



On the interest to observe the Galilean Satellites atmospheres with LUVOIR

F. Leblanc, C. Schmidt & A. Oza

LATMOS/CNRS, UPMC, Paris, France

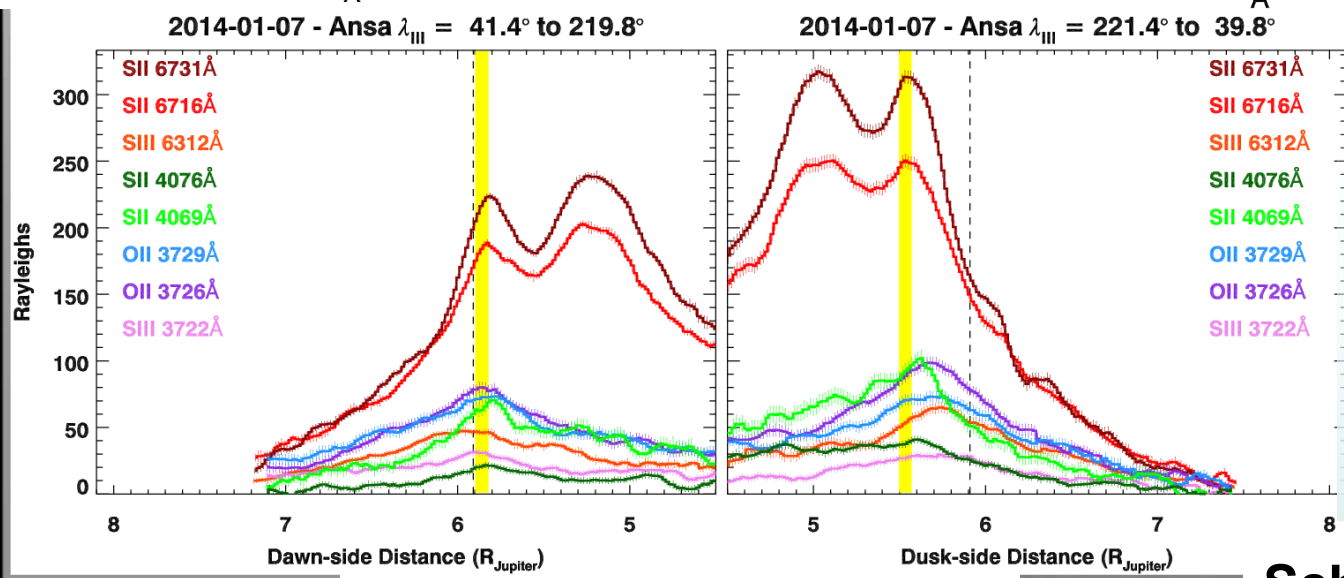
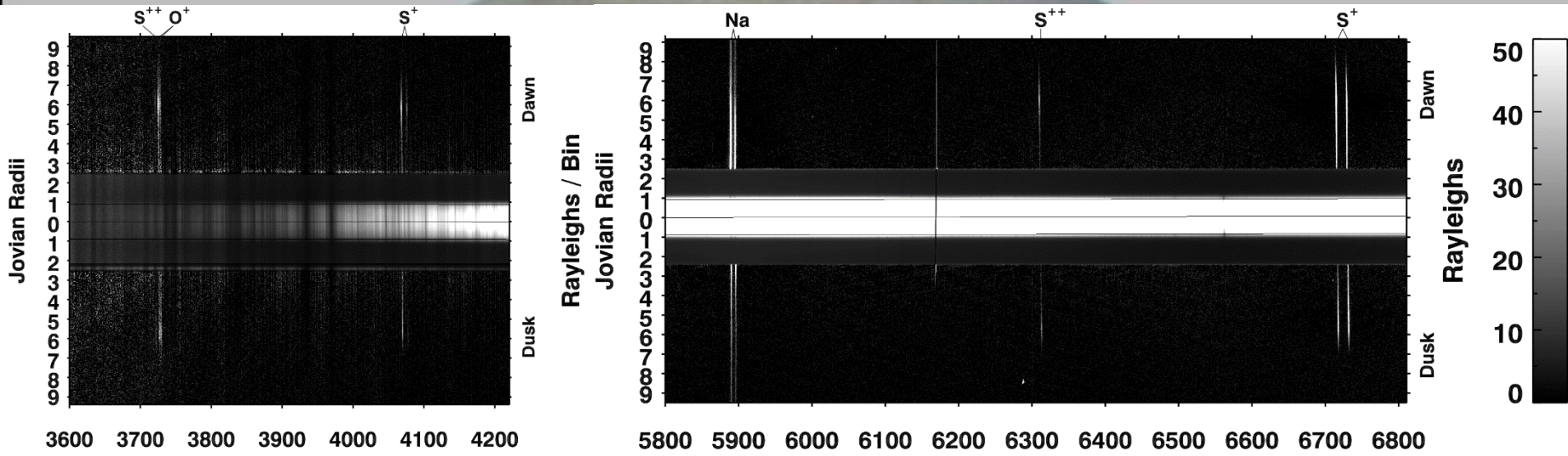


Io atmosphere and torus

January, 11, 2017

Atelier de prospective pour une contribution française au LUNAR

Visible Spectrum of the Torus (APO)



