Ground-based secondary eclipse observations

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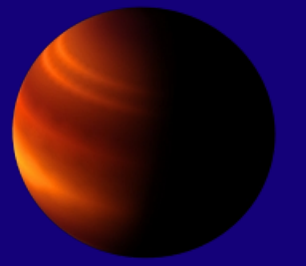
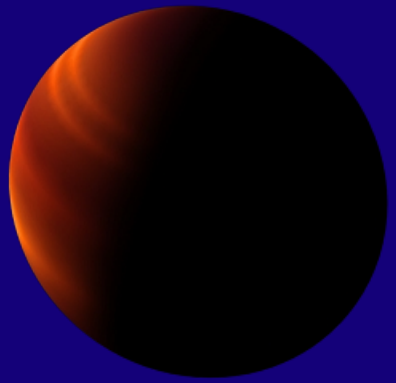
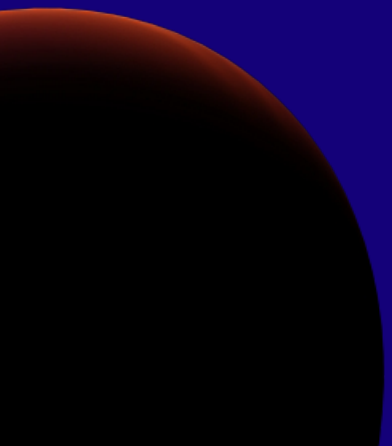
Raine Karjalainen, Emanuele Di Gloria,
Matthew Kenworthy

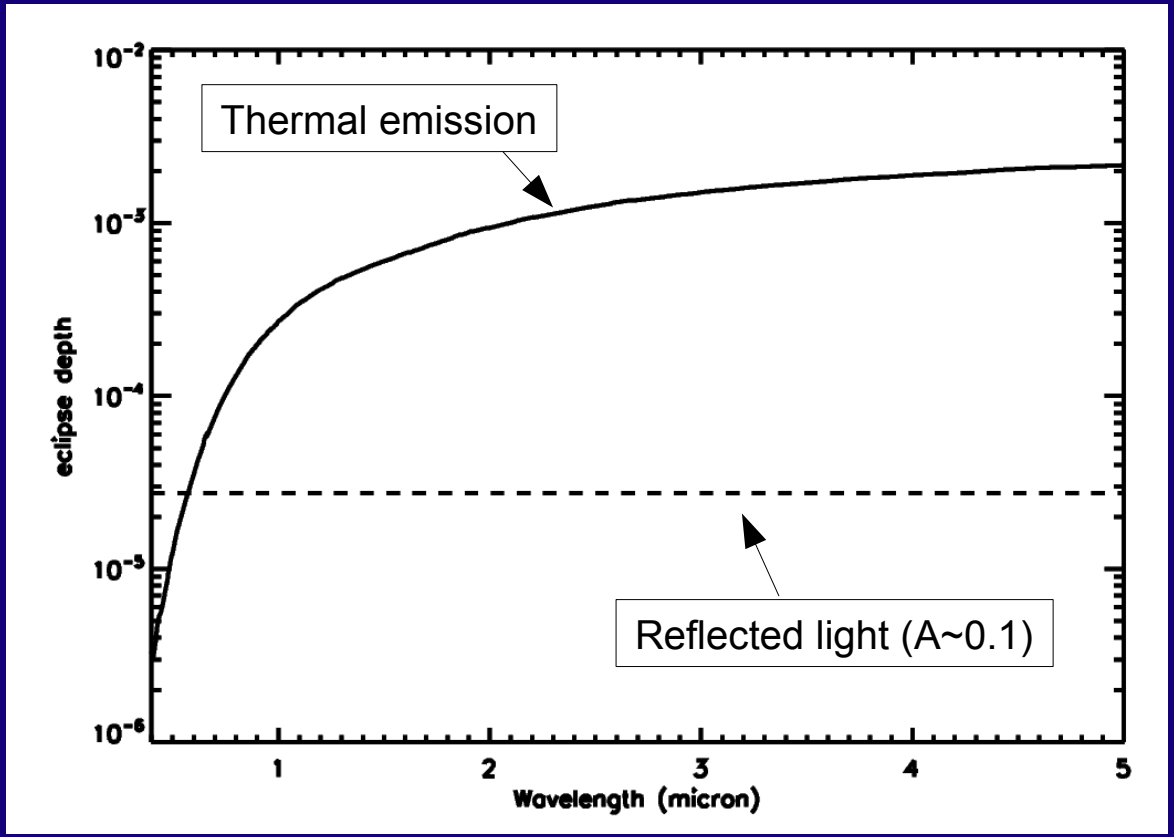




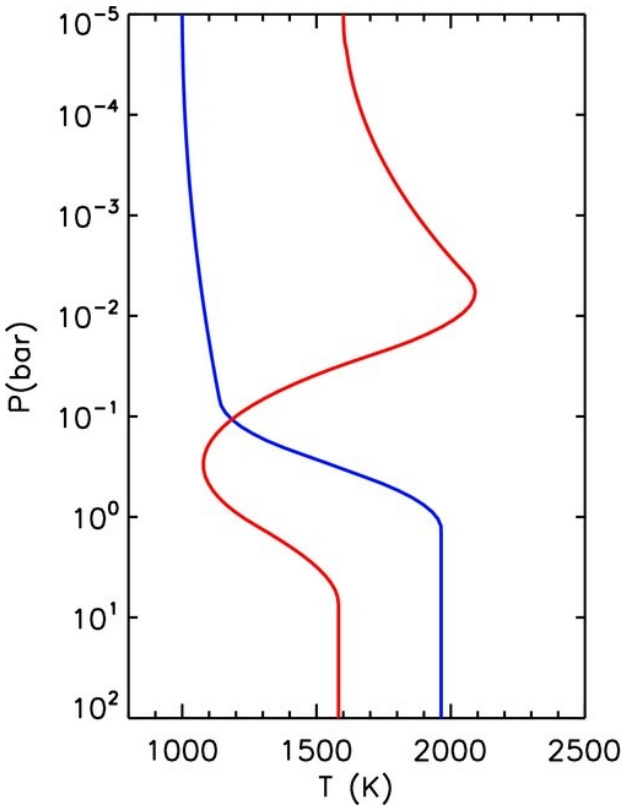


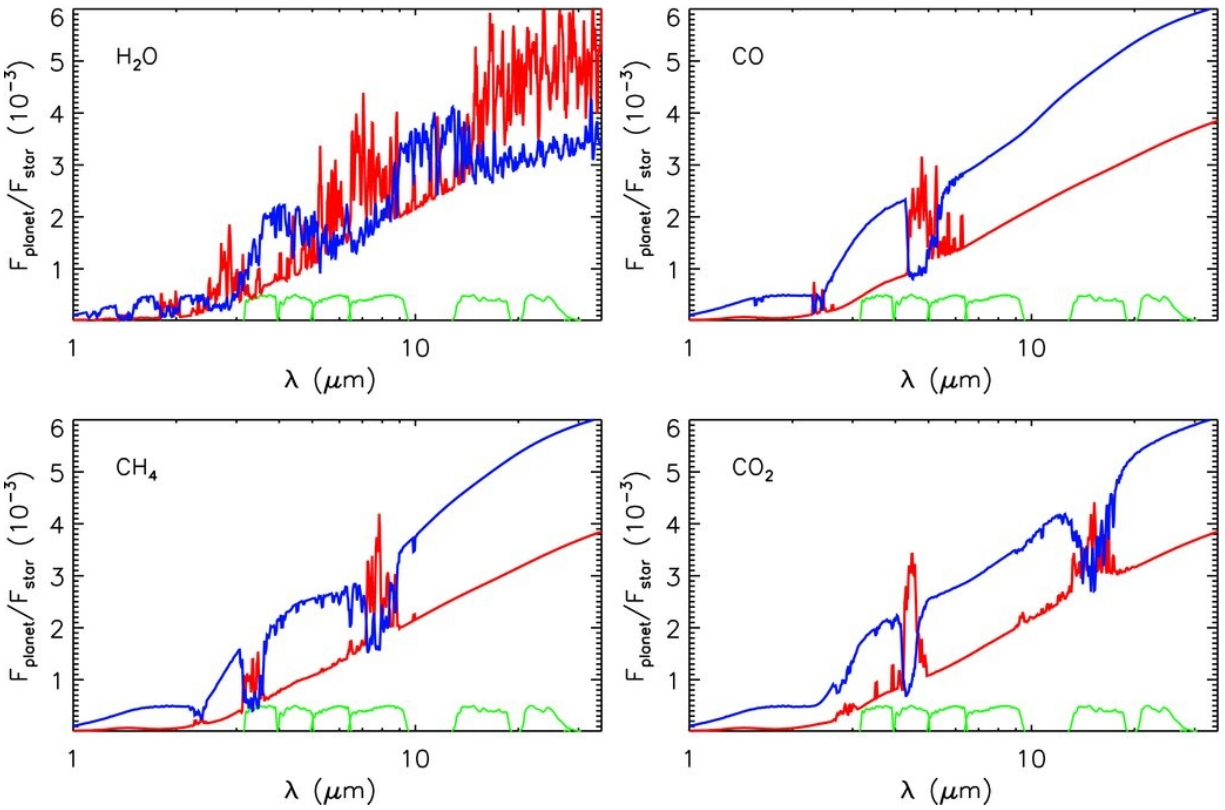
What do we learn from secondary eclipses

- Light coming from the planet
- For hot Jupiters: Typically thermal emission
- Can determine
  - composition
  - temperature structure



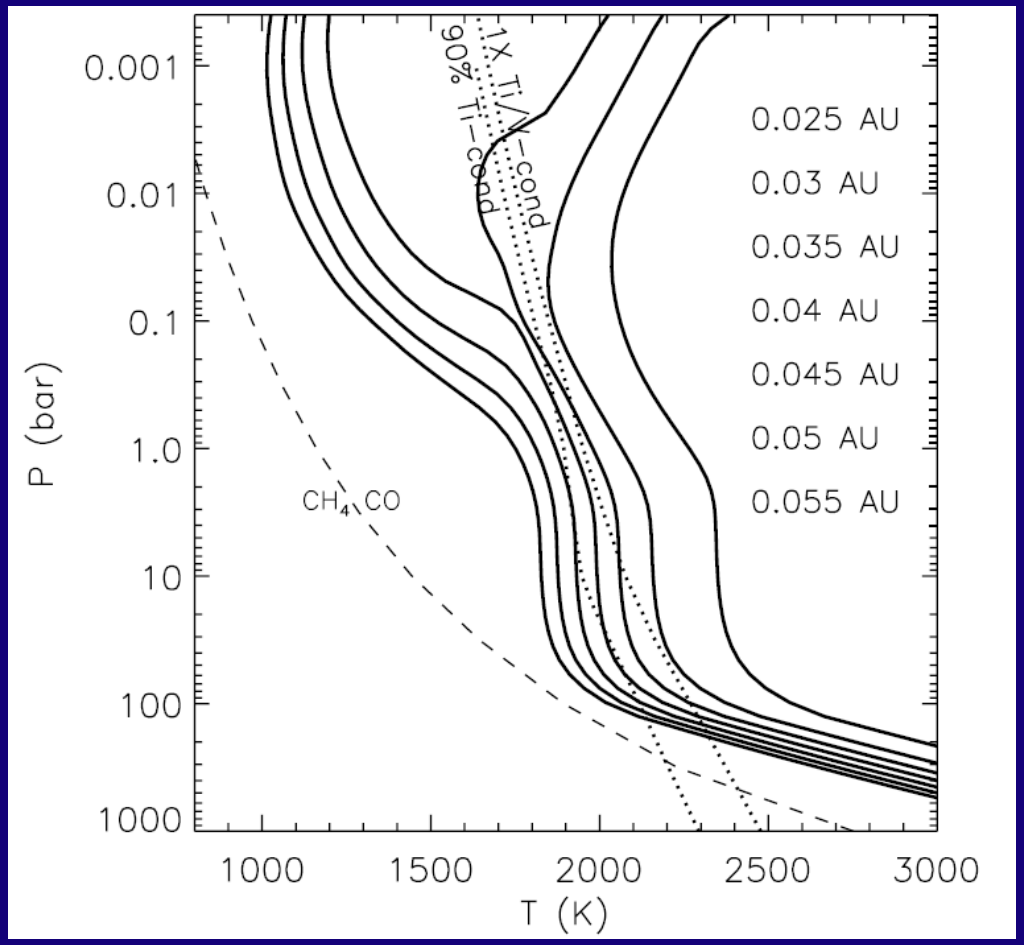
Structure of the atmosphere: inversion layers

