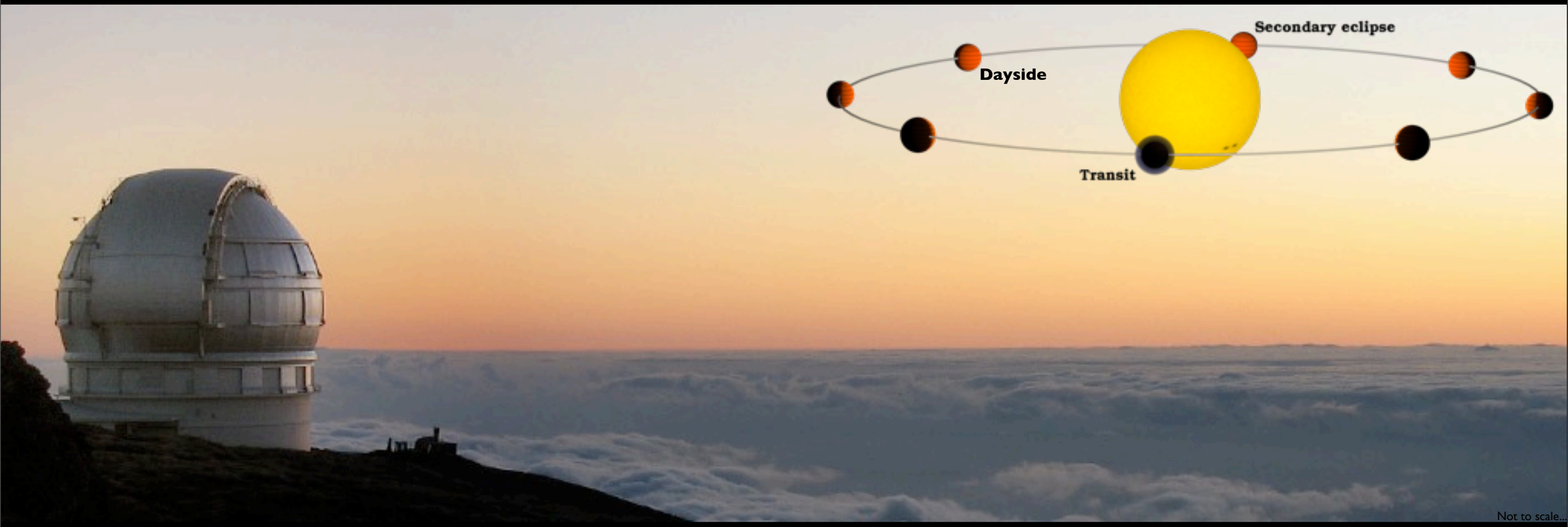
Observations of Optical Secondary Eclipses of Transiting Hot Jupiters with the Gran Telescopio Canarias



Jayne Birkby

Leiden Observatory, The Netherlands (birkby@strw.leidenuniv.nl)

Ignas Snellen, Ernst de Mooij, Matteo Brogi, Bas Nefs (Leiden Observatory, The Netherlands)
Johannes Koppenhofer (University Observatory Munich, Germany)
Simon Albrecht (Massachusetts Institute of Technology, USA)
Ian Skillen (Isaac Newton Group, Spain)
Adam Burrows (Princeton University, USA)

Why Optical Secondary Eclipses?

Jayne Birkby, Leiden Observatory birkby@strw.leidenuniv.nl

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Secondary eclipse depths directly measure the flux of the planet.

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Expected levels of optical reflected light and optical thermal emission are closely linked.

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There are:

~30 planets with secondary eclipse measurements, mostly observed with Spitzer (λ>3μm)

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But:

Most information on thermal structure of the atmosphere and the presence of absorbing species are short-wards of Spitzer, near the peak of the SED, where H_20, CO_2, CH_4 and CO molecular bands are located.

