ARIEL

6e journée ESEP

IAP, 29 novembre 2016

Présentation par Pierre Drossart

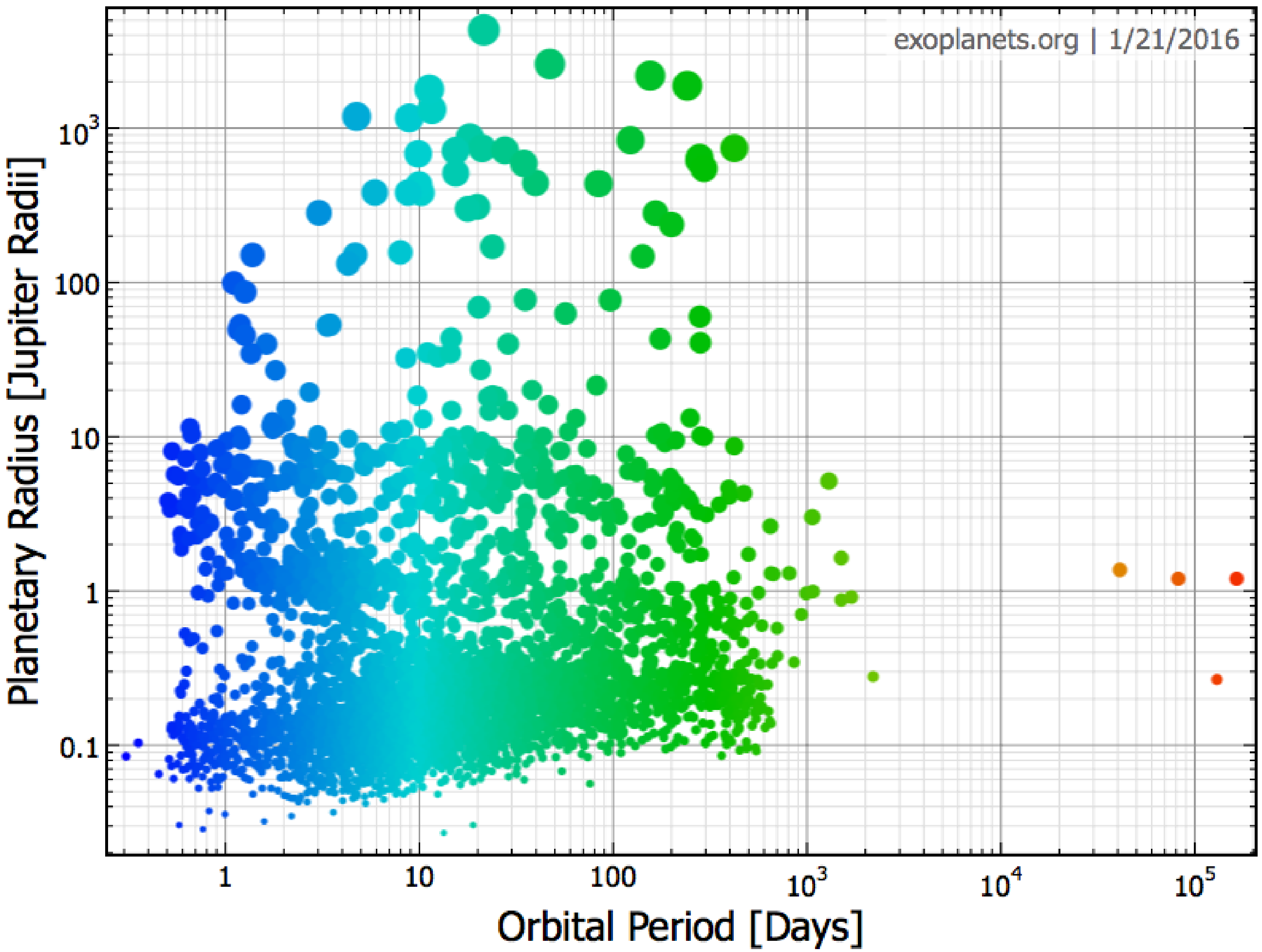
Préparée à partir des contributions de :

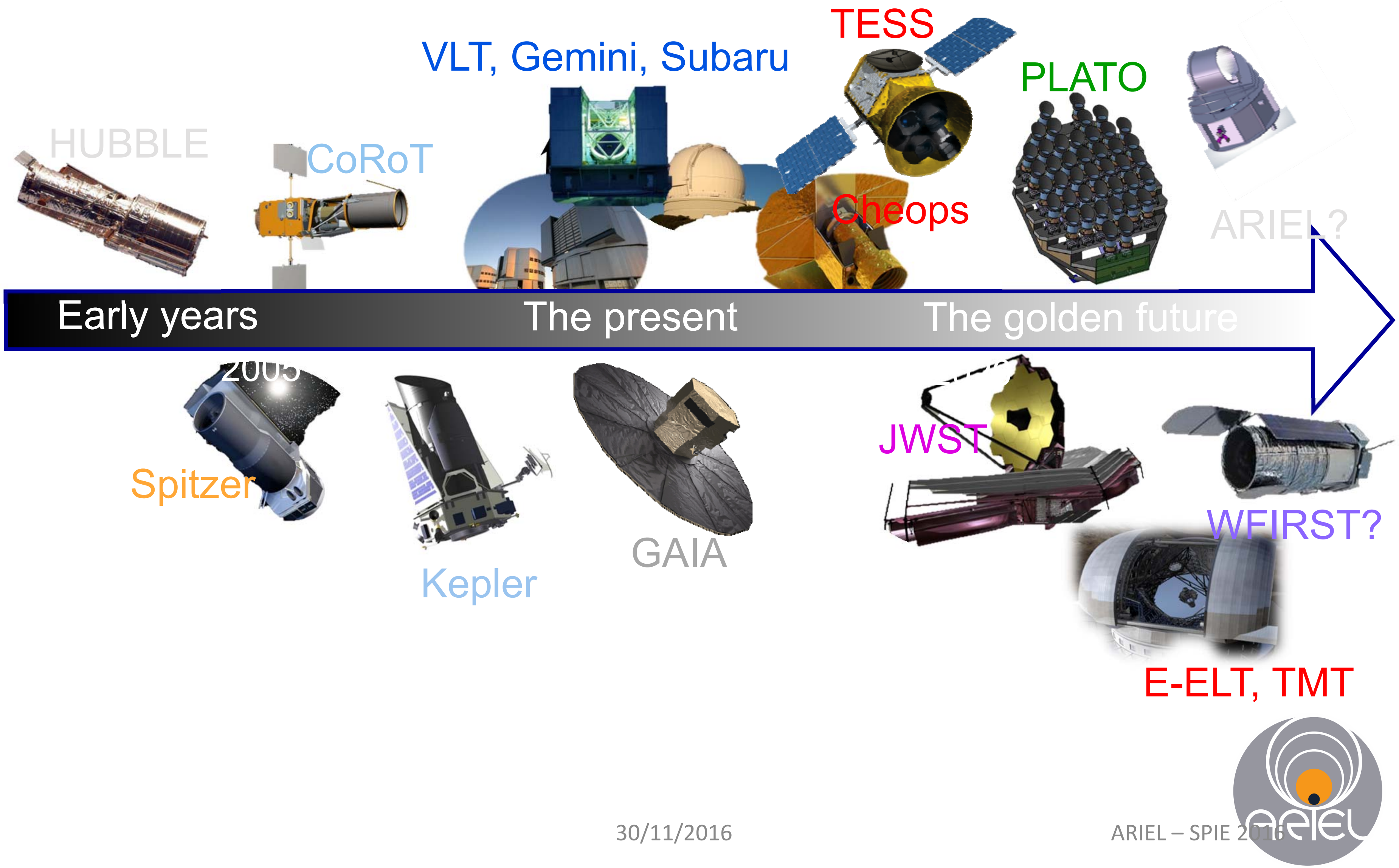
G. Tinetti, JP Beaulieu, M. Ollivier, G. Pillbratt,

