SA42A-01

ROLE of AURORAL SCIENCE in SOLAR SYSTEM AERONOMY

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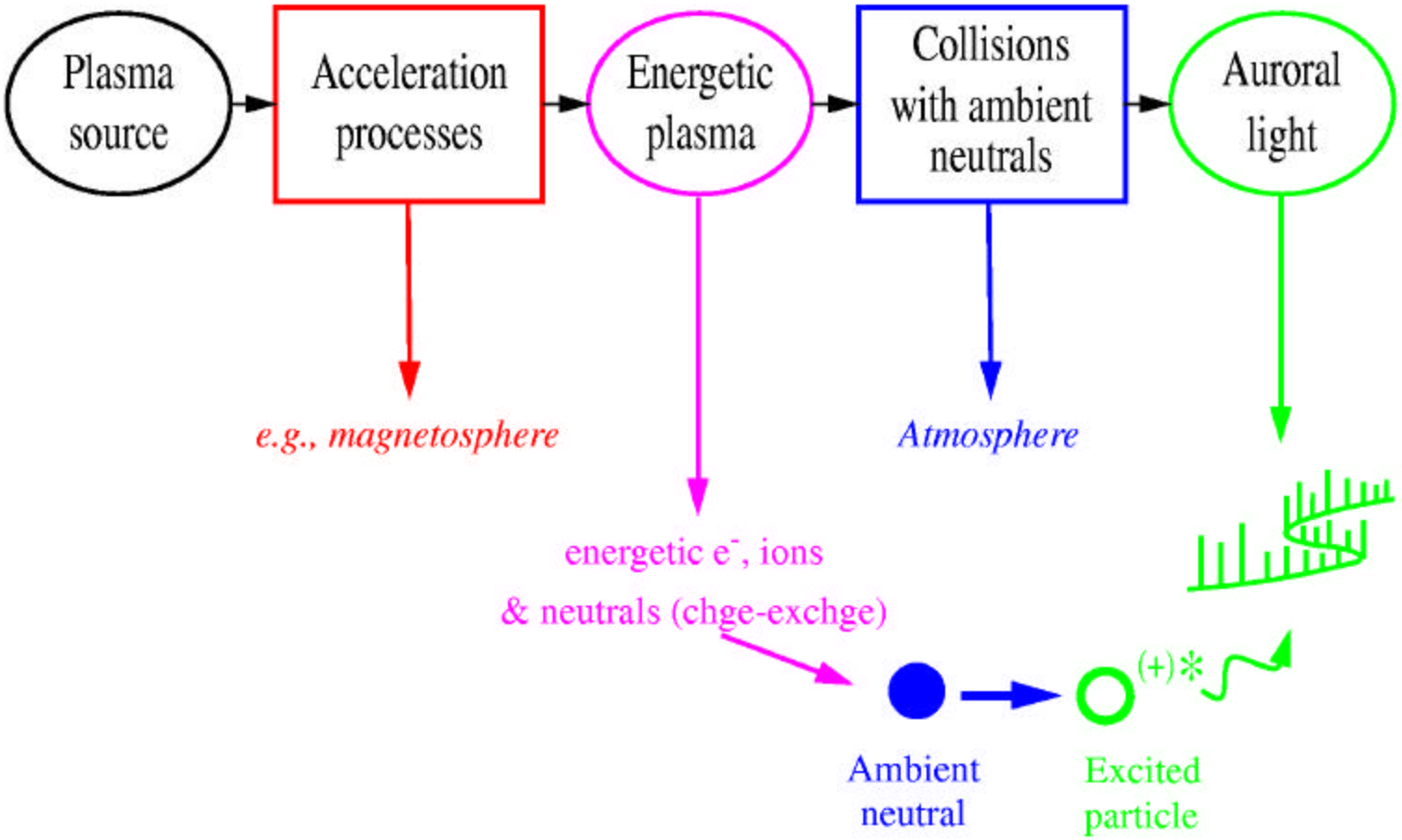
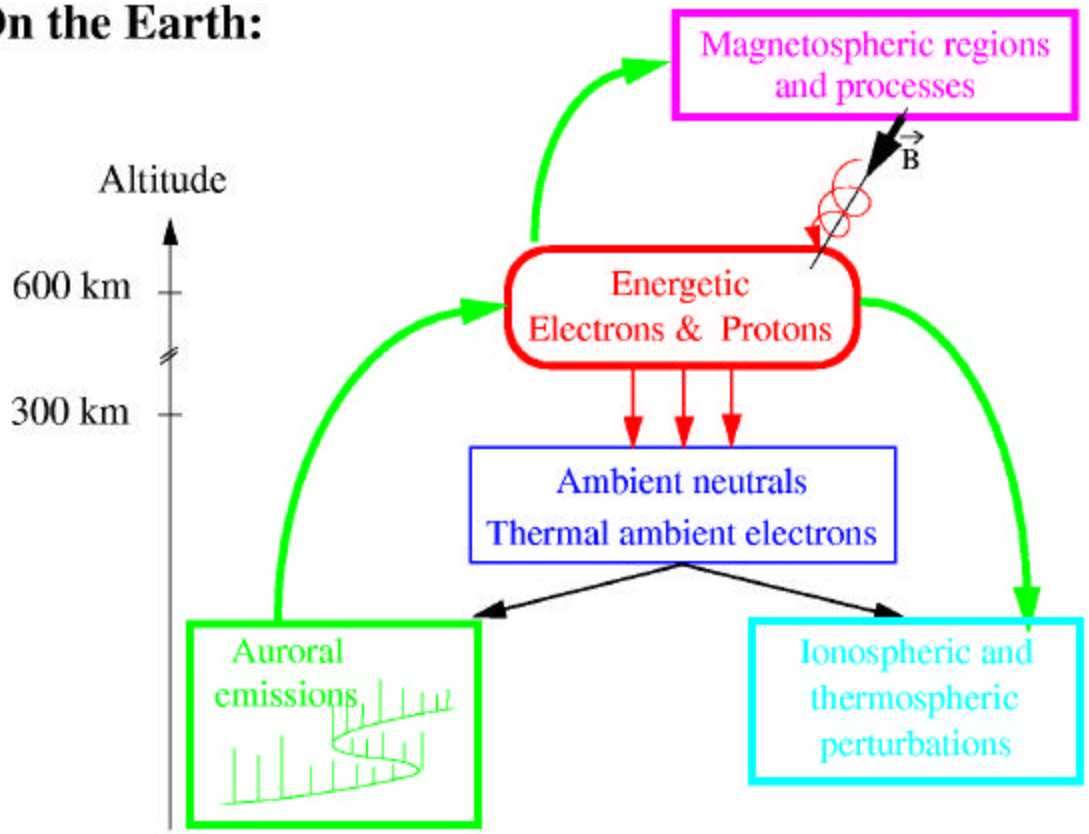
- Definition for aurora
- Interest of auroral studies at the Earth and Jupiter
- Modeling auroral processes
- Comparative approach between solar system atmospheres: X-rays, OI 135.6 nm
- Discussion