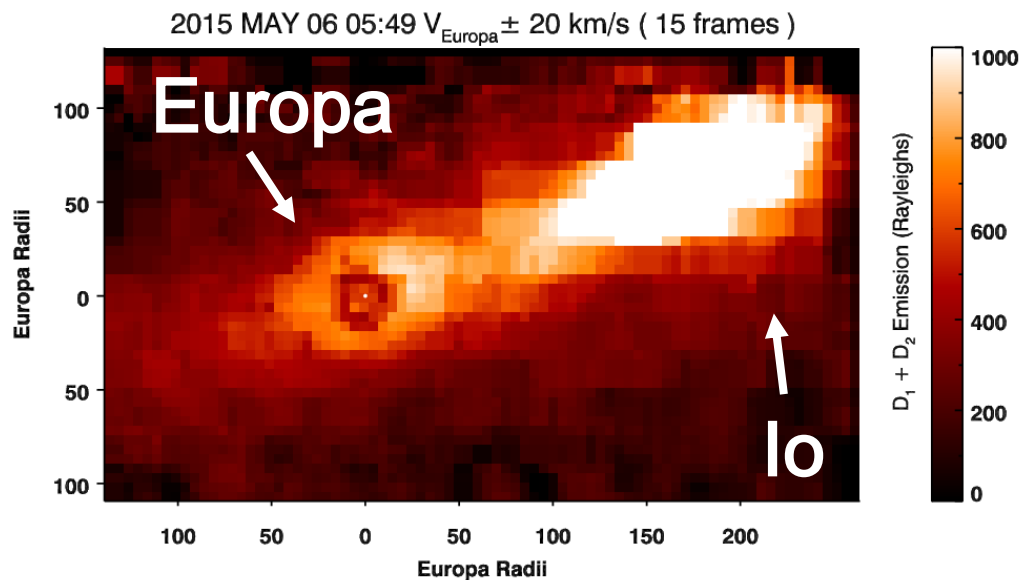
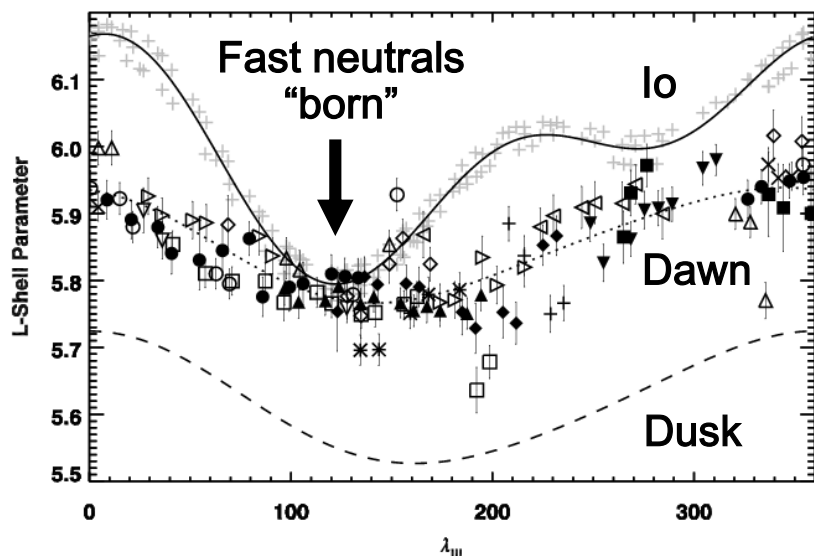
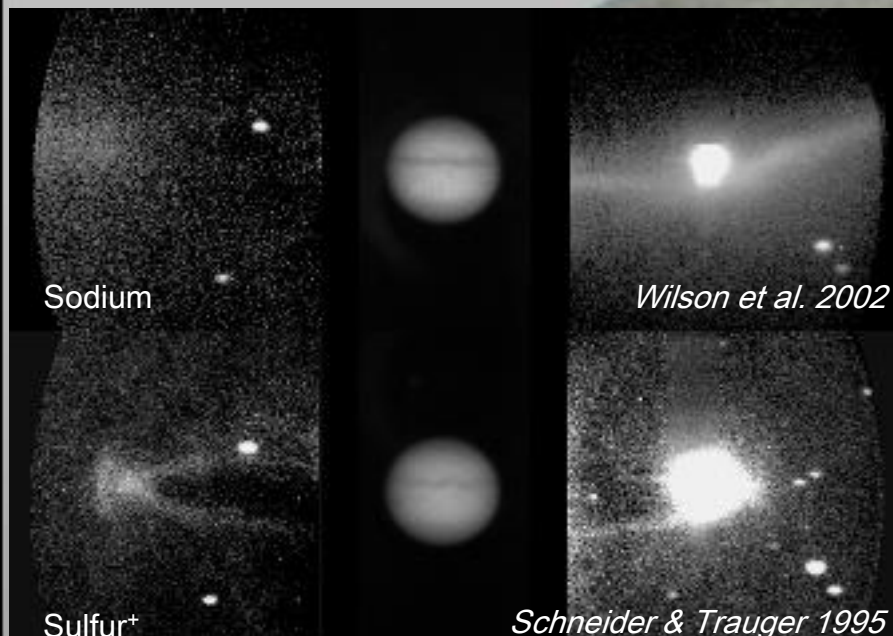
Visible yields
 plasma density &
 ion mixing ratios

