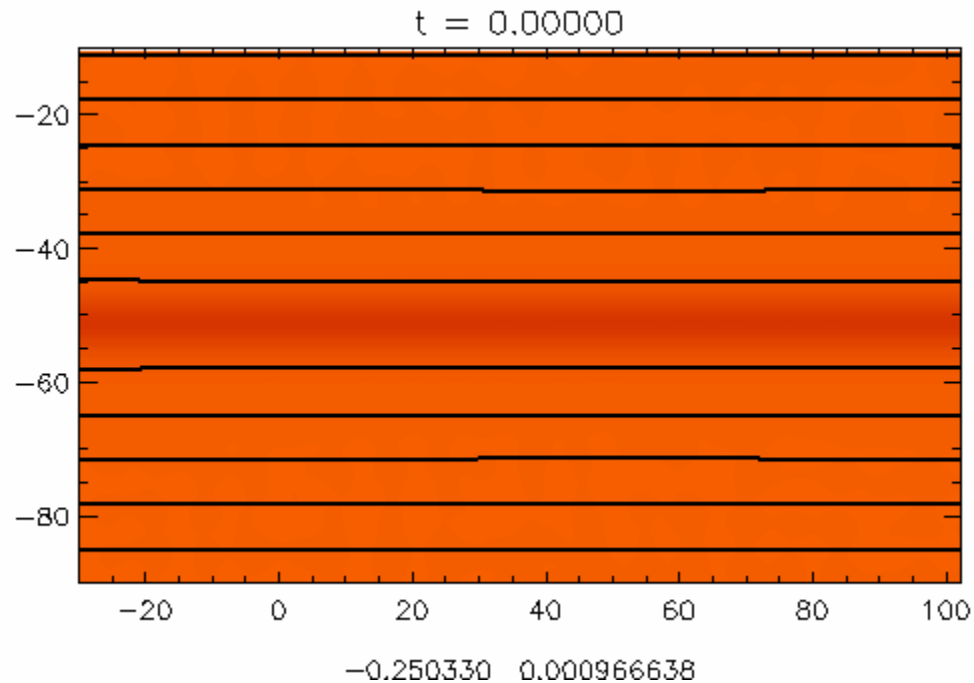


Electron Energization in Magnetic Reconnection

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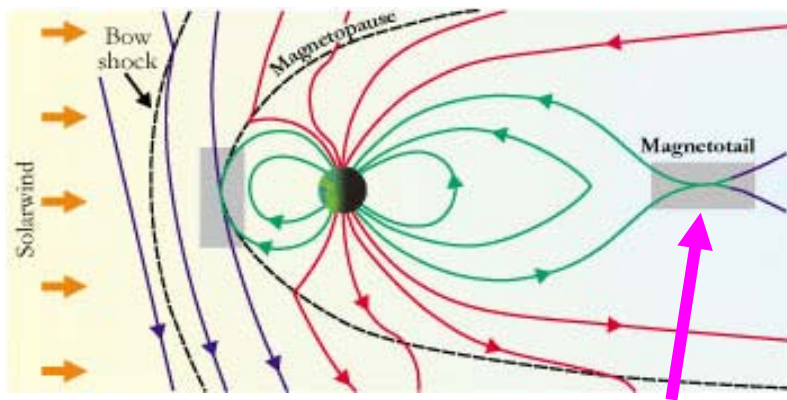
Magnetic Reconnection

- What is magnetic reconnection?

