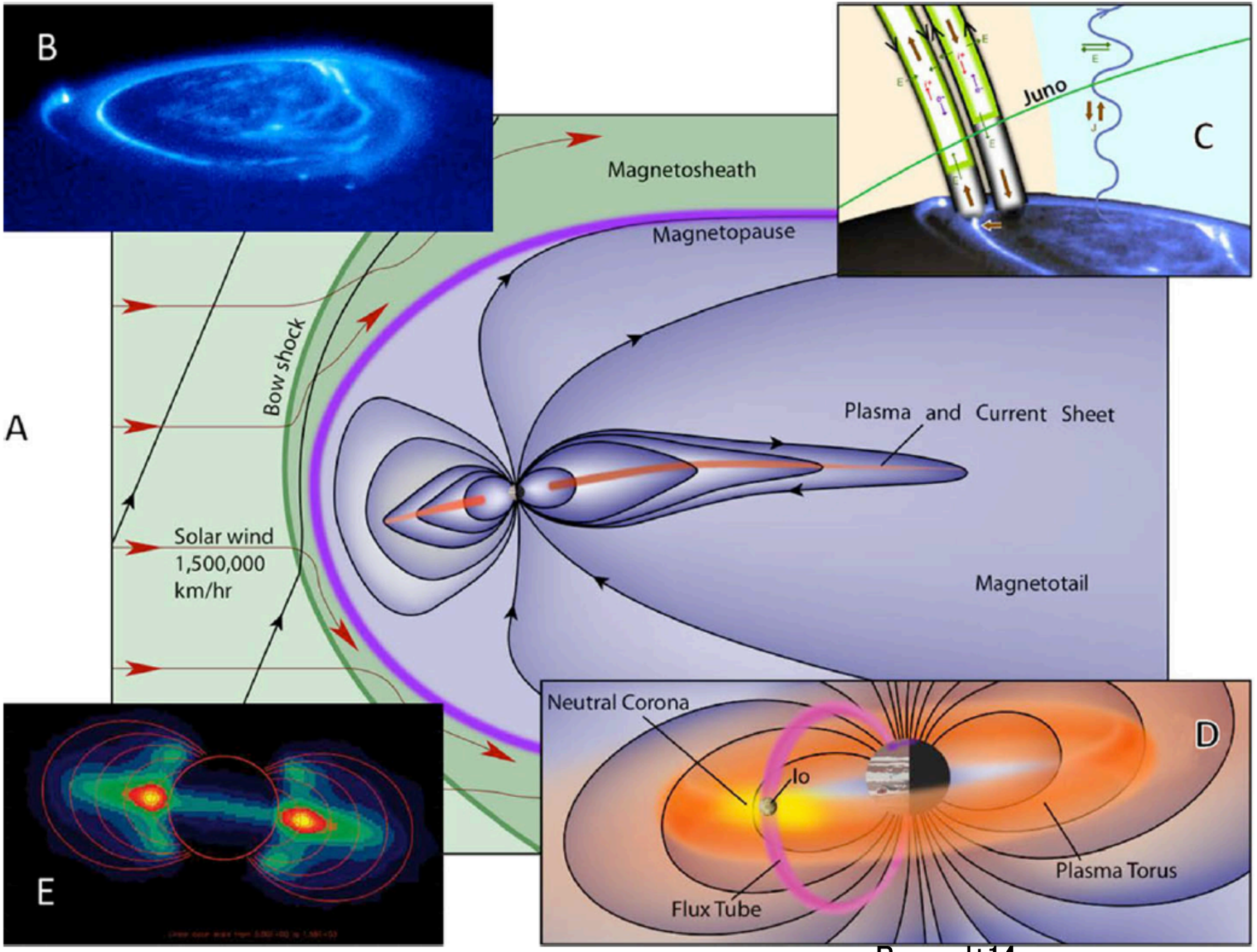
PSWS meeting 2017

Multi-wavelength observations of Jupiter's aurora during Juno’s cruise phase

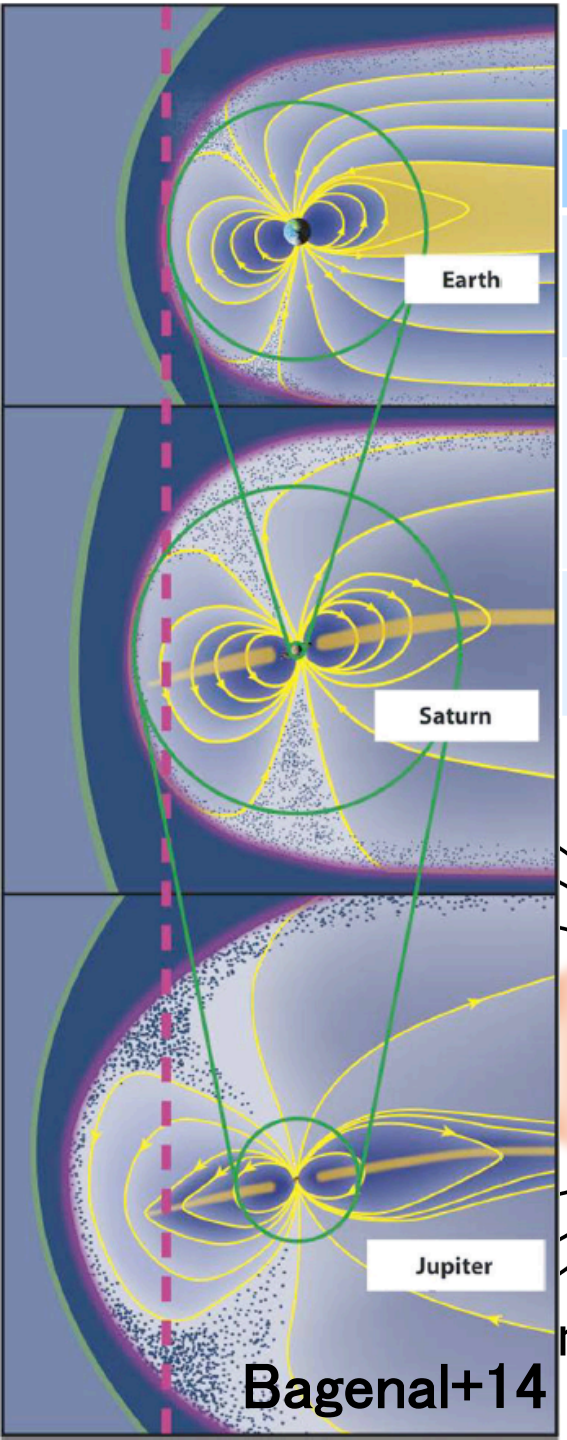
T. Kimura (RIKEN)

