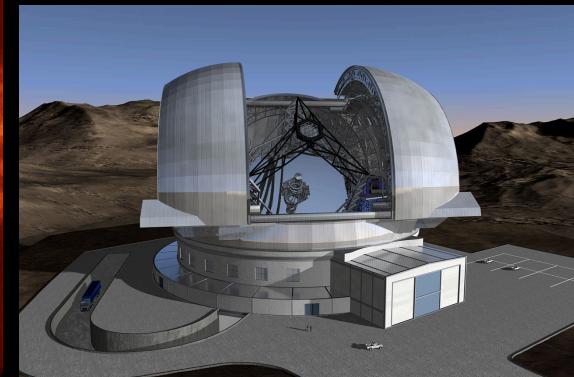
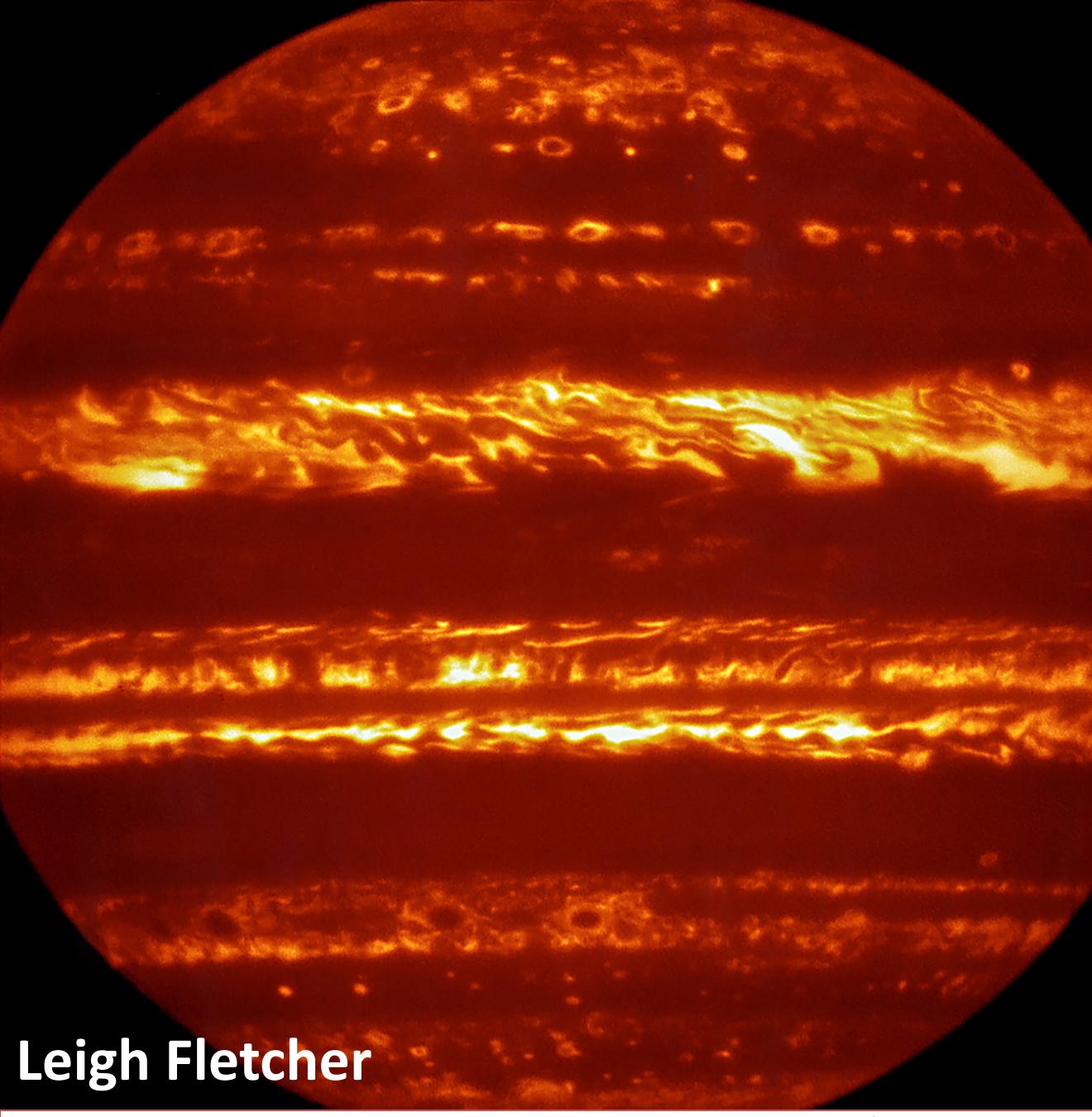