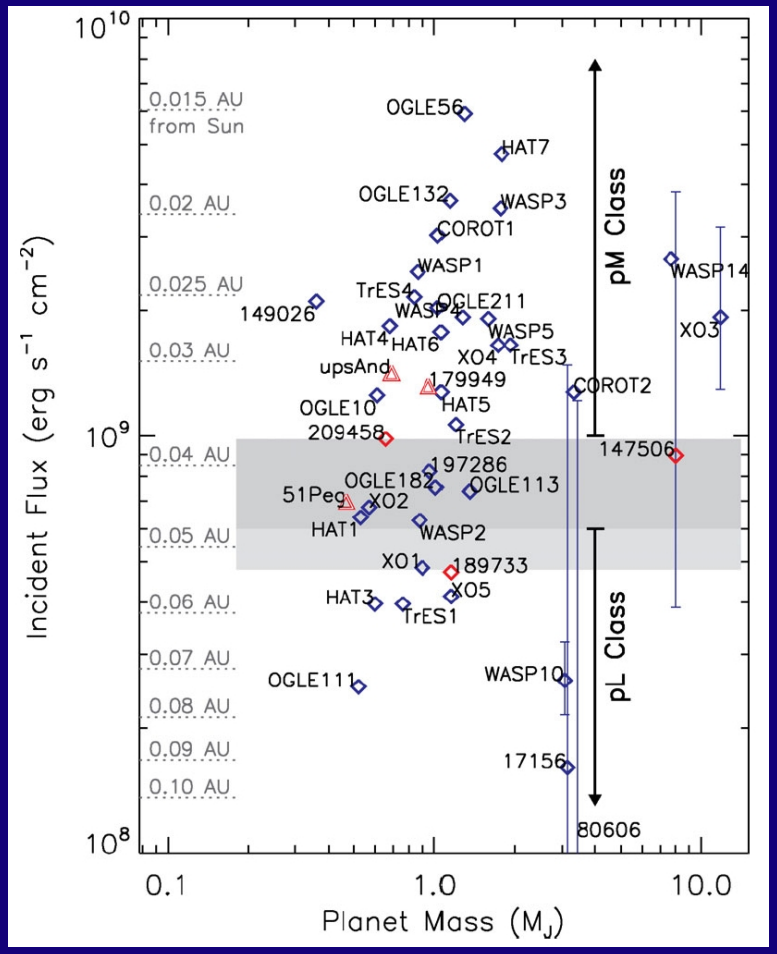




Madhusudhan and Seager (2010), ApJ 725, 261

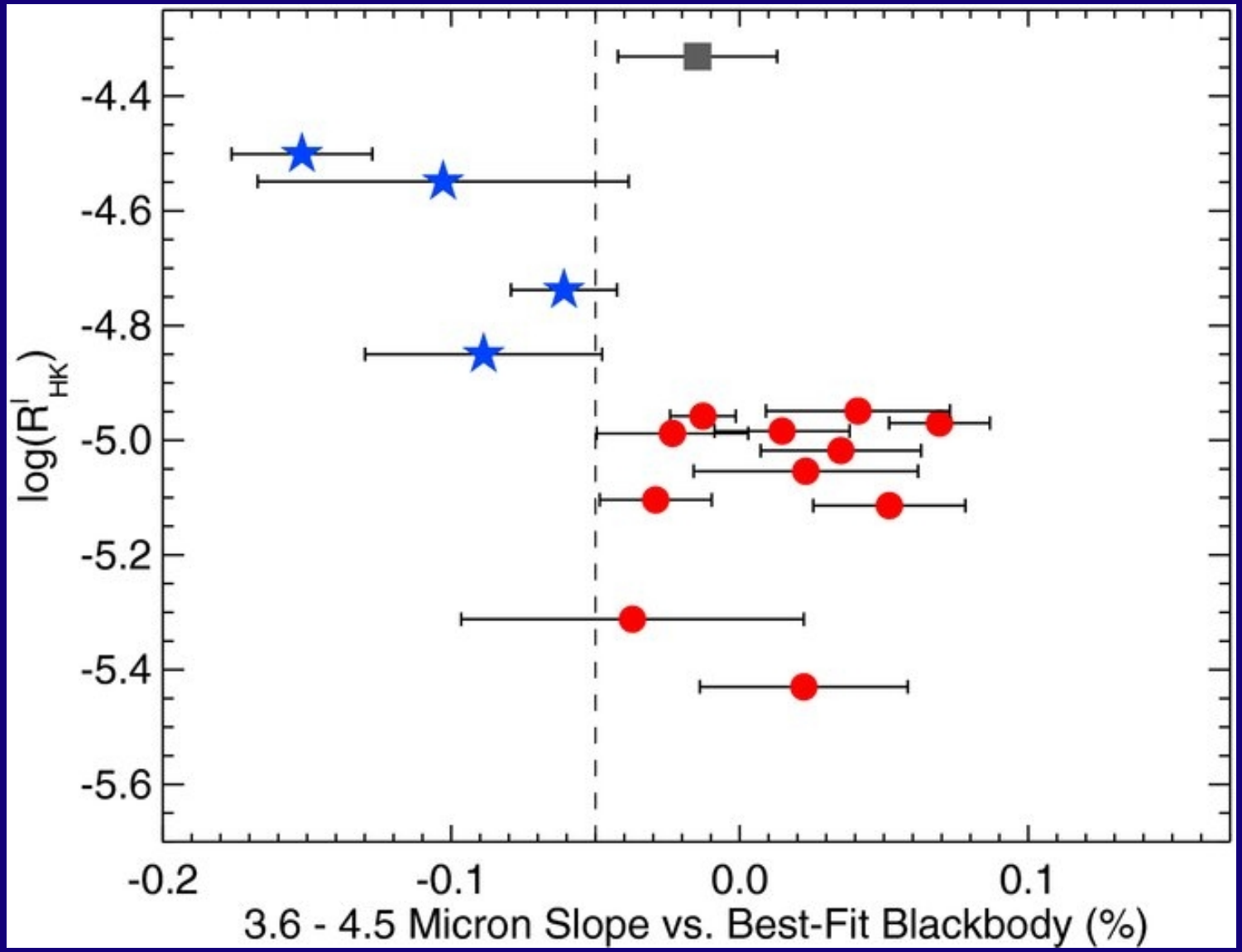
Incident radiation?





Fortney et al. 2008

Stellar activity?



Knutson et al. 2010

Ground-based observations

- Near-infrared secondary eclipse observations probe the spectral energy distribution of a hot-Jupiter near its peak
- Optical observations ($\lambda < 1$ μm) probe the emission in the Wien Limit
- Provide important constraints on the energy budgets

The GROUSE project

- Near-infrared observations of the secondary eclipses of hot-Jupiters
- Goal: Determine the planet's SEDs
- Currently 10 targets observed

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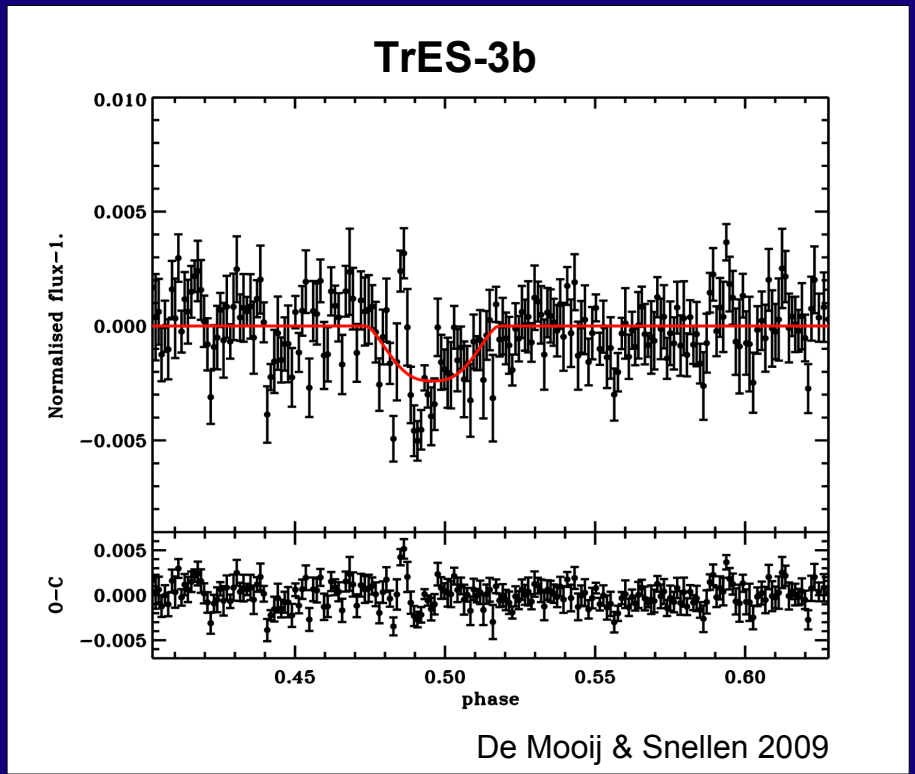
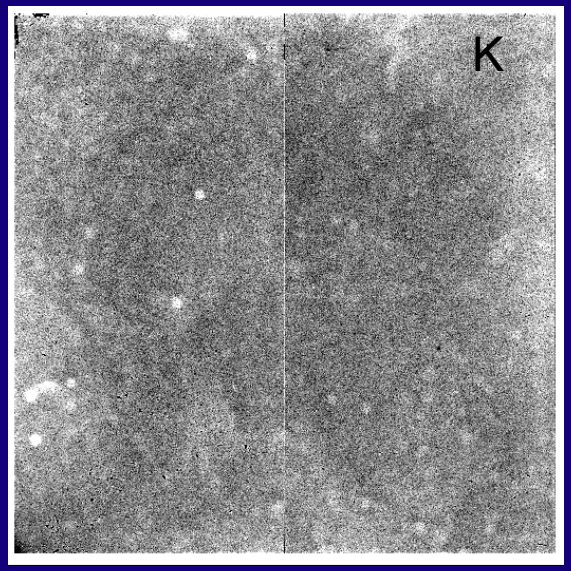
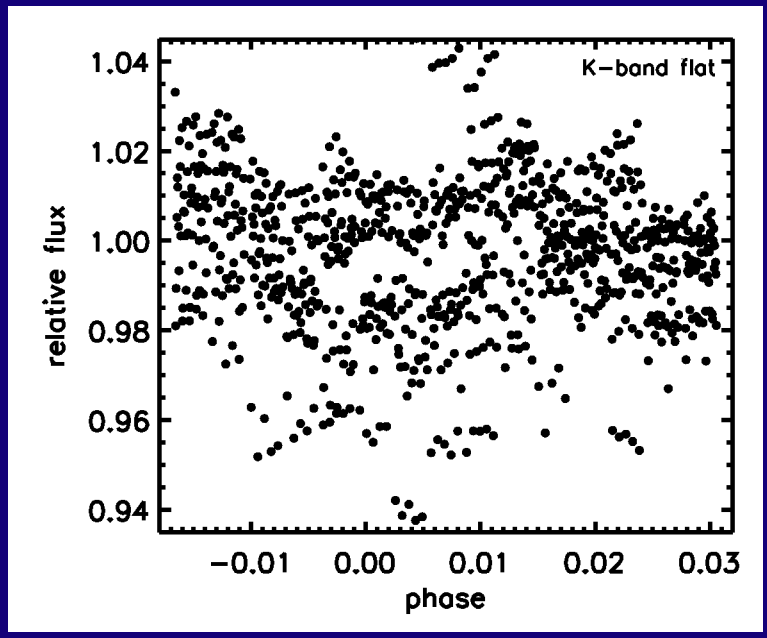


De Mooij & Snellen 2009

Dust on dewar window glows in K-band!