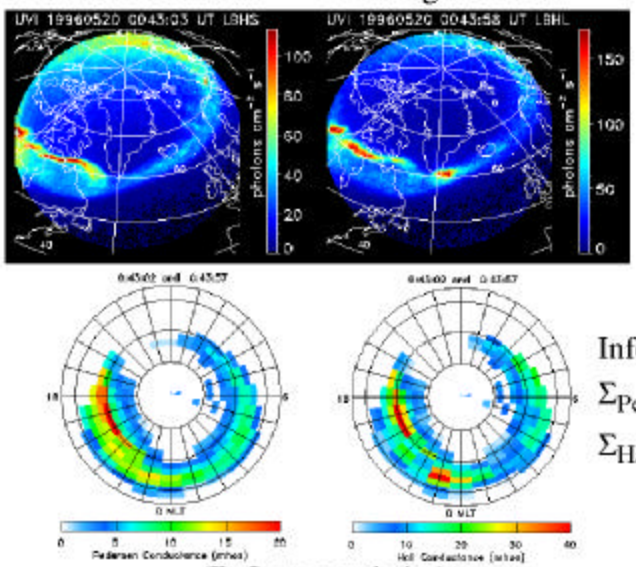
+ Aurora: optical manifestation of the interaction of energetic extra-atmospheric electrons, ions, or neutrals with an atmosphere.

