Giant planets in the Solar System

Ongoing and upcoming observations and their implication for exoplanet and brown dwarf studies.

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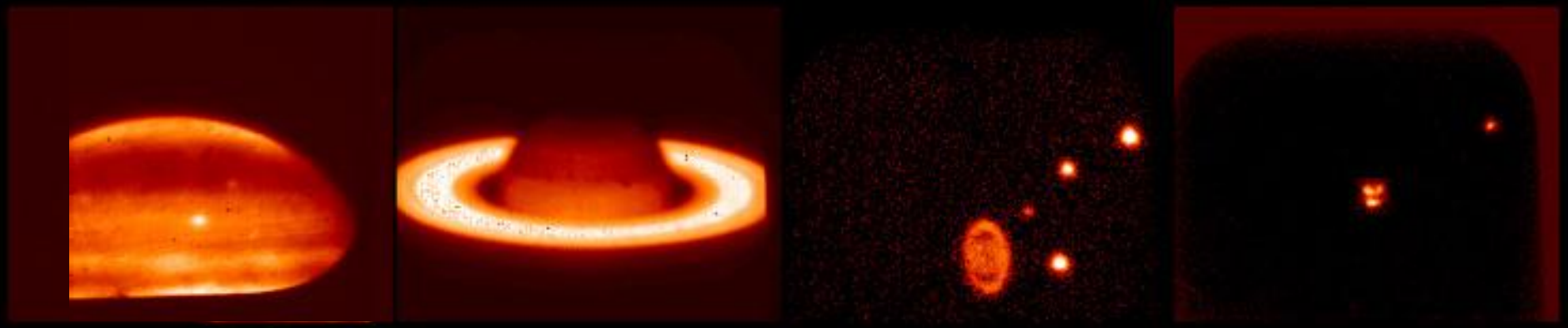
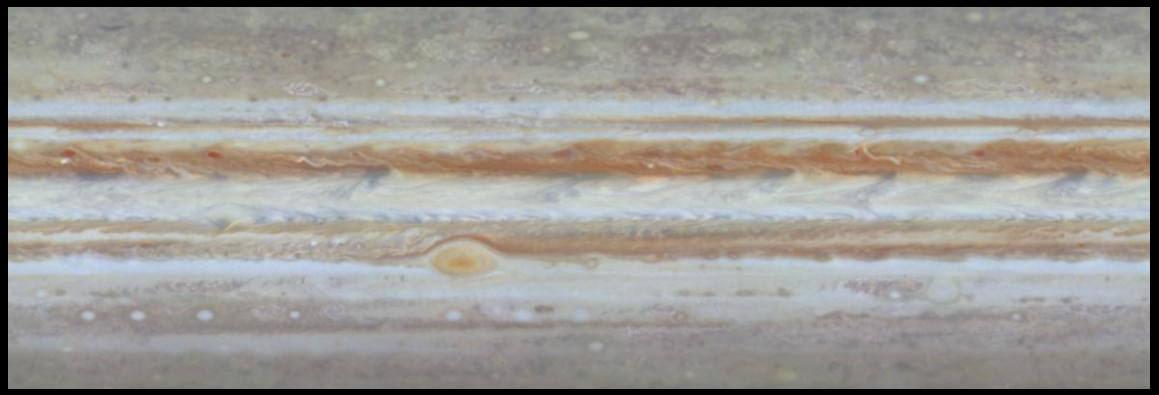
ESO IN THE 2020S

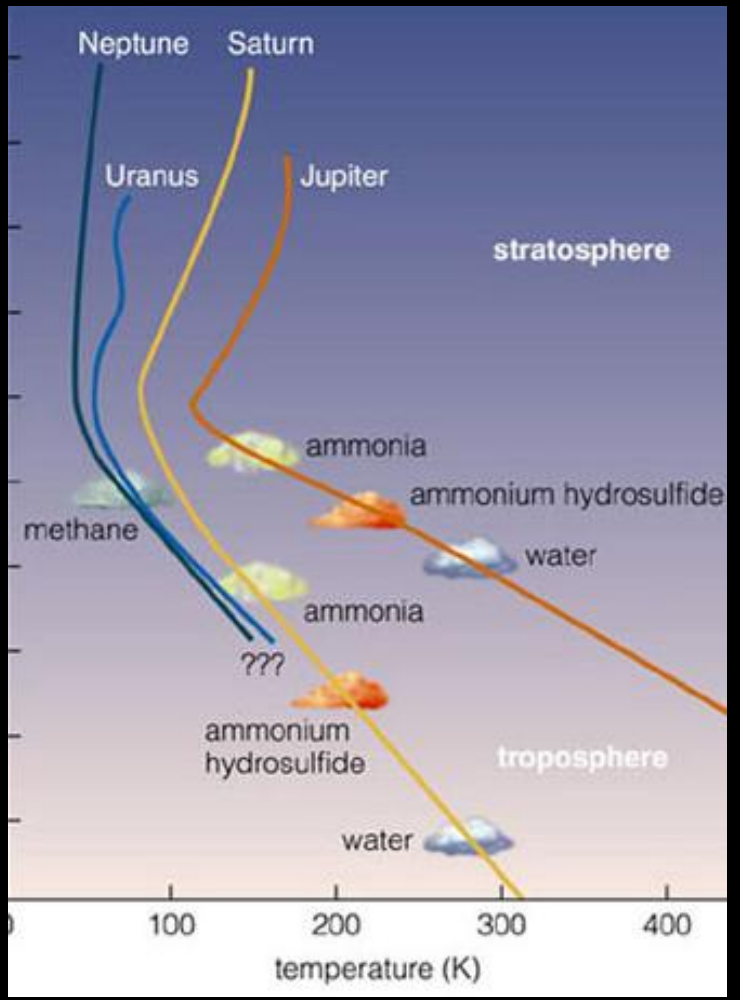
Gas Giants and Ice Giants



Jupiter	Saturn	Uranus	Neptune
1 M_J, 318 M_E	0.299 M_J, 95.2 M_E	0.046 M_J, 14.5 M_E	0.054 M_J, 17.1 M_E
Dynamic hydrogen rich atmosphere with icy clouds			
Rings, moons, magnetic fields			
Hydrogen interior		Methane/water ice interior	
Internal heat		Inclined pole	Internal heat