- Glow from dust/optical elements visible





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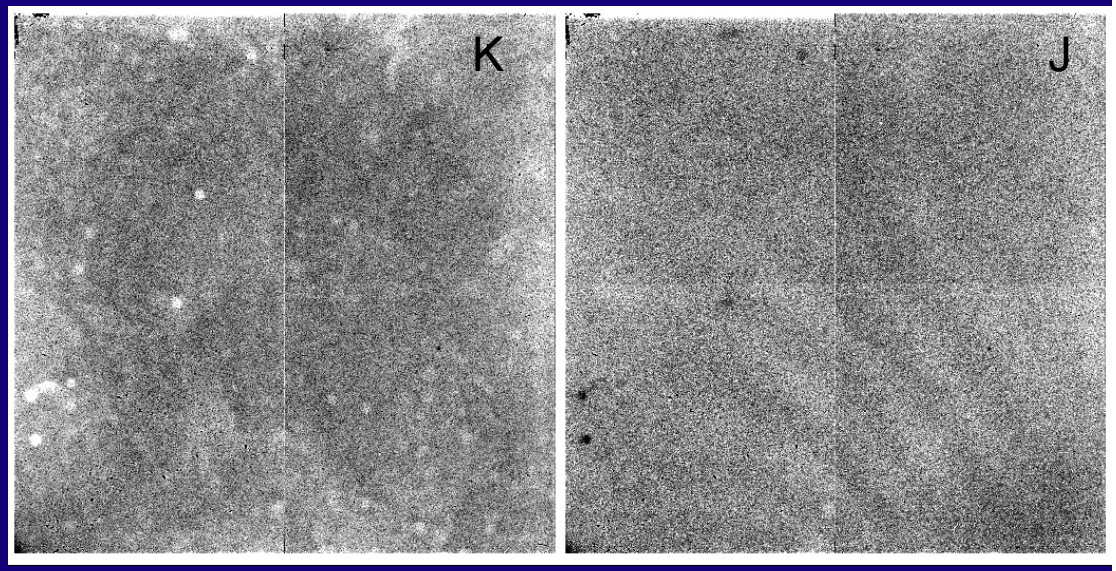
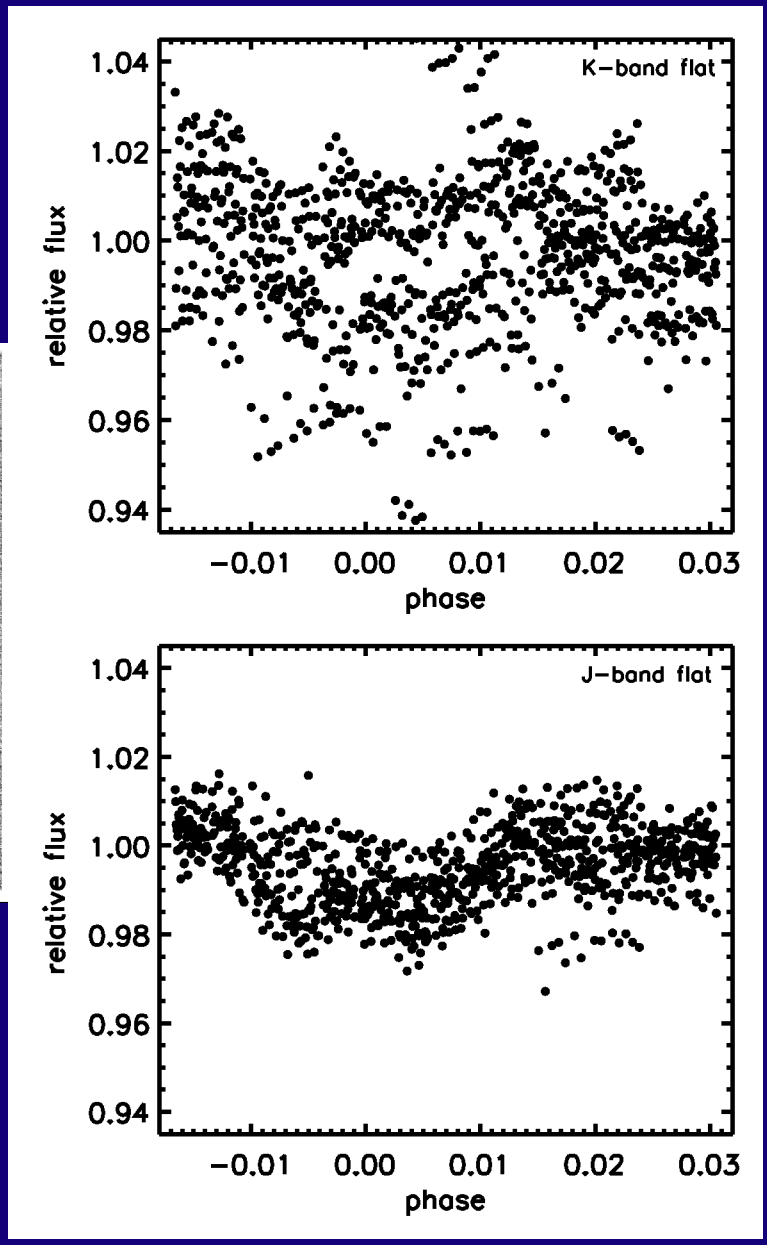
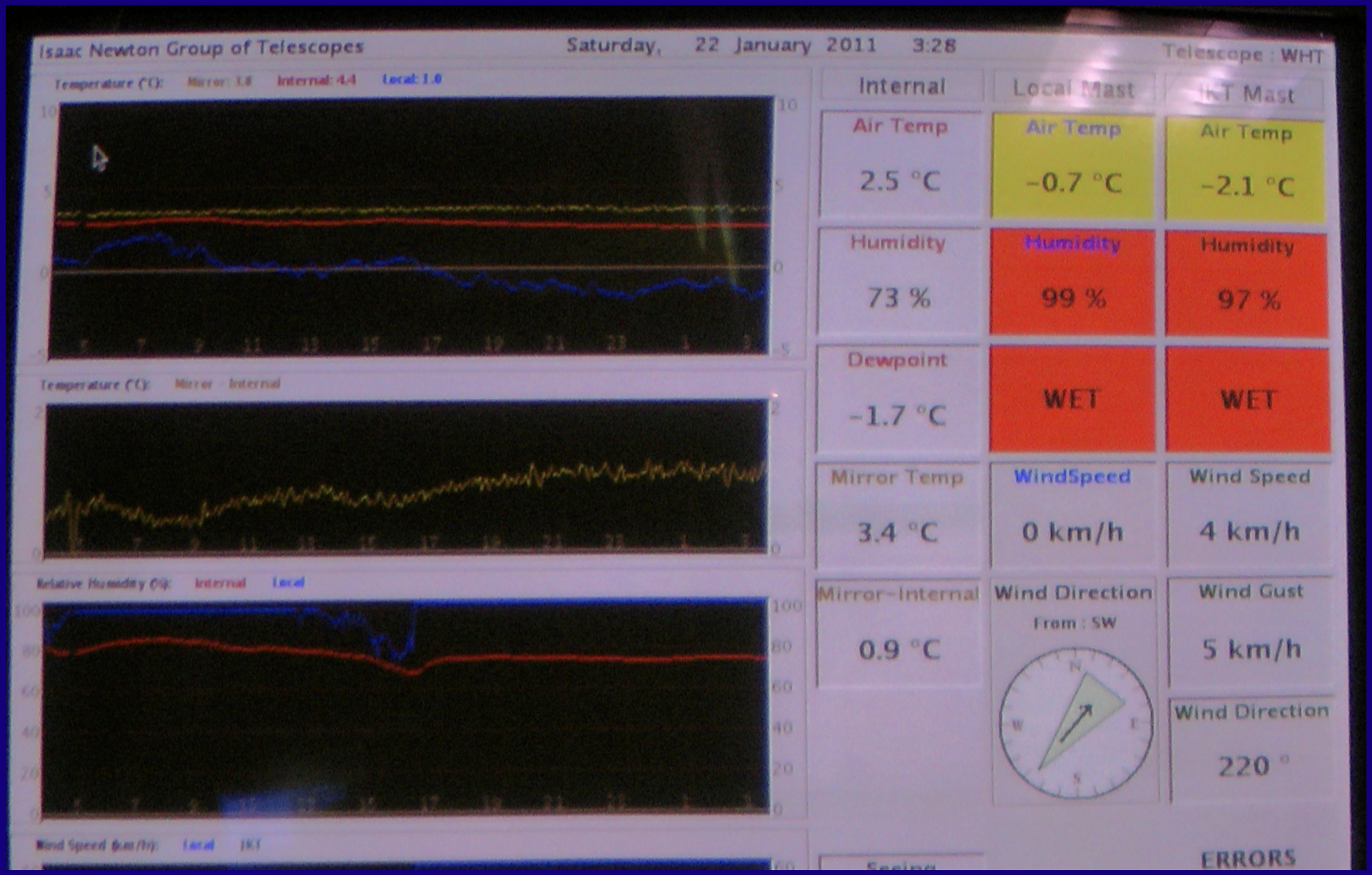




Solution to some of the problems



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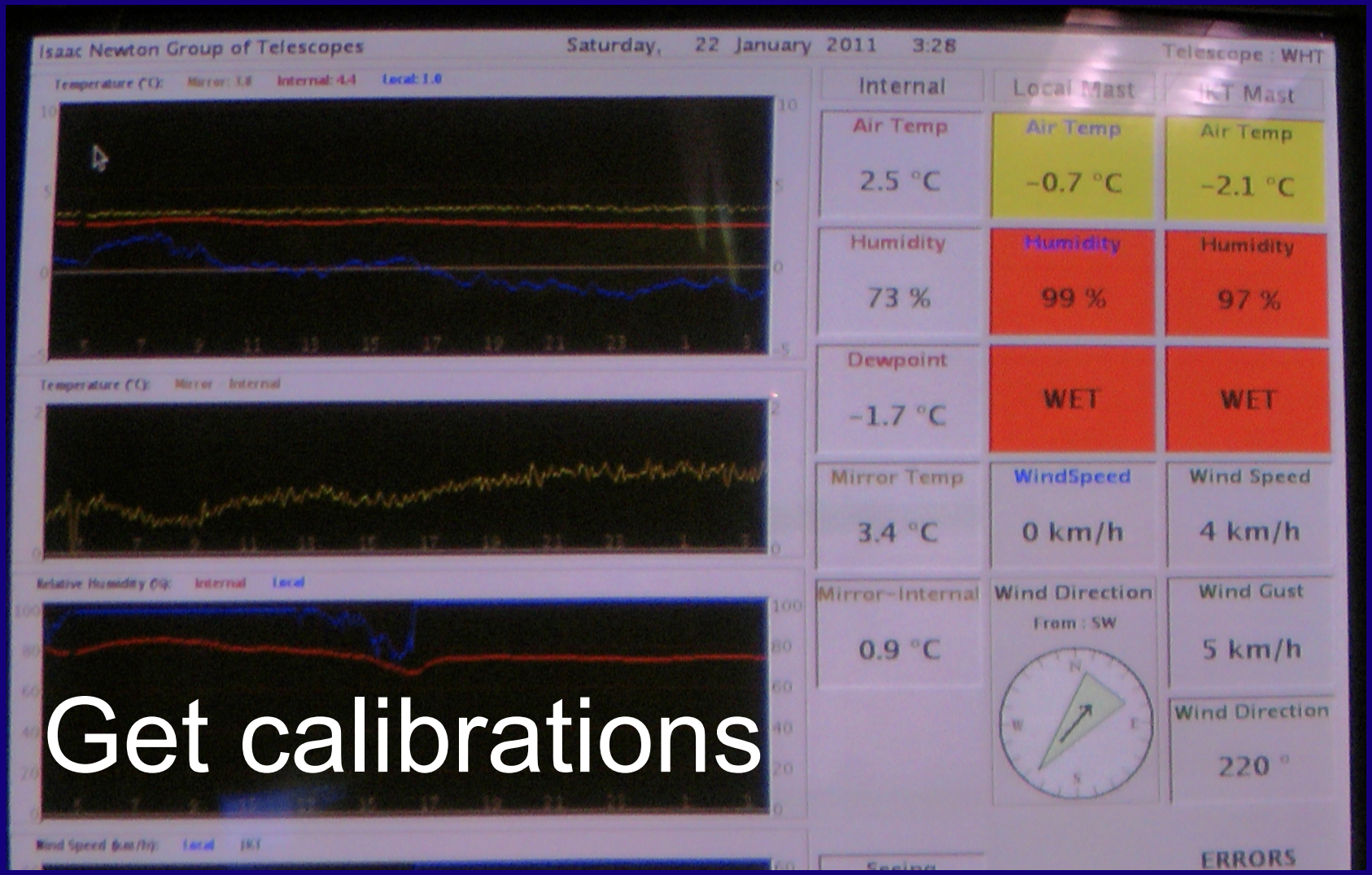

