ISAS seminar 2011/4/27

The current status of the analysis of the Jovian infrared auroral data and the development of the near-infrared echelle spectrometer

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Introduction: Jovian MIT coupling

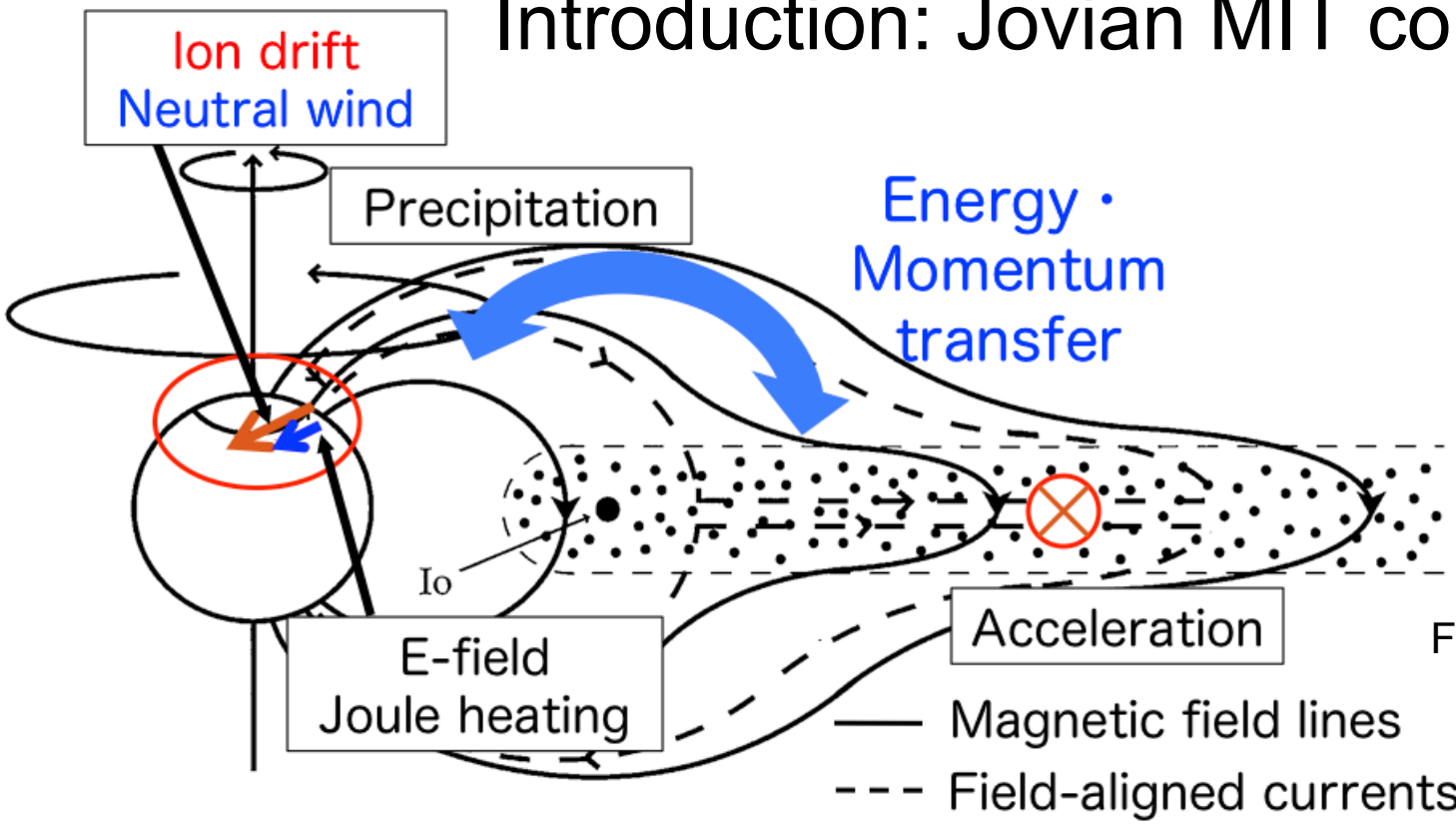


Fig. Mechanisms of the Jovian MIT coupling system (Cowley and Bunce, 2001)

the dynamical and electromagnetic coupling between the Magnetosphere, Ionosphere, and Thermosphere (MIT coupling)

- The electric field originates from the Jovian rapid rotation and dynamics of the magnetospheric plasma cause Joule heating and ion drift in the thermosphere.
- The penetrating electrons cause auroras