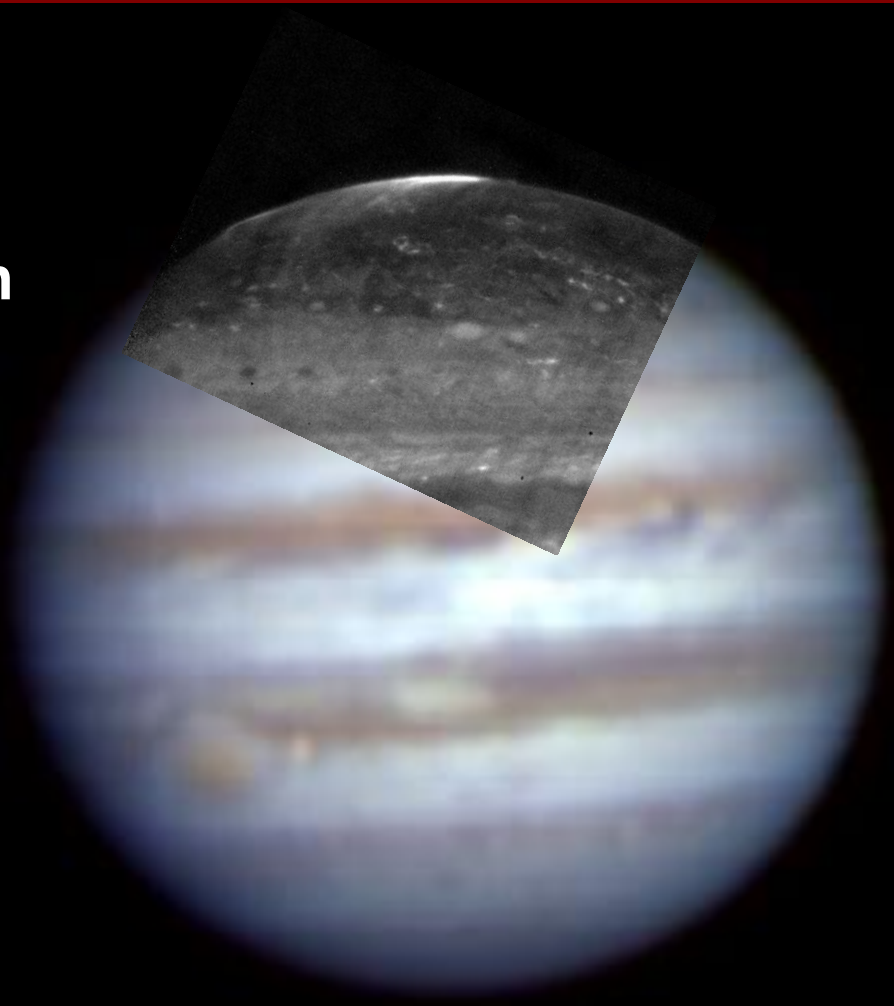
Gas Giants as dynamic, multi-layer astrophysical targets





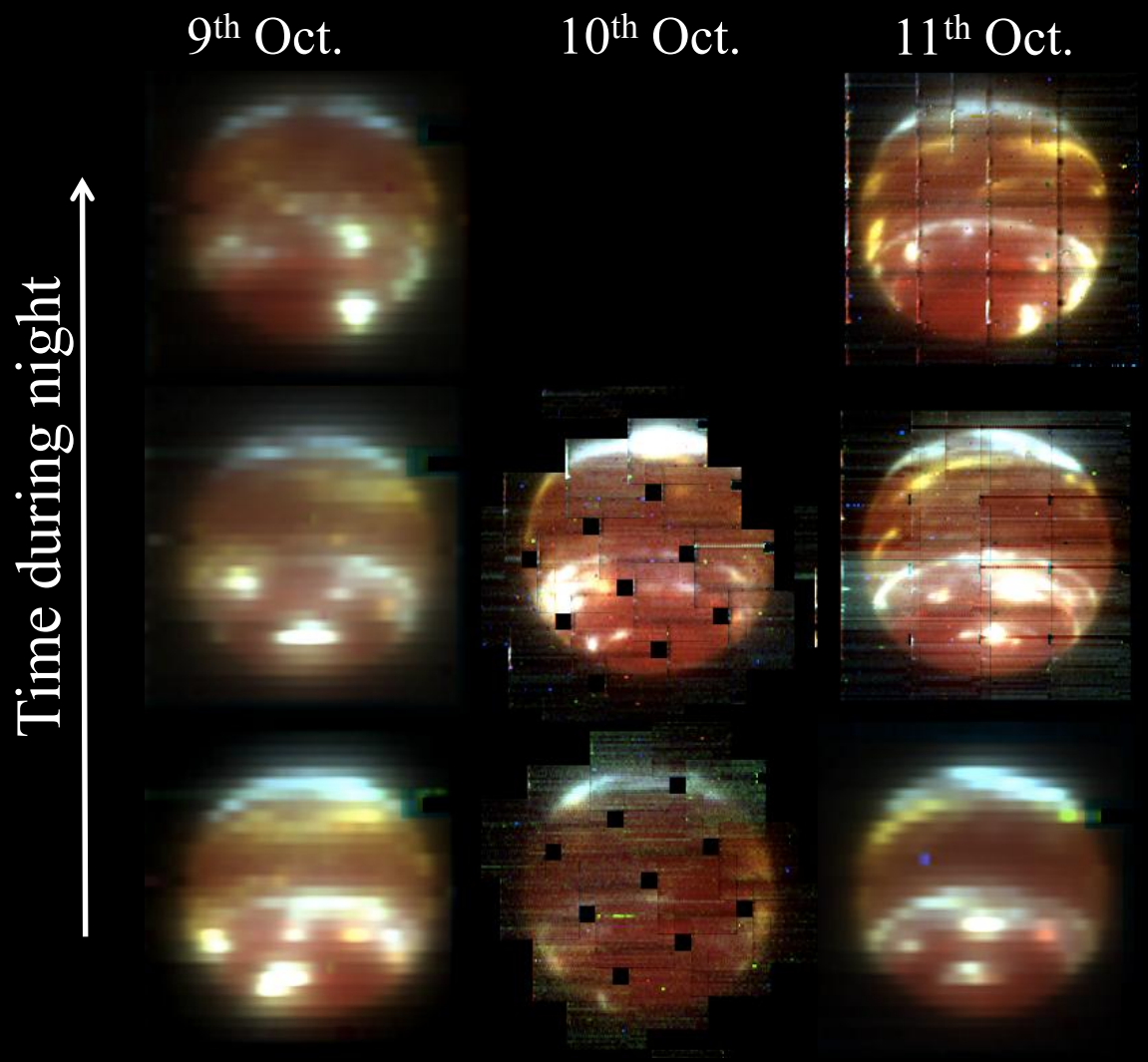
High-spatial resolution spectral imaging