O. Puig, et l' ESA/SST ARIEL

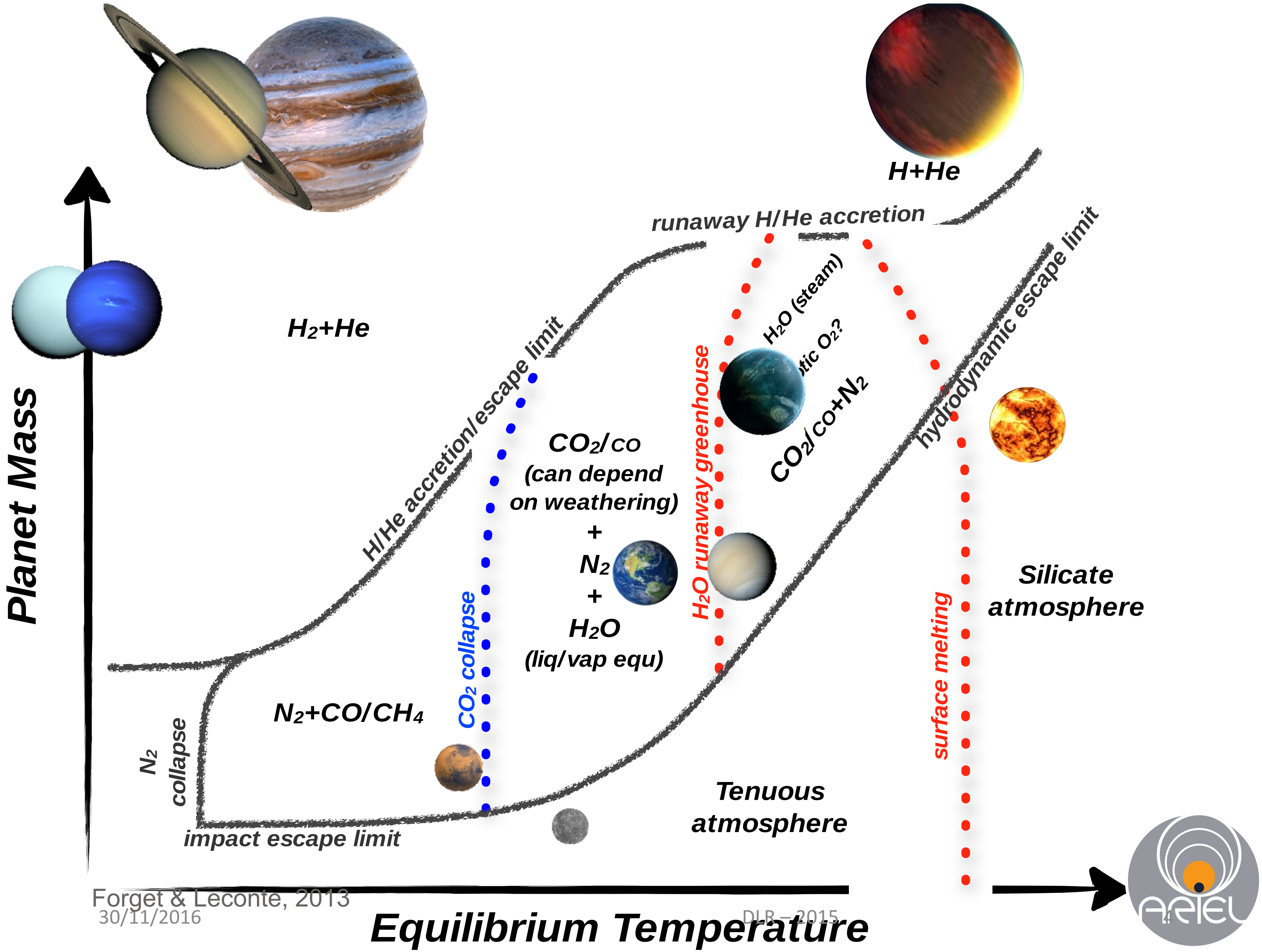
Exoplanets – today

3544 planets in our Galaxy, 2696 transiting….and more to come!



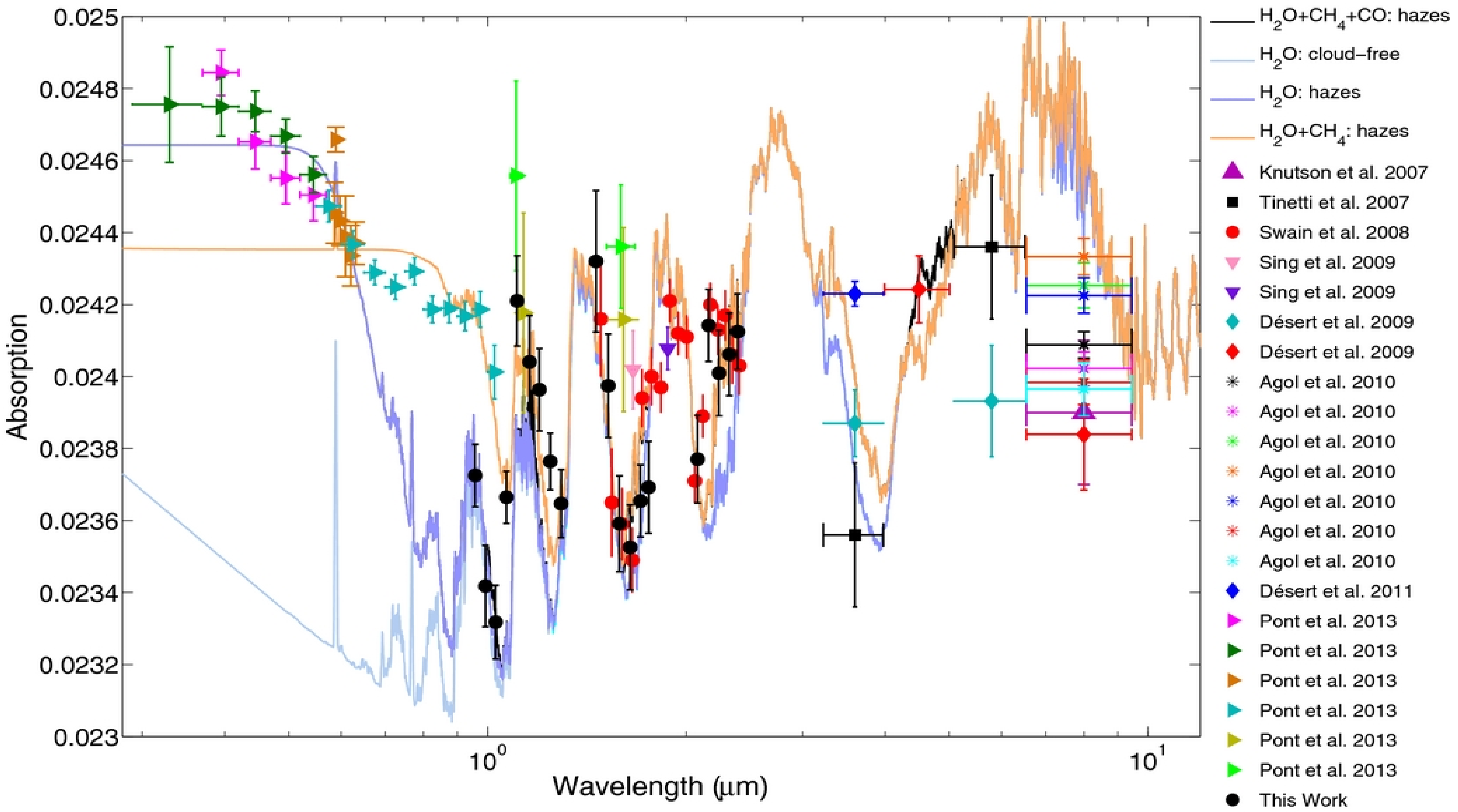


HUBBLE
CoRoT
VLT, Gemini, Subaru
TESS
Cheops
PLATO
ARIEL ?
Early years
The present
The golden future
2003
Spitzer
Kepler
GAIA
JWST
WFIRST?
E-ELT, TMT



