

Evidence for an evolving dust cloud in the exoplanet KIC 12557548 b

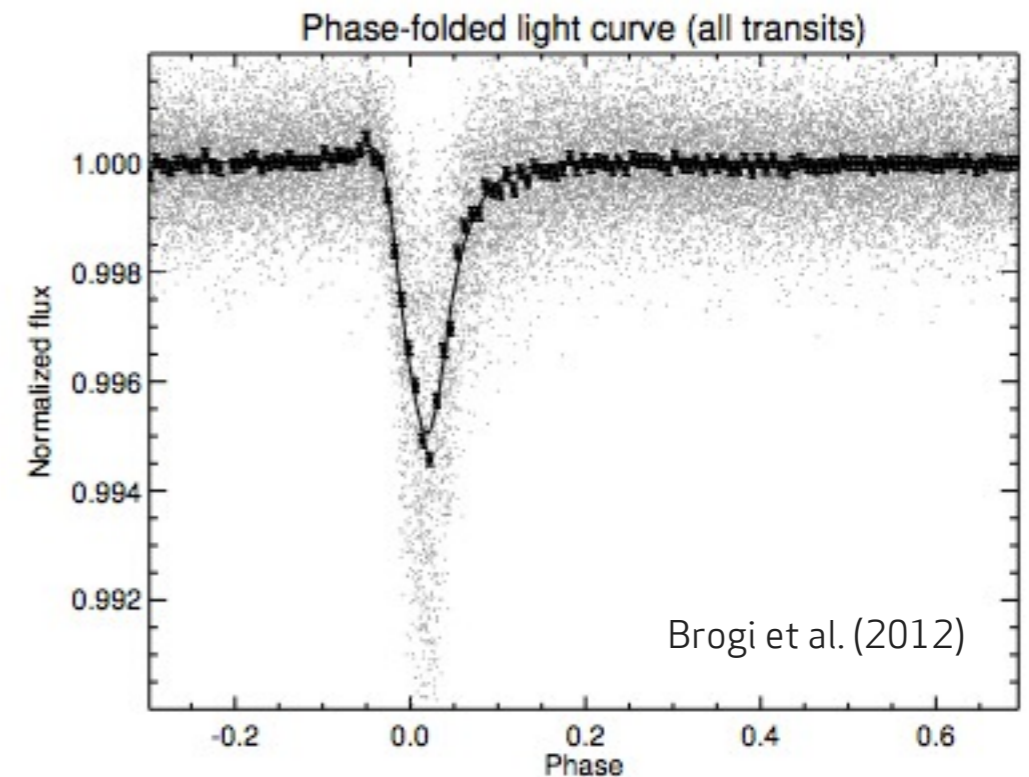


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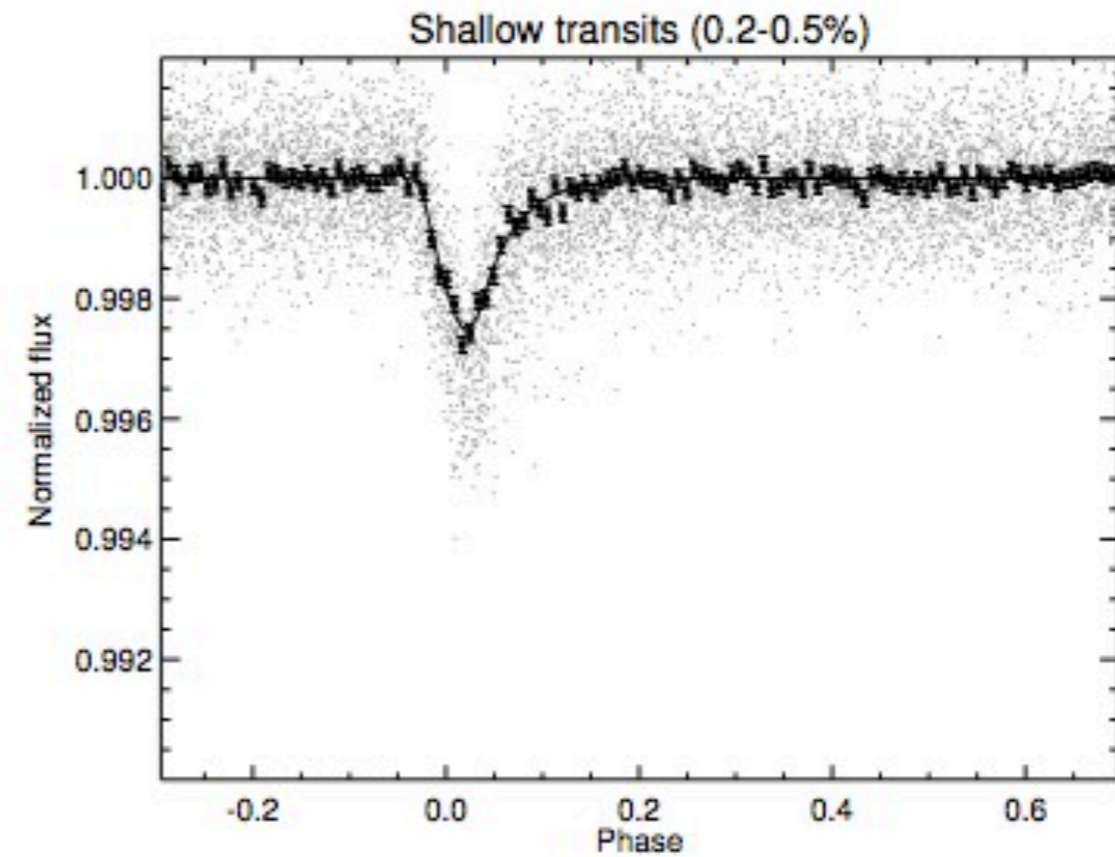
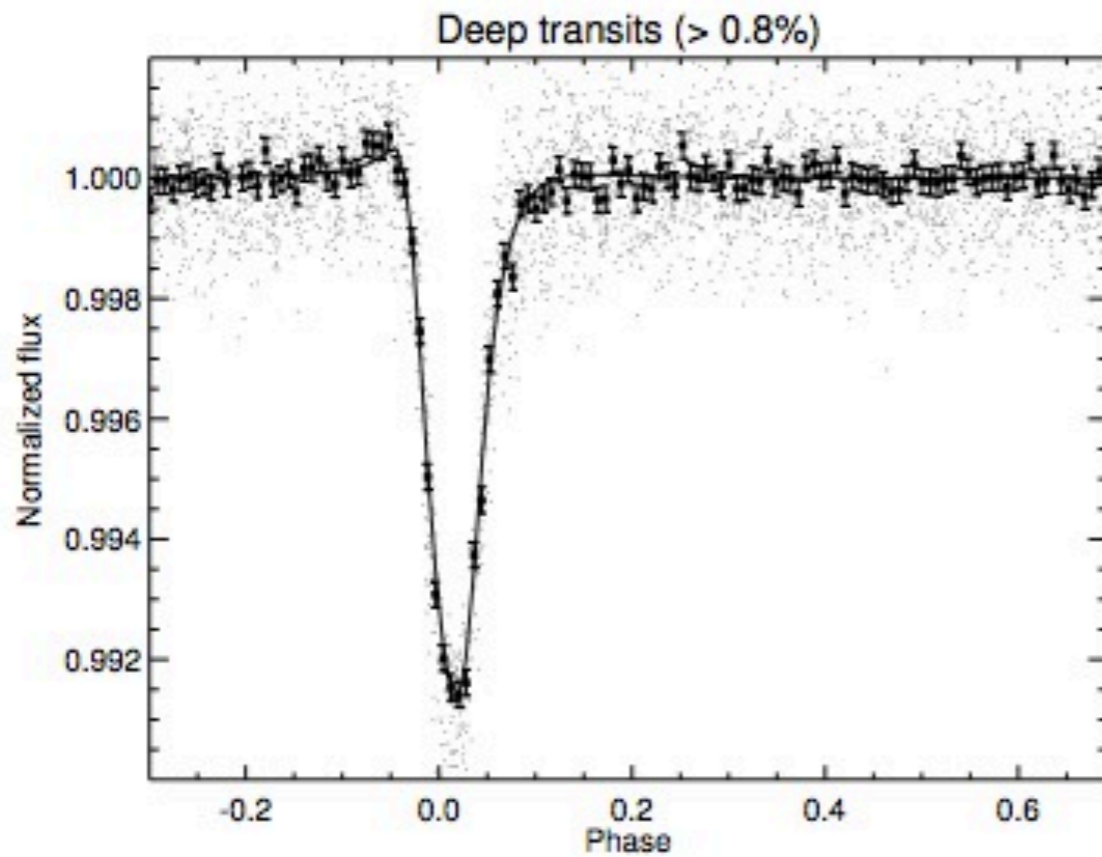
Warwick, 31 March 2015