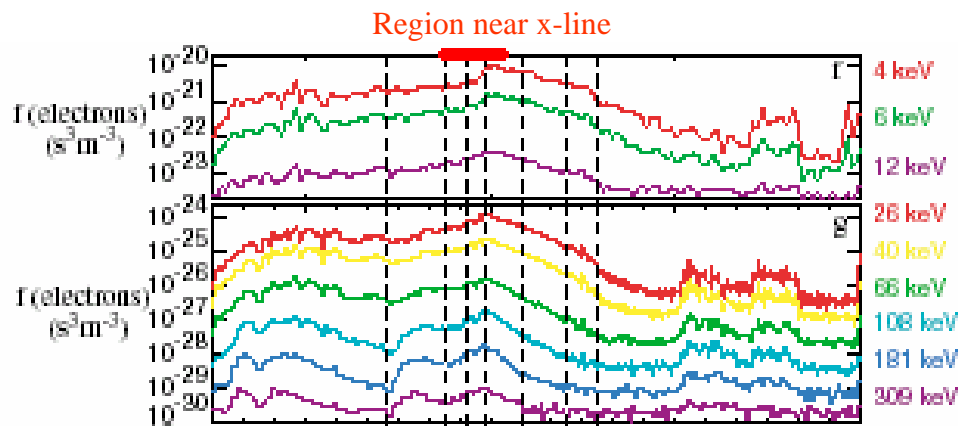


- Magnetic field lines break and reform to release their magnetic energy into the surrounding plasma.