Forget & Leconte, 2013

Exo-atmospheres with current telescopes



Danielski et al., 2014

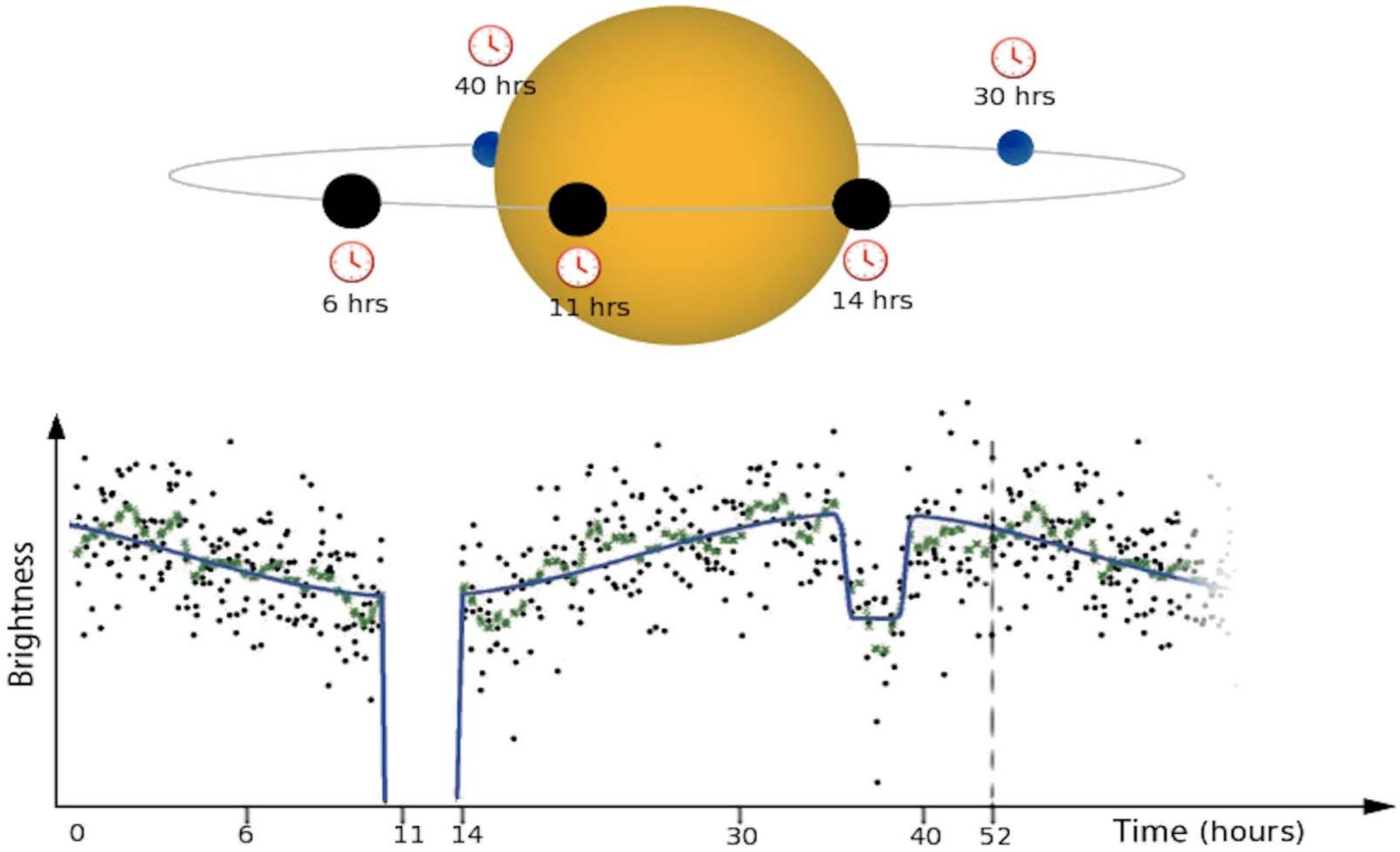
A host of questions for next decade...

Detection of planetary atmospheres, their composition and structure

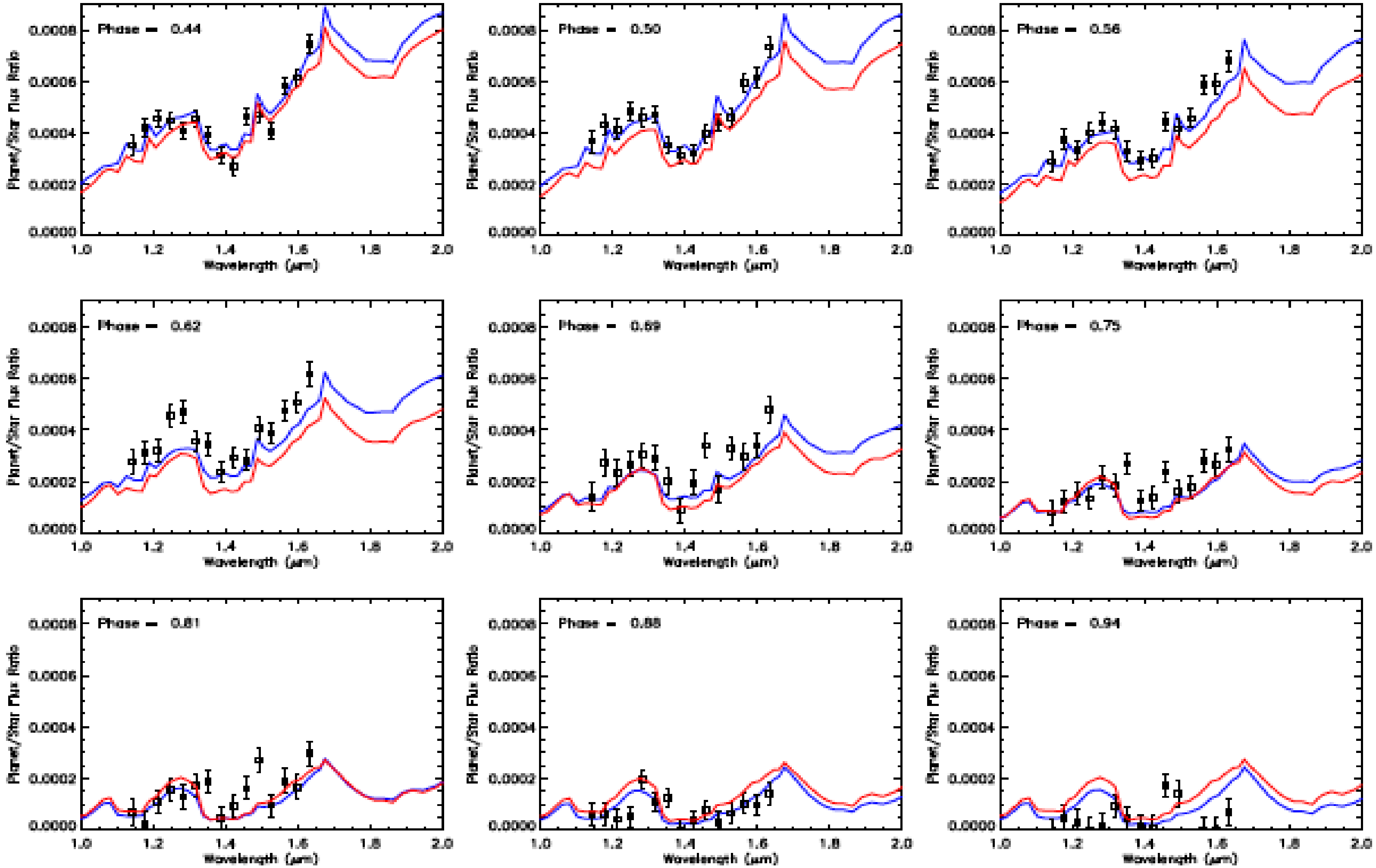
• Determine vertical and horizontal temperature structure & their diurnal/seasonal variations
• Identify chemical processes at work (thermochemistry, photochemistry, transport quenching)
• Constrain planetary interiors (breaking the radius-mass degeneracy)
• Quantify the energy budget (albedo, temperature)
• Constrain formation and evolution models (evidence for migration)
• Detect secondary atmospheres around terrestrial planets (evolution)
• Investigate the impact of stellar and planetary environment on exoplanet properties

