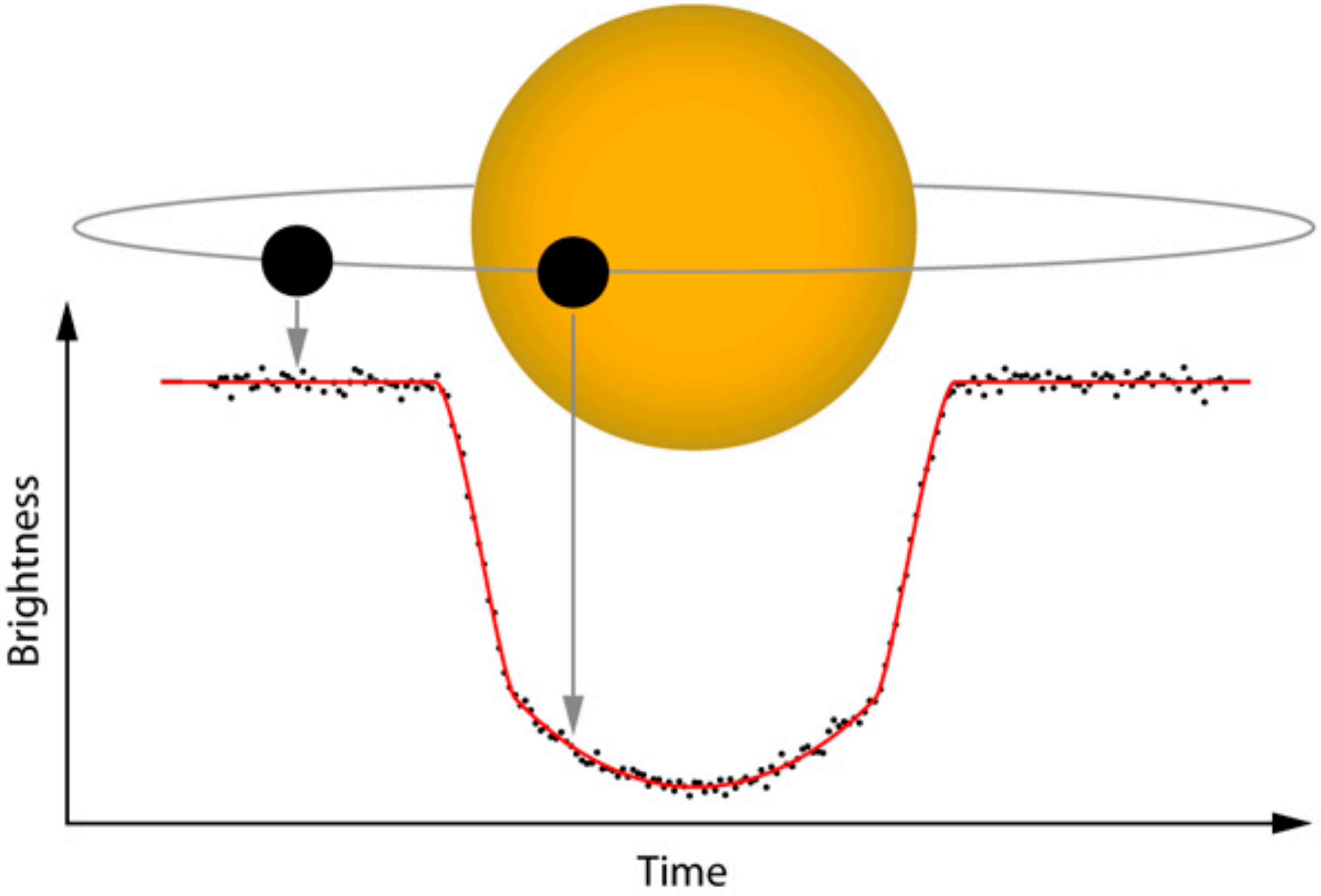
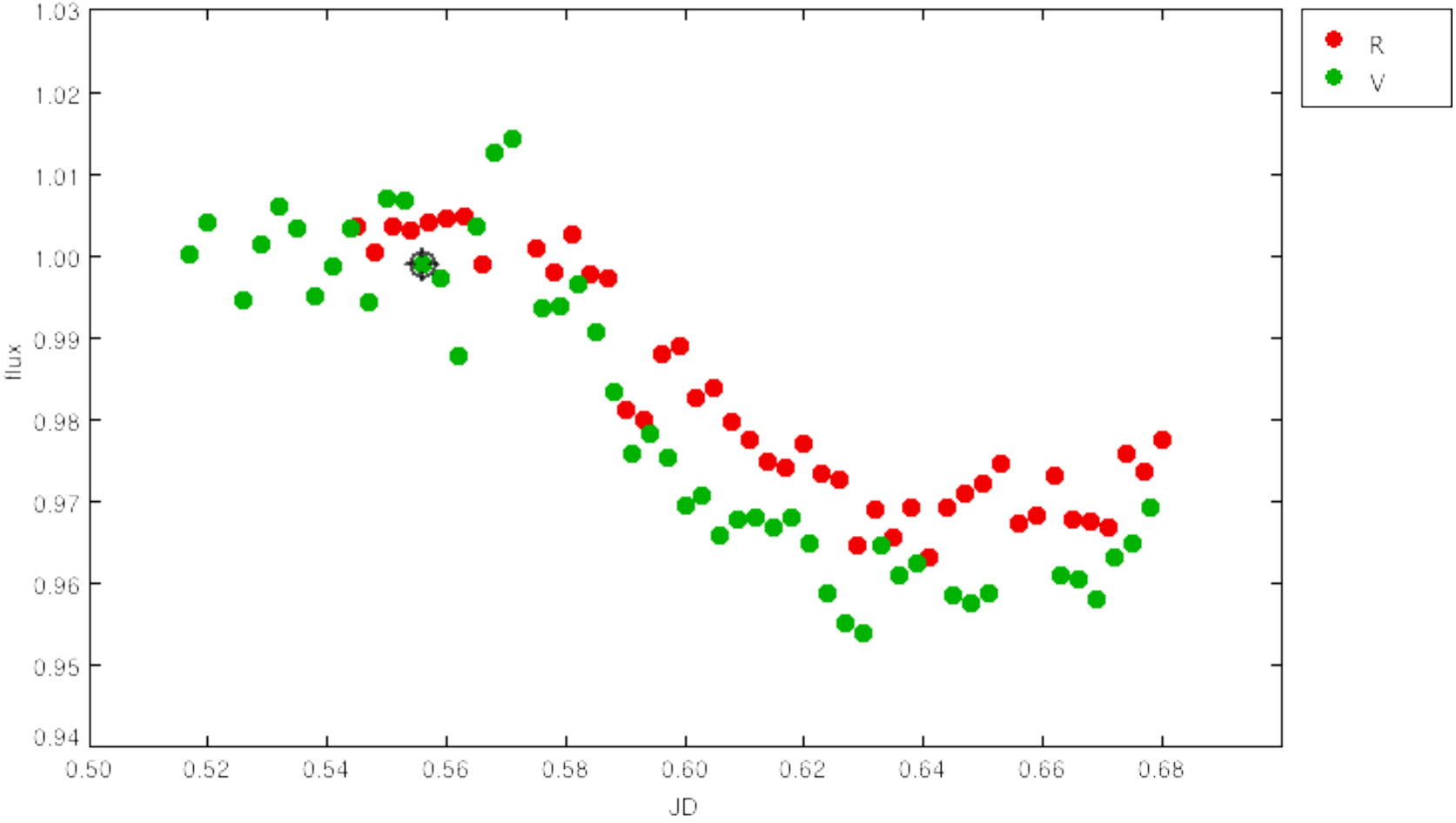
Multicolour photometry of transiting exoplanets