UV yields plasma
 temperatures

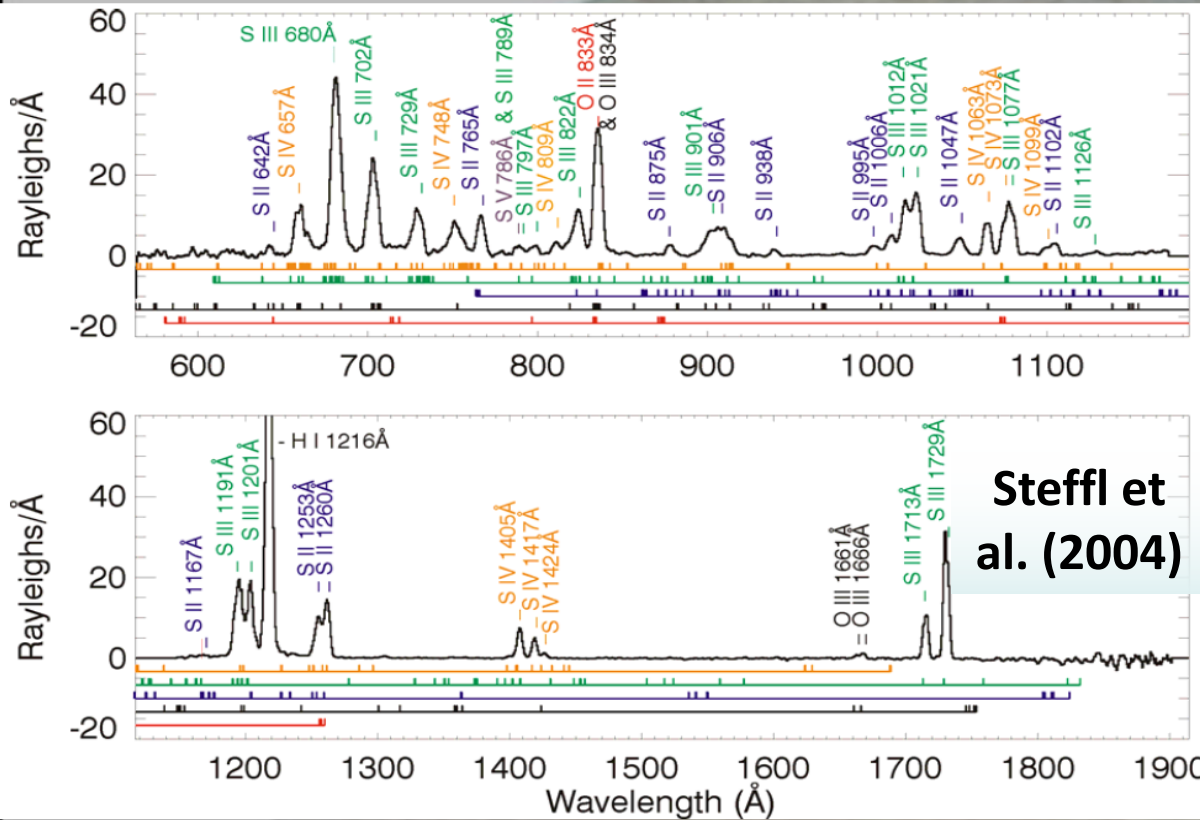
Apache Point Observatory 3.5m Schmidt et al. (2017)

Neutral Bombardment of Europa

- Io-Torus interaction causes dissociative recombination of molecular ions.
- Fast atoms periodically hit Europa when geometry is right.
- Observed: $\text{NaCl}^+ + e^- \rightarrow \text{Na}^* + \text{Cl}$
Europa catches $\sim 10^{23}$ Na atoms/s.
S and O transfer rate?



LUVOIR, the Io Atmosphere & Plasma Torus



← UV

IR (volcanic), Visible (n_e) & UV (aurora, T_e) data will characterize the *whole* system.