Background

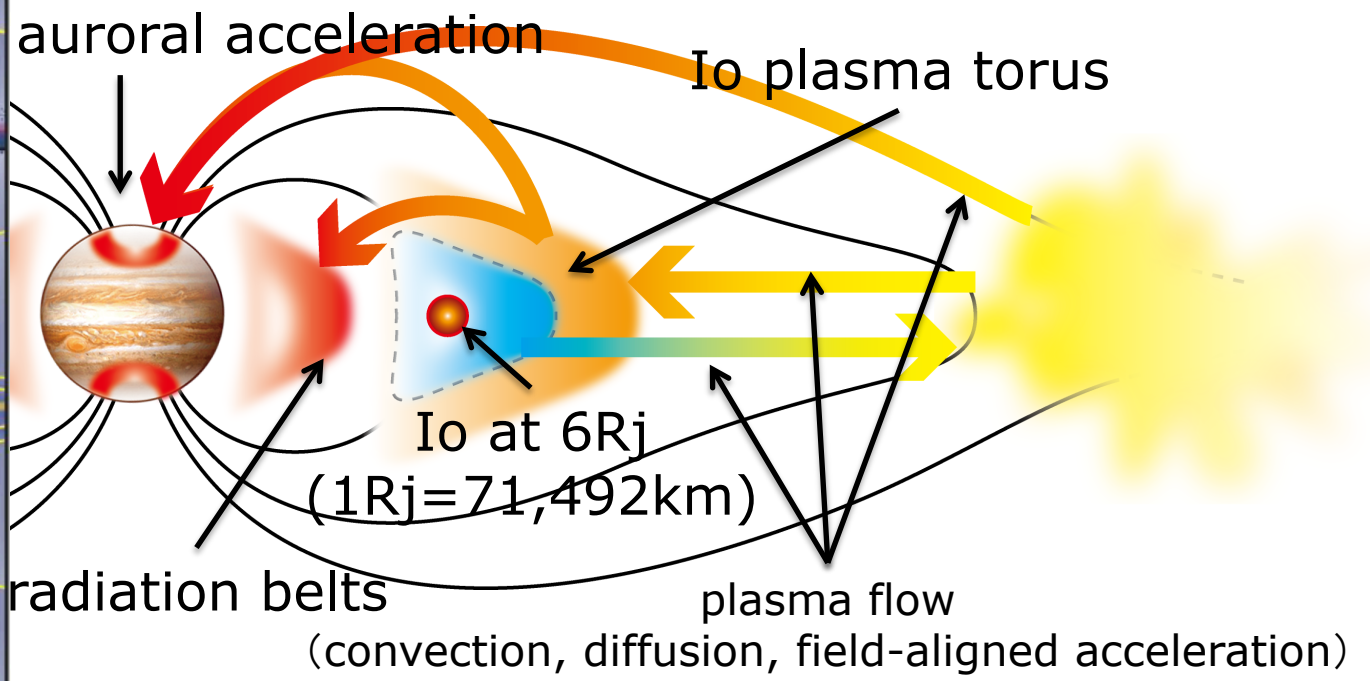

B
C
Juno
Magnetosheath
Magnetopause
Bow shock
A
Plasma and Current Sheet
Solar wind
1,500,000
km/hr
Magnetotail
Neutral Corona
D
Io
Plasma Torus
Flux Tube
E

Bagenal+14

Planetary parameters

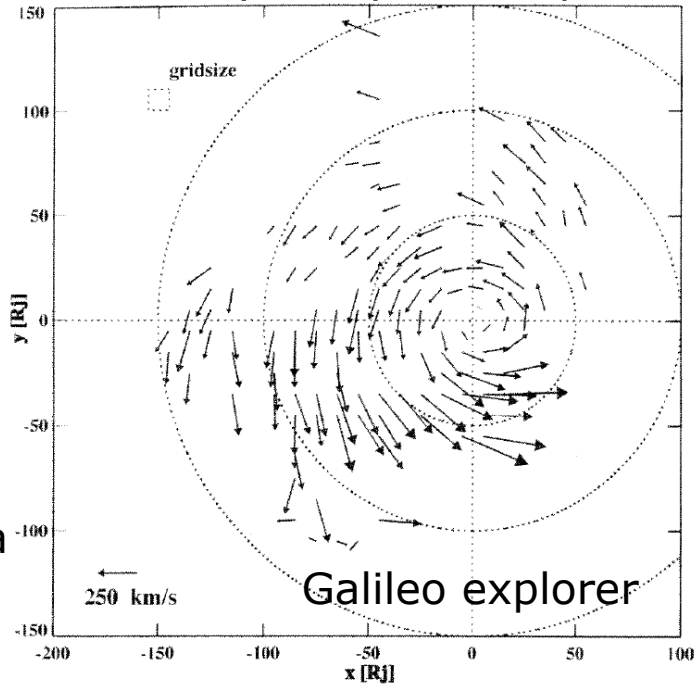


	Earth	Jupiter	Saturn
Spin period (hr)	24	9.92	10.56
Magnetic moment (Earth=1)	1	20,000	600
Plasma source (kg/s)	5	260-1400	12-250