ELT Exploration of Giant Planet Systems



Leigh Fletcher



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European
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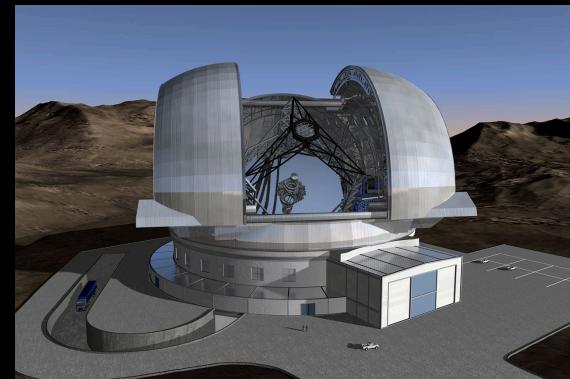
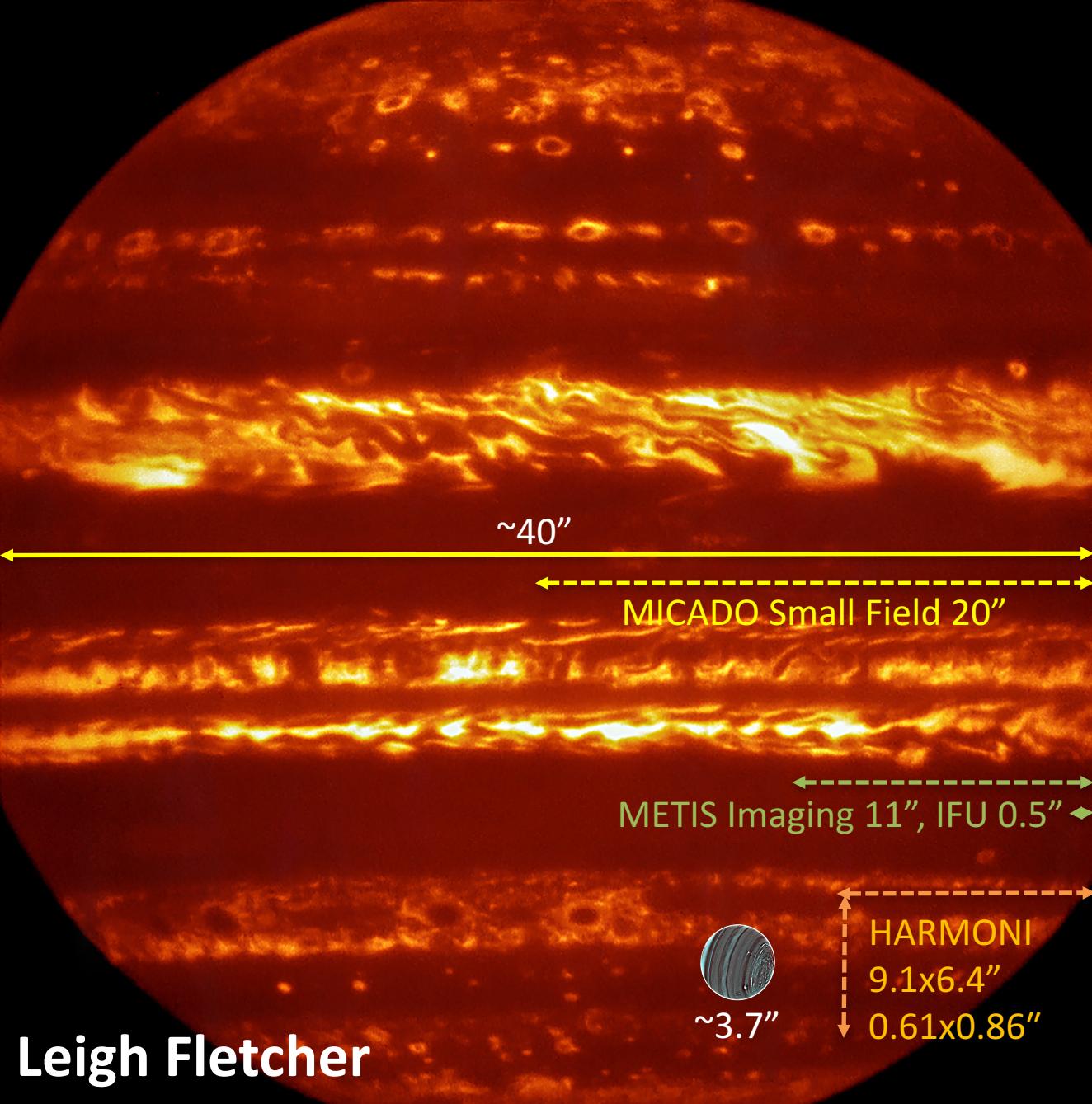