Motivation

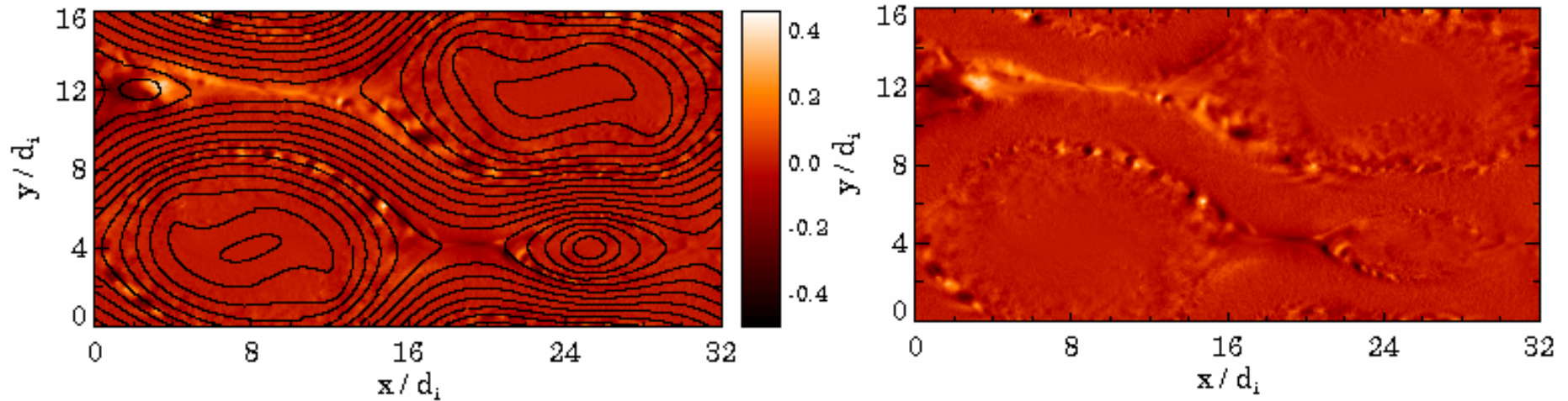


Magnetotail
Reconnection



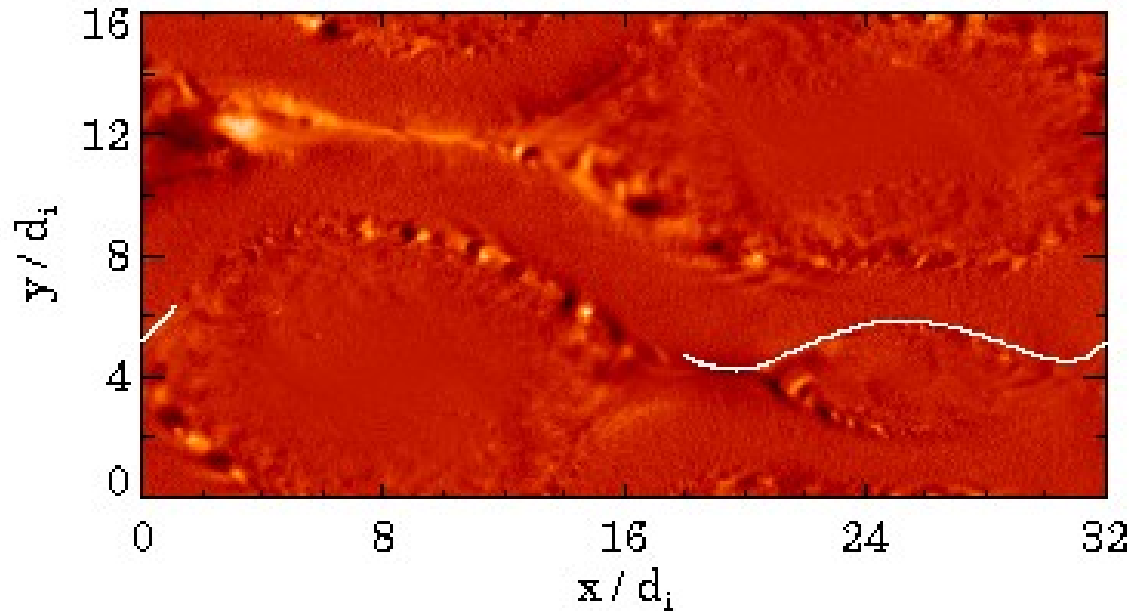
- Magnetic reconnection generally regarded responsible for energizing charged particles
- Satellite (WIND spacecraft) detected energetic charged particles in the Earth's magnetotail
- But how?

Method: Test Particle Tracing

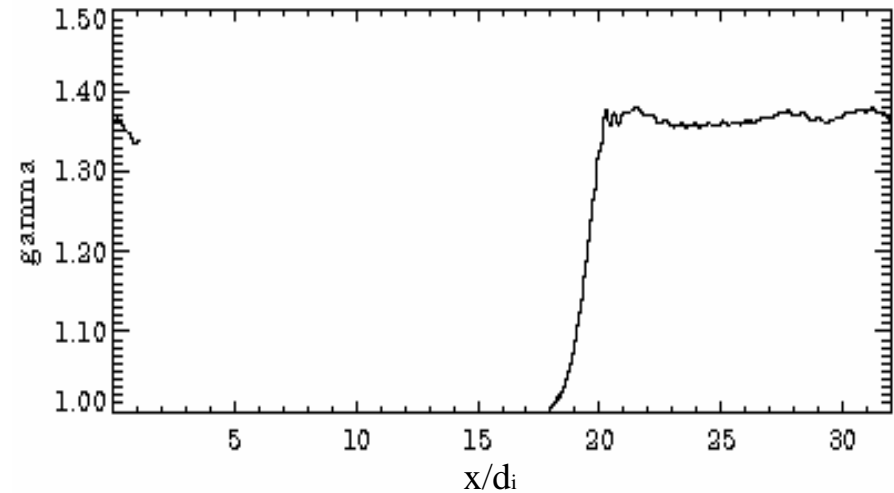
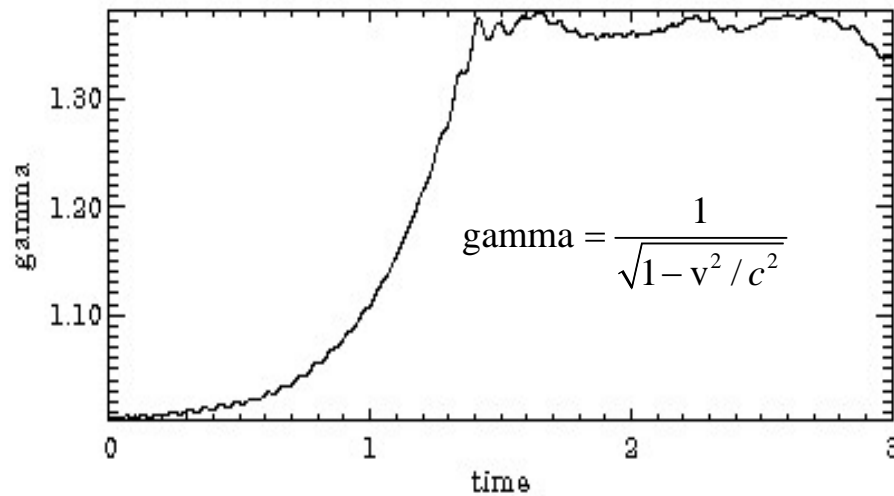