Rotating magnetosphere

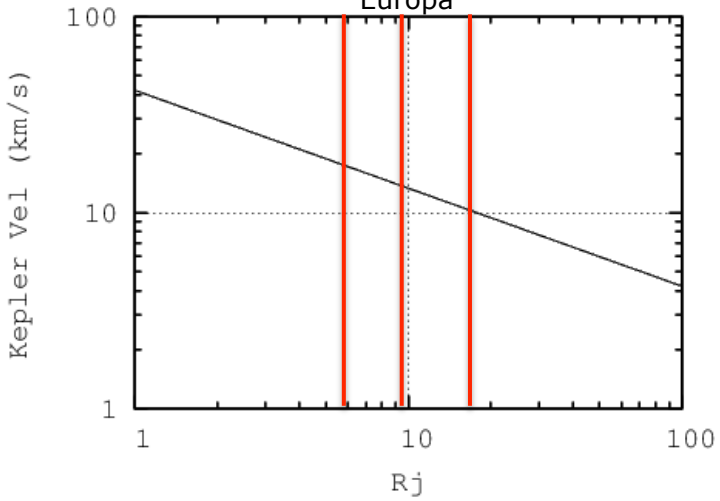
Bulk velocity in equatorial plane

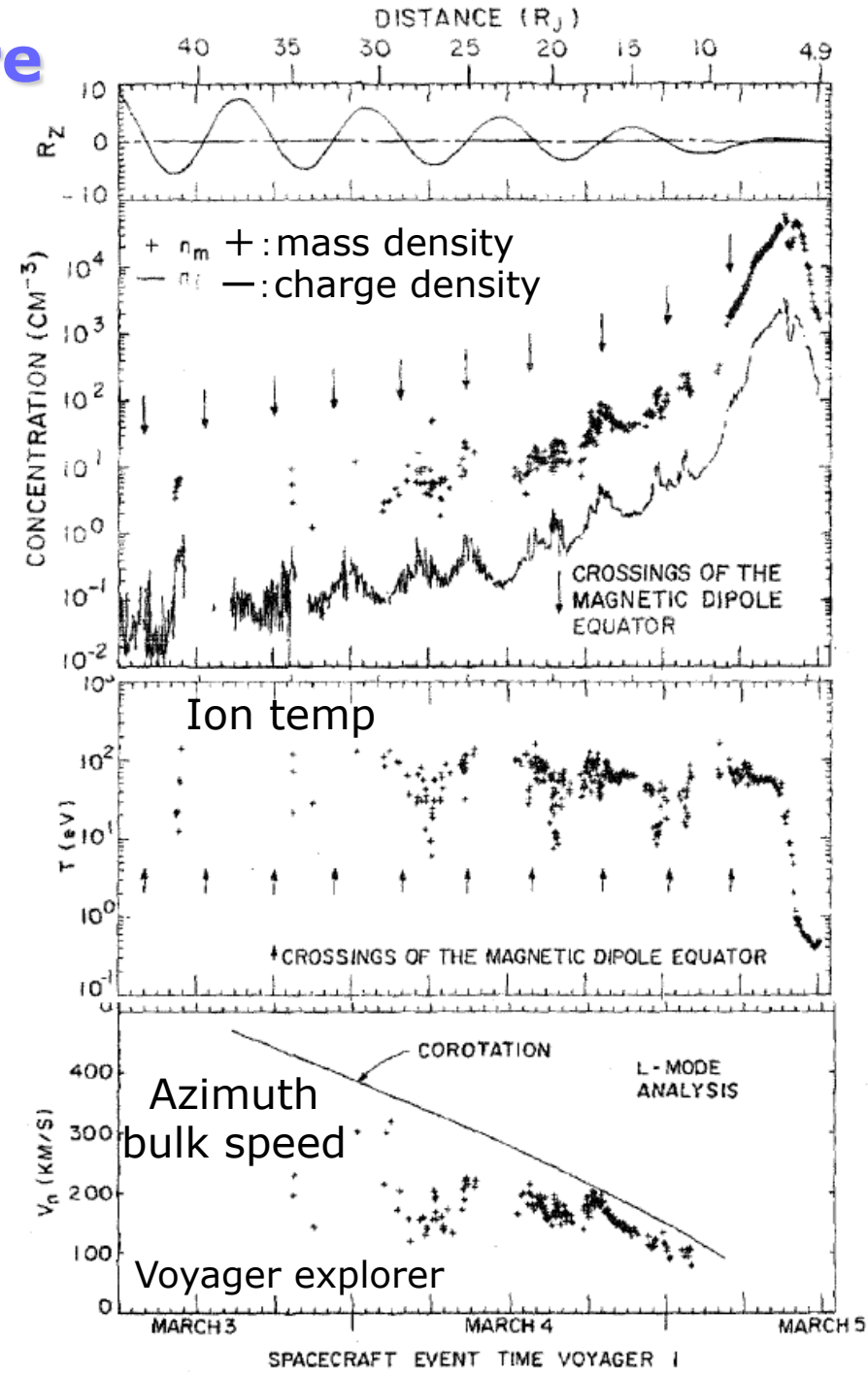


Khurana +04

Galileo explorer

Kepler speed





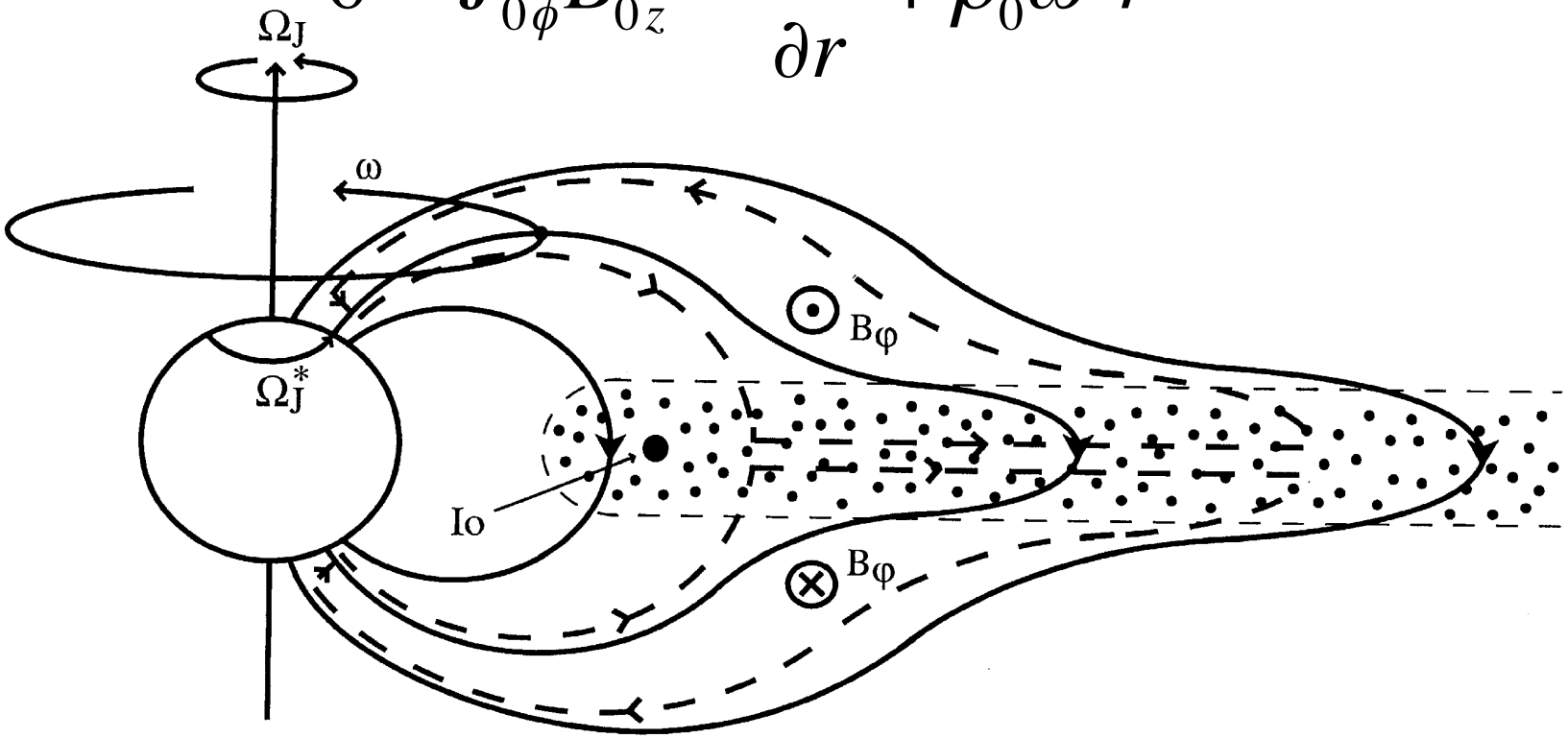
Steady state

Force balance in equatorial magnetosphere

$$\dot{\rho}\boldsymbol{\Omega}\times\mathbf{r}+2\rho\boldsymbol{\Omega}\times\dot{\mathbf{r}}+\rho\boldsymbol{\Omega}\times(\boldsymbol{\Omega}\times\mathbf{r})+\nabla\cdot\mathbf{P}=\mathbf{j}\times\mathbf{B_0},$$

approximately

$$0\sim J_{0\phi}B_{0z}-\frac{\partial p_0}{\partial r}+\rho_0\omega^2 r$$



Cowley and Bunce, 01

Big questions

- How mass, momentum, and energy are dynamically transferred in rotating magnetosphere
  - Transfer from planet/moon to m'sphere is dominant.
  - How about from m'sphere to planet?
  - Especially in radial direction?
- How some plasmas are accelerated up to 50 MeV in system where planet electromagnetically couples with m'sphere?

Transient brightening of Jupiter's aurora observed by the Hisaki satellite and Hubble Space Telescope during approach phase of the Juno spacecraft

Tomoki Kimura (RIKEN),

Jonathan D Nichols (Leicester U), Rebecca Gray, Sarah V Badman (Lancaster U) , Chihiro Tao (NICT), Go Murakami (JAXA), Atsushi Yamazaki (JAXA), Fuminori Tsuchiya (Tohoku U), Kazuo Yoshioka (U of Tokyo), George B Clark (APL), Denis C Grodent (U of Liège), Hajime Kita (Tohoku U), I. Yoshikawa (U of Tokyo) Masaki Fujimoto (JAXA), and Hisaki Science Team

Jupiter observing campaign 2016-2017

Juno

In-situ measurement
(B, particle, wave)

Auroral particle precipitation

Radial diffusion, w-p interaction

Injection / interchange

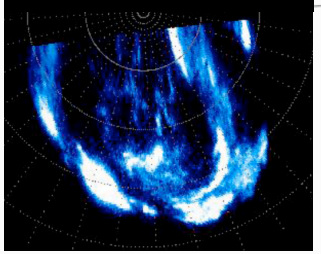
Io

magnetic reconnection?

interchange

Kimura+15

High res auroral imaging



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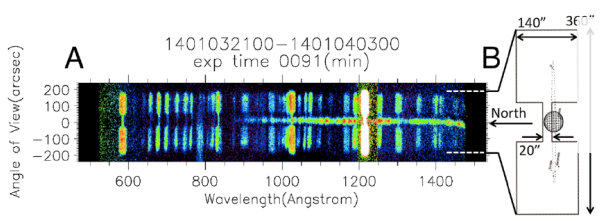
JAXA, NASA, NAOJ, Tohoku U.