Transit & eclipse spectroscopy

aiming at 10^{-4} stellar flux at multiple wavelengths

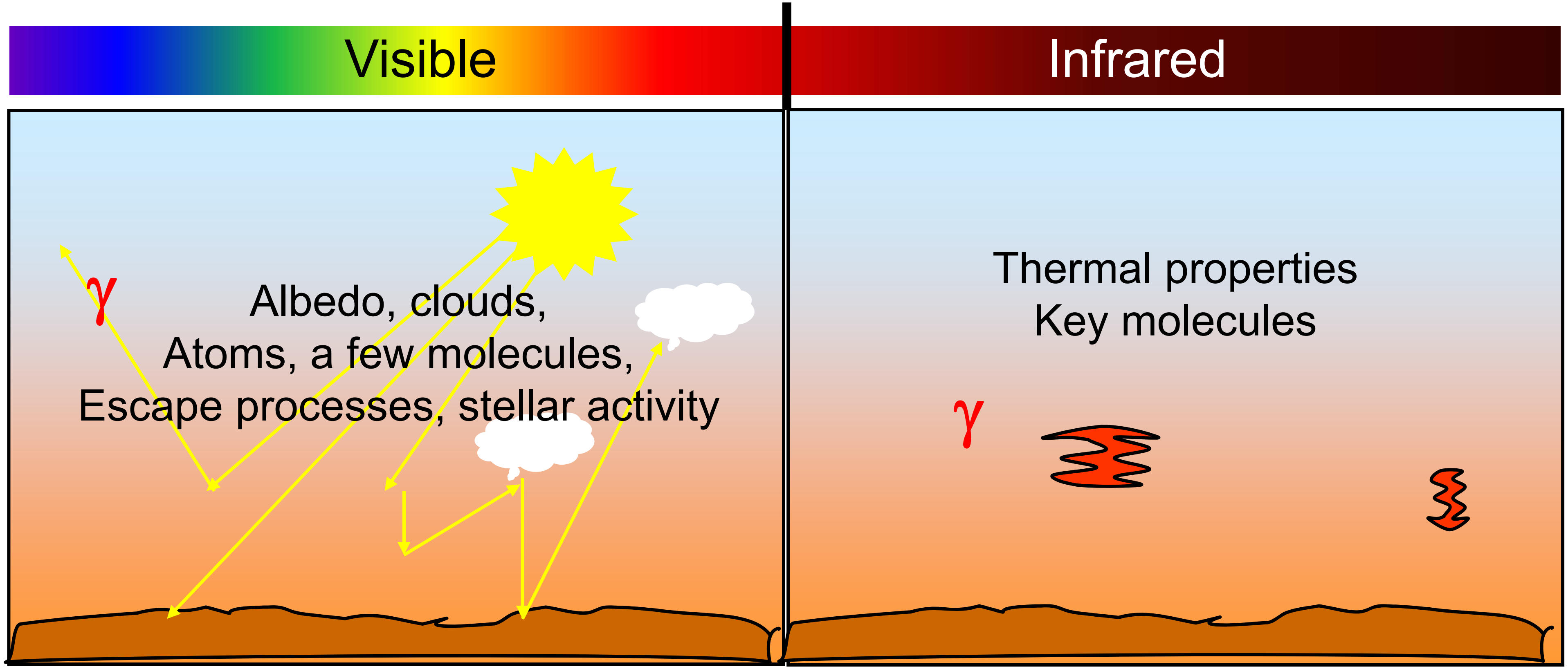


Spectra as function of orbital phase



Kataria et al, 2015

Spectral region

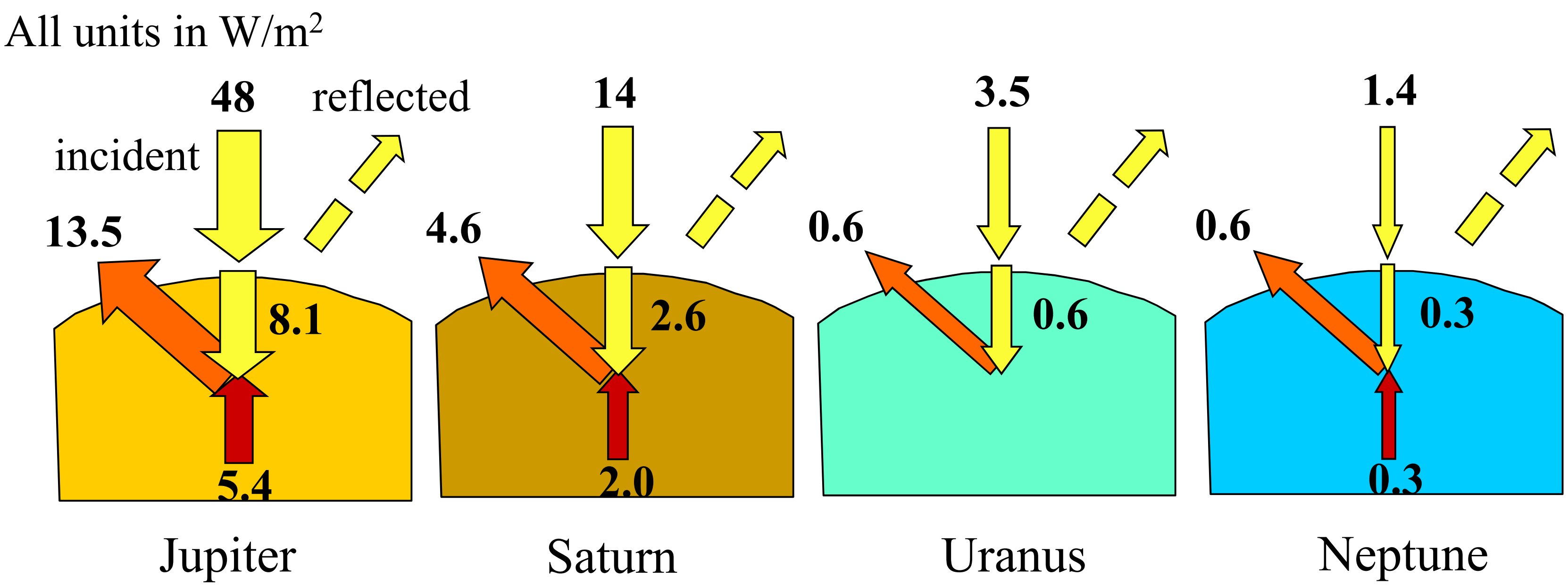


photometry bands (VIS+NIR) + spectroscopy 2-8 micron

Planetary energy balance

as provided by ARIEL

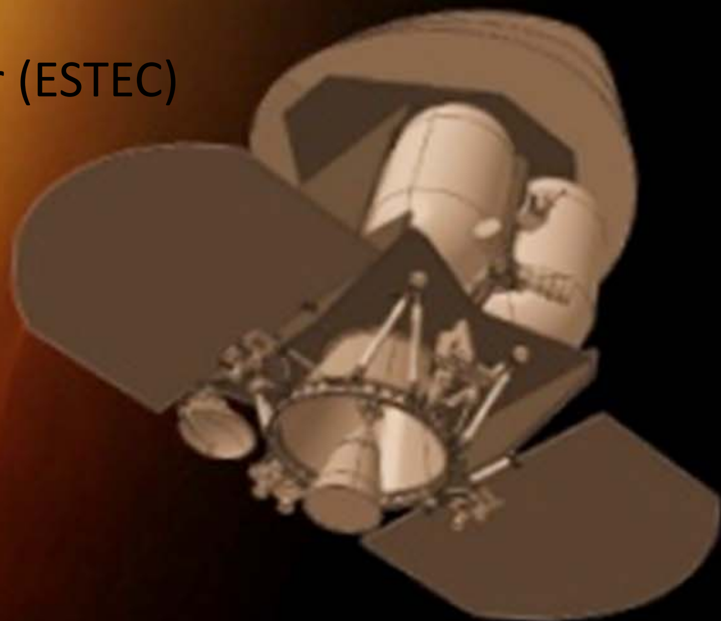
- Giant planets in the Solar System



ARIEL Telescope and Payload Design

From Paul Eccleston (Ariel project manager, STFC – RAL Space

Goran Pilbratt, Ariel study manager (ESTEC)



ARIEL

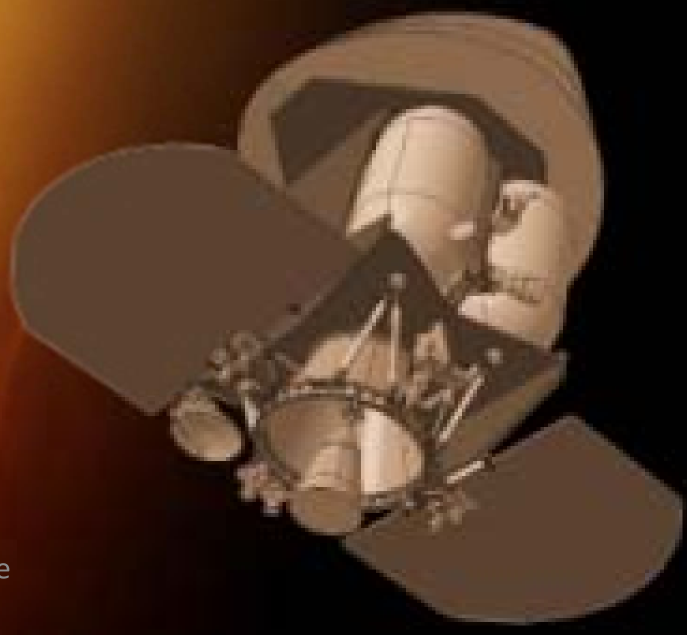
ATMOSPHERIC REMOTE-SENSING INFRARED EXOPLANET LARGE-SURVEY

~500 Exoplanet atmospheres

1m class telescope in space (L2)