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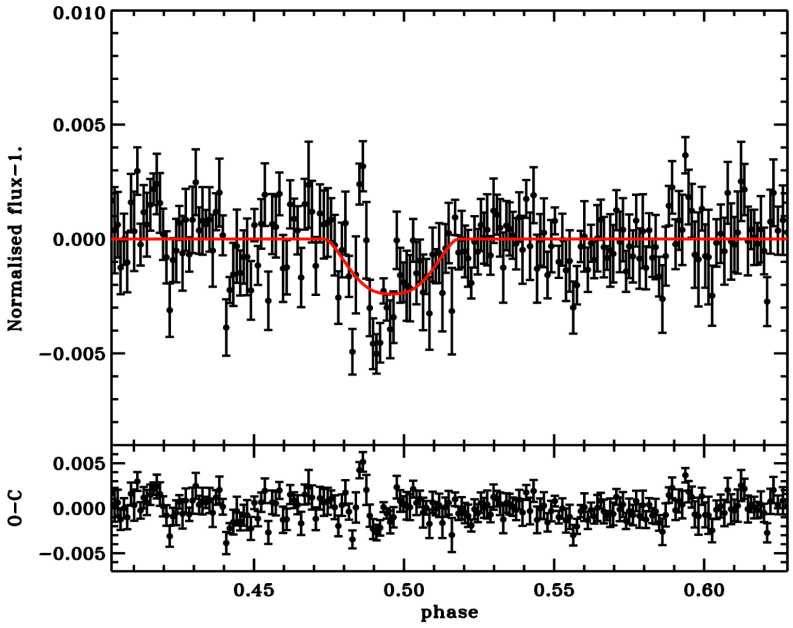
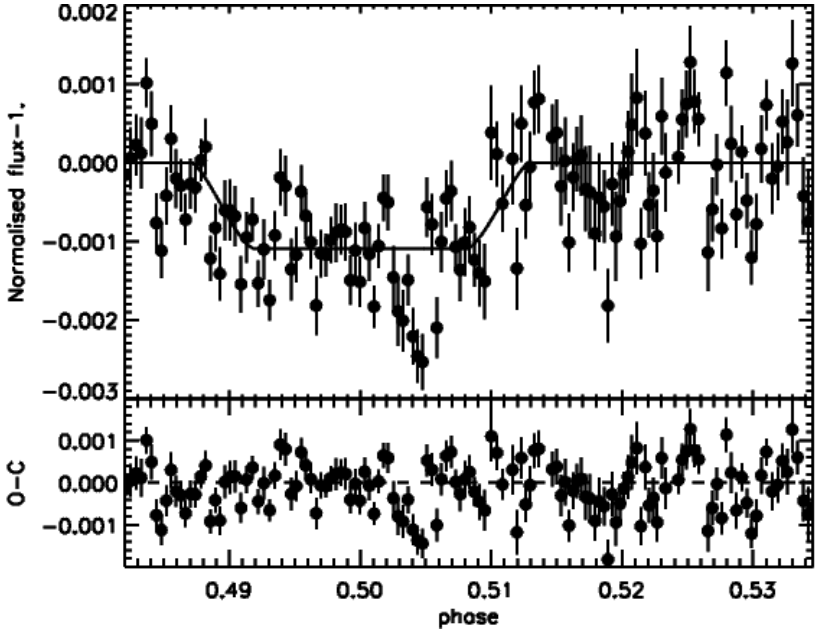
TrES-3b



De Mooij & Snellen 2009

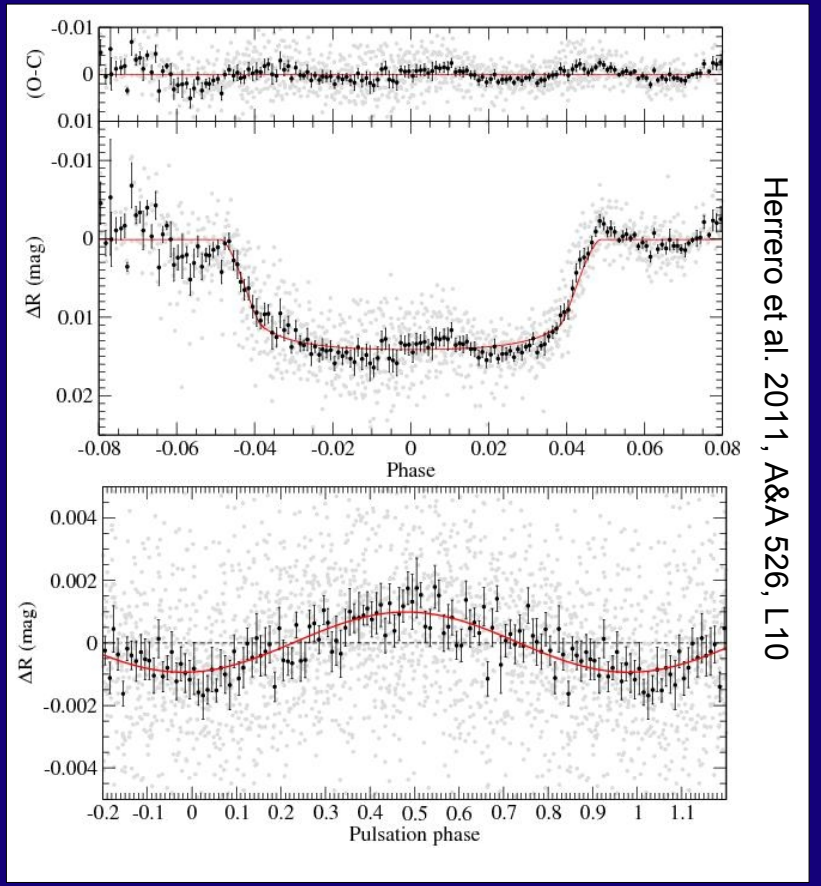
HAT-P-1b



De Mooij et al. 2011

The GROUSE project III: The secondary eclipse of WASP-33b

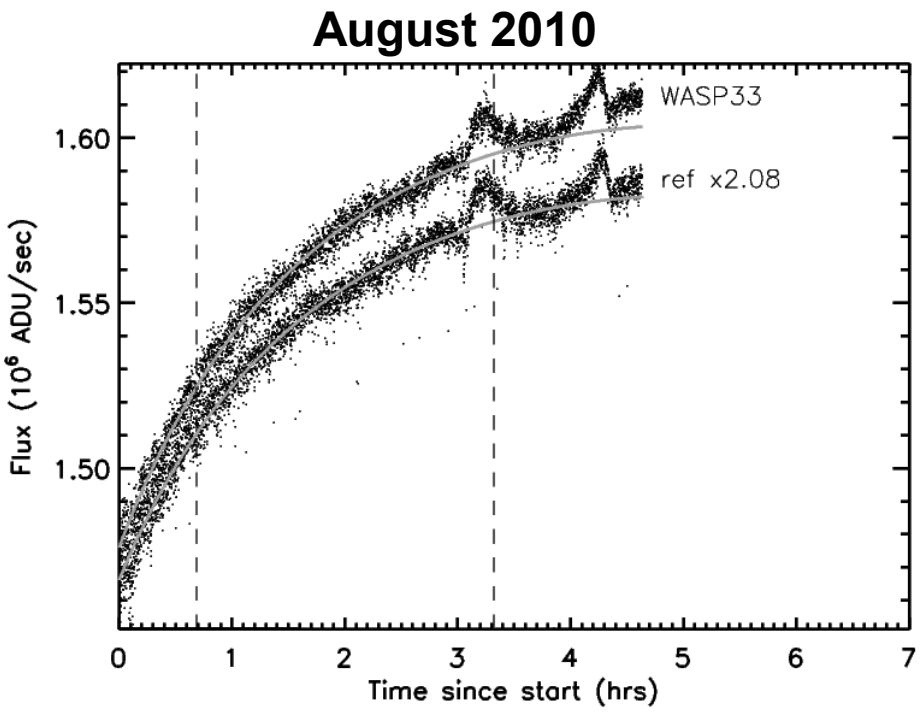
- Host-star:
  - A-type star
  - T_{eff}=7430K
  - Star shows pulsations (δ Scuti)
- Very hot Jupiter
  - Incident radiation: $1.2 \cdot 10^{10}$ erg/sec/cm^2
  - Equilibrium temperature: 3300K

