

Pro – Am collaborations on exoplanet transit and eclipse science



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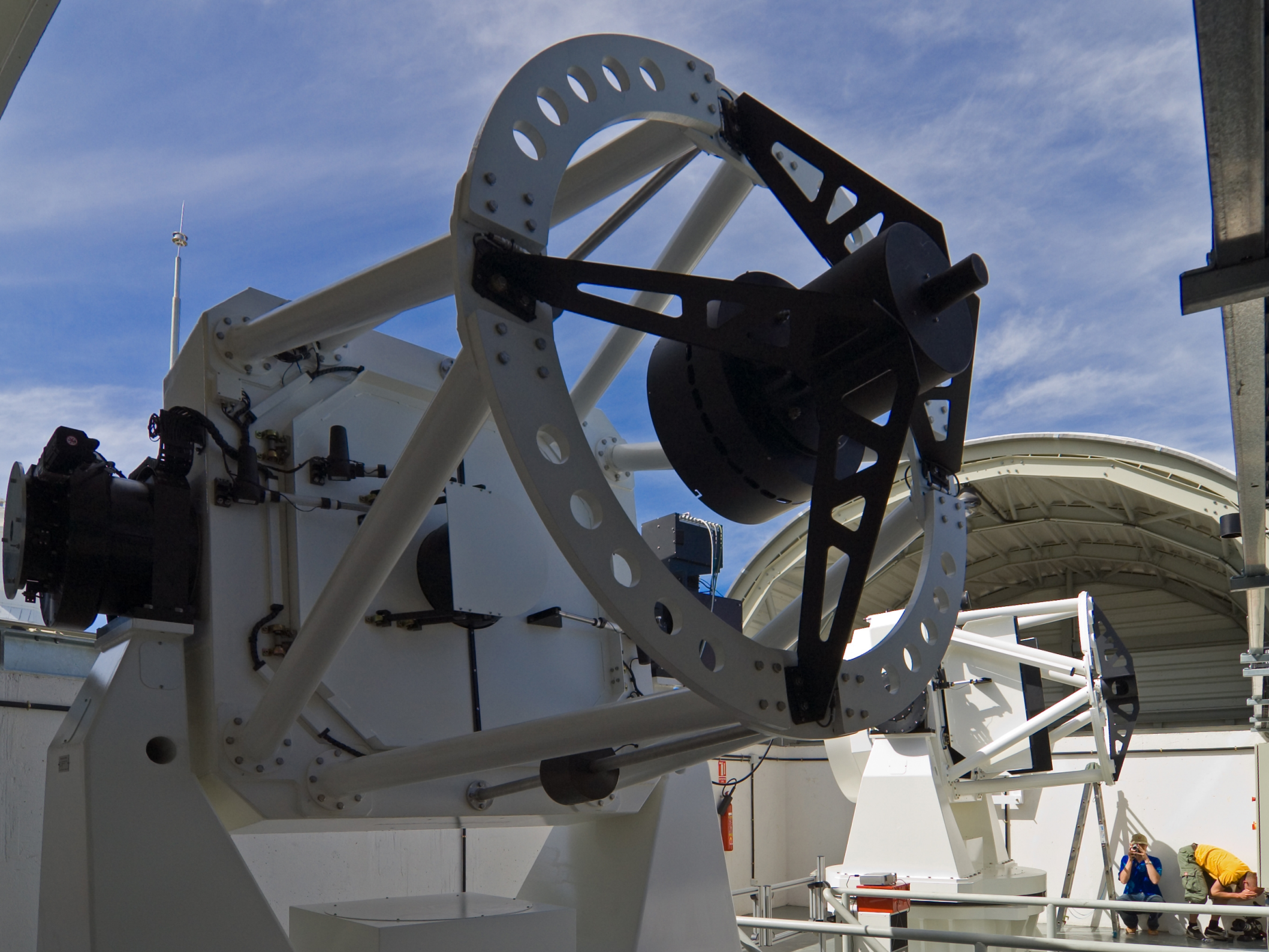


Twin 1.2m telescope located on Tenerife

WiFSIP – wide field imager

SES - Echelle spectrograph







In operation for 11 years

Fully robotic operations

STELLA - STELLAr Activity



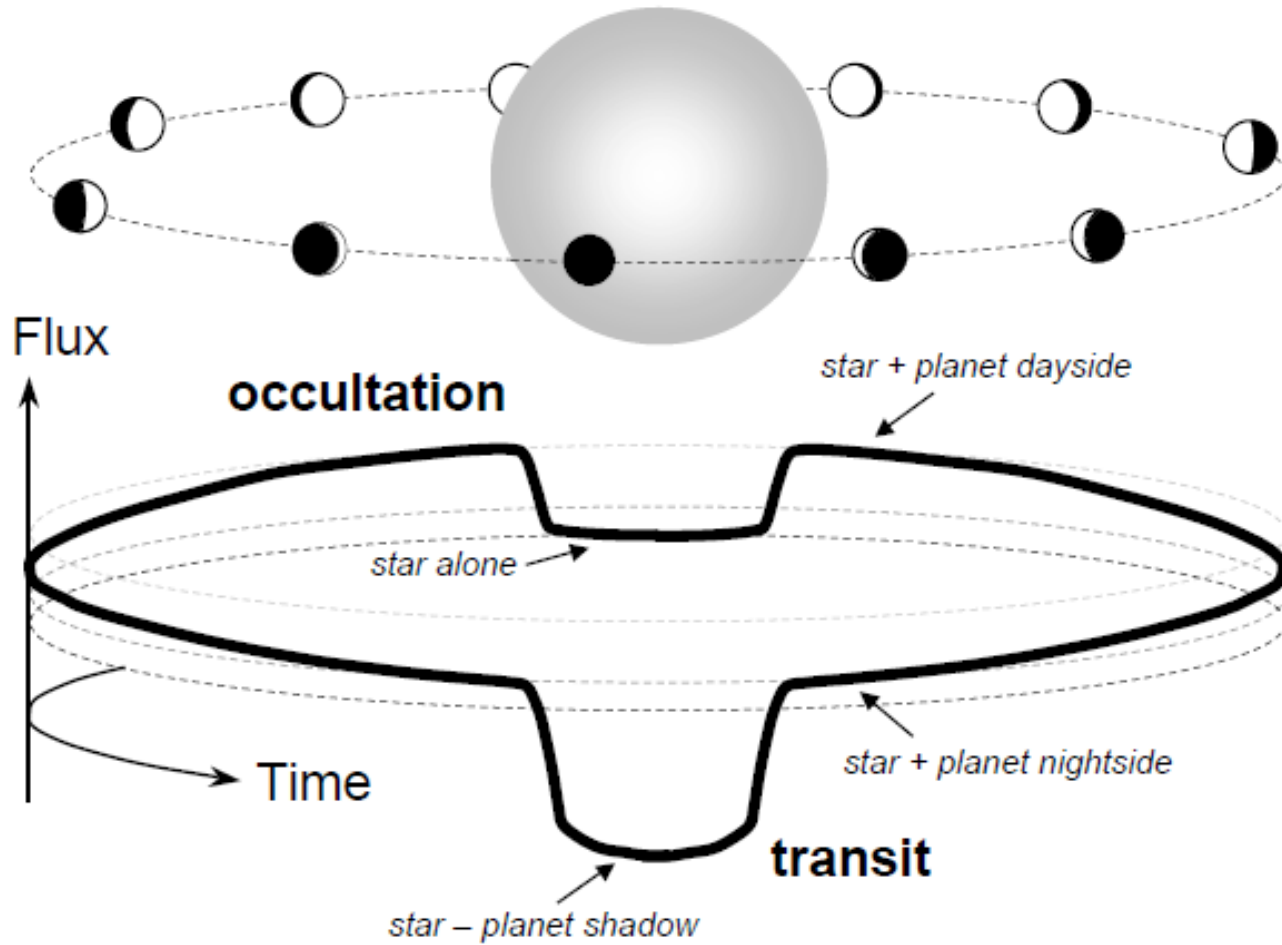


Pro – Am collaborations

- ephemeris refinement of 21 Hot Jupiters
- spin-orbit misalignment of the super-Earth GJ1214
- optical albedos of hot to ultra-hot Jupiters

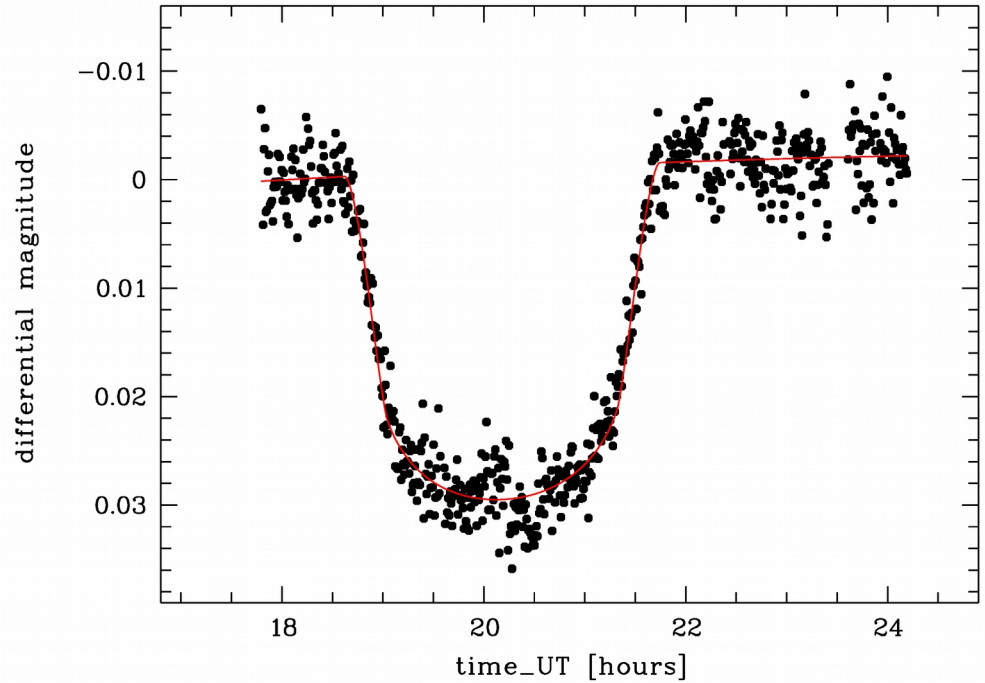
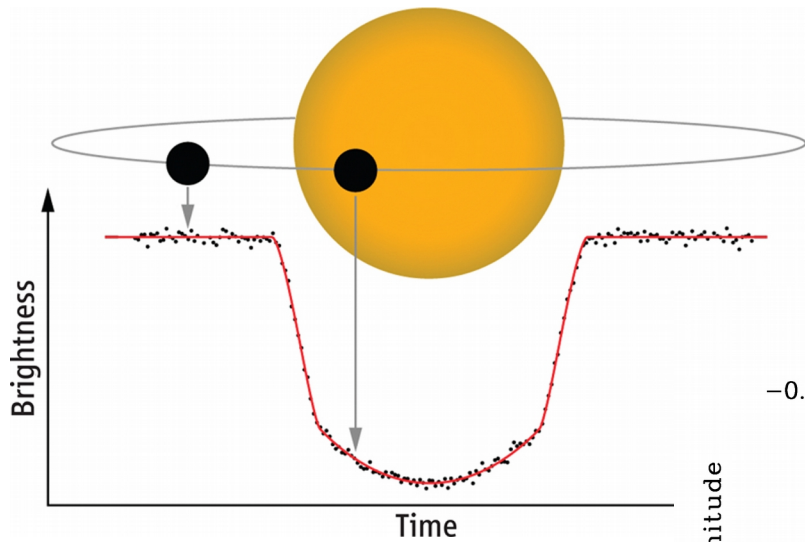
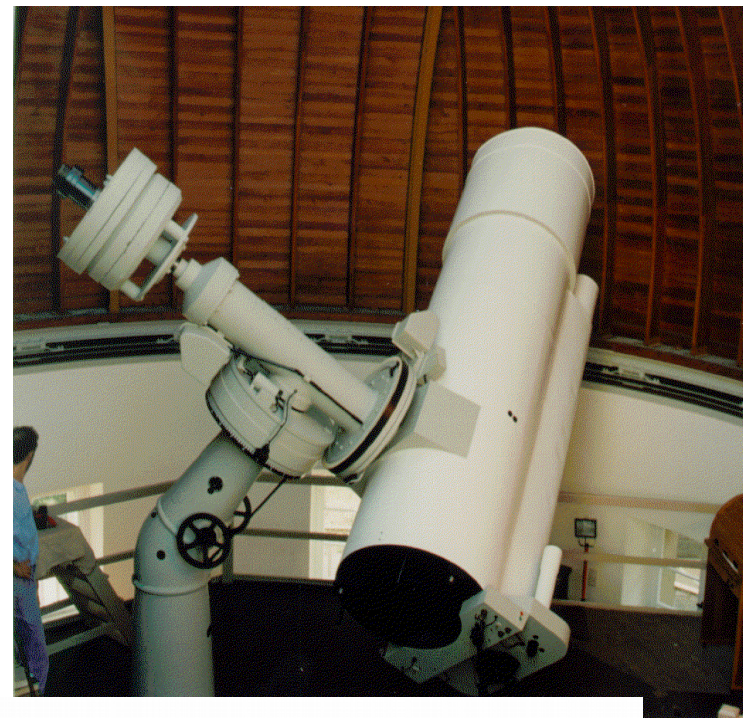