Auroral emission

Torus emission

HST

Hisaki



Aurora & torus monitoring

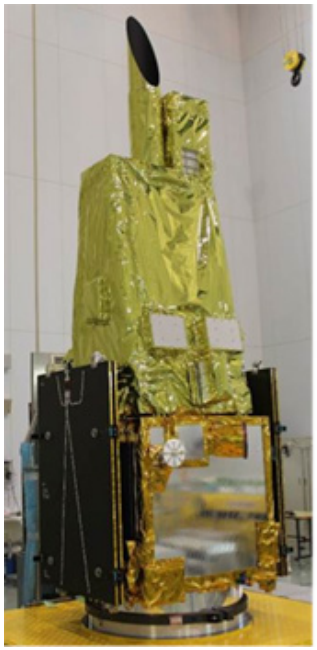
Kimura+15

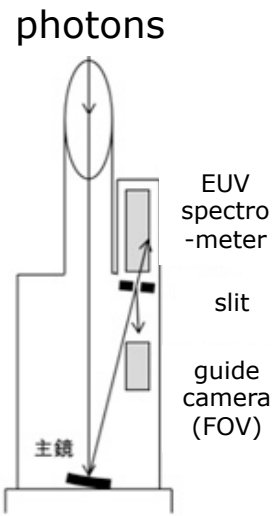
Hisaki (SPRINT-A) mission

- An earth-orbiting Extreme Ultraviolet (EUV) spectroscopic mission
- The first mission of the ISAS/JAXA Small scientific satellite series (Previous mission name: SPRINT-A)
- EXCEED measures EUV emissions from tenuous gases and plasmas around the planets
- Observation targets : Mercury, Venus, Mars, Jupiter, and Saturn

Major specifications

- Launch date : 14th Sep 2013
- Weight：330kg
- Size：1m×1m×4m
- Orbit：950km×1150km (LEO)
- Inclination: 31 deg
- Mission life ：>1 year
- Pointing accuracy : ±2 arc-min (improved to ±5arc-sec by using a guide camera FOV)





EUV spectrometer
“EXCEED” onboard Hisaki

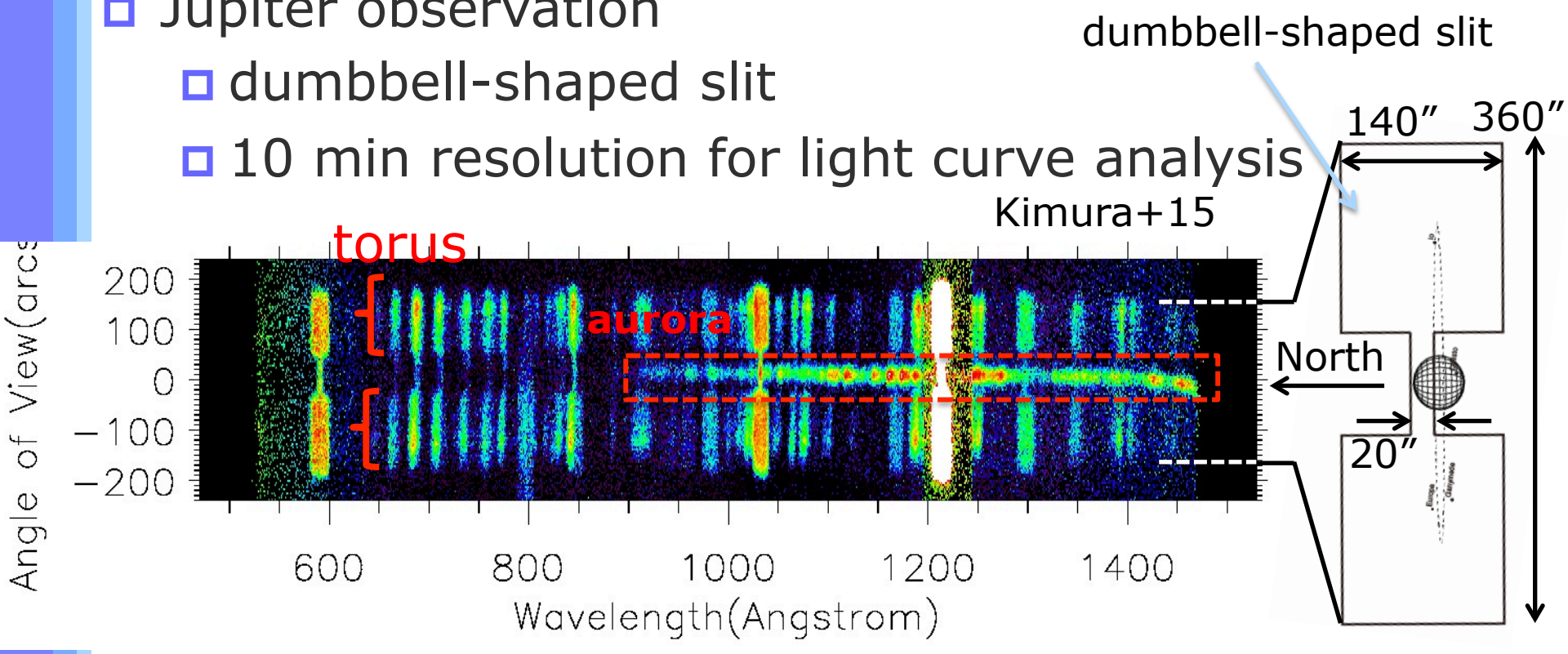
Led by ISAS/JAXA, Univ. of Tokyo, and Tohoku Univ.

Hisaki data

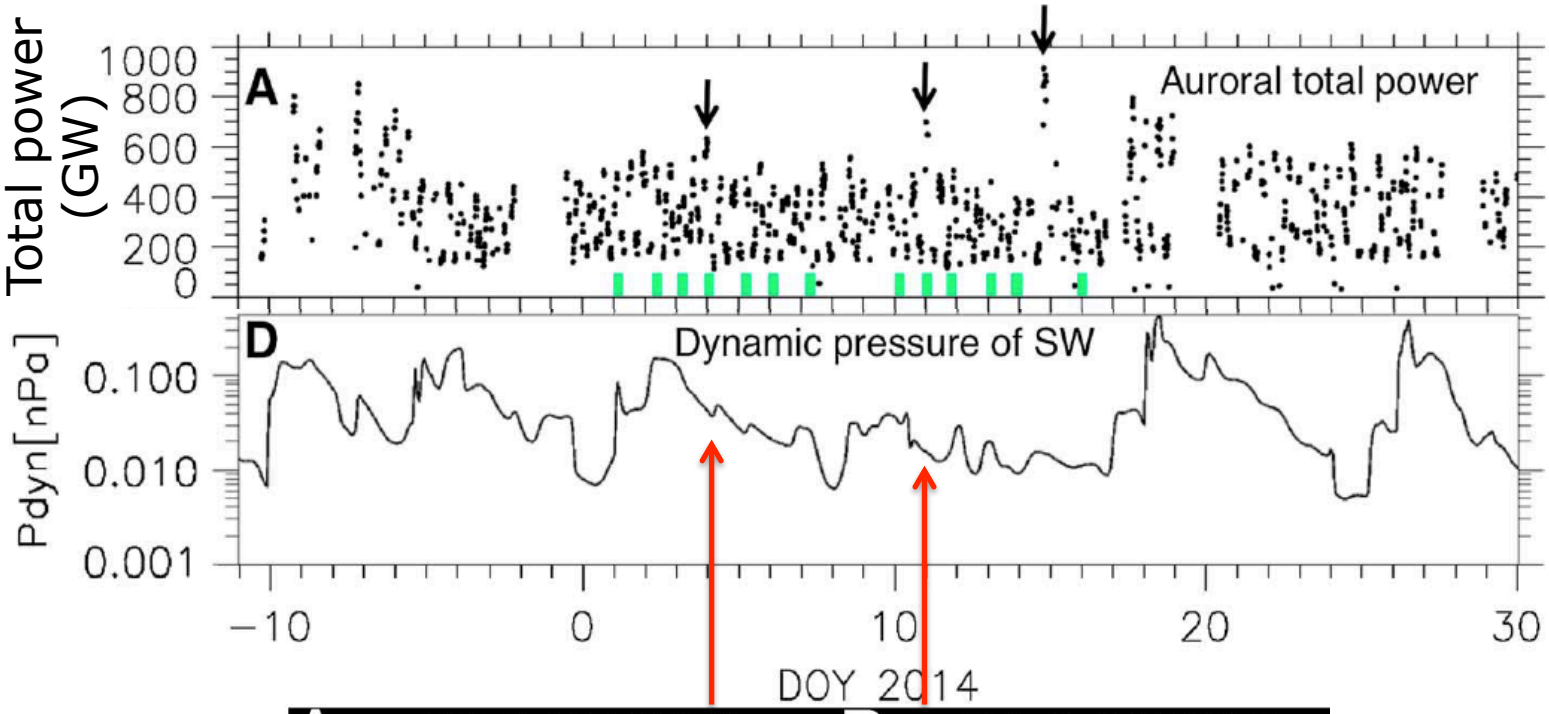
- EUV spectrometer "EXCEED"