L’ filter ESO/NACO imaging with AO



VLT/MUSE false colour RGB image constructed from commissioning data observed in February 2014

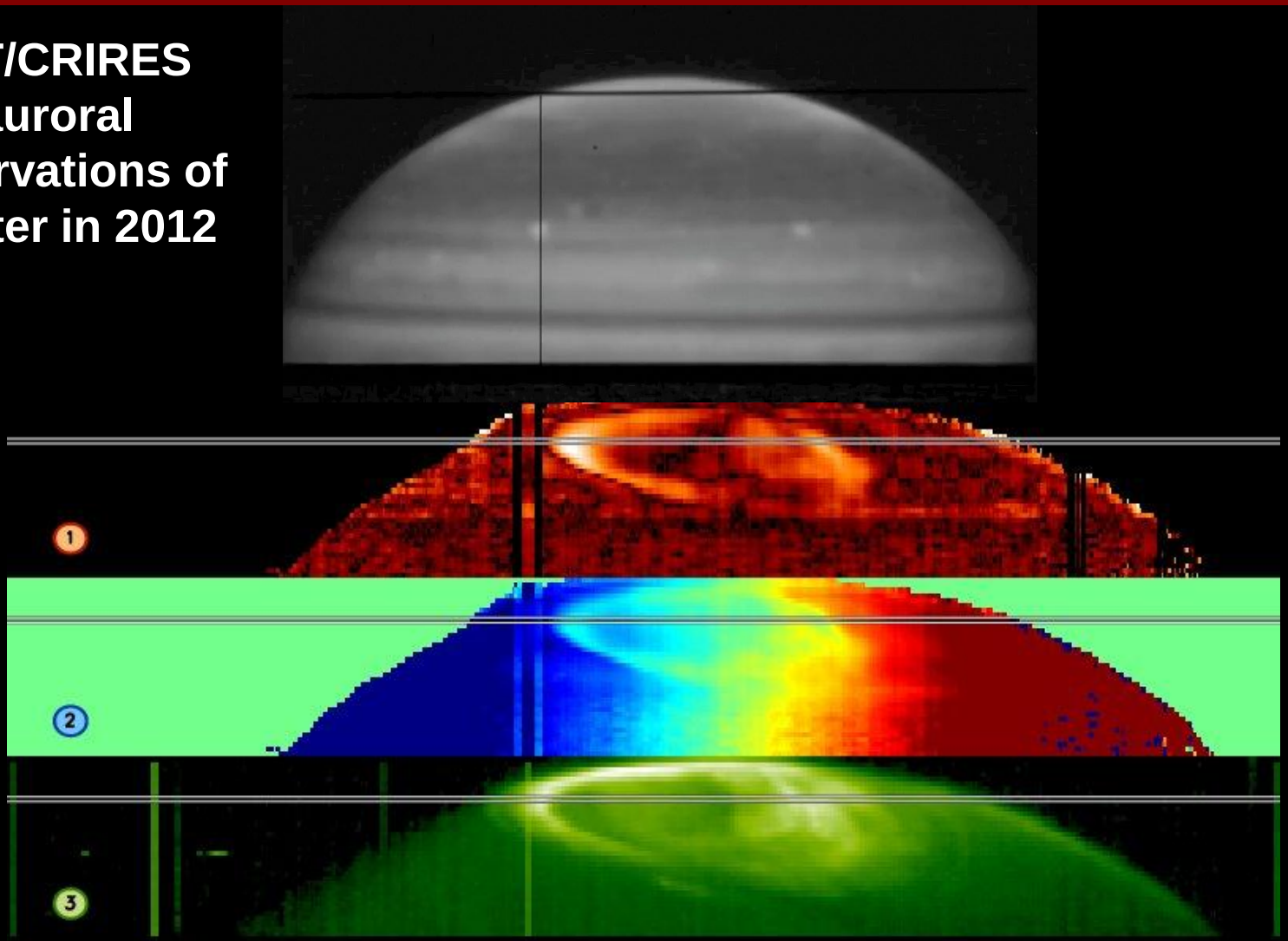
High-spatial resolution spectral imaging



- *ESO-VLT/SINFONI* in October 2013.
- J (1.1-1.4 mm) and H (1.45-1.85 mm) bands
- 'cube' with 2200 wavelengths, spectral Resolution is 2000 (J) and 3000 (H).
- FOV is 3"x3" with pixel size of 0.05"x0.1" or 4x4 mosaic of 0.8"x0.8" frames with pixel size of 0.0125"x0.025".
- Observations made with Adaptive Optics.

