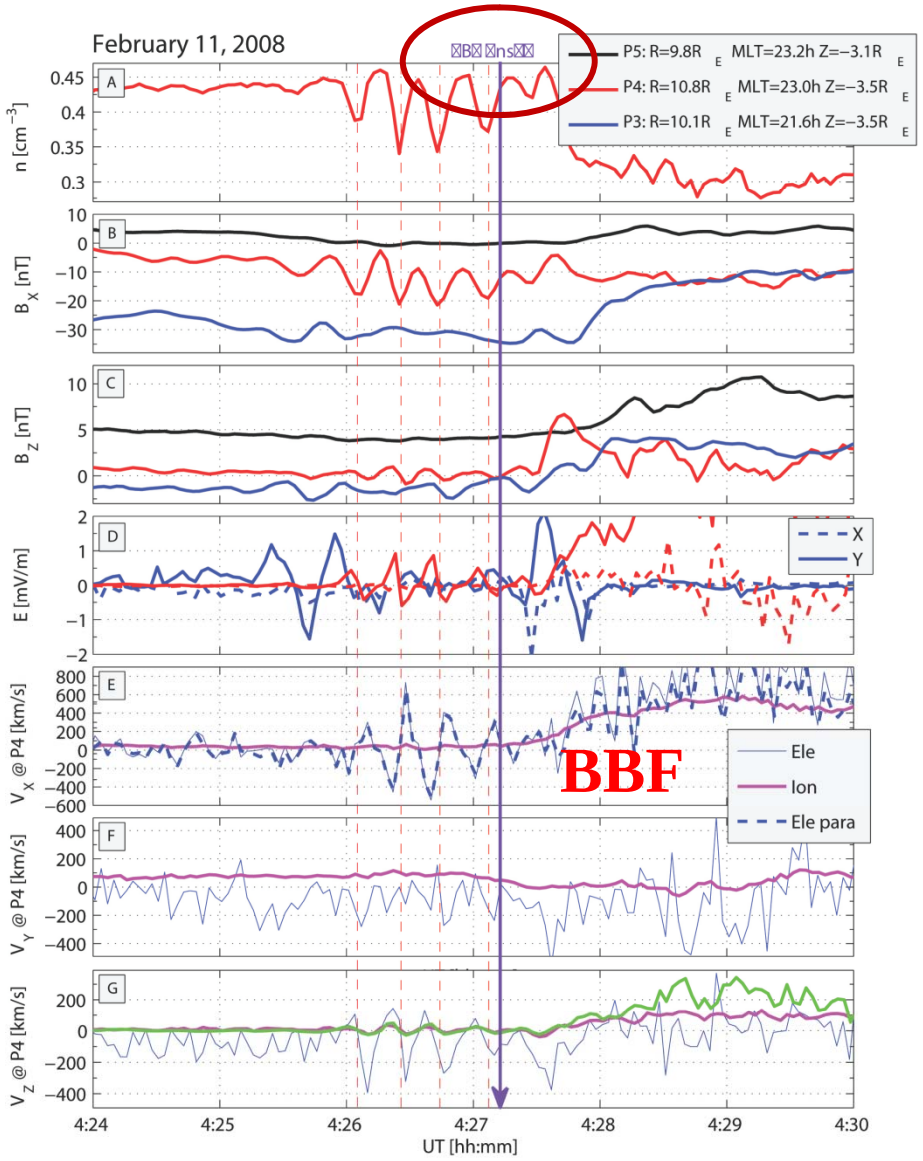
- excited tailward of Bzmin (where tailward dBz/dr)
- periodic in Y structures (fingers) moving duskward at ion ~drift velocity → translate to t-variations
- **δBx**, **den**, Bz, **δEy**(phase-shifted)
- electron **Vex** (no Vix!) f-aligned – kinetic signature
- in application to THEMIS at 11Re – expected in the off-equatorial 'horns', "sausage-like" geometry