Wavelength range	550 – 1450Å
Spatial resolution (for Jupiter mode)	17" (~1Rj around opposition)
Field of view	360" (~20Rj)
Spectral resolution (FWHM)	~1.0 nm (140" slit)
Effective area	2cm^2 @100nm

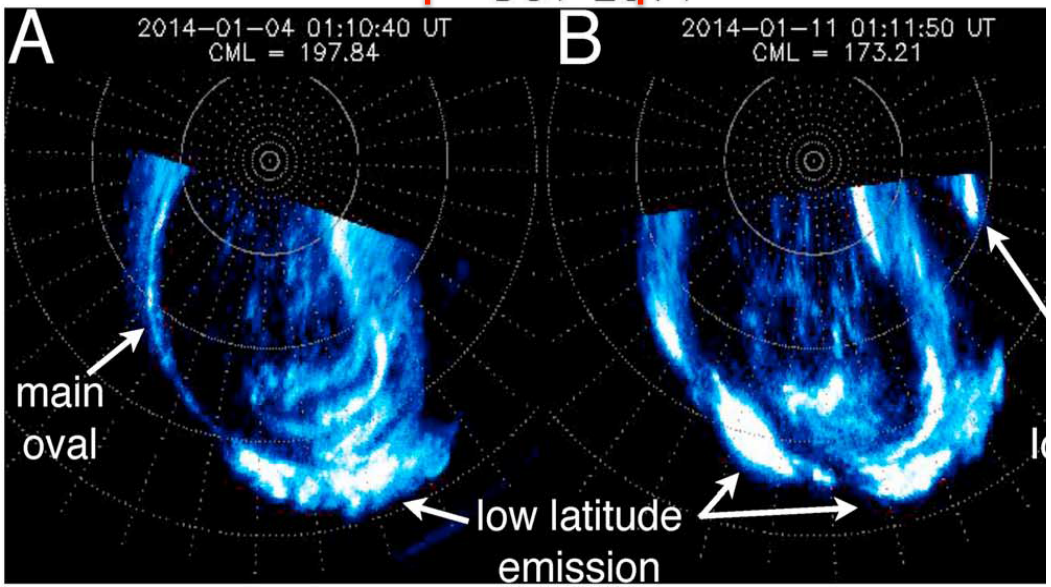
- Jupiter observation
  - dumbbell-shaped slit
  - 10 min resolution for light curve analysis



Transient aurora during SW quiet period

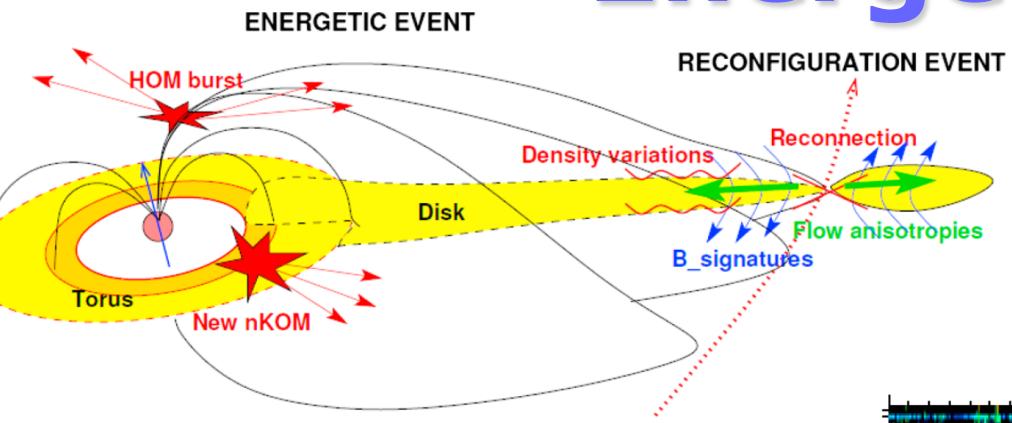


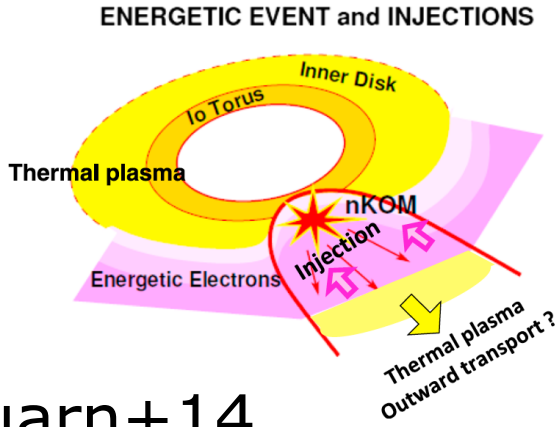
Structure of transient aurora (HST)

