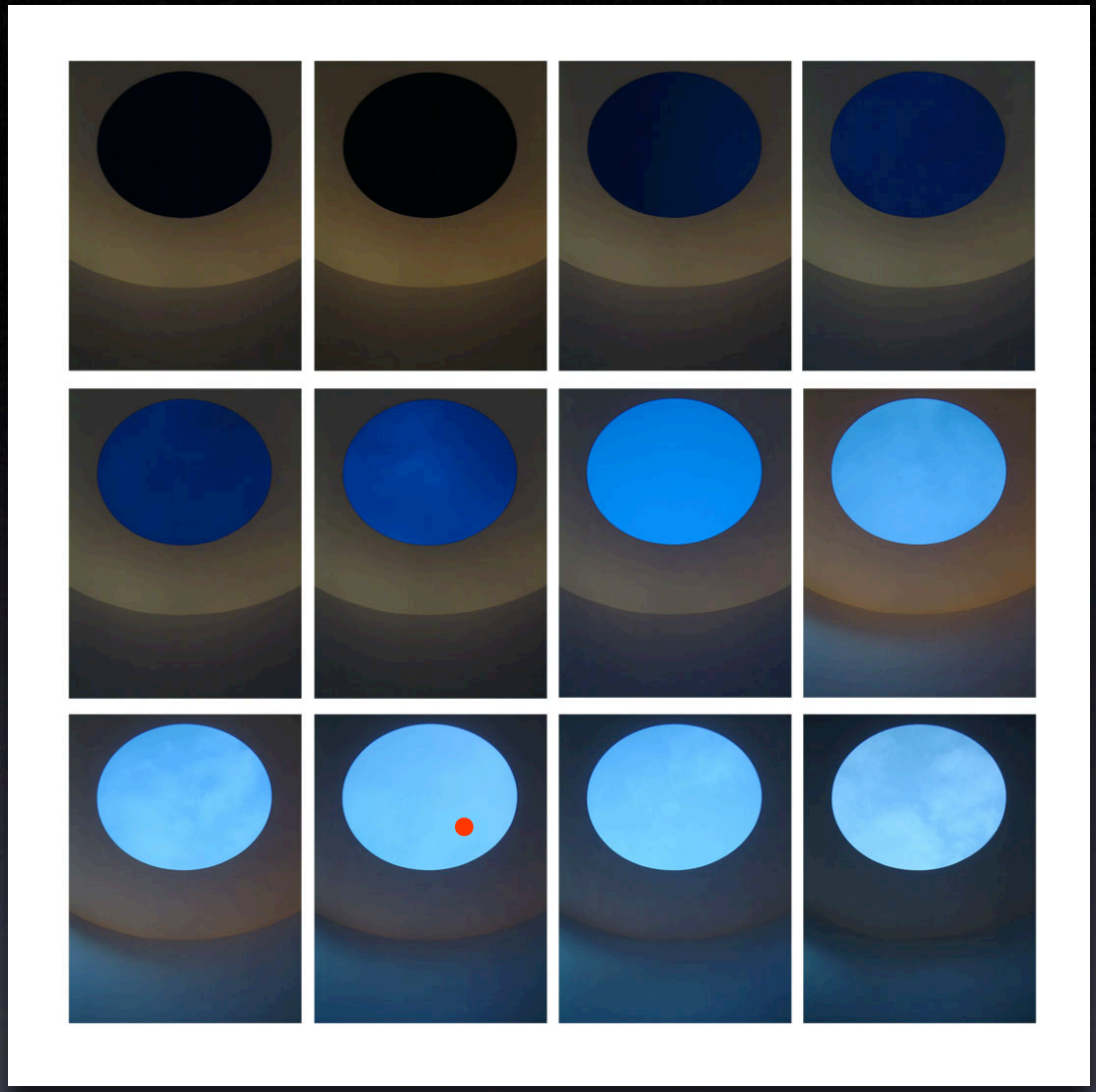
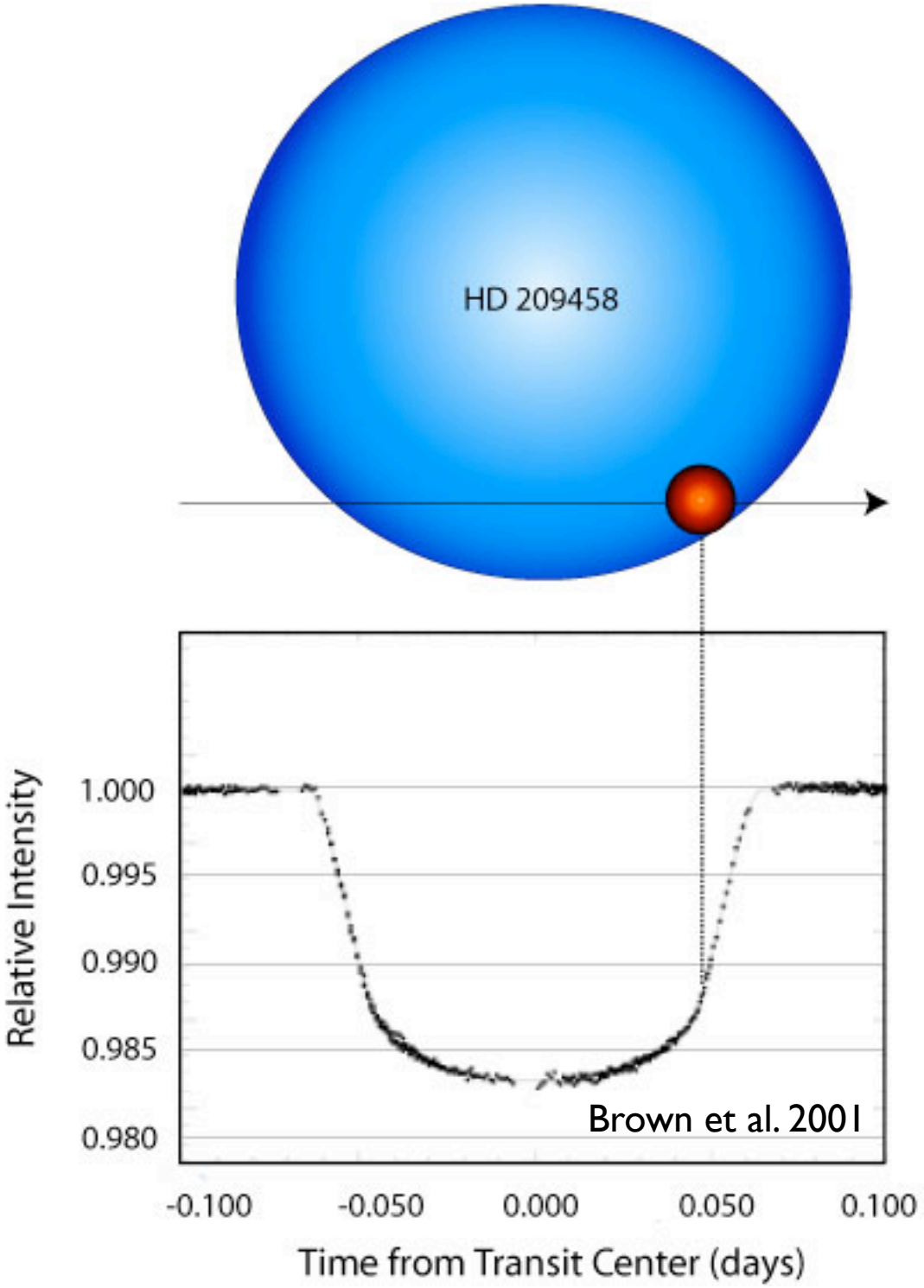
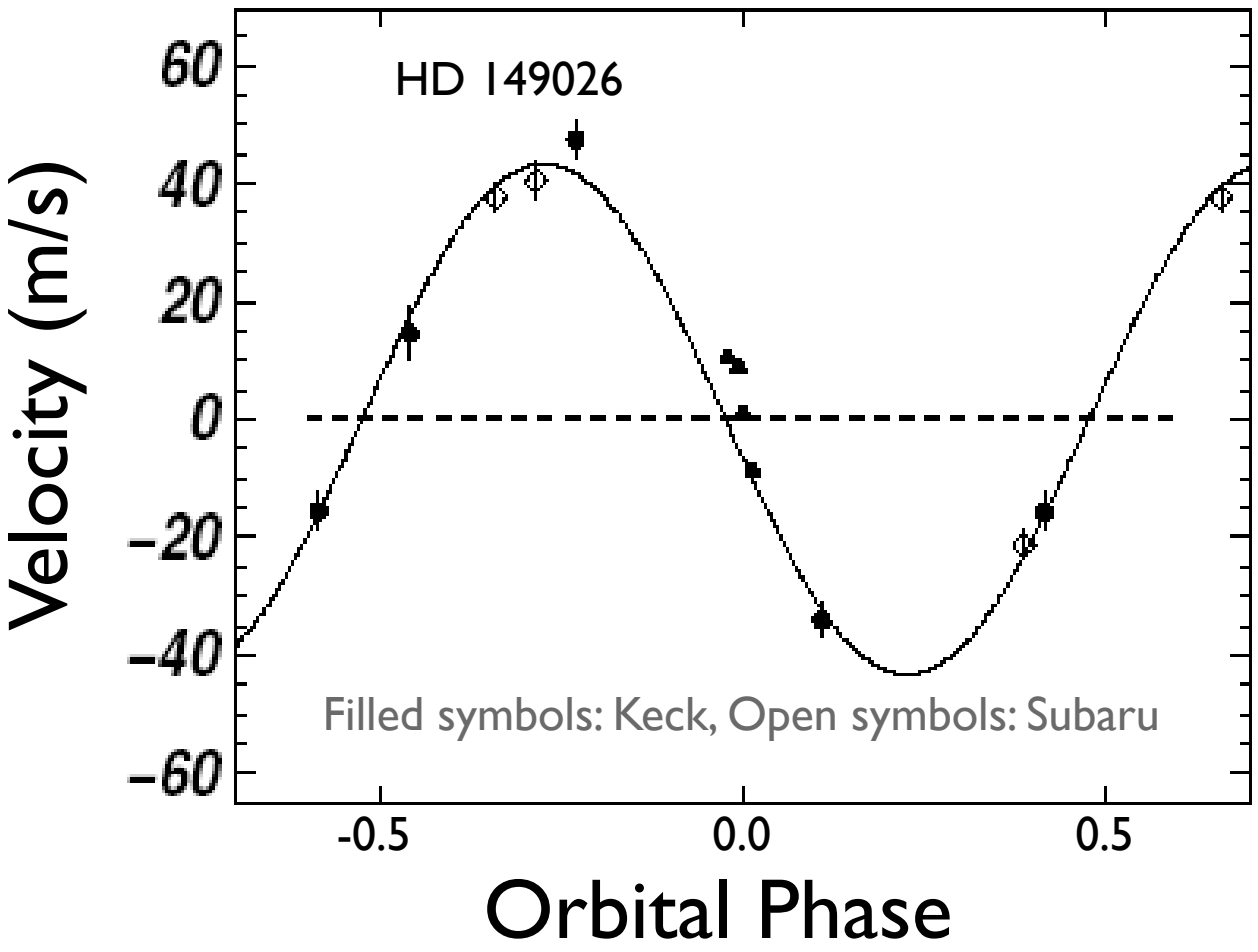