Introduction to KIC 12557548 b

- Unusual, disintegrating, comet-like planet candidate
- Very short period: ~15.7 hrs
- Discovered in *Kepler* data by Rappaport et al. (2012)
- Small mass: ~0.1 M_{\oplus}
- High temperature: $T \sim 2100$ K on the surface
- Among the smallest-mass bodies ever detected.
- The first extrasolar planet shown to be geologically active.
- A similar planetary candidate, KOI-2700b, has been identified since (Rappaport et al. 2013)

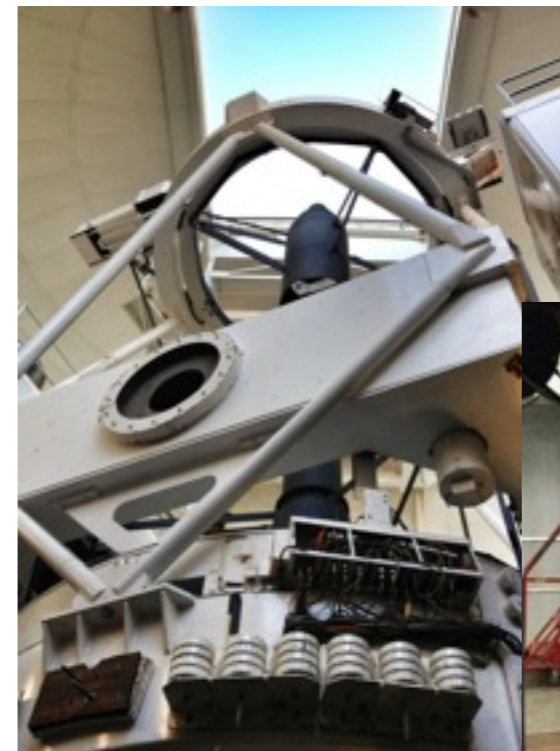


Introduction to KIC 12557548 b

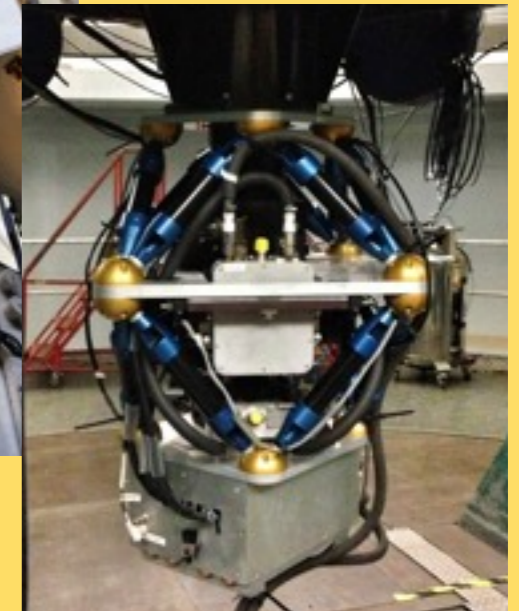


Expectations & Observations

- To confirm the dust tail explanation, multi-wavelength observations needed
- Aim: to measure the colour dependence of the extinction and scattering
- Observations:
 - in u', g' and z' bands (simultaneously)
 - with ULTRACAM
 - on the William Herschel Telescope
 - 5 clear nights
 - cadence: 6.6 seconds (z' & g' bands)

