Auroral signatures of Jupiter's magnetospheric injections

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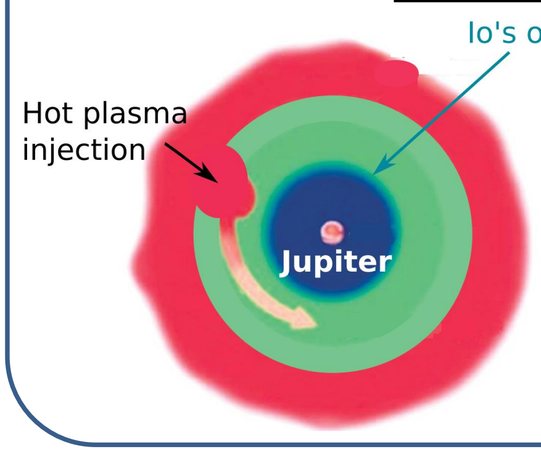
Conceptual model of Jupiter's magnetospheric injections



[Mauk *et al.* 2002]

Injections are associated with radial planetward transport of hot and sparse plasma as a response to the outward transport of cold and dense plasma originating from the Io plasma torus. Injection events involve high-energy particles within a colder background plasma. As a consequence, plasma injection processes are markers of the radial plasma transport in the Jovian middle magnetosphere. During plasma event, *in situ* measurements show higher mean energy, a broader energy spectrum and a differential drift across the field lines due to the magnetic field gradient and curvature drifts

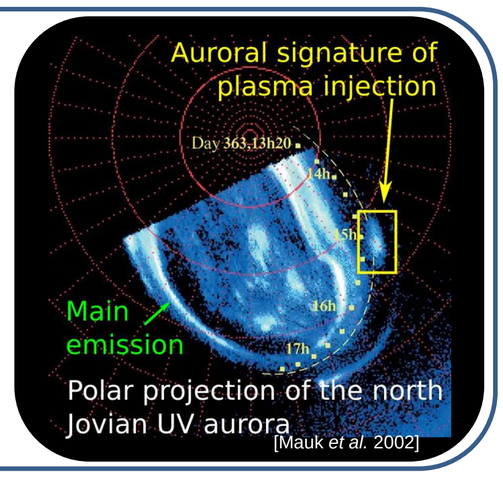
Hubble Space Telescope UV observations


[Bonfond]

At Jupiter, energetic particle injections are associated with isolated equatorward patchy auroral UV emissions.

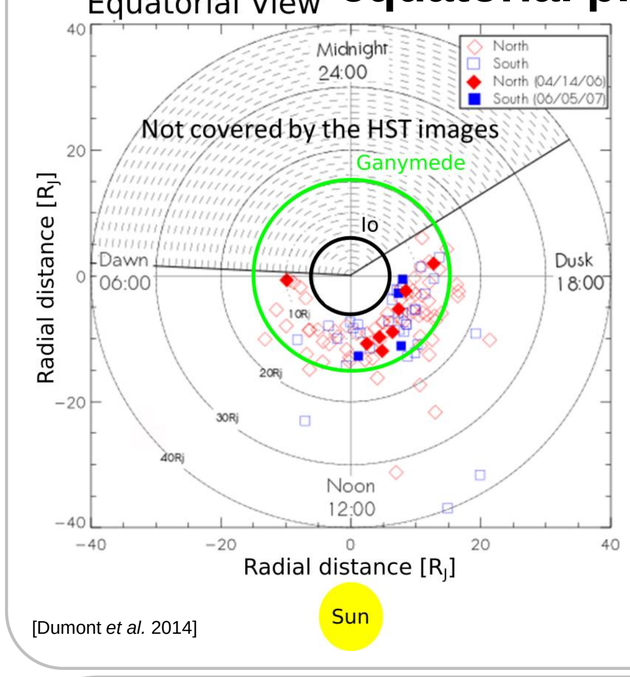
Databases:
a) Hubble Space Telescope (HST) observations obtained from 2000 to 2007 (~ 2000 images) → identification of 130 individual UV auroral features
b) HST spectral observations collected on 8 January 2014 in the northern hemisphere