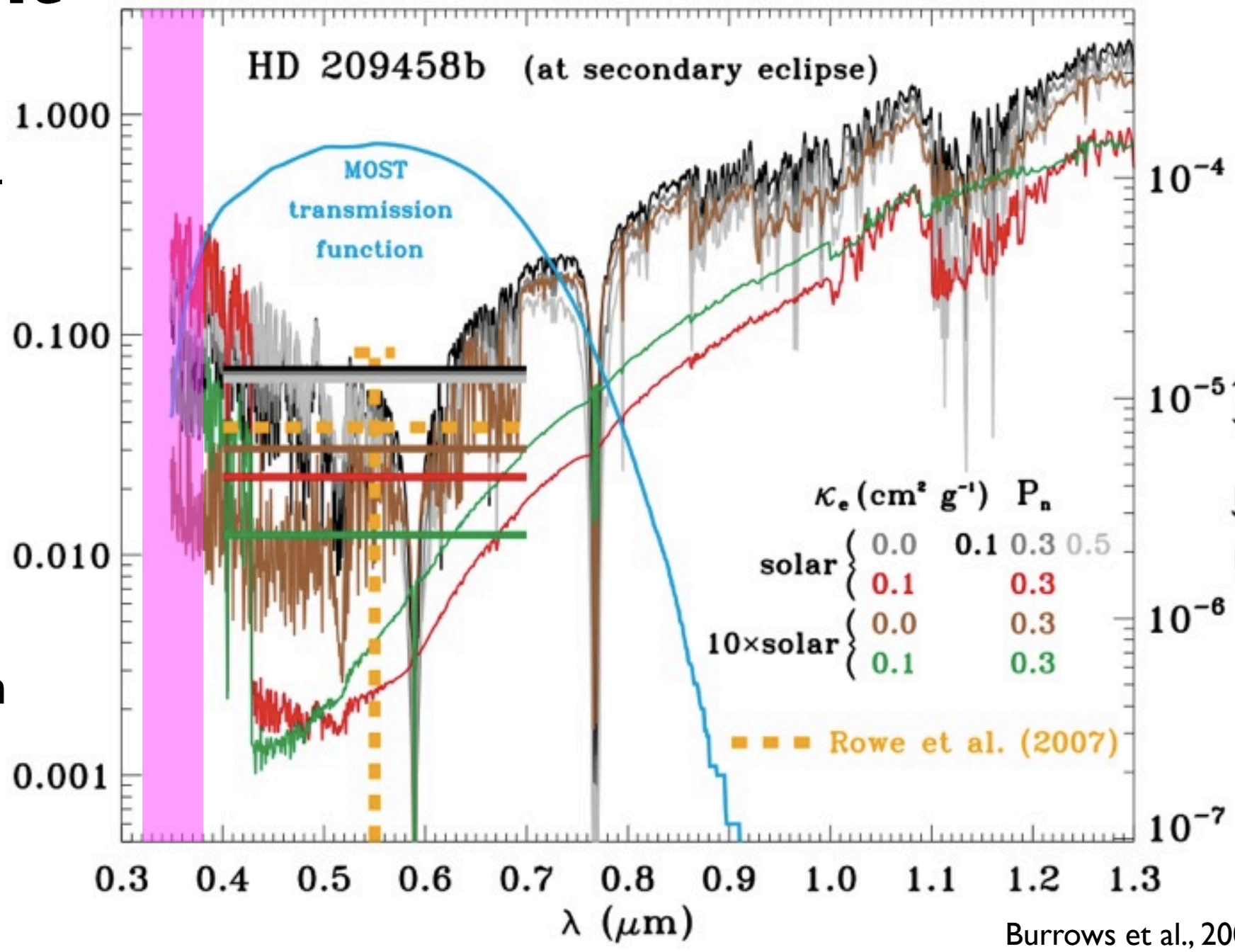
Jayne Birkby, Leiden Observatory birkby@strw.leidenuniv.nl

Why Optical Secondary Eclipses?

Reflected Light

Burrows et al. (2008) models showed an increase in planet-star flux ratio when Rayleigh scattering dominates the reflection spectrum.

Potentially observable planet-star flux ratios in the *u'*-band?



Burrows et al., 2008

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So far:

- **~10** secondary eclipses observed at optical wavelengths (but see Lopez-Morales & Coughlin poster 40.10 for Kepler secondary eclipse updates)

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- How do we get 10^8 photons (10^{-4} precision) across a range of filters from the ground?