Example 1 *(Sergeev et al. JGR 2012)*

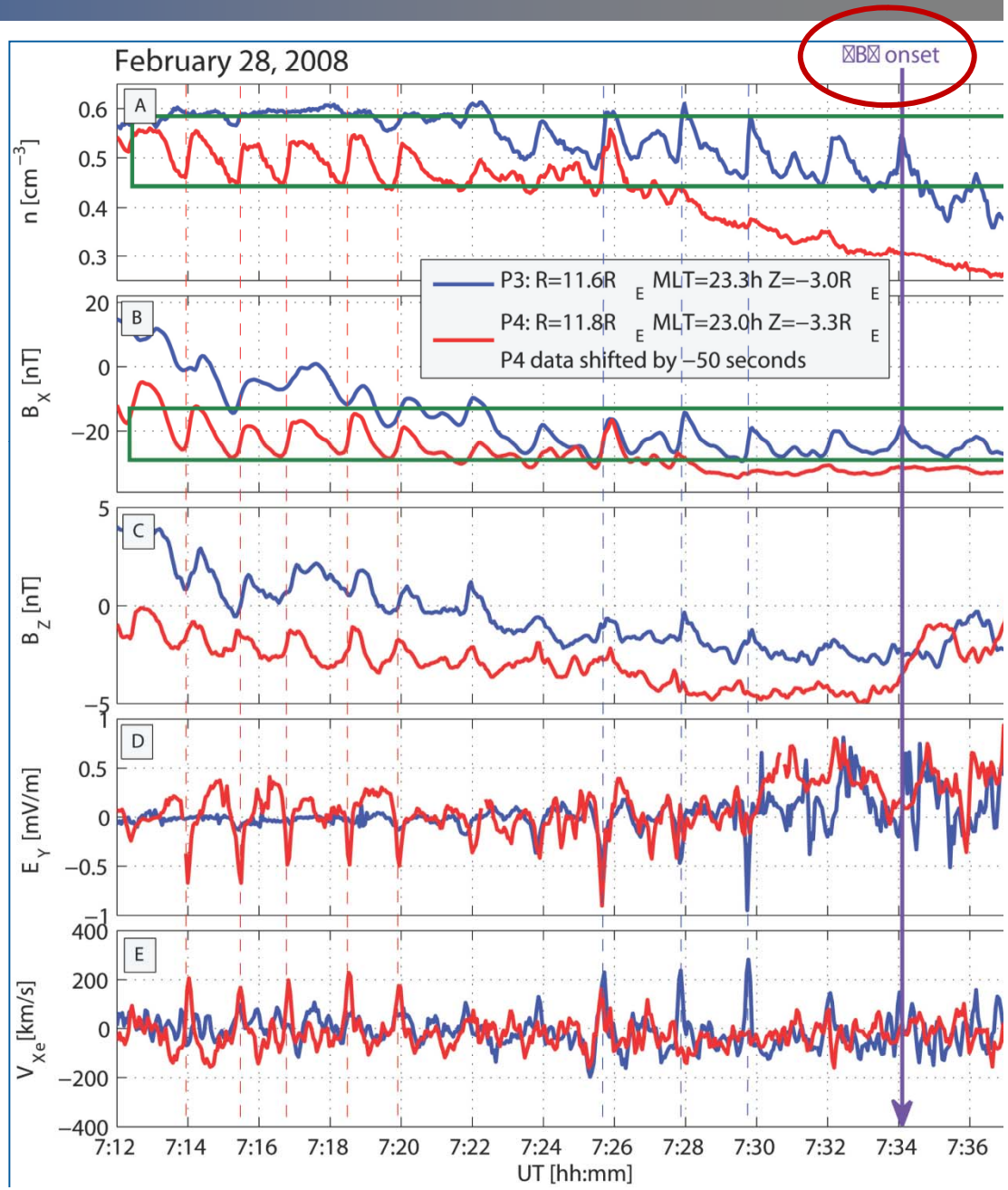
- Bz~2nT (near Bzmin ?)
- periodic (T~20 sec) variations
- most strong at off-equatorial location, <u>not flapping waves</u>
- **δBx,** den, Bz, δEy,

• electron Vex (no Vix) – kinetic signature; largest component, f-aligned, amplitude up to 50% of ion thermal velocity



