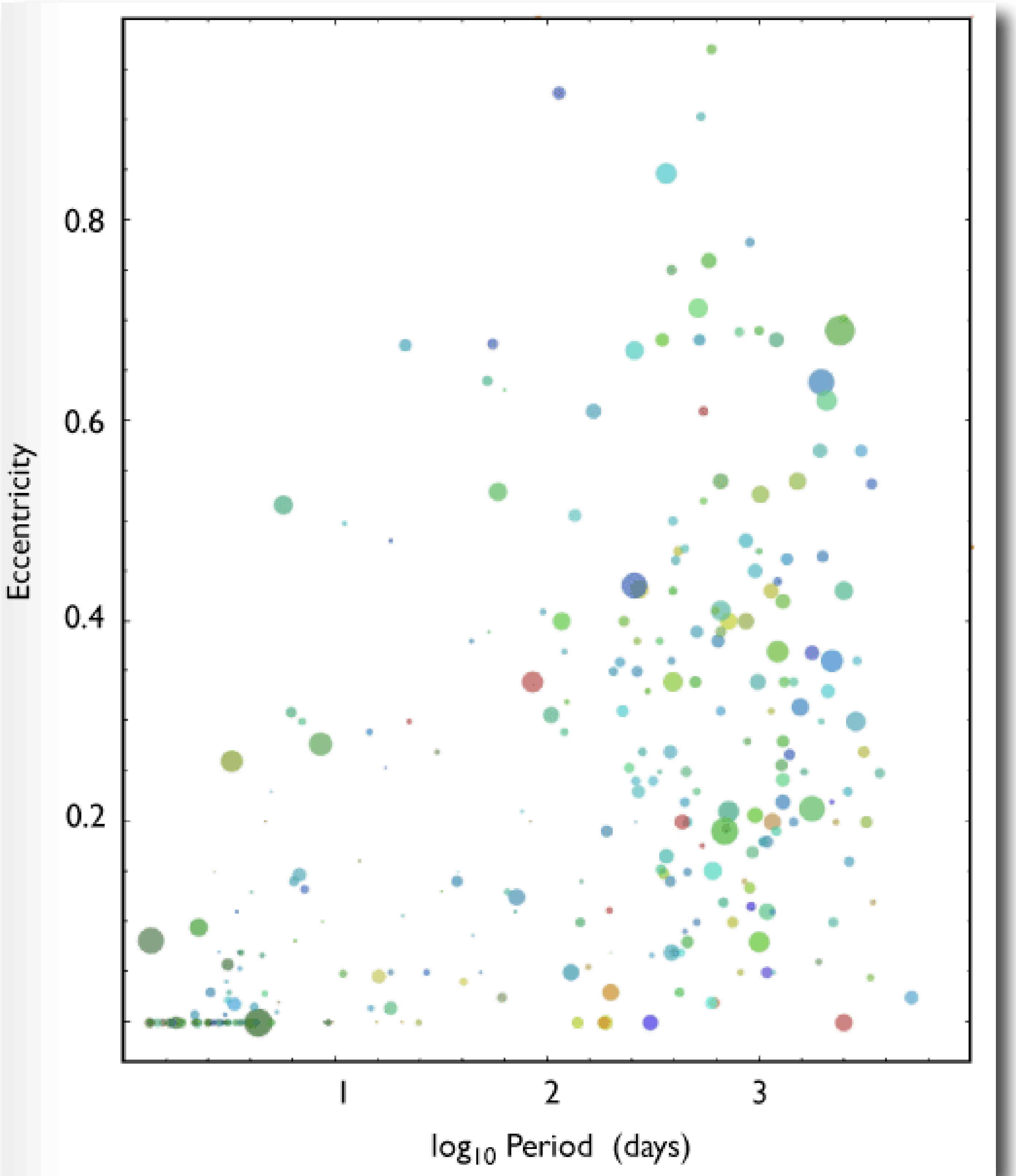
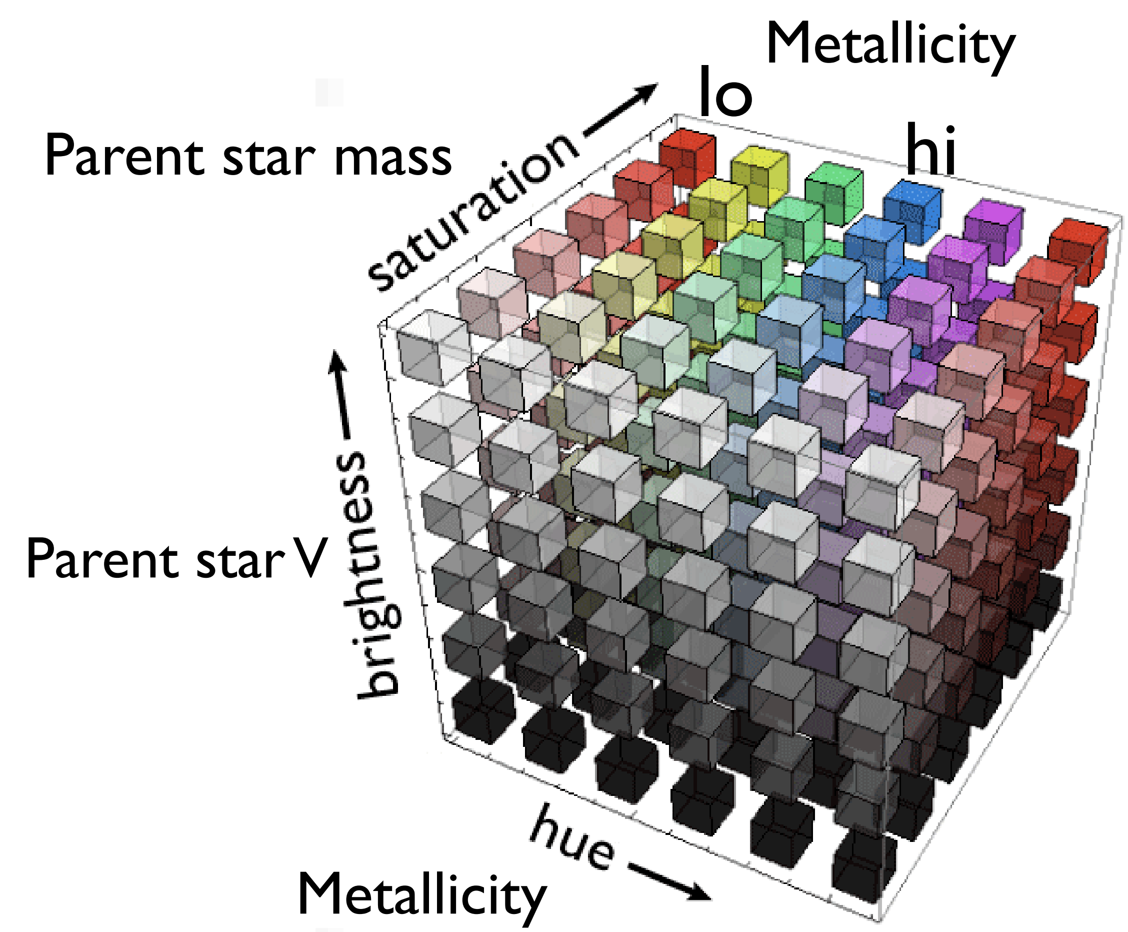