Detection and Characterization of Transiting Planets

Gregory Laughlin - UCO/Lick observatory

Transit of Venus
June 2004



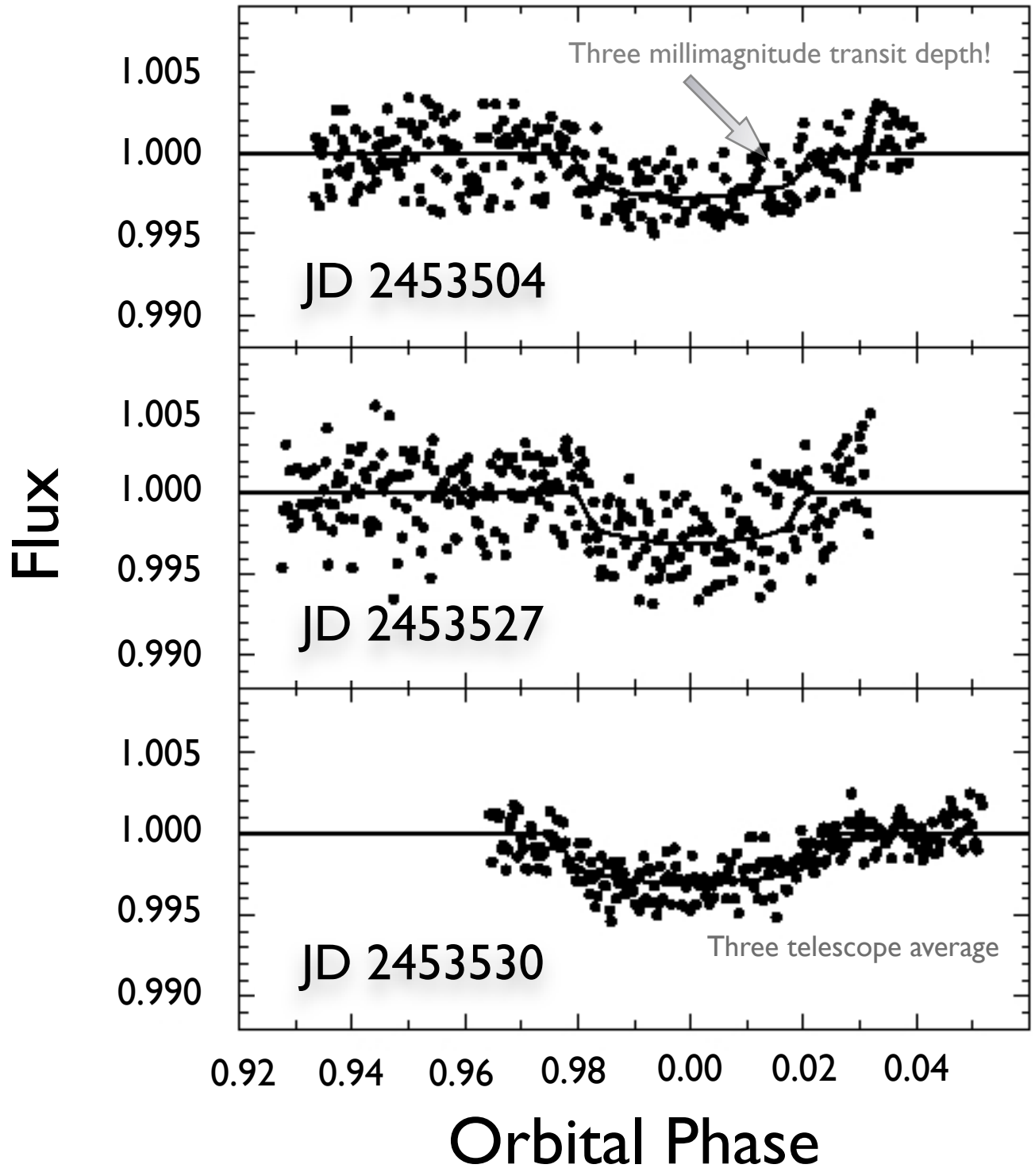


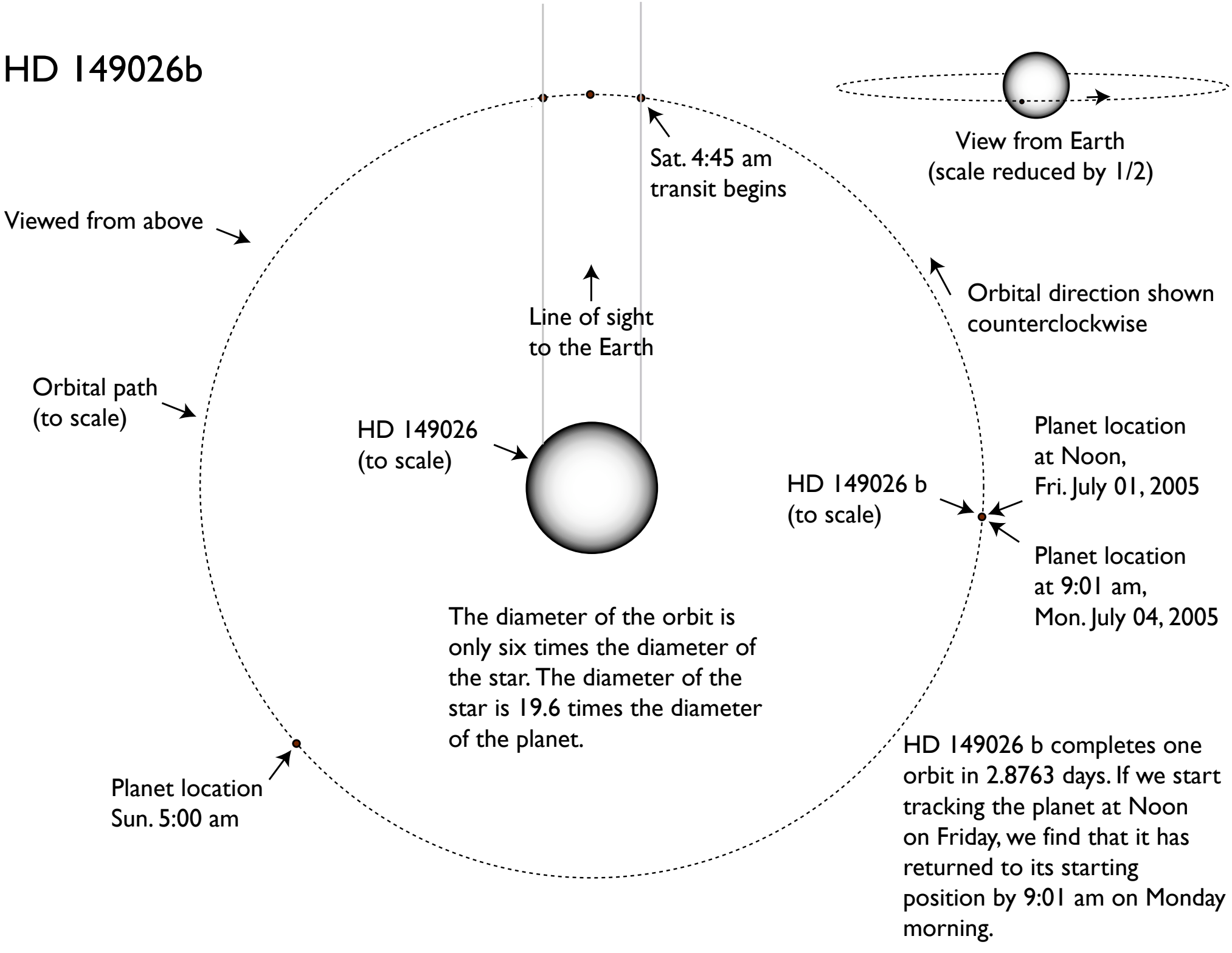
HD149026

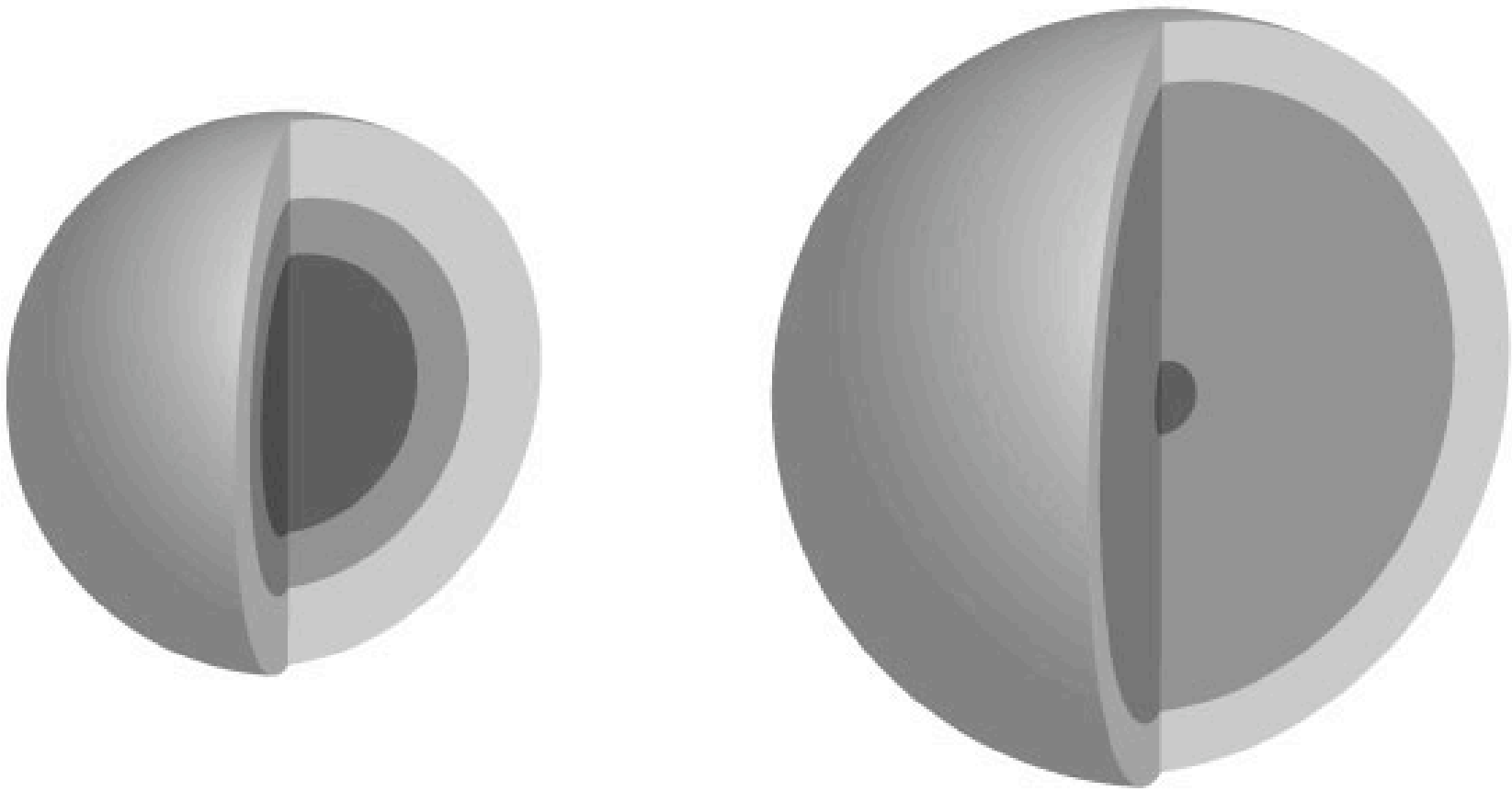
R	1.45 (0.1) Rsun
M	1.3 (0.1) Msun
L	2.7 (0.5) Lsun
d	79 (7) pc
Teff	6147 (50) K
Age	2.0 (0.8) Gyr
Type	G0 IV
V	8.15
vsini	6.0 (0.5) km/s
[Fe/H]	0.36 (0.05) dex
dec	+30

HD149026 b

P	2.8766 (0.001) d
e	0.00 (fixed)
K	43.3 (1.2) m/s
Msini	0.36 (0.03) Mjup


Three millimagnitude transit depth!
JD 2453504
JD 2453527
JD 2453530
Three telescope average
Flux
1.005
1.000
0.995
0.990
0.92
0.94
0.96
0.98
0.00
0.02
0.04
Orbital Phase

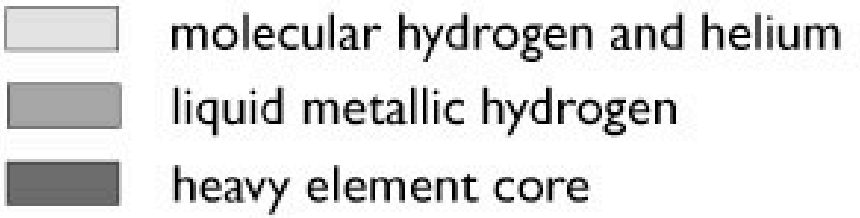

HD 149026b
View from Earth
(scale reduced by 1/2)
Sat. 4:45 am
transit begins
Viewed from above
Line of sight
to the Earth
Orbital direction shown
counterclockwise
Orbital path
(to scale)
HD 149026
(to scale)
HD 149026 b
(to scale)
Planet location
at Noon,
Fri. July 01, 2005
Planet location
at 9:01 am,
Mon. July 04, 2005
The diameter of the orbit is only six times the diameter of the star. The diameter of the star is 19.6 times the diameter of the planet.
Planet location
Sun. 5:00 am
HD 149026 b completes one orbit in 2.8763 days. If we start tracking the planet at Noon on Friday, we find that it has returned to its starting position by 9:01 am on Monday morning.