Introduction: thermosphere and aurora

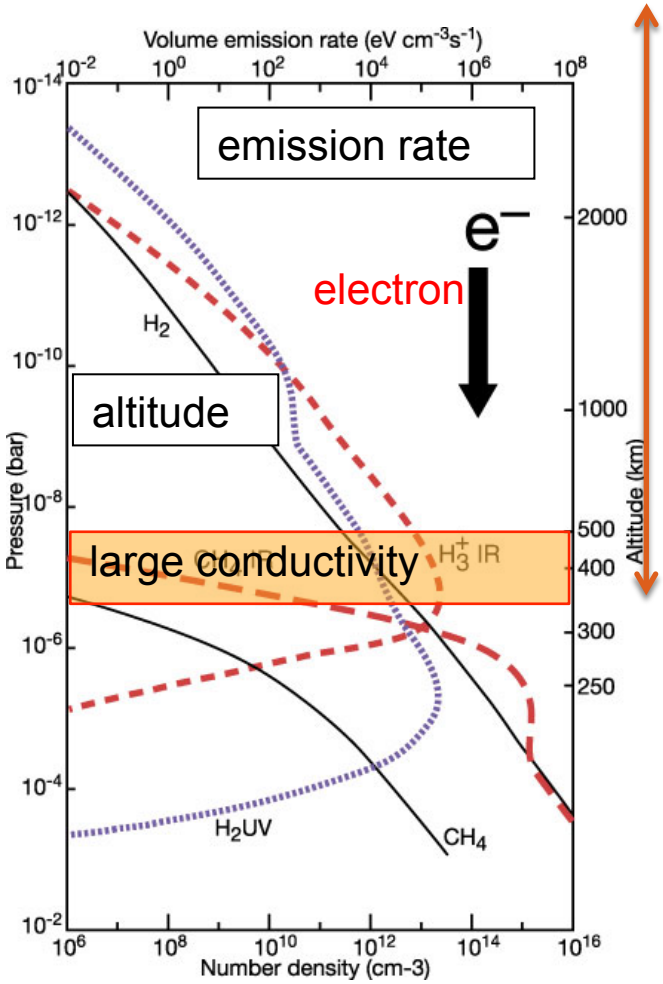


Fig. Jovian thermospheric structure and auroral emission (Grodent et al., 2001)

Thermosphere

This thermospheric region emits the infrared aurora in 2-4 microns
from H2 (neutral) and H3+ (plasma).
This region is the key region for the MIT coupling, because the large electric conductivity.
The remote sensing of the aurora is the best way to investigate this region.

H2 (neutral) emission reflect the atmospheric temperature caused by e- precipitation and Joule heating.
H3+ (plasma) directly reflect the precipitation and atmospheric temperature.