Highly stable over a few hours,
high visibility of sky

Spectral range:
~0.5-8 micron



Payload Module Functions

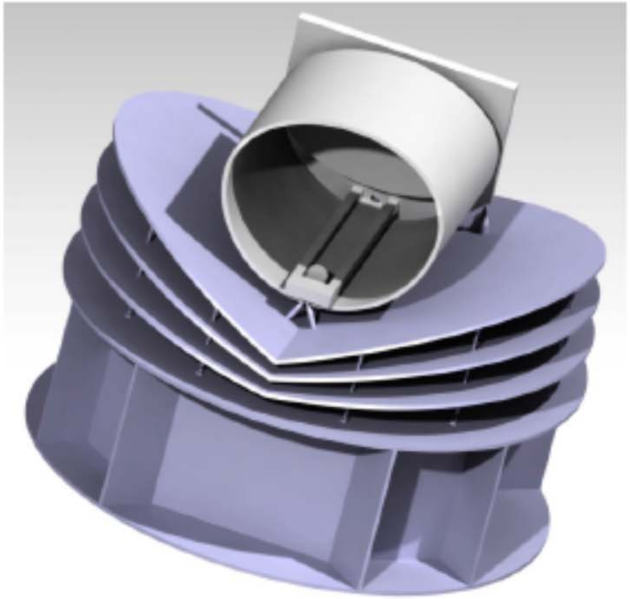
- Telescope (~1 meter class), passively cooled to <80K, diffraction limit at ~3 μm
- Single spectrometer module with dual optical chains providing R ~ 200 coverage from 1.95 – 7.8 microns on single detector
- FGS system (redundant) which doubles as a NIR photometer for stellar variability monitoring
- Common optical bench and structure to support both the instrument boxes and the telescope primary mirror
- Thermal isolation from SVM via V-grooves and GFRP / CFRP struts and isolating cryo-harnesses.

Telescope Parameters

Parameter	Ch0 (1.95-3.9m)	Ch1(3.9-7.8um)
Telescope f/number	f/13.4 (for 0.9 diameter circular aperture)	
Entrance pupil diameter	Elliptical, 1.1 m x 0.7 m (equivalent to 0.9 m circular)	
Plate scale at prime focus	58 um / arc sec	
Collimated beam diameter after M3	Elliptical, 22.2 mm x 14.5 mm	
f/no at spectrometer input	20.5	10.3
Space envelope (optics only)	1400 mm (z) x 950 mm (y) x 1200 mm (x)	

Spacecraft

Under study by industry (x2) and ARIEL Consortium (PLM)

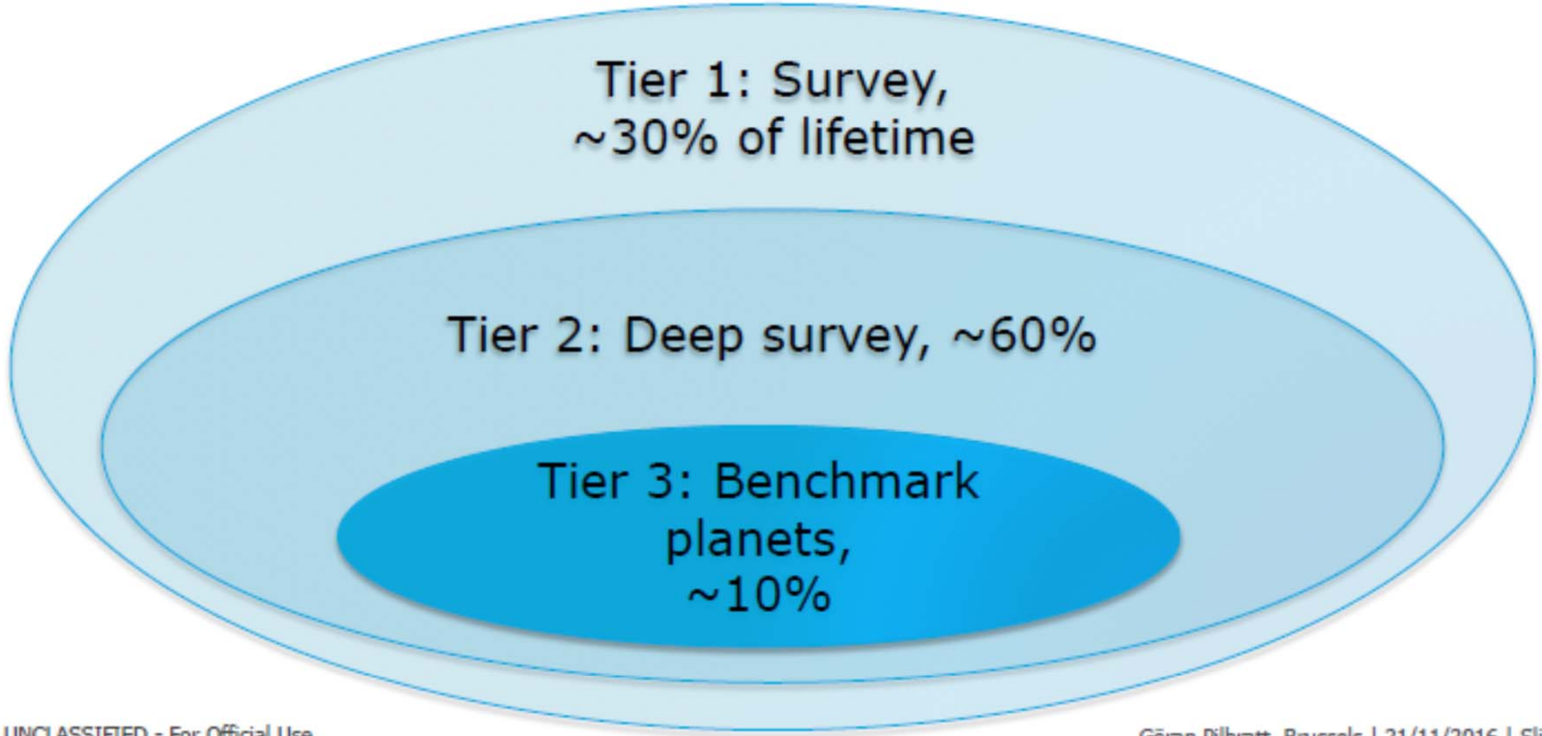


Instrument
- Spectrometers:
  - 1.25-1.9 um, R~10
  - 1.95-3.95 um, R~100
  - 3.95-7.8 um, R~30
- Photometer:
  - 3 VNIR channels (0.5-1.2 um)

Telescope
- 3-mirror off-axis afocal
- 1.1 x 0.7 m aperture

Spacecraft & mission
- Payload module (PLM) passively cooled
- Detectors actively cooled
- Large halo-orbit around L2 – 4 (6) years