Example 2 *(Panov et al. JGR 2012)*

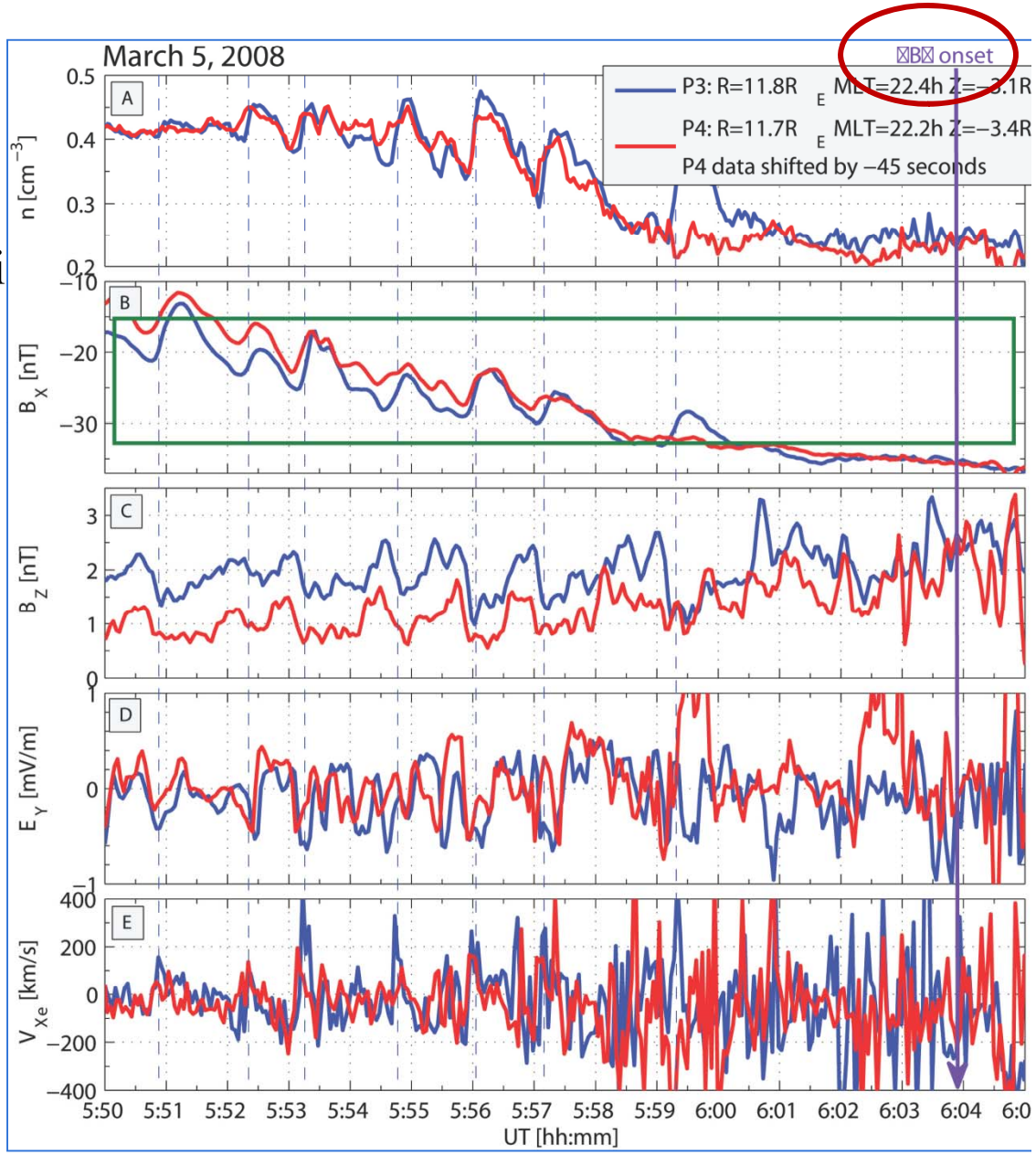
- Bn~1-2nT (near Bzmin ?)
- periodic (T~100 sec) variations most strong at off-equatorial locati
- move duskward P3→P4 (0.9Re) at ~120km/s (≈ ion ~drift velocity), cross-tail scale ~6000km (half-period)
- **δBx,** den, Bz, δEy (spiky, phase-shifted against δBx)
- electron Vex (no Vi) – spiky, in phase with δEy
- continue for >20min !! Not directly associated with SBS onset