H2 and H3+ emissions seem to show the same morphology…

Past observation

Intensity maps

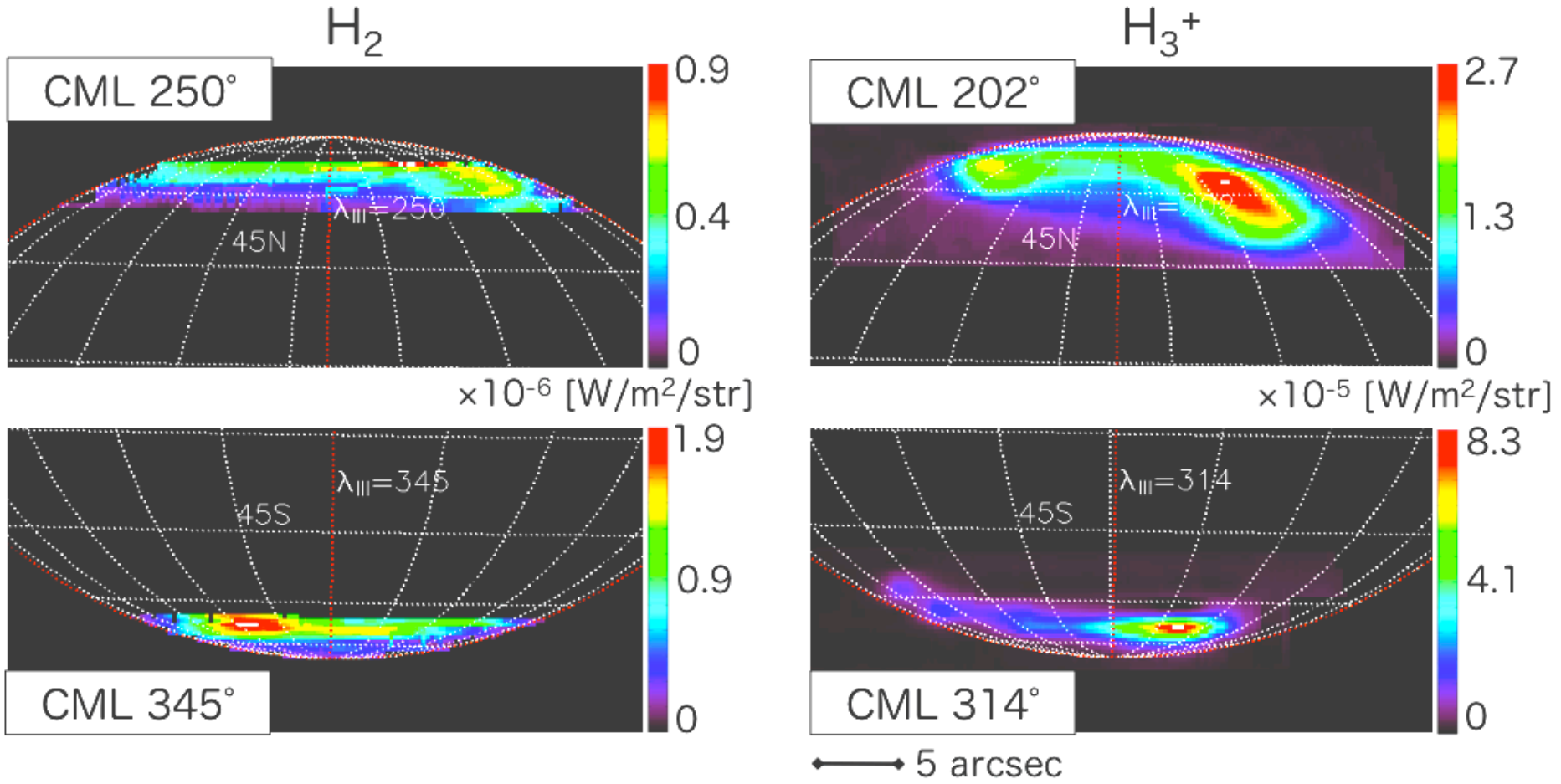
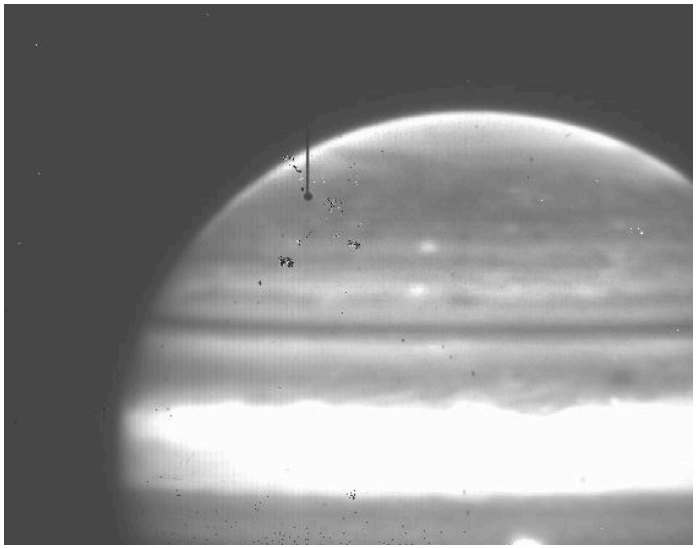
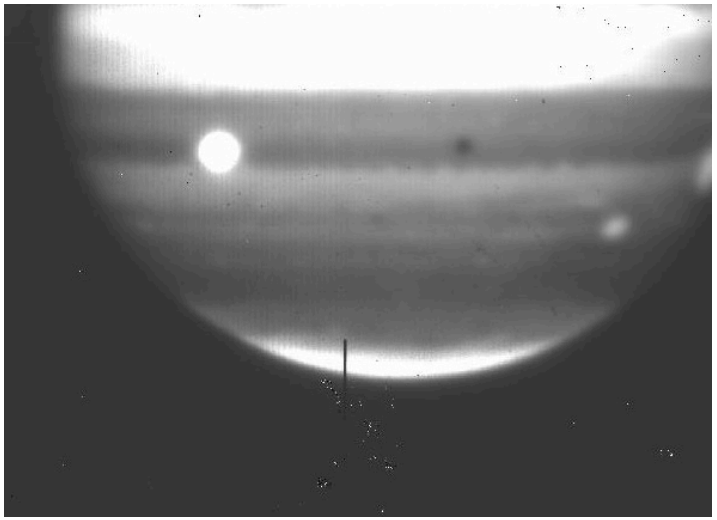


Fig. 2009/9/6 Jovian aurora (left : H_2, right : H_3^+; top: North, bottom: South)

In past, observation, we show the morphological differences of the H2 and H3+ aurora. What is the origin of this difference?