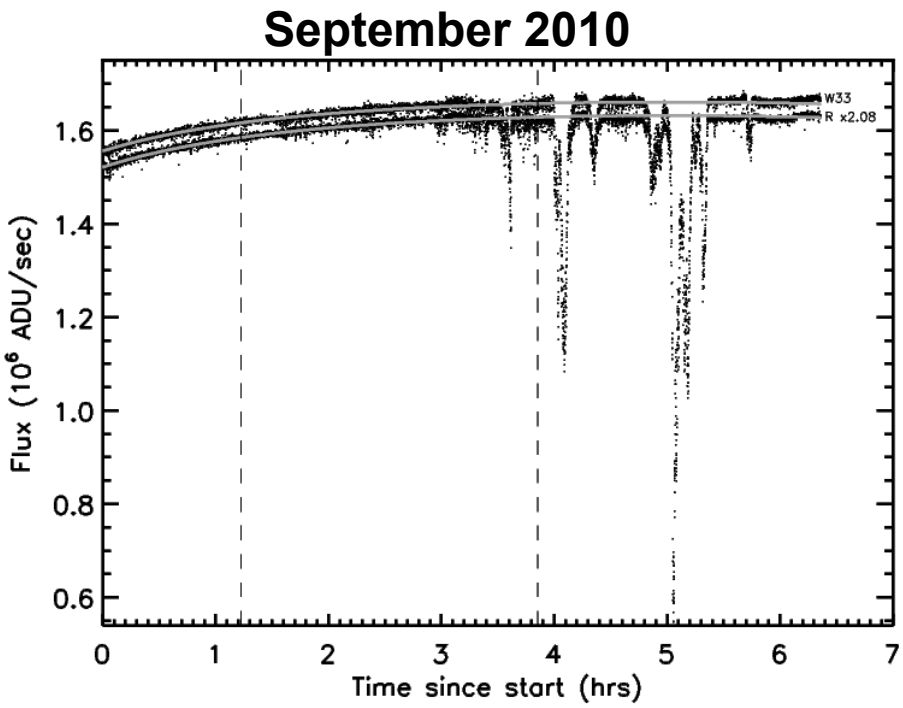


Herrero et al. 2011, A&A 526, L10

De Mooij, Brogi, De Kok, Snellen, Kenworthy & Karjalainen
A&A submitted

The secondary eclipse of WASP-33b





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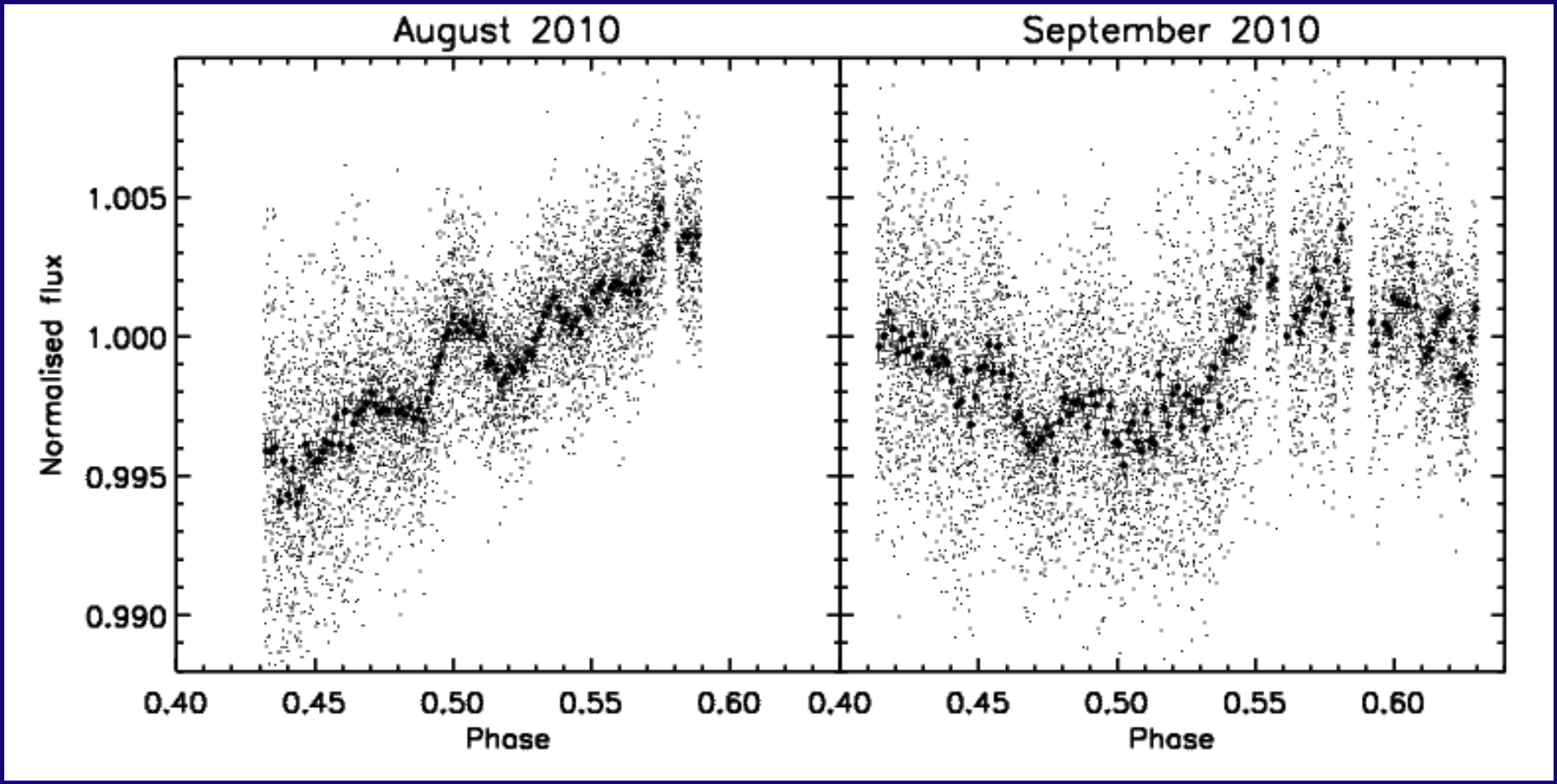

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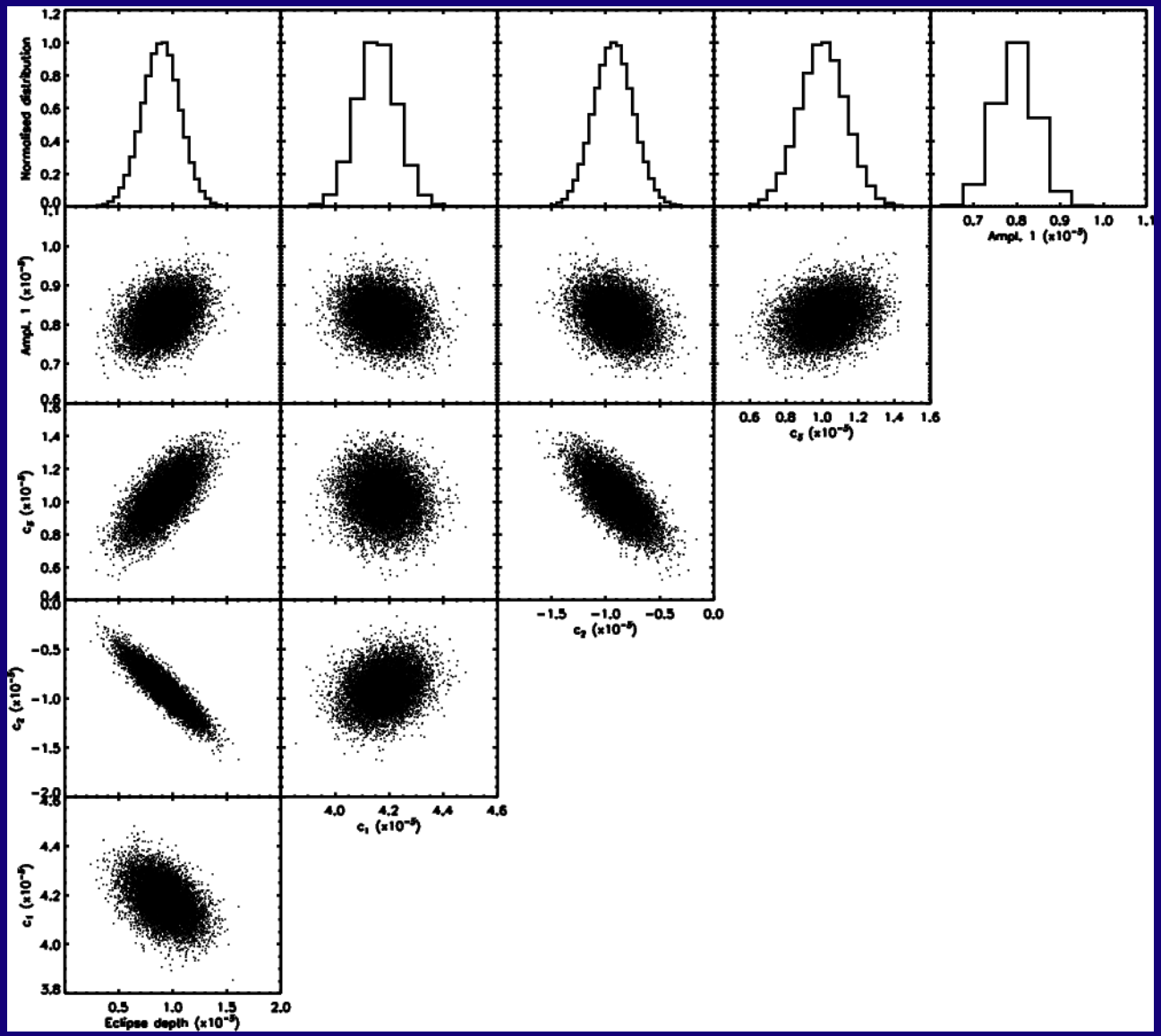

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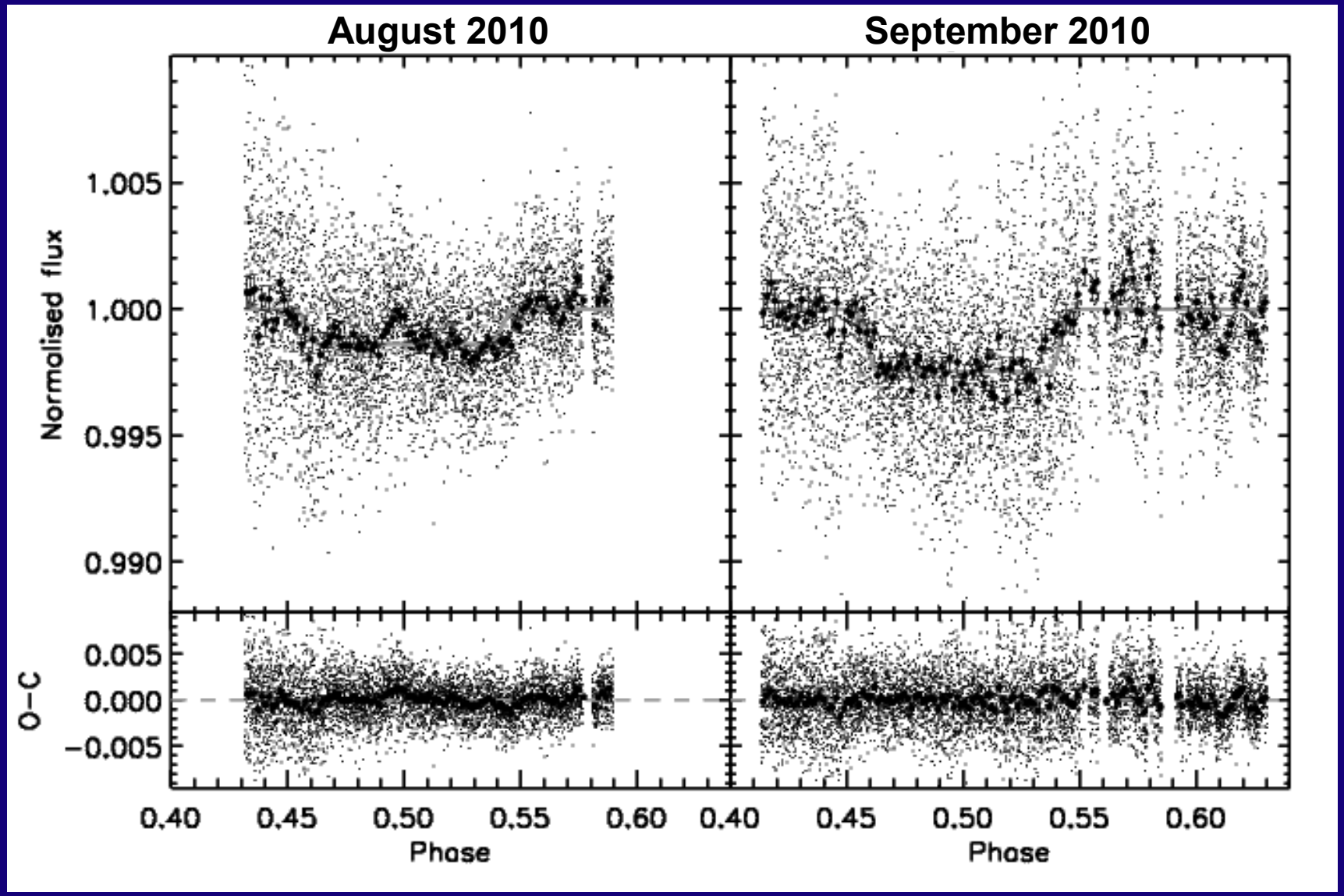

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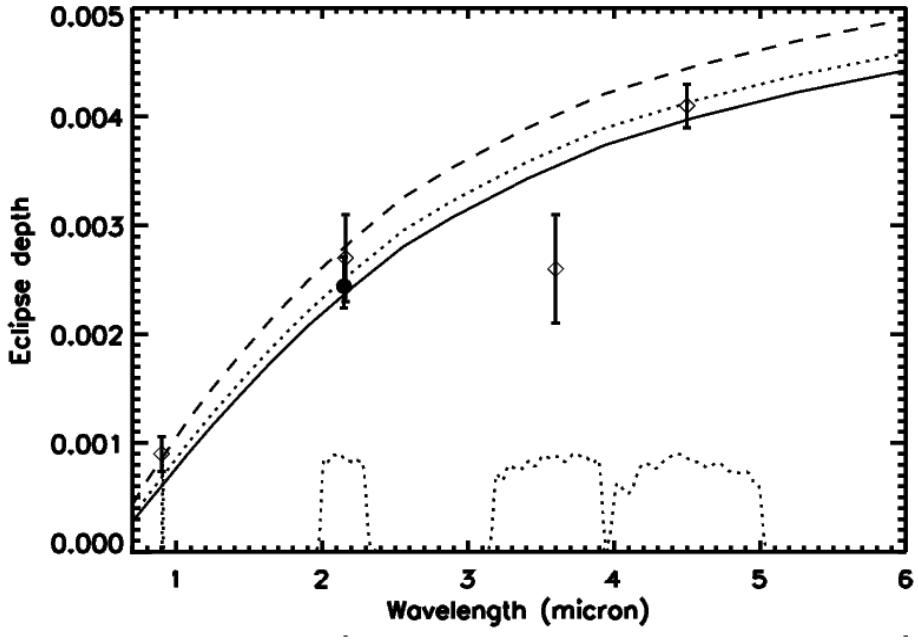