Transiting planetary systems

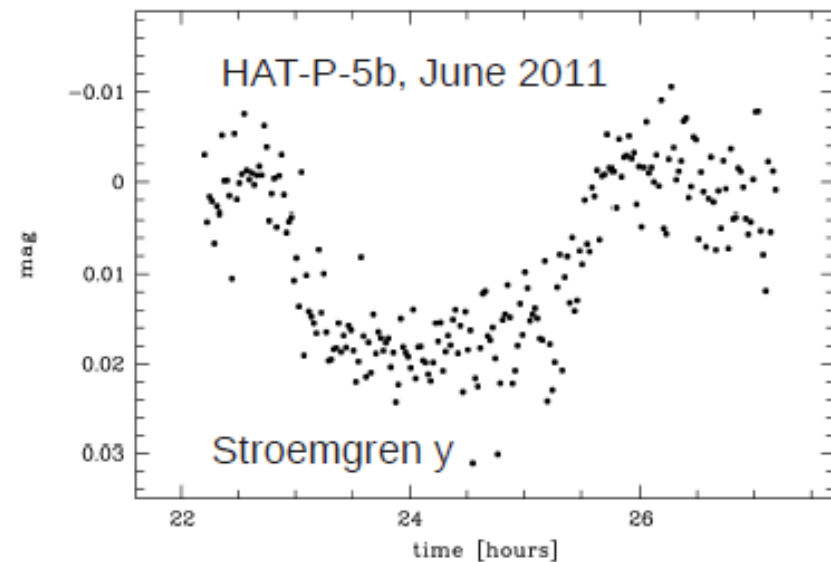
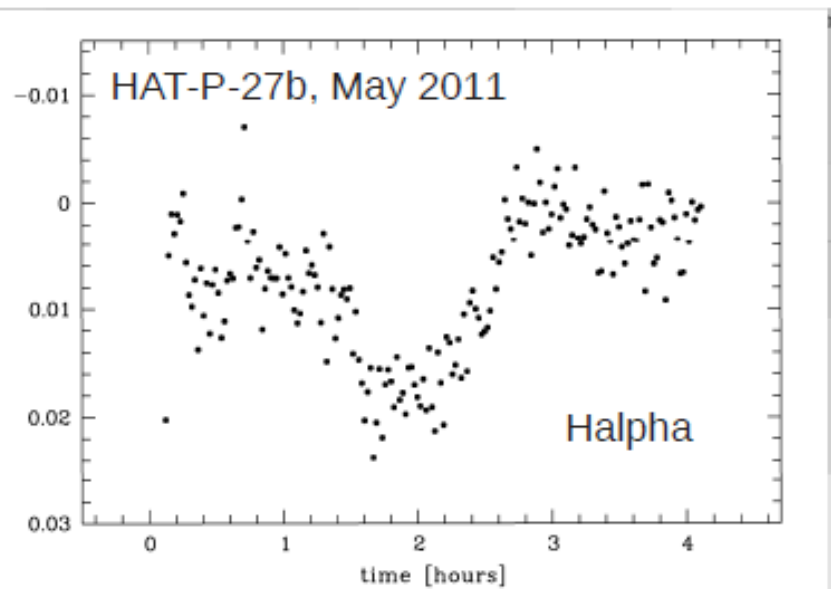
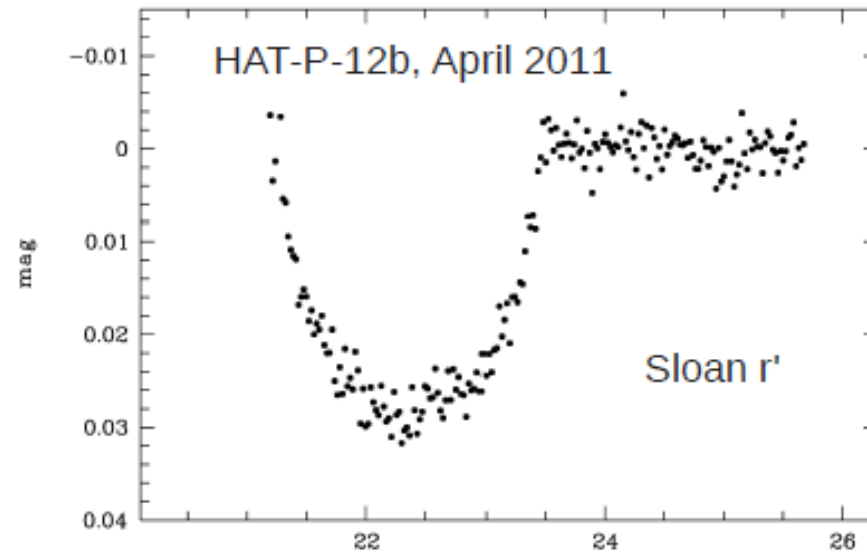


Winn 2010

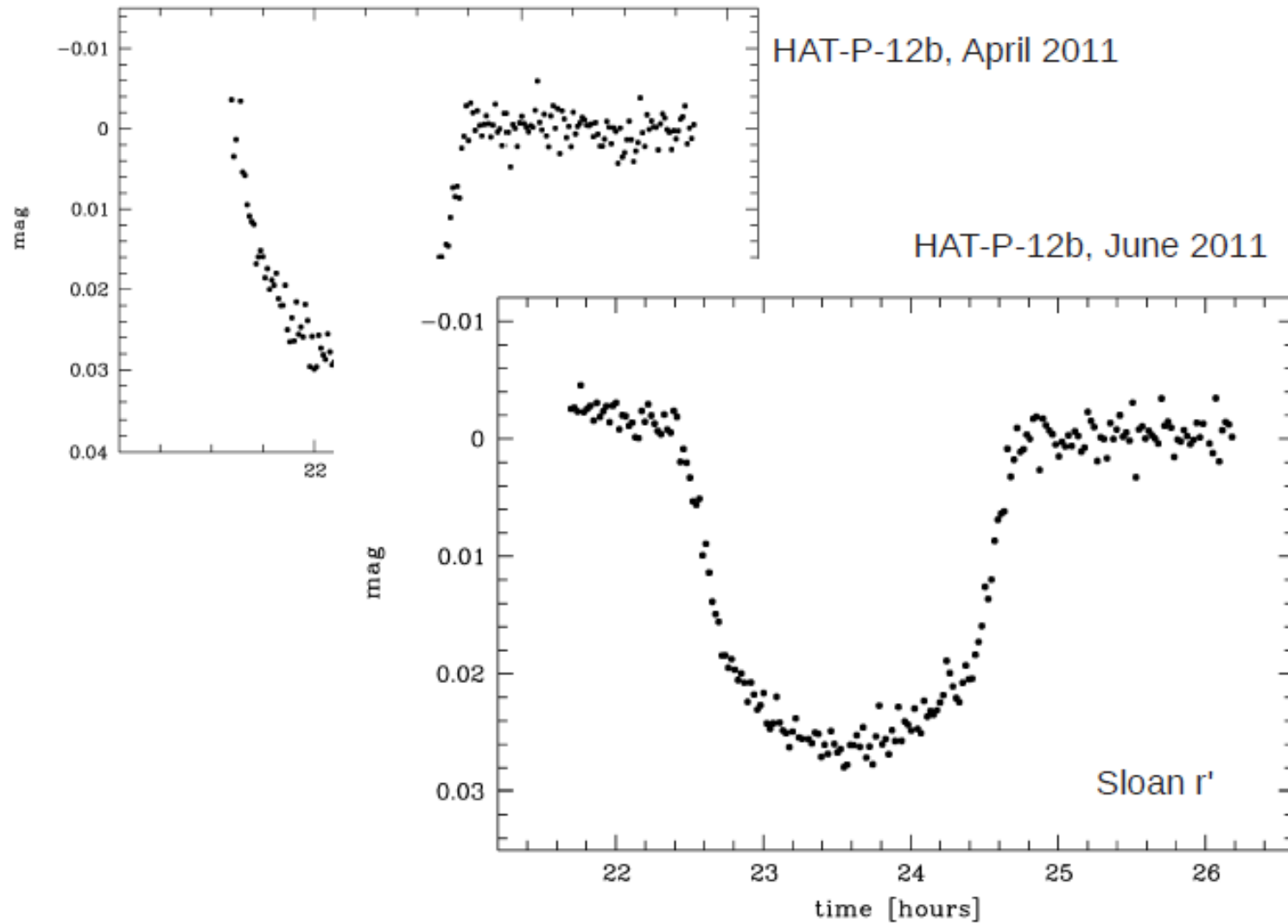
Observation of transit events



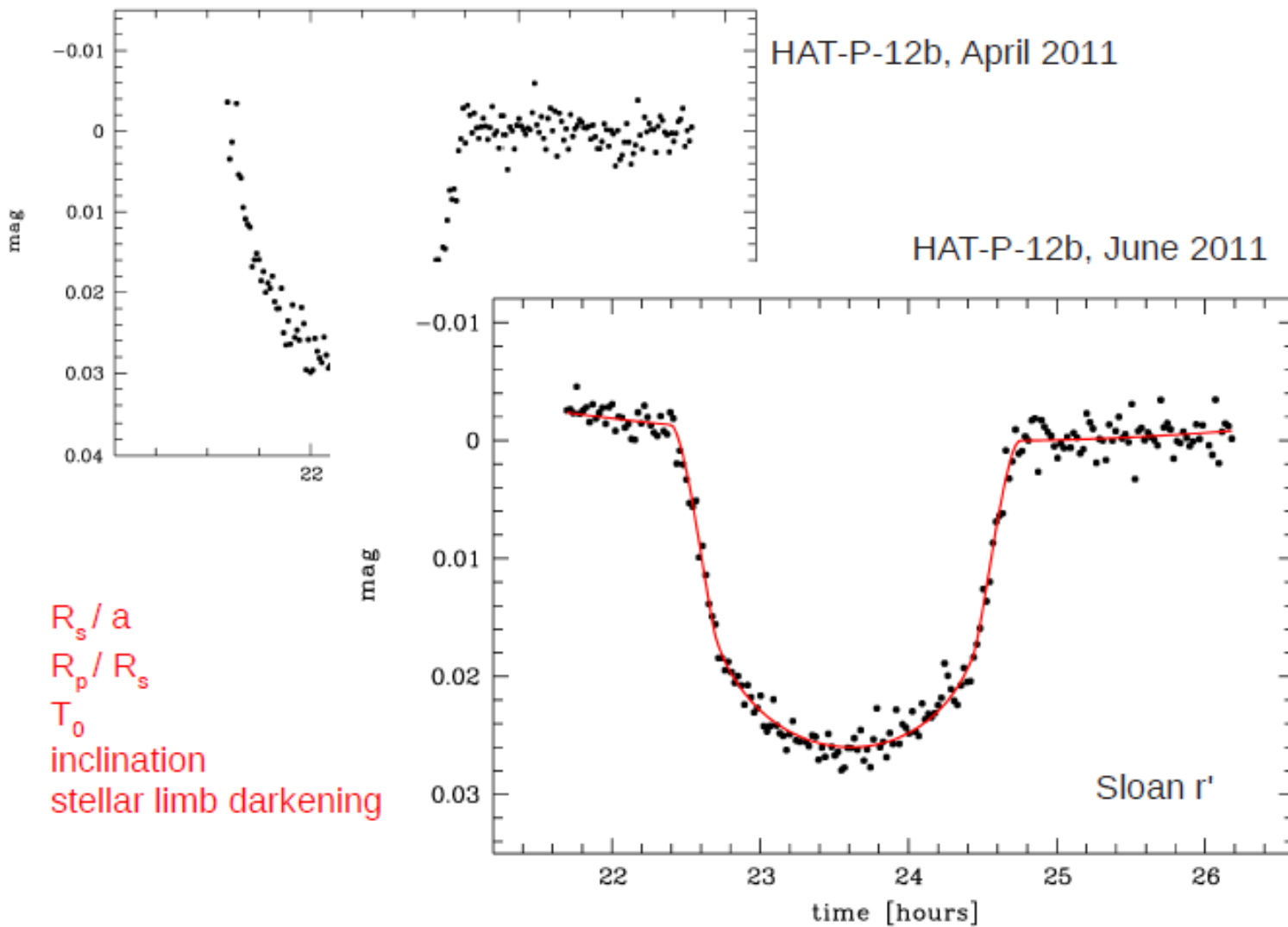
Getting experience with the imager of STELLA



Getting experience with the imager of STELLA



Getting experience with the imager of STELLA



Ephemeris refinement of 21 Hot Jupiters



$$T_c = T_0 + n \cdot P$$



Ephemeris refinement of 21 Hot Jupiters



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$$\Delta T = \sqrt{\Delta T_0^2 + (n \cdot \Delta P)^2}$$



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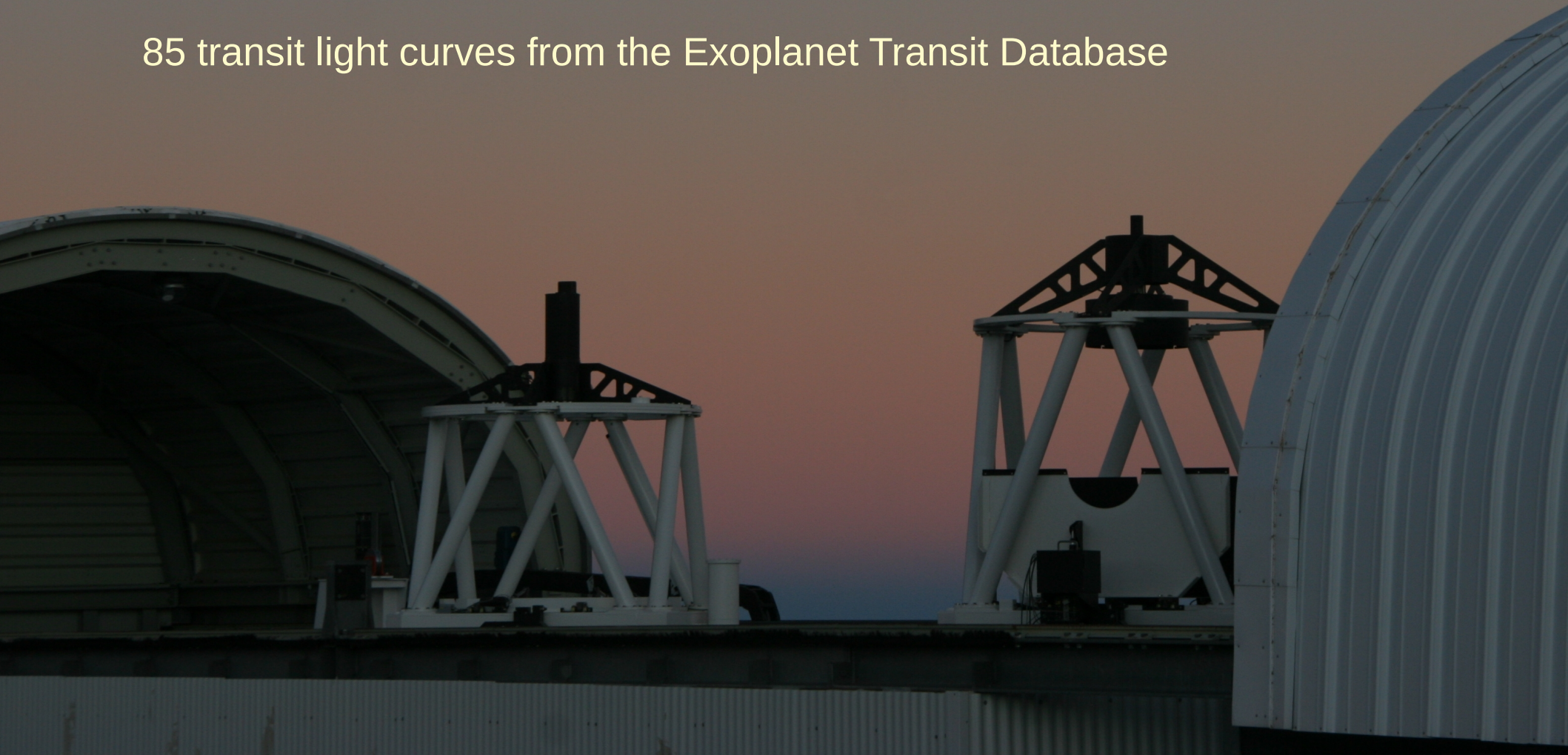
Seq	Planet	ΔT_c (min)	Reference
1	WASP-73b	171.7	Delrez et al. (2014)
2	WASP-117b	143.1	Lendl et al. (2014)
3	HAT-P-31b	106.1	Kipping et al. (2011)
4	KELT-8b	103.8	Fulton et al. (2015)
5	HAT-P-46b	40.9	Hartman et al. (2014)
6	HAT-P-29b	38.8	Buchhave et al. (2011)
7	HAT-P-45b	25.2	Hartman et al. (2014)
8	KELT-10b	24.3	Kuhn et al. (2016)
9	HAT-P-42b	23.7	Boisse et al. (2013)
10	HAT-P-35b	22.9	Bakos et al. (2012)
11	WASP-99b	21.3	Hellier et al. (2014)
12	HAT-P-44b	16.8	Hartman et al. (2014)
13	HAT-P-43b	15.2	Boisse et al. (2013)
14	KELT-15b	14.1	Rodriguez et al. (2016)
15	WASP-37b	13.3	Simpson et al. (2011)
16	HAT-P-15b	13.2	Kovács et al. (2010)
17	HAT-P-34b	12.3	Bakos et al. (2012)
18	HAT-P-52b	12.2	Hartman et al. (2015)
19	KELT-3b	12.1	Pepper et al. (2013)
20	WASP-86/KELT-12b	11.6	Faedi et al. (2016)
21	WASP-58b	11.1	Hébrard et al. (2013)