Juan Fabregat

GEOS meeting 2017


Brightness
Time

HAT-P 10b transit



RAYLEIGH SCATTERING IN THE ATMOSPHERE OF THE WARM EXO-NEPTUNE GJ 3470B

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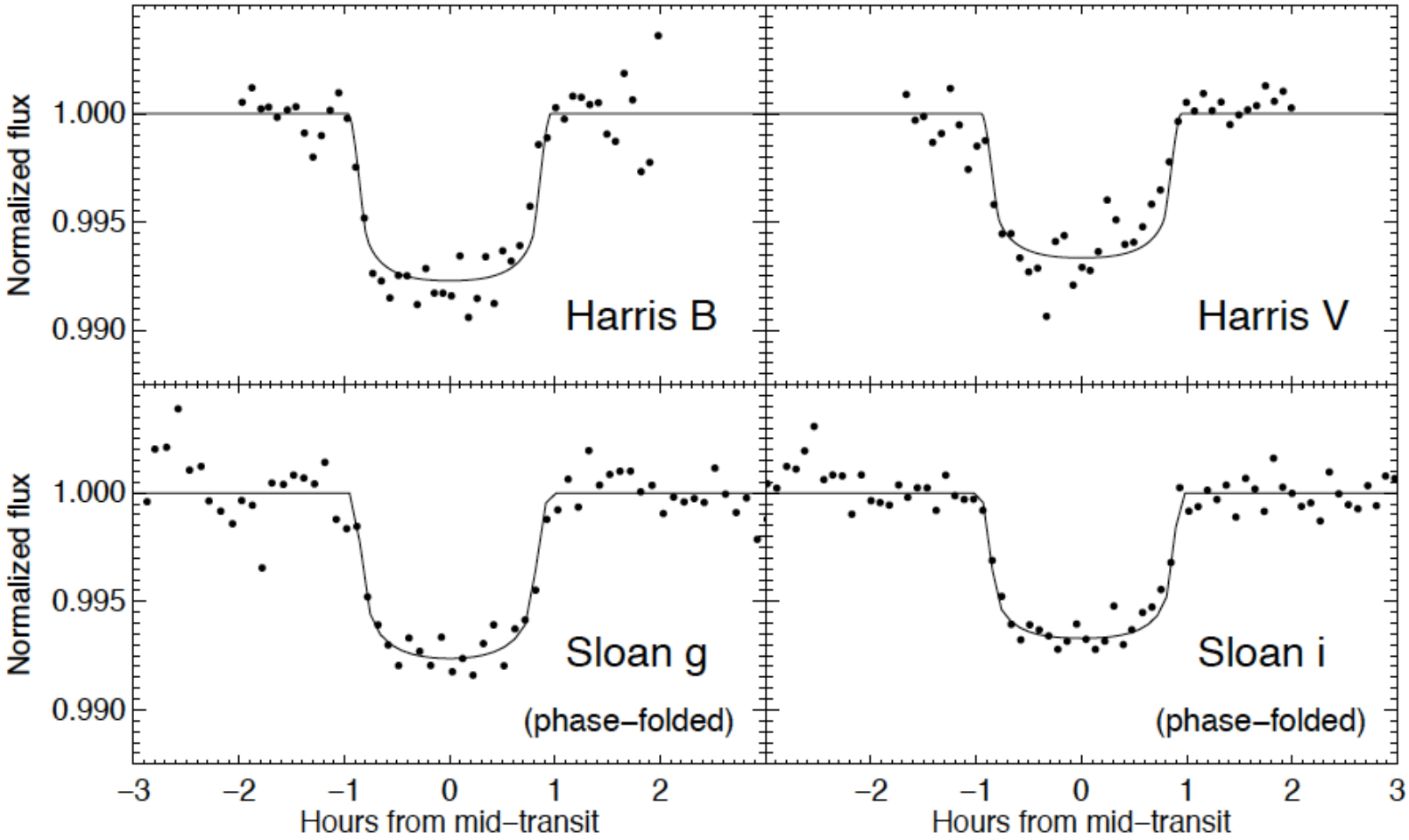
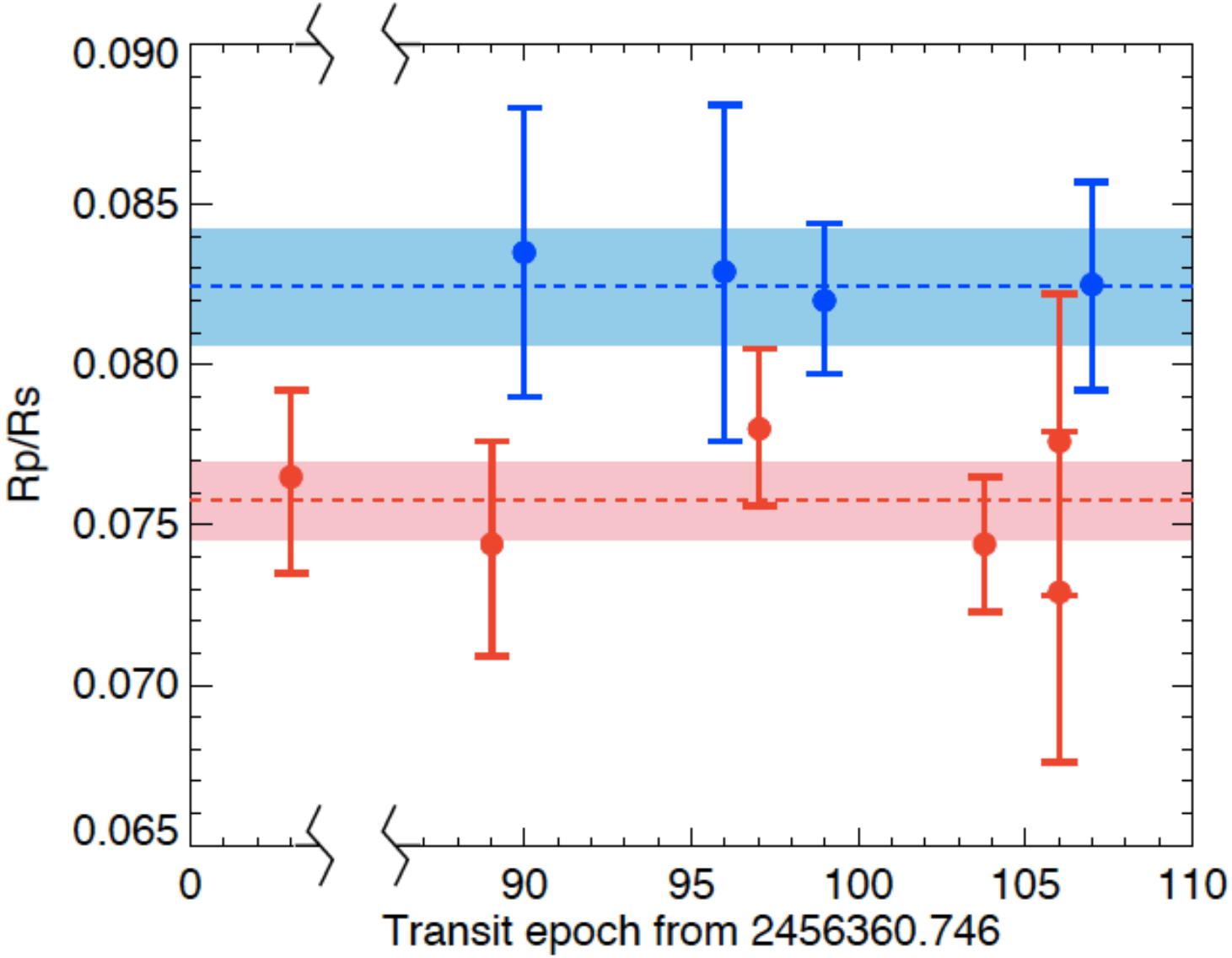
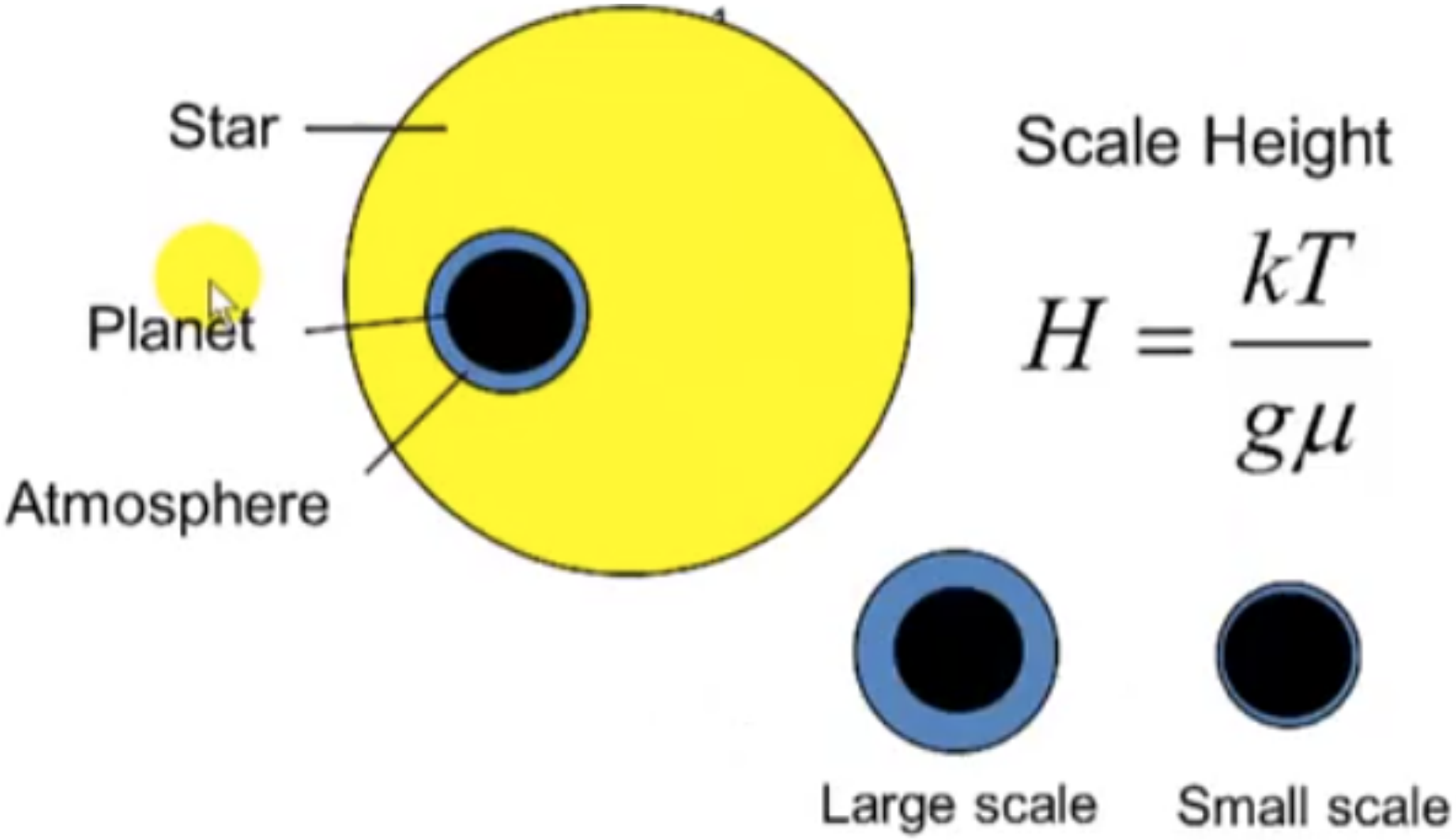
Draft version November 19, 2015