Subaru





Observations in last year

table. Observation status

date	2010/9/16, 18, 25		10/12
Instrument	IRTF/CSHELL		Subaru/IRCS
Diameter	3 m		8 m
Target lines	H_2 $S_1(1)$ 2.122 μm	H_3^+ $Q(1,0^-)$ 3.953 μm	H_2 & H_3^+ 2 μm
Integration times	5 min.×6 (total 2h)	1 min.×10 (total 0.5h)	6 min × 14 step (total 2h)
Field of View	0.5 ” × 30 ”		0.14” × 5”
spectral resolution	43,000		20,000
Objectioves	H_2、H_3^+ Intensity、velocity		H_2、H_3^+ Intensity、Temperature

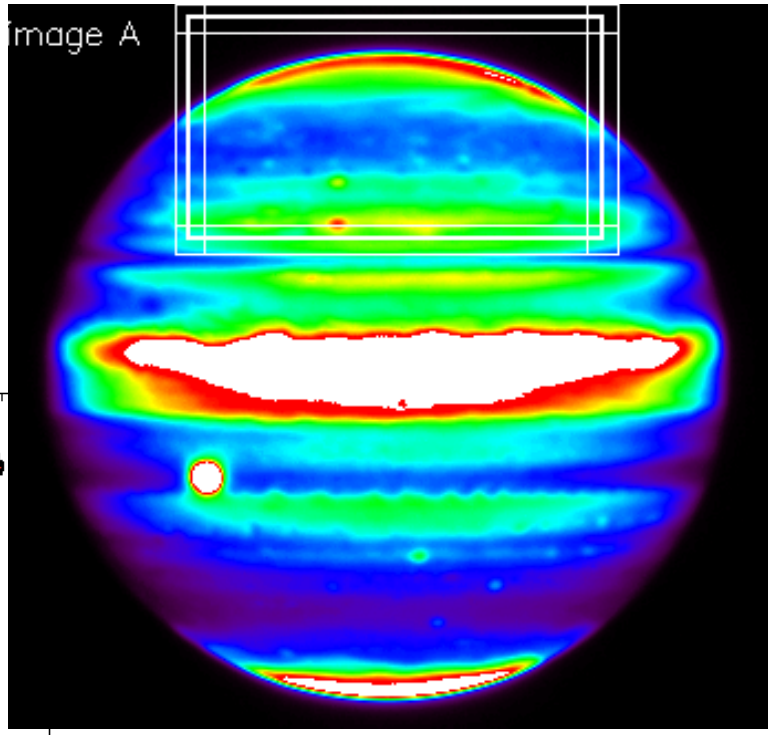
We proposed the measurement of the distributions of brightness, temperature, and line-of-sight velocity of Jovian H2 and H3+ to reach the morphological difference.