Example 3 *(Uritsky et al. GRL 2009, …)*

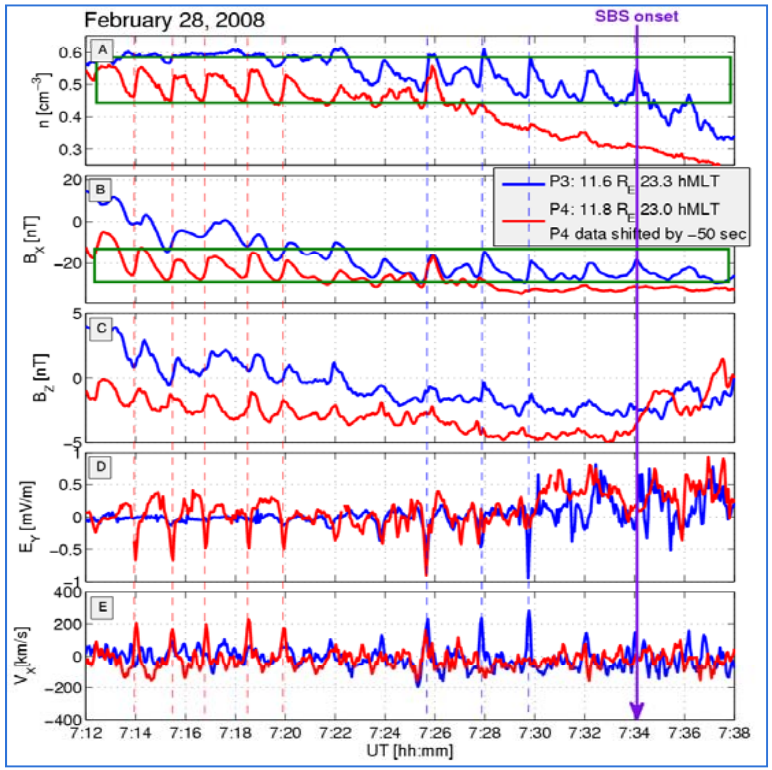
- Bn~1-2nT (near Bzmin ?)
- periodic (T~100 sec) variations most strong at off-equatorial locati
- move duskward P3→P4 (0.9Re) at ~100km/s (≈ ion ~drift velocity) cross-tail scale ~4500km (half-period)
- **δBx**,den, Bz, δEy (spiky)
- electron Vex (no Vi) – spiky, in phase with δEy (more noisy data..)
- continue for >10min , not directly associated with SBS onset