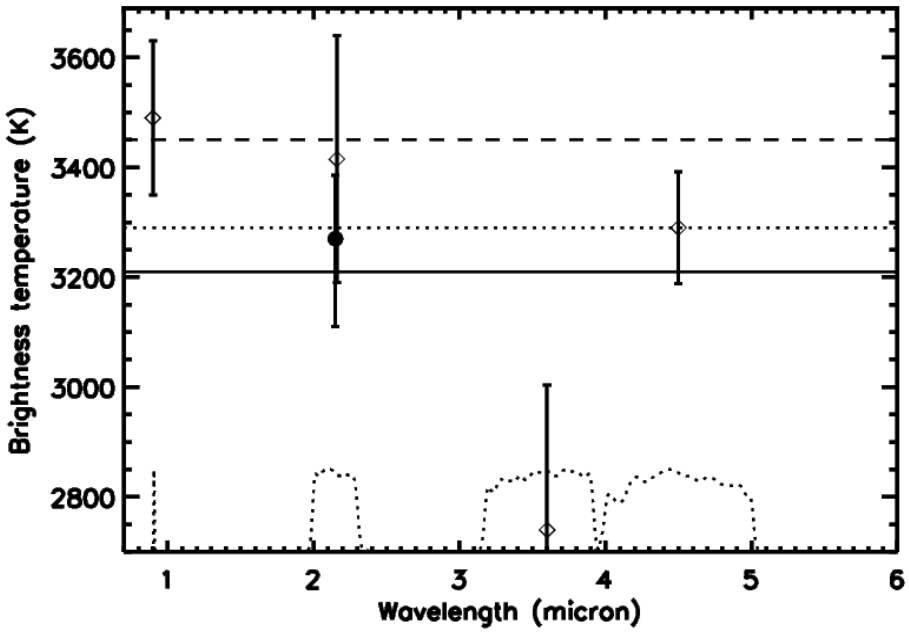

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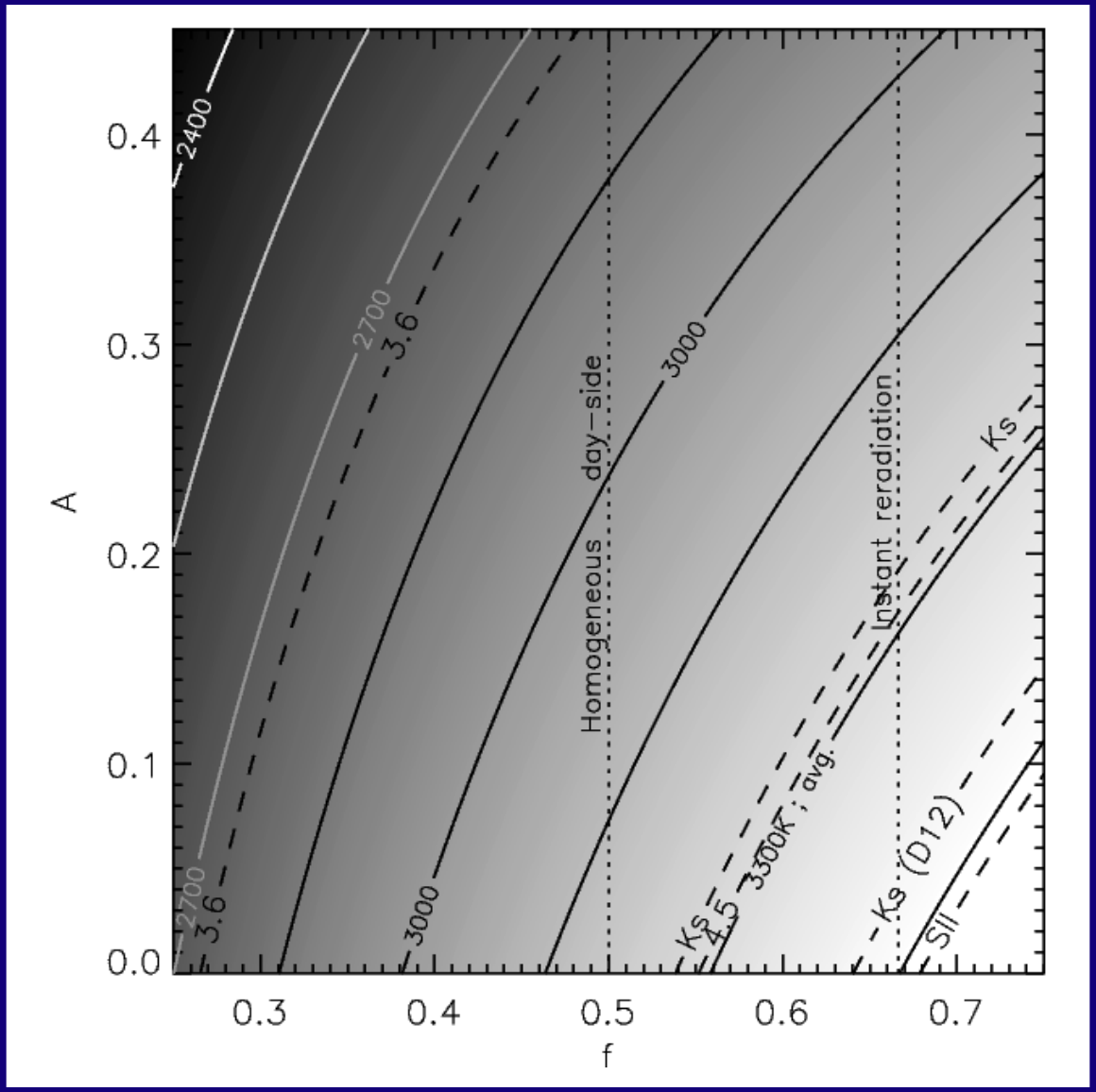
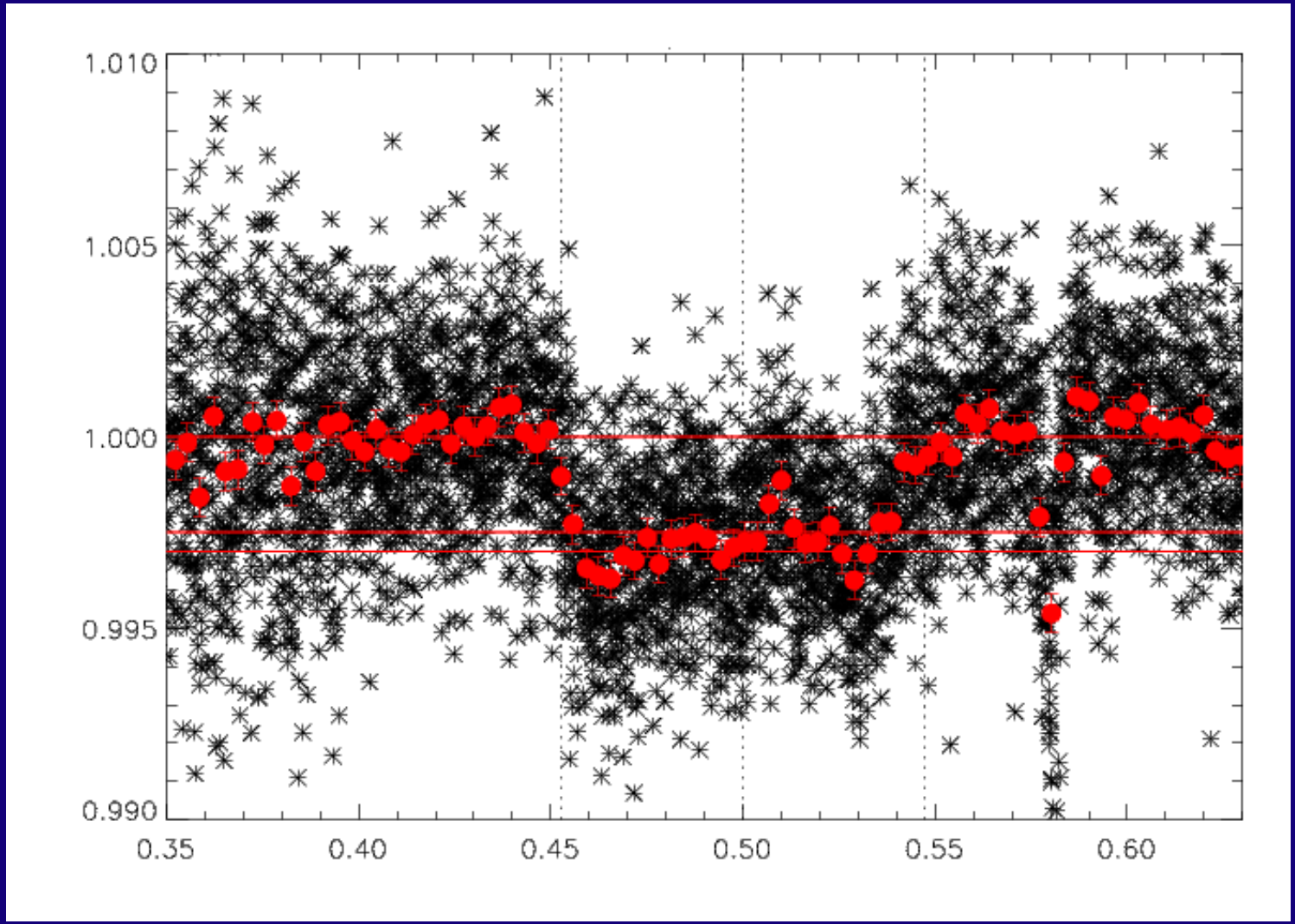
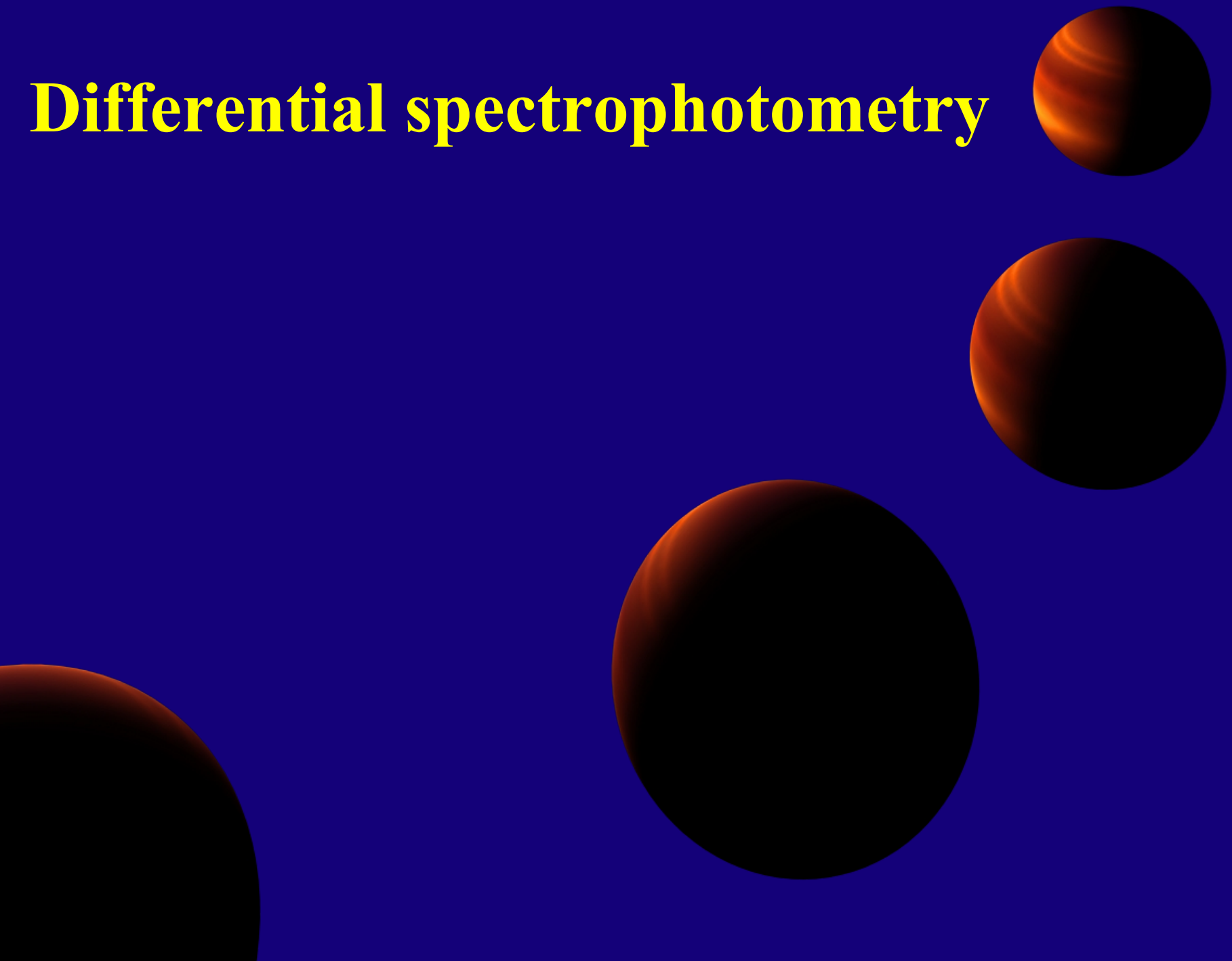