Ephemeris refinement of 21 Hot Jupiters



35 transit light curves of professional observatories 0.8m – 2.15m

85 transit light curves from the Exoplanet Transit Database



Ephemeris refinement of 21 Hot Jupiters



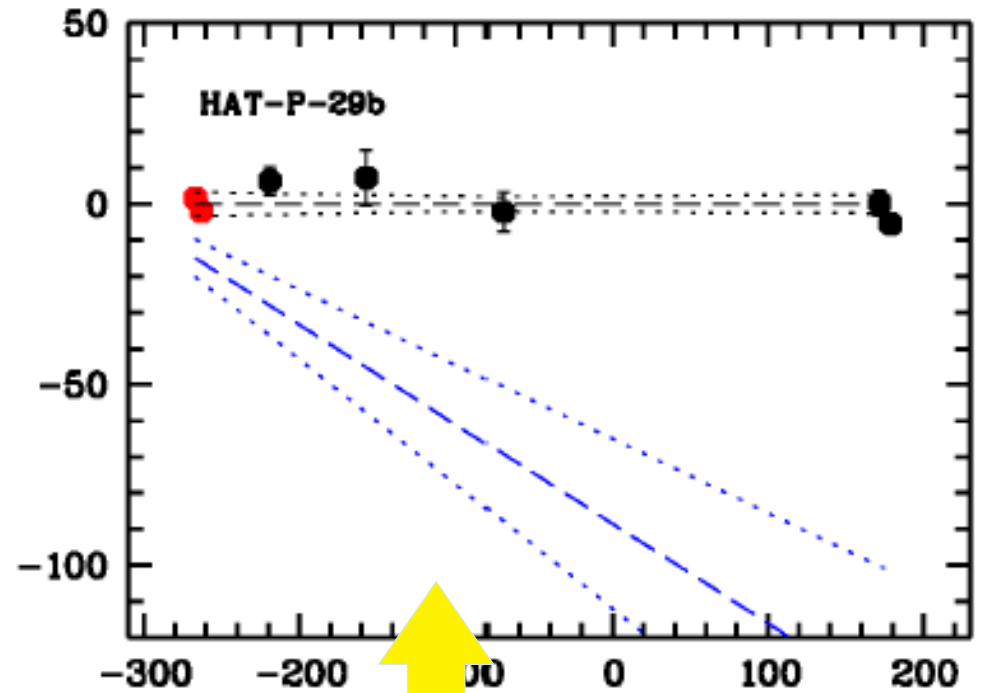
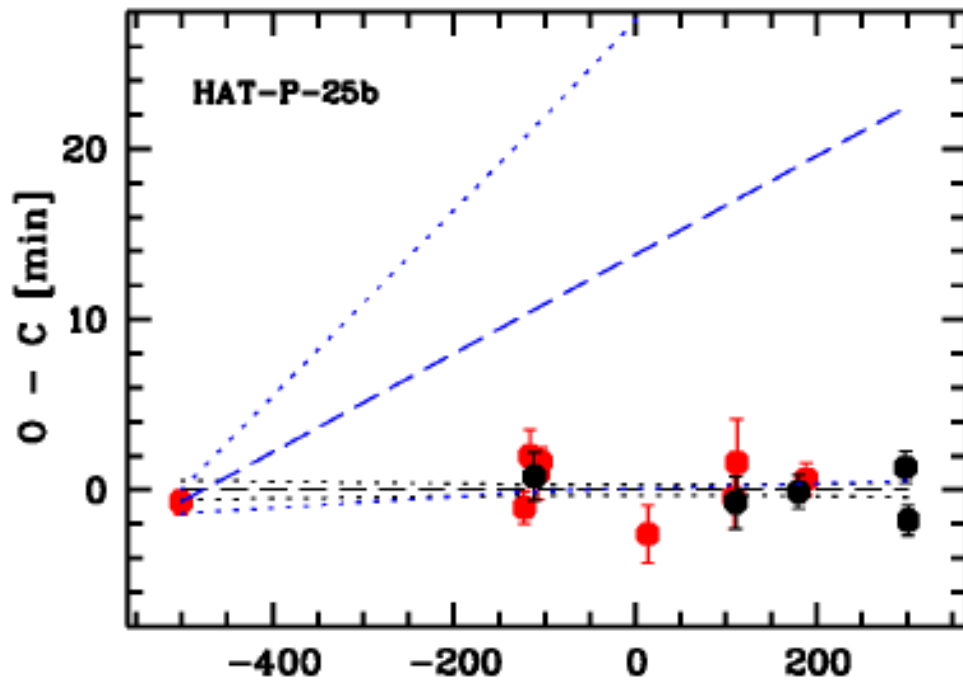
35 transit light curves of professional observatories 0.8m – 2.15m

85 transit light curves from the Exoplanet Transit Database



for all targets,
the period precision was increased by **an order of magnitude**
the final timing uncertainty was **lower than 6 minutes**

Ephemeris refinement of 21 Hot Jupiters

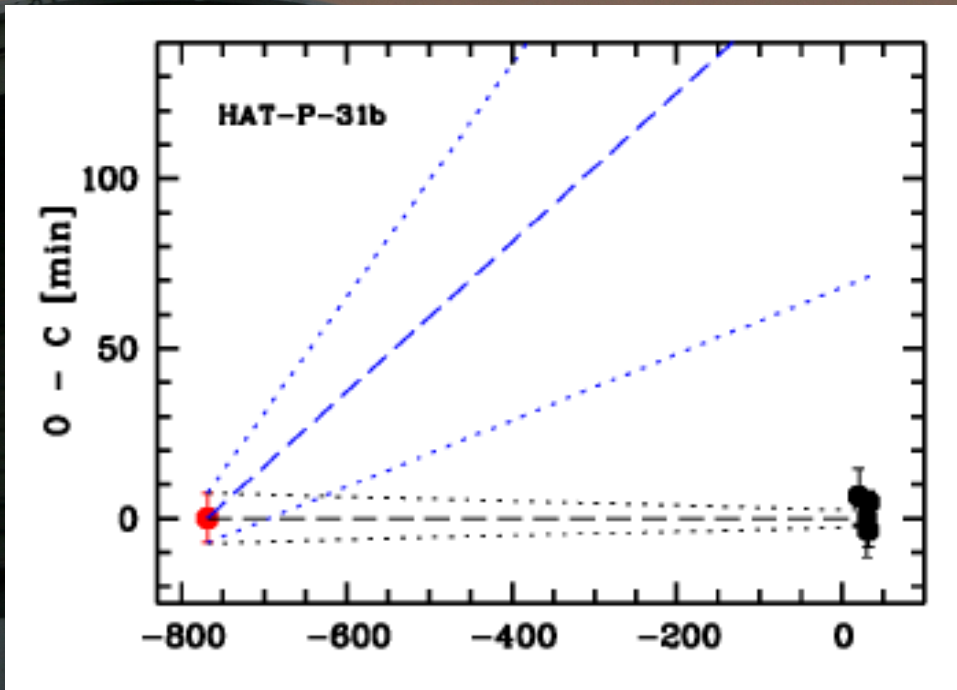
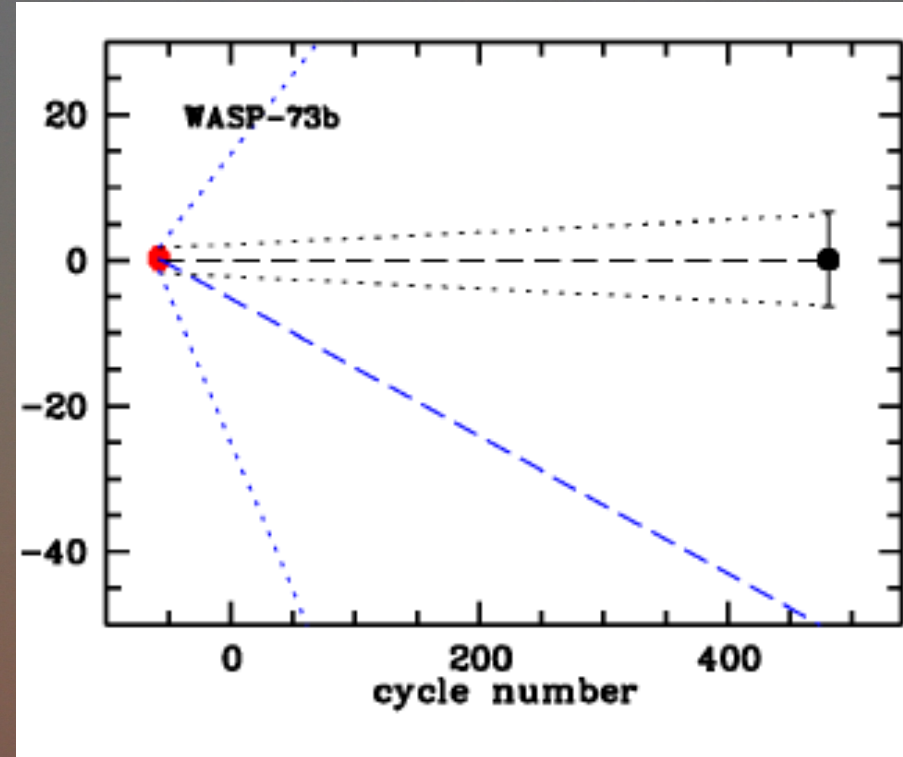
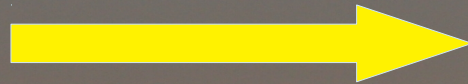