On the Earth:



2 AURORA: **Remote sensing of energy particle input**
- for estimation of the atmospheric response,
- for tracking magnetospheric regions and processes

POLAR UVI images

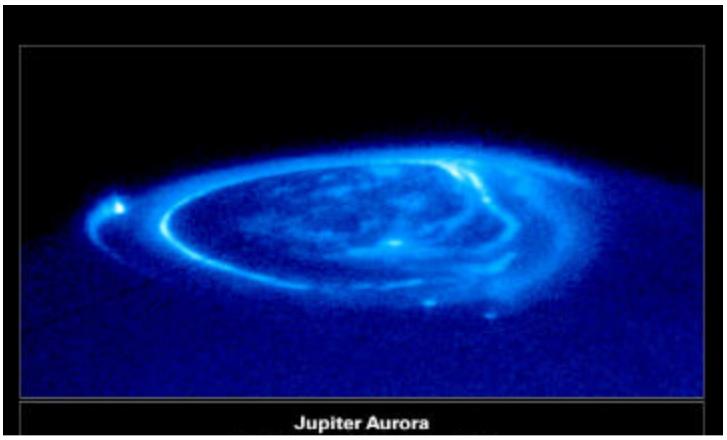


Inferred Σ_{Ped} and Σ_{Hall}

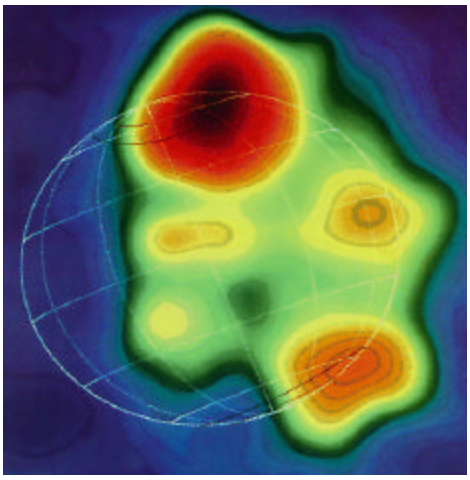
(D. Lummerzheim)

2 Auroral imaging from space is the **only way to get a snapshot** of the particle energy input over the **entire** auroral oval.