- 2D Fully kinetic simulations of reconnection
 - Take a snapshot of the electromagnetic field
- Place electrons in region of interest
- Trace electron motion
- Investigate the more energetic electrons

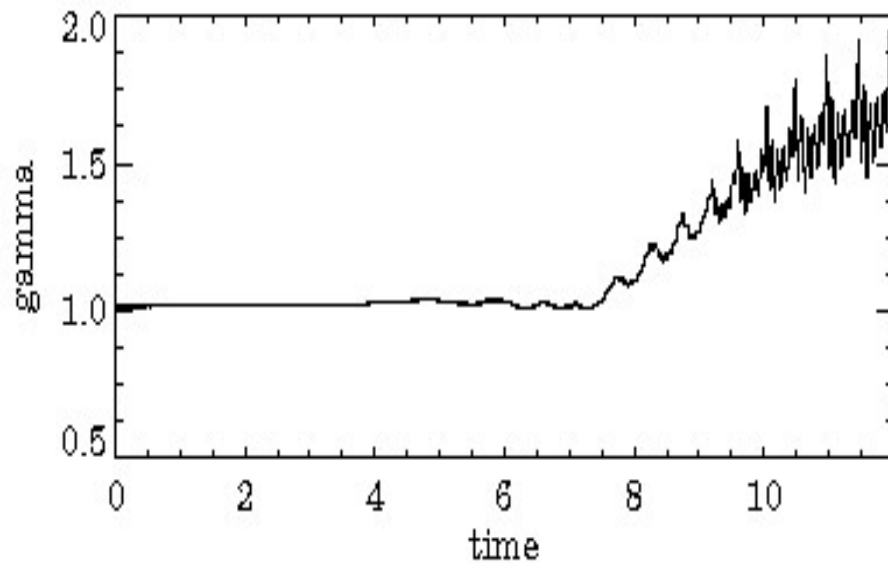
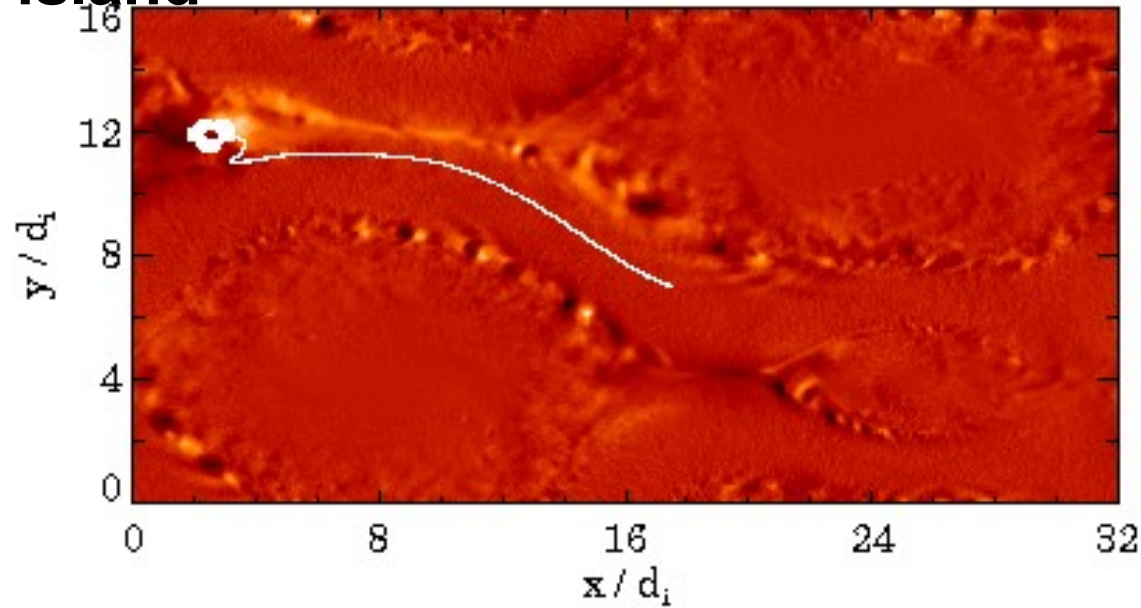
Electron passing through the x-line