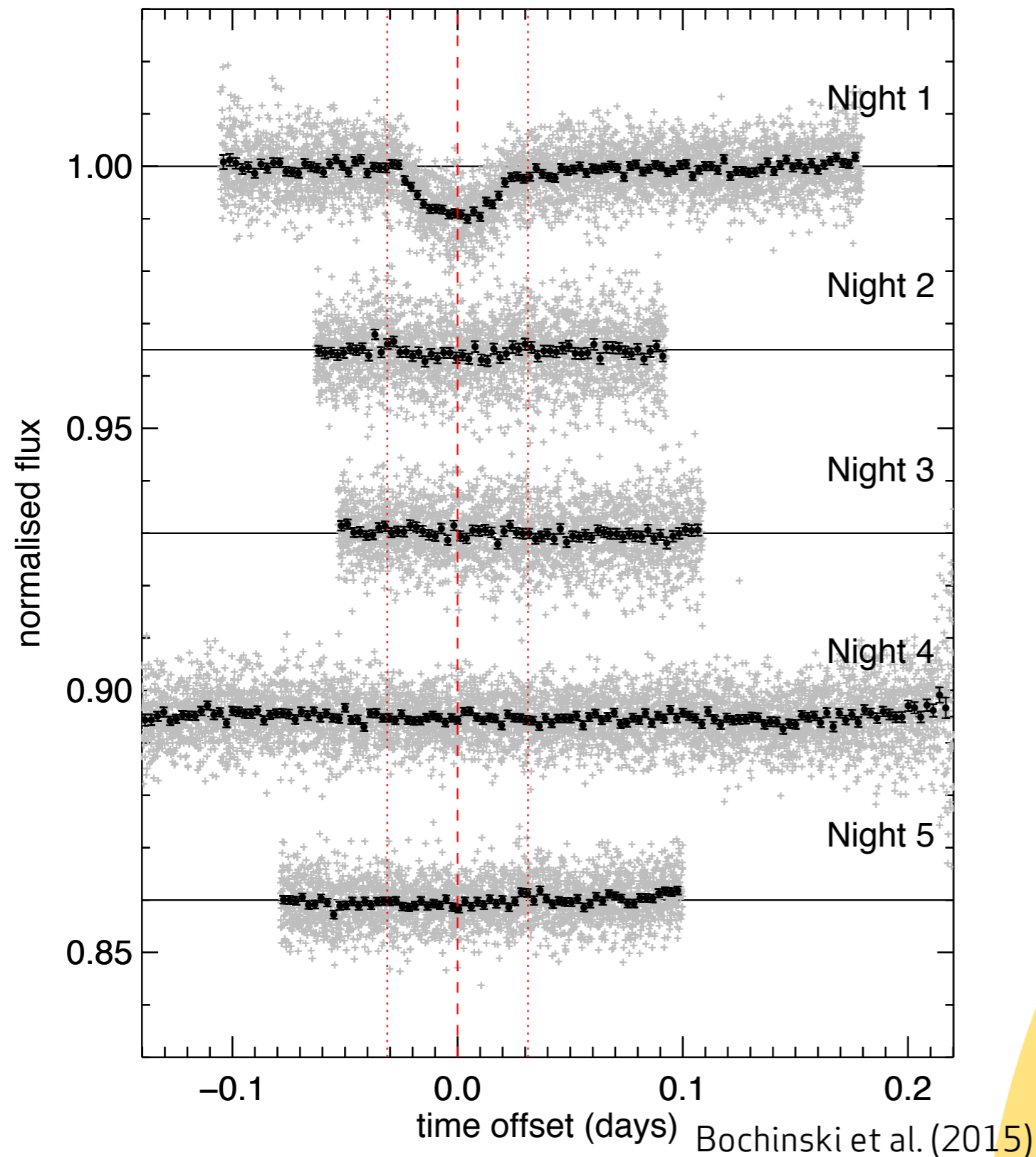


William Herschel Telescope



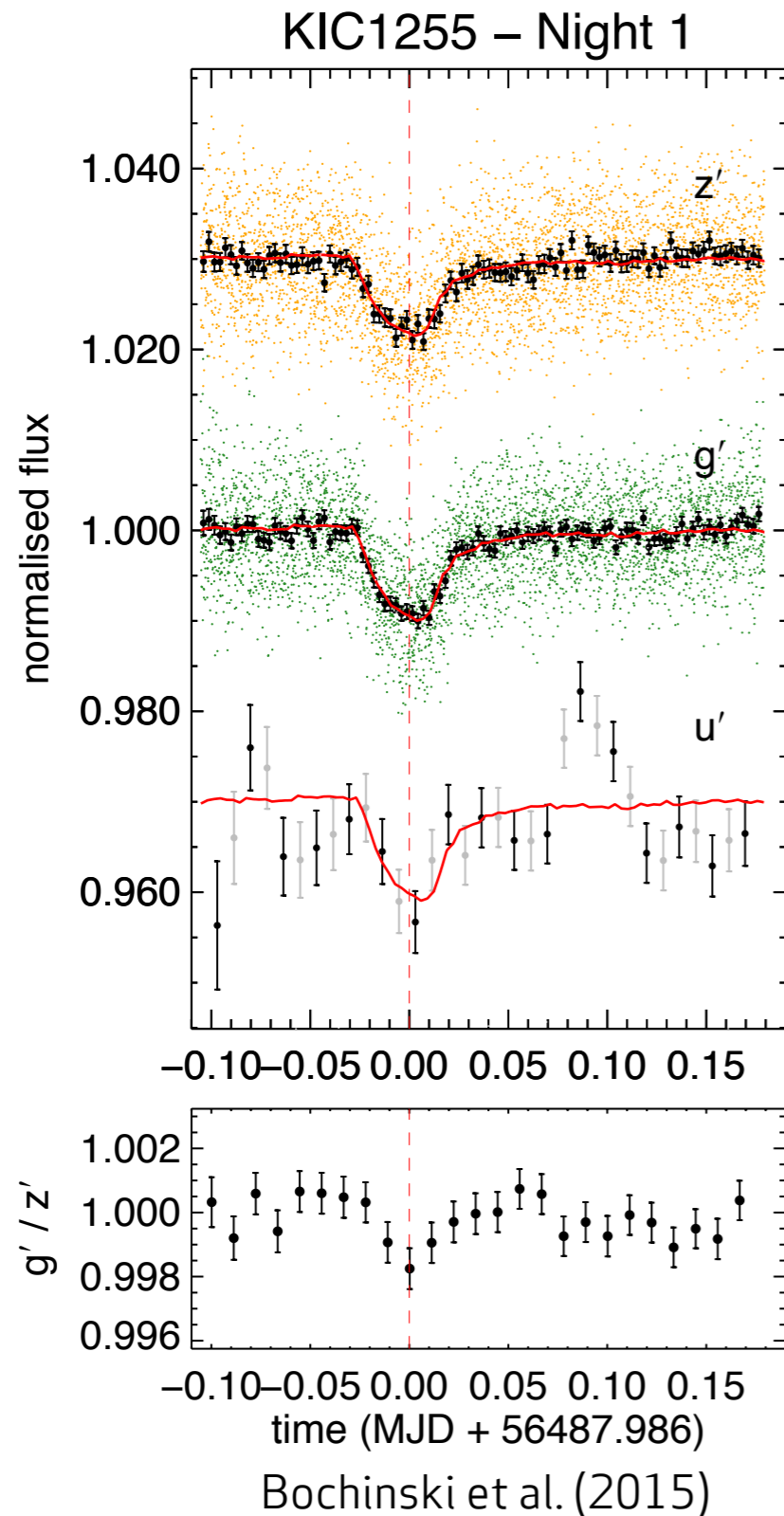
ULTRACAM

Light curves: all nights



- well behaved g' band light curves on all nights
- highest time-resolution of a KIC 1255 b transit to date (6.6s in z' and g', 39s in u')
- planet entered a quiescent period just after Night 1 - normal and observed by *Kepler* as well around 3% of the time