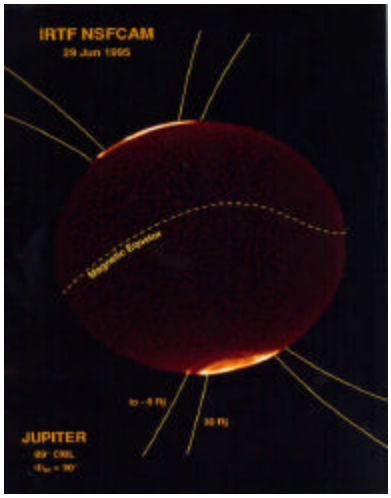
JOVIAN AURORA



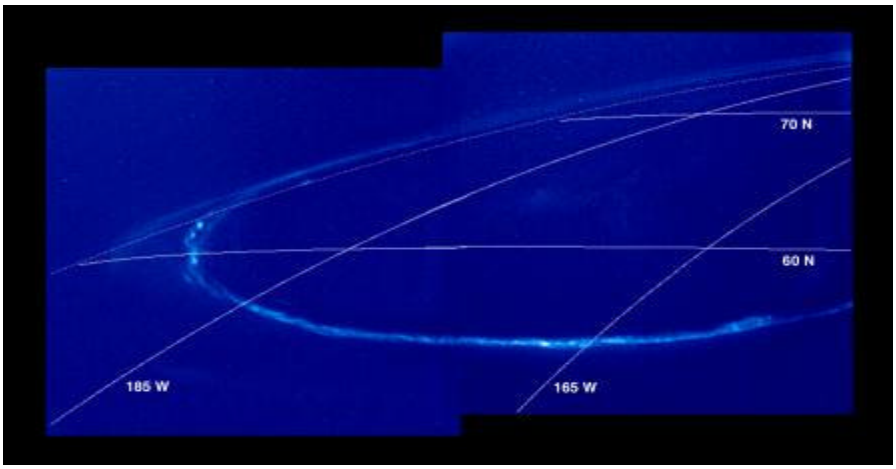
UV, HST/STIS (NASA, J. Clarke)



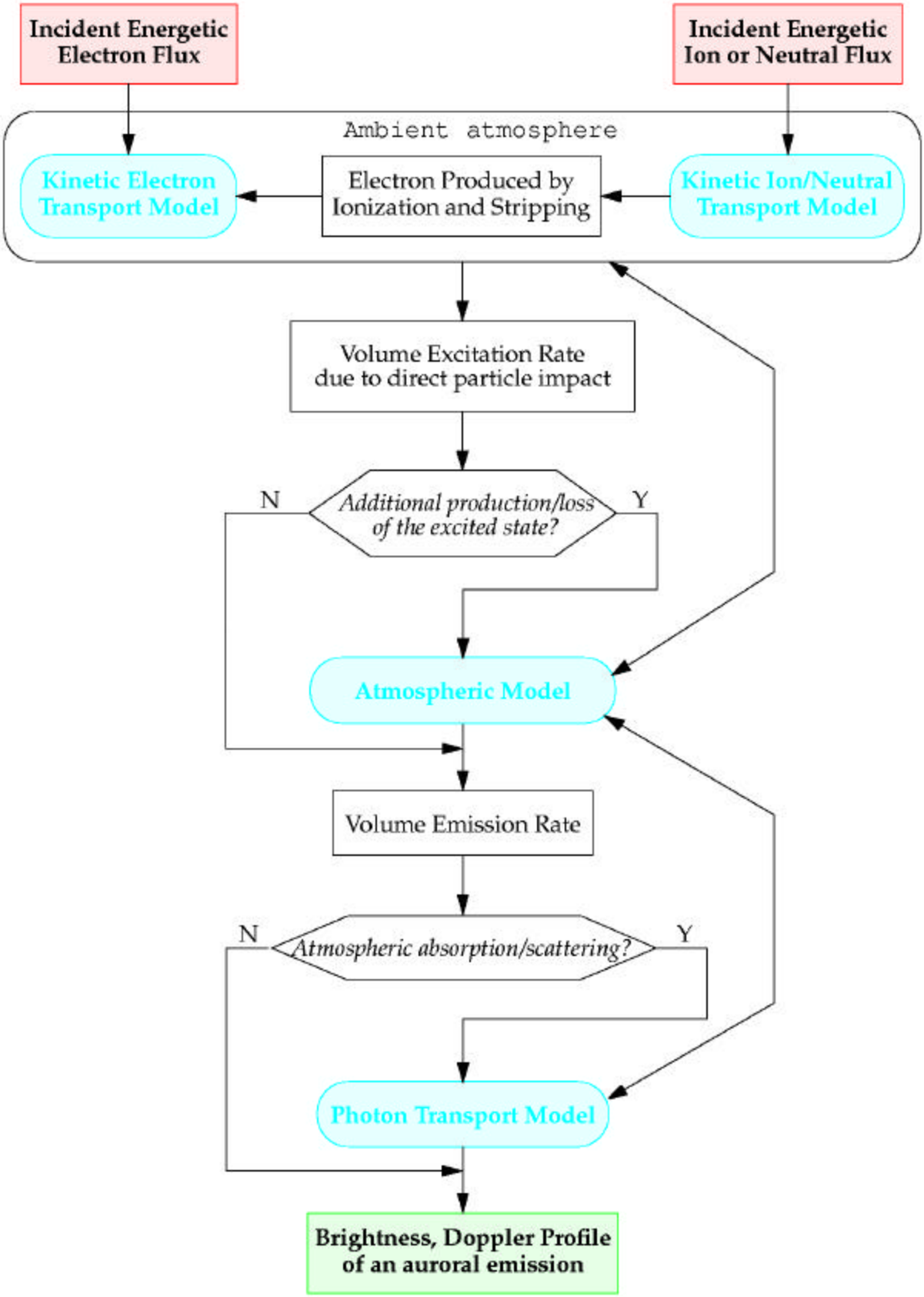
Soft X-rays, ROSAT (J.H. Waite)