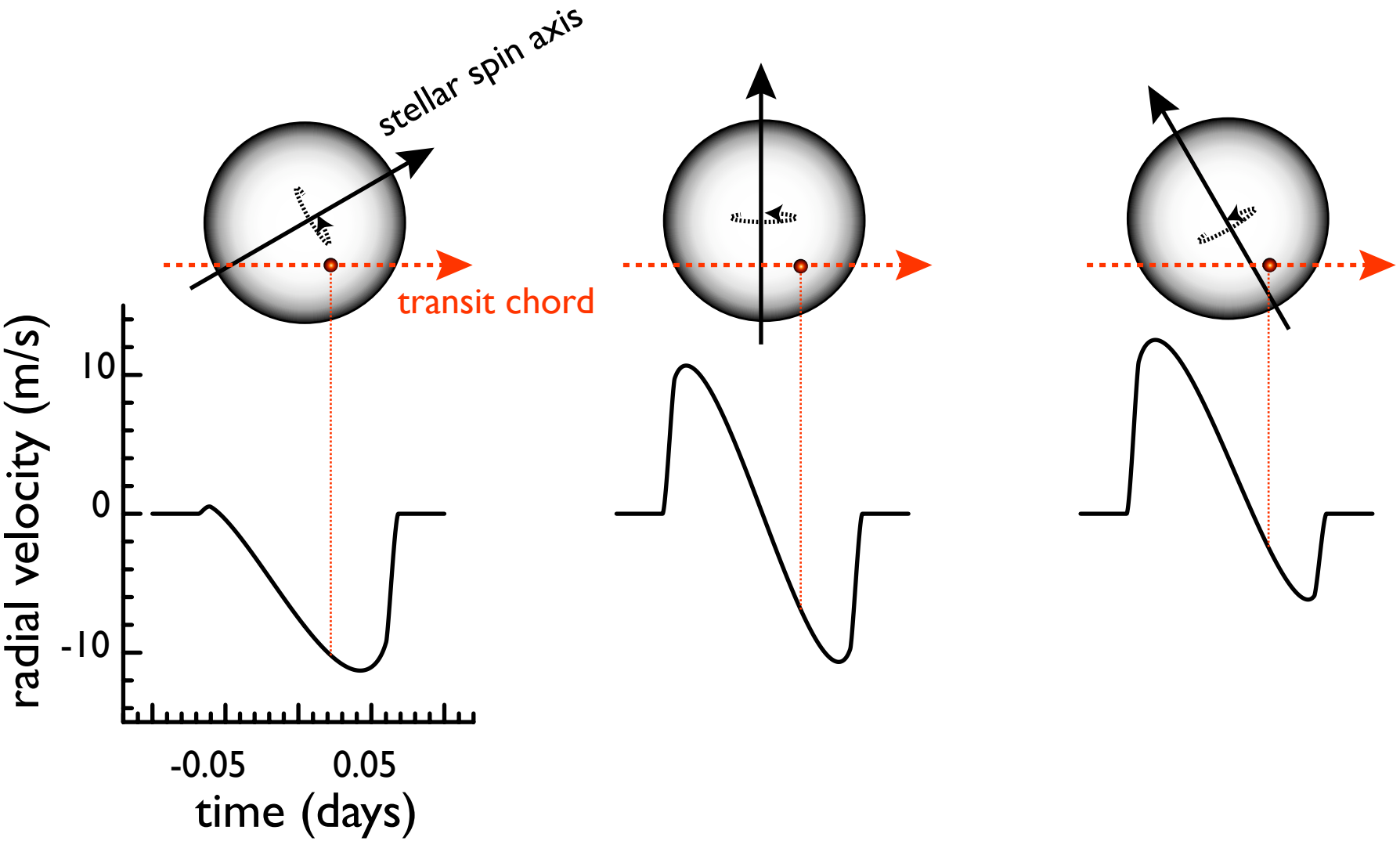


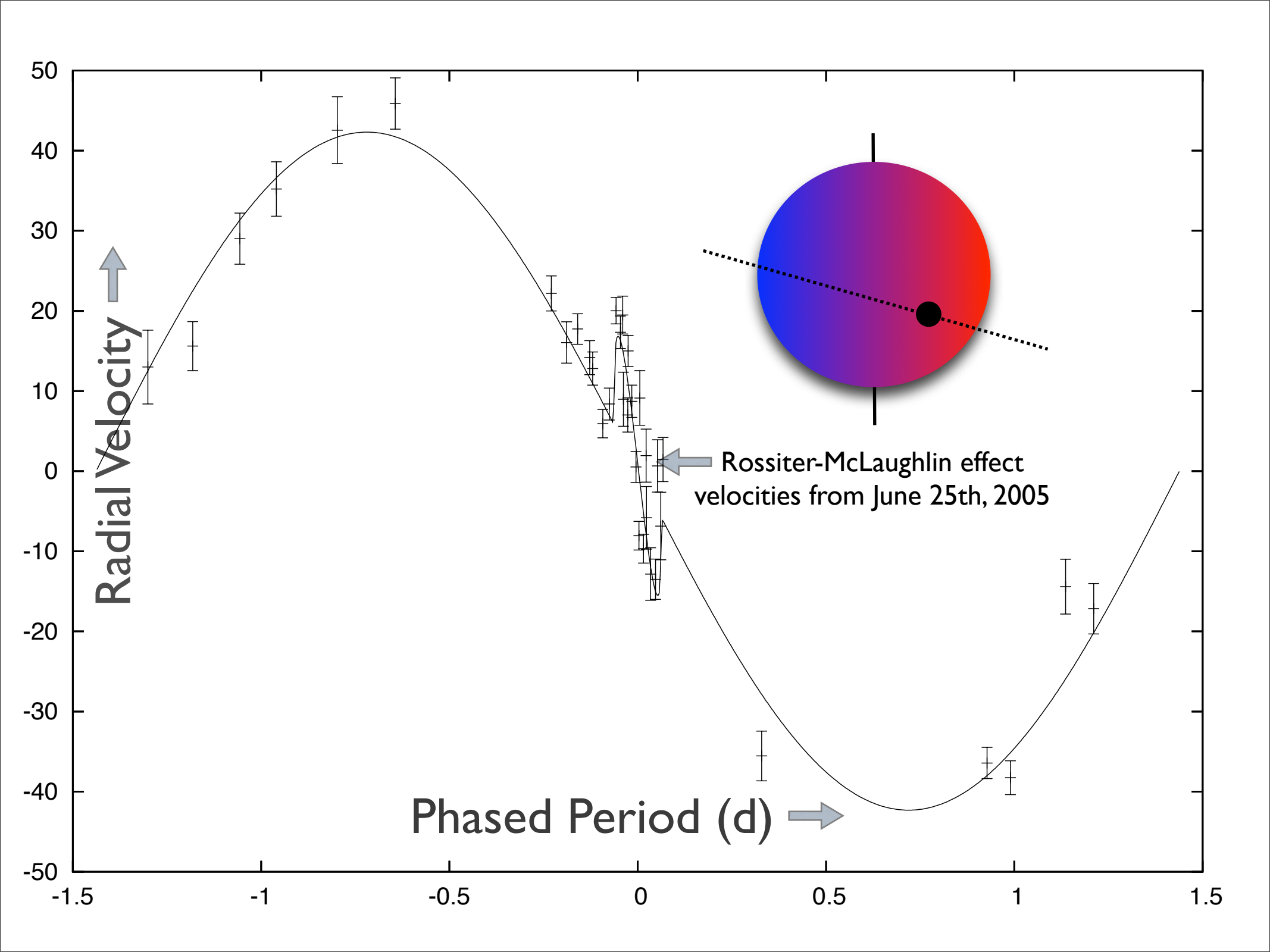
HD 149026 b

Jupiter

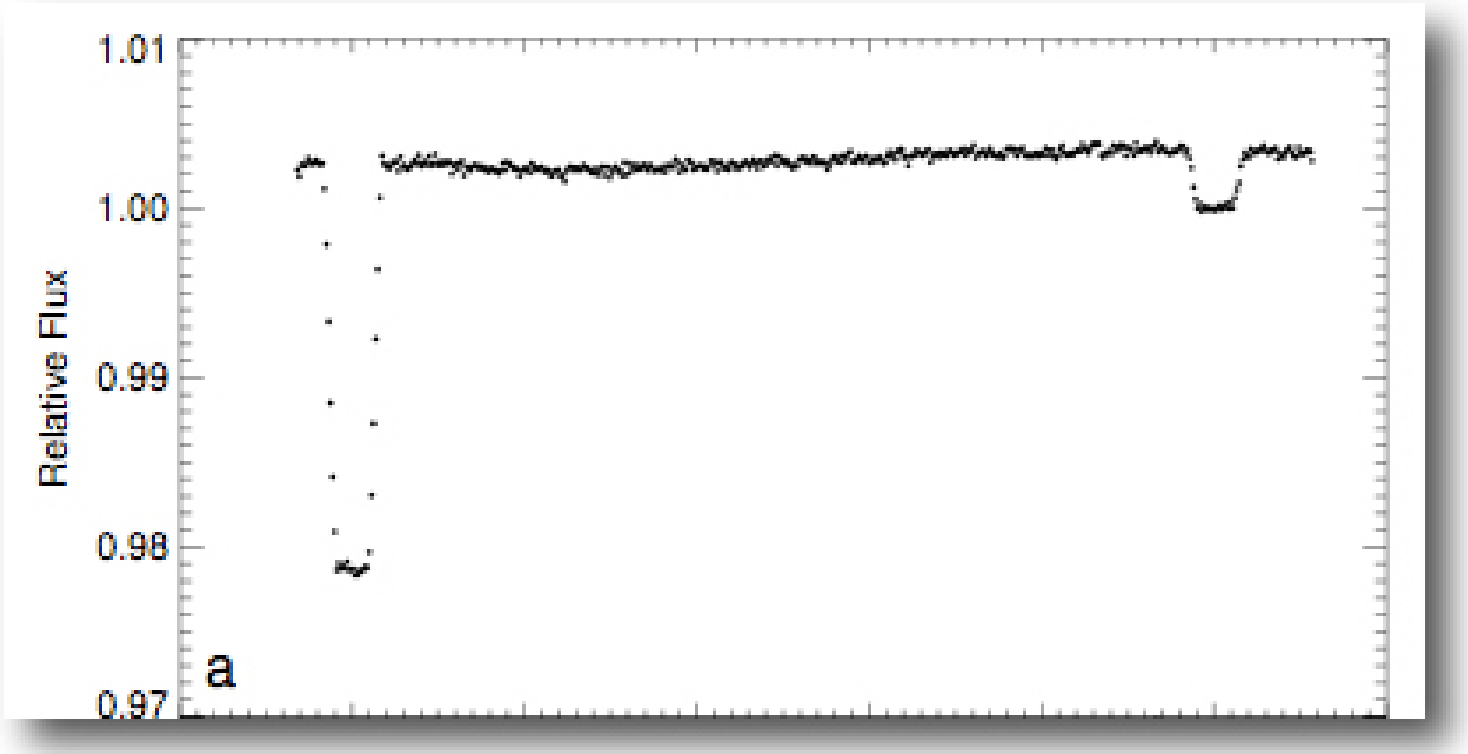
R/Rjup 10.5 gm/cc	R/Rjup 5.5 gm/cc	Mcore
0.594	0.662	89.3
0.681	0.745	74.5
0.769	0.818	60.0
0.866	0.905	
43.6		

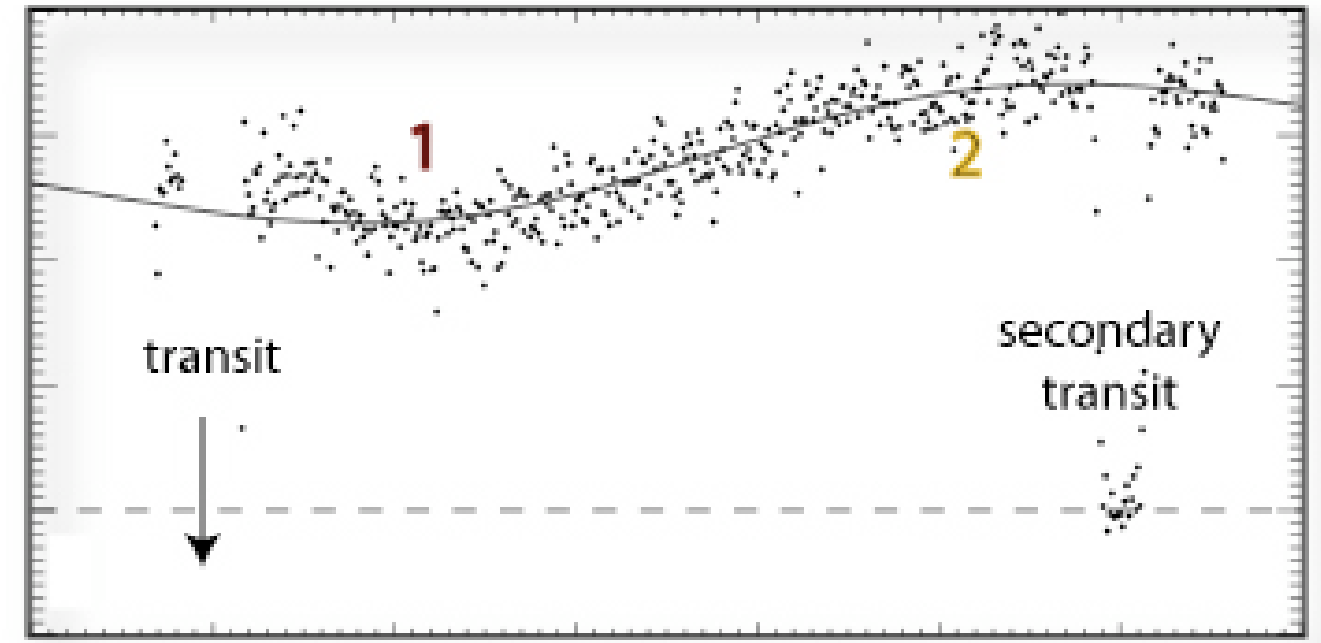



stellar spin axis
transit chord
radial velocity (m/s)
10
0
-10
-0.05
0.05
time (days)