Objectives of this study: characterize and define the properties of the auroral signatures of plasma injections



[Mauk *et al.* 2002]

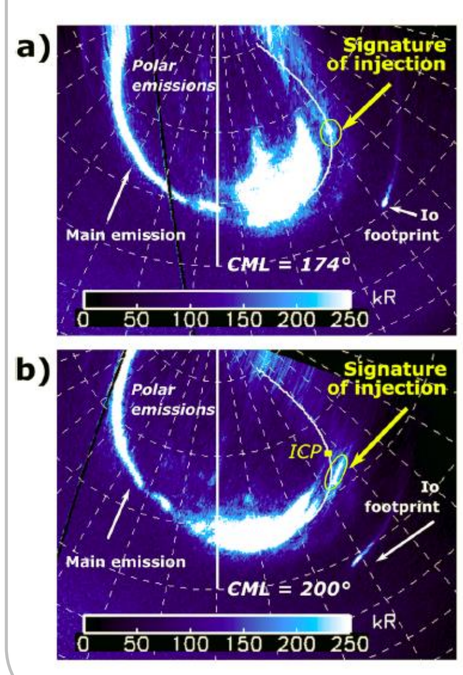
Distribution of mapping auroral features in equatorial plane in Local Time

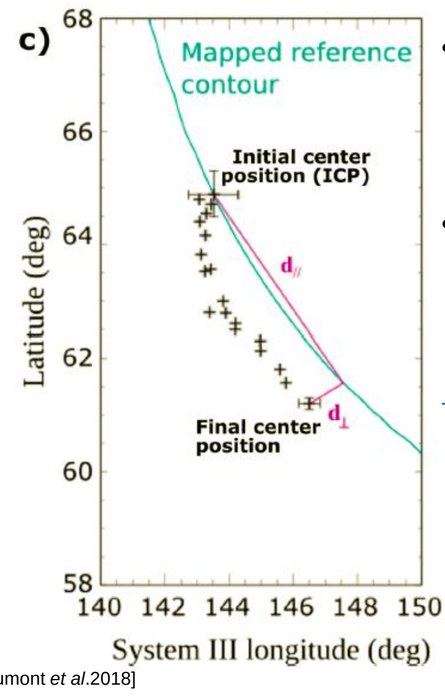


[Dumont *et al.* 2014]

- Relatively frequent: on average at least every other day
- The orbit of Io appears as a natural inner boundary
- Present simultaneously at different local times and at different radial distances (where 1 R_J = 1 Jovian radius = 71492 km)

Evolution of auroral signatures of injections





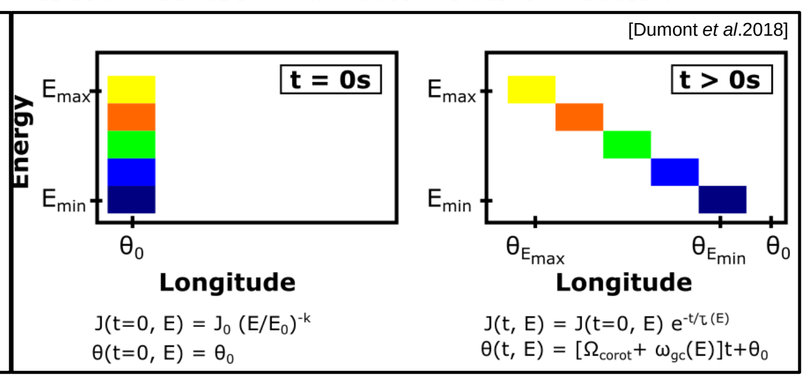
[Dumont *et al.*2018]

- Latitudinal displacement equatorward
- Longitudinal displacement (in quasi corotation)

→ **Compatible with magnetospheric injections moving planetward and lagging corotation**