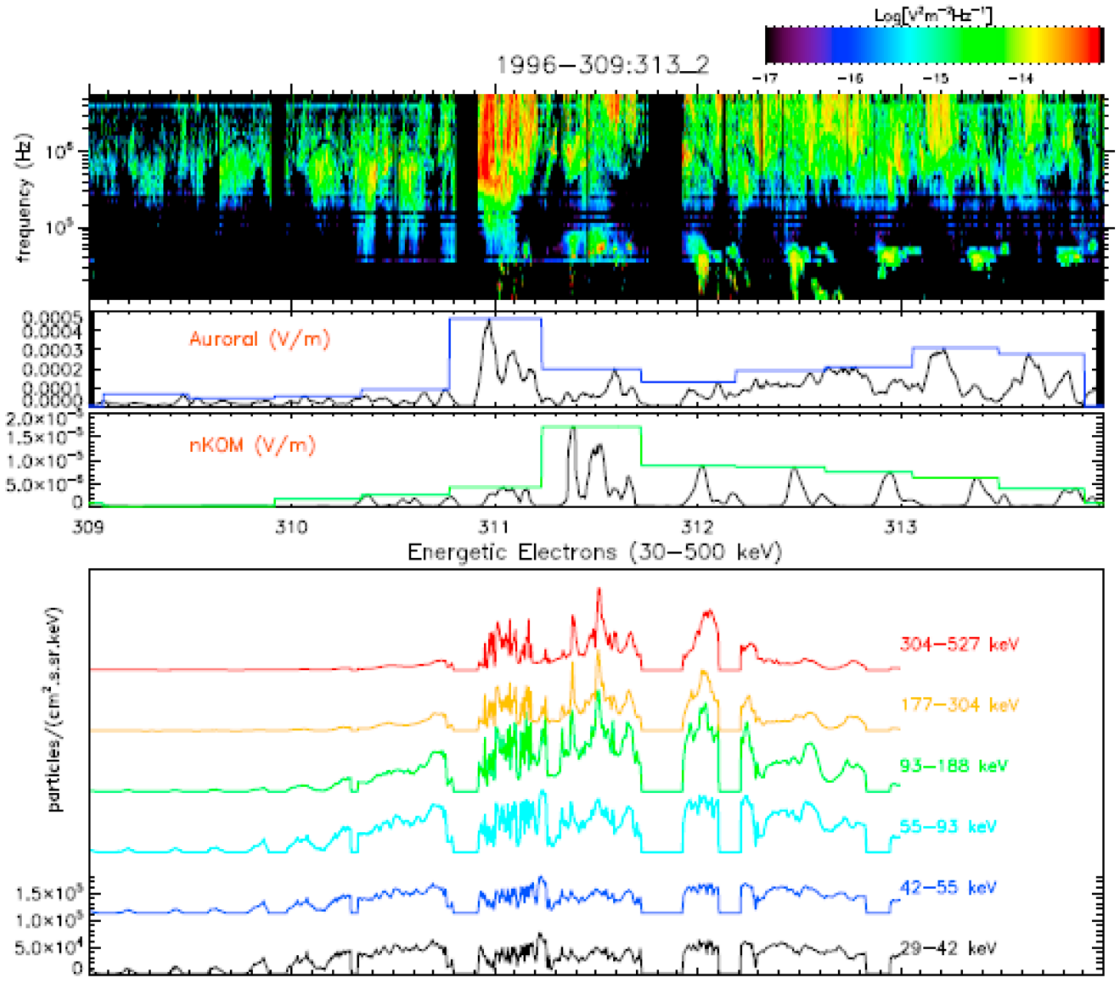


Kimura+15

Energetic event





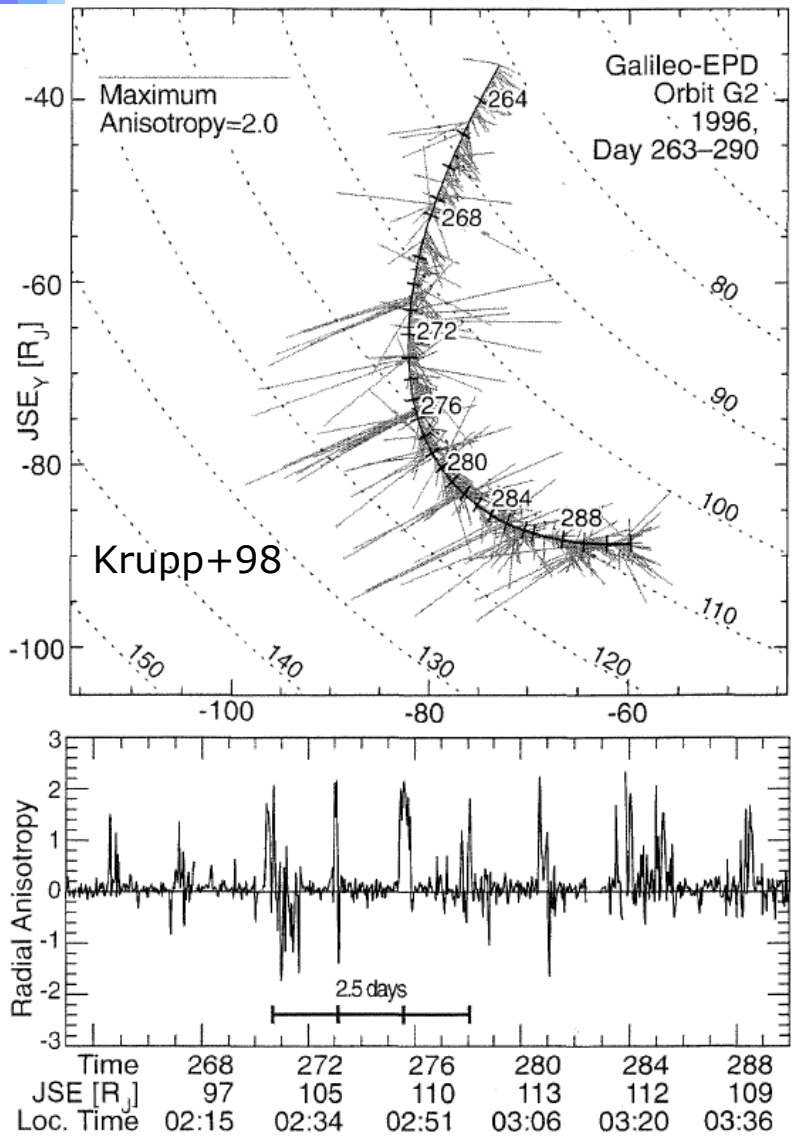


Louarn+14

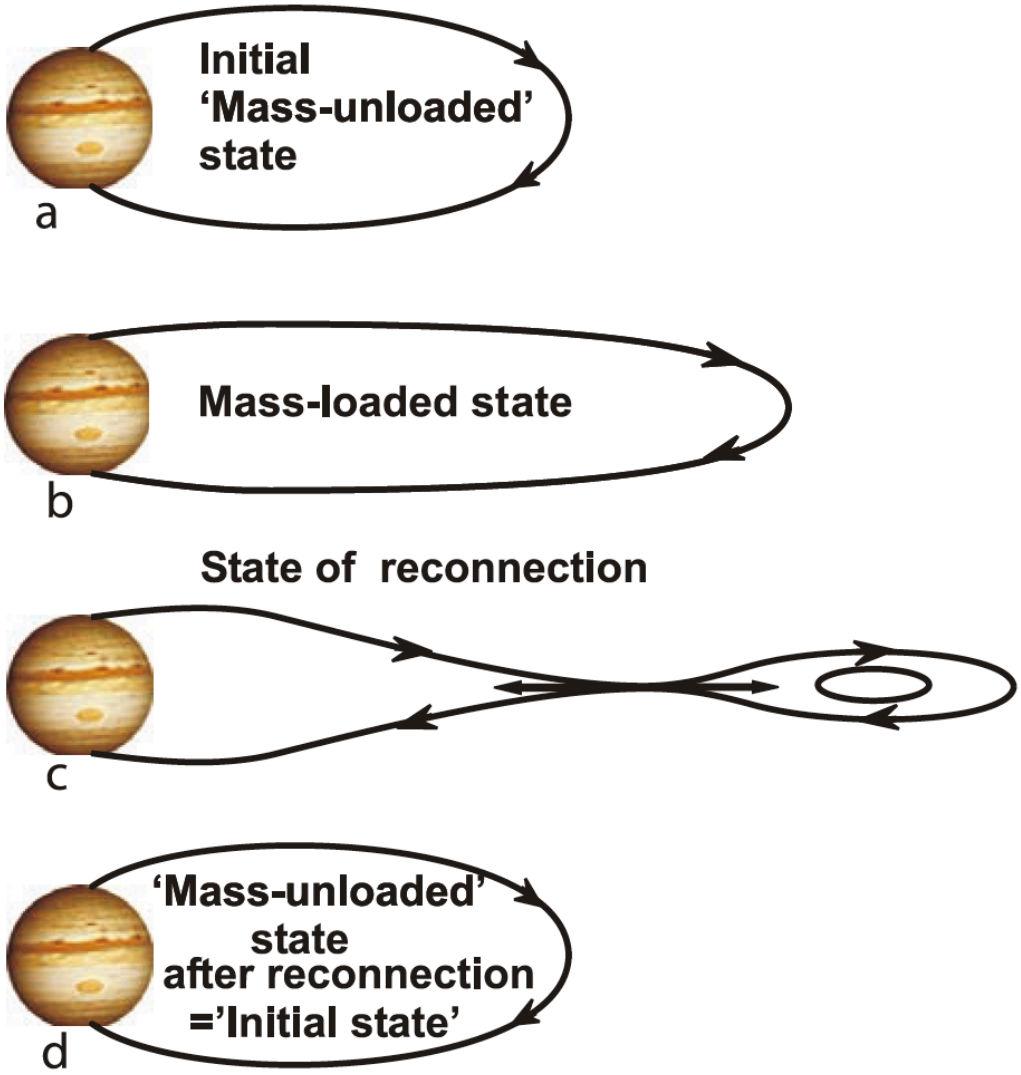
(Louarn et al., 1998, 2000, 2007, 2014)