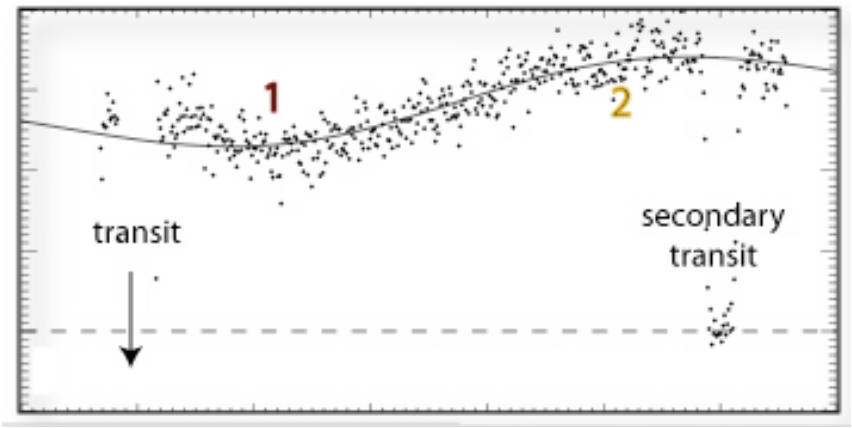

Radial Velocity
Phased Period (d)
Rossiter-McLaughlin effect
velocities from June 25th, 2005
50
40
30
20
10
0
-10
-20
-30
-40
-50
-1.5
-1
-0.5
0
0.5
1
1.5

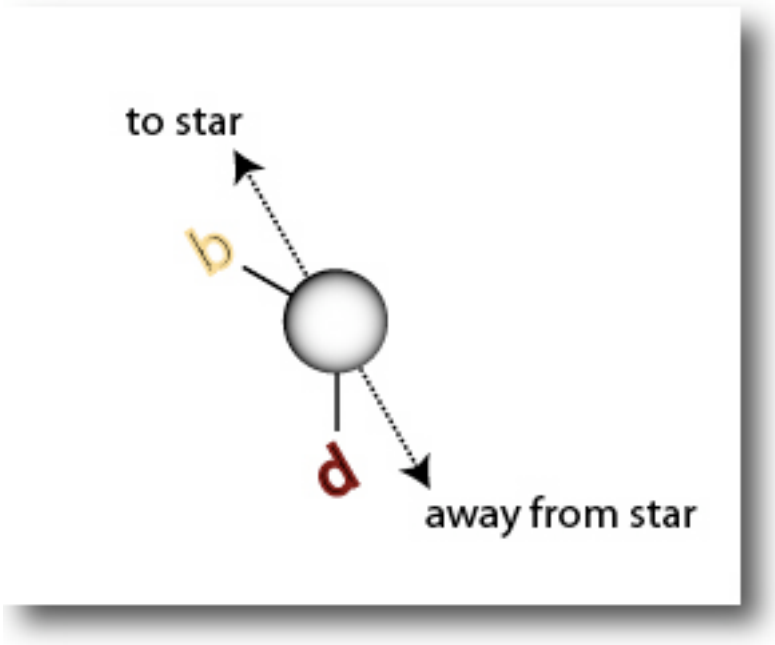
	Planet		Orbit				
	Mpl [M_J]	Rpl [R_J]	P [days]	Ttr [JD-2450000]	i [°]	a [AU]	
OGLE-TR-10	0.61 (0.13)	1.122 (+0.12-0.07)	3.101278 (_4)	3890.678 (_1)	87.2-90	0.04162 (0.00069)	[Konacki05]Pont
OGLE-TR-56	1.29 (0.12)	1.30 (0.05)	1.211909 (_1)	3936.598 (_1)	81.0 (2.2)	0.0225 (0.0004)	[K03]Torres04/Po
OGLE-TR-111	0.52 (0.13)	1.01 (0.04)*	4.0144479 (_41)	3799.7516 (_2)	88.1 (0.5)	0.0467 (0.005)	[Pont04]Santos06
OGLE-TR-113	1.32 (0.19)	1.09 (0.03)	1.4324757 (_13)	3464.61665(_10)	88.8-90	0.0229 (0.0002)	[Bouchy04]Bouch
OGLE-TR-132	1.14 (0.12)	1.18 (0.07)	1.689868 (_3)	3142.5912 (_3)	81.5 (1.6)*	0.0299*	[Bouchy04]Gillon
HD189733	1.15 (0.04)	1.156 (0.046)	2.2185733 (_19)	3988.80336 (_23)	85.76 (0.29)	0.031 (0.001)	[Bouchy05]Winn
HD149026	0.330 (0.02)	0.726 (0.064)	2.87598 (_15)	3527.87455 (_90)	85.8 (+1.6-1.3)	0.042	[Sato05]Charbonn
TrES-1	0.76 (0.05)	1.081 (0.029)	3.0300737 (_26)	3186.80603 (_28)	>88.4	0.0393 (0.0011)	[Alonso04]Sozetti
TrES-2	1.198 (0.053)	1.220 (+.045-.042)	2.47063 (_1)	3957.6358 (_10)	83.90 (0.22)	0.0367 (+_12-_05)	[ODonovan06] So
TrES-3	1.92 (0.23)	1.295 (0.081)	1.30619 (_1)	4185.9101 (_3)	8215 (0.21)	0.0226 (0.0013)	[ODonovan07]
HD209458	0.657 (0.006)	1.320 (0.025)	3.52474859 (_38)	2826.628521 (_87)	86.929 (0.010)	0.047 (+.001-.003)	[Charbonneau00]
XO-1	0.90 (0.07)	1.184 (+.028-.018)	3.941534 (_27)	3887.74679 (_15)	89.36 (+.46-.53)	0.0488 (0.0005)	[McCullough06]H
XO-2	0.98 (0.02)	0.964 (+.02-.009)	2.615838 (_8)	4147.74902 (_20)	>88.35		[Burke07]
HAT-P-1	0.53 (0.04)	1.36 (+.11-.09)	4.46529 (_9)	3984.397 (_9)	85.9 (0.8)	0.0551 (0.0015)	[Bakos07]
HD147506	8.17 (0.72)	1.18 (0.16)	5.63341 (_13)	4212.8561 (_23)	90.0 (1.0)	0.0685 (0.0017)	[Bakos07]
WASP-1	0.867 (0.073)	1.443 (0.039)	2.519961 (__18)	4013.31269 (_47)	>86.1	0.0382 (0.0013)	[Cameron06]Shpo
WASP-2	0.81-0.95	1.038 (0.050)	2.152226 (_4)	4008.73205 (_28)	84.74 (0.39)	0.0307 (0.0011)	[Cameron06]Char
GJ436	0.071 (0.006)	0.35 (0.03)	2.64385 (_9)	4222.616 (_1)	86.5 (0.2)	0.028 (0.001)	[Gillon07]

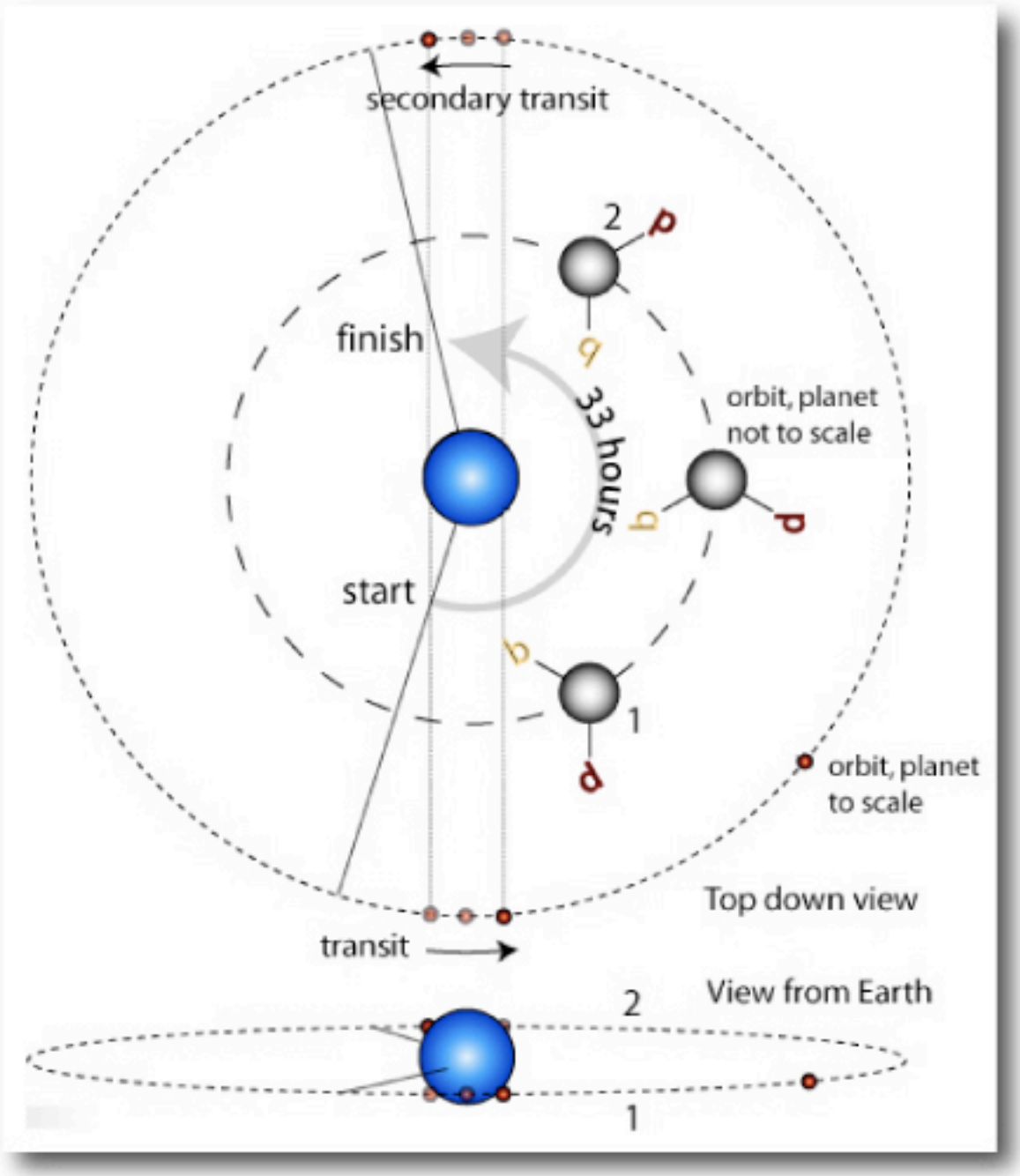




Incredible follow-up observations are being made with Spitzer. These observations of HD 189733 come from Knutson et al. 2007.