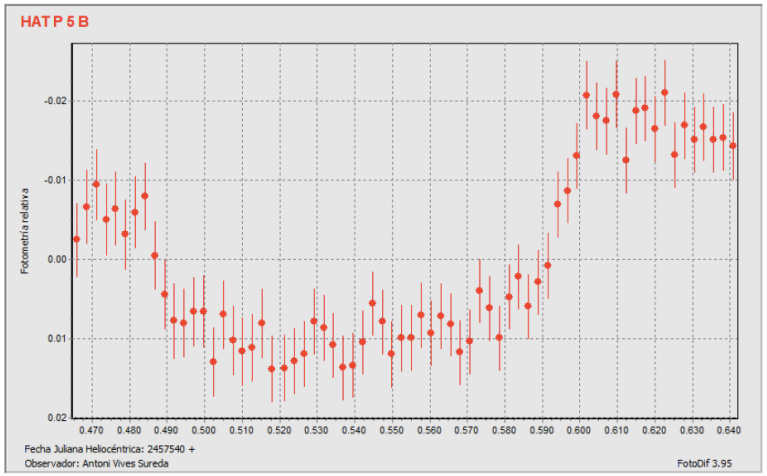

0.090
0.085
0.080
0.075
0.070
0.065
Rp/Rs
0
90
95
100
105
110
Transit epoch from 2456360.746