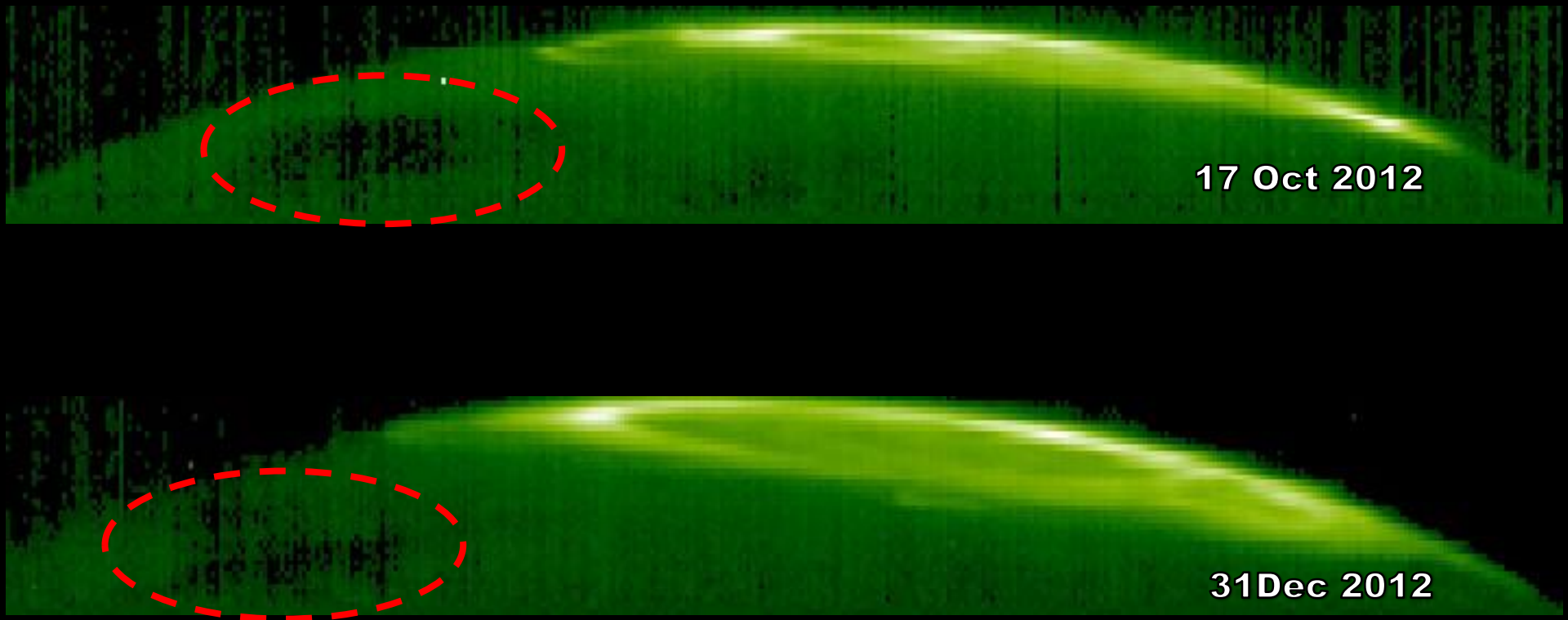
High spectral resolution observations

VLT/CRIRES auroral observations of Jupiter in 2012

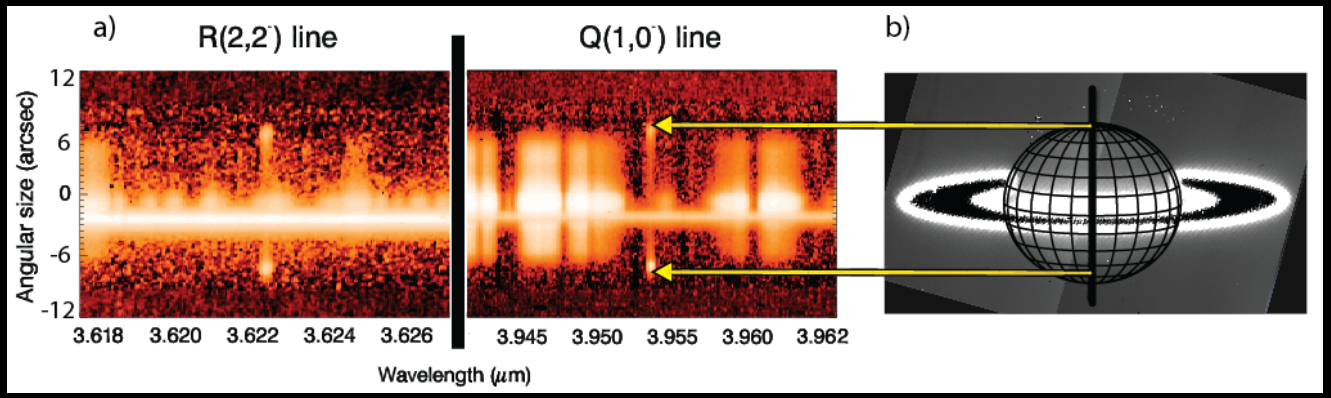


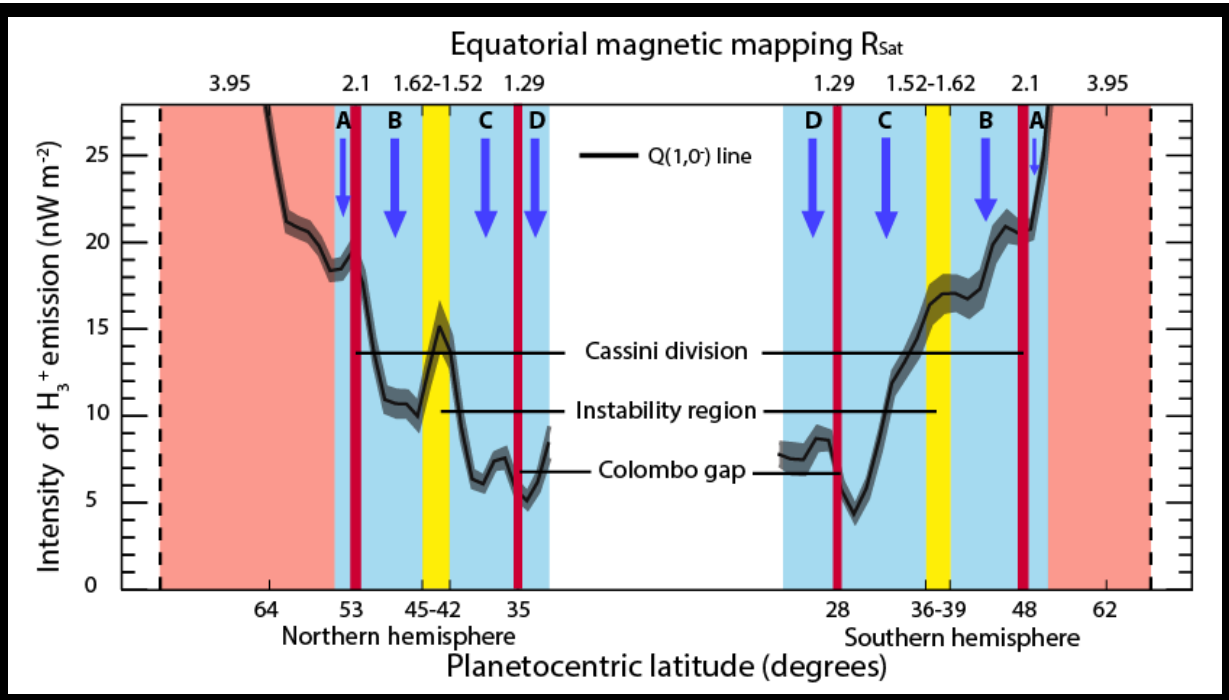
High signal-to-noise extended source spectral observations