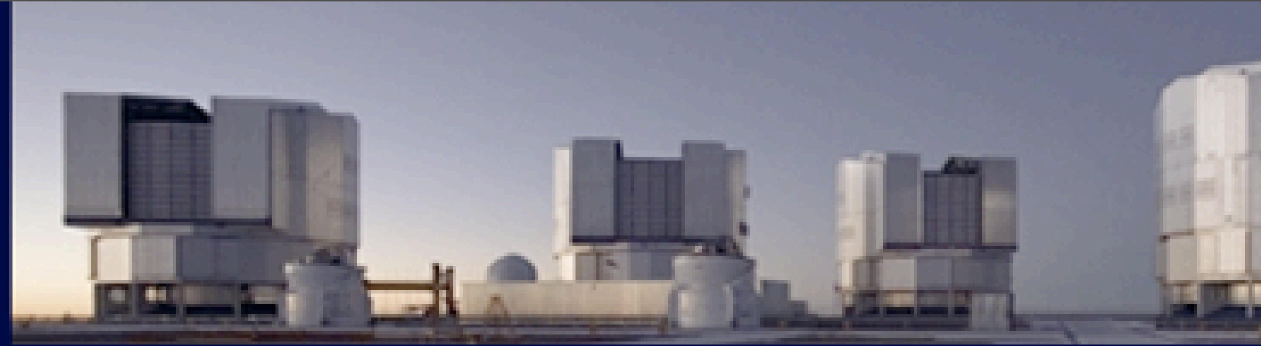