Timing deviation old vs. new ephemeris: **> 2 hours**

Ephemeris refinement of 21 Hot Jupiters

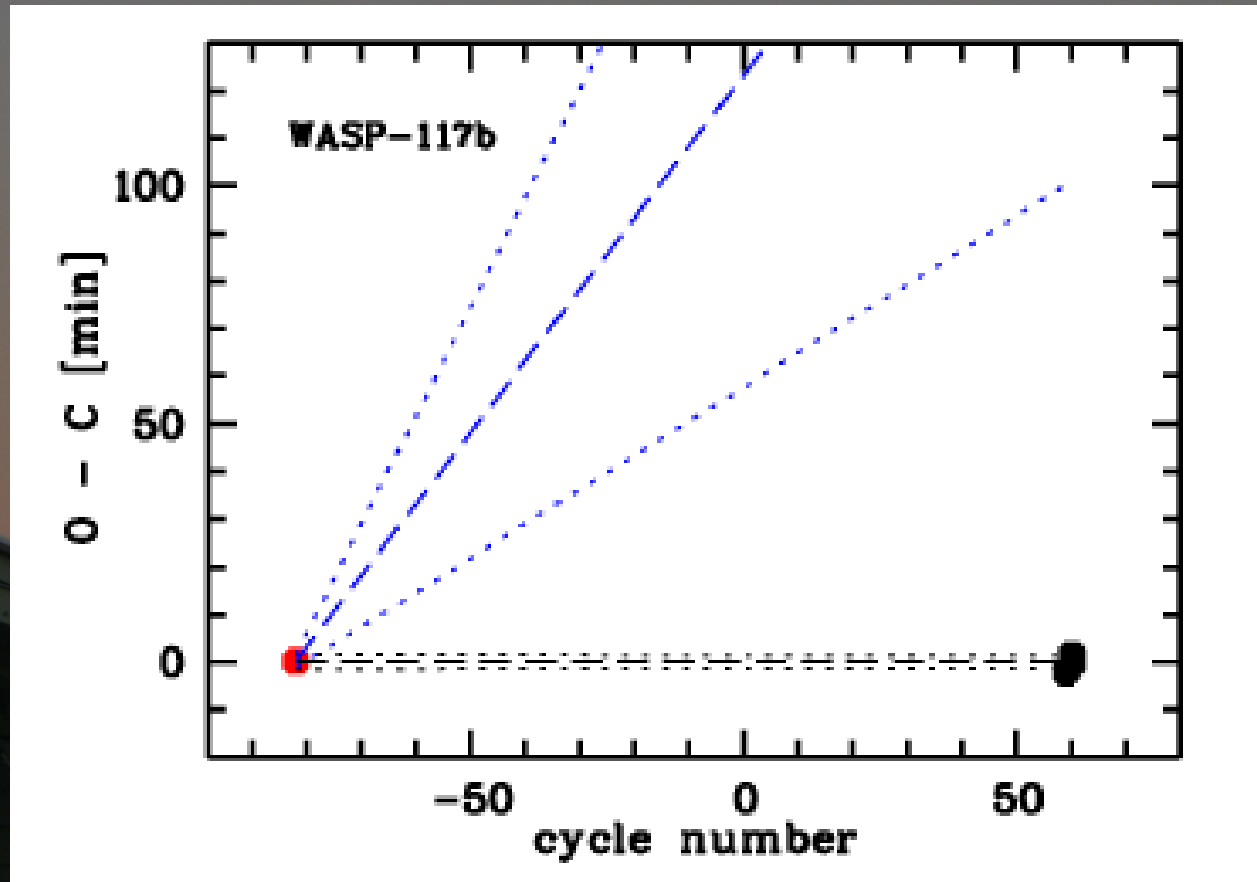


Timing uncertainty drop
from 173 min to 6 minutes

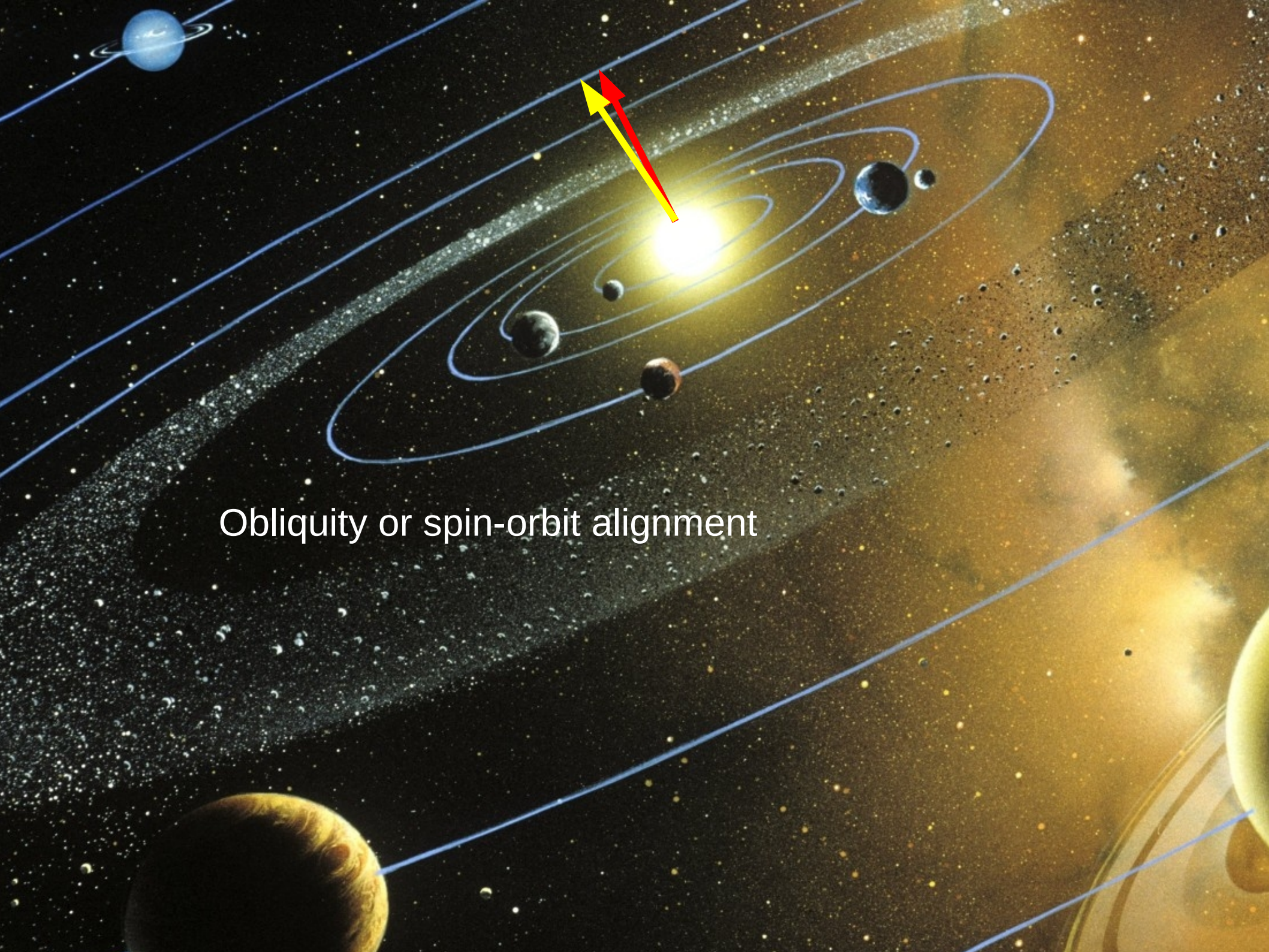


Timing deviation: > 2 hours

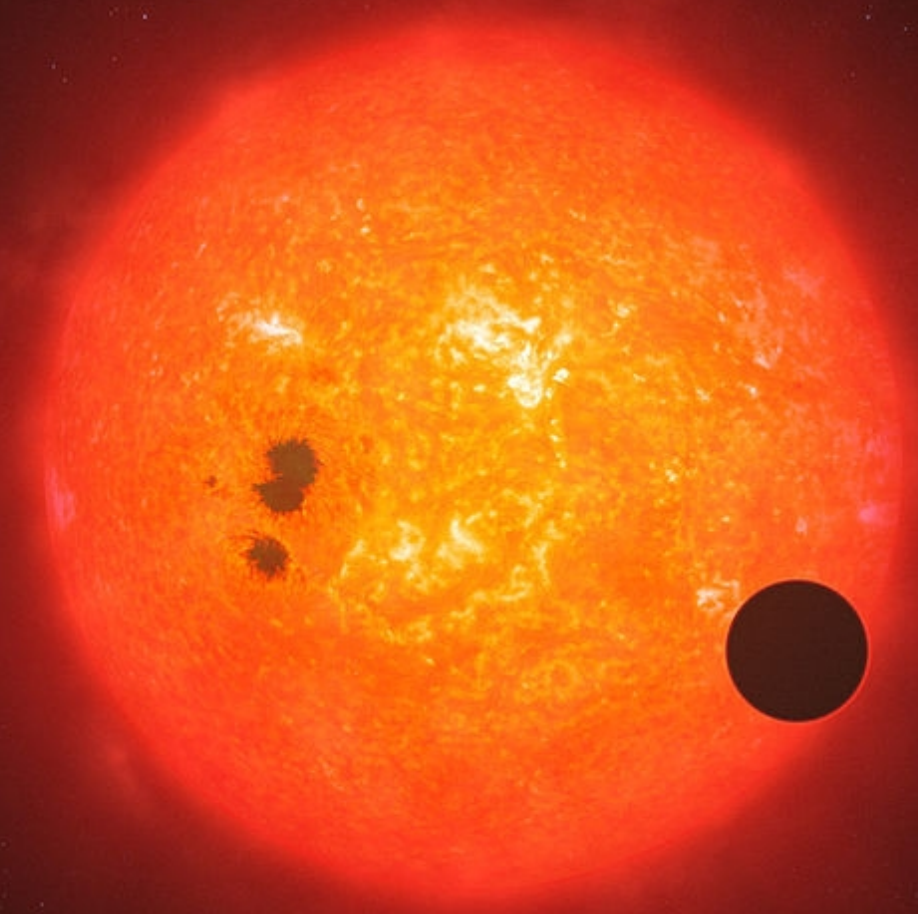
Ephemeris refinement of 21 Hot Jupiters



Timing deviation old vs. new ephemeris: **3.5 hours**

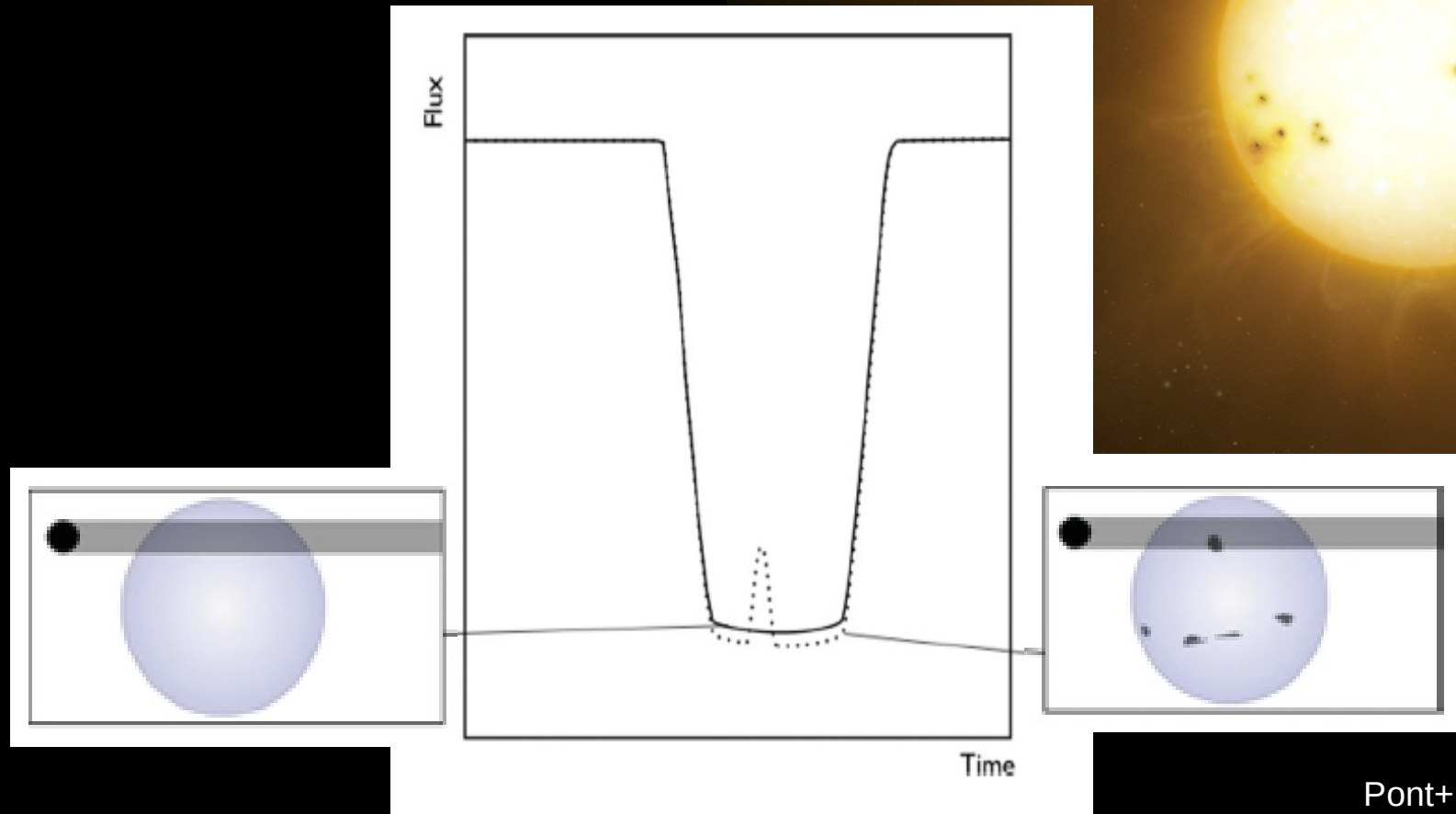


Obliquity or spin-orbit alignment



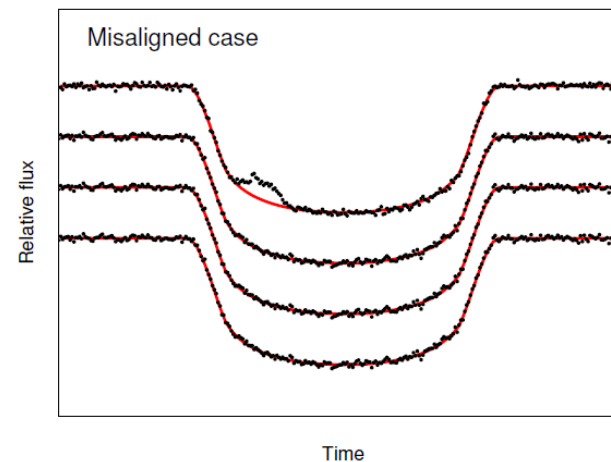
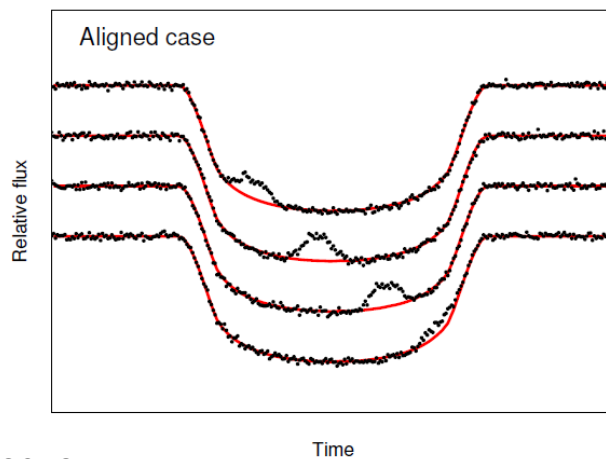
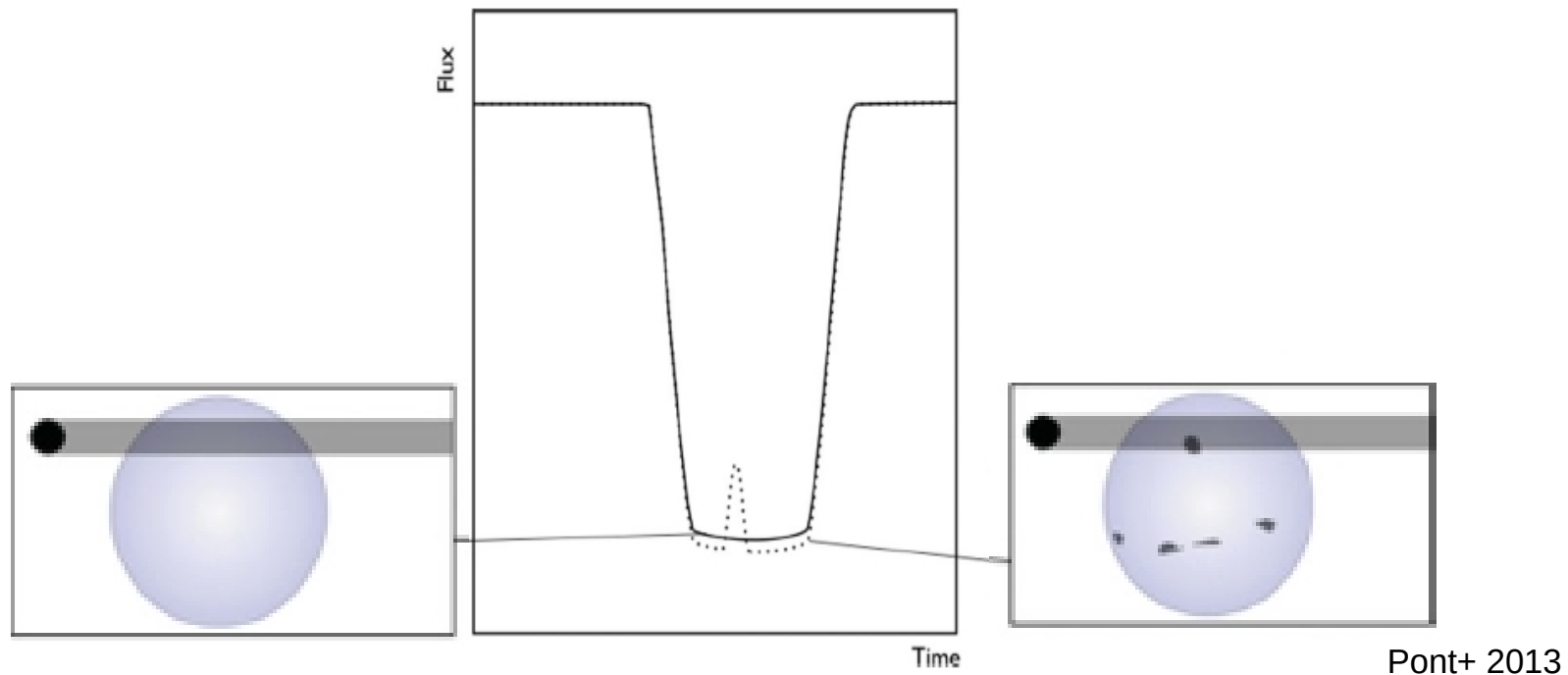
GJ1214b – a super Earth transiting an active M dwarf