VLT/CRIRES sub-auroral observations



High signal-to-noise extended source spectral observations



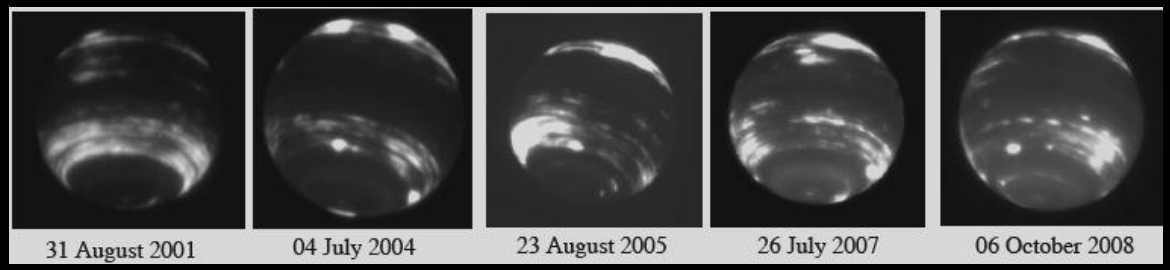


Keck/NIRSPEC Cassini mission support observations Detect 'Ring Rain' on Saturn

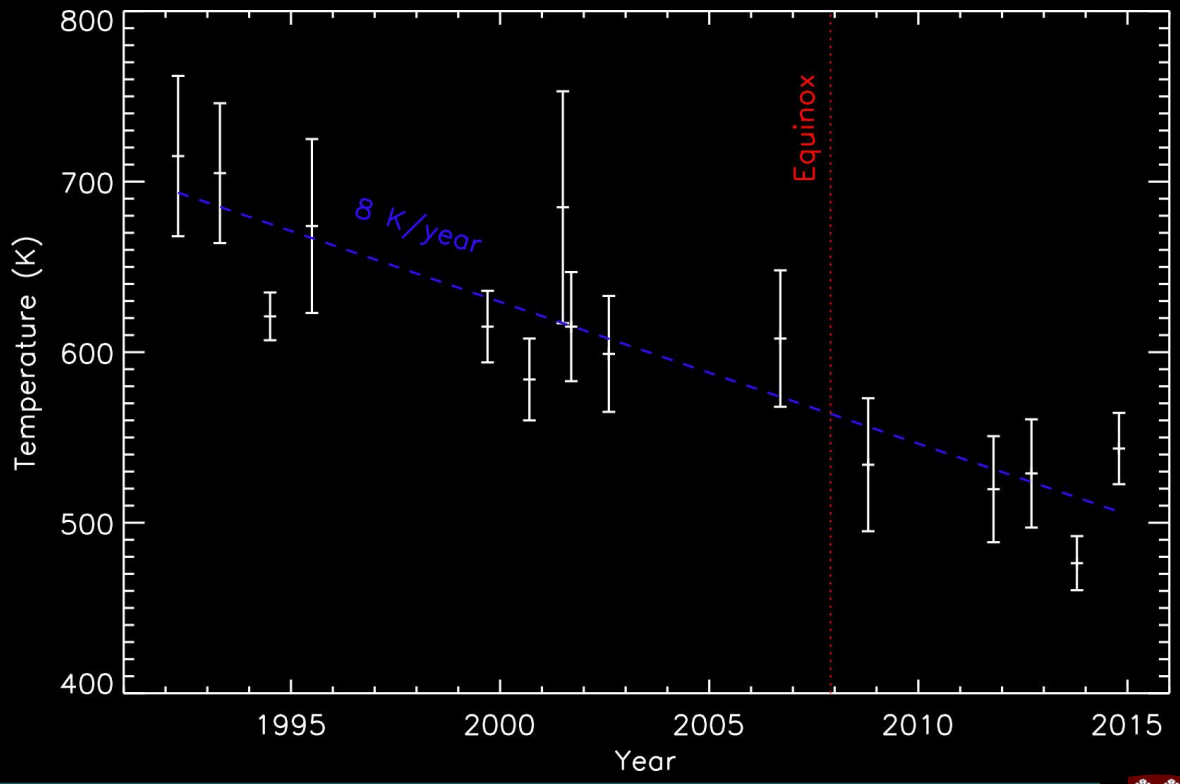
O'Donoghue *et al.* (2013) , *Nature*, **496**, p.193-195

Long-term and seasonal variations

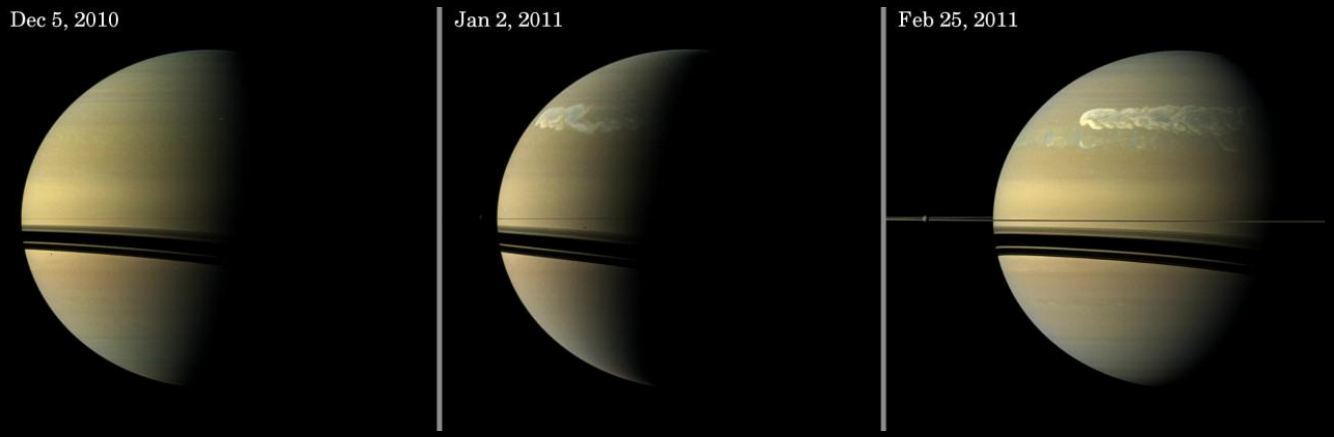
Neptune's thermal emission
Fletcher et al., 2014