6D correlation diagram





Information from the European Southern Observatory

ESO Press Release 07/01

4 April 2001

For immediate release

Exoplanets: The Hunt Continues!

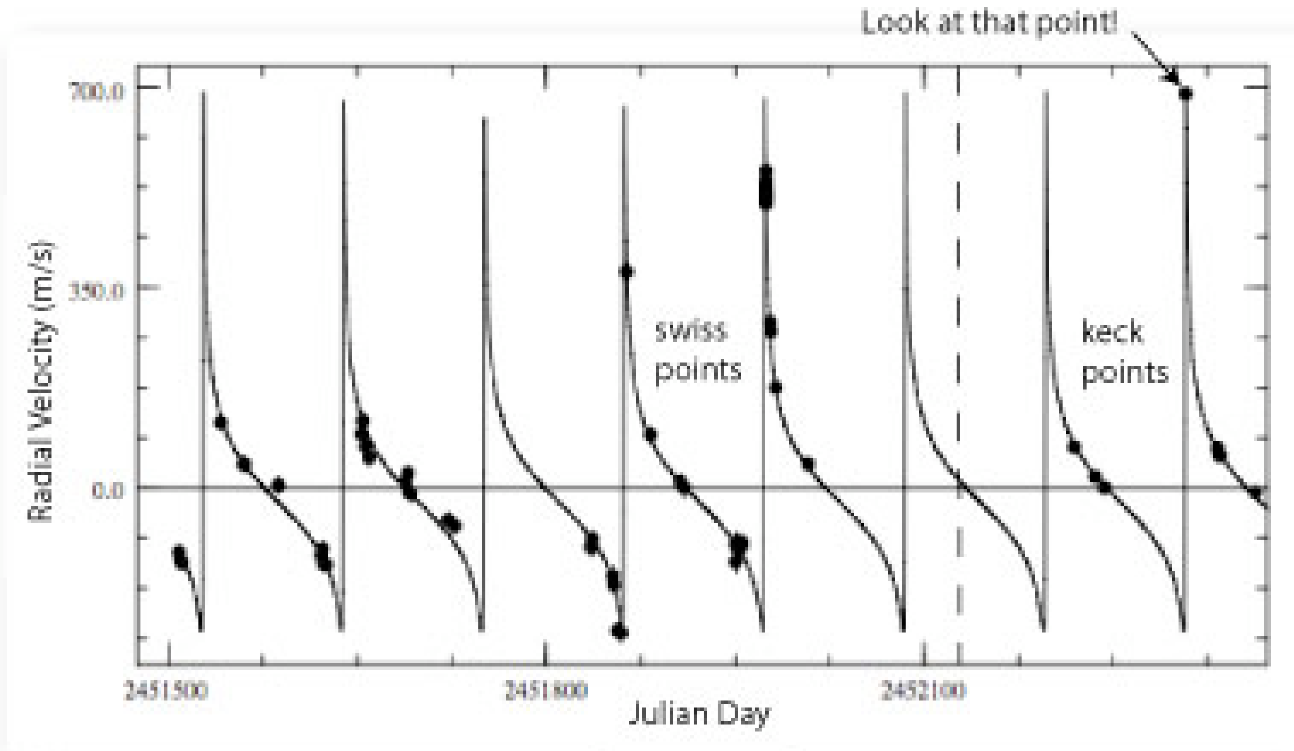
Swiss Telescope at La Silla Very Successful

Summary

The intensive and exciting hunt for planets around other stars ("exoplanets") is continuing with great success in both hemispheres.

