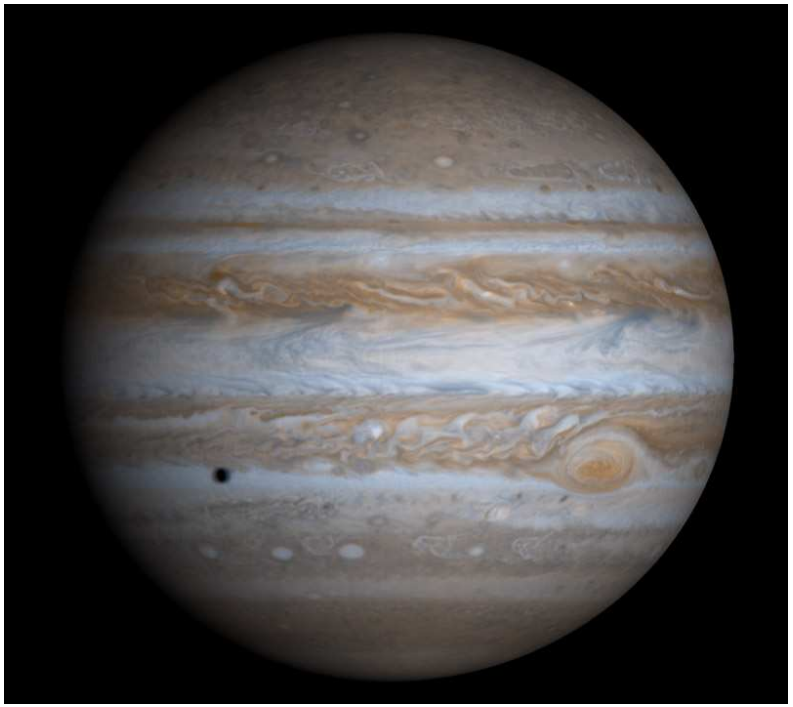
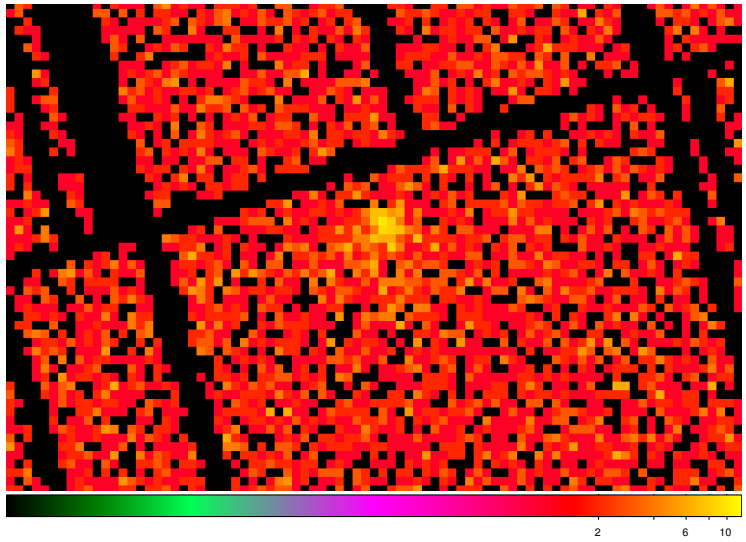
X-ray Observations of Jupiter

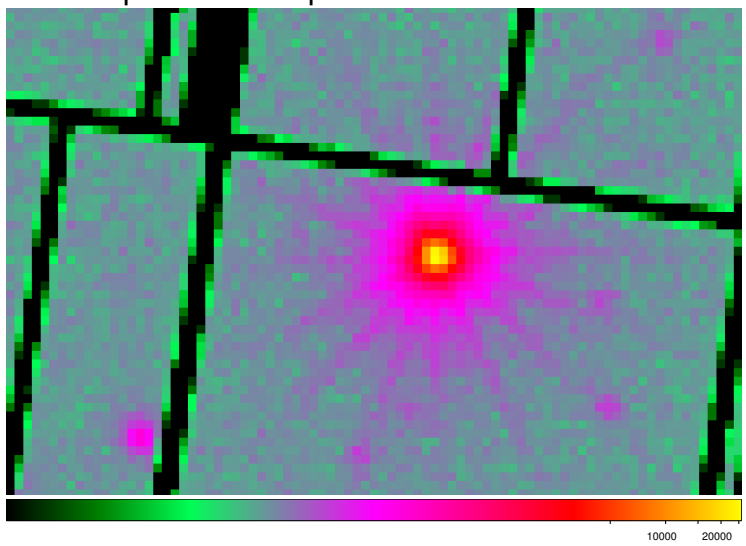
presented by A. Lohfink



Planet vs. Seyfert Galaxy



Jupiter in EPIC-pn



MCG-02-14-009 in EPIC-pn

Same detector and approximately same exposure...