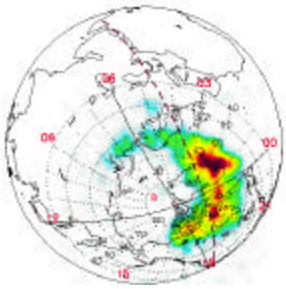
H_3^+ in **IR**, IRTF/Mauna Kea
(NASA, J.E.P. Connerney, T. Satoh)



Nightisde **Visible** Jovian Aurora
SSI/Galileo (NASA, JPL)

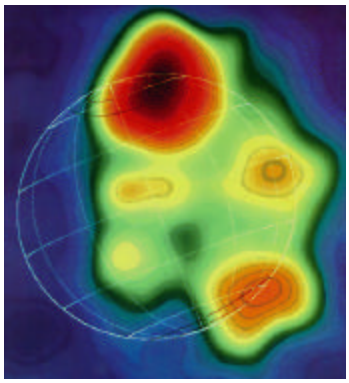

Incident Energetic Electron Flux
Incident Energetic Ion or Neutral Flux
Ambient atmosphere
Kinetic Electron Transport Model
Electron Produced by Ionization and Stripping
Kinetic Ion/Neutral Transport Model
Volume Excitation Rate due to direct particle impact
N
Additional production/loss of the excited state?
Y
Atmospheric Model
Volume Emission Rate
N
Atmospheric absorption/scattering?
Y
Photon Transport Model
Brightness, Doppler Profile of an auroral emission

COMPARATIVE APPROACH:
Aurora in X-RAYS



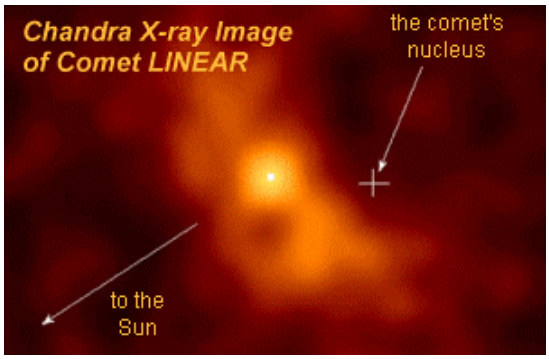
Earth: Polar/PIXIE
(NASA, N. Ostgaard)

Energy source: Magnetospheric keV electrons (X-rays observed at Saturn expected to be similarly produced)
Neutrals: N_2, O_2, O



Jupiter: ROSAT
(J.H. Waite)

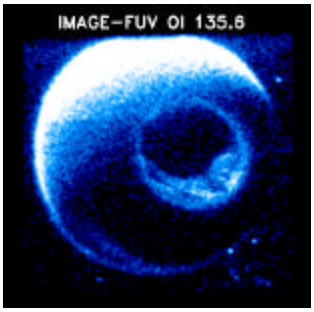
Energy source (high latitude): Magnetospheric heavy oxygen and sulfur ions
Neutrals: H_2, H