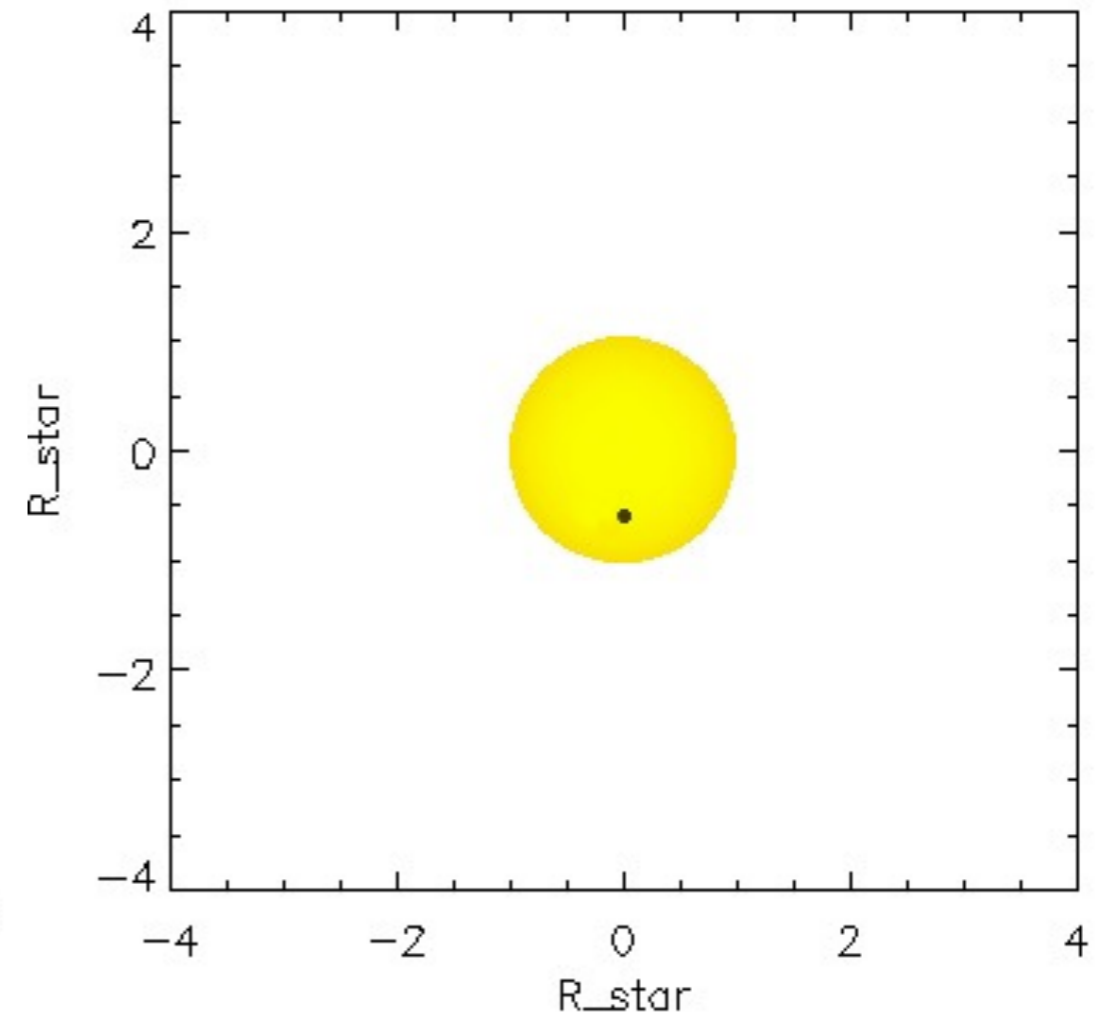
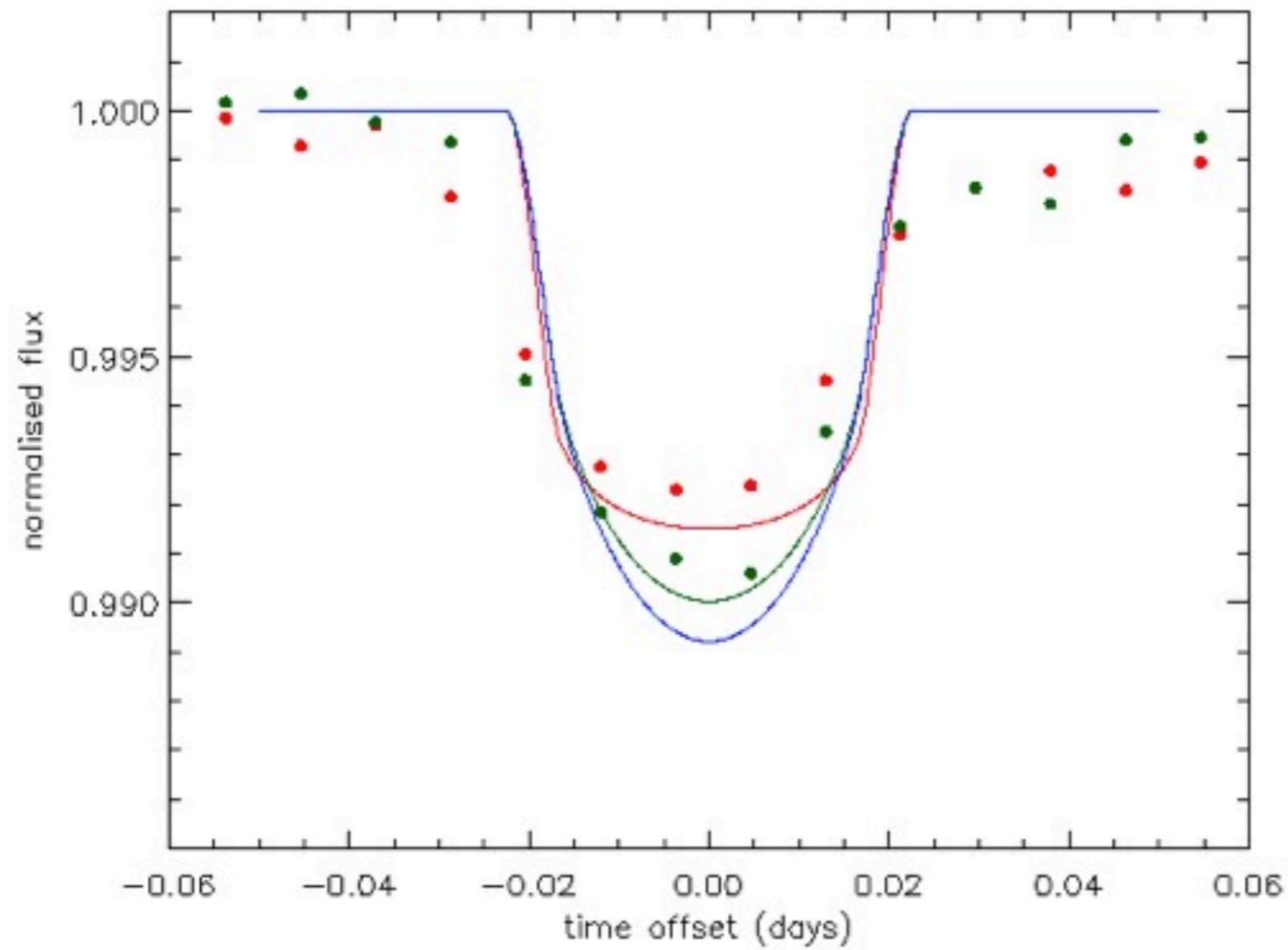
Light curves: night 1



Filters	Night 1	
	R_p/R_*	$d^{\frac{1}{2}}$ †
z'	0.0826 $^{+0.0013}_{-0.0016}$	0.0922 $^{+0.0020}_{-0.0016}$
g'	0.0891 $^{+0.0014}_{-0.0010}$	0.0999 $^{+0.0013}_{-0.0015}$
u'	0.090 $^{+0.016}_{-0.020}$	0.104 $^{+0.018}_{-0.020}$