Period/azimuthal scale ~correspond to auroral waves by Uritsky et al

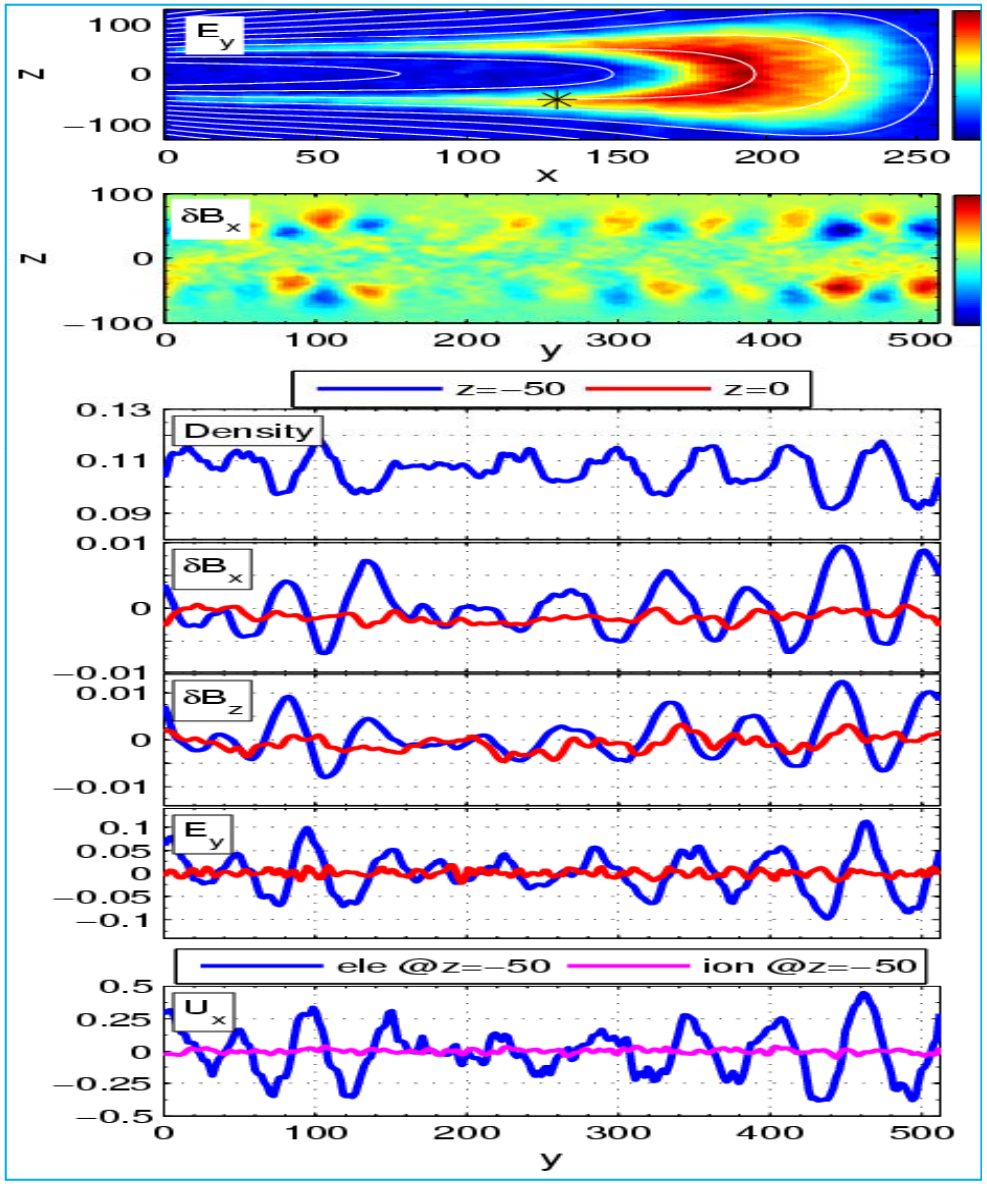


Mode identification

- **δBx**, den, δEy, δVex (no Vi) in phase with δEy (FAC signature!!)
- off-equatorial location, sausage-like
- spatially periodic, drift duskward with in drift velocity ~100km/s, scalesize ~1Re