Uranus upper atmosphere temperature over 20 years, measured with UKIRT, IRTF, Gemini, VLT and Keck
Melin et al. 2015



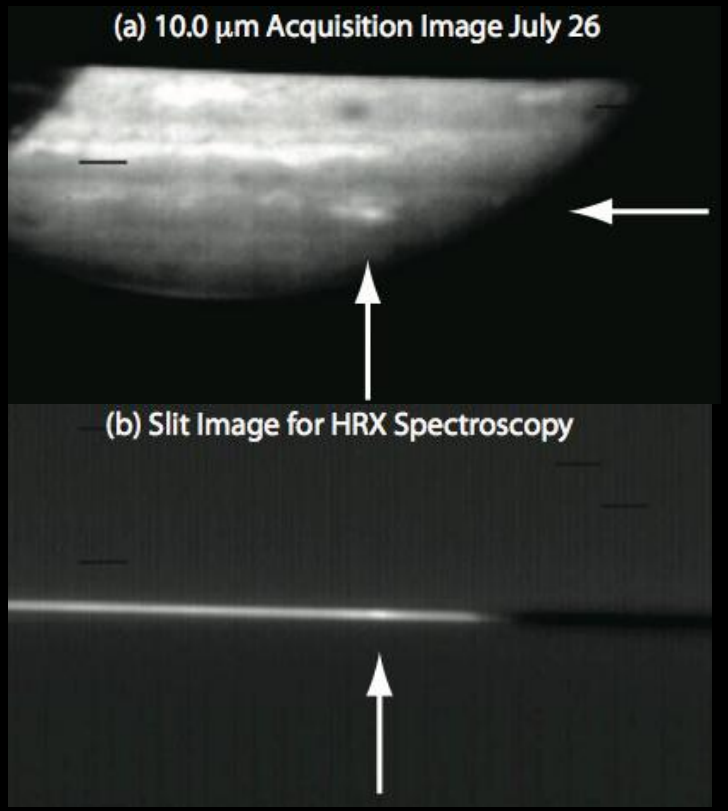
Short-term variability and the ability to monitor at short notice



Saturn's 'Great Springtime Storm' in Cassini/ISS visible light
Credit: NASA/JPL-Caltech/Space Science Institute

Thermal infrared images of Saturn from the Very Large Telescope Imager and Spectrometer for the mid-Infrared (VLT/VISIR) instrument
Image credit: ESO/Univ. of Oxford/T. Barry

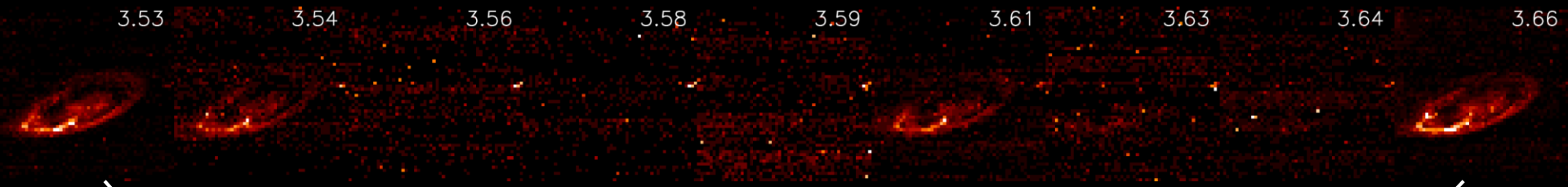
Short-term variability and the ability to monitor at short notice



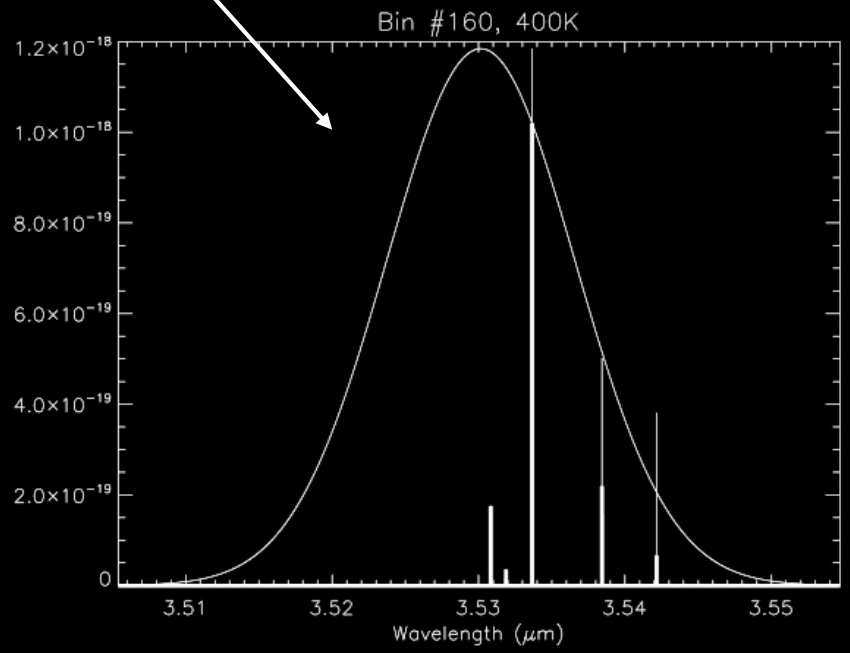
Echelle spectroscopy of the impact site obtained by VLT/VISIR on July 26 2009, 7 days after the impact