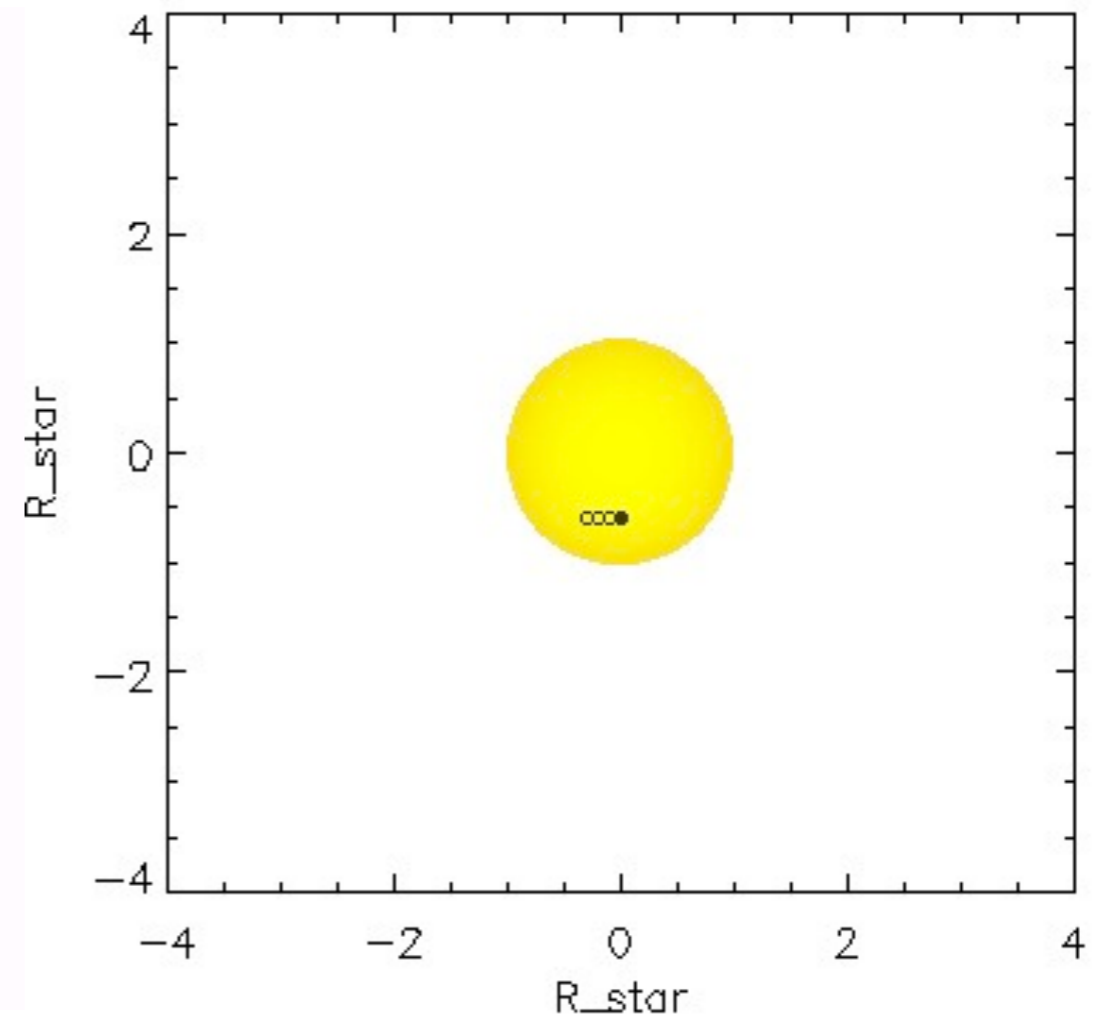
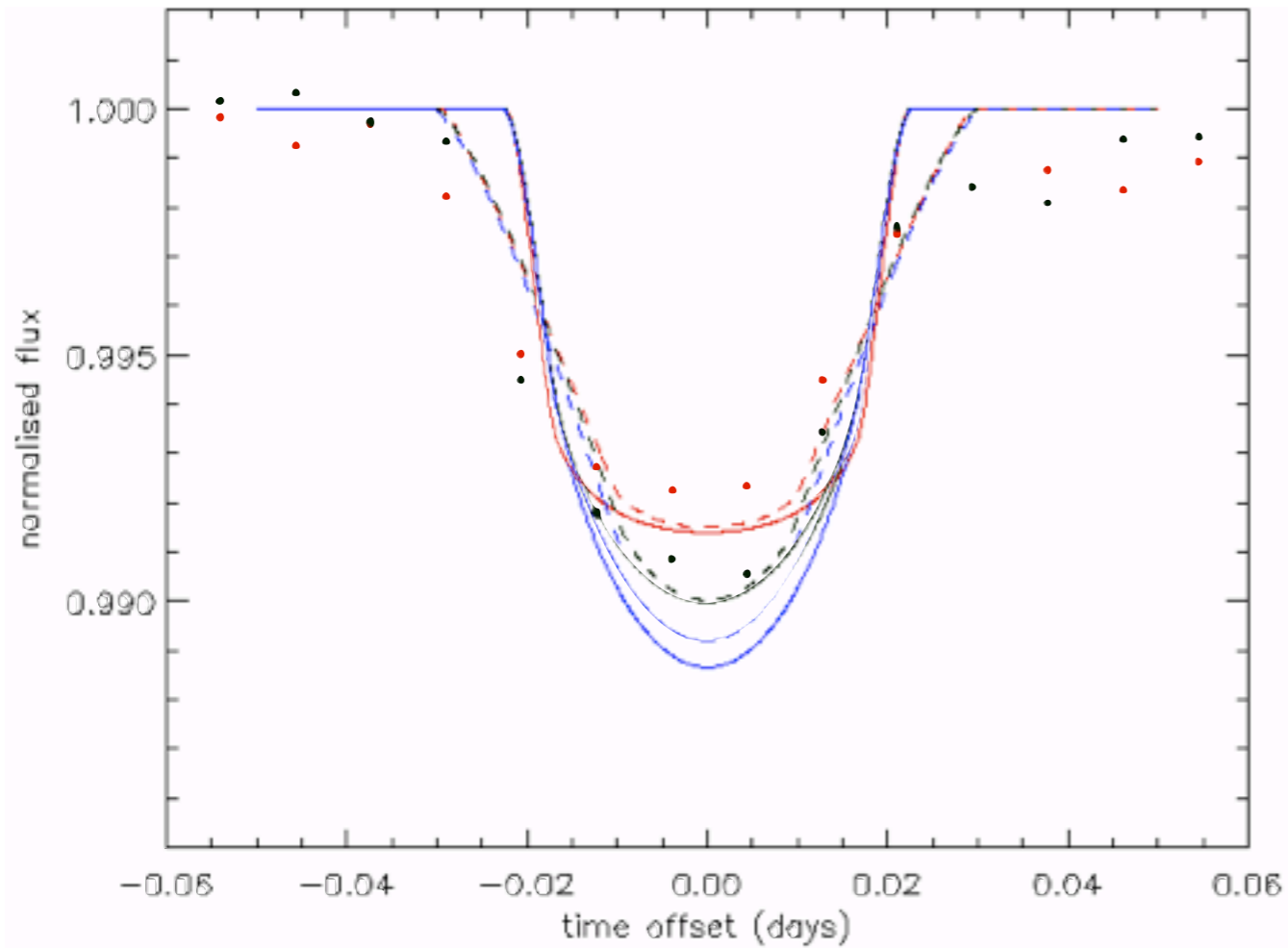
- Modelled transits using (i) Mandel & Agol (ii) scaled *Kepler* short-cadence curve
- Detected in-transit colour difference between g' and z' bands at >3.7 sig regardless of the model used
- Flare-like signals visible in u' band with traces in z' and g' bands as well -> potentially signatures of star-planet interactions