THEMIS



PIC simulations

Conclude

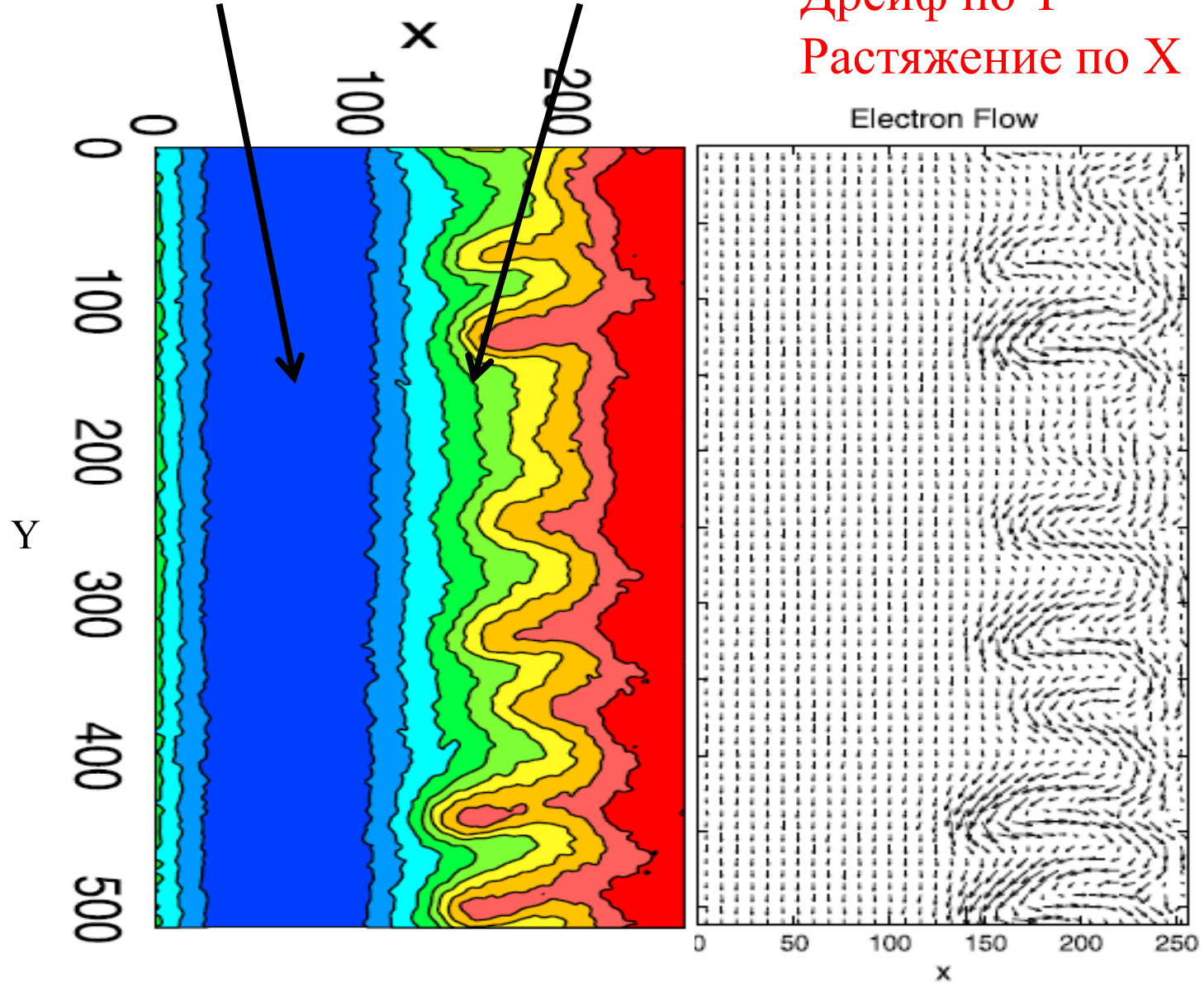
- Signatures of well-defined Ballooning/ IC structures preceeding substorm onset , kinetic , may be quite typical in THEMIS data
- Non-local instability, seen at off-equatorial location, initiated tailward of 11Re
- Major disagreement with simulations – too large δBx is observed
- Future work
  - PIC simulations for “realistic” (?) configurations and Mi/Me
  - Systematic survey of THEMIS observations
  - Correlation with auroral waves etc
  - Role in substorms ?