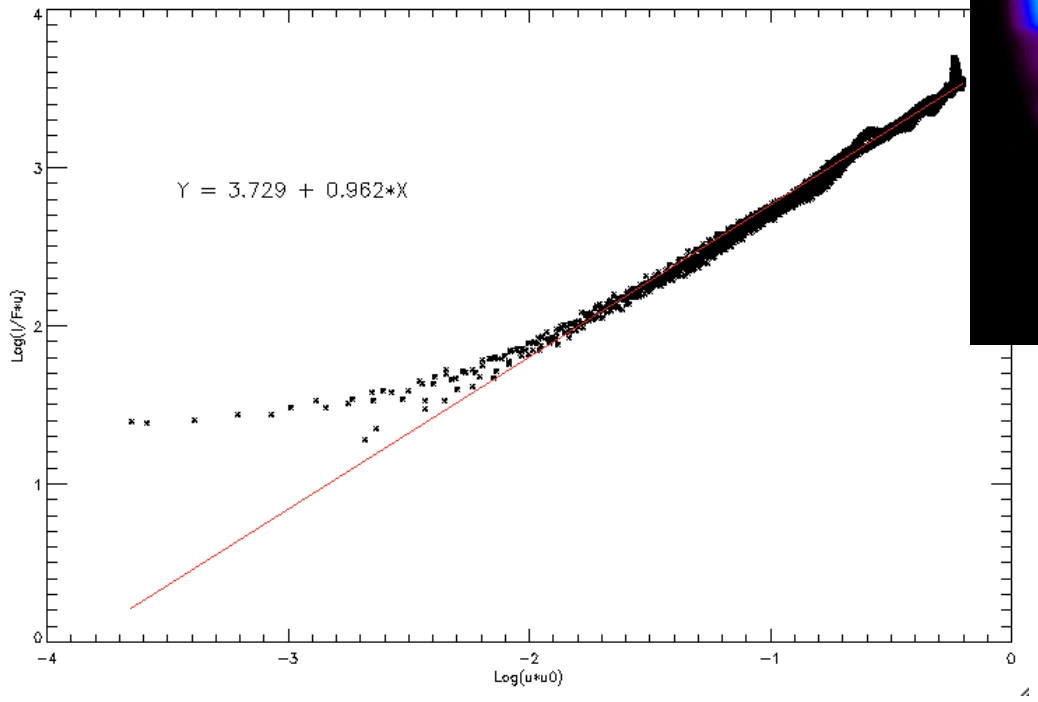
Analysis

Definition of the Center position

- Fitting of the Minnaert function

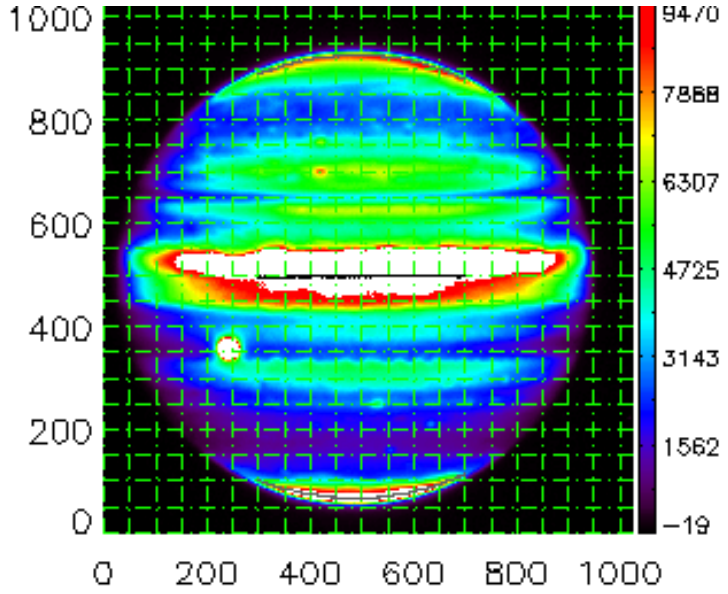
[東西]
緯度ごとに領域を区切って計算
±3 pixel　= 0.2 arcsec