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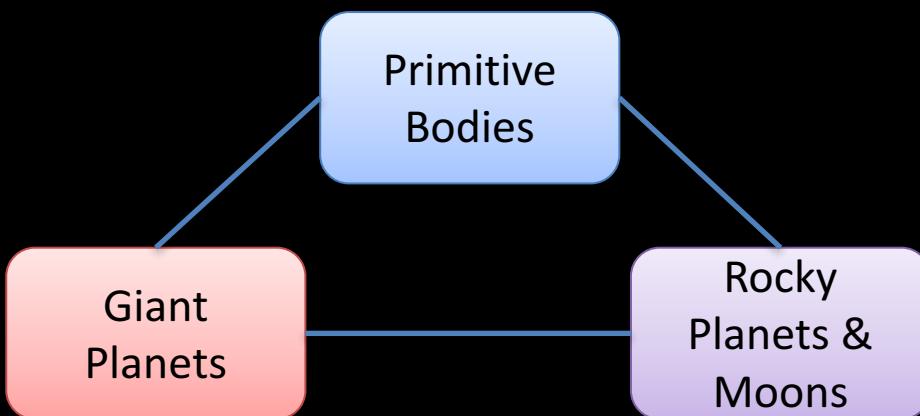
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Taster of ELT Science Cases

- Building blocks and primitive materials.
- Activity/outgassing of asteroids/comets.
 - Origins of asteroids.
 - Volatile delivery to forming planets.
- Physical properties of KBOs, TNOs, Centaurs
- Cometary activity changes at great distance.
- Multiplicity/satellites of small bodies



- Titan's seasons/hydrology.
- Sensitive limb views & spatial chemical maps of Mars & Venus.
- Io frost/volcanism cycles; volcanic plumes
- Surfaces ices, contaminants and activity on icy satellites.
- Watery plumes from Europa/Enceladus.
- Tenuous KBO atmospheres