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The GTC Optical Secondary Eclipse Survey

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Instrument: OSIRIS broad-band imaging CCD (7.8'x8.5') on the 10.4m GTC

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Technique: **defocus** bright targets, **windowing** readout mode, **rapid cadence** (5-14 sec in *z'*, ~60 sec in *u'*), **sufficient baseline** for accurate depth measurement and decorrelation of systematics (90 hour large ESO program)

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WARNING: these are

Preliminary Results

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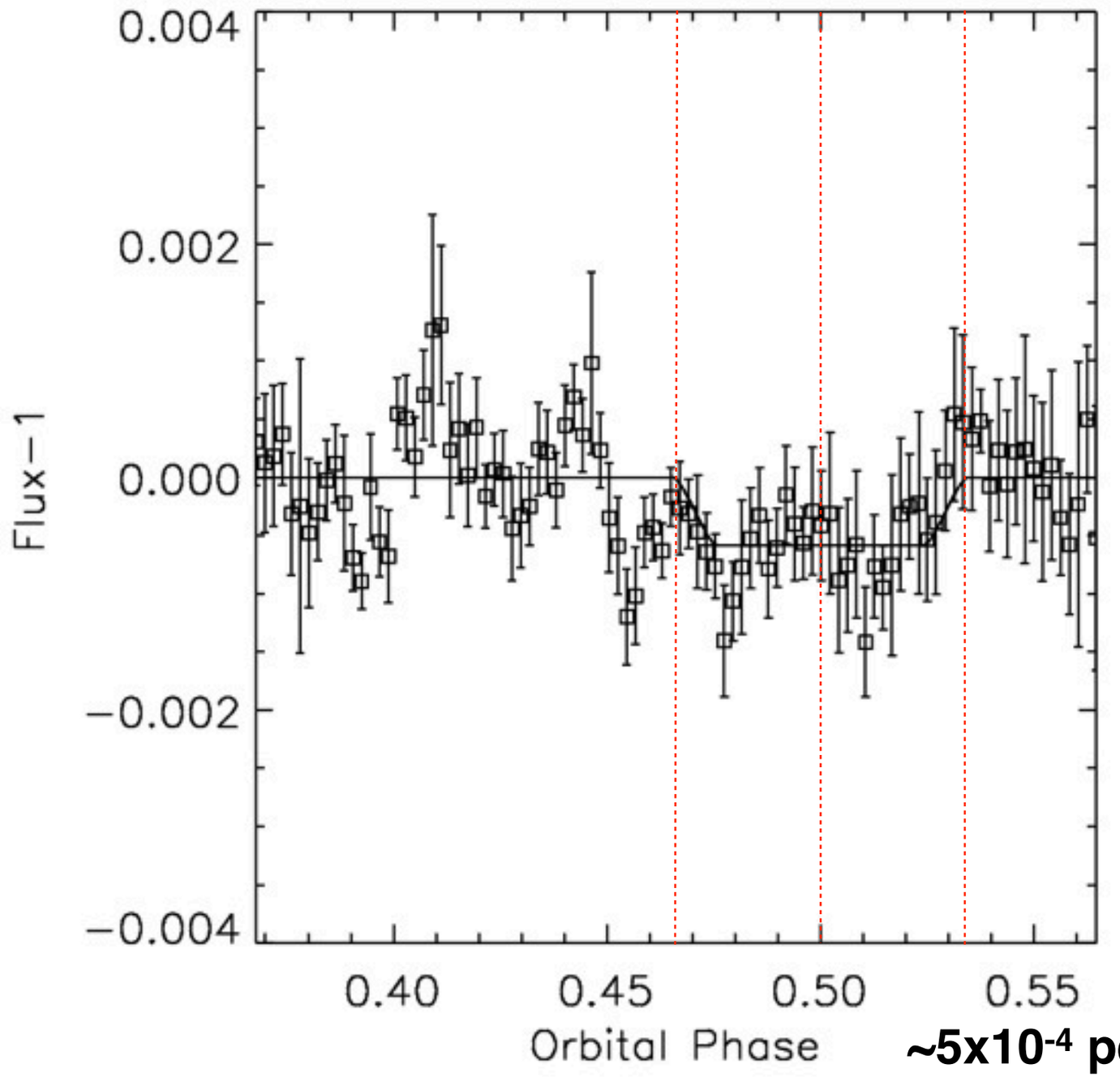
CoRoT-1b z′-band