3-tier observing strategy

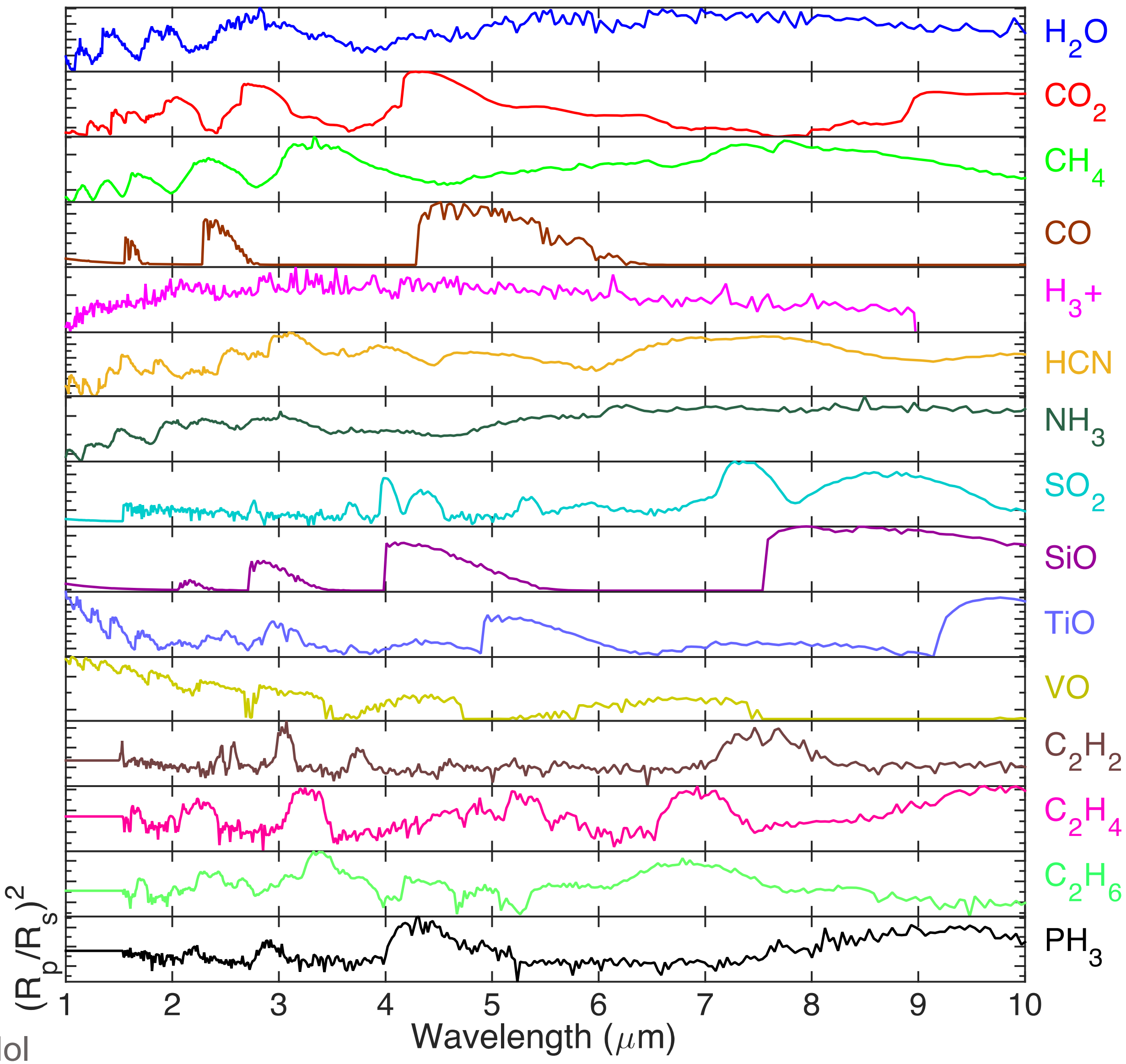


Schedule

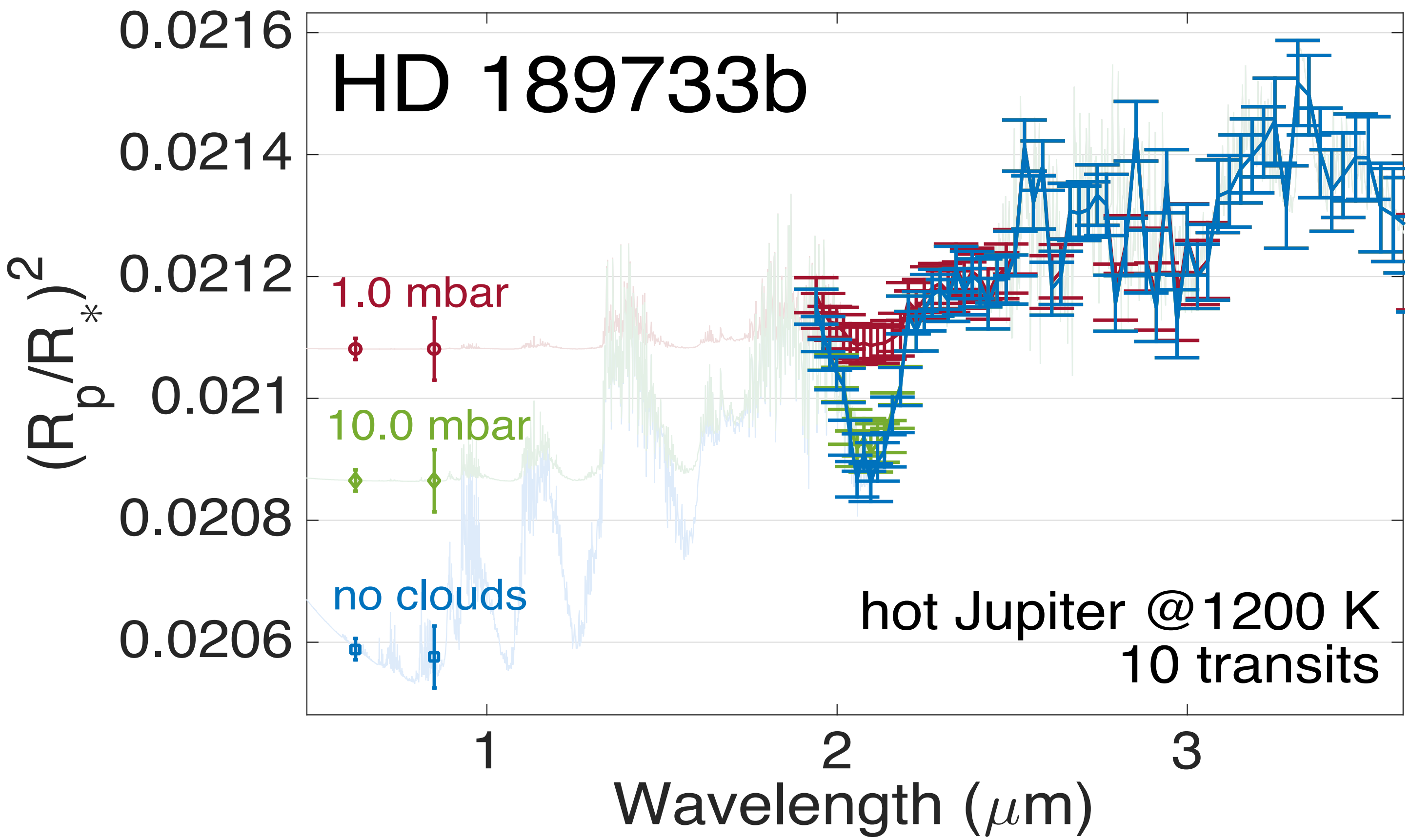
Current plan for M4 mission implementation

• Phase 0 (internal to ESA)	Jun-Sep 2015
• ITT for industrial phase A studies	Oct 2015
• Industrial phase A studies kick-off	Mar 2016
• **Science workshop in Brussels**	**Nov 2016**
• Mission selection review	Feb-May 2017
• Presentations in Paris	TBA early May 2017
• Selection of M4 mission by the SPC	Jun 2017
• Phase B1 for selected mission	Jul 2017-Sep 2018
• Mission adoption review	Sep/Oct 2018
• Adoption by the SPC	Nov 2018
• Phase B2/C/D kick-off	Jul 2019
• Launch	2026