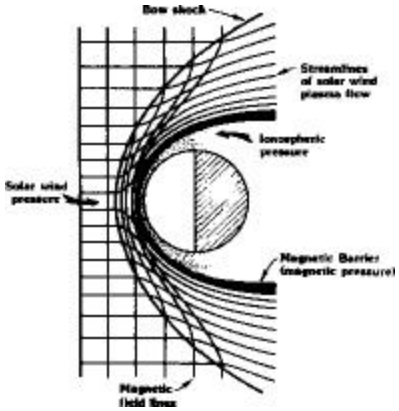
Comet Linear: Chandra
(NASA, SAO, CXC,
STScI, Lisse et al.)

Energy source: Heavy, high charge state solar wind ions (similar effect expected at Mars and Venus)
Neutrals: cometary gas (H_2O, OH, …)

COMPARATIVE APPROACH:
Aurora at/around OI 135.6 nm

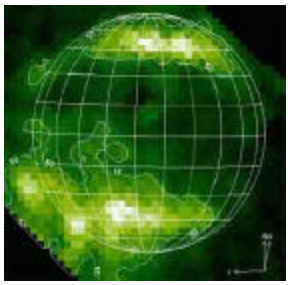


Earth:
IMAGE/SI13
(NASA/UC Berkeley,
S. Mende and T. Immel)

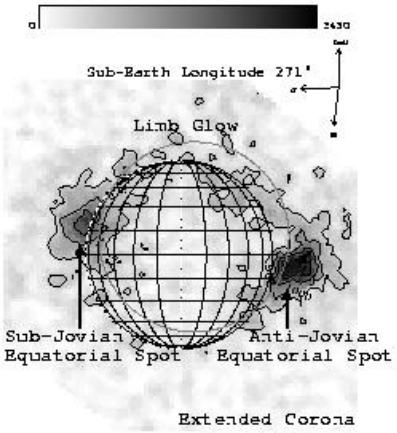


Venus
(Luhmann, AGU, 1990)

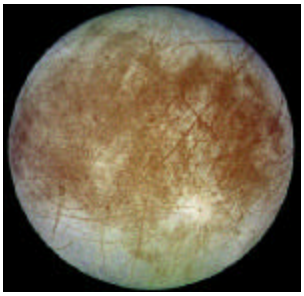
Observations at OI 135.6 nm by
PVO/UVS (Phillips et al., 1986)



Ganymede
HST/STIS – OI 135.6 nm
(NASA, STScI, P.D. Feldman,
M. McGrath)



Io
HST/STIS – OI 135.6 nm
(Retherford et al., JGR, 2000)



Europa
(Galileo Project,
JPL, NASA)

DISCUSSION: ROLE of AURORAL SCIENCE in SOLAR SYSTEM AERONOMY

- **Aurora: unique and valuable probe of the solar system**
  - Remote-sensing of magnetic field configuration
  - Tracer of plasma interactions
  - Indicator of the energy source (type, energy, …)
  - Fingerprint of the atmospheric constituents

- With improving observational/modeling capabilities over last decades, a large diversity of magnetic field geometries, plasma interactions, energy sources, and atmospheric species has been revealed through auroral observations

  ⇨ **Comparative auroral studies**, a rich field which is expected to play a crucial role by initiating and stimulating new findings/understanding in aeronomy.

- **Issues**:

  - **On the Earth:** Global auroral imaging used narrow-band filters. Need for global spectral imaging. And what after Polar, IMAGE?

  - **Auroral analysis and modeling challenges:**
    - Identify all emission sources and track them
    - Uncertainties on input parameters
    - Configuration of the magnetic field environment

  - **Comparative approach:** Support by funding agencies?

Discussion group:

http://www.bu.edu/csp/imaging_science/aeronomy-sol-sys.html