VLT/ELT Spatial Resolution

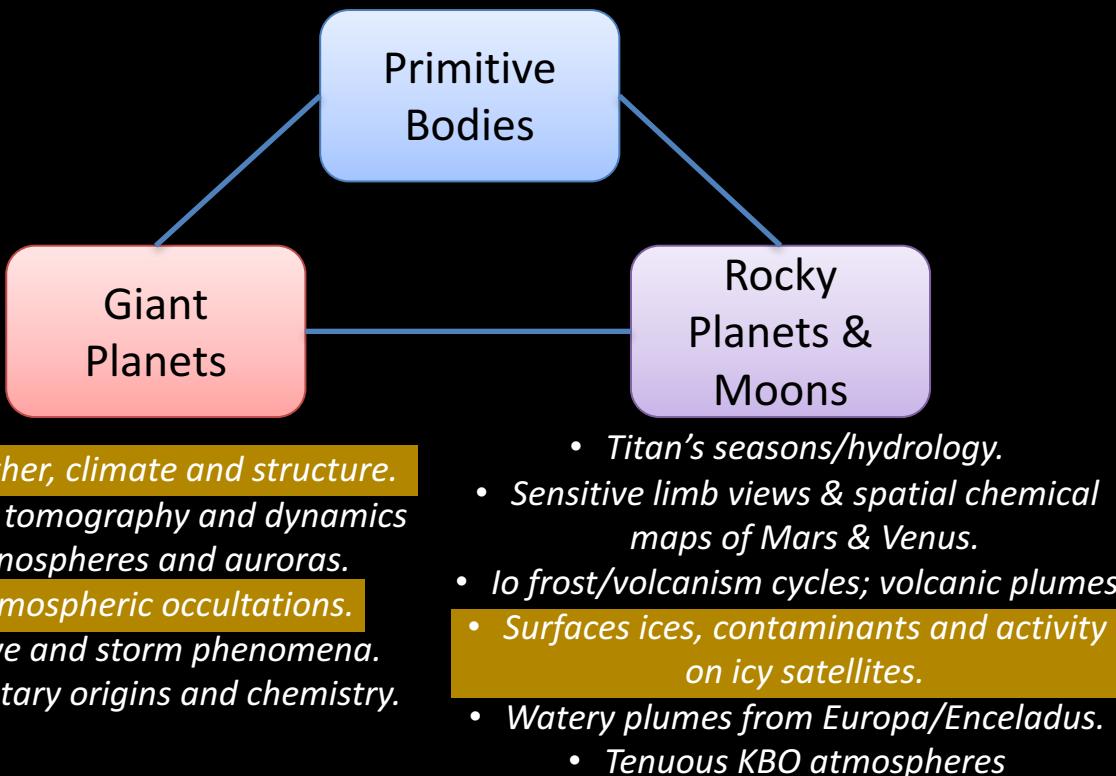
Wavelength μm	VLT [mas]	ELT [mas]
0.5	16	3
1	31	6
2	63	13
3	94	19
5	157	32
8	252	52
10	315	65
14	440	90
19	598	123

Solar System Diameters

Target	Diameter [mas]
Mars	25100
Ceres	840
Uranus	3700
Neptune	2400
Pluto	110
Io	1200
Ganymede	1800
Titan	800
Triton	130