Neutrals:
 Na I: 5890 & 5896Å
 K I: 7665 & 7699Å
 O I: 6300Å
 SO: 1.707 um

Ions:
 S II: 4069, 4076, 6716 & 6731Å
 S III: 3722, 6312, 9531Å
 O II: 3726 & 3729Å
 O III: 5007Å

← Visible & IR

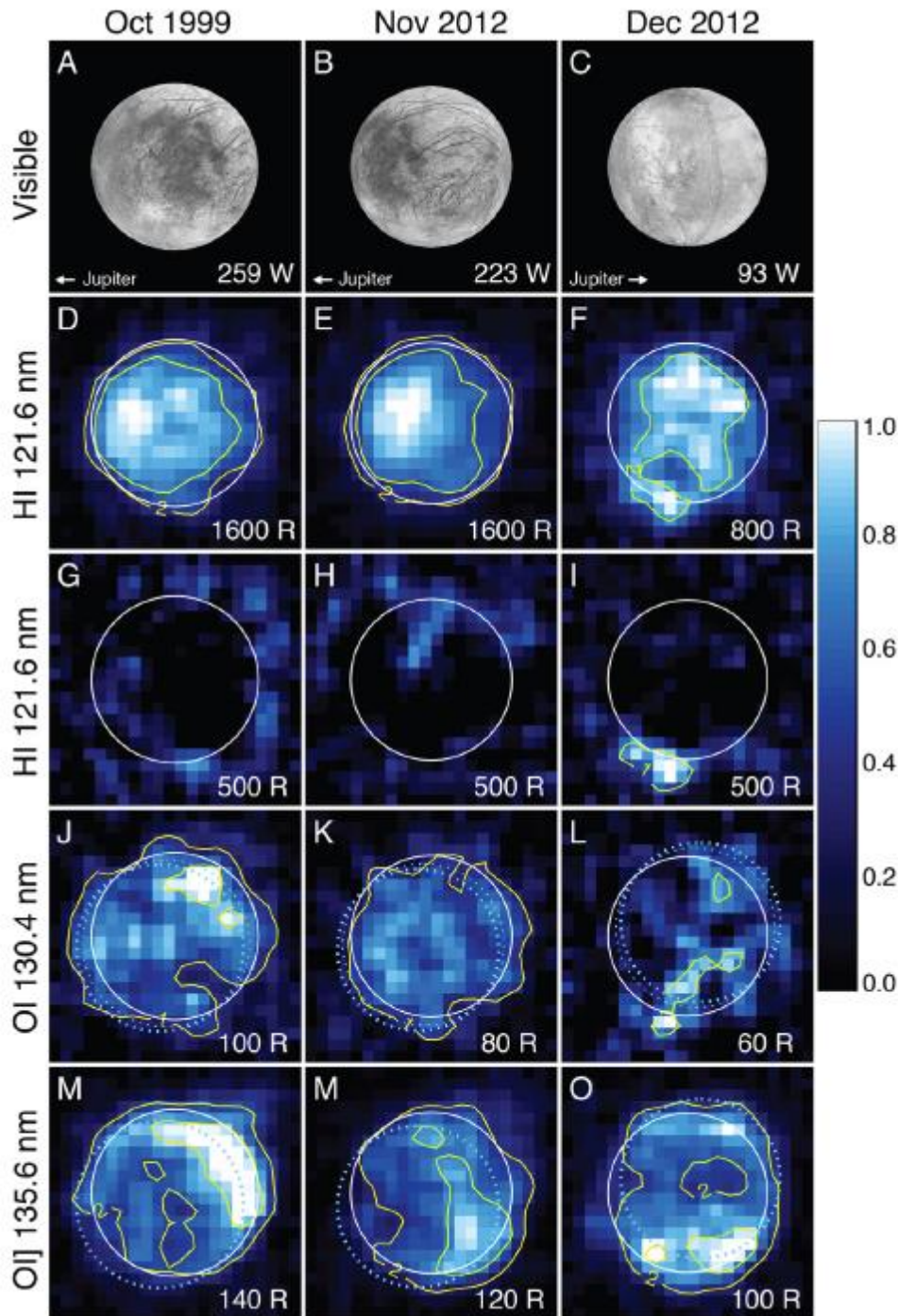


Europa atmosphere and plume

January, 11, 2017

Atelier de prospective pour une contribution française au LUNAR

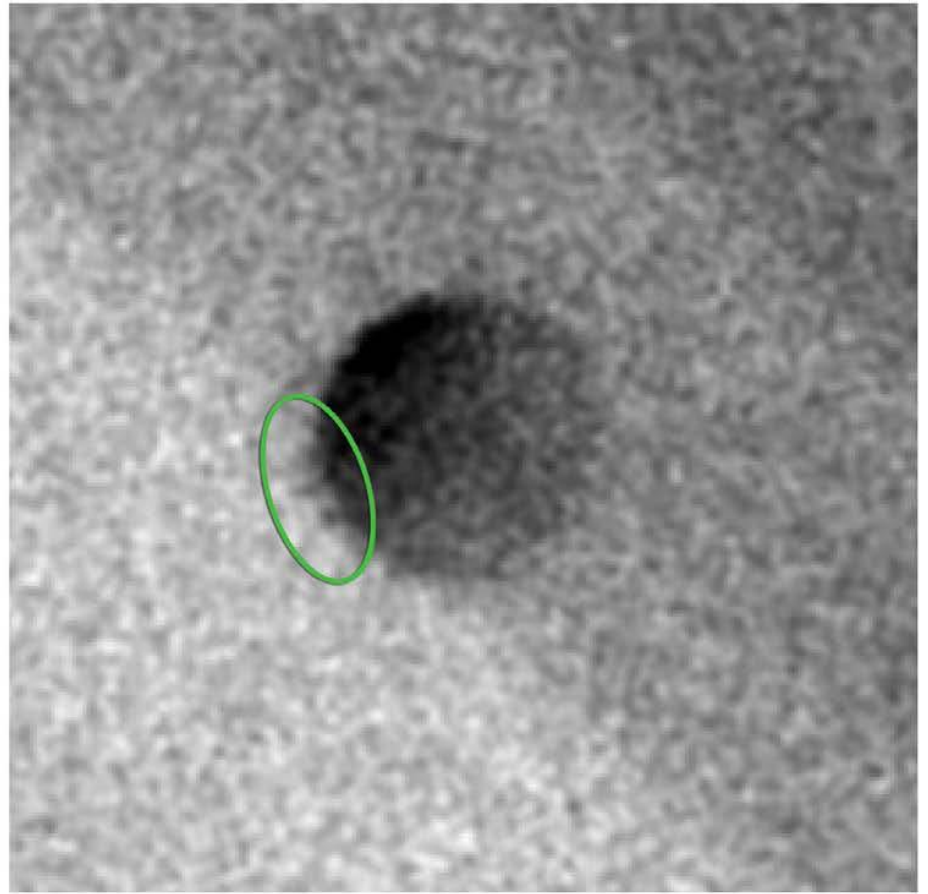
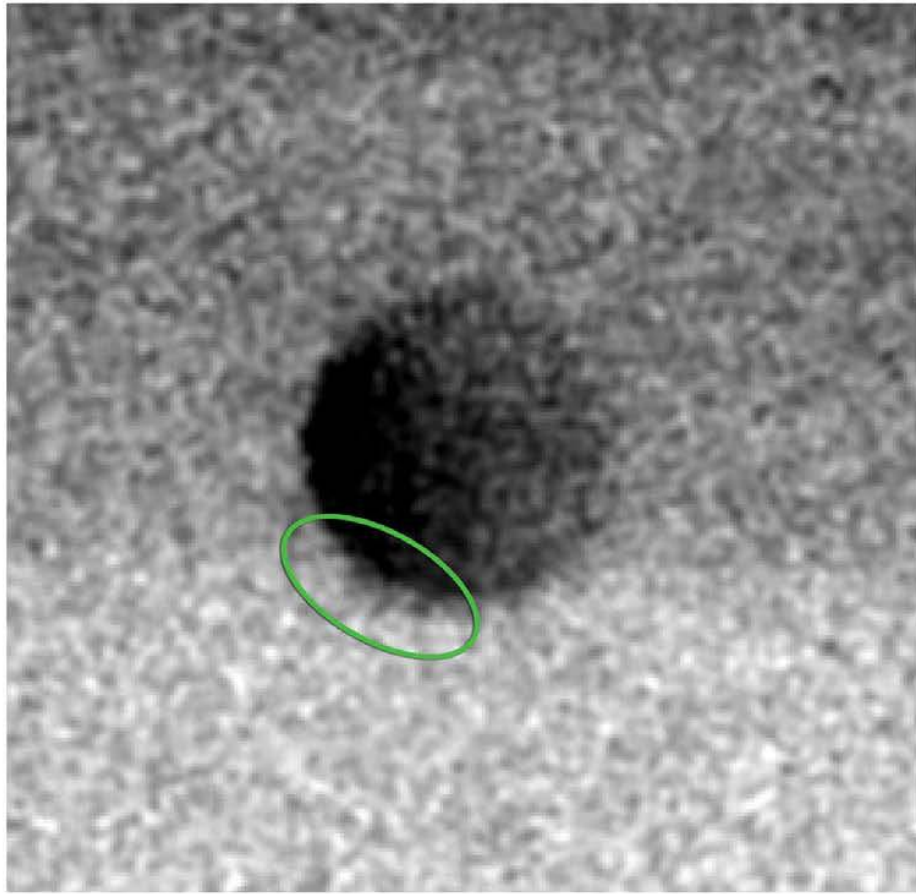
Roth et al. (2013)