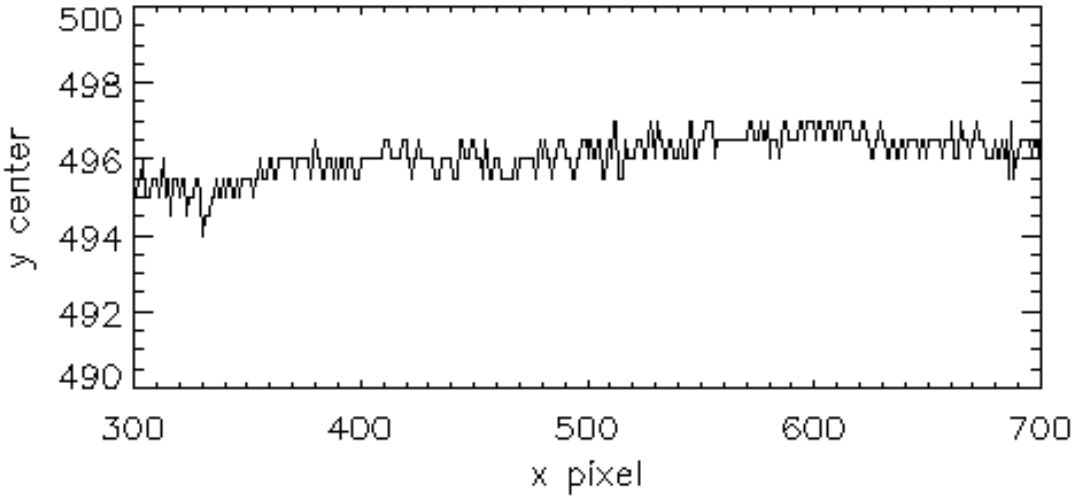


Definition of the Center position

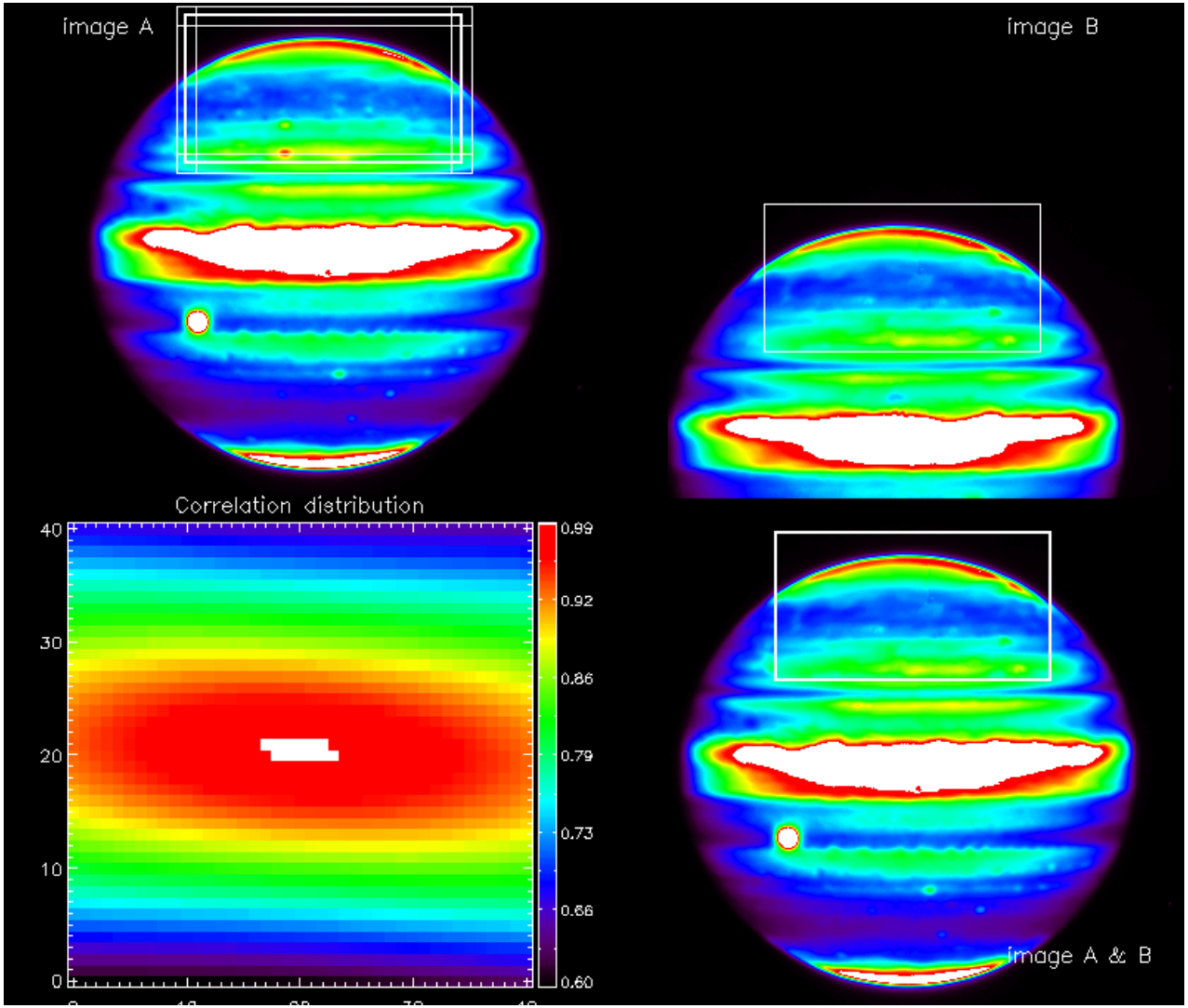
- 極の明るさ最大座標の中央



[南北]
±2 pixel = 0.1 arcsec



Definition of the Center position