Active stars and transiting planets



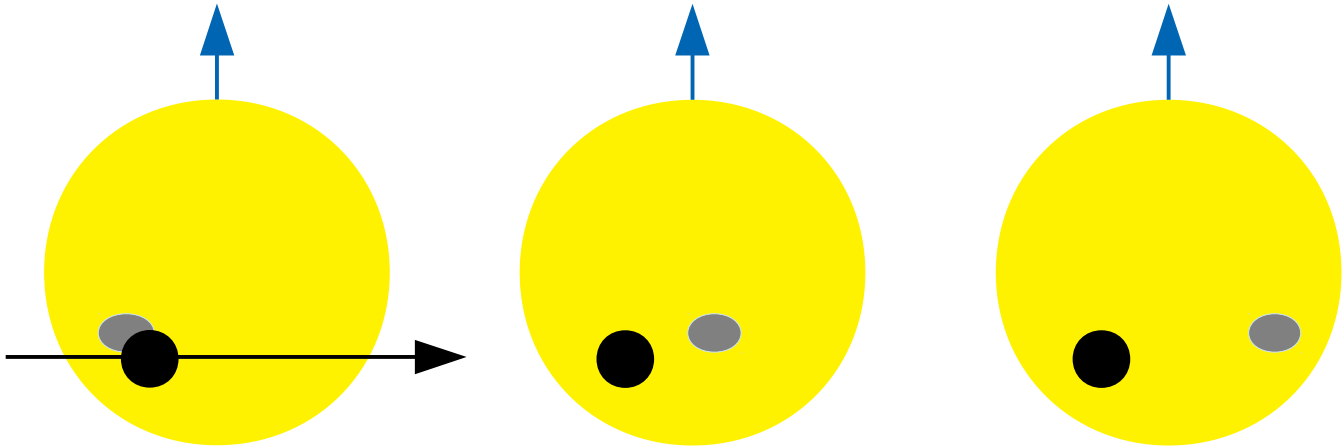
Pont+ 2013

The tracking of a starspot by the transiting planet

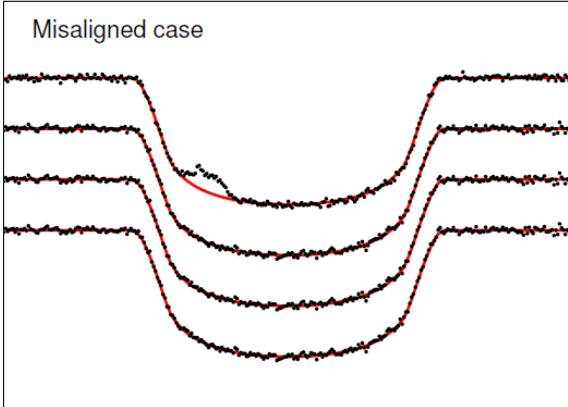
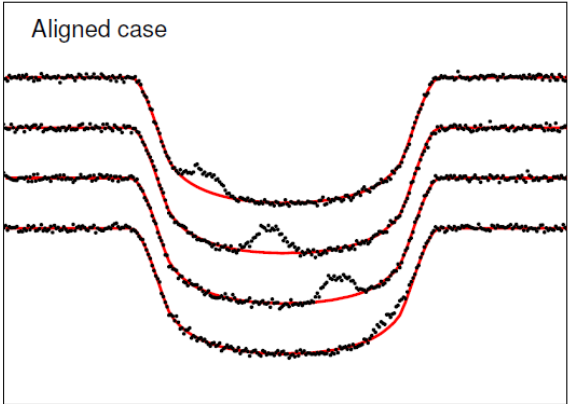
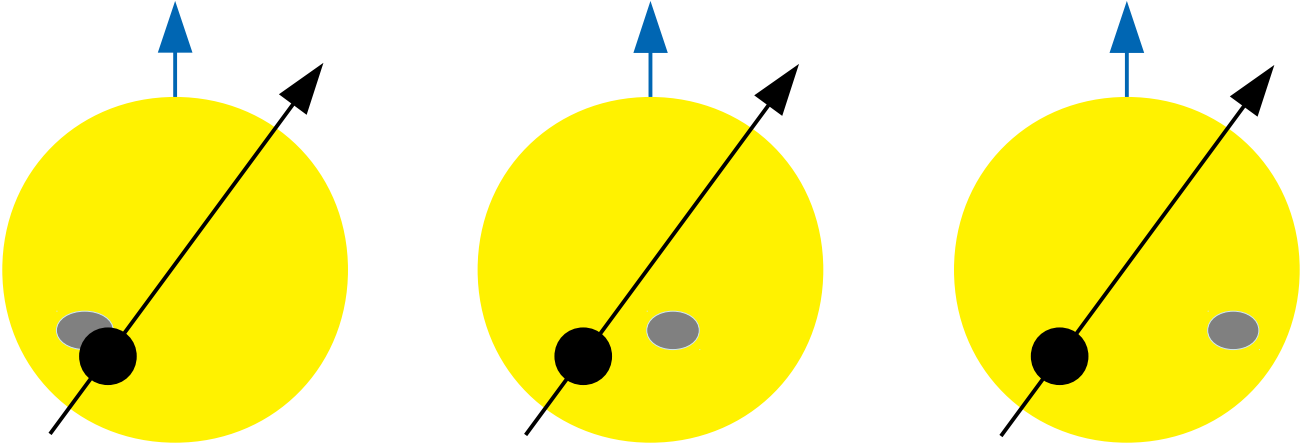