~5x10^{-4} per 5 minutes

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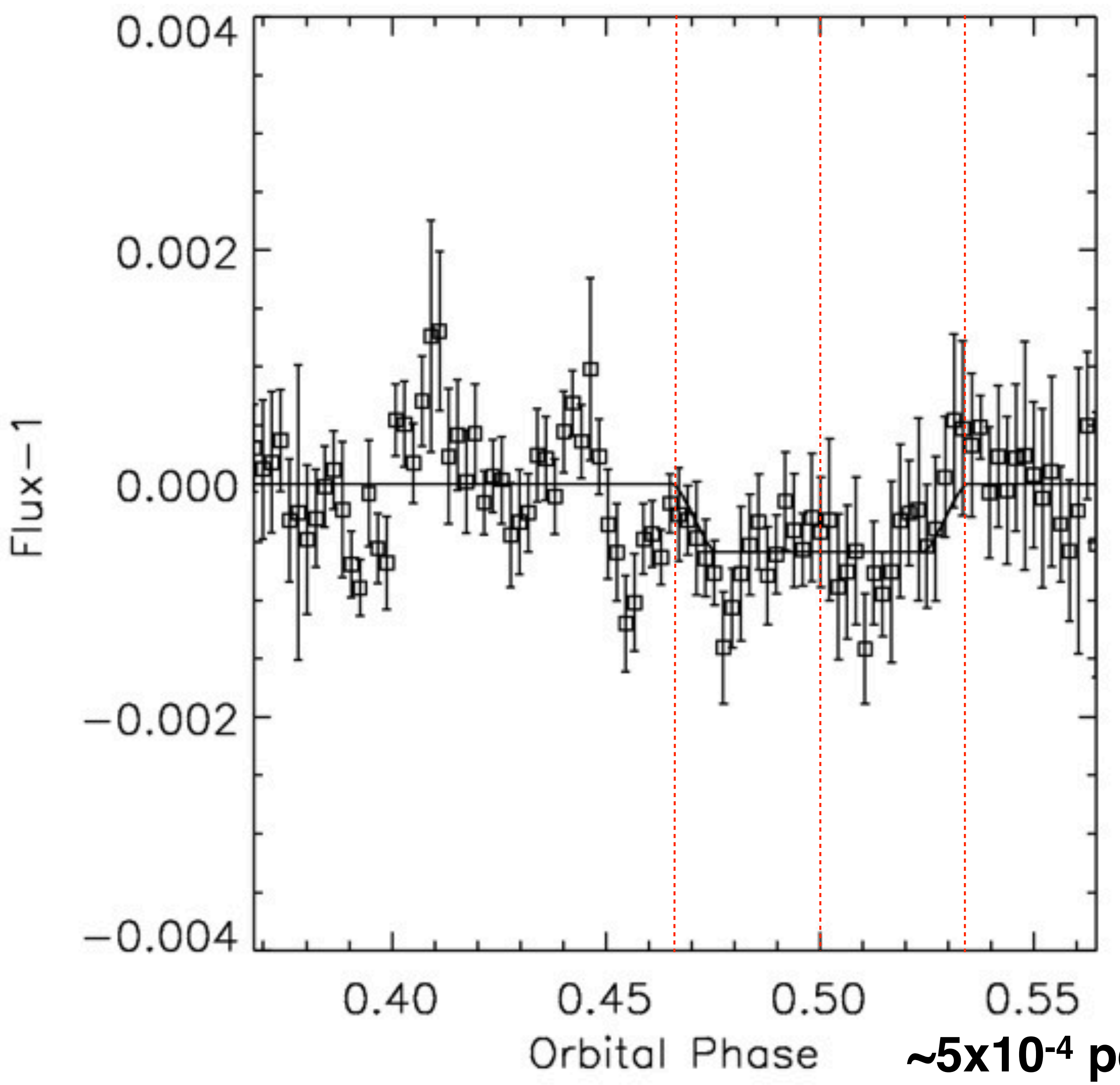