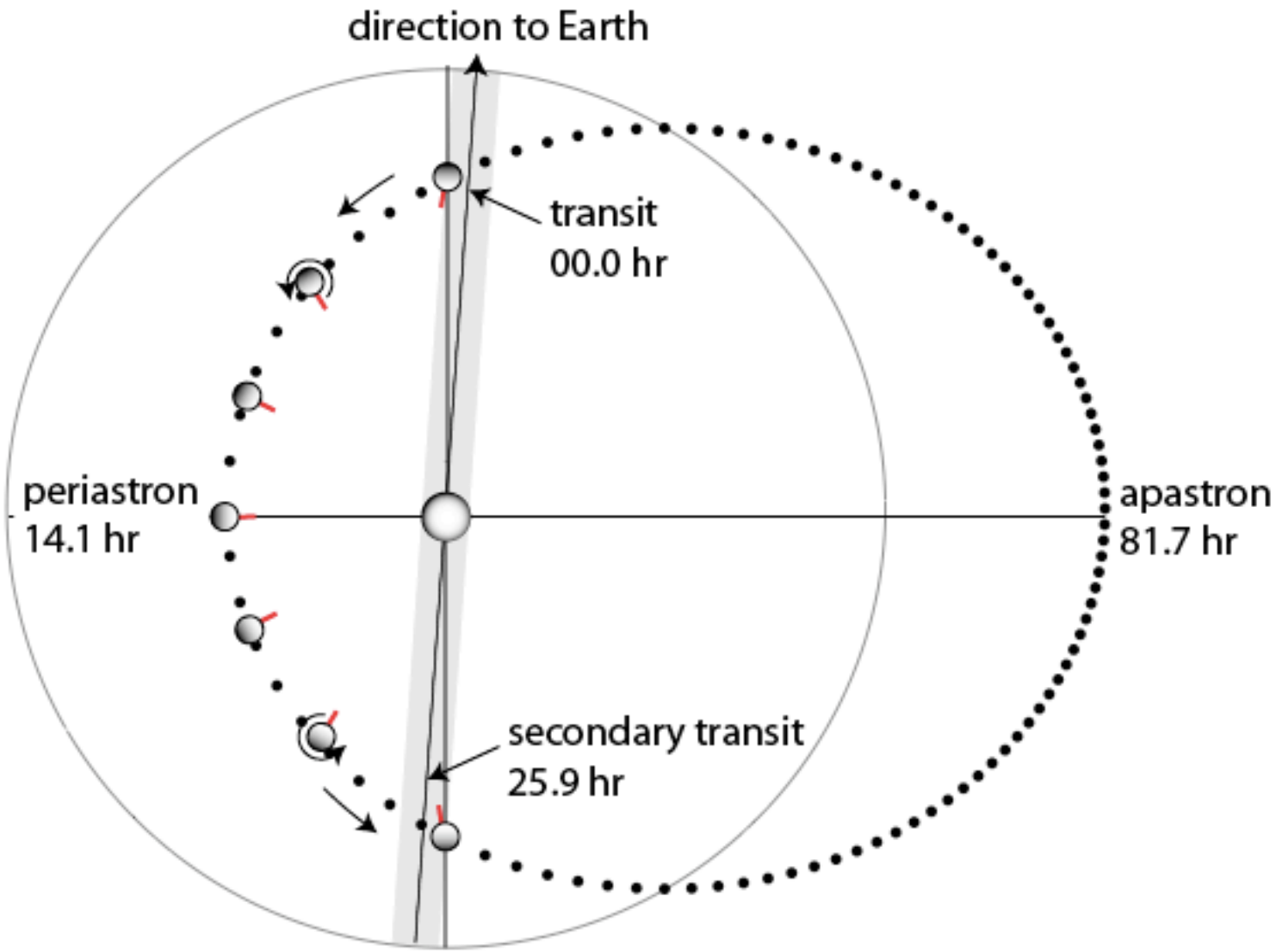


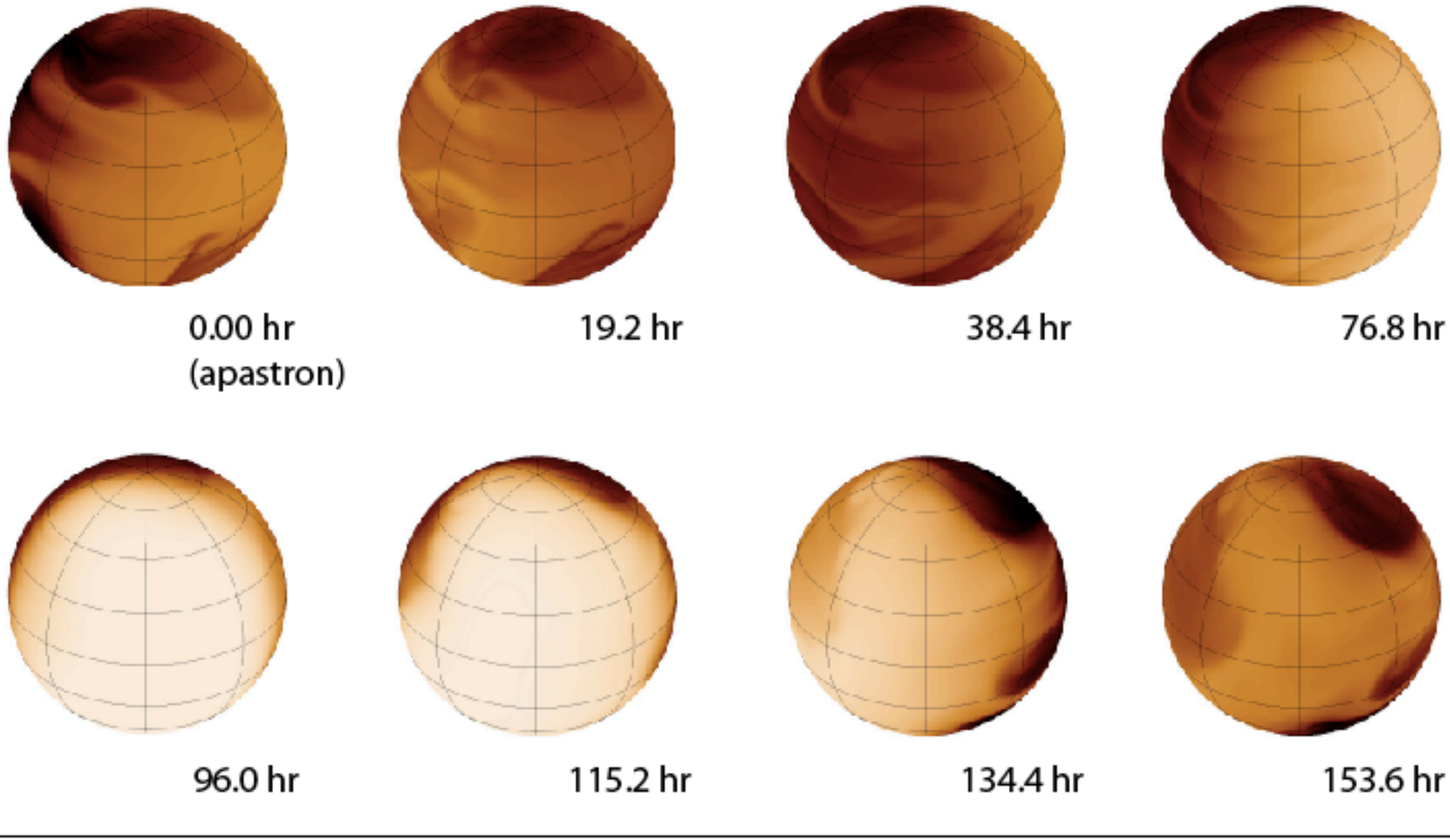


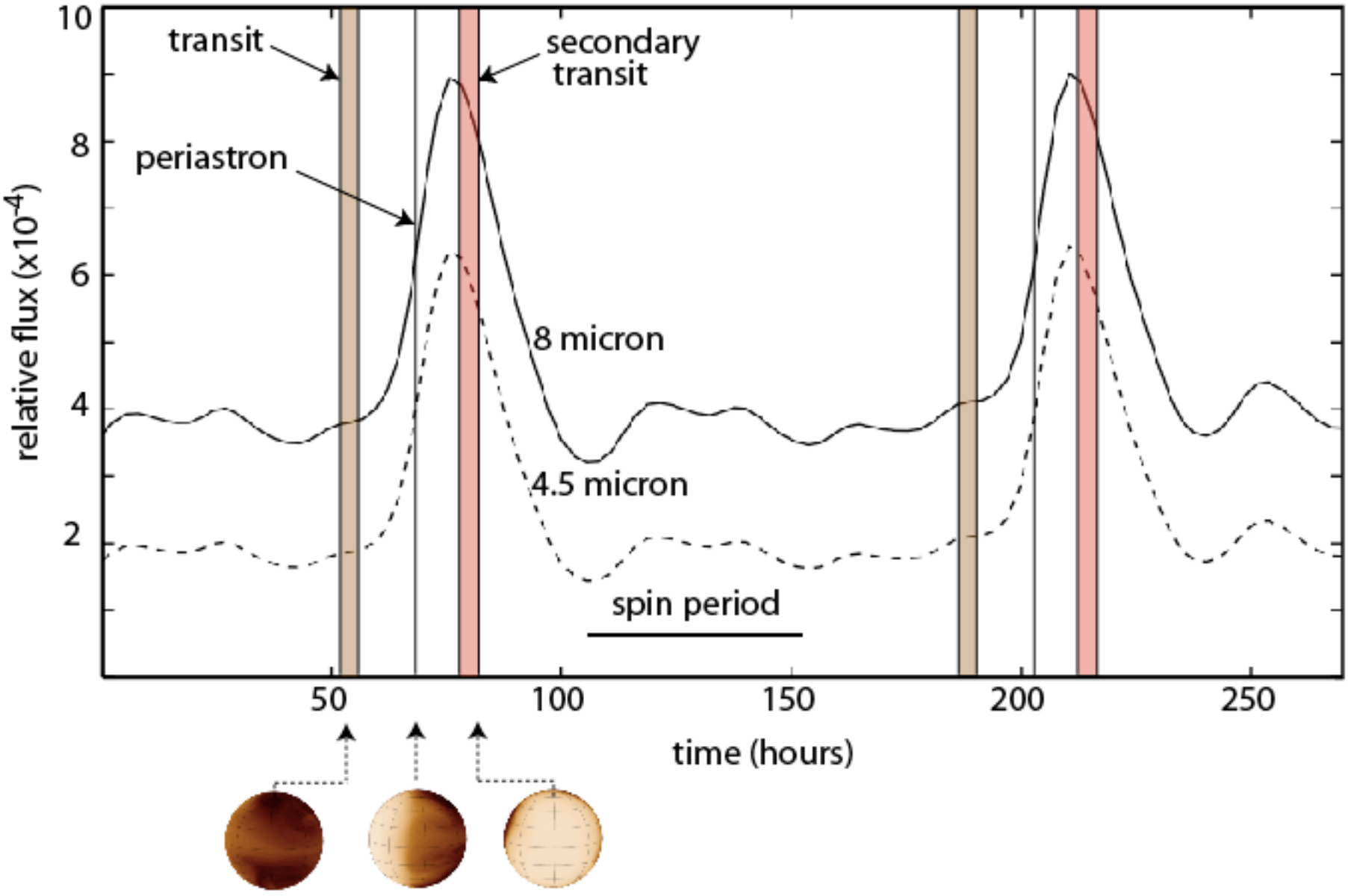


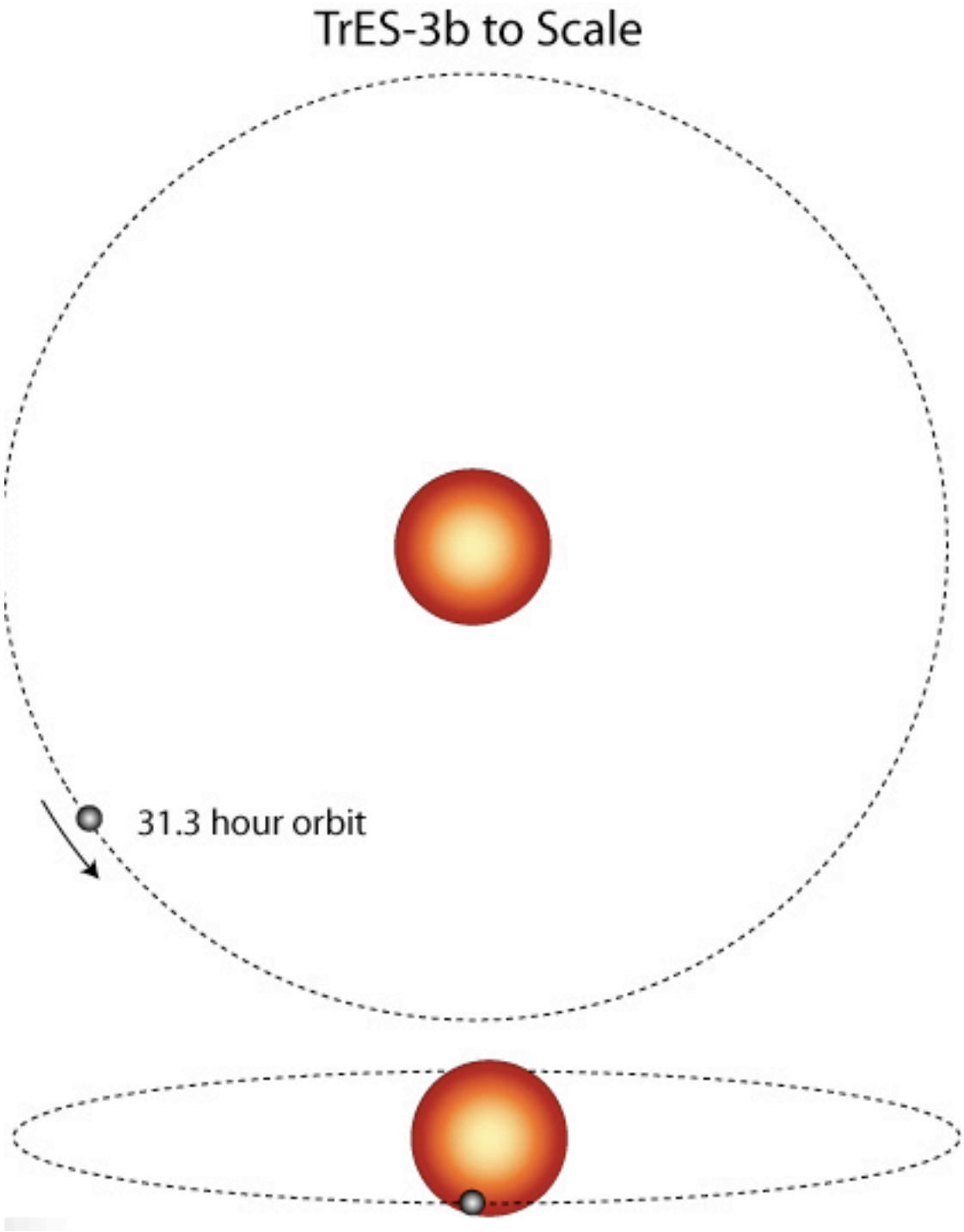
Interpretation of the result: Hottest and coldest spots are on the same side of the planet.