Key molecules absorbing in IR

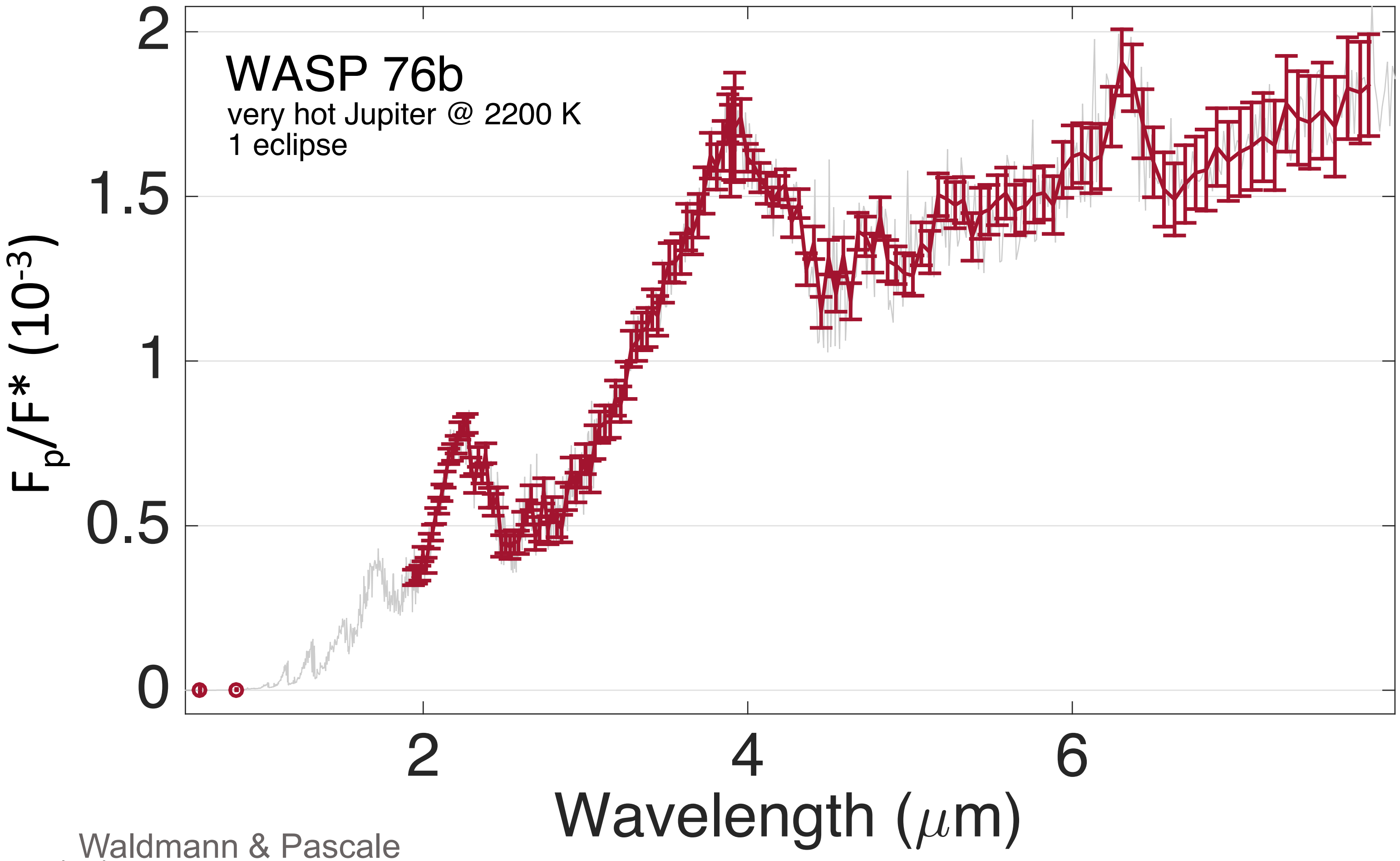


FGS & Cloud deck



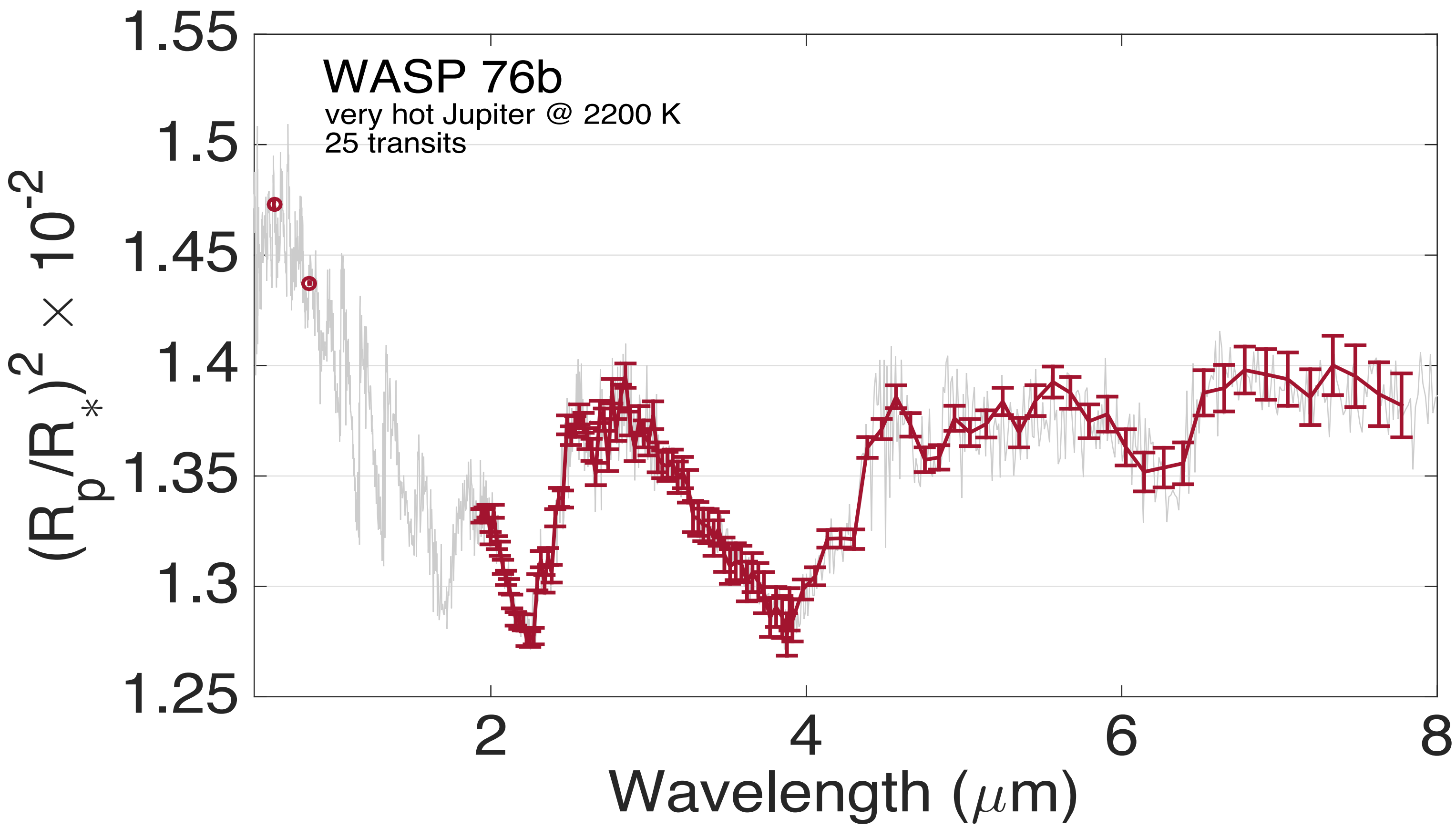
Waldmann & Pascale

Very hot-Jupiter – ARIEL spectrum



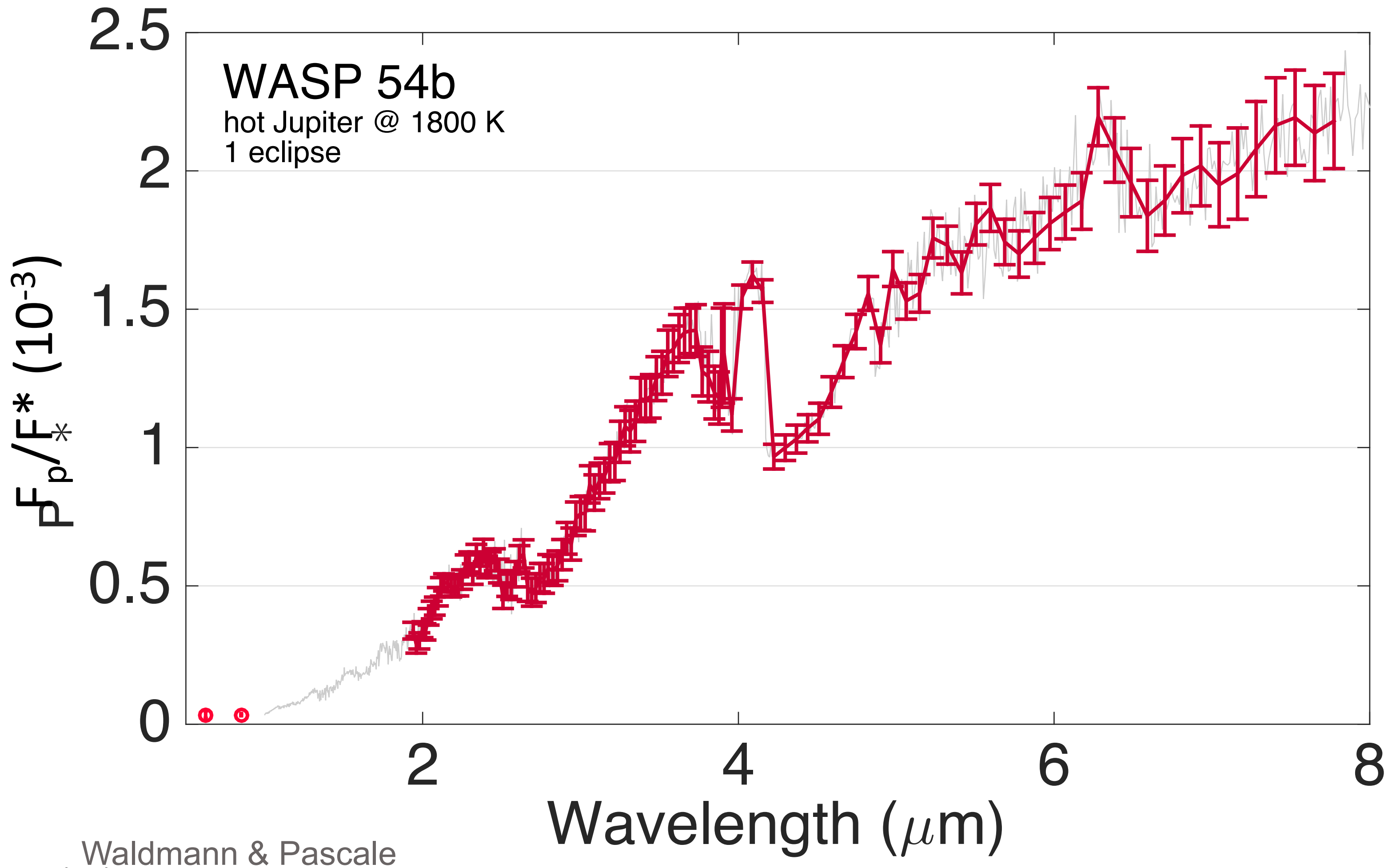
Waldmann & Pascale

Very hot-Jupiter – ARIEL spectrum



Waldmann & Pascale

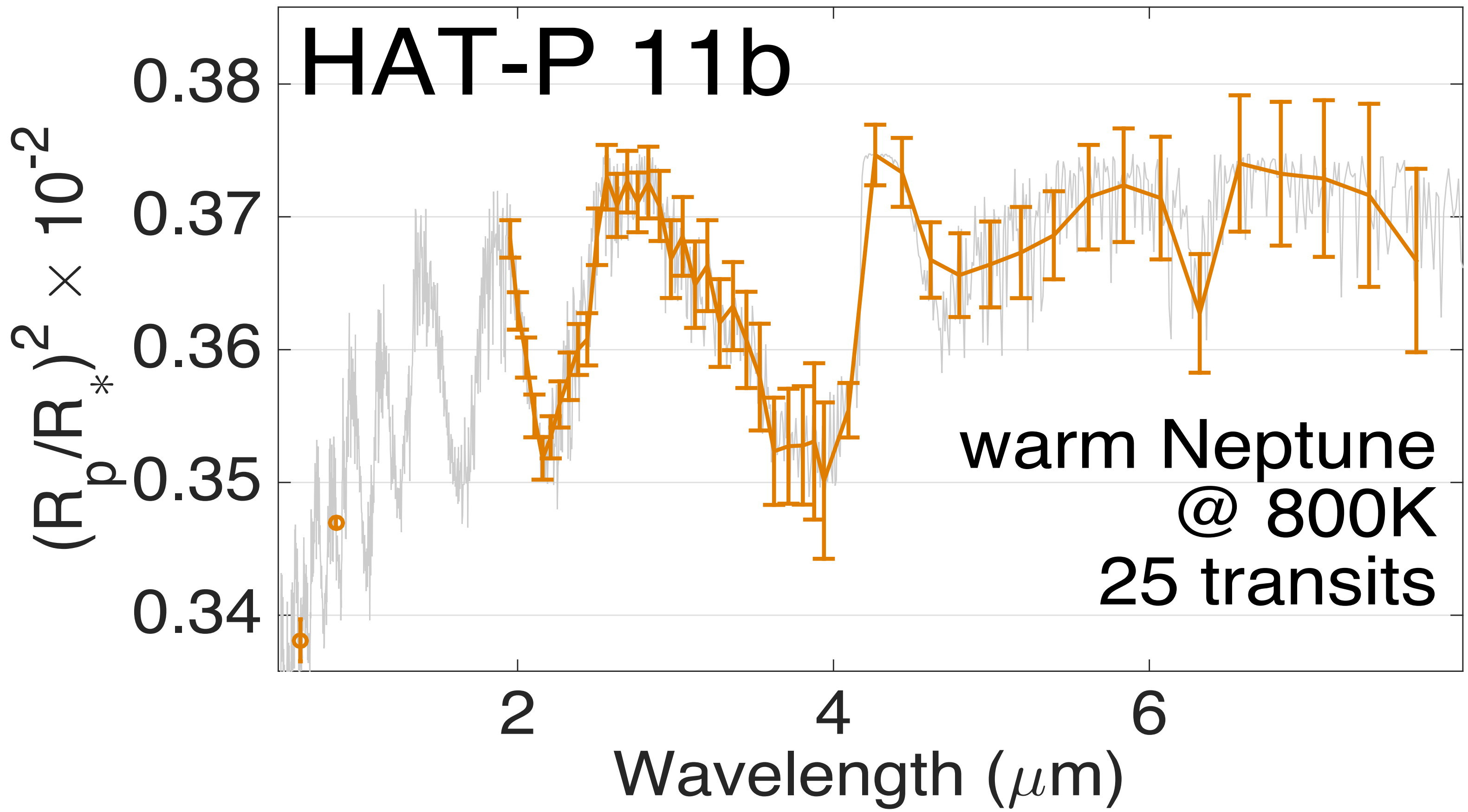
Hot-Jupiter – ARIEL spectrum



Waldmann & Pascale

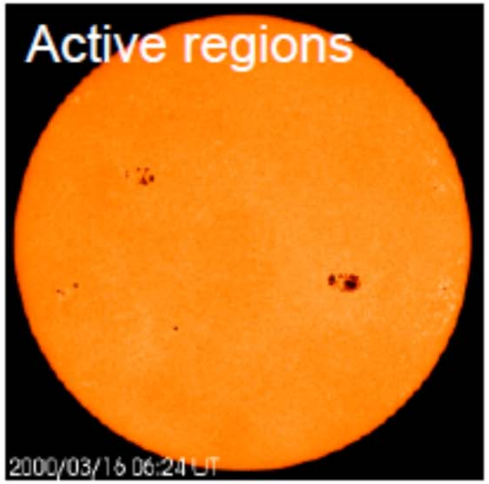
30/11/2016

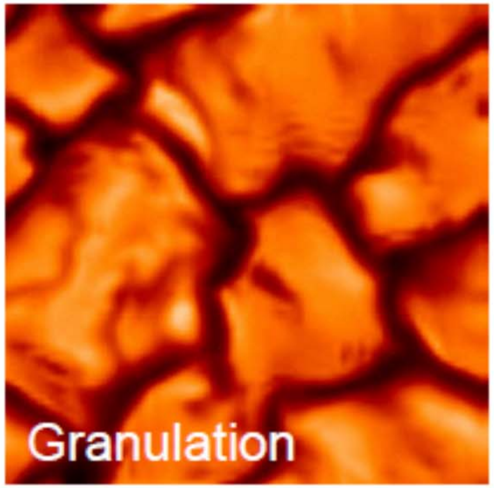
Warm Neptune – ARIEL spectrum



Waldmann & Pascale

Taking Stellar variability into account





Optical monitoring is key

Active Regions

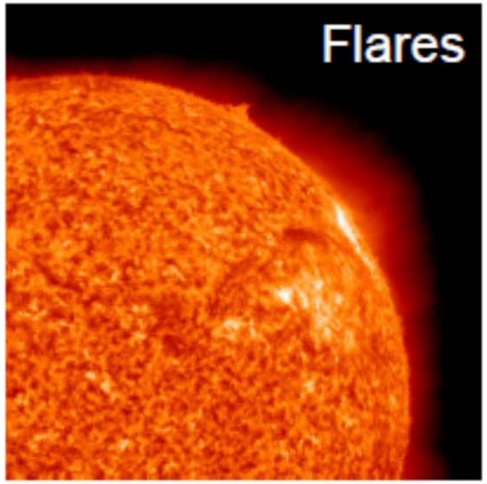
- Properties correlate well with colour measured in ARIEL optical filters
- Sum synthetic spectra to correct