- Seyfert Galaxy: much farther away but brighter
- Planet: *much* closer but much fainter

$\Rightarrow$ What produces X-rays on/around Jupiter?

Or differently:

Why should I want to look at such bad data?

How to produce X-rays?

There many processes that lead to the generation of X-rays, this is a selection:

- synchrotron radiation: take charged particles in B-field and accelerate them along field lines
- bremsstrahlung: light weight charged particle (e.g. e^-) gets decelerated in field of big nucleus
- Comptonization: inverse Compton scattering (γ scatters on e^- and gains energy)
  $\Rightarrow$ All of these produce a smooth continuum, which looks like a hump!

charge exchange:

$$A^{q+} + M \rightarrow A^{(q-1)+,*} + M^- \rightarrow A^{(q-1)+} + M^- + \gamma$$

A^{q+}: highly ionized atoms

M: target

Why observe Jupiter in X-rays?

possibilities to learn about:

- magnetosphere
- interaction with solar wind

How?

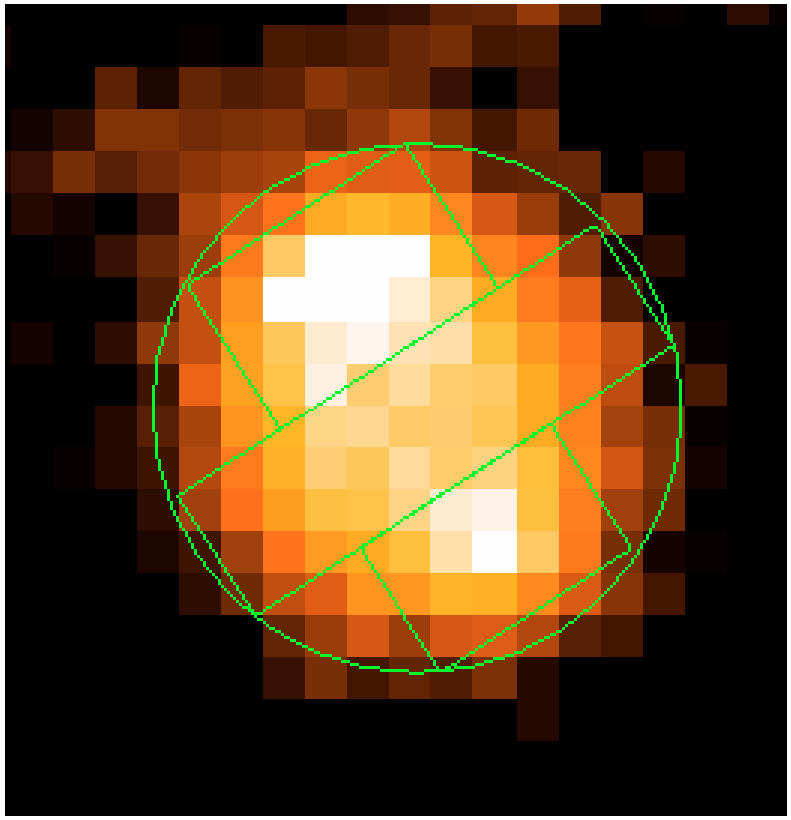
Big effective area needed to collect enough photons $\Rightarrow$ *XMM*