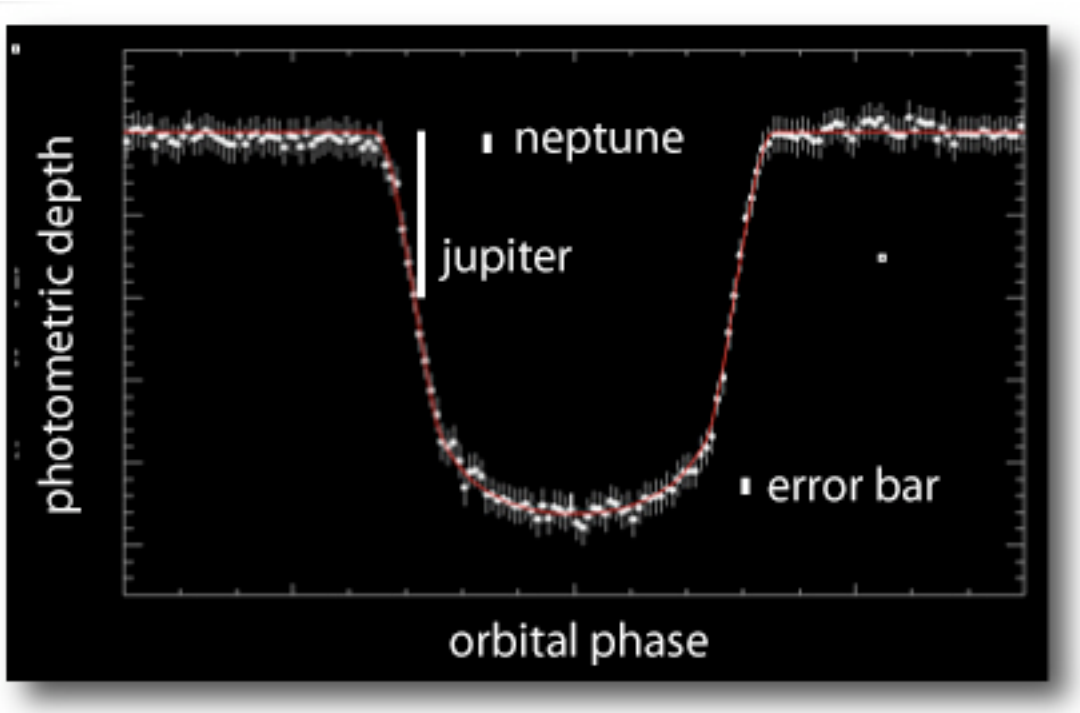
HAT-P-2b


direction to Earth
transit
00.0 hr
periastron
14.1 hr
apastron
81.7 hr
secondary transit
25.9 hr


0.00 hr
(apastron)
19.2 hr
38.4 hr
76.8 hr
96.0 hr
115.2 hr
134.4 hr
153.6 hr

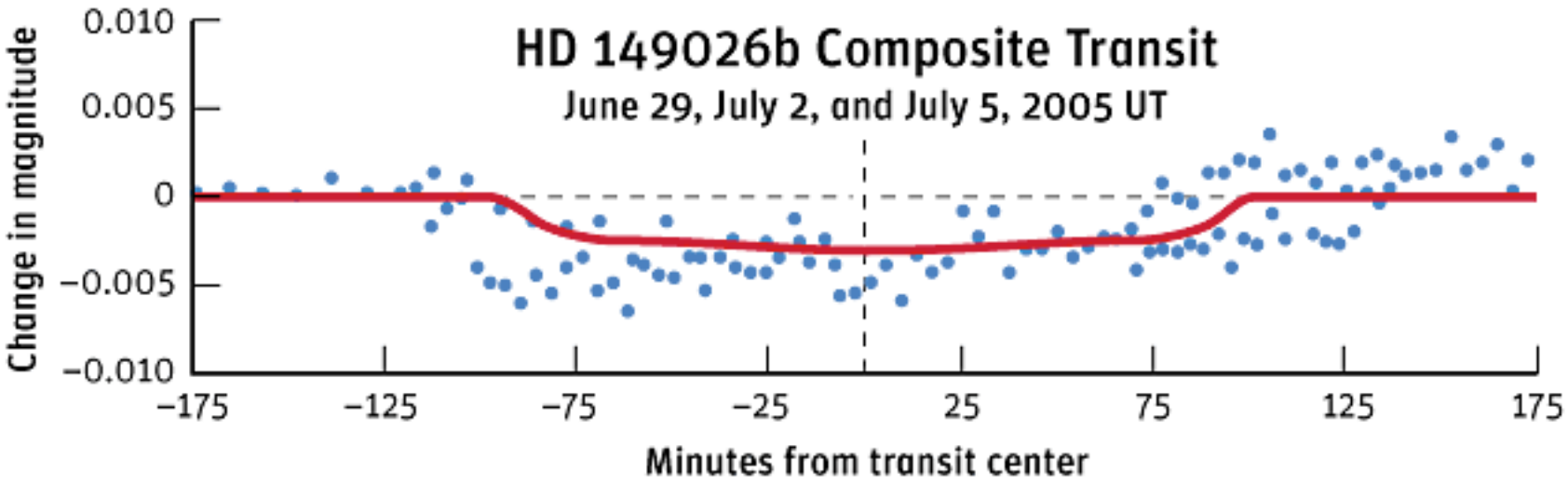

transit
secondary transit
periastron
8 micron
4.5 micron
spin period
relative flux (x10^{-4})
time (hours)
10
8
6
4
2
50
100
150
200
250

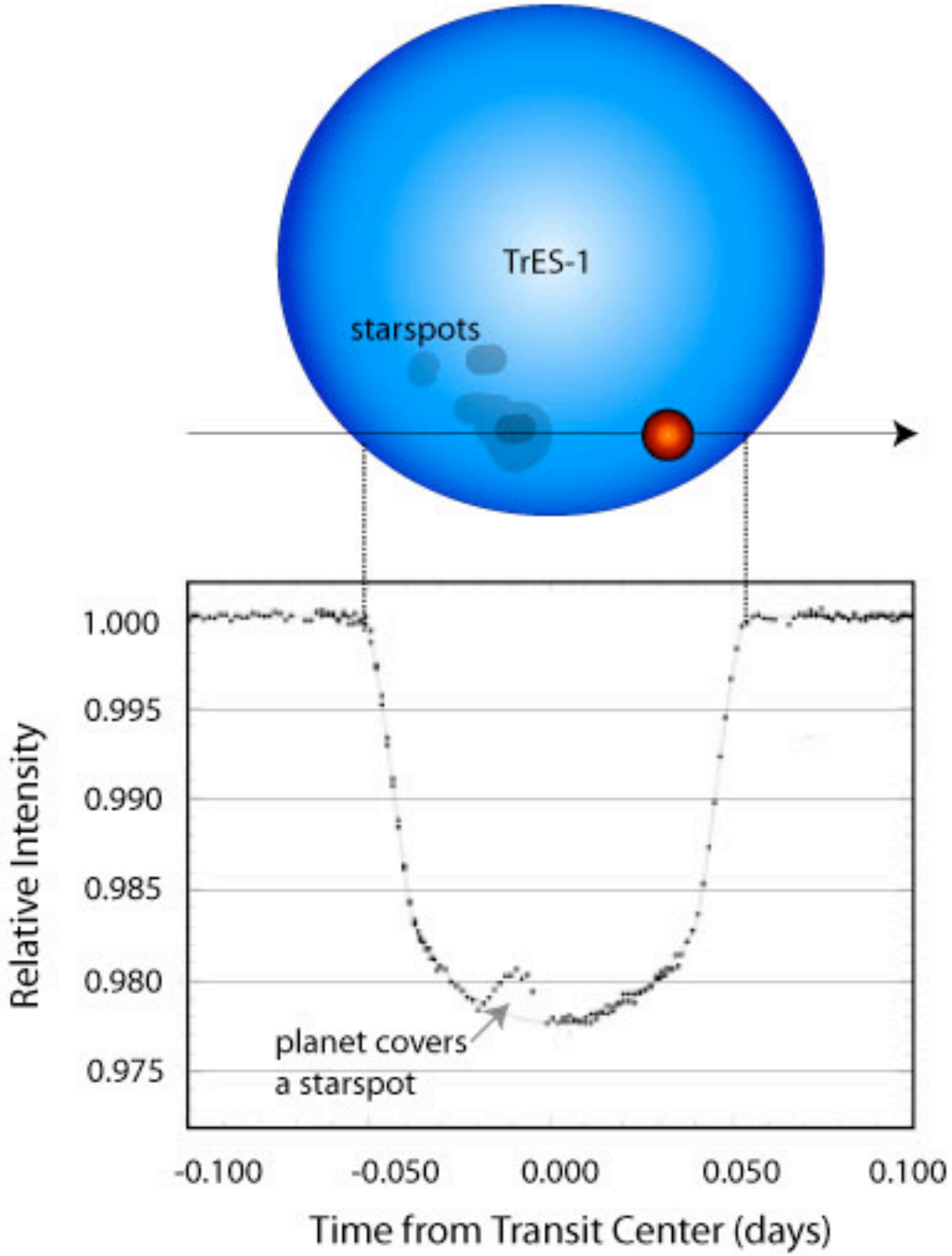

TrES-3b to Scale
31.3 hour orbit



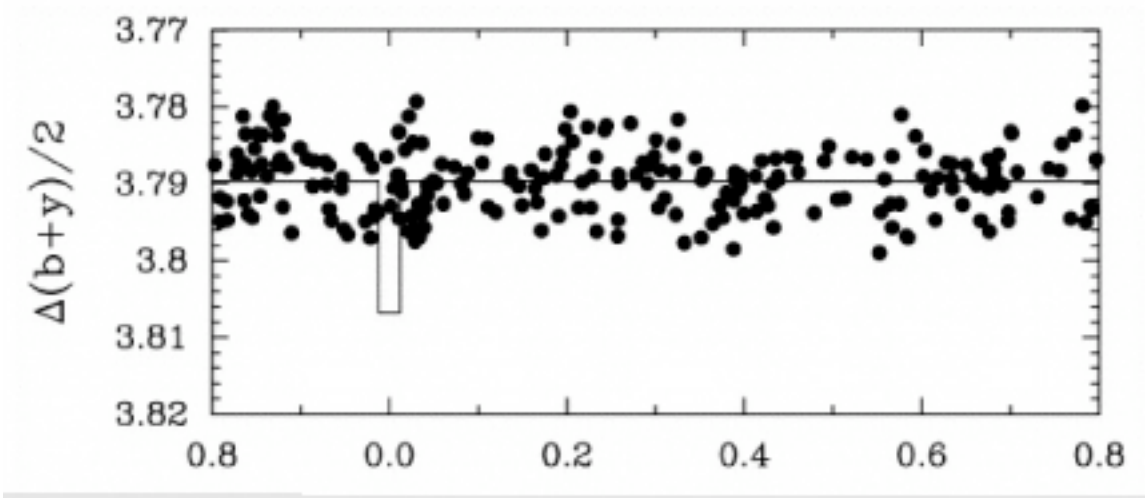
CoRoT's precision is turning out to be excellent...

Amateur astronomer Ron Bissinger observed the HD 149026b transit from his backyard in Pleasanton as soon as the transit was announced




TrES-1
starspots
1.000
0.995
0.990
0.985
0.980
0.975
Relative Intensity
planet covers
a starspot
-0.100
-0.050
0.000
0.050
0.100
Time from Transit Center (days)

Gl 436 was the first Neptune-mass planet discovered (Butler et al. 2004)



Folded photometry (taken over a baseline of several years) showed no indication of a transit.

Detection of transits of the nearby hot Neptune GJ 436 b

M. Gillon[1,2], F. Pont[1], B.-O. Demory[1,3], F. Mallmann[3], M. Mayor[1], T. Mazeh[4], D. Queloz[1], A. Shporer[4], S. Udry[1], C. Vuissoz[5]

[1] Observatoire de Genève, Université de Genève, 1290 Sauverny, Switzerland
[2] Institut d'Astrophysique et de Géophysique, Université de Liège, 4000 Liège, Belgium
[3] Observatoire François-Xavier Bagnoud - OFXB, 3961 Saint-Luc, Switzerland
[4] School of Physics and Astronomy, Raymond and Beverly Sackler Faculty of Exact Sciences, Tel Aviv University, Tel Aviv, Israel
[5] Laboratoire d'Astrophysique, Ecole Polytechnique Fédérale de Lausanne (EPFL), Observatoire, 1290 Sauverny, Switzerland

Received date / accepted date

Abstract. This Letter reports on the photometric detection of transits of the Neptune-mass planet orbiting the nearby M-dwarf star GJ 436. It is by far the closest, smallest and least massive transiting planet detected so far. Its mass is slightly larger than Neptune's at $M = 22.6 \pm 1.9\ M_{\oplus}$. The shape and depth of the transit lightcurves show that it is crossing the host star disc near its limb (impact parameter 0.84 ± 0.03) and that the planet size is comparable to that of Uranus and Neptune, $R = 25200 \pm 2200$ km $= 3.95 \pm 0.35\ R_{\oplus}$. Its main constituant is therefore very likely to be water ice. If the current planet structure models are correct, an outer layer of H/He constituting up to ten percent in mass is probably needed on top of the ice to account for the observed radius.