Vasyliunas tail reconnection

Flow vector of energetic ions in tail region (Krupp+98)



Krongerg+07



Problem

1. Temporal and spatial evolutions of the transient aurora and energetic events were not resolved in previous observations
2. Because of lack of continuous monitoring that spans duration of transient aurora

Purpose

1. Investigate temporal spatial evolutions of transient aurora based on continuous monitoring of aurora with Hisaki & HST
2. Discuss evolution of energetic event

Overview

Power emitted from northern aurora

IMF |B|

IMF clock angle

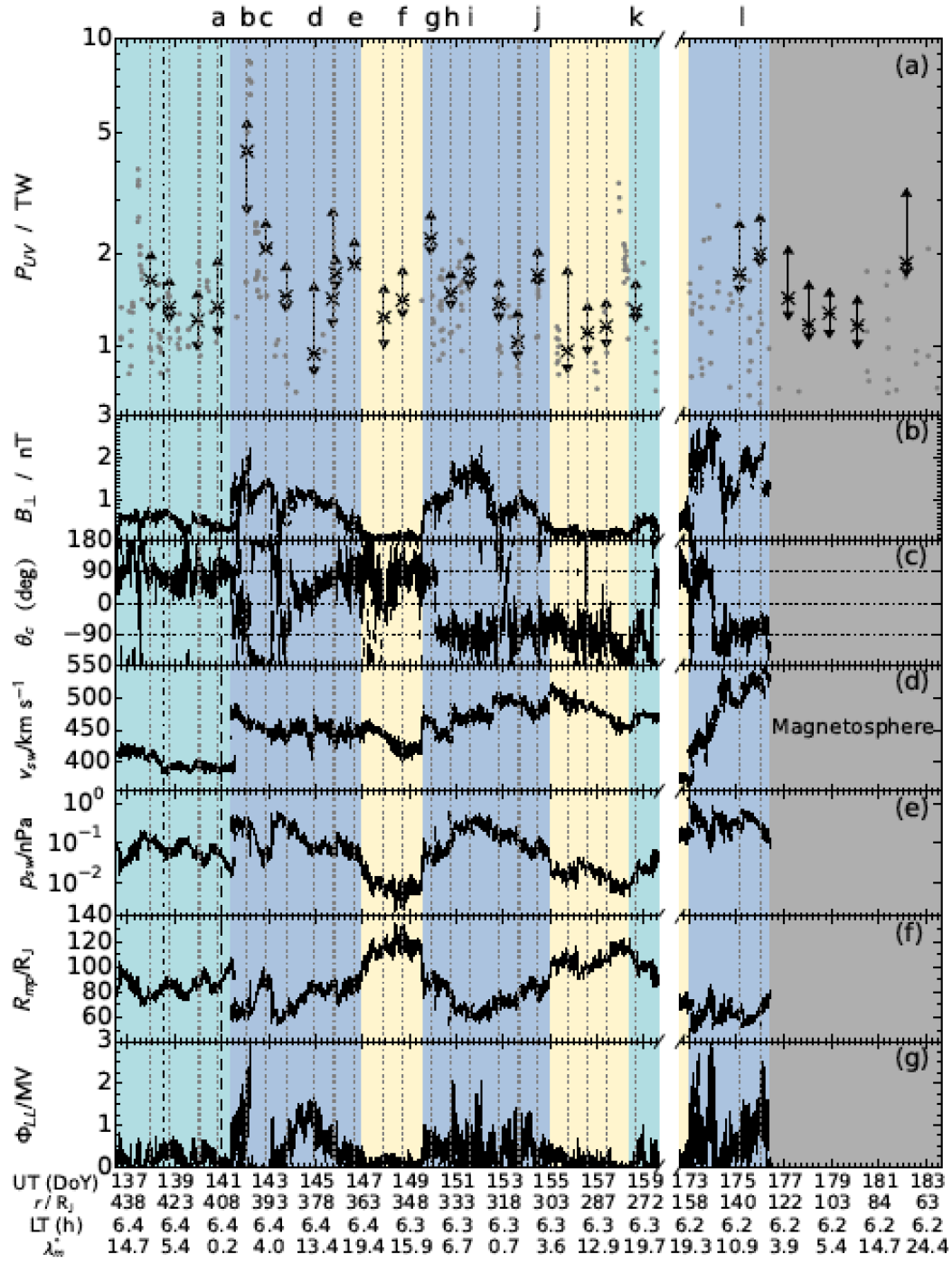
SW radial velocity

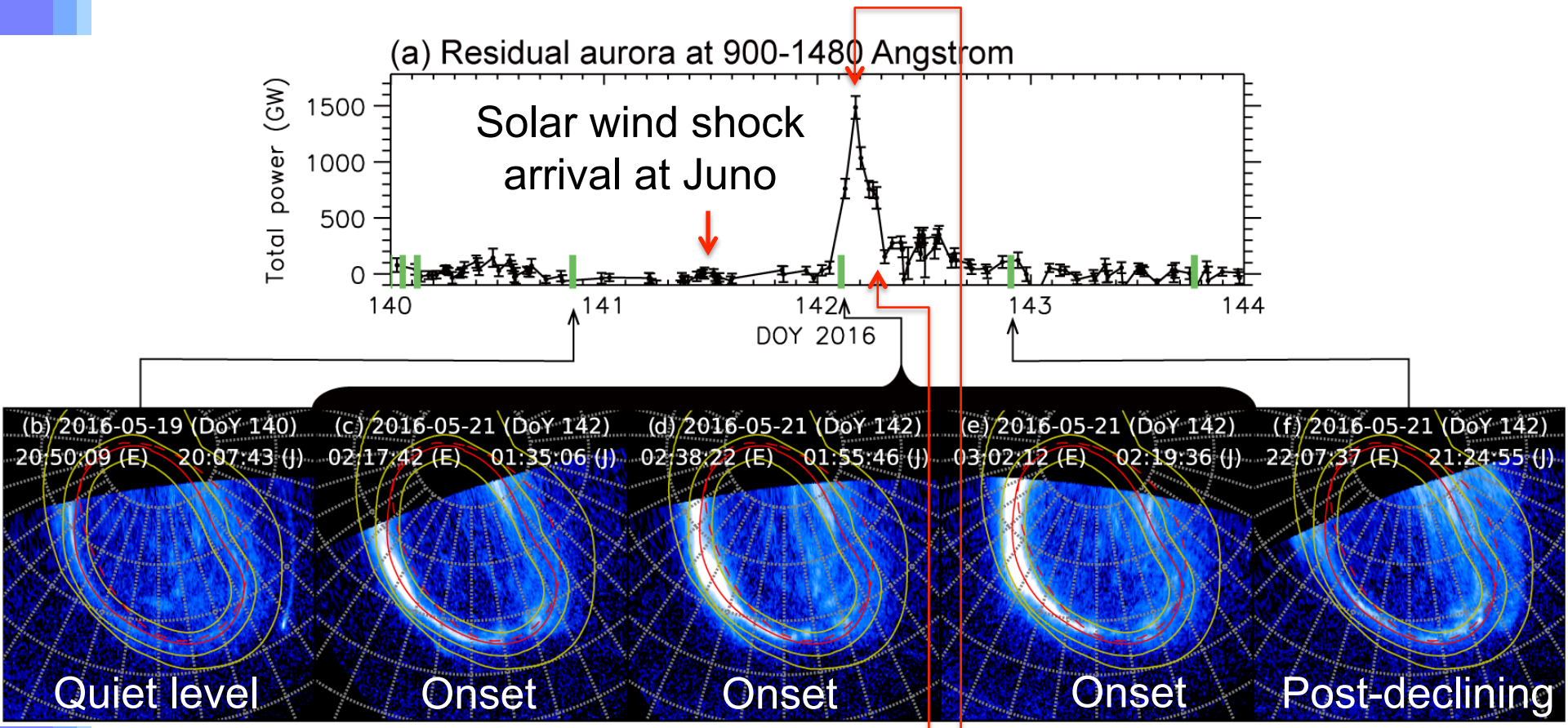
SW dynamic pressure

Magnetopause stand-off distance

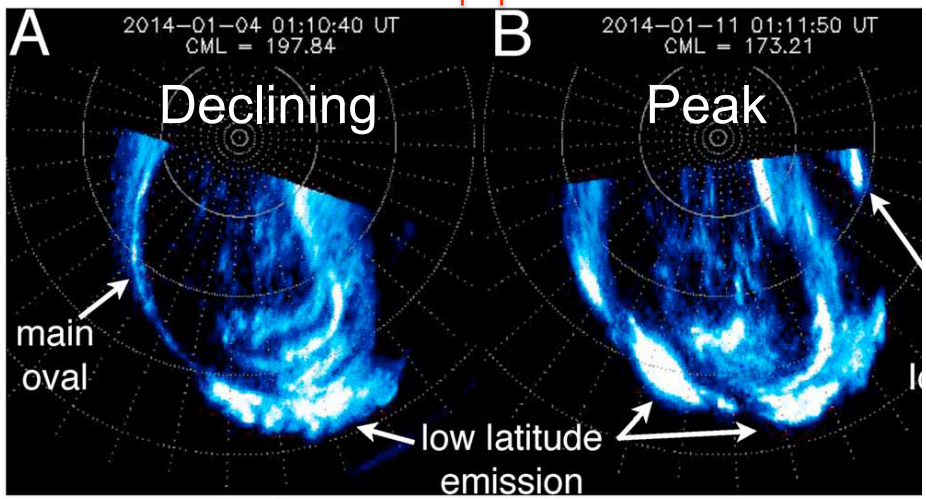
Reconnection voltage

Nichols+17





Kimura+17



Kimura+15

Temporal sequence

timescale of aurora

a few hours

1-2 rotations