- Particle gains a substantial amount of energy as it passes through the x-line
- Essentially all energy gained is at the x-line

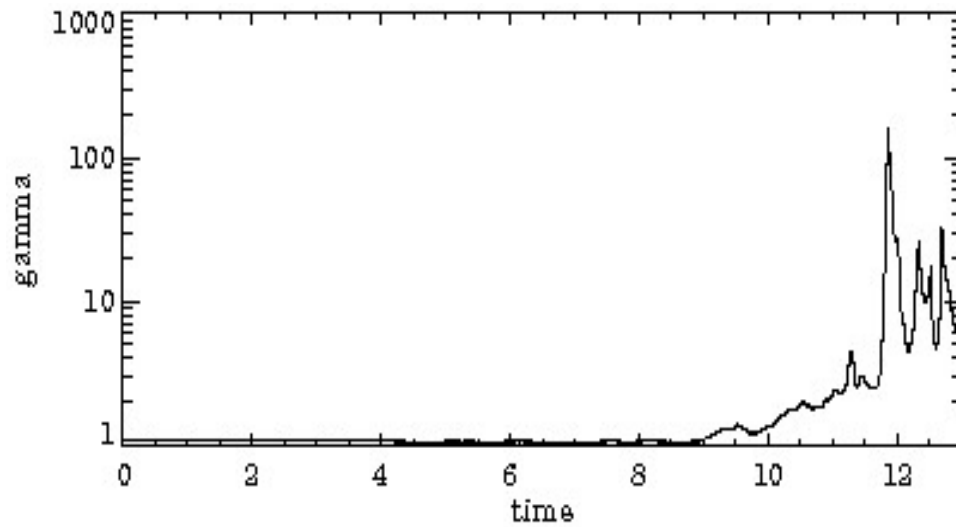
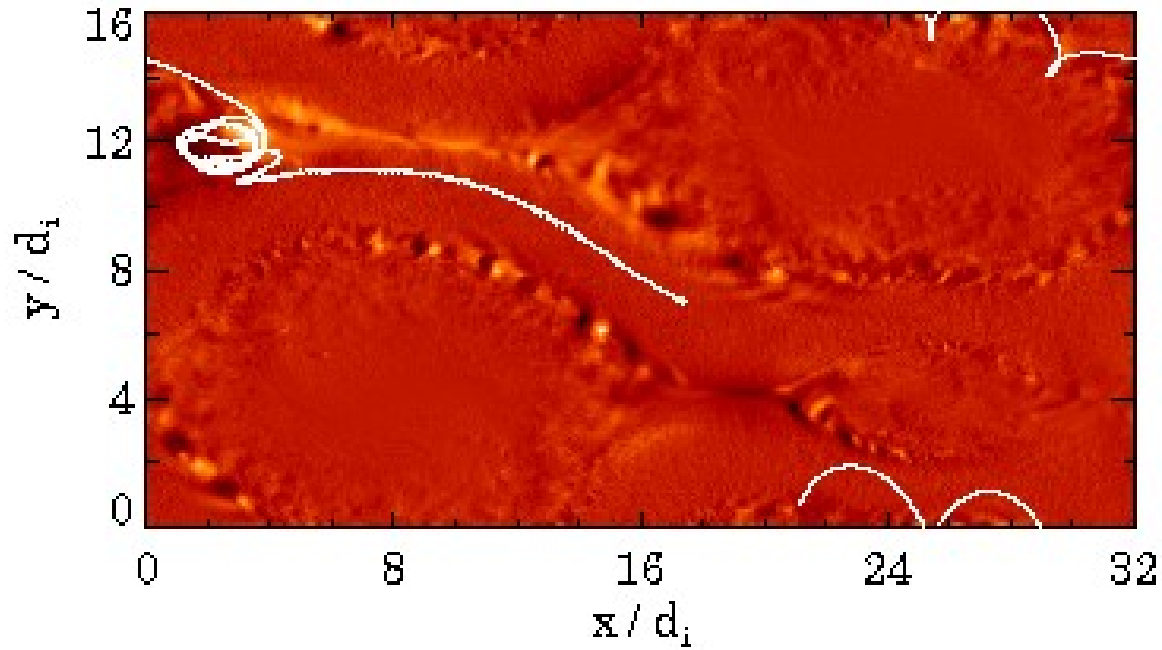