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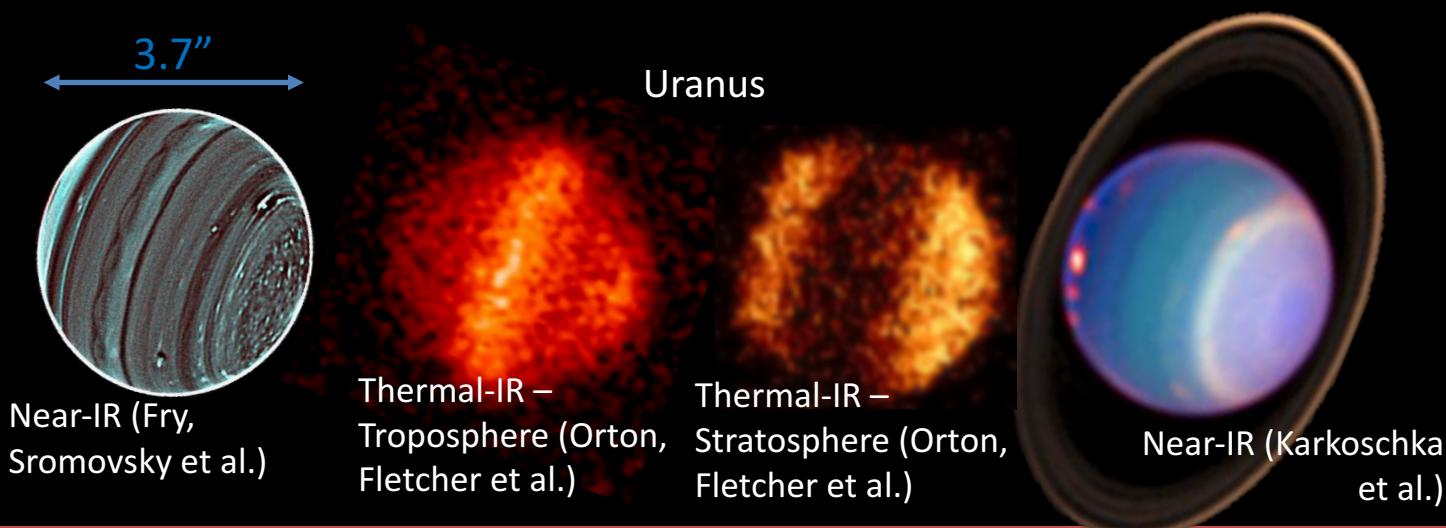
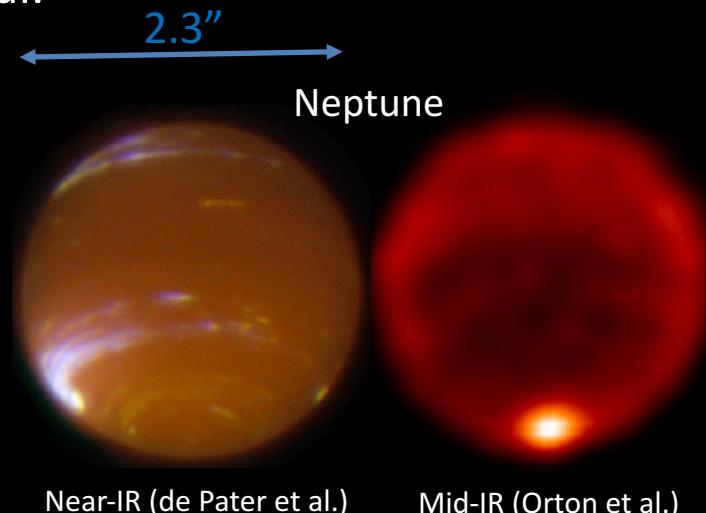
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Case 1: Revealing the Ice Giants

- Planetary class between gas giants and terrestrial.
- Single flyby 1980s, hope for 2030s/40s orbiter.
- **Extreme contrasts:**
 - Uranus tilt, negligible heat source.
 - Neptune seasons, powerful heat source.
- Chemistry and dynamics notably different from Jupiter/Saturn.
- **ELT Prospects:**
 - MICADO – cloud tracking, winds, dynamics.
 - HARMONI – cloud structure & composition.
 - METIS – temperatures, aurora, chemistry.