More results coming up

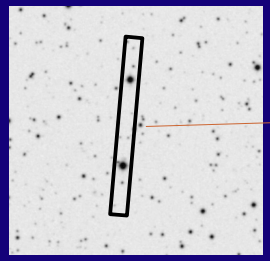


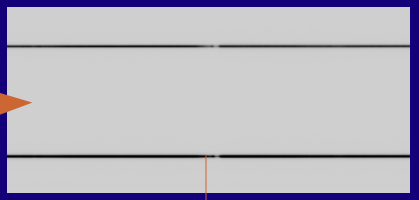
Differential spectrophotometry

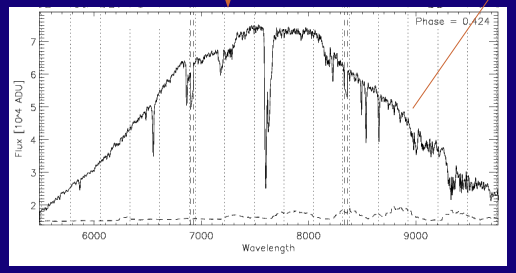


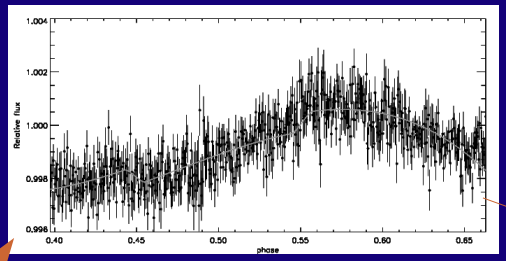
Towards shorter wavelengths: Optical spectrophotometry of WASP-12b

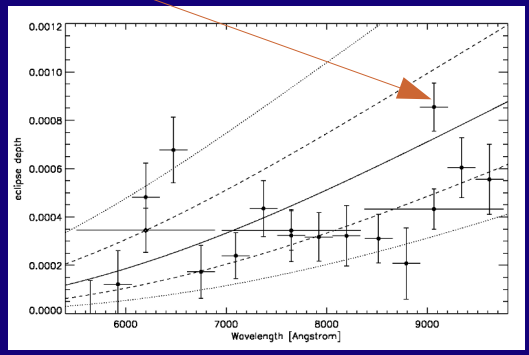
- Optical photometry probes planetary emission in the Wien limits → Sensitive to the temperature of emitting region
- Photometry only allows one band at a time → use differential spectrophotometry