Modelling



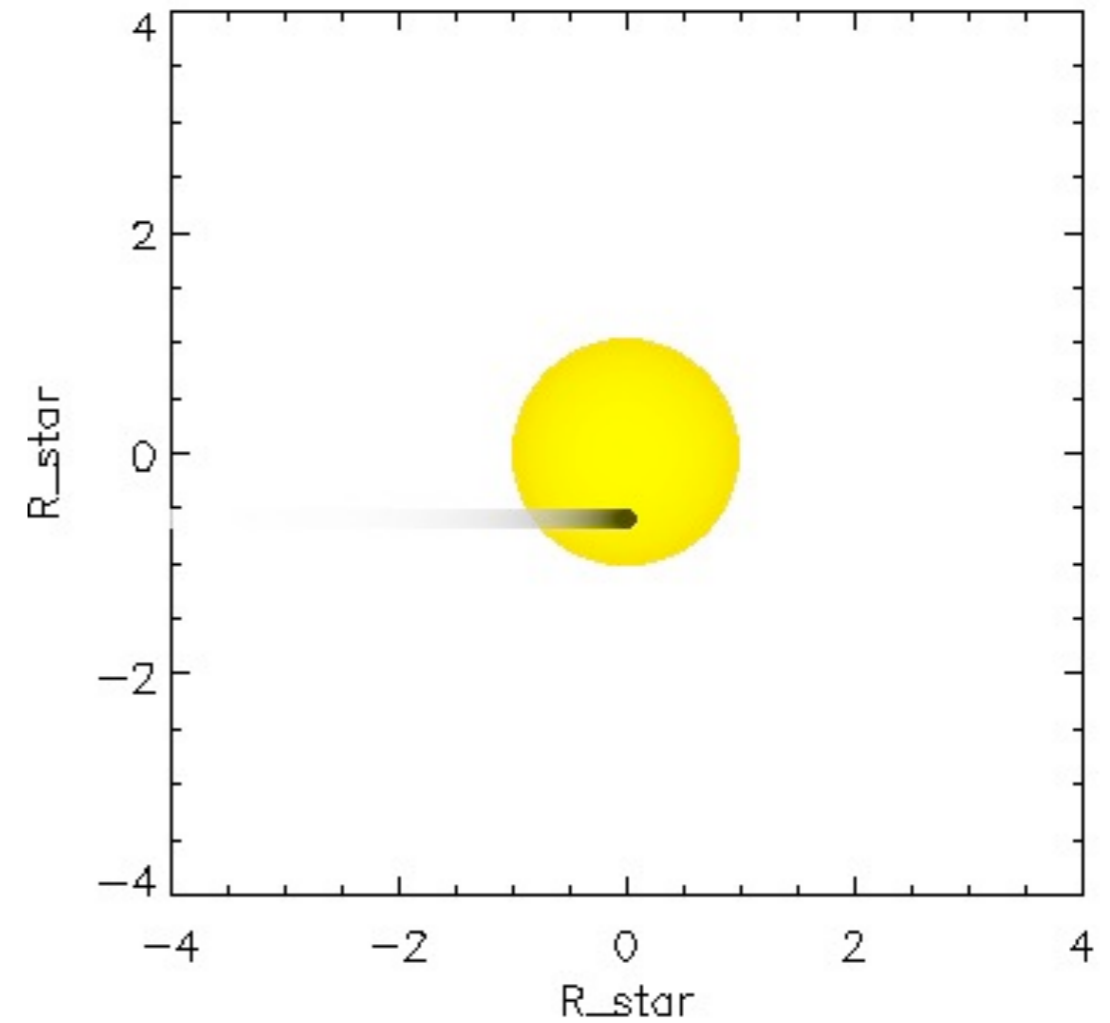
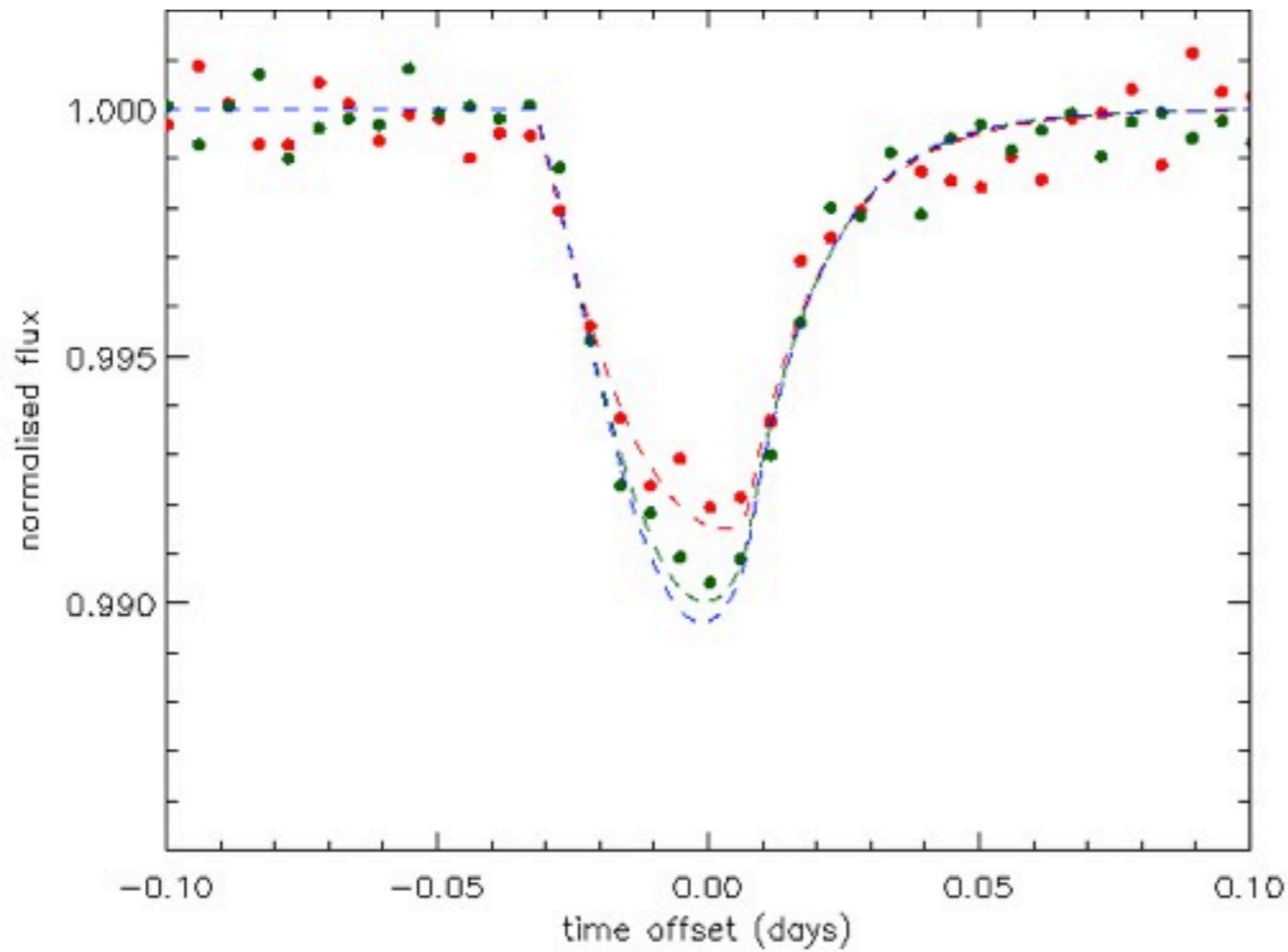
Mandel & Agol: single planet