Planetary atmospheres

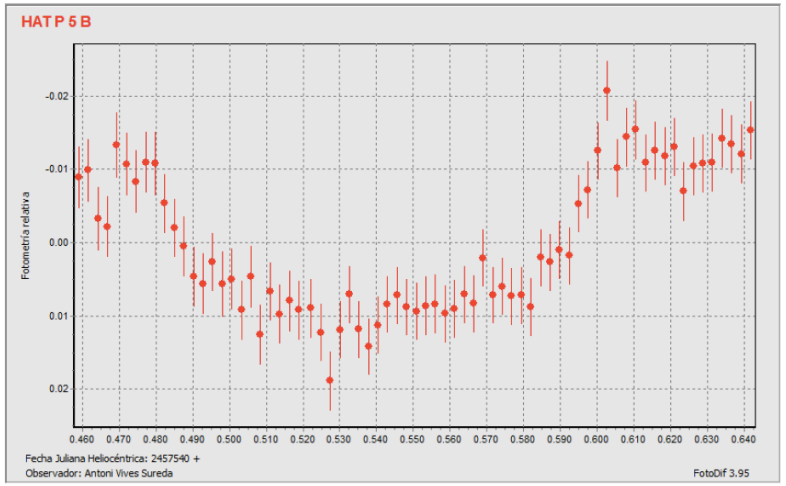


Hat-P-5b, OSN 31 May 2016

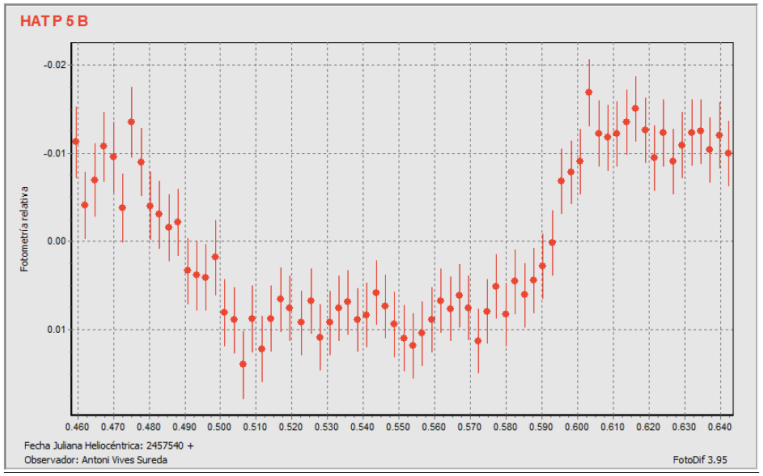
HAT- P – 5 b filtro B:



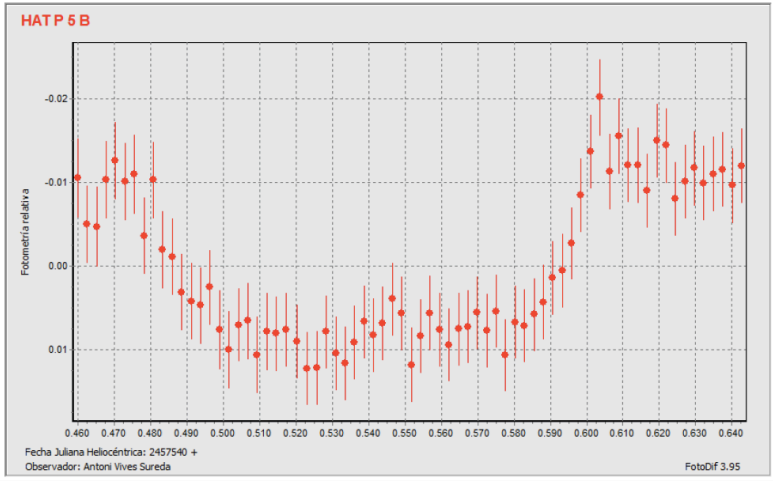
HAT- P – 5 b filtro V:



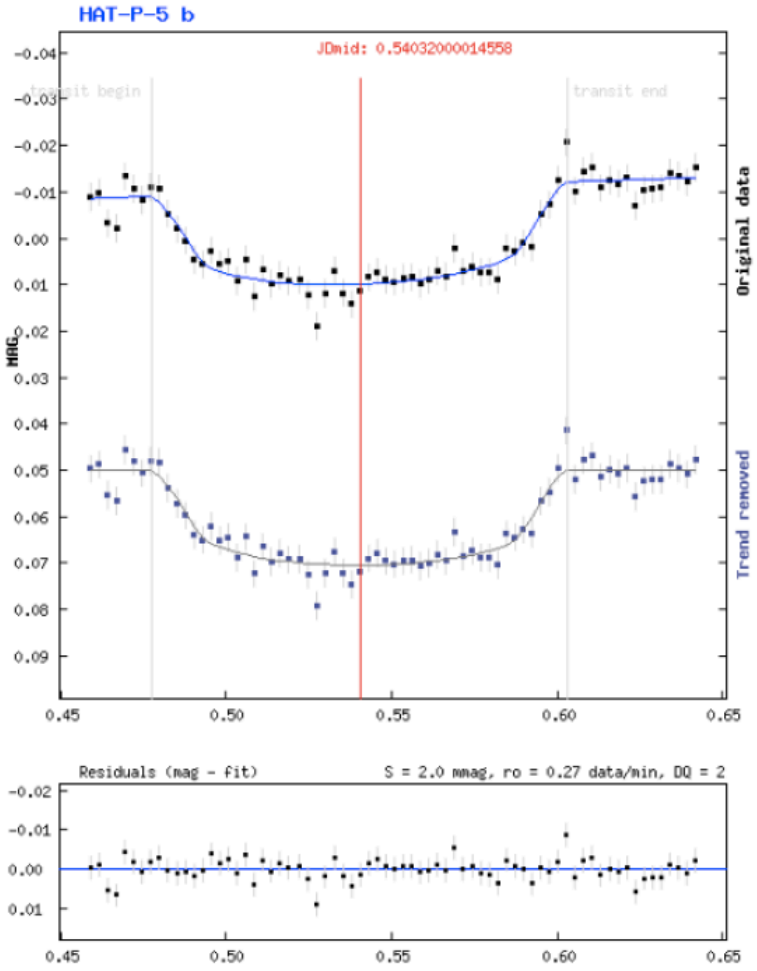
HAT- P – 5 b filtro R:

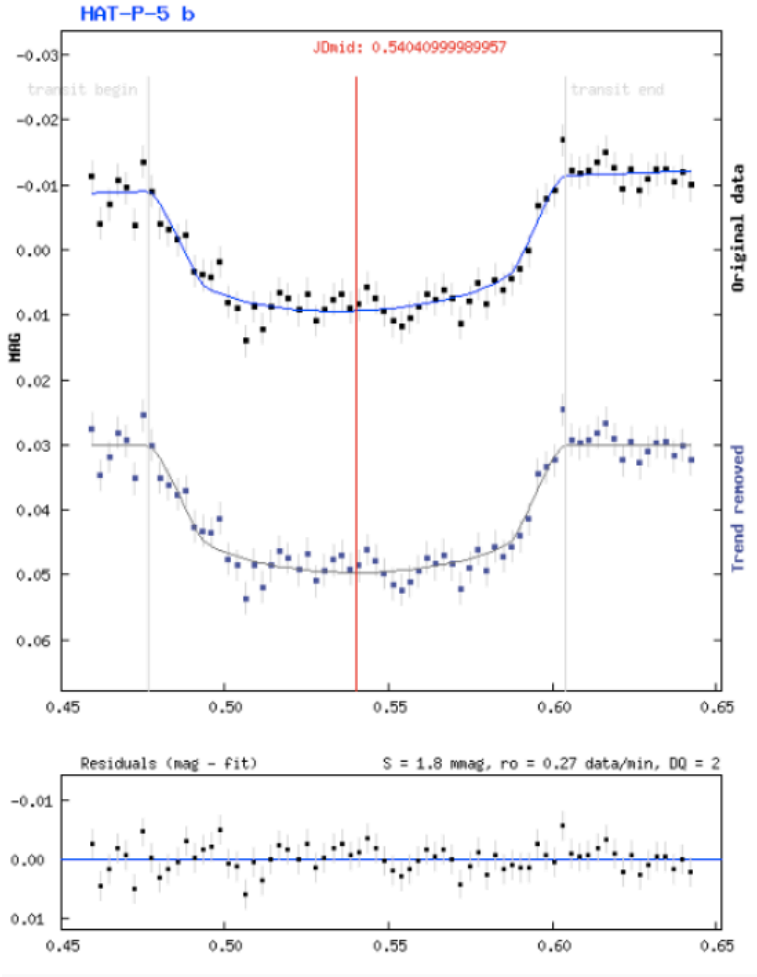


HAT- P – 5 b filtro I:



Hat-P-5b, OSN 31 May 2016





Hat-P-5b, OSN 31 May 2016

HAT – P – 5b filtro B:

JD MID: 2457540.53883 ± 0.00084

HJD MID: 2457540.54147 ± 0.00084

Duración: 179.6 ± 2.9 min

Transit depth: 0.0221 ± 0.0008 mag

HAT – P – 5b filtro I:

JD MID: 2457540.53725 ± 0.00089

HJD MID: 2457540.53989 ± 0.00089

Duración: 185.4 ± 3.0 min

Transit depth: 0.0198 ± 0.0008 mag

HAT – P – 5b filtro R:

JD MID: 2457540.53777 ± 0.00081

HJD MID: 2457540.54041 ± 0.00081

Duración: 182.9 ± 2.8 min

Transit depth: 0.0196 ± 0.0007 mag

HAT – P – 5b filtro V:

JD MID: 2457540.53768 ± 0.00092

HJD MID: 2457540.54032 ± 0.00092

Duración: 181.2 ± 3.2 min

Transit depth: 0.0205 ± 0.0008 mag

WASP-109b, OSN 30 May 2016

FILTRO B

JD mid:	2457539.44233 +/- 0.00120	
HJD mid:	2457539.44794 +/- 0.00120	(helcor = **0.00561**)
Duration:	157.4 +/- 4.7	minutes
Depth:	0.0119 +/- 0.0007	mag

FILTRO I

JD mid:	2457539.43992 +/- 0.00132	
HJD mid:	2457539.44553 +/- 0.00132	(helcor = **0.00561**)
Duration:	185.0 +/- 5.3	minutes
Depth:	0.0135 +/- 0.0008	mag

FILTRO R

JD mid:	2457539.44347 +/- 0.00485	
HJD mid:	2457539.44908 +/- 0.00485	(helcor = **0.00561**)
Duration:	179.4 +/- 16.6	minutes
Depth:	0.0125 +/- 0.0029	mag

FILTRO V

JD mid:	2457539.44083 +/- 0.00227	
HJD mid:	2457539.44644 +/- 0.00227	(helcor = **0.00561**)
Duration:	177.0 +/- 7.9	minutes
Depth:	0.0126 +/- 0.0013	mag

TeES-3b, OAO 25 August 2016

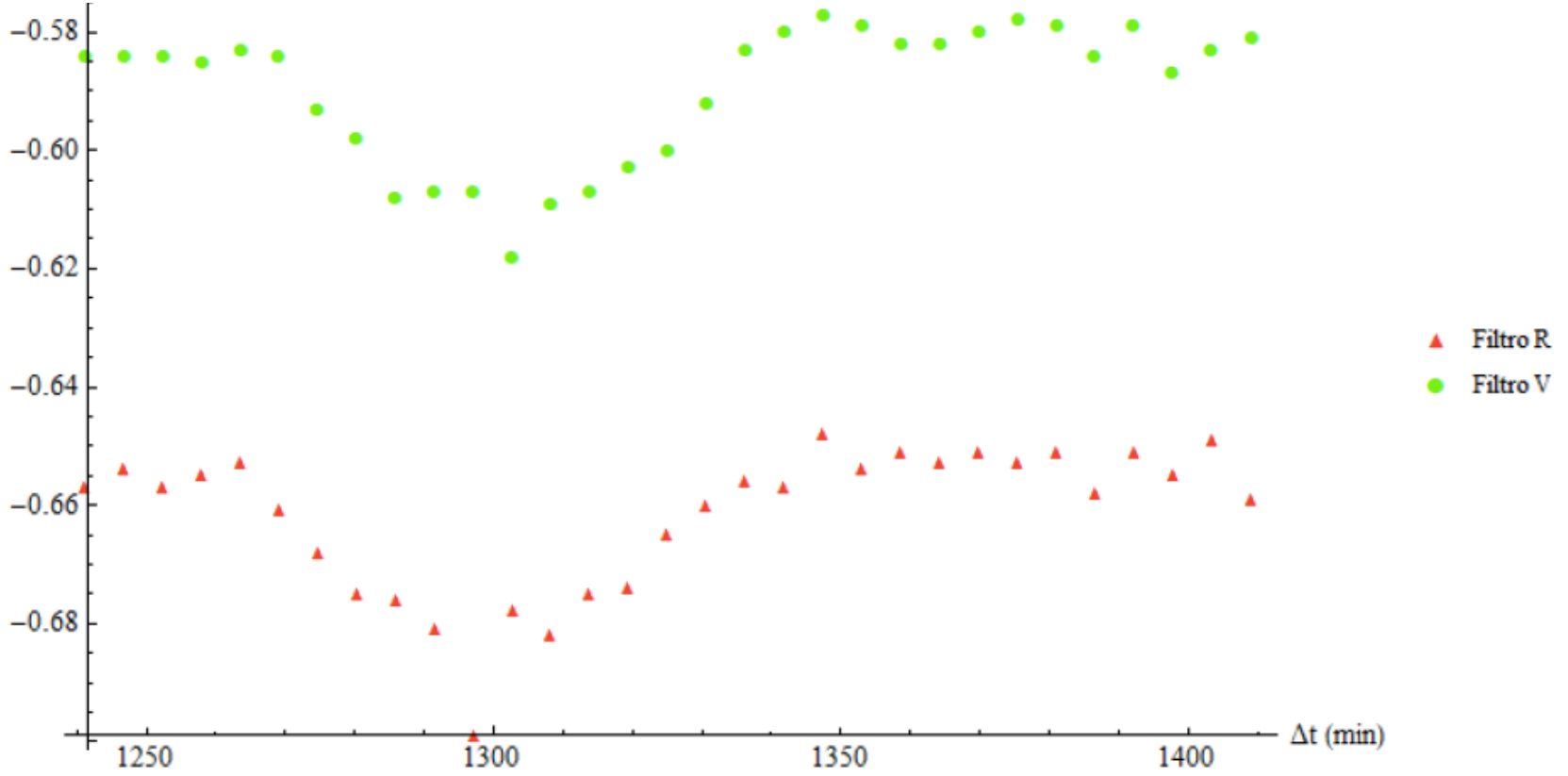


Figura 2: Fotometría diferencial en el filtro R y filtro V.