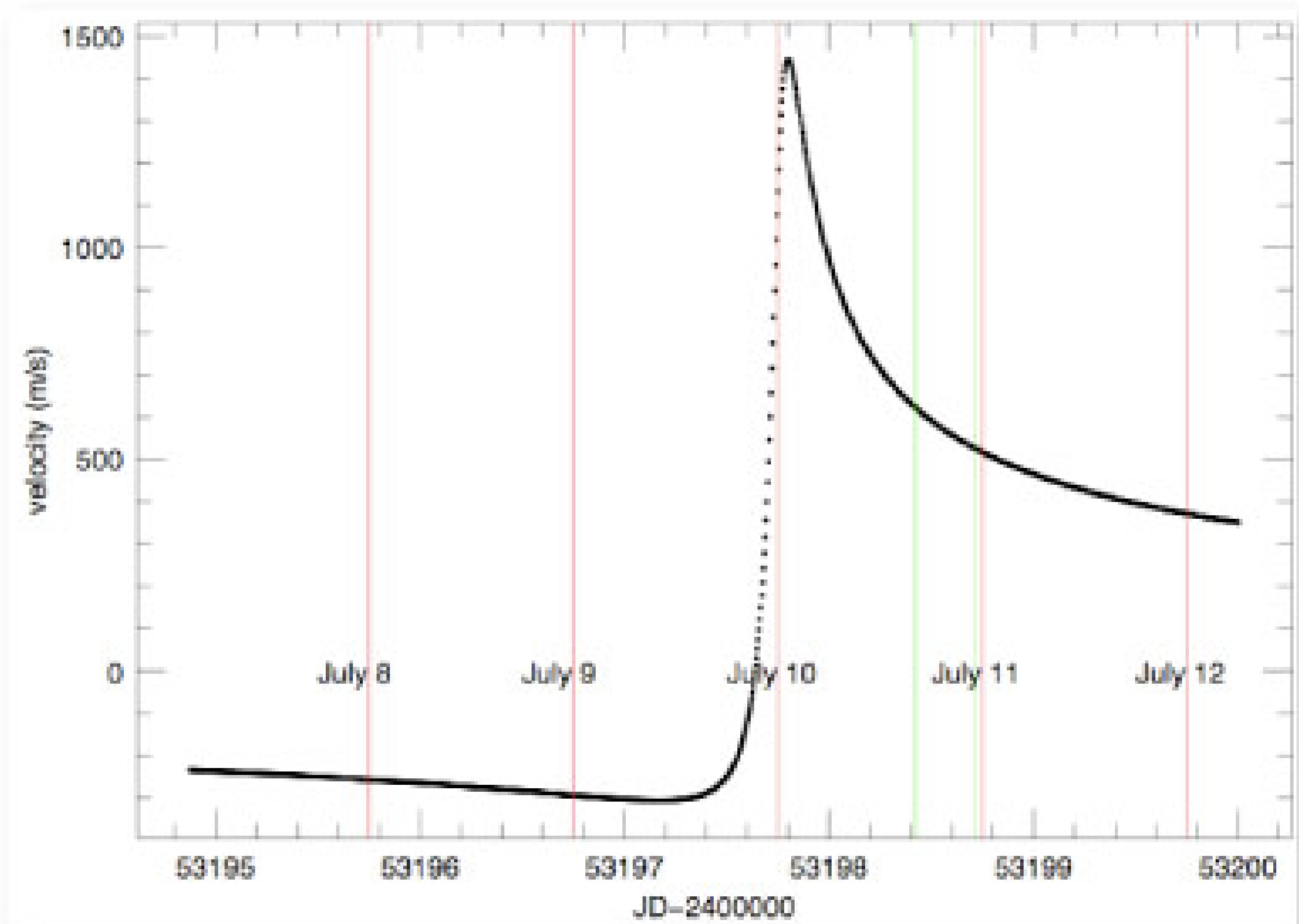
Today, an international team of astronomers from the Geneva Observatory and other research institutes [1] is announcing the discovery of no less than eleven new, planetary companions to solar-type stars, HD 8574, HD 28185, HD 50554, HD 74156, HD 80606, HD 82943, HD 106252, HD 141937, HD 178911B, HD 141937, among which two new multi-planet systems . The masses of these new objects range from slightly less than to about 10 times the mass of the planet Jupiter [2] .