Key words. planetary systems – stars: individual: GJ 436 – techniques: photometry

François-Xavier Bagnoud Observatory - OFXB, Saint-Luc (VS)

OBSERVATOIRE
FRANÇOIS-XAVIER BAGNOUD
ST-LUC

Home page

What's new ?

Welcome to the new OFXB website !

Location & Organisation

The François-Xavier Bagnoud Observatory (OFXB) is located above Saint-Luc, a small village laying in Val d'Anniviers - swiss Alps, nearby Sierre. OFXB is managed by a non-profit-making foundation. This project became reality in 1995 thanks to the generosity of the FXB foundation.

What OFXB offers...

The site where OFXB has been built benefits from the Alps legendary tranquility and beauty. Several summits above 4000m are easily visible, especially the Matterhorn, providing scenic landscapes. Furthermore, it is famous for pure and steady nights, especially suited for astronomy observing. From experimented amateur astronomers to schoolchildren, the Observatory welcomes all and features a full range of activites thanks to available facilities : 60cm reflector equipped with an high performance CCD camera, 15cm apochromatic refractor and a fully equipped auditorium for 3D shows and conferences. Kitchen and lavatories are available for visitors. A funicular links the Observatory from the village.

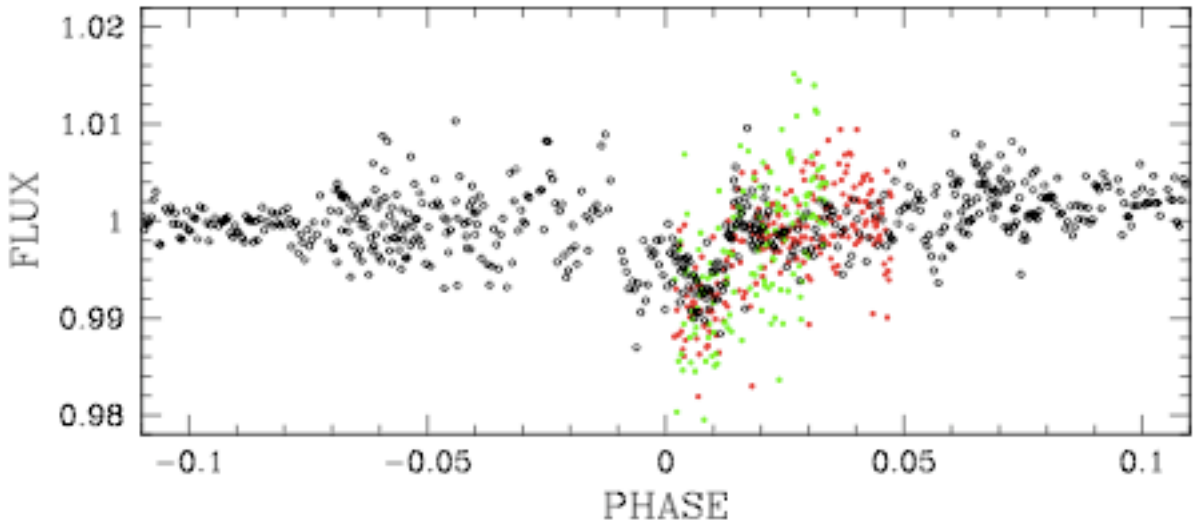


Fig. 1. OFXB (*black*) and Wise (*red: 1m, green: 46cm*) photometry phase-folded using the ephemerids and period presented in Maness et al. (2007).

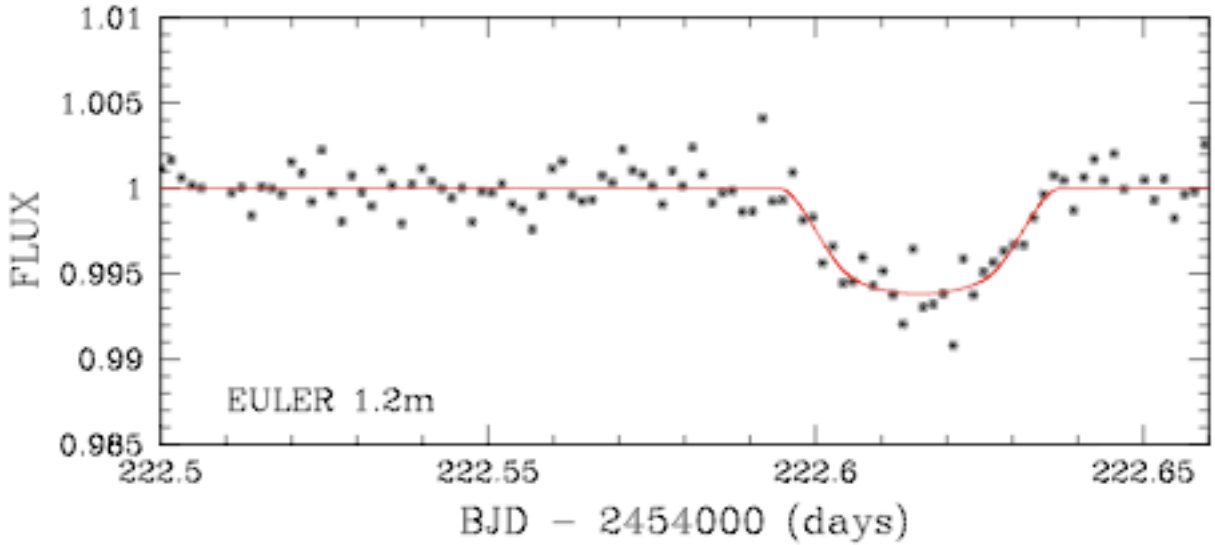
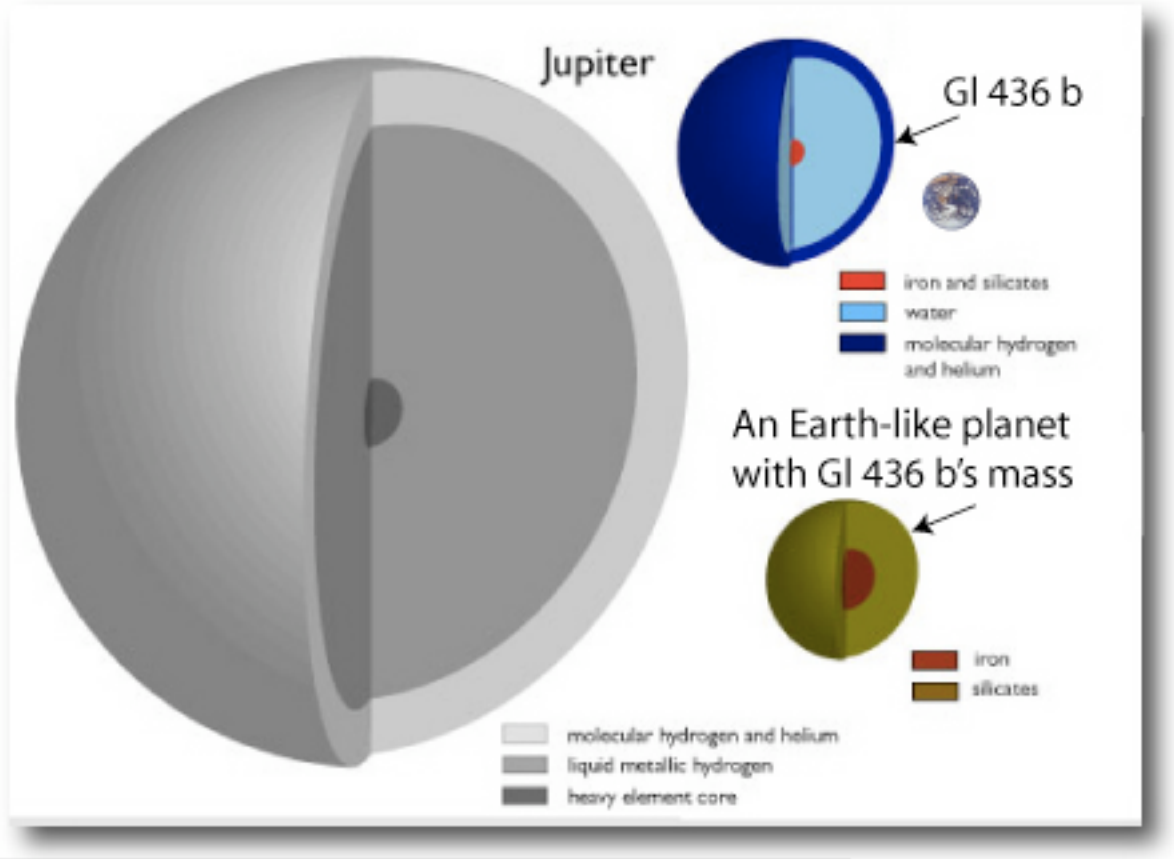
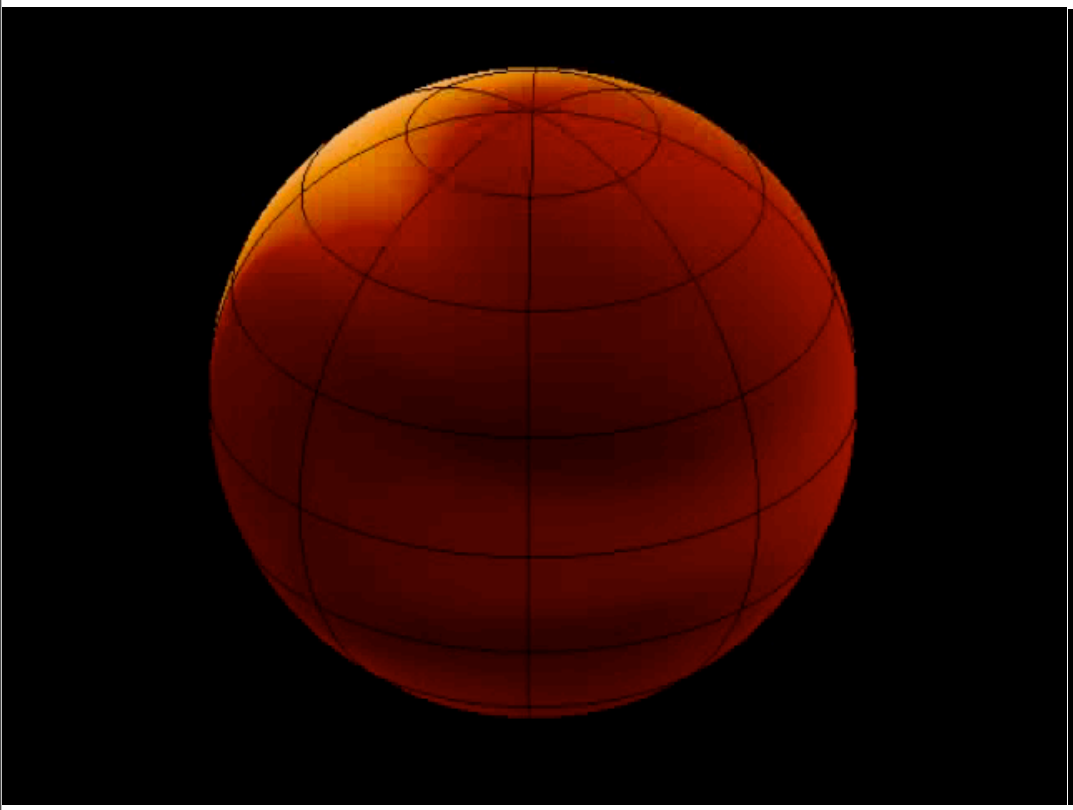