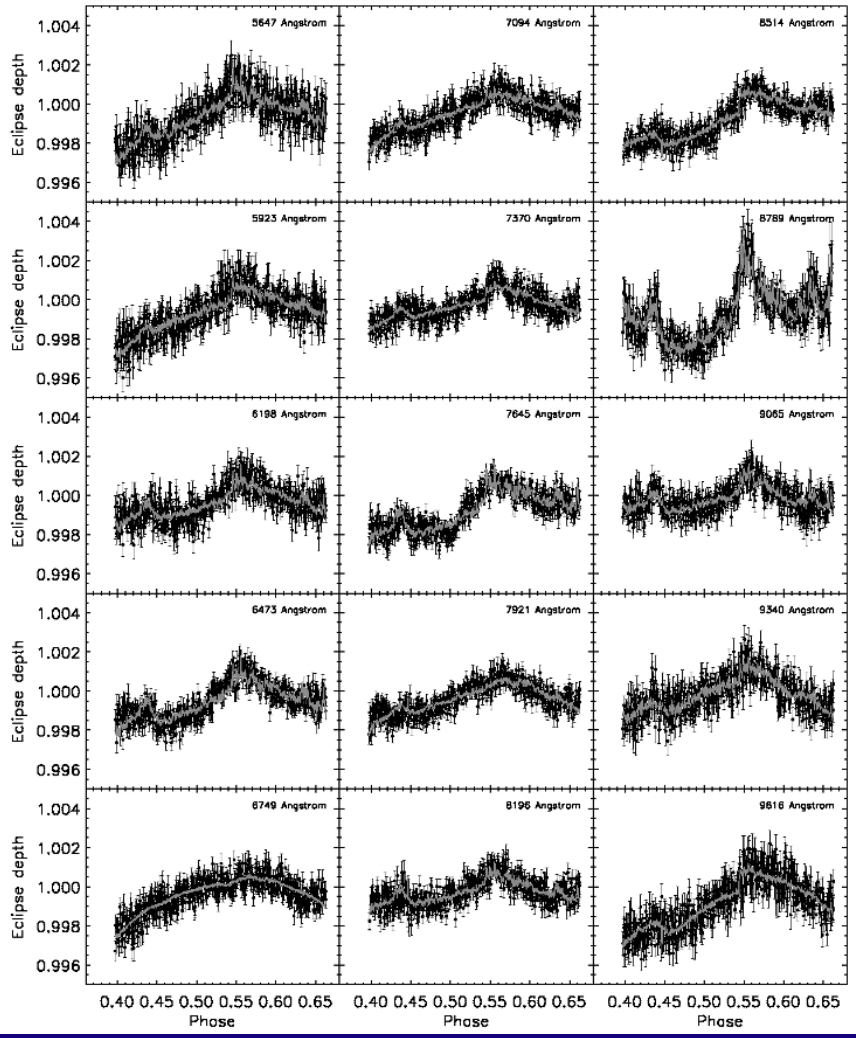


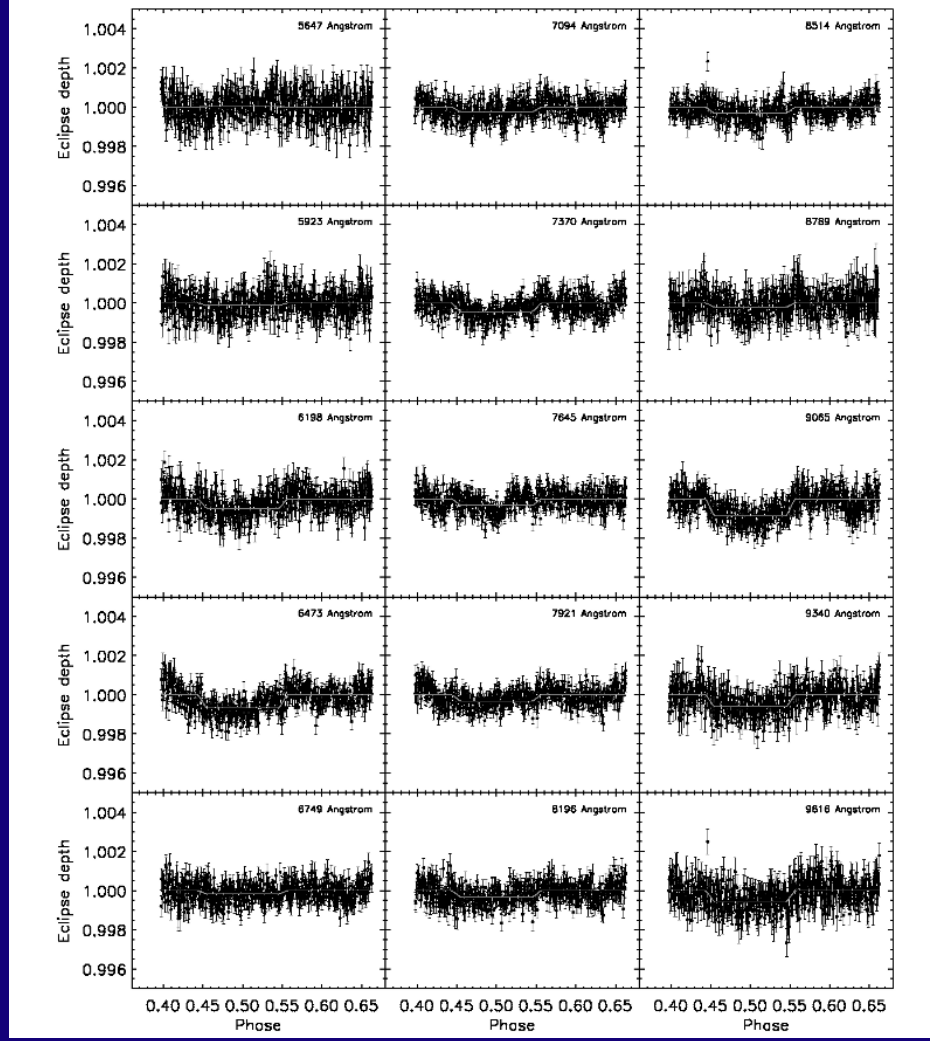




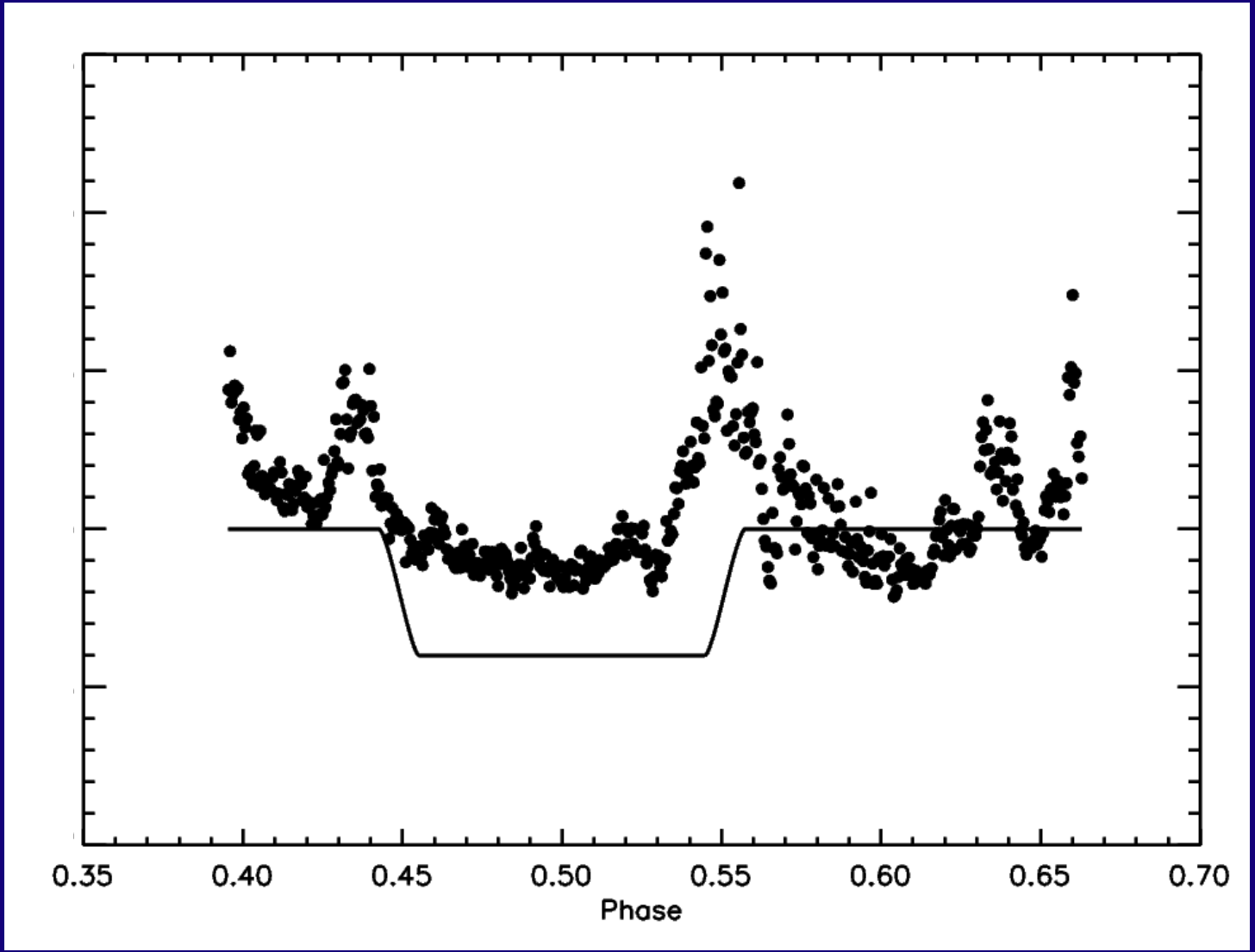


Preliminary lightcurves of WASP-12b

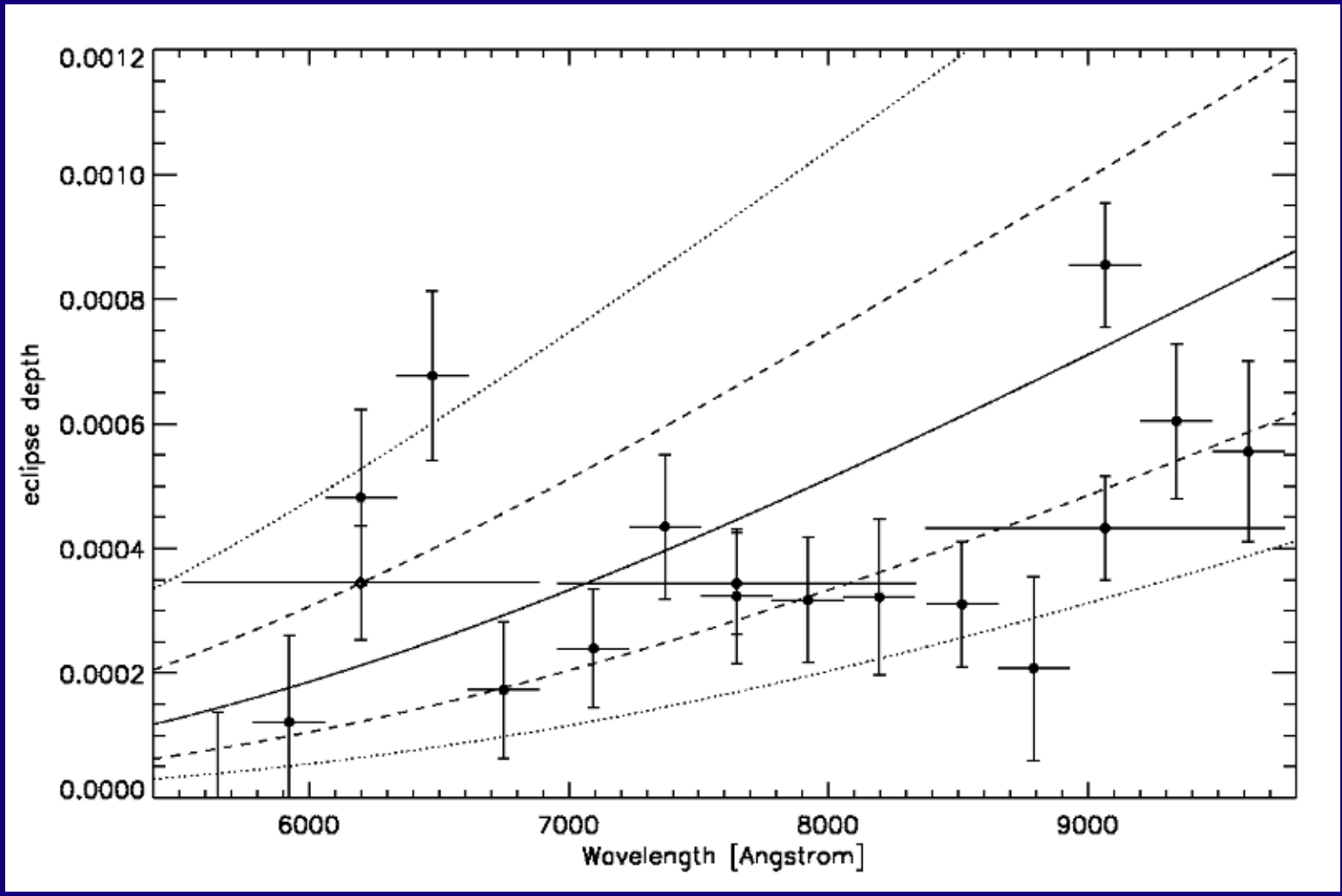




Seeing variations...



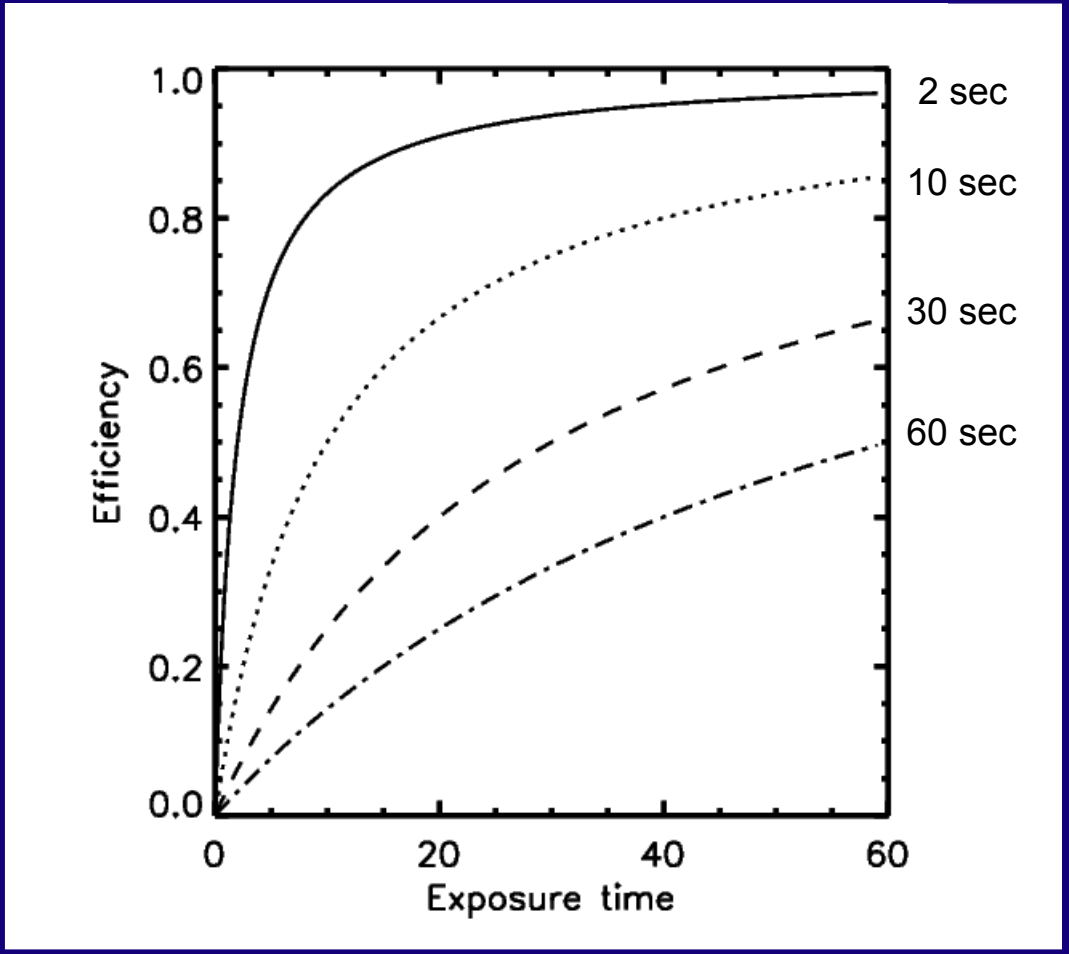
Preliminary optical measurements of WASP-12b



A new instrument for high-precision photometry of bright stars

Why we need a fast read-out

- Typical instruments have very large overheads



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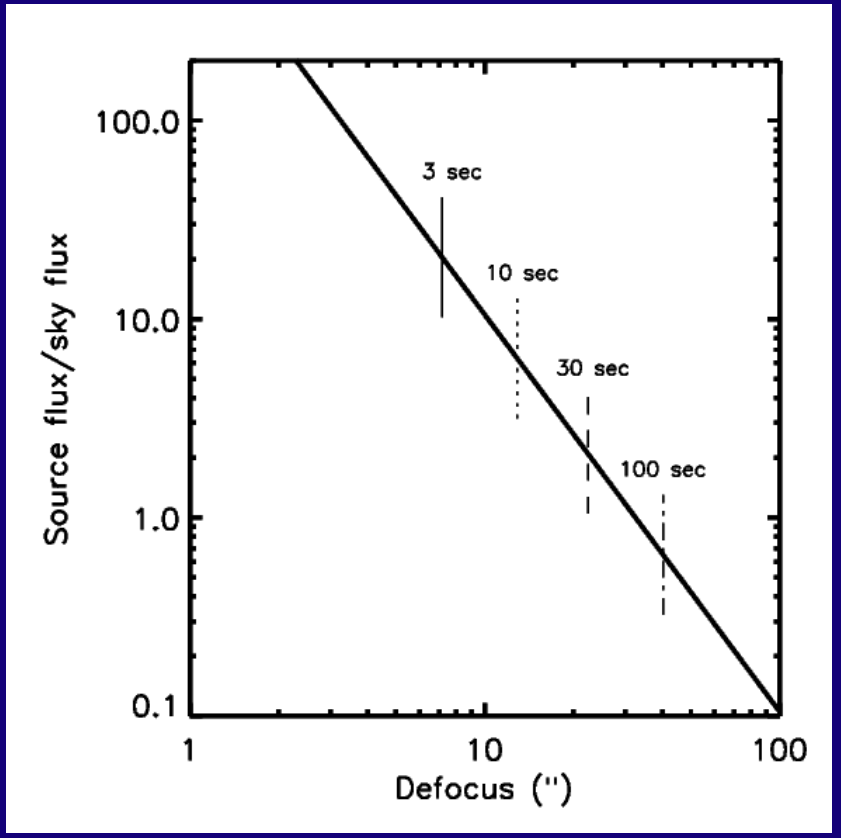

A wide-field, dual-beam, fast-read-out imager for characterising exoplanet atmospheres

- Proposed instrument:
  - FOV: ~0.4'
  - Detectors: 2kx2k EEV CCD230-42
  - Read-out time: < 2sec
  - Dual beam: *ug & riz*
  - To be mounted on the 1.6 meter telescope at the Obsevatoire du Mont-Mégantic

PI: Ray Jayawardhana

Advice for observers

- Get as much baseline as possible, this is extremely important both for robustly correcting systematics and analysing the red-noise
- Take as many good calibrations as possible.
- In case of bad weather characterise the instrument (e.g. Non-linearity).
- Keep everything as stable as possible