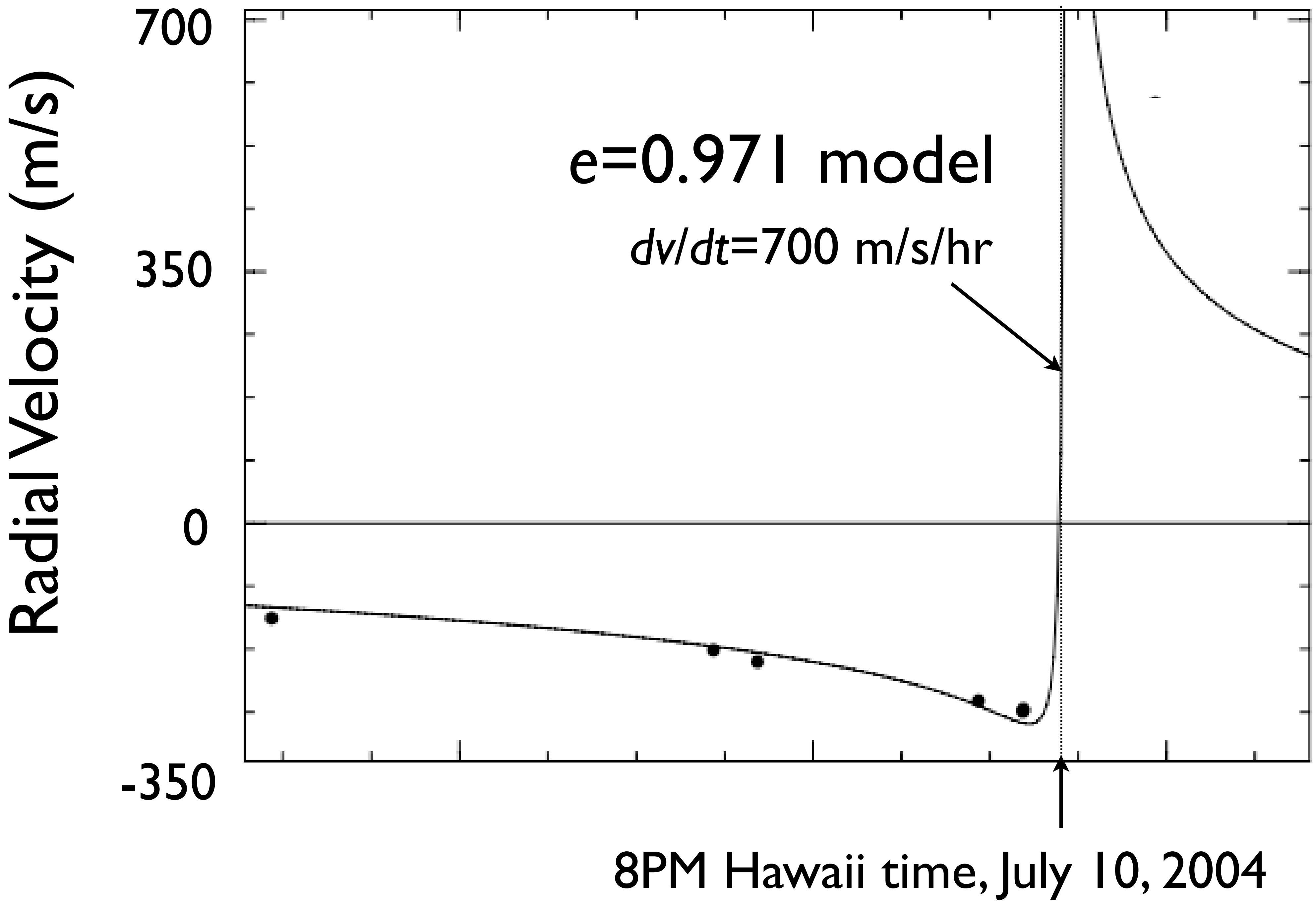
The new detections are based on measured velocity changes of the stars [3] , performed with the CORALIE spectrometer on the Swiss 1.2-m Leonard Euler telescope at the ESO La Silla Observatory , as well as with instruments on telescopes at the Haute-Provence Observatory and on the Keck telescopes on Mauna Kea (Hawaii, USA).