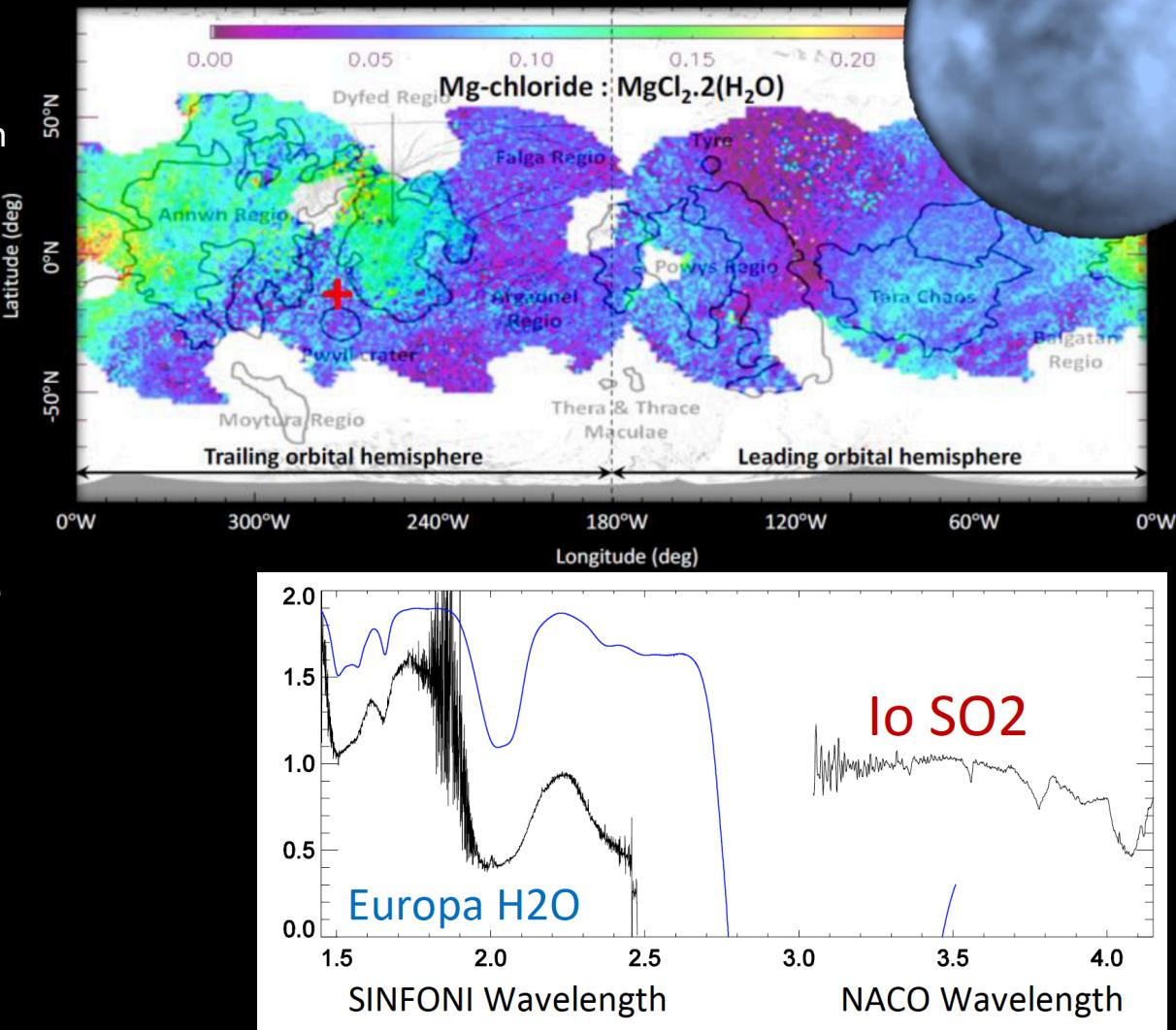
Case 2: Planetary Satellites

- **Goals of JUICE and Europa Clipper:**

- Near-IR global mapping of satellite surfaces 25 m – 10 km scales.
- Europa from ELT: 140 10mas HARMONI pixels in $1.52'' \times 2.14''$
- ~ 23 km/spixel (!)

- Spacecraft spectral resolution $\sim 5\text{-}10$ nm ($R=200\text{-}400$); HARMONI $R=500\text{-}20,000$.

- Opportunity for **ESO-ESA partnership** in preparing for these missions?