Modeling of the effect of the differential electrons drift on these auroral features

Schematic representation of the electron drift model associated with auroral signature of an injection in the Jovian magnetosphere



[Dumont *et al.*2018]

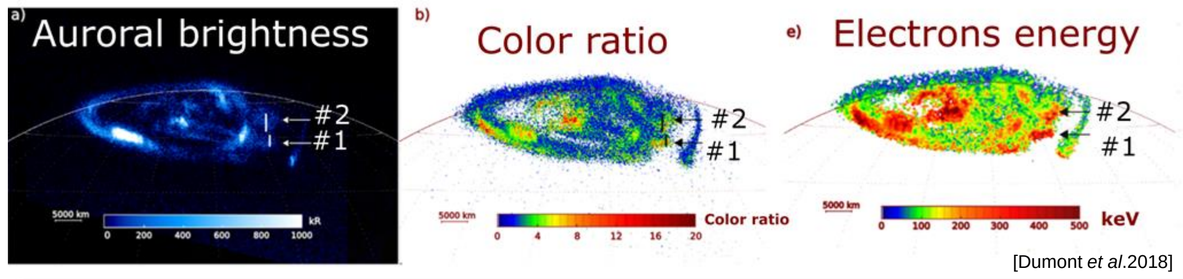
The drift rates of the charged particles due to the gradient and curvature drifts depend on the particles' energy

- The brightness of the auroral features decreases with time : the energy density declines with time → the gradient and curvature drifts disperse the total injection energy over a wider region and the injected particles suffer additional losses, due to strong pitch angle scattering leading to the precipitation of the electrons into the aurora
- The longitudinal width of the auroral features increases with time

→ **Quantifying the longitudinal size and the evolution of the injected electron population in the Jovian magnetosphere as a function of the spectral index (κ)**

→ Using the model backward, we infer the age of structures from the observed evolution of the longitudinal size :on average, between a half and a full rotation of Jupiter, which is in agreement with the observations

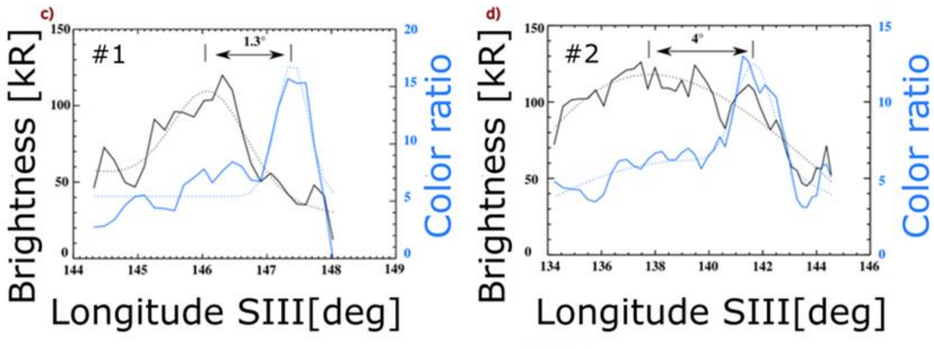
HST spectral observations



[Dumont *et al.*2018]

Color ratio → spatial variations of the amount of absorption by methane (the amount of absorption increases from dark blue to red)
→ characteristic energy of the auroral precipitation (the energy is determined by assuming a model atmosphere)

#1 and #2 indicate two auroral signatures of plasma injections (the mean energy is higher than in the surrounding emissions).



[Dumont *et al.*2018]

Maxima of color ratio and of brightness are not collocated

→ **The color ratio peaks upstream of the feature relative to the plasma rotation direction, as expected for auroral signatures of injections**, since the high-energy electrons drift upstream of the low-energy electrons, as evidenced by in situ measurements.

References : Mauk *et al.* 2002, doi:10.1038/4151003a Dumont *et al.* 2014,doi:10.1002/2014JA020527 Dumont *et al.* 2018, doi:10.1029/2018JA025708