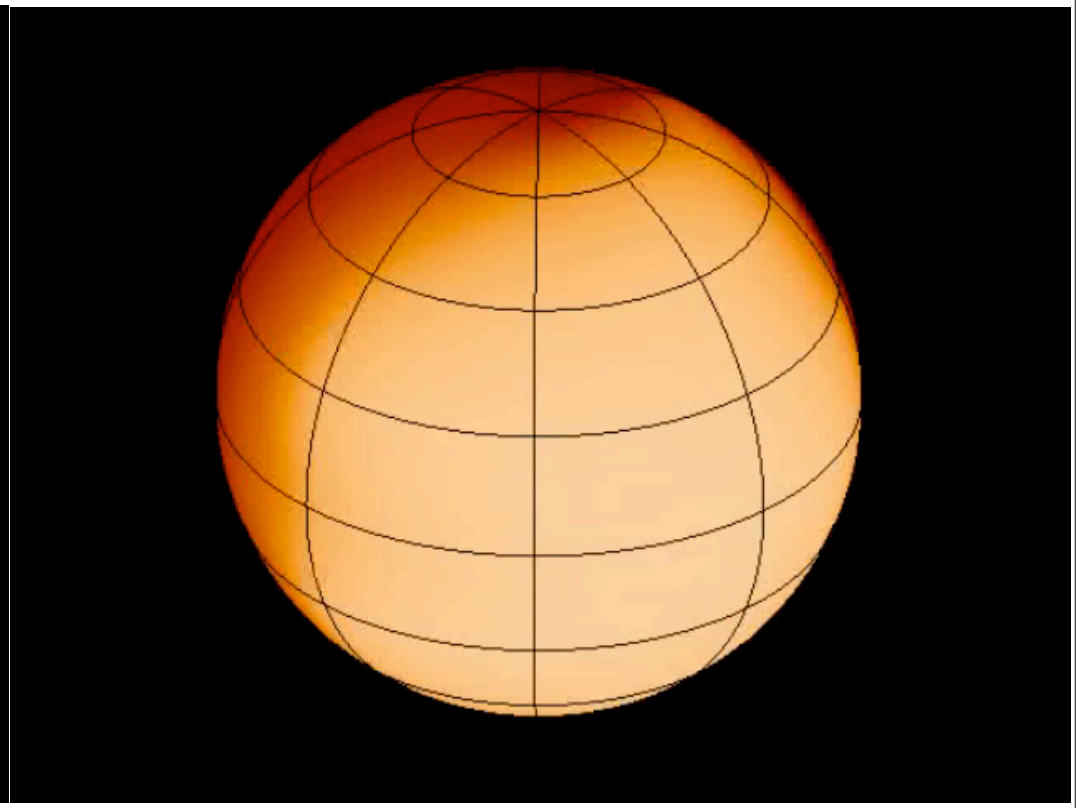
Fig. 2. Euler V-band transit photometry. The best-fit transit curve is superimposed in red.



Gl 436 is made mostly of water. It migrated to its current location

Weather forecast for Gl 436b (2 full orbits)

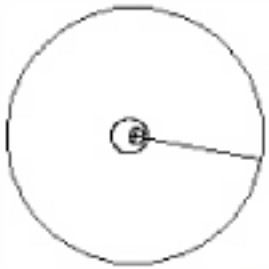
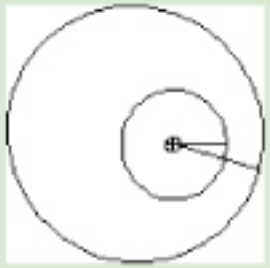
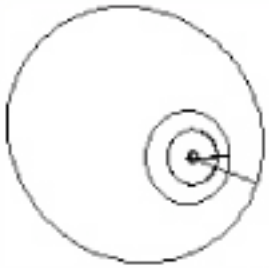
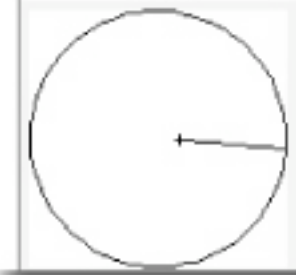


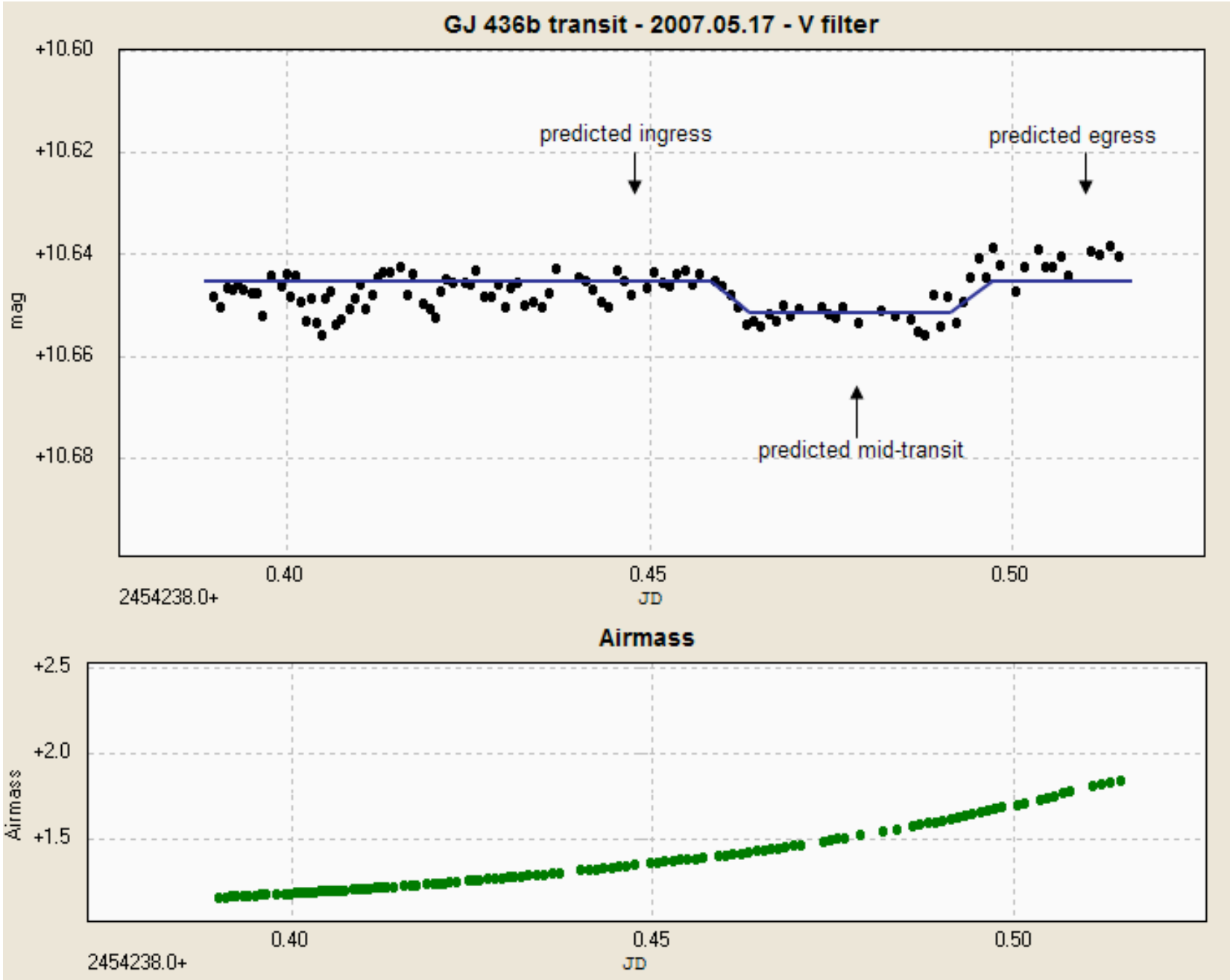


Western Hemisphere

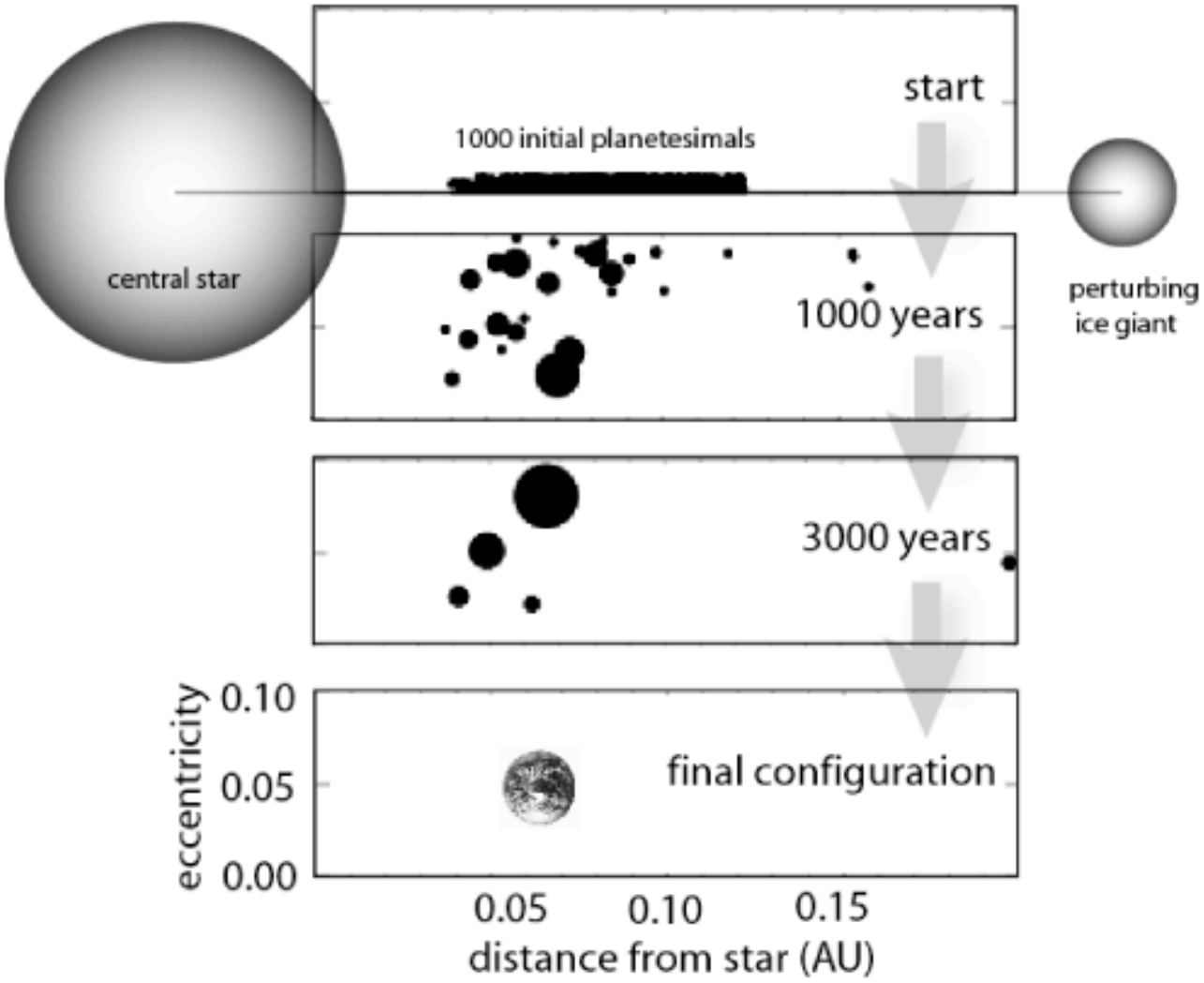
Eastern Hemisphere

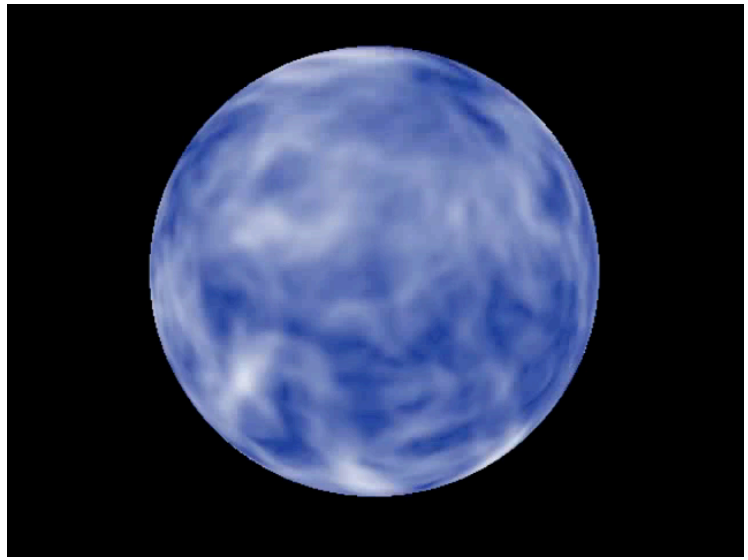
Stable fits for gj436_M07K

	χ^2	Planets	Uploaded on	by
	2.46	4	2006-12-16, 08:47:45	flanker
	Stable for at least 1000 years			
	2.72	3	2007-04-28, 02:59:25	schneidi
	Stable for at least 100 years			
	3.71	4	2006-12-14, 18:55:48	EricFDiaz
	Stable for at least 1000 years			
	4.40	1	2007-04-24, 05:36:14	eugenio
	Stable for at least 100 years			



Data taken last night by Tonny Vanmunster (Belgium)





Hydrodynamical simulation of the atmospheric flow on Gl 581

Our simulations of planet formation are indicating that it's very likely that Earth-size planets are common on short-period orbits around low-mass stars.

I predict that within a year, there will be an RV+photometric ground-based detection of a potentially habitable planet transiting an M dwarf.

www.oklo.org