” ...significant coincident surpluses of hydrogen Lyman- α and oxygen O I 103.4 nm emissions above the Southern hemisphere in December 2012. ”

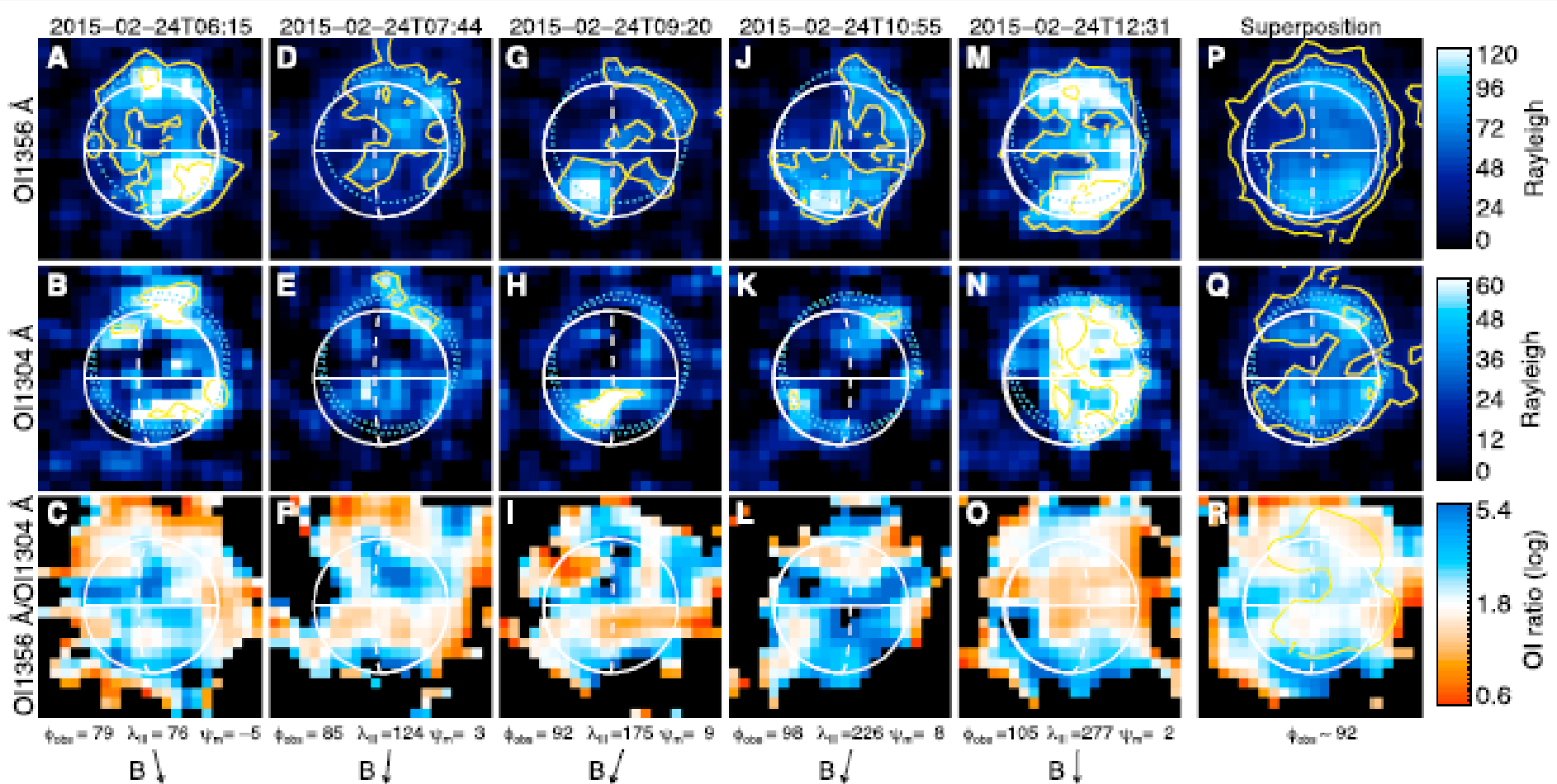
“Nondetection in November and in previous HST images from 1999 suggests varying plume activity...”