Particle circulating around secondary island



Particle gains energy as it circulates around the secondary island

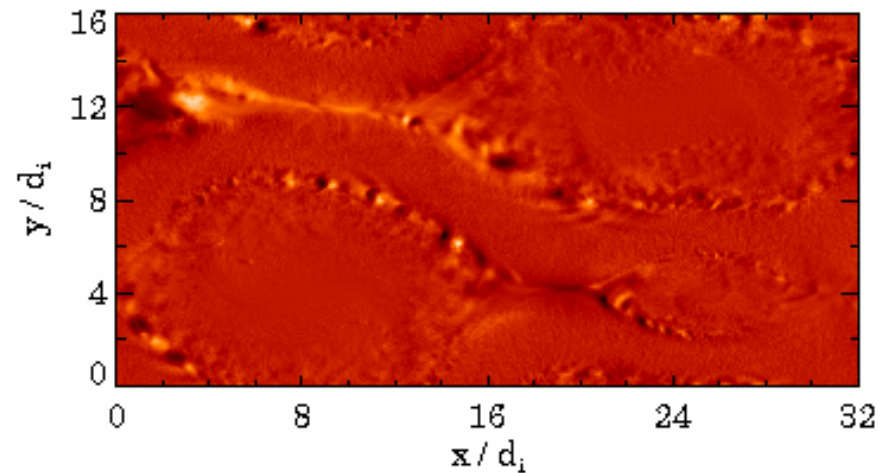
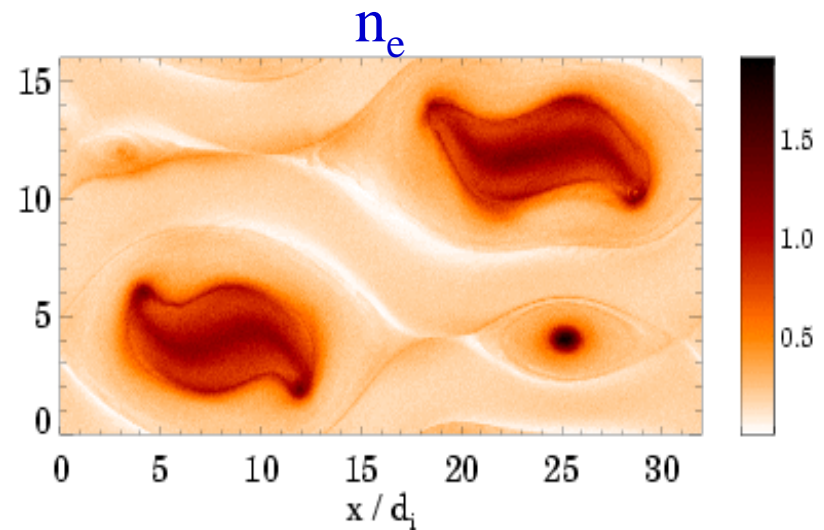
Particle gains practically no energy as it moves in region of unreconnected field lines.