But: PSF is too big

$\Rightarrow$ regions not spatially resolved

$\Rightarrow$ demix

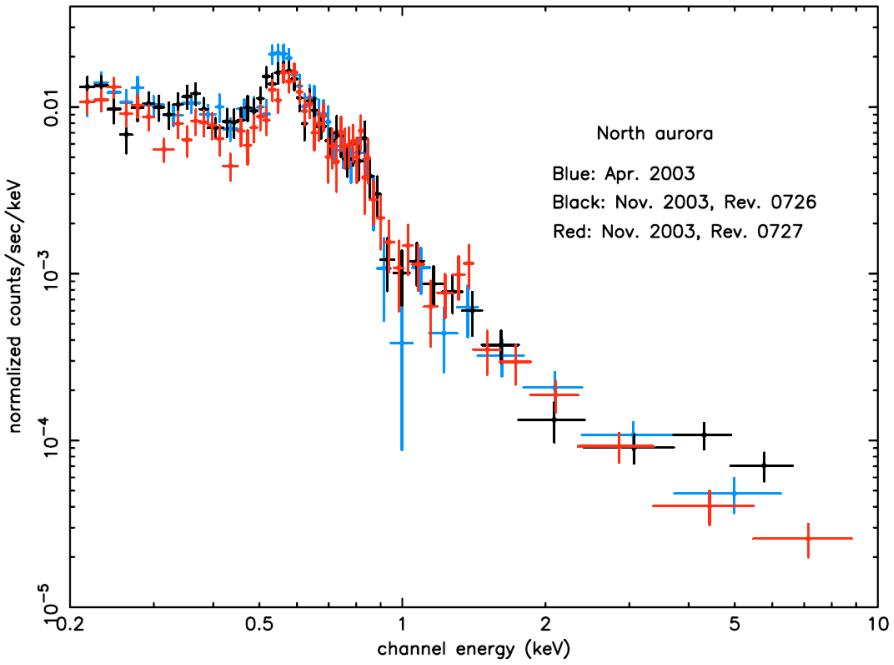
The Data Reduction/Images



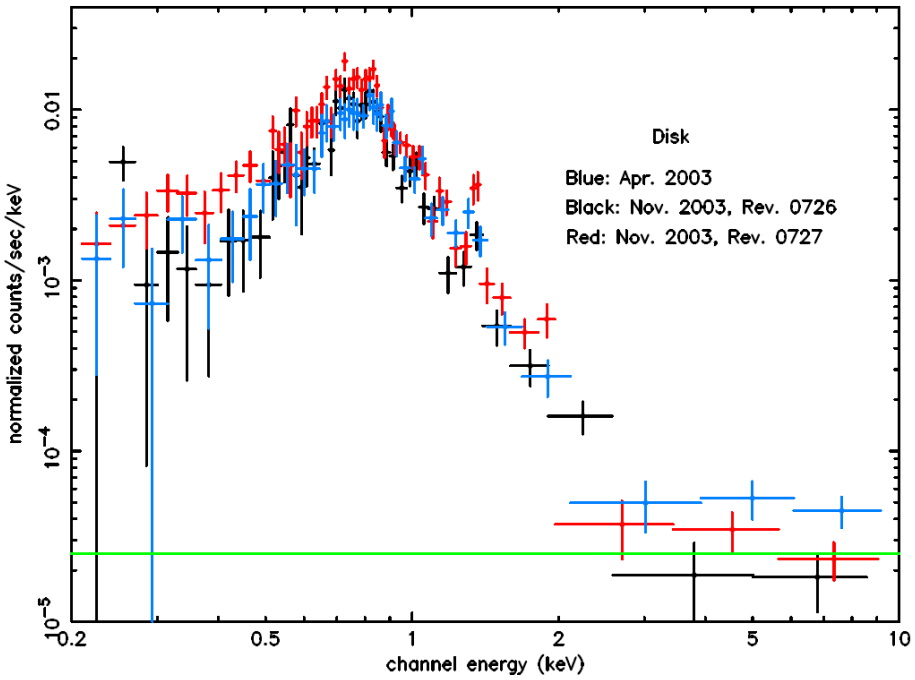
Branduardi-Raymont 2007

- 3 *XMM* observations (110+245 ksec)
  - April 2003
  - November 2003
- 3 different regions
  - 2 auroral region: anti-correlated with solar flux
  - disk region: correlated with solar flux

Spectra I



Branduardi-Raymont 2007



Branduardi-Raymont 2006

- spectral shape different between aurora and disk ⇒ need different models
- auroral region: spectrum extends to higher energies
- disk region: spectrum truncates earlier

Spectra II

Aurora spectrum:

- best fit model: bremsstrahlung + bremsstrahlung/power law + lines
- depends on flux
- lines: OVII, OVIII

Disk spectrum:

- best fit model: plasma model + lines
- lines: MgXI, SiXII
- does not change with flux

$\Rightarrow$ solar wind

Results/What does it all mean?

What is happening at the poles?