Europa's plumes seen in absorption by HST



Sparks et al. (2016)

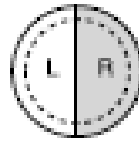
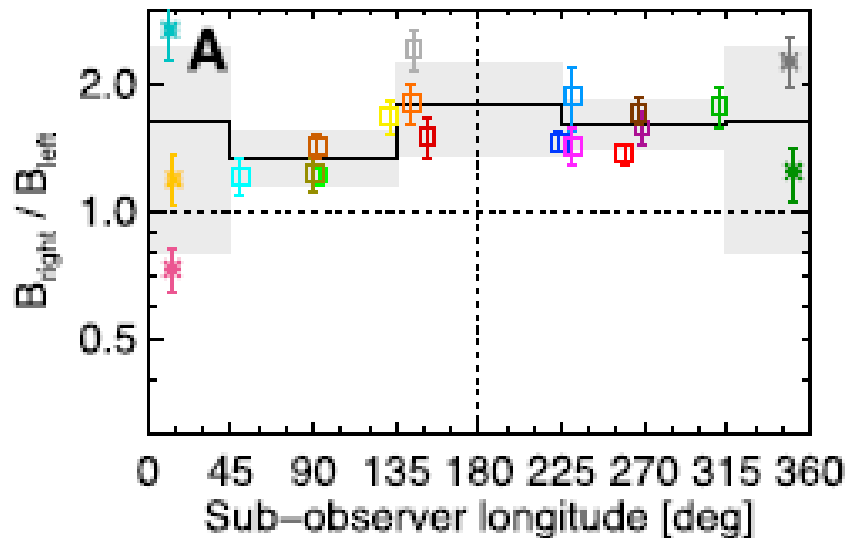
3 out of ten observations



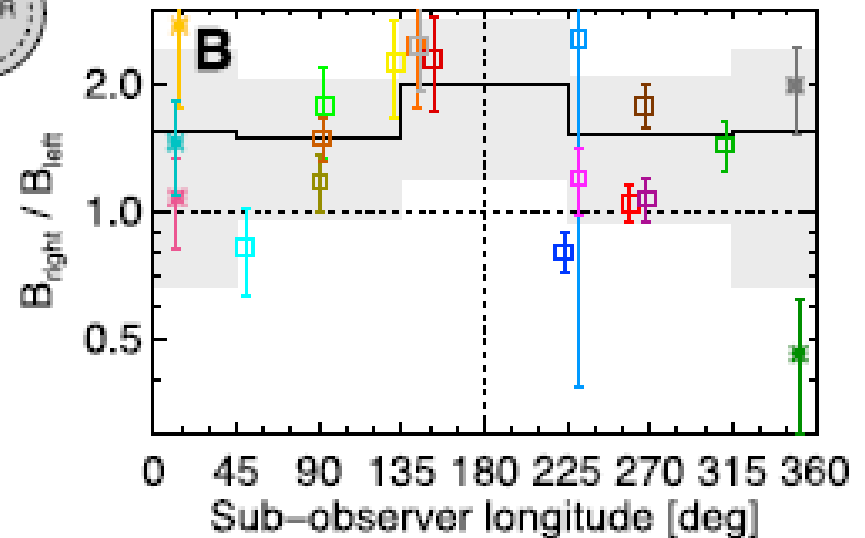
Roth et al. (2015)

“systematic variations correlated to the periodically changing plasma environment.”