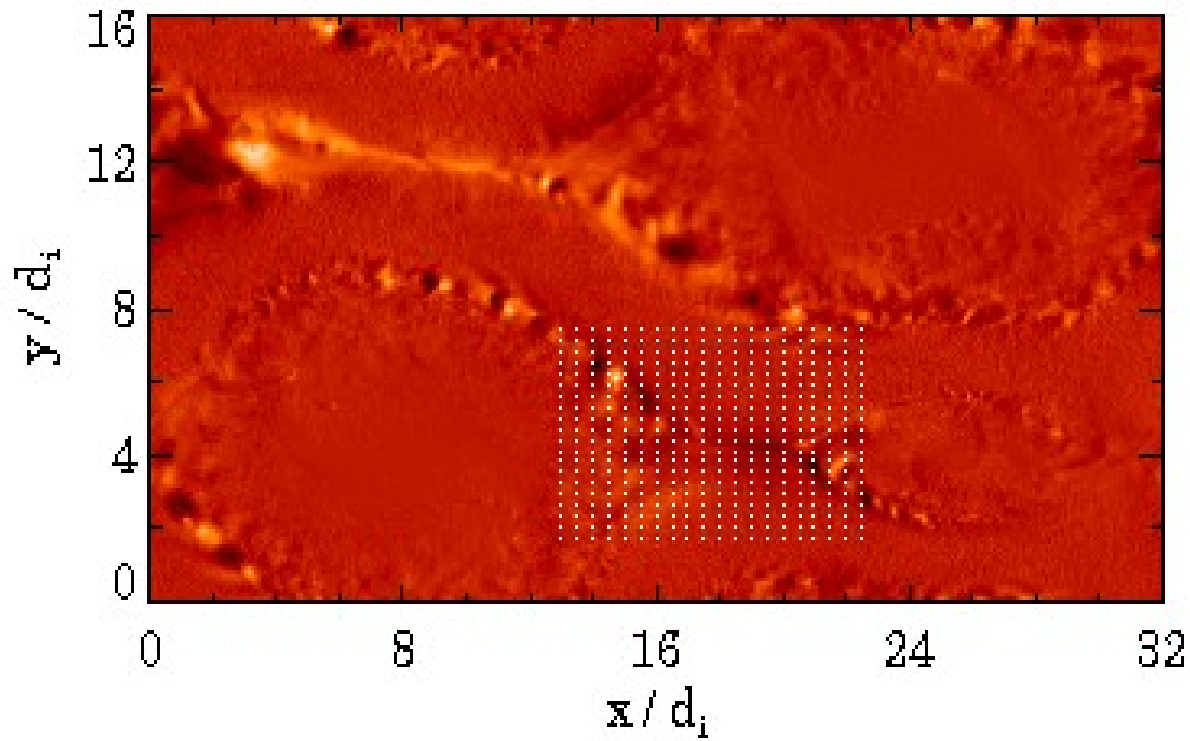


It is possible for a particle to become **very** energetic as it circulates around the secondary island

The Low-Density Cavities

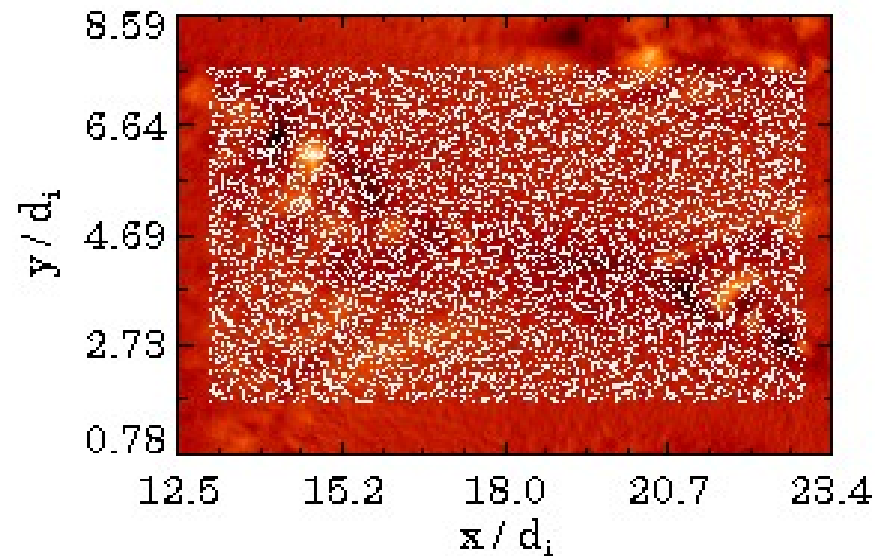
- Reconnection with a guide field => density cavities: Extremely low densities.
- Large electric fields associated with these cavities.
- Particle in the low density regions of the separatrixes may become very energetic