Sanchis-Ojeda+ 2013

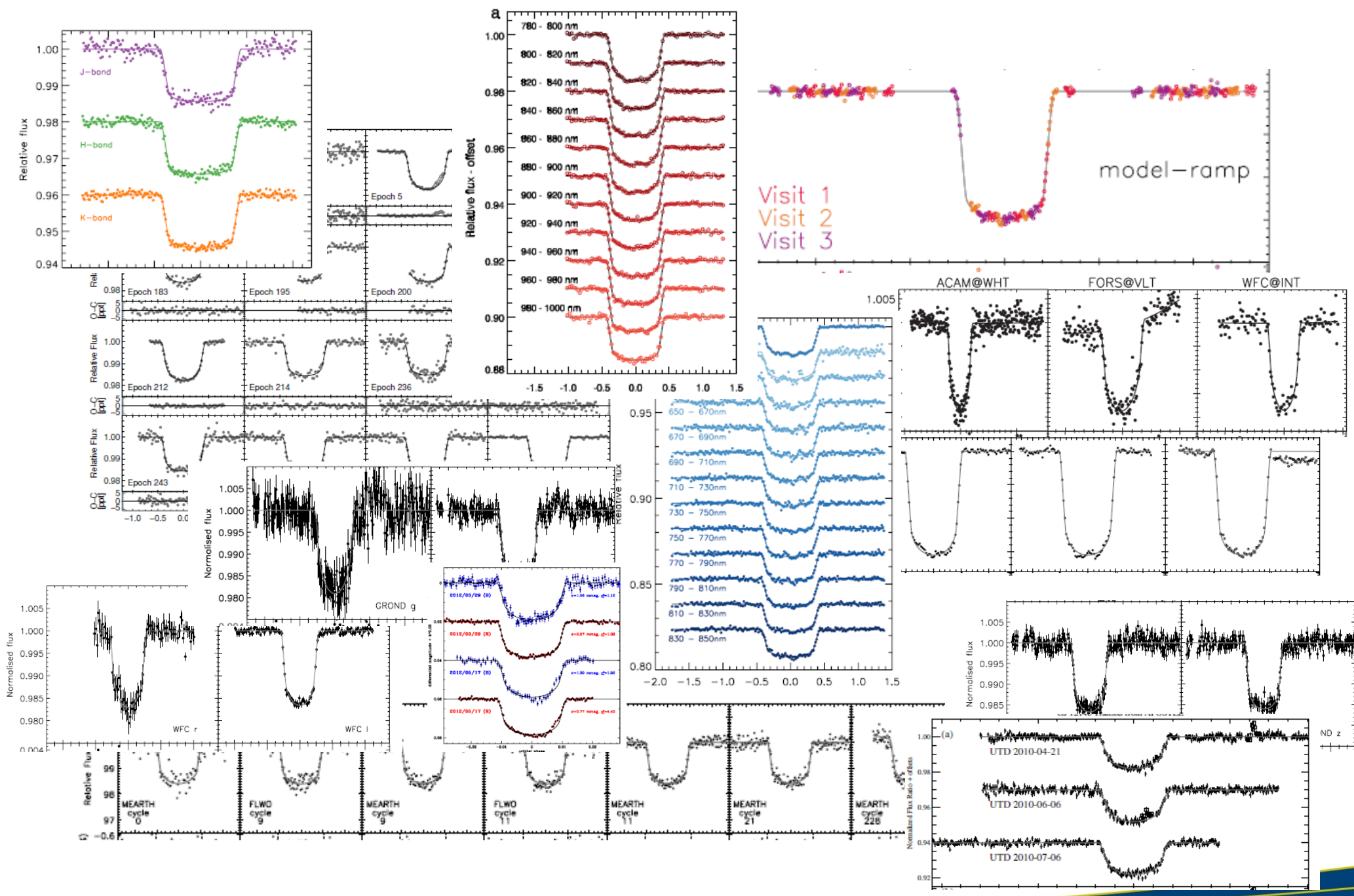
aligned



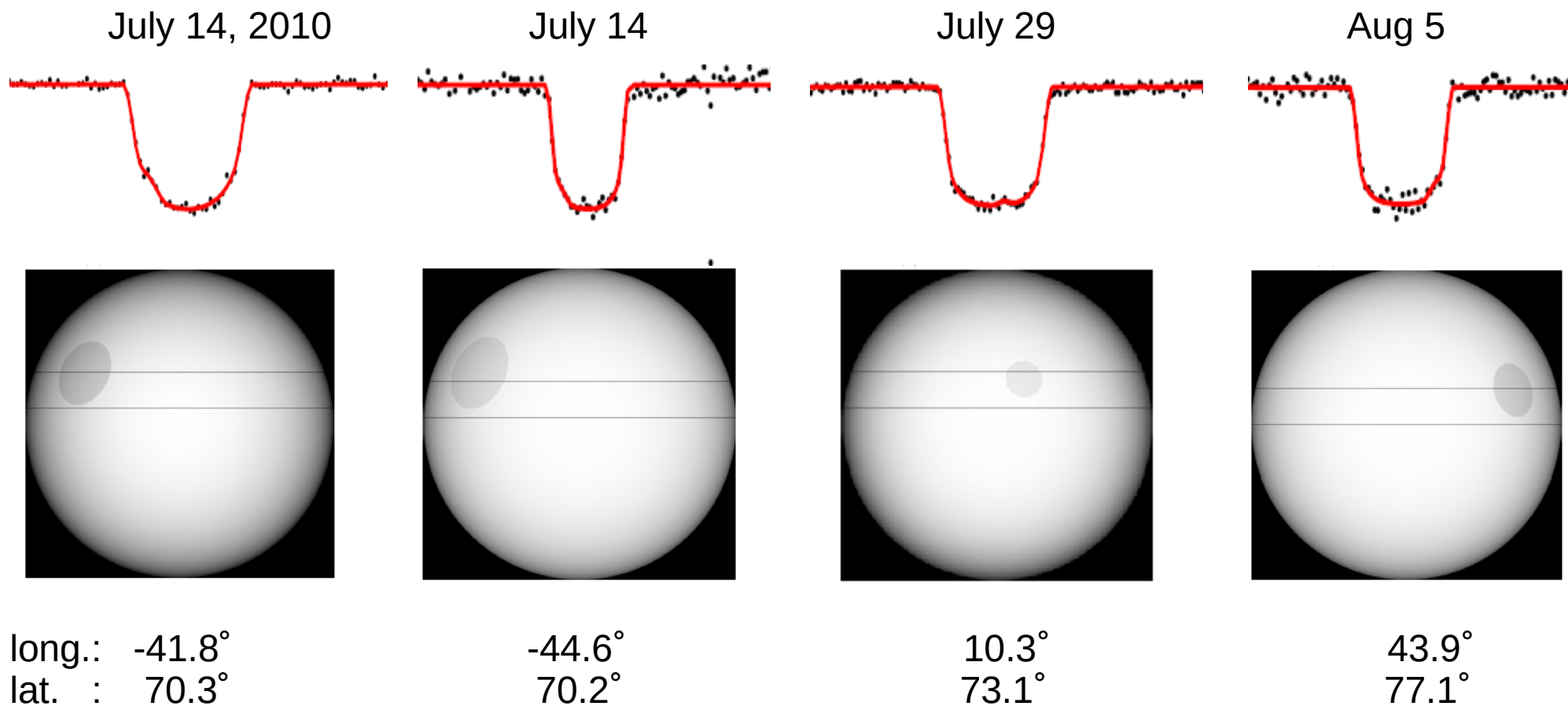
misaligned



Sanchis-Ojeda+ 2013

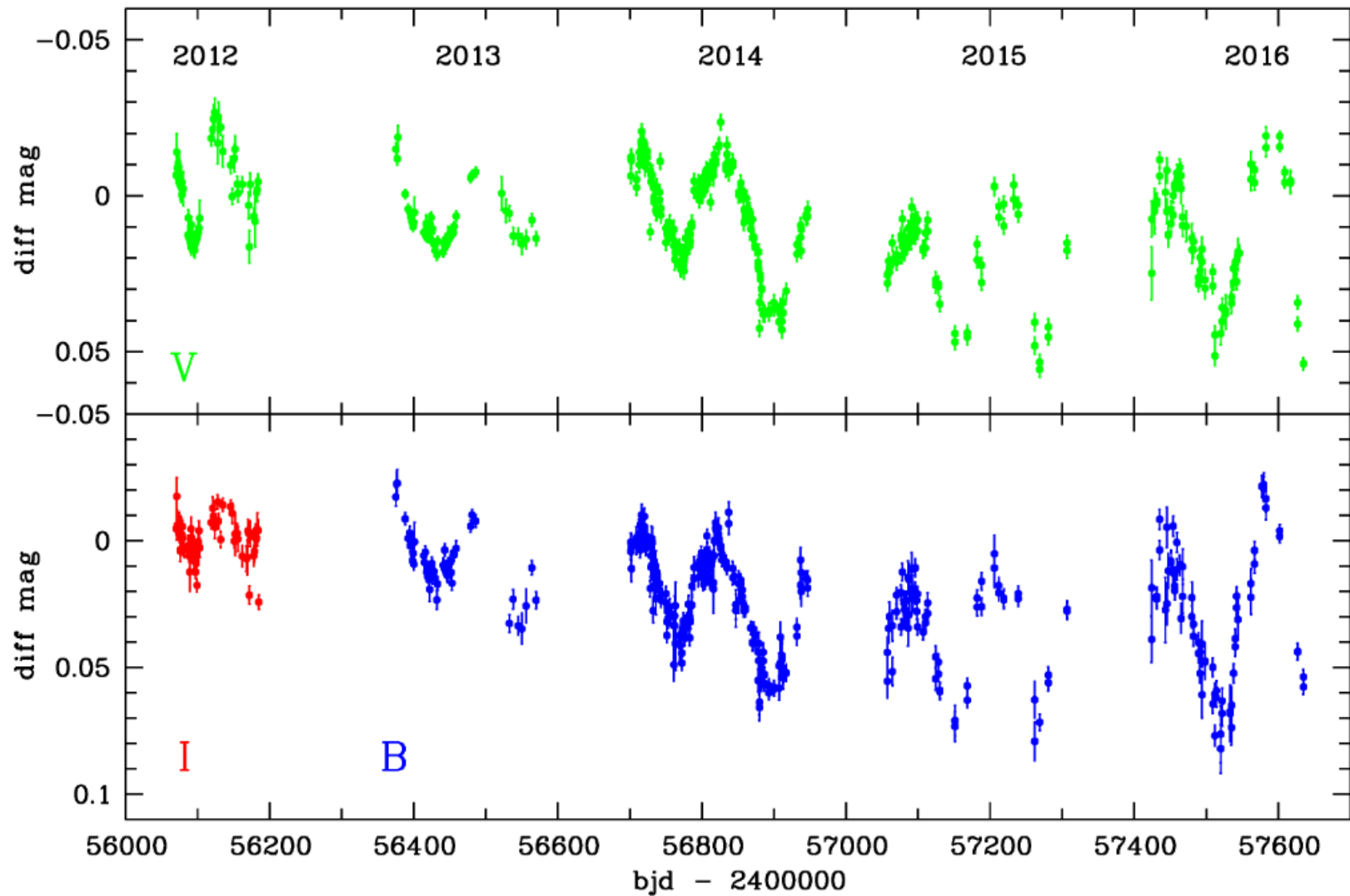


Starspot tracking of GJ 1214



→ $\lambda = 4^\circ \pm 9^\circ$

GJ1214 – M dwarf with 125 days rotation period

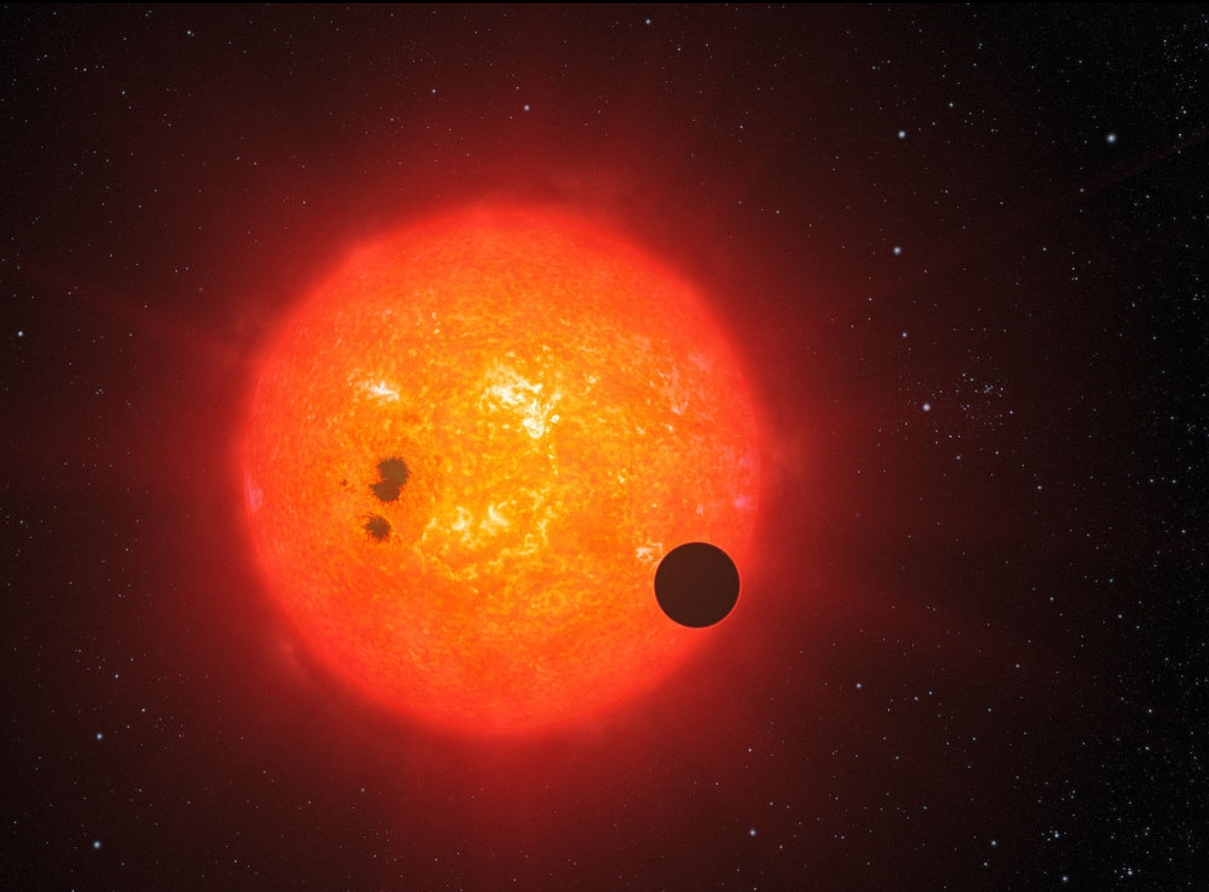


Mallonn et al. 2018

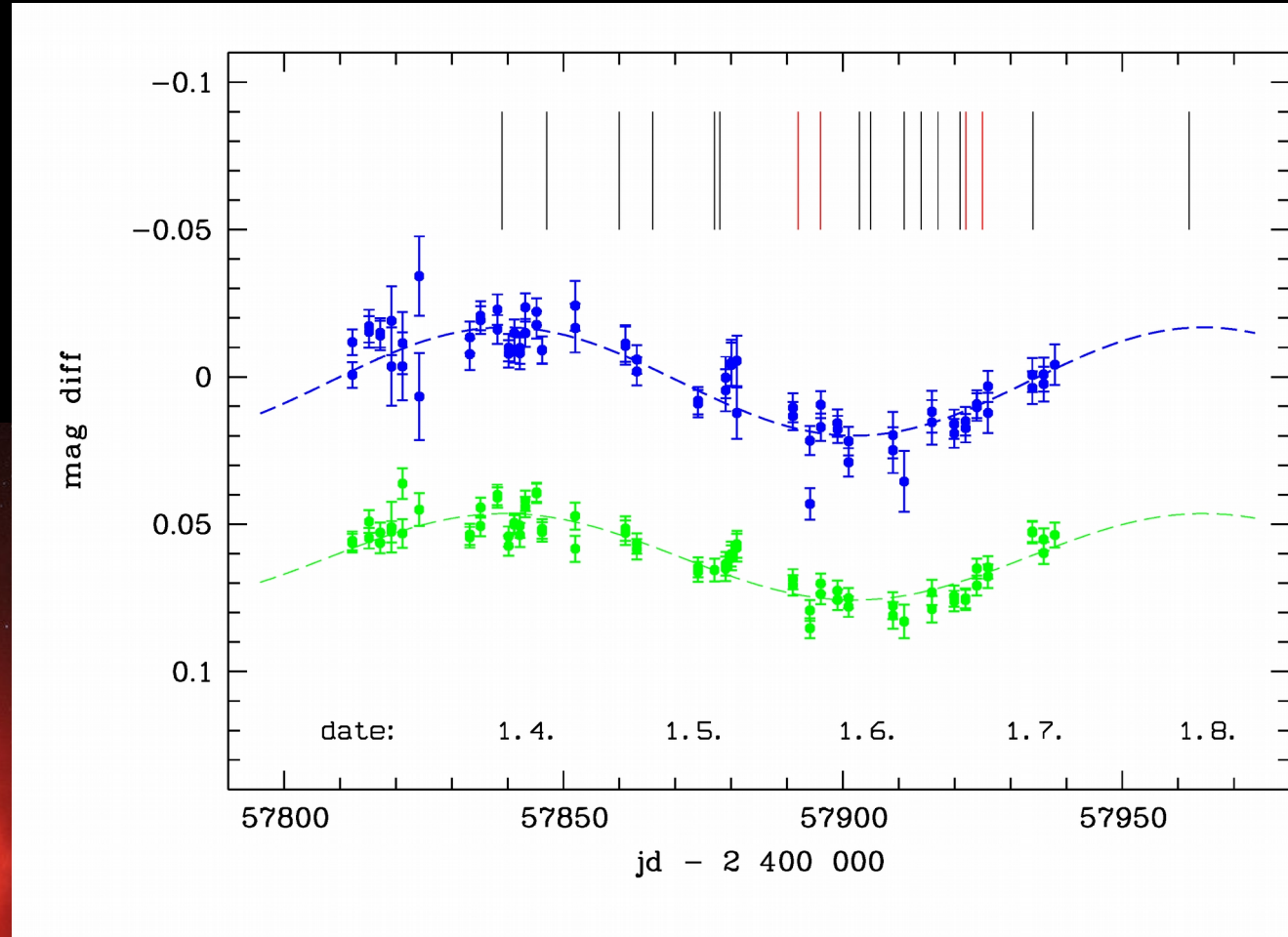
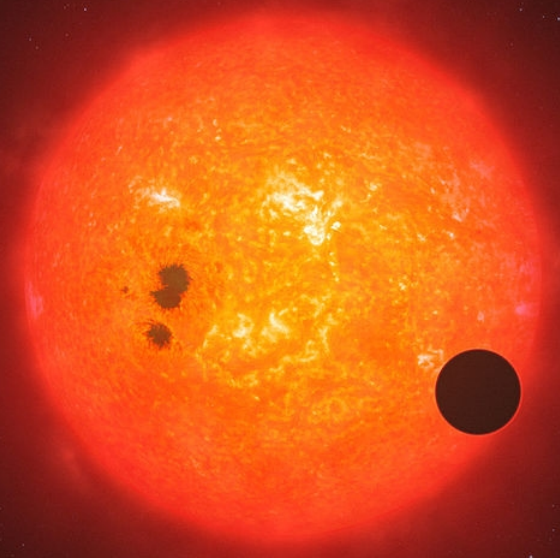
New observing campaign in 2017 April to June