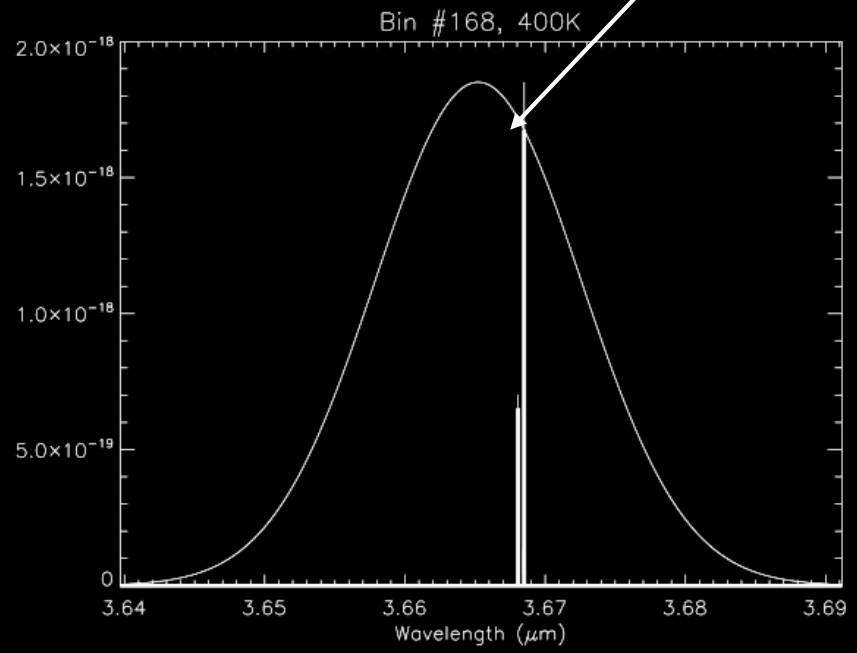
Fletcher et al., 2010

Difficulties with space-based observations



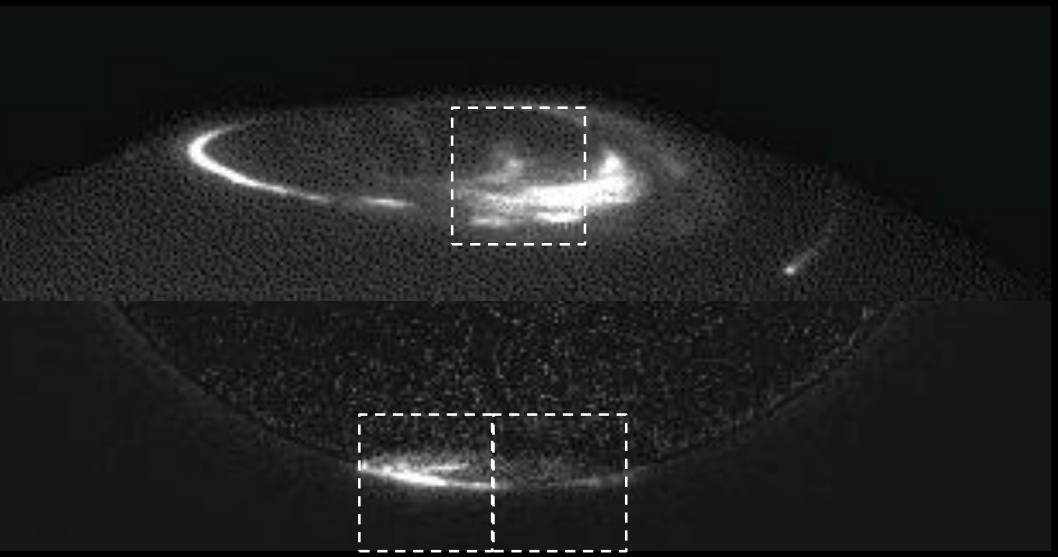
Cassini/VIMS auroral observations

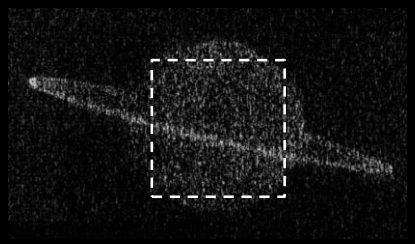




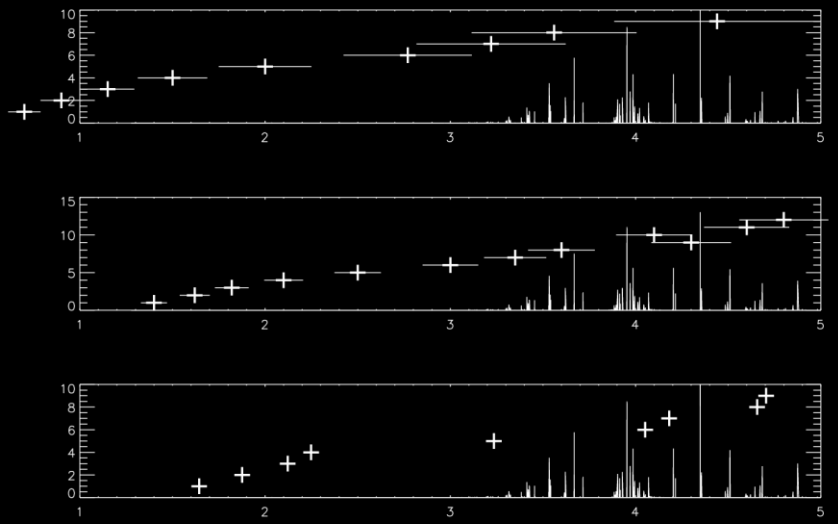
Difficulties with JWST observations

JWST/NIRSpec IFU field of view

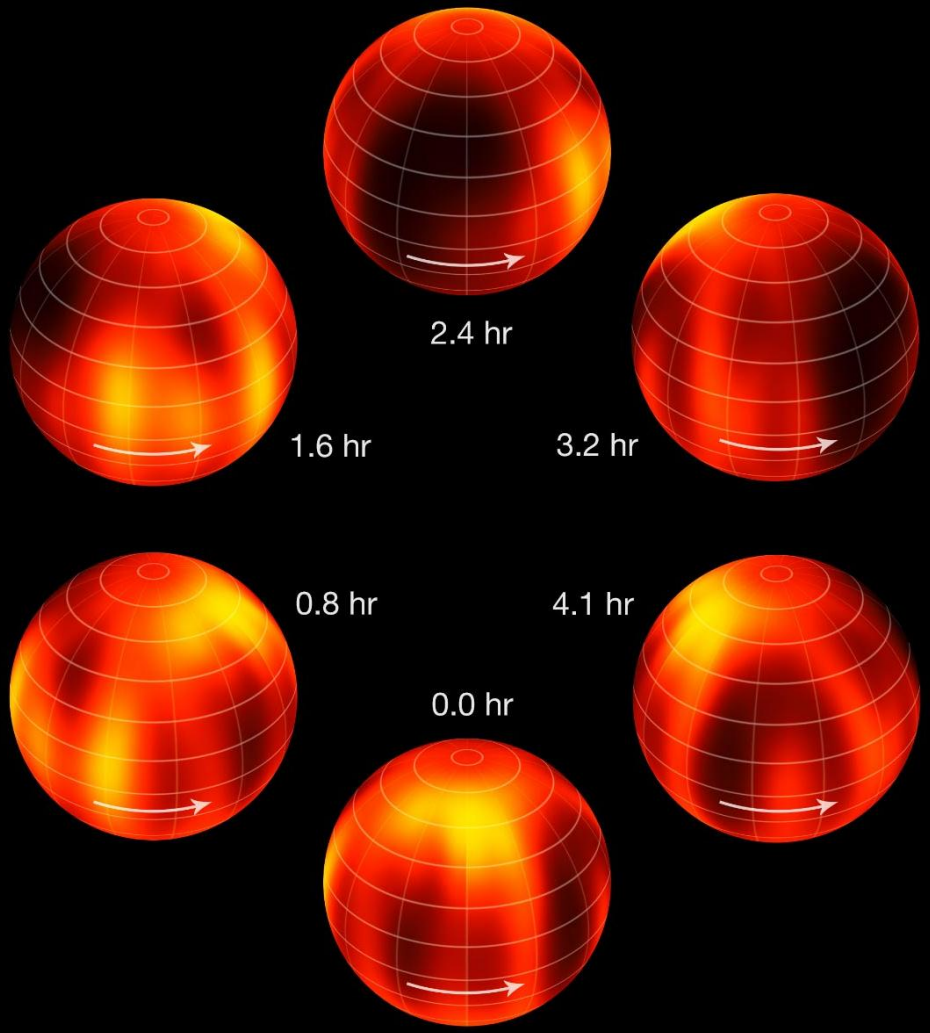




JWST/NIRCAM filters



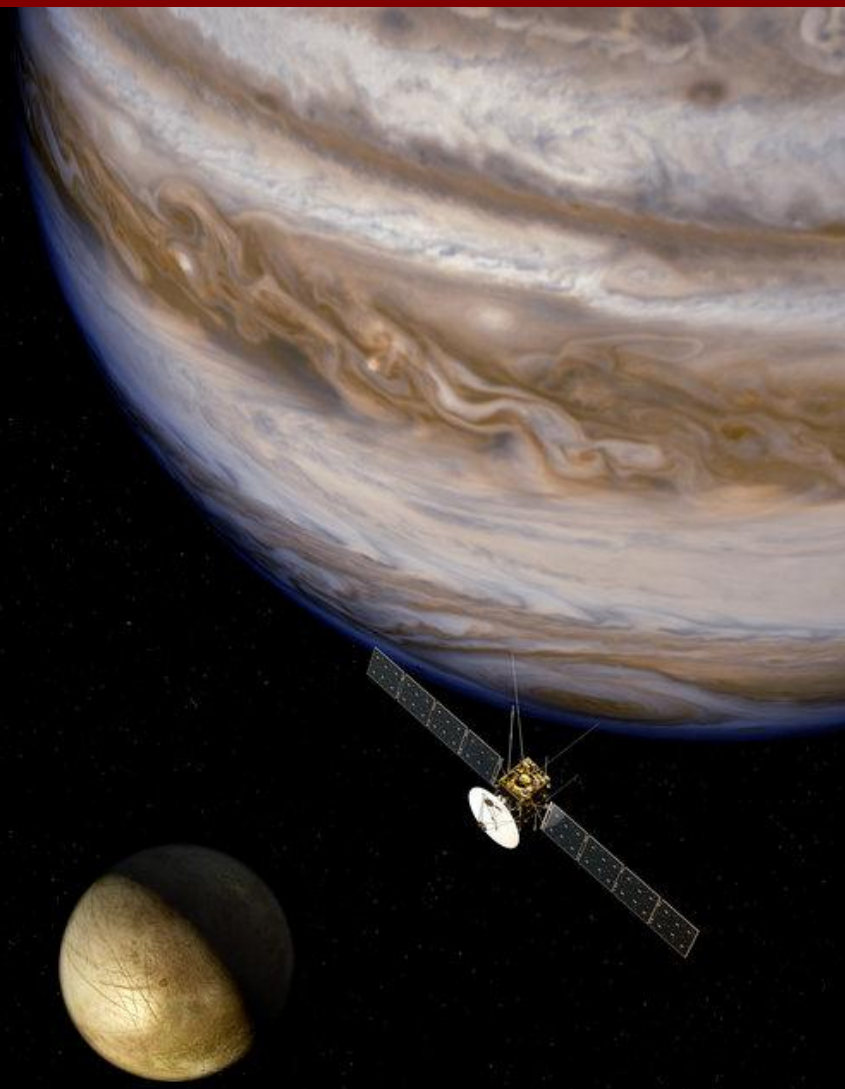
Comparisons with exoplanets and Brown Dwarfs



A Global Cloud Map of the Nearest Known Brown Dwarf Luhman 16B observed with VLT/CRIRES
Crossfield et al., 2014

Mission support: ESA's JUICE mission

- launch in 2022
- pre-arrival observations in 2028-2029
- orbit insertion in January 2030
- the spacecraft will perform a 2.5 year tour in the Jovian system



Conclusions: What is needed

- Wide fields-of-view, up to 1 arcmin
- Broad wavelength coverage, including L' band and >5 micron
- AO Imaging with narrow wavelengths or spectral imaging up to 5 micron
- Support for high spectral resolution & for wide wavelength observations, with AO
- >10m telescopes for weak emission
- Director's Discretionary Time
- Spacecraft mission support (2017 & 2028+)