tail RX?

injection at inner MS?

Onset

dawn storm initiation with expansion in latitude and longitude, rapid increase in the total power

Peak

continuing dawn storm, spot merging into dawn storm, outer emission initiation, and total power peak

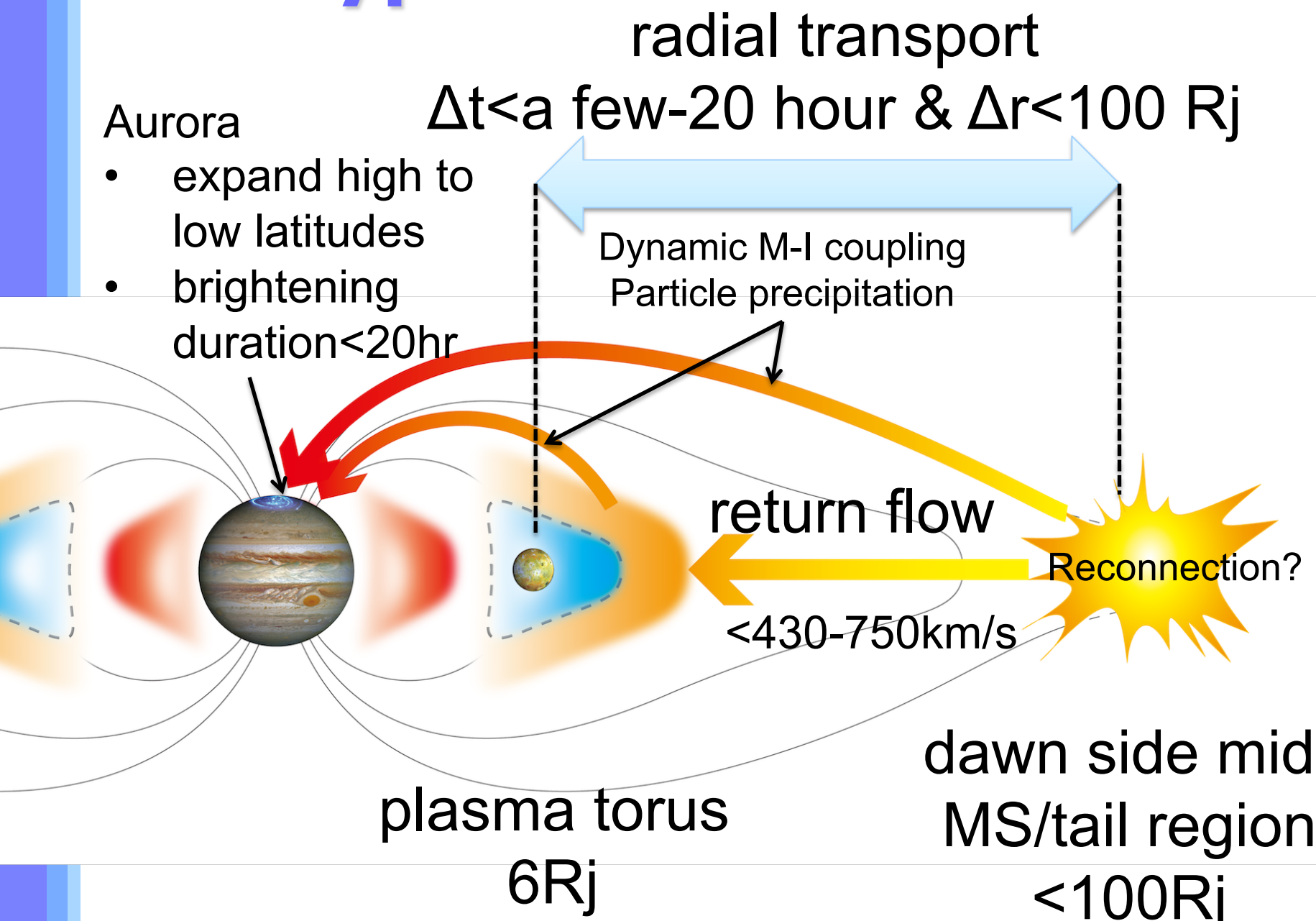
Declining

dawn storm dissipation, continuing outer emission, and total power declining

Post-declining

remnant outer emission, and quiet level of total power

A hypothesis to be tested



Summary

1. By continuous monitoring with Hisaki and HST we discovered a transient auroral emission with one of the largest peak powers that have been observed in the entire Hisaki mission
2. Dawn storm is found to be followed by outer emission during the transient aurora
3. We speculate energy for these disturbances is released via tail reconnection and transported to Jupiter within a few – 20 hours