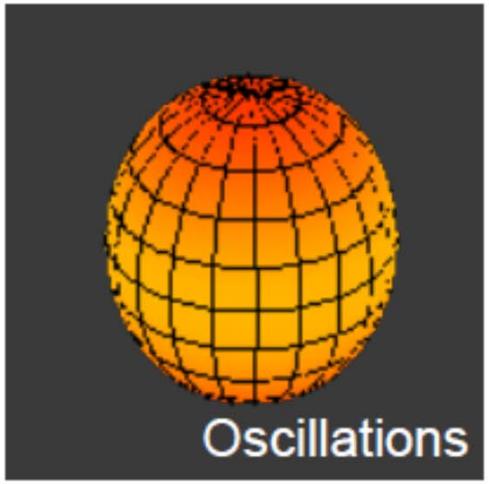
Flares

- Rare (few % of sample)
- Good contrast optical-IR

Granulation / Oscillations

- Average ΔT synthetic spectra to correct





KU LEUVEN

[Images: SOHO/MDI, SOHO/EIT, Robinson, Konkoly obs.]

Conclusions

- Thousands of exoplanets discovered and more to come.
- We now need to understand how planets form & evolve
- The way forward is to study the *atmospheric chemistry of exoplanets*
- We need to study a large population of objects to draw conclusions
- Ariel would deliver *transformational science:*

  - Large survey of planetary atmospheres (~ 500)
  - Hundreds of hot & warm planets spectroscopically observed
  - Molecular abundances 3 orders of magnitude lower than currently possible
  - Fourfold increase in the number of detected molecules