Modelling



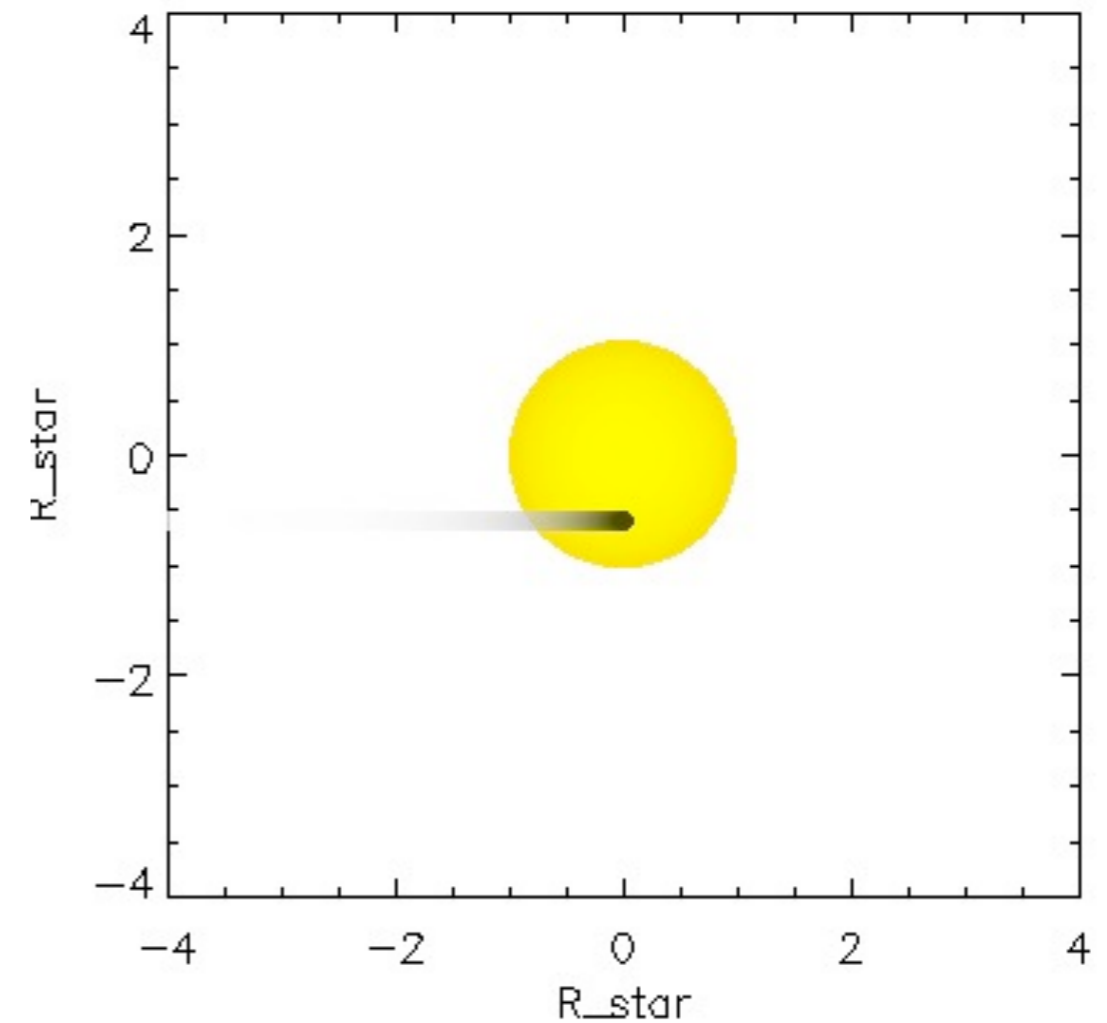
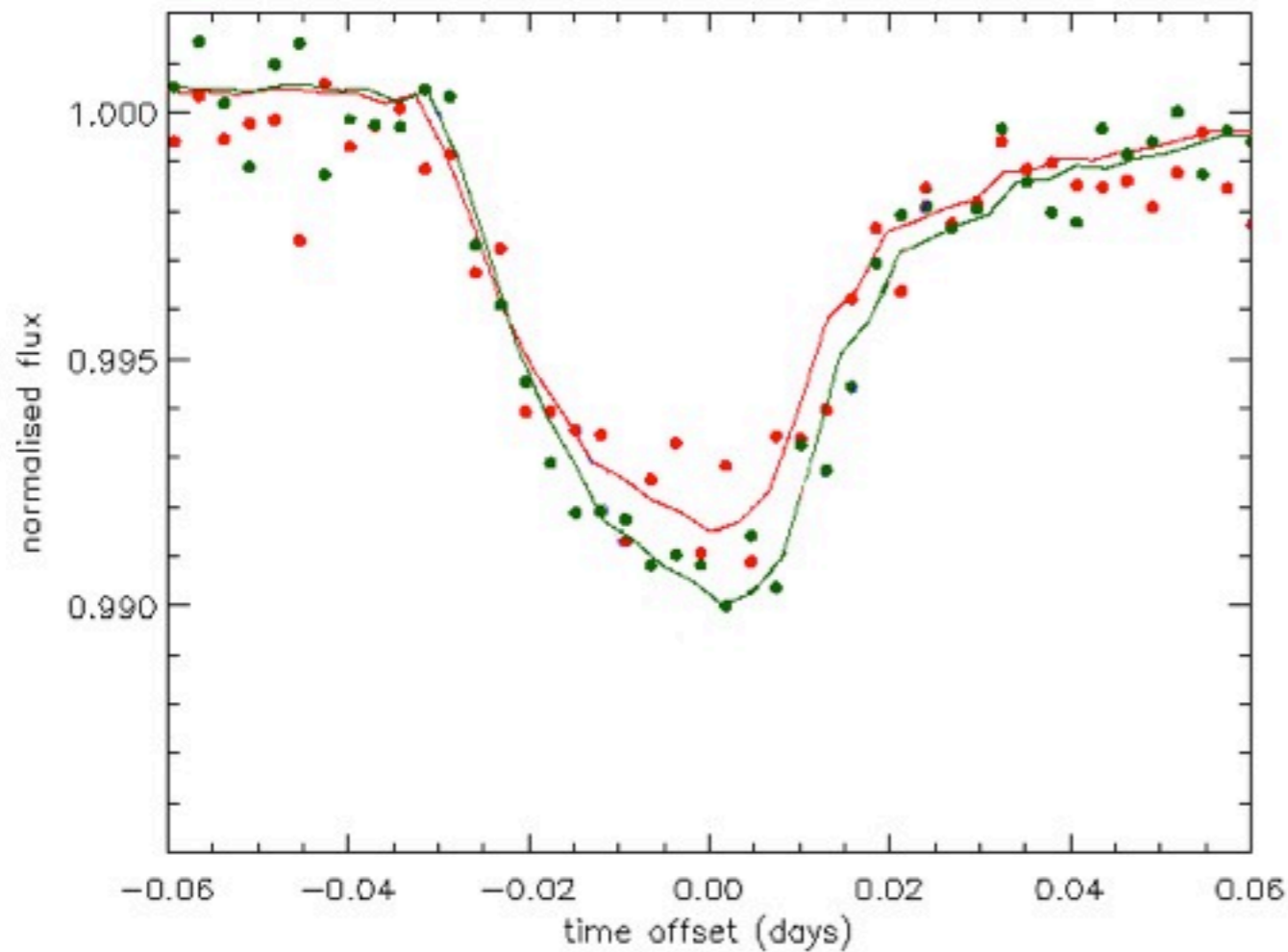
Mandel & Agol: four planets