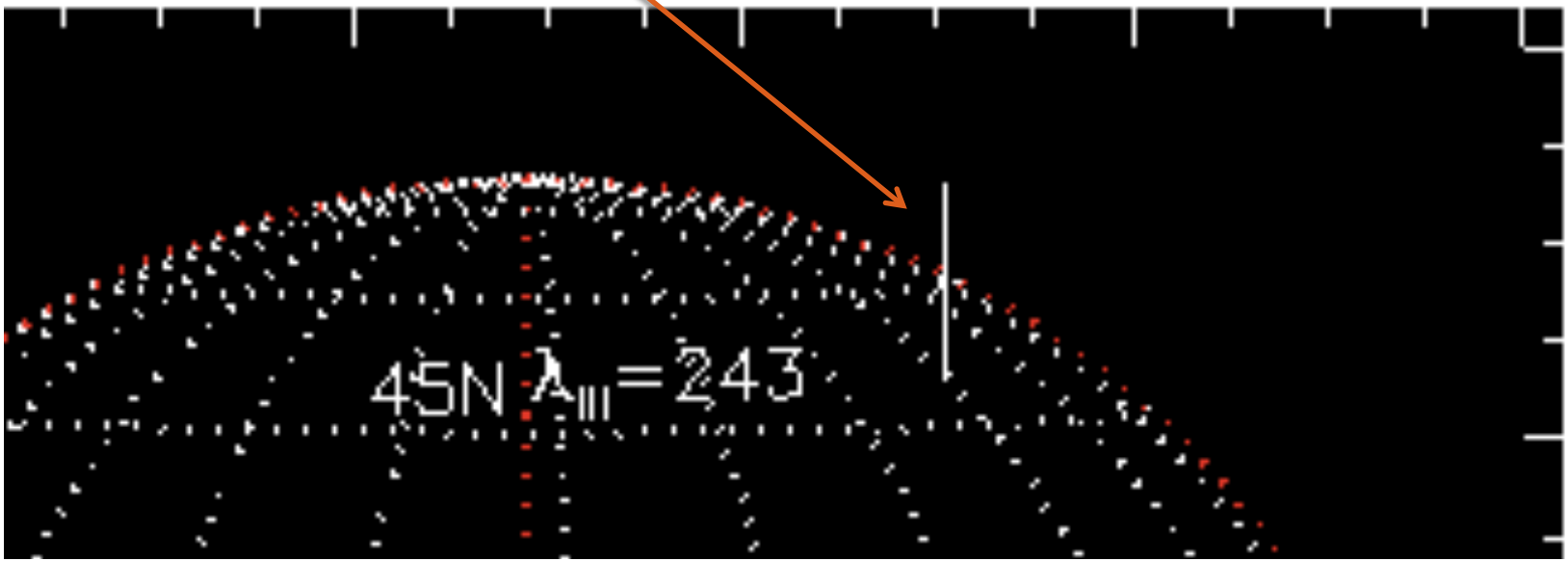


相関をとり、各slit位置での木星中心を決定

Definition of the Slit position

- Slit 位置の決定が完了
- 今後、発光強度、温度のmappingを行う

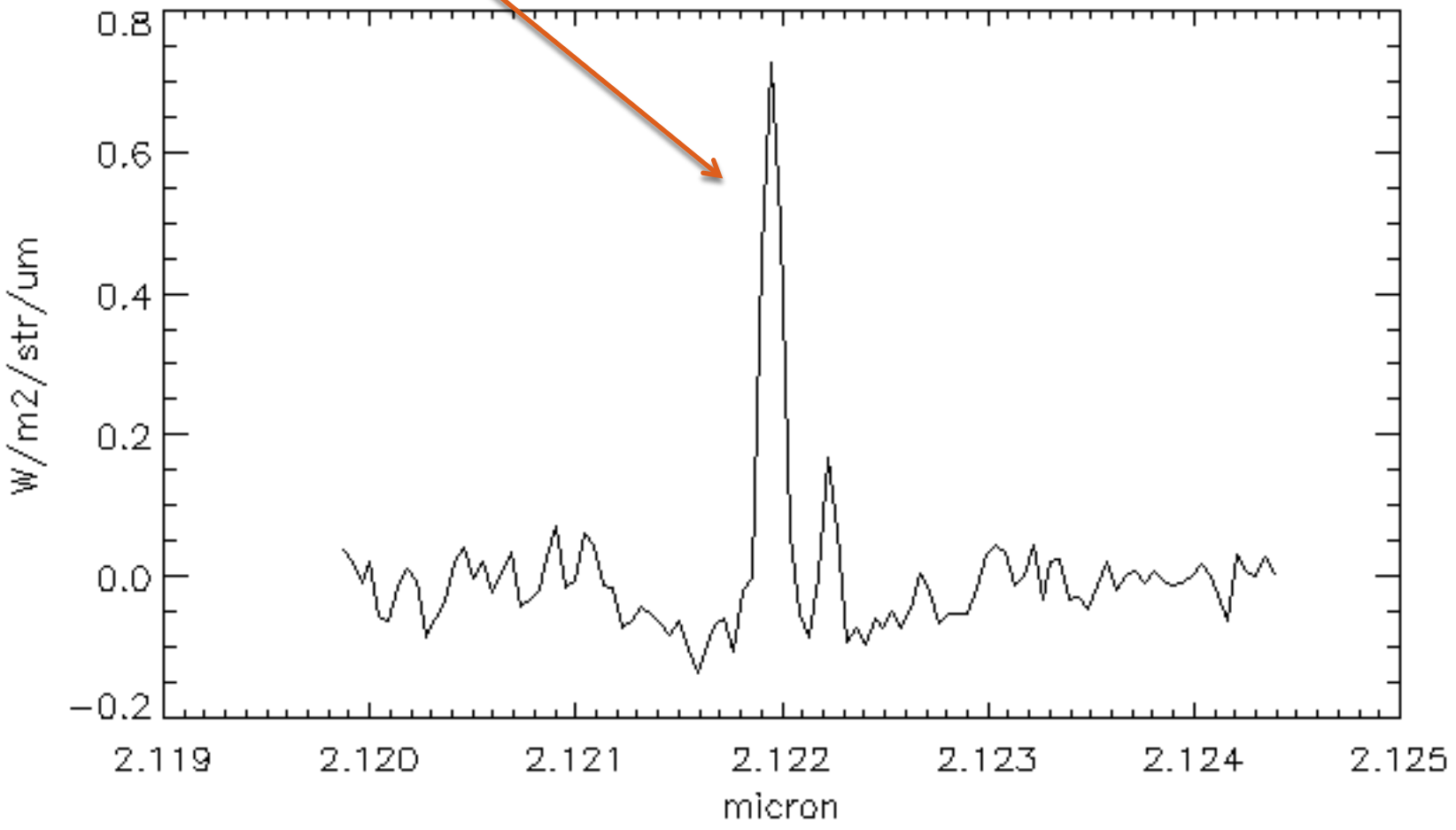
Slit位置
(一例)