B_Z (слева) и V_{ele} (справа) в XY плоскости

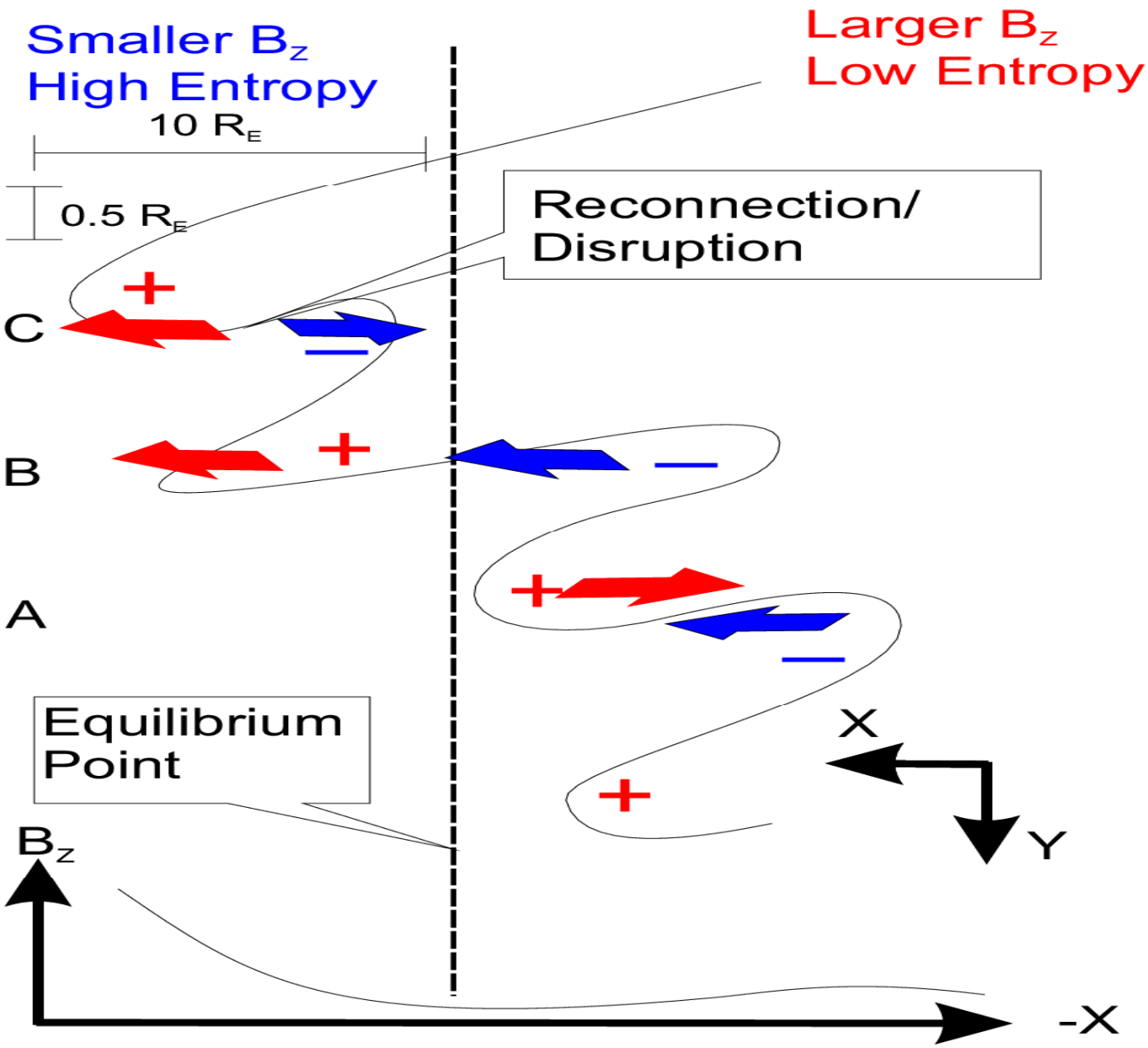
Ме́ньшие B_Z

Бо́льшие B_Z

Дрейф по Y
Растяжение по X



Pritchett and Coroniti, (2010)


Smaller B_z
High Entropy
10 R_E
0.5 R_E
Larger B_z
Low Entropy
Reconnection/
Disruption
C
B
A
Equilibrium
Point
B_z
X
Y
-X

Выводы

Анализ наблюдений THEMIS от 28.02.2008 между 6:50 и 7:50 UT показал:

- Плазменный слой был согнут около 11 P_3 на 15 градусов (предположительно солнечным ветром).
- С изгибом значительно выросли колебания, вызванные раскачкой кинетической баллонной/перестановочной неустойчивостью.
- В процессе развития неустойчивости сформировался одномерный (без B_Z) ТТС, в котором наблюдались признаки пересоединения между при $-16<X<-11$ P_3.