TeES-3b, OAO 25 August 2016

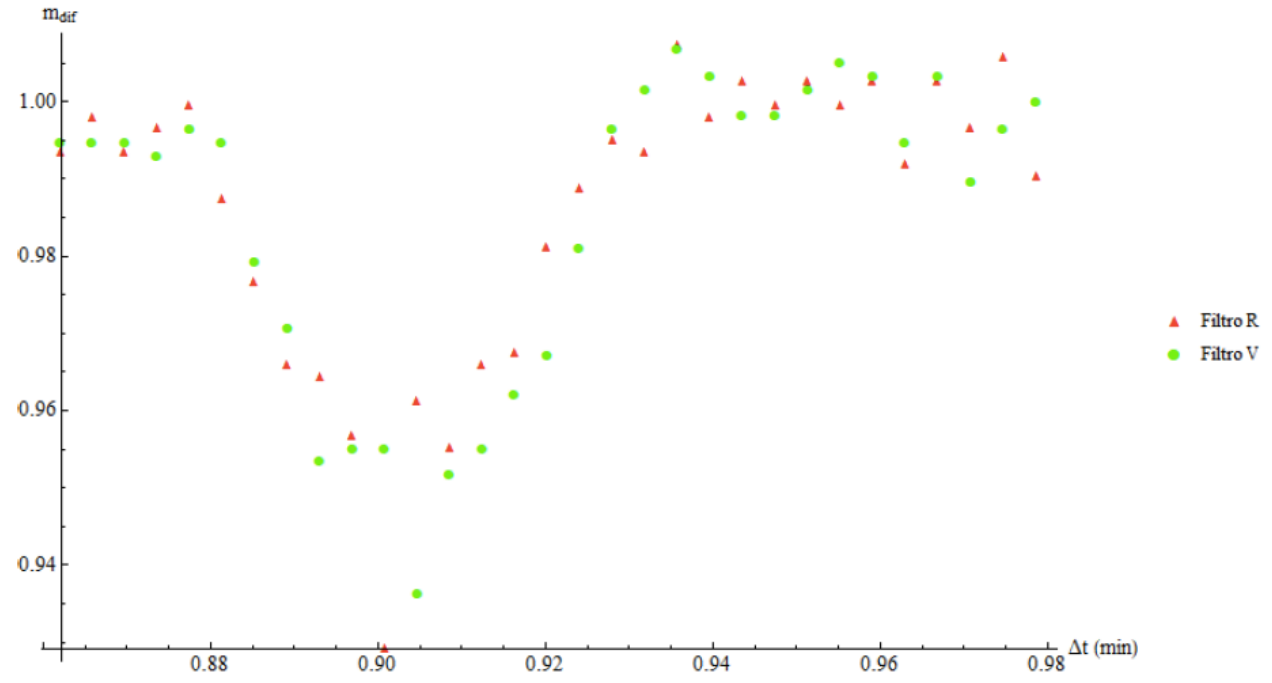


Figura 3: Fotometría diferencial en el filtro R y filtro V normalizada. Se observa una pequeña diferencia en la profundidad del tránsito.