Modelling



Transmissive dust tail

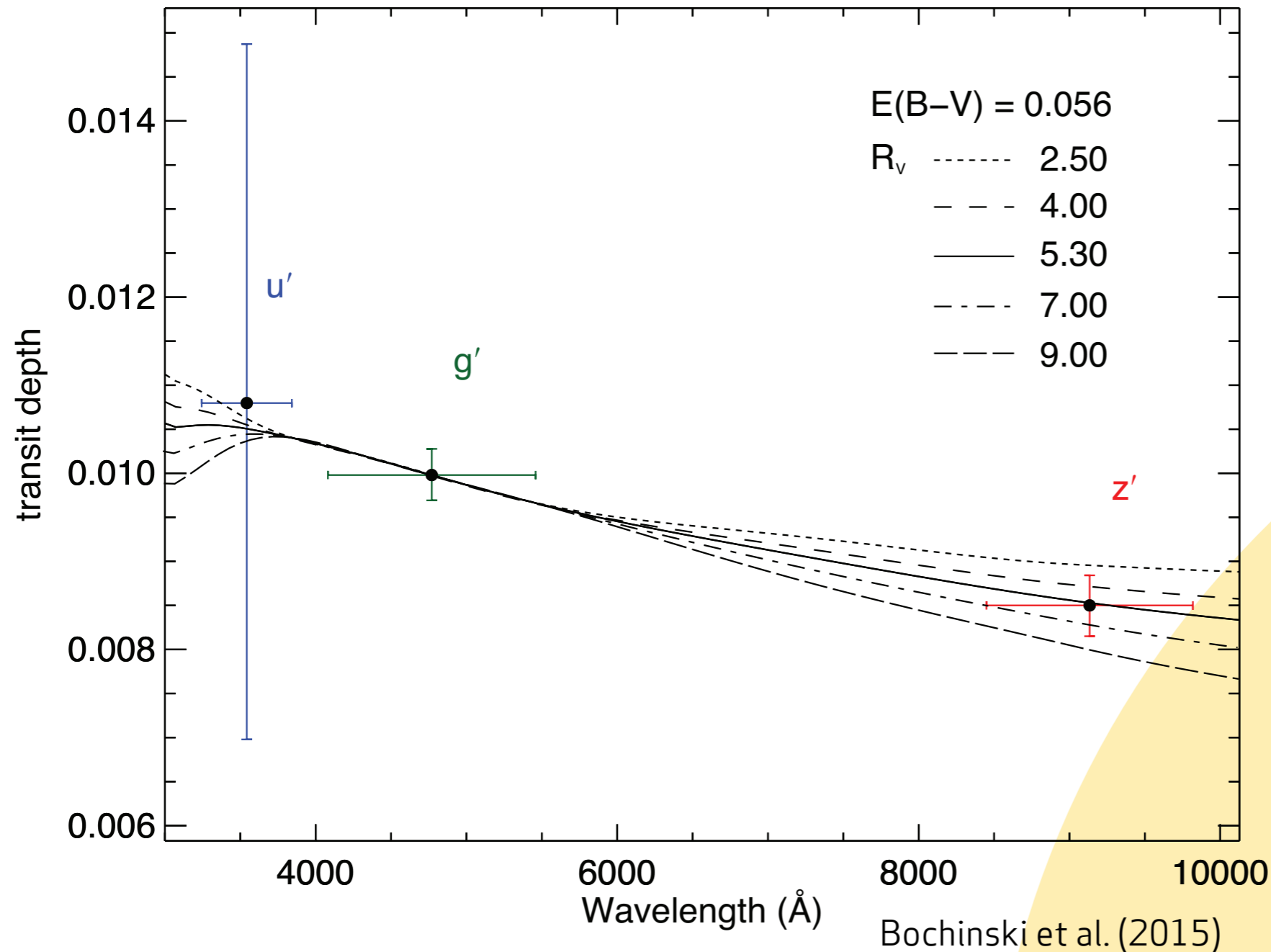
Modelling



Scaled Kepler template

Grain size modelling

CCM extinction curve



- Modelled the results with the CCM ISM reddening model for different R_v values
- Best R_v fit: 5.3 (the typical largest grains in the ISM)
- We managed to constrain the size of the grains to 0.25 - 1 micron

Summary

- we observed KIC 12557548 b in z' g' & u' bands simultaneously
- we acquired the highest cadence observations for individual transits of KIC 12557548 b (6.6 sec in z' & g')
- we observed several flare-like events, that could be signatures of star-planet interactions
- we detected for the first time a colour dependence of the transit depth of KIC 1255 (at 3.8 sigma) providing evidence in favour of the disrupting low-mass rocky planet for this observation
- we compared the result to the CCM absorption curve to see our grains are consistent with the largest found in the ISM: 0.25 - 1.0 micron
- this technique offers to gain the first glimpse under the surface of a rocky exoplanet
- more in our paper - Bochinski et al. (2015)



KIC 12557548 b
Night 1 observations

William Herschel Telescope