1. e^- get accelerated [$\Rightarrow$ produces continuum at higher energies ??]
2. ions get created by charge exchange $\Rightarrow$ produce lines
3. e^- brake at ions $\Rightarrow$ bremsstrahlung

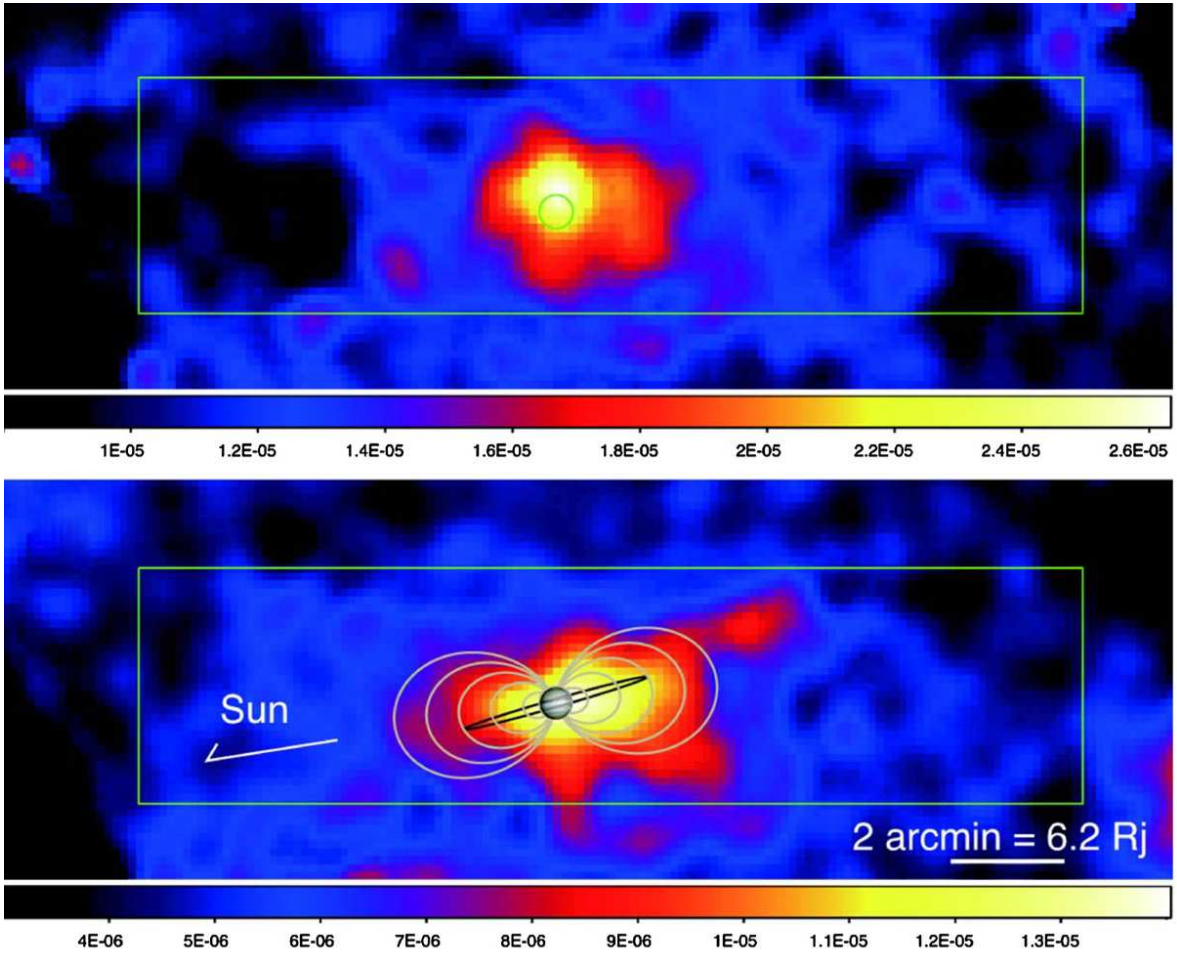
What is happening at the equator?

1. solar wind hits outer atmosphere of Jupiter and interacts with it...

Open Questions?

- Where? How? And which ions are created in the auroral regions?
- What is the high energetic component?
- Is the disk emission independent of the magnetosphere?

Suzaku



Top: 0.1-1 keV band image **Bottom:** 1-5 keV band image

Ezoe, et al. 2010