The Magnetosphere

- Energized particles trapped on closed field lines:
  - plasma sheet, radiation belts/ring current

- Energy from solar wind
  - Polar magnetic field lines open to interplanetary B
  - Solar wind E transferred in, and then to closed region (i.e., reconnection)
The Earth’s Coupled Magnetosphere-Ionosphere System

- Electric fields and currents couple to the conducting ionosphere
  - *Upward currents give the aurora*
- Plasma and field structure and dynamics of the system result from the electrodynamically coupled magnetospheric and ionospheric plasma
Major AOS Space Plasma Activities
The Earth’s Coupled Magnetosphere-Ionosphere System

Radiation belt electron formation and loss and related plasma wave observations and theory - Richard Thorne, Wen Li, Jacob Bortnik (lead PIs)

Large-scale plasma, field, current modeling of coupled system; plasma entry - Chih-Ping Wang (lead PI)

Dynamical energy transfer processes throughout the system – Toshi Nishimura (lead PI)

Major disturbances of the coupled system - Larry Lyons, Toshi Nishimura (lead PIs)

Next: Some sample topics of possible interest to plasma physics community
Wen Li: Wave-particle interaction in the radiation belts

Important wave modes
- Whistler-mode chorus
- Plasmaspheric hiss
- Electromagnetic Ion Cyclotron wave
- Magnetosonic wave

Topics:
- Evaluate wave generation mechanism and propagation characteristics
- Quantify waves role in energetic outer-belt electron dynamics under various levels of magnetic activity
- Determine particle precipitation rate from each type of wave

[Thorne, 2010]
• Jacob Bortnik and student Xin An

• LAPD experiment exploring whistler mode wave generation
Pre-onset M-I waves develop to the onset waves

$\rightarrow$ Pre-onset waves act as a seed of onset instability

Remained small but abruptly amplified when fast flows reach them

$\rightarrow$ Pre-onset flow made the waves more unstable
• Toshi Nishimura with student Bea Gallardo
• Tremendous flow enhancement with substorm auroral onset

(A) Poleward flow enhancement
(B) Equatorward flow enhancement
(C) Equatorward flow enhancement
(D) Poleward flow enhancement

2008-08-28/05:37:24
2008-08-28/05:37:39
2008-08-28/05:37:48
2008-08-28/05:38:00

- Strong flows associated with auroral beading
- Average flow enhancements reaches ~ 1000 m/s in magnitude
- Clockwise flow shear: Equatorward flow enhancement ahead of the bead followed by a poleward flow enhancement
Magnetic low frequency oscillations within 0.006~0.025 Hz have usually been associated with ballooning instability that leads to substorm onset in the near-Earth transition region for very high $\beta$ plasma sheet. 

- Found these oscillations when the near-Earth plasma sheet becomes unstable against ballooning mode in moderate $\beta$ plasma sheet.
- But also found that similar type of magnetic oscillations can be observed preceding earthward moving flows from middle tail to the near-Earth region.
- MHD wave analysis indicates that are likely slow mode magnetosonic waves that are generated right ahead of flow channels.
- Suspect that the oscillations preceding substorm onset may not be generated locally by instabilities, but may be caused by earthward moving flow channels before the substorm onset.

Xiaoyan Xing: Ballooning instabilities in the plasma sheet
• Localized fast flow channels propagate from dayside to nightside and connecting dayside and nightside transient phenomena via the polar cao.

• Suggest dayside-polar cap-nightside interaction by flow channels, having large impacts on dynamics of the M-I coupling system.

• New paradigm: major driver of NASA Heliophysics System Observatory