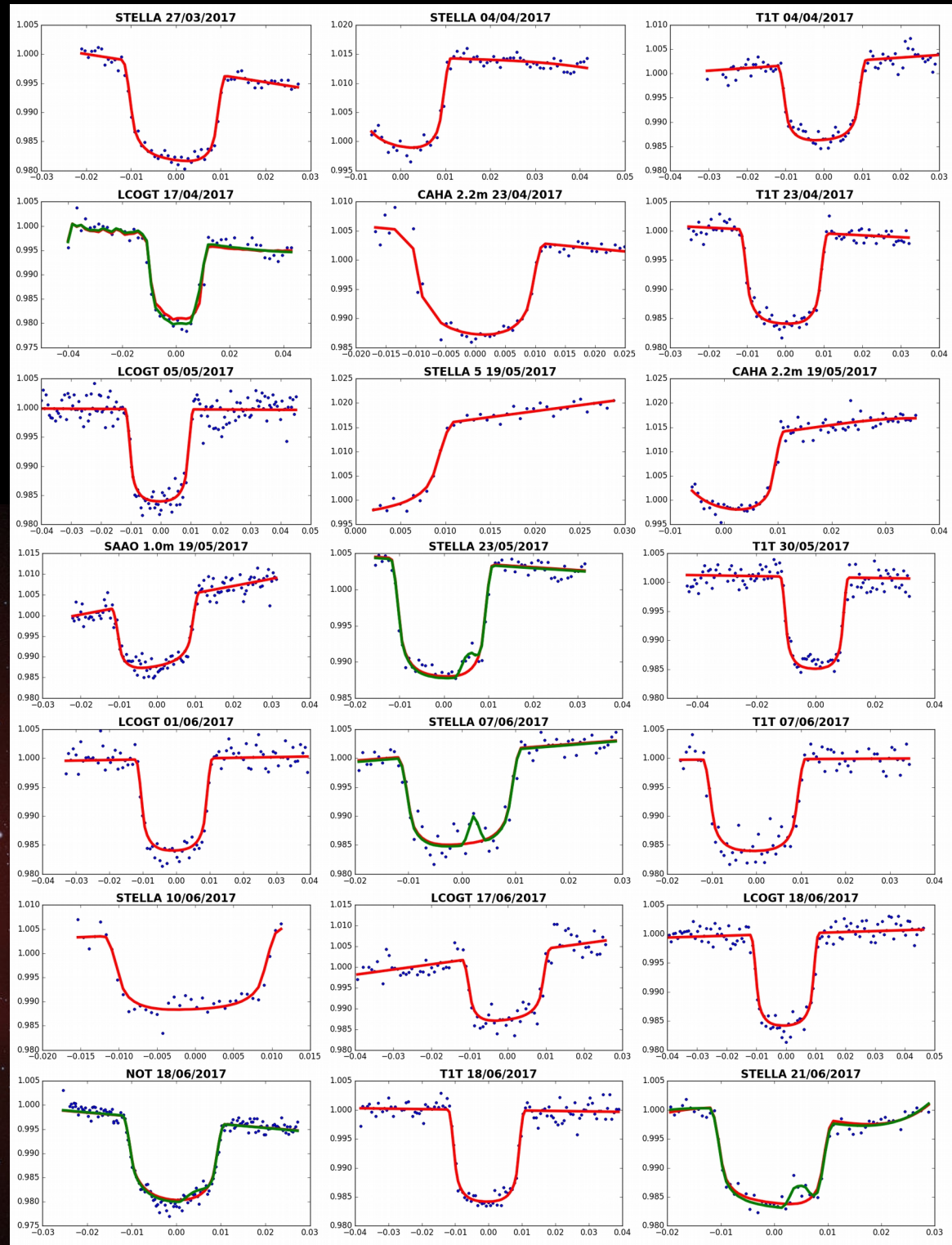
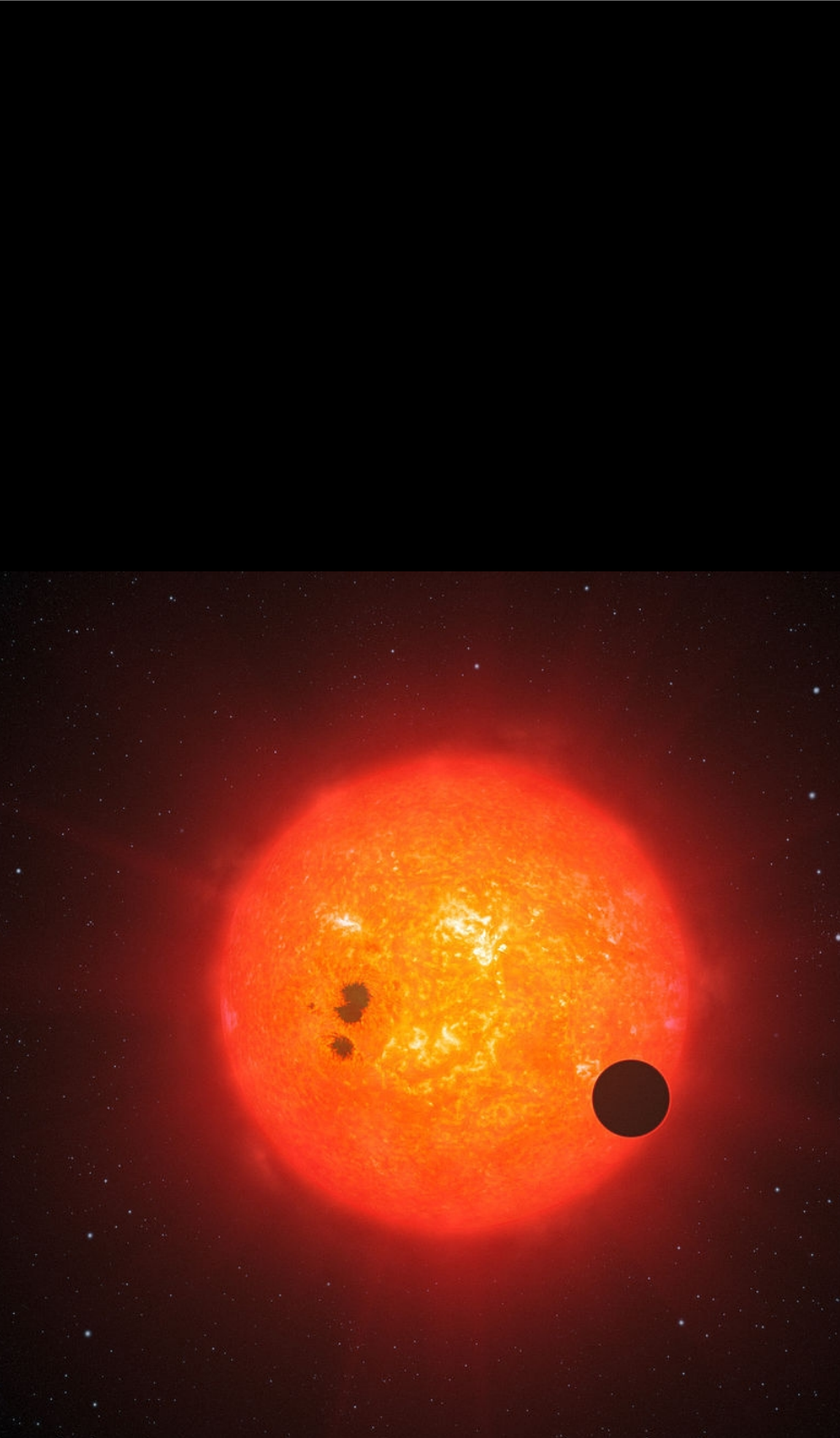
Observe as many transits as possible during an interval of three months

STELLA
Calar Alto
Nordic Optical Telescope
Las Cumbres Observatory
Trebur 1m Telescope

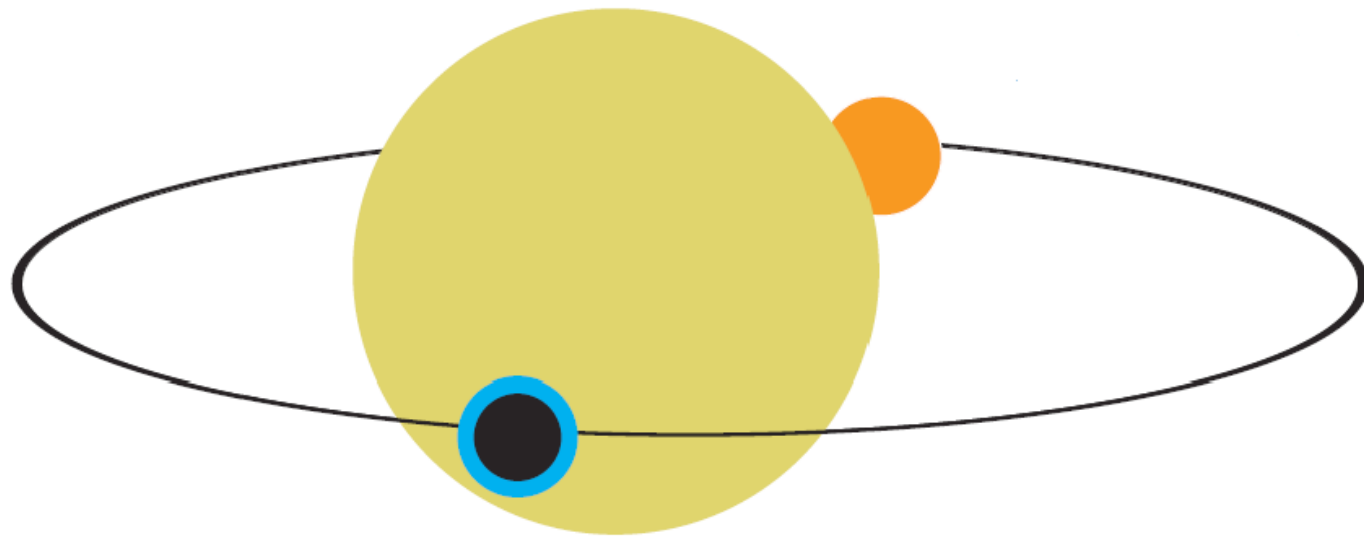


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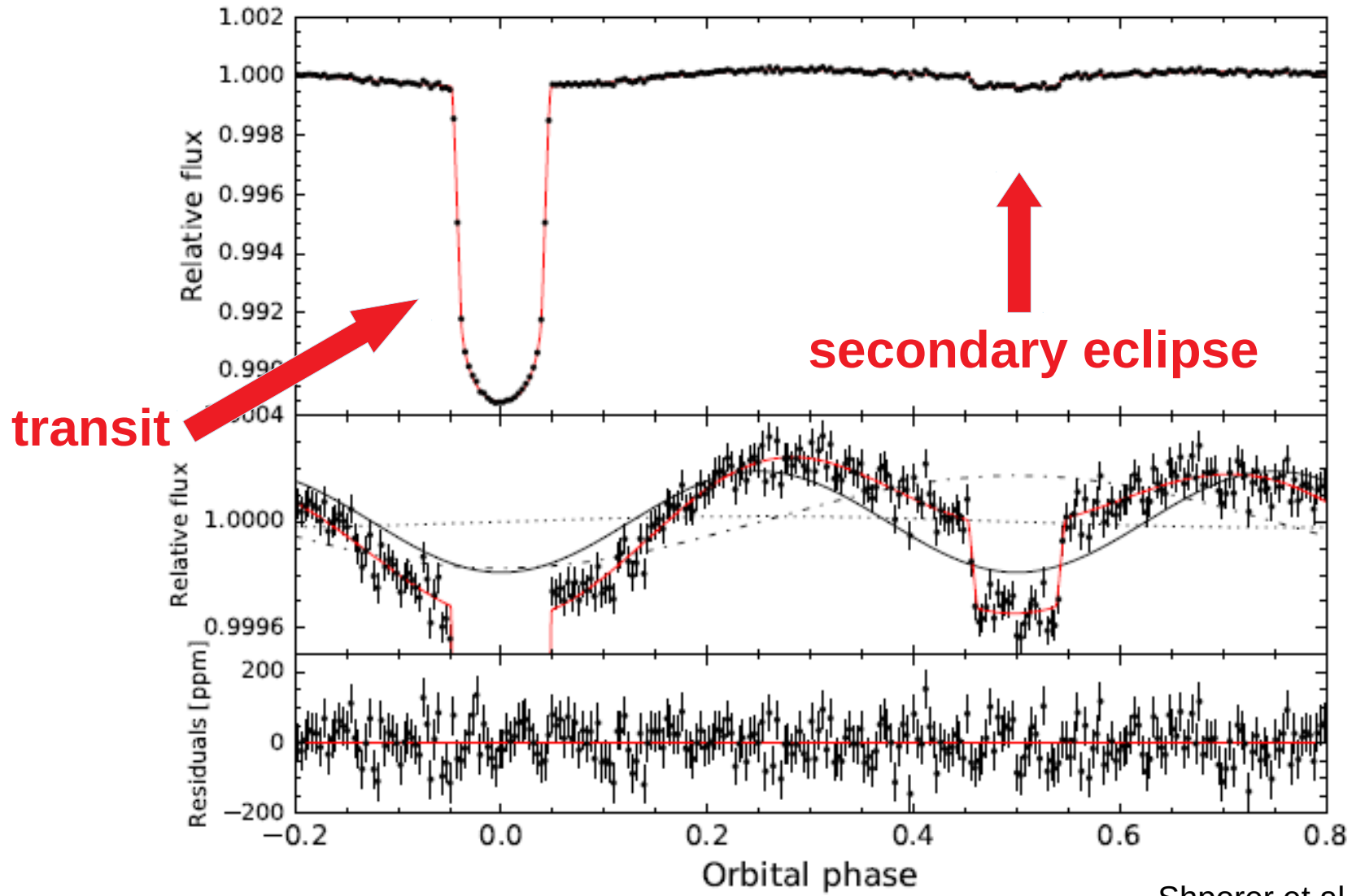