TeES-3b, OAO 25 August 2016

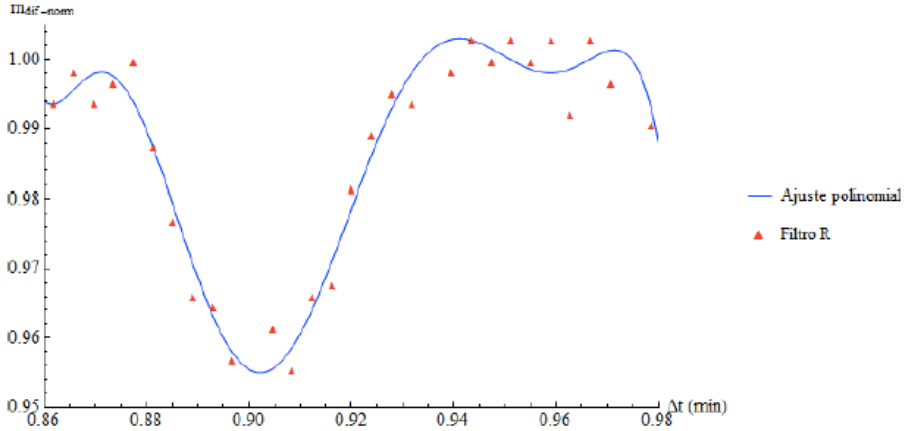
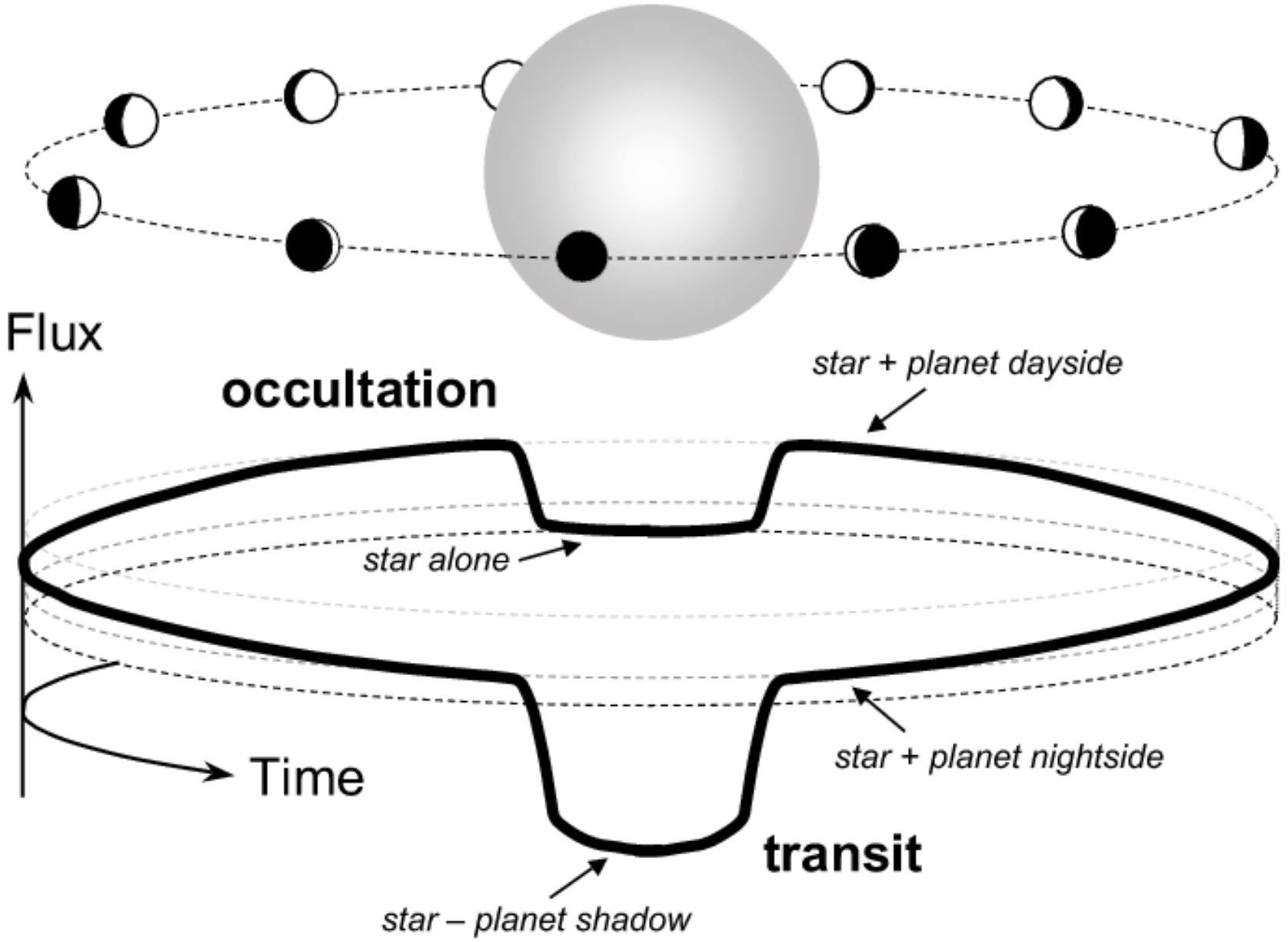
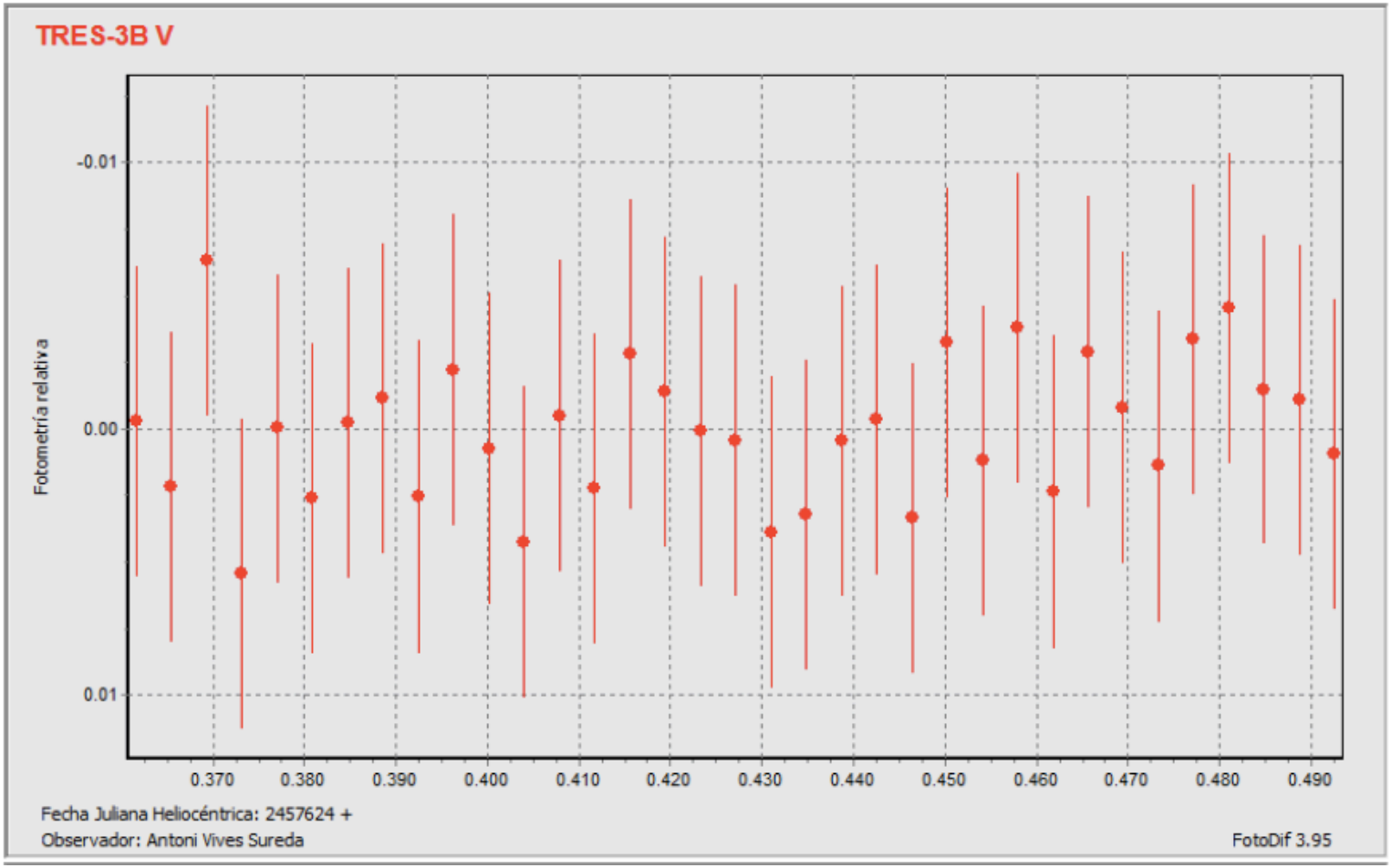


Figura 5: Ajuste polinómico de grado 10 a los datos del filtro R. Hemos suprimido un punto conflictivo. Aumentar el grado del polinomio no proporciona una mejora apreciable.