Flux calibration

H2輝線

絶対値が合わない。
計算確認中



Development

Scientific Targets and Priority

Table. Scientific targets and the success level of our spectrometer

Success Lv.	target	Intensity [W/m^2/str]	Velocity	Integration time	Obs. sequence
Minimum	Jovian H_3^+ 3.9μm intensity	5x10^{-6}	few km/s	2-3 min/1 shot	1 map/day, continue for several weeks
Nominal	Jovian H_3^+ 3.9μm velocity	5x10^{-6}	few km/s	2-3 min/1 shot	1 map/day, continue for several weeks
Full	Jovian H_2 2.1μm intensity	5x10^{-7}	-	5 min/1 shot x 6	After H_3^+ observation, 1 slit position
	Venus 1.27μm airglow	～1x10^{-5}	-	1 min/1 shot	In the daytime
	Venus 2.3μm CO,CO2	～1x10^{-5}	-	1 min/1 shot	In the daytime
Extra	Jovian H_2 2.1μm velocity	5x10^{-7}	100-300 m/s	5 min/1 shot x 6	Before or after H_3^+

We are developing the echelle spectrometer, which is optimized for observation of Jovian aurora in 1-4 um.

Optical Design

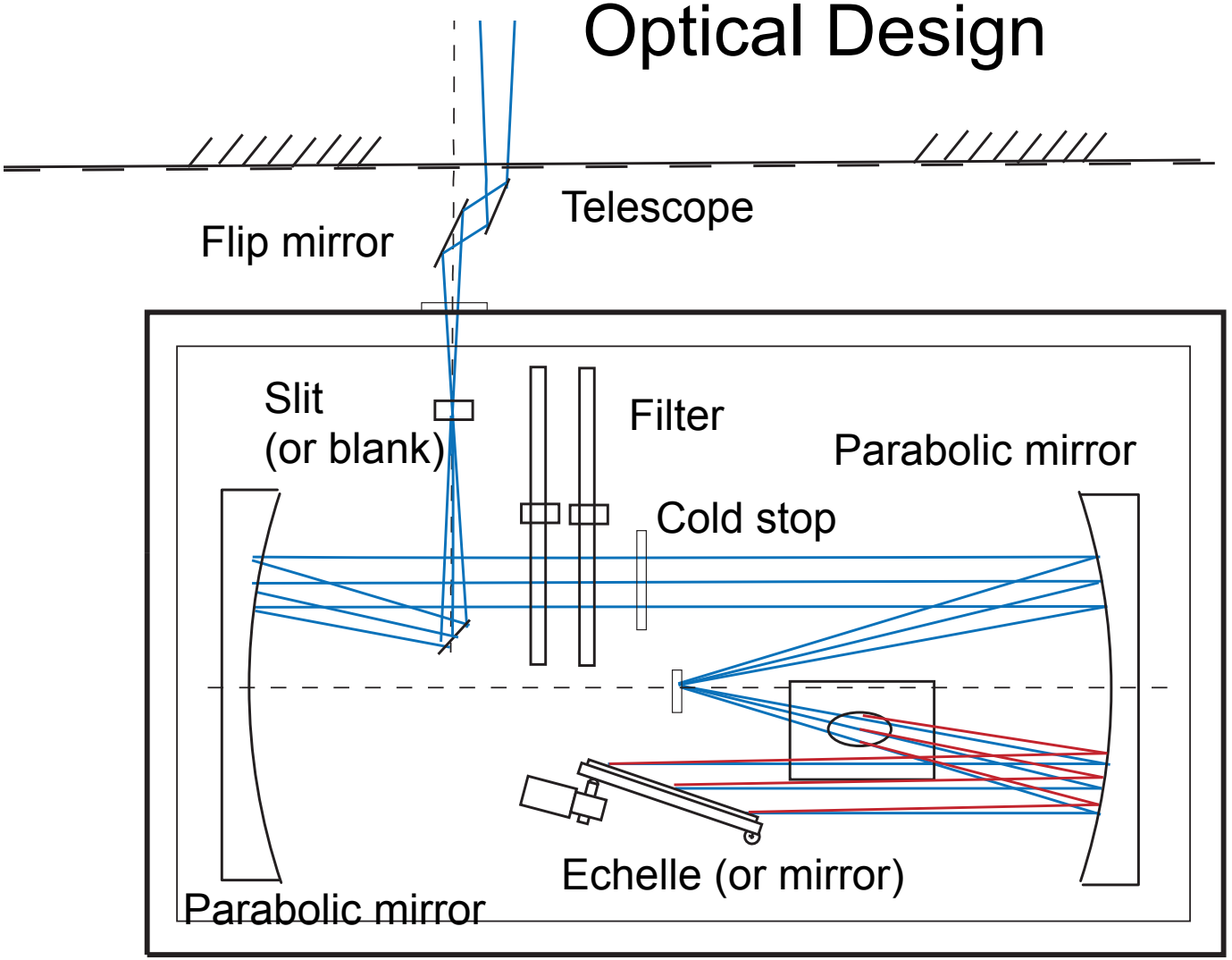


Fig. Optical Design of our spectrometer

This spectrometer has camera mode.

END