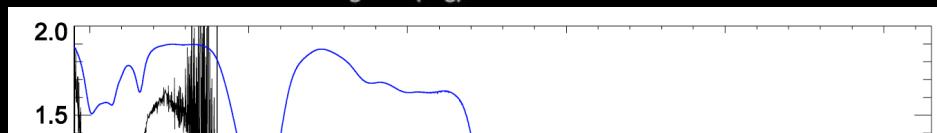
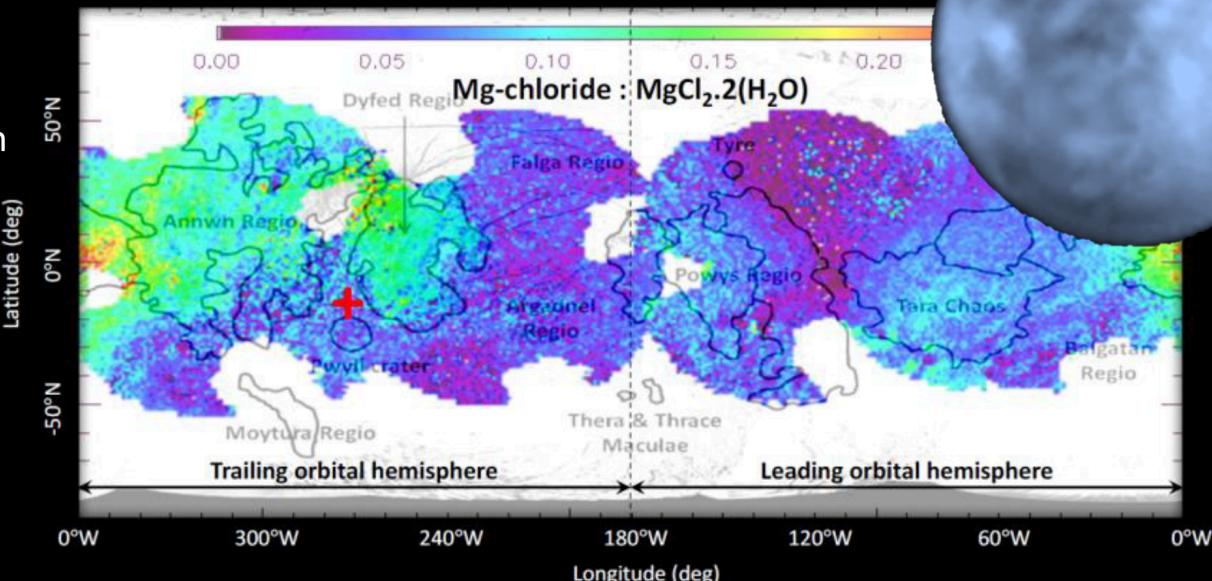
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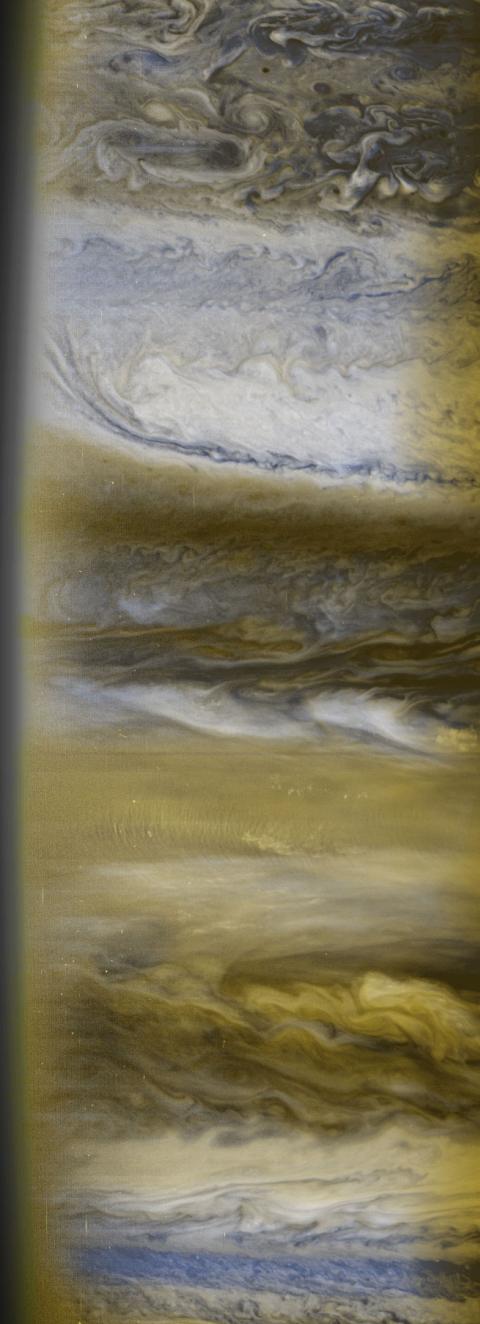
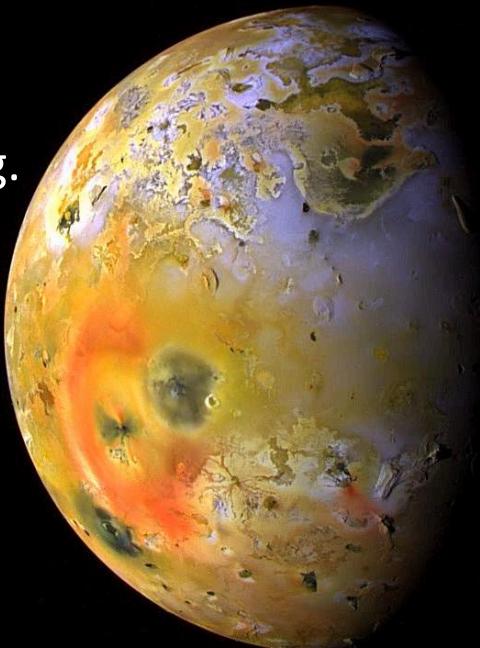
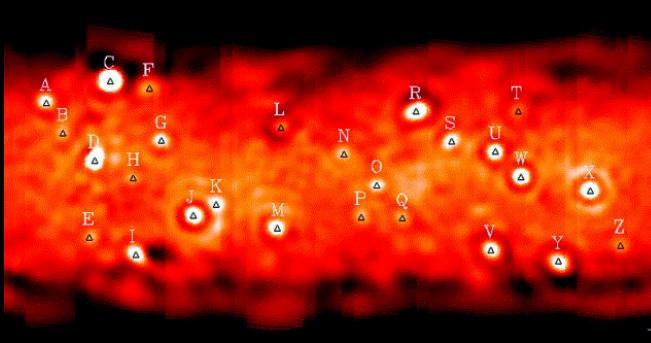
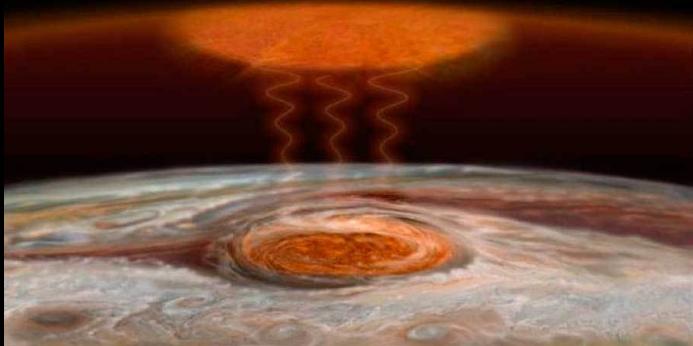
VLT SINFONI
 $R > 1500$

VLT SPHERE
 $R \sim 30$

ELT HARMONI
 $R > 3000$

JUICE
 $R_{\text{VISNIR}} \sim 700$

Case 3: Jovian Occultations



- Jupiter's ~40" disc too large for traditional mapping/mosaics.
- Waves couple tropospheric weather to middle/upper atmosphere heating.
- Spacecraft occultations provide sub-km vertical resolution.
- **Io volcanoes as point sources?**
 - Sources 1300 K, area 10-50 km²
 - Multiple occultations ingress/egress every 42 hours!
- Also:
 - Watch SO₂ **atmosphere collapse** to frost in eclipse...
 - Detect ~300 km tall **volcanic plumes...**

Solar System Science from ELTs

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Giant Planets

- Weather, climate and structure.
- Cloud tomography and dynamics
 - Ionospheres and auroras.
 - Atmospheric occultations.
 - Wave and storm phenomena.
- Planetary origins and chemistry.

Primitive Bodies

Rocky Planets & Moons

- Titan's seasons/hydrology.
- Sensitive limb views & spatial chemical maps of Mars & Venus.
- Io frost/volcanism cycles; volcanic plumes
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