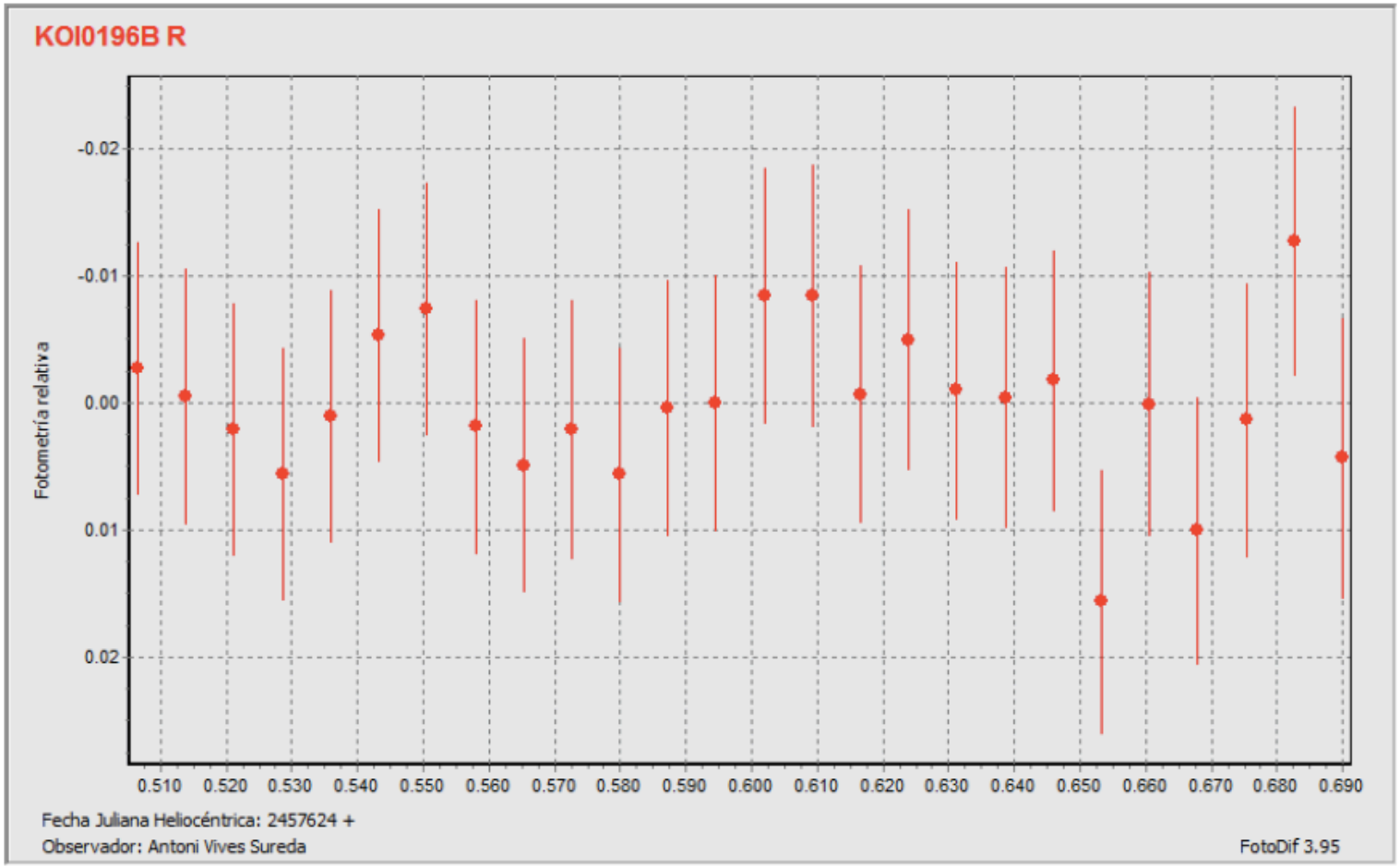
A partir de este ajuste y siguiendo los pasos comentados anteriormente, obtenemos los siguientes valores: $A_V = 0{,}00172$ y $A_R = 0{,}00151$, es decir, el área del tránsito en el filtro V es aproximadamente un 10 % mayor.


Flux
occultation
star + planet dayside
star alone
Time
star + planet nightside
transit
star – planet shadow

TeES-3b, OAO 23 August 2016



KOI0196b, OAO 25 August 2016



Kepler transits and occultations

Exoplanets	$R_p\ (R_J)$	i (degrees)	a(Au)	Occultation Depth(ppm)	Transit Depth(mag)	Geometric Albedo
Kepler - 5b	$1.426^{+0.036}_{-0.051}$	$89.14^{+0.44}_{-0.32}$	$0.0538^{+0.0015}_{-0.0021}$	$18.6^{+5.1}_{-5.3}$	0.0078 (ETD)	0.121
Kepler - 6b	$1.304^{+0.018}_{-0.033}$	$88.93^{+0.19}_{-0.17}$	$0.04852^{+0.00074}_{-0.00133}$	$11.1^{+4.8}_{-5.3}$	0.0113 (ETD)	0.07
Kepler -7b	$1.622^{+0.013}_{-0.013}$	$85.161^{+0.055}_{-0.054}$	$0.06067^{+0.00059}_{-0.0059}$	39^{+11}_{-11}	0.0081 (ETD)	0.248
Kepler- 8b	$1.416^{+0.053}_{-0.062}$	$83.978^{+0.036}_{-0.032}$	$0.0474^{+0.0018}_{-0.0021}$	26^{+10}_{-10}	0.0097 (ETD)	0.133
Kepler- 10b	$0.1321^{+0.0044}_{-0.0026}$	$85.1^{+3.4}_{-4.3}$	$0.01720^{+0.00081}_{-0.00168}$	$7.5^{+2.0}_{-2.1}$	0.000191 (Holczer, 2016)	0.58
Kepler – 12b	$1.754^{+0.031}_{-0.036}$	$88.796^{+0.088}_{-0.074}$	$0.0553^{+0.0010}_{-0.0012}$	$20.2^{+8.3}_{-7.6}$	0.0174 (ETD)	0.092
Kepler – 41b	$1.040^{+0.035}_{-0.035}$	$82.214^{+0.090}_{-0.085}$	$0.02396^{+0.00081}_{-0.00080}$	44^{+15}_{-16}	0.011048 (Holczer, 2016)	0.108
Kepler – 43b	$1.219^{+0.065}_{-0.064}$	$84.646^{+0.107}_{-0.091}$	$0.0460^{+0.0026}_{-0.0025}$	11^{+40}_{-37}	----------	0.071
Kepler – 76b	$1.36^{+0.12}_{-0.12}$	$77.55^{+0.20}_{-0.17}$	$0.0274^{+0.0020}_{-0.0019}$	$131.6^{+8.7}_{-8.0}$	----------	0.246
Kepler – 91b	$1.367^{+0.069}_{-0.060}$	$69.68^{+0.67}_{-0.57}$	$0.0731^{+0.0034}_{-0.0031}$	35^{+18}_{-18}	0.000472	0.46
Kepler – 412b	$1.341^{+0.044}_{-0.046}$	$80.559^{+0.084}_{-0.079}$	$0.02897^{+0.00093}_{-0.00092}$	53^{+21}_{-24}	0.010533 (Holczer, 2016)	0.113
TrES – 2b	$1.247^{+0.050}_{-0.045}$	$83.872^{+0.020}_{-0.018}$	$0.0367^{+0.0014}_{-0.0013}$	$7.7^{+2.4}_{-2.6}$	0.0169	0.031
HAT – p7b	$1.419^{+0.178}_{-0.085}$	$83.143^{+0.023}_{-0.02}$	$0.0355^{+0.0045}_{-0.0021}$	$71.2^{+1.9}_{-2.2}$	0.0067	0.2044
KOI – 13b o Kepler – 13 A b	$1.512^{+0.035}_{-0.035}$	$86.770^{+0.048}_{-0.052}$	$0.03641^{+0.00087}_{-0.00087}$	$172.0^{+1.7}_{-1.6}$	0.0046	0.4565
KOI – 13b o Kepler – 13 A b	$2.63^{+1.04}_{-0.82}$	$86.769^{+0.046}_{-0.050}$	$0.063^{+0.0025}_{-0.0020}$	$170.8^{+1.6}_{-1.5}$	0.0046	0.4532
KOI – 13b o Kepler – 13 A b	$2.216^{+0.087}_{-0.087}$	$86.770^{+0.047}_{-0.046}$	$0.0533^{+0.0021}_{-0.0022}$	$170.8^{+1.6}_{-1.5}$	0.0046	0.4529

Conclusions

- Differences in transit curve depths observed
- A protometric accuracy of ~0.003 mag or better needed
- Results to be confirmed. Long term programme.