OI1356 Å



OI1304 Å

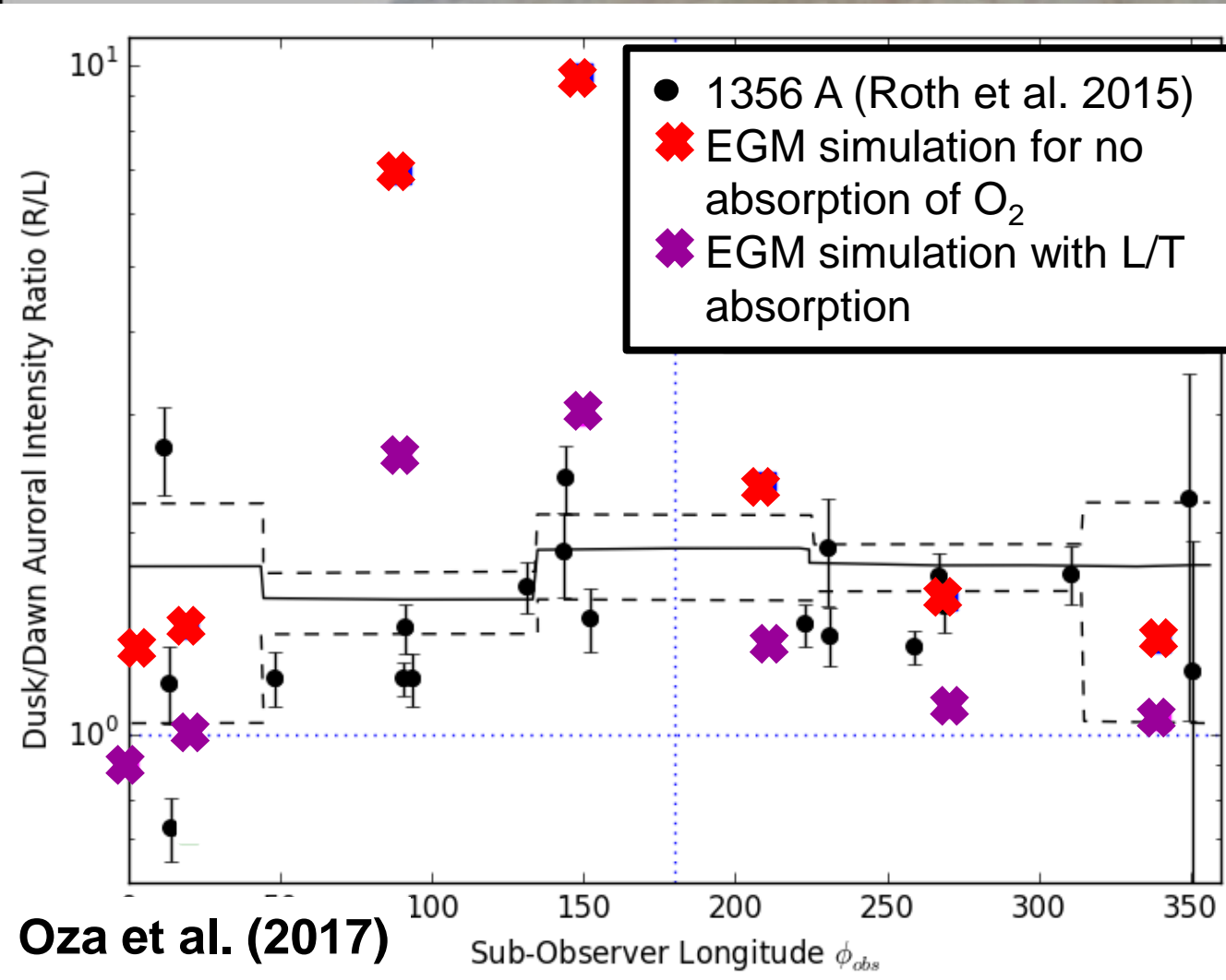


Roth et al. (2015)

“The dusk side is consistently brighter than the dawnside with only few exceptions...”

“Europa’s bound atmosphere is dominated by O₂.”

Origin of the Dawn-dusk asymmetry in oxygen exosphere.



The EGM predicts a dawn/dusk asymmetry as observed, due to

- O₂ transport with time scale of the order of Europa rotation,
- rotation of main sources of O₂.

The absorption controls the size of the dawn/dusk asymmetry.

⇒ The spatial distribution of O₂ depends on Europa phase angle.

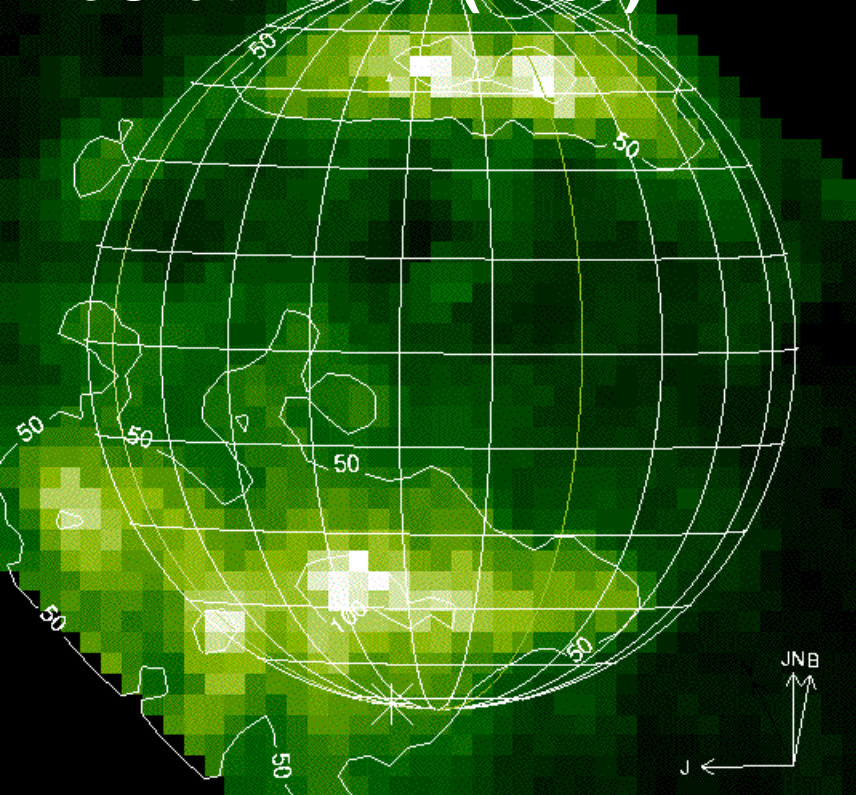
We need LUVOIR to track:

- Europa's atmosphere variability as induced by its interaction with Jupiter's magnetosphere.**
- Europa's atmosphere orbital evolution induced by its rotation and interaction with the surface.**
- Europa's atmosphere short terms variability induced by plumes.**
- Europa's composition, structure...**