Optical albedos of hot Jupiters

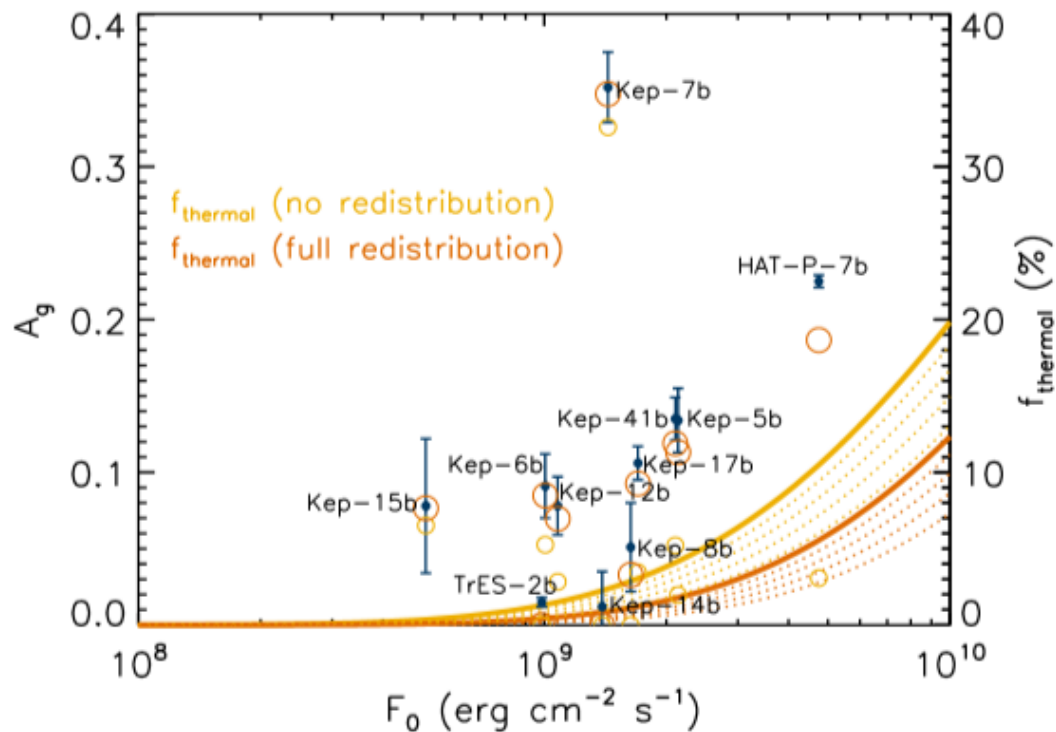


Optical albedos of hot Jupiters



Shporer et al. 2019

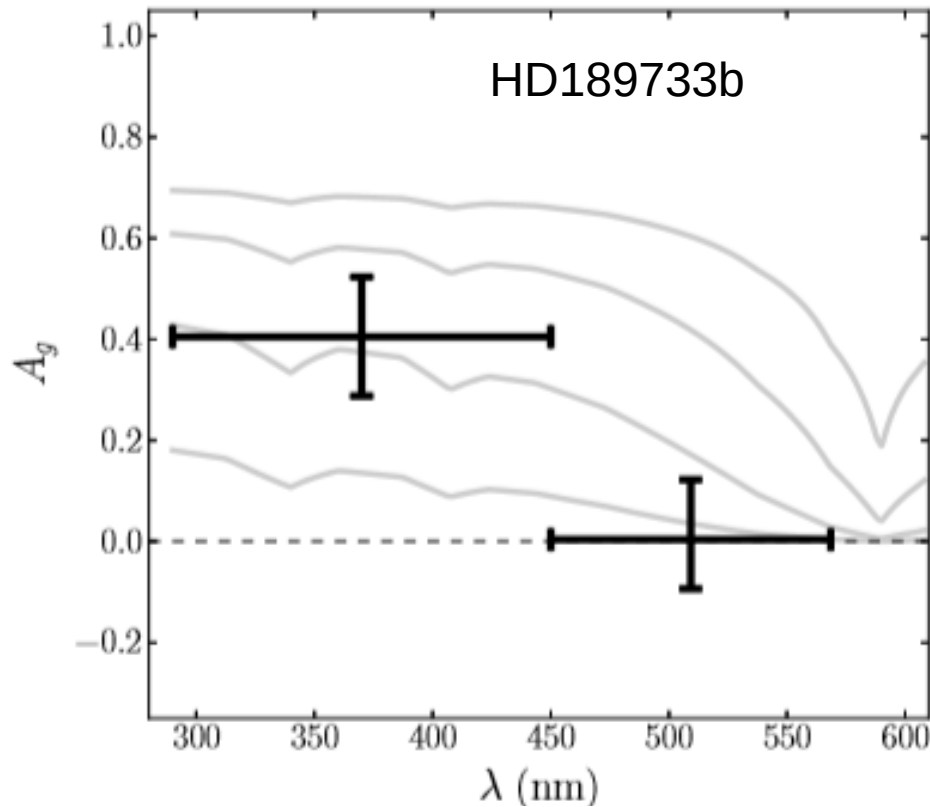
Optical albedos reveal clouds on the planet day sides



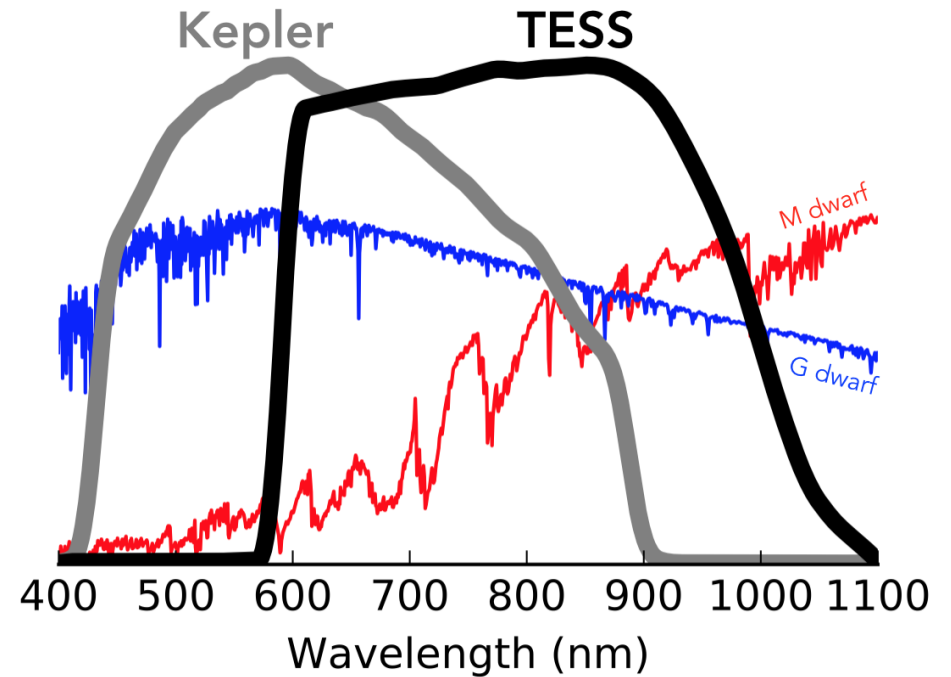
Heng 2013

Planet	Geometric	Bond
Mercury	0.142 [24]	0.088 [25]
Venus	0.689 [24]	0.76 [26]
Earth	0.434 [24]	0.306 [27]
Mars	0.170 [24]	0.25 [28]
Jupiter	0.538 [24]	0.503 [29]
Saturn	0.499 [24]	0.342 [30]
Uranus	0.488 [24]	0.300 [31]
Neptune	0.442 [24]	0.290 [32]

Optical albedos reveal clouds on the planet day sides

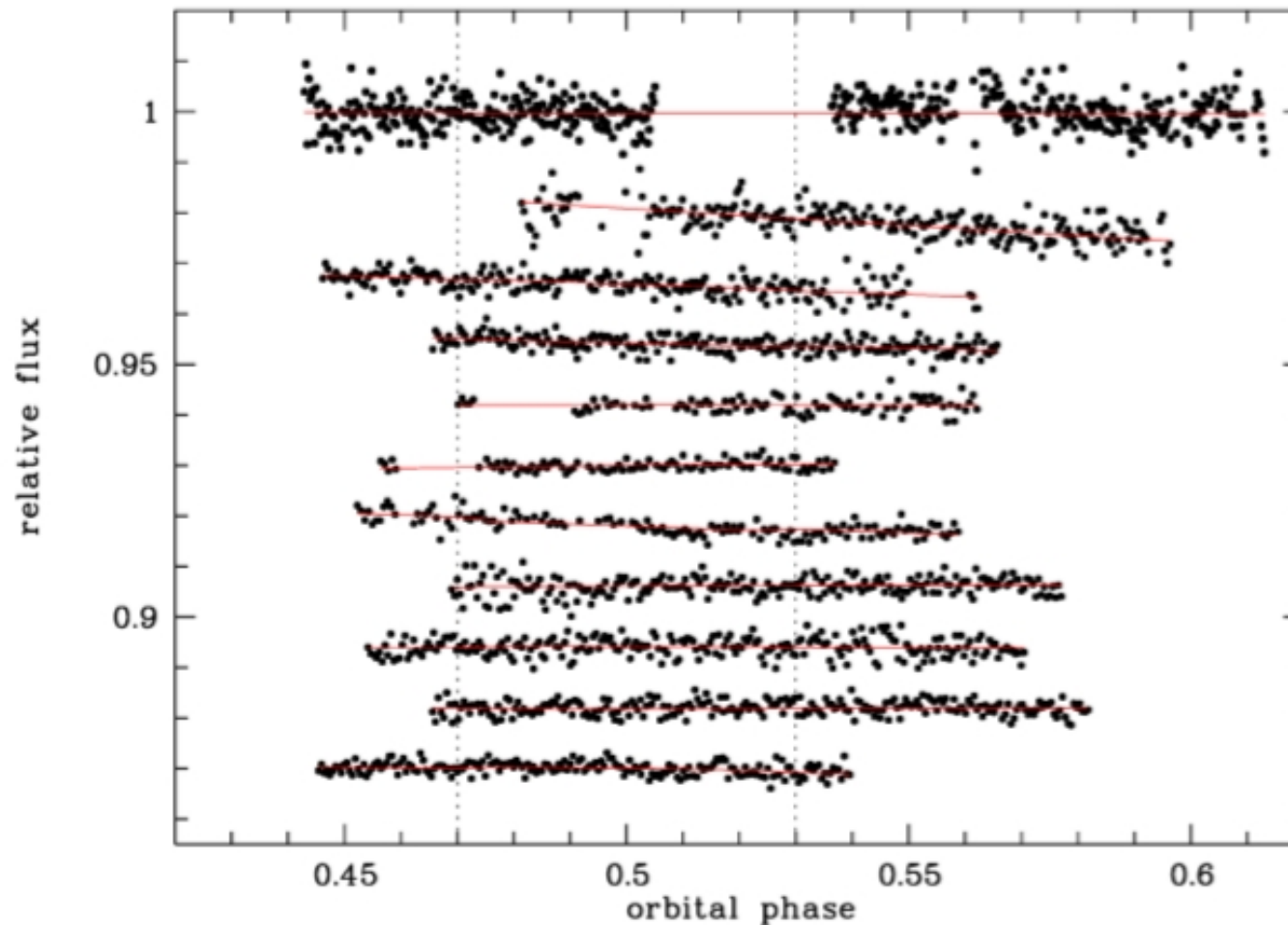


Evans et al. 2013



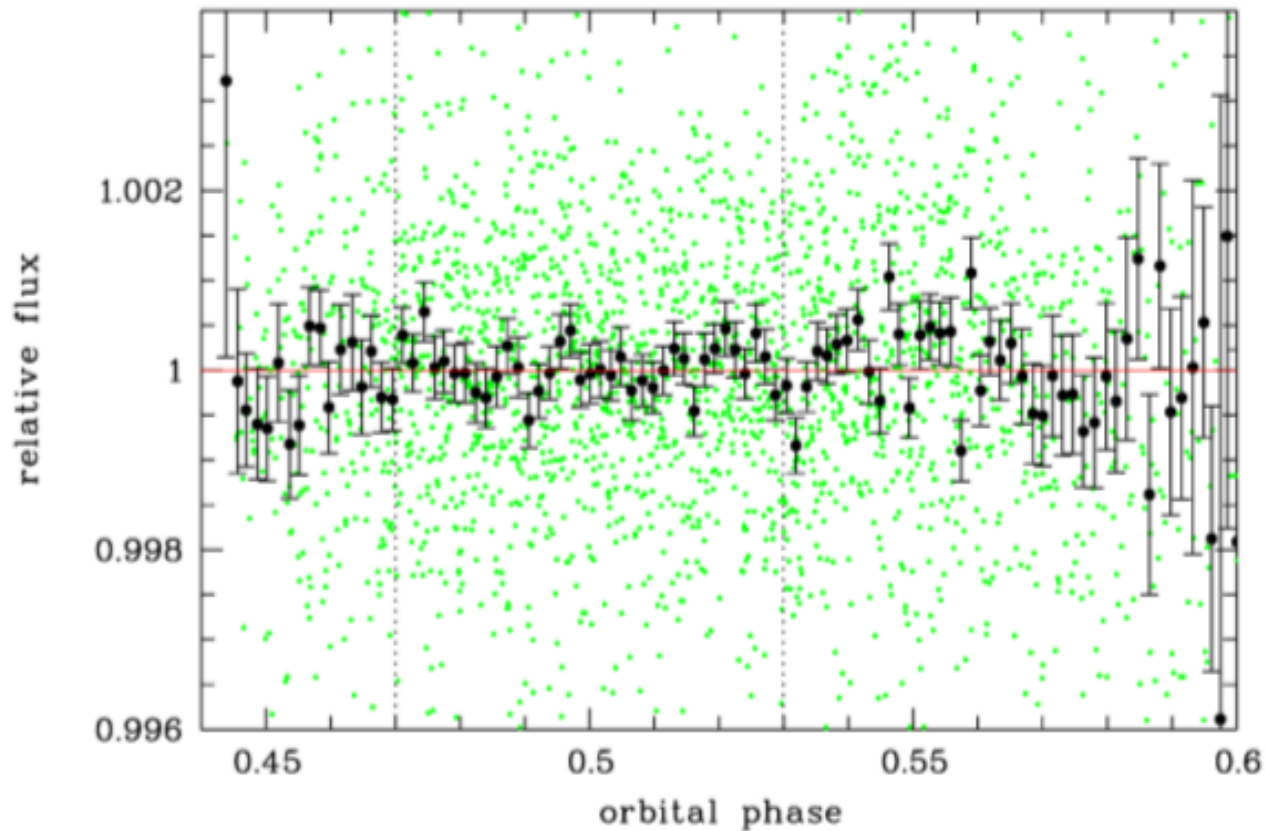
Optical albedos - because we can!

Pilot project on HAT-P-32b at 900nm in Sloan z' with STELLA



Optical albedos - because we can!

Pilot project on HAT-P-32b at 900nm in Sloan z' with STELLA



Standard deviation of **0.35 ppt in 5 min bins**

Eclipse depth of **0.0 ± 0.1 ppt** **→ albedo < 0.2**

Optical albedos - the new observing campaign

2.5m Nordic Optical Telescope

1.2m STELLA

0.8m Telescope Joan Oró

+ additional observing proposals
submitted

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acceptance of seven
amateur observatories

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The NOT observes in Johnson B, all other Johnson V

Targets for 2019:

- WASP-43b
- WASP-103b
- TrES-3b
- KELT-16b
- HAT-P-32b

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Contributions are welcome

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Thank you

