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

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Why Optical Secondary Eclipses?
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- iii) fraction of energy transported to the night-side.
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Expected levels of optical reflected light and optical thermal emission are closely linked.
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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 $H_2O$, $CO_2$, $CH_4$ and $CO$ molecular bands are located.
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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?
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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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**Filters**: Rayleigh scattering $u'$ ($\lambda$3500 Å), Thermal tail $r'$ ($\lambda$6300 Å), $i'$ ($\lambda$7800 Å), and $z'$ ($\lambda$9250 Å)
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**Targets:** WASP-12b, CoRoT-1b, TrES-3b, WASP-3b and HAT-P-7b (expected depth > 0.01%, $P < 3$ days, $V < 13.6$)
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Filters: Rayleigh scattering \(u' (\lambda 3500 \text{ Å})\), Thermal tail \(r' (\lambda 6300 \text{ Å})\), \(i' (\lambda 7800 \text{ Å})\), and \(z' (\lambda 9250 \text{ Å})\)

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

WARNING: these are preliminary results.
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CoRoT-1b z′-band

WARNING: these are ~5x10^{-4} per 5 minutes
Preliminary Results

CoRoT-1b $z'$-band

$\sim 5 \times 10^{-4}$ per 5 minutes
**Preliminary Results**

**CoRoT-1b z′-band**

WARNING: these are Bright variable star in window - choose references carefully

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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.
Ground-based optical secondary eclipses constrain thermal and reflective properties of exoplanet atmospheres.

With GTC OSIRIS we currently achieve $5 \times 10^{-4}$ 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!