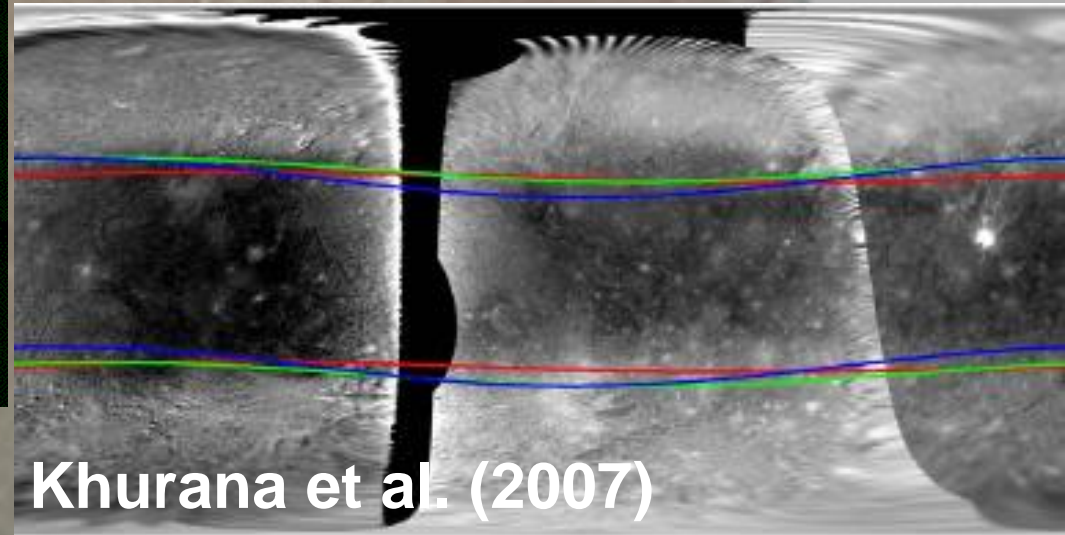
Ganymede atmosphere and magnetosphere

Ganymede oxygen aurora McGrath et al. (2008)



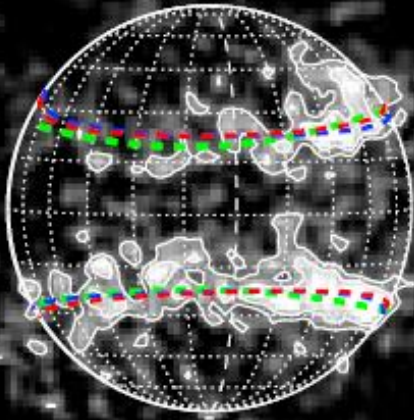
Internal B field

⇒ Internal radiation belt and
observation of aurora
emissions (Feldman et al. 2000)



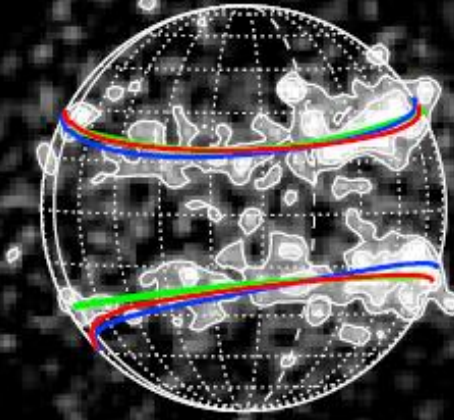
⇒ Protected from energetic ions of less than 10 MeV and
electrons impacts at mid latitude

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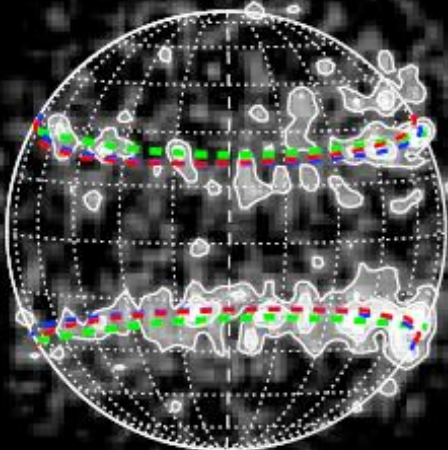


SubObs Long = 98°-111°

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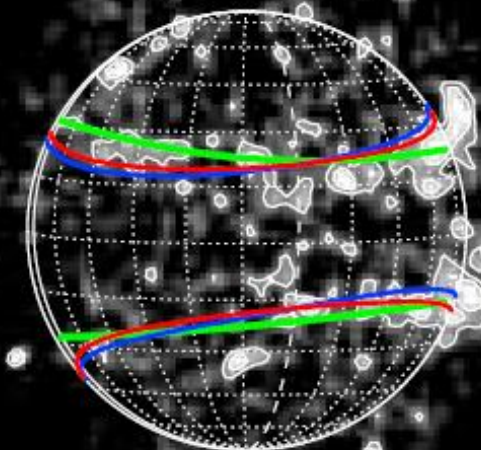


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SubObs Long = 90°-104°

Visit 2, below current sheet



**The search for
a subsurface
ocean in
Ganymede
with Hubble
Space
Telescope
observations
of its auroral
ovals**

**Saur et al.
(2015)**

We need LUVOIR to track:

- Ganymede's atmosphere variability as induced by its interaction with Jupiter's magnetosphere: origin of the aurora, influence of a potential sub-surface ocean...**
- Ganymede's atmosphere orbital evolution induced by its rotation and interaction with the surface as for Europa**
- Ganymede's atmosphere composition and structure...**