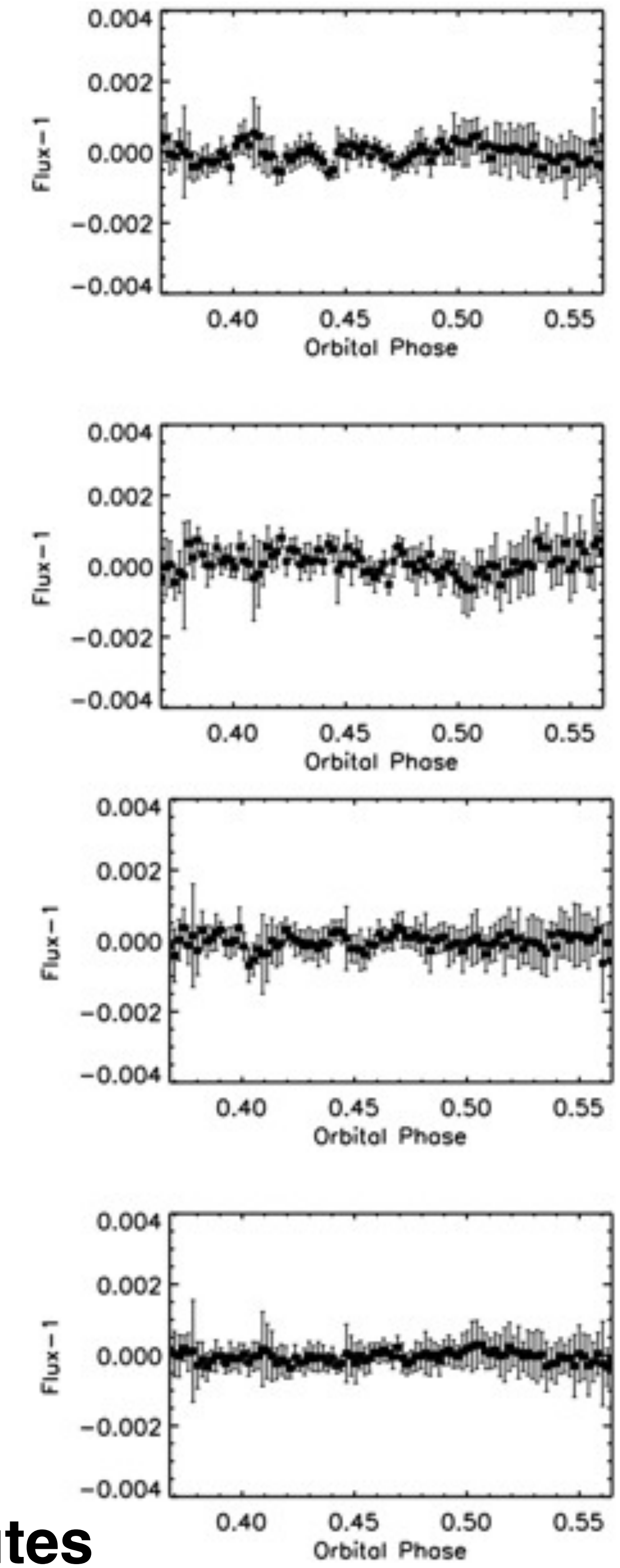

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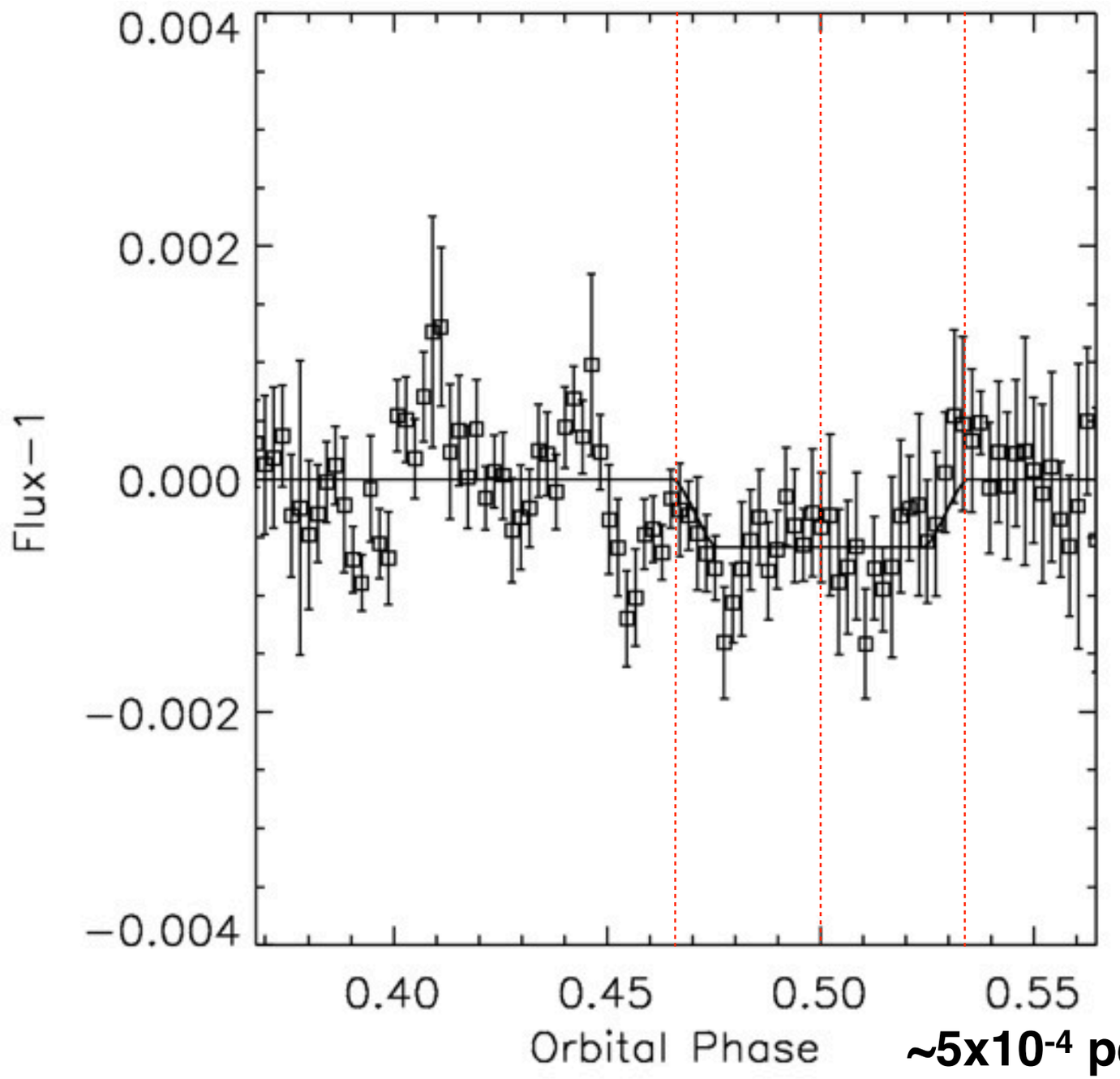
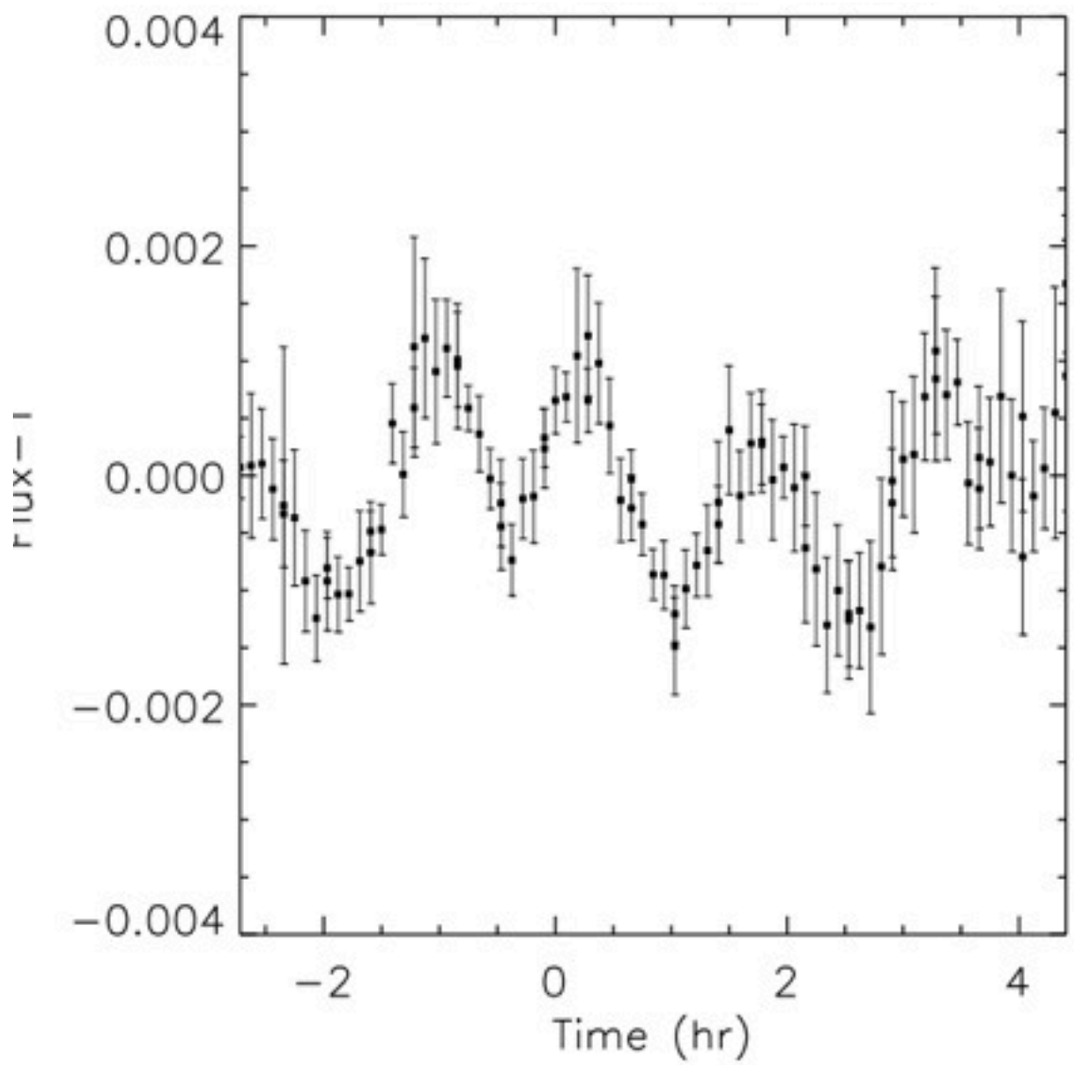


Bright variable star in window - choose references carefully



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- TrES-3 b and HAT-P-23 b in z′ and u′ both under analysis (very tentative current limit at 5×10^{-4} per 10 minutes in u′).

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- Awaiting WASP-12 b observations.

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- Additional K_s-band secondary eclipses with LIRIS on WHT from the GROUSE Project for TrES-3b (de Mooij & Snellen, 2009), CoRoT-1b and HAT-P-7b.

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Conclusions

- Ground-based optical secondary eclipses constrain thermal and reflective properties of exoplanet atmospheres.
- With GTC OSIRIS we currently achieve 5×10^{-4} precision per 5 minutes in the z′-band.
- Tentative confirmation of CoRoT-1b z′-band thermal emission.
- HAT-P-23b, TrES-3b and WASP-12b under observation but HATP-7b too bright for our strategy.
- Further analysis and understanding of systematics required!

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