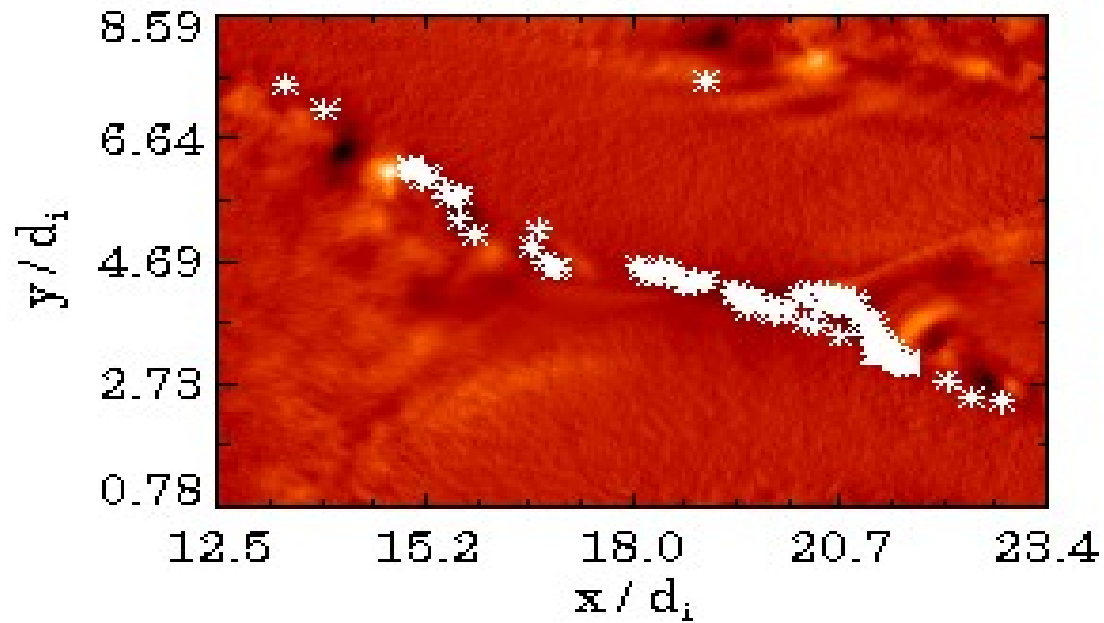


Method

- Start particles randomly in the region containing the low density cavities
- Sort out the most energetic particles



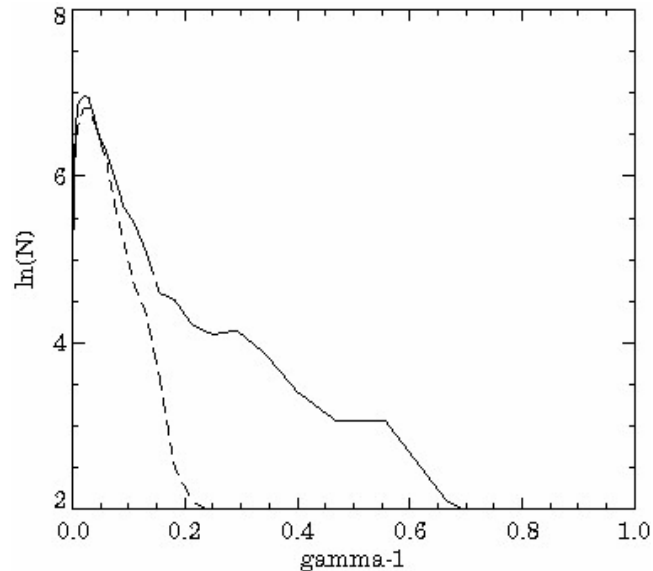
Result



Some of the most energetic particles come from the **low** density region of the separatrix

Power-Law Distribution

Test-Particle Simulation



- Power-law distribution indicates that a very small portion of electrons are accelerated to extremely high energy

Conclusion

- Electrons are substantially energized when they pass in close proximity to the x-line.
- Secondary islands produce even more energetic electrons by trapping and continuously accelerating them.
- The most energetic electrons tend to originate from the low-density region