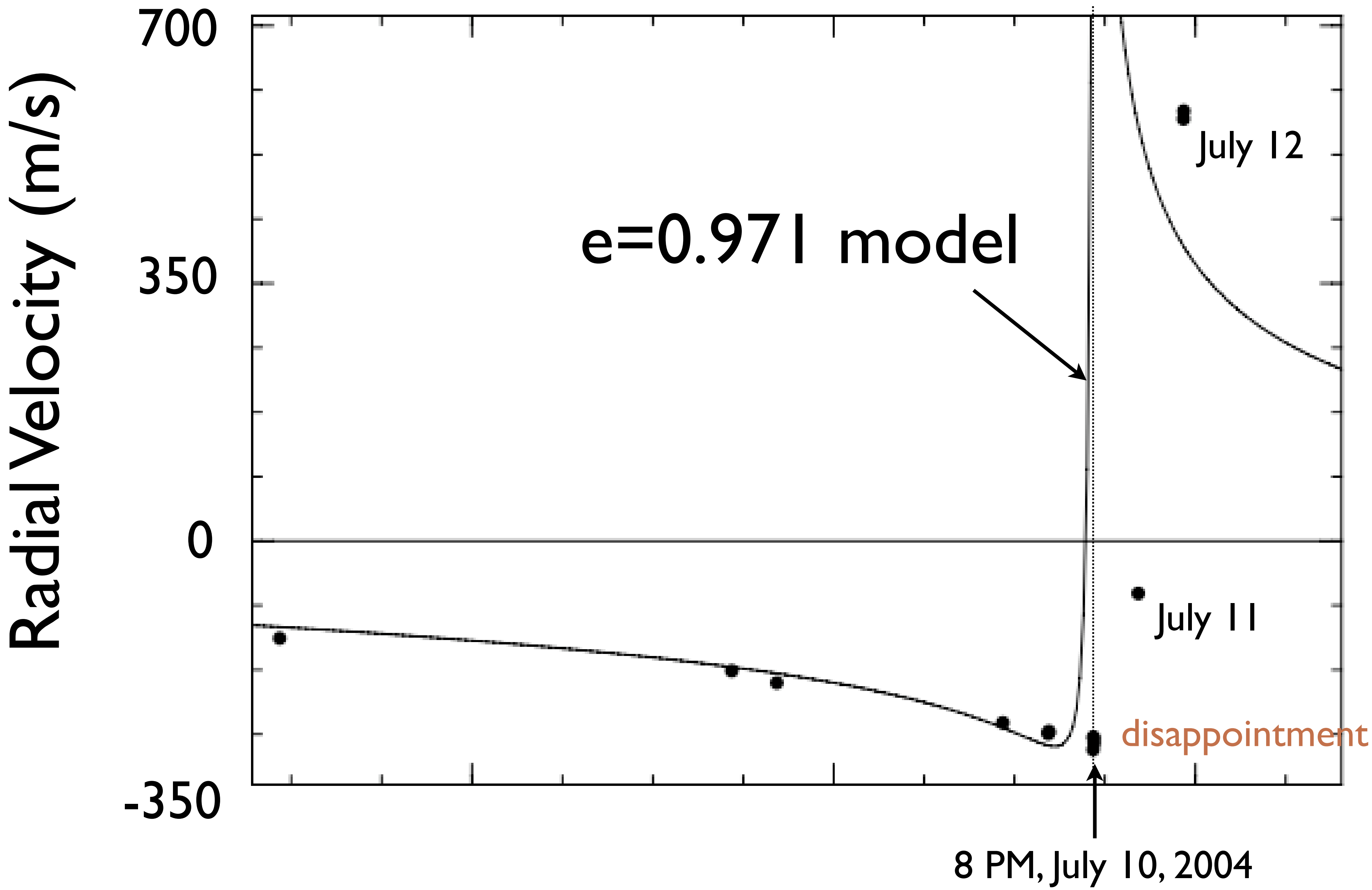
The initial Keck observations of HD 80606 suggested an eccentricity for b of e=0.971 +/- 0.017! This would have put periastron passage at a staggering 2.5 stellar radii.

Serendipitously, Doppler Planet Search time at Keck was scheduled for 5 successive nights in July 2004. HD 80606 was just visible at dusk (dec=+60, HA>5) during these nights. The best fit to the radial velocity data predicted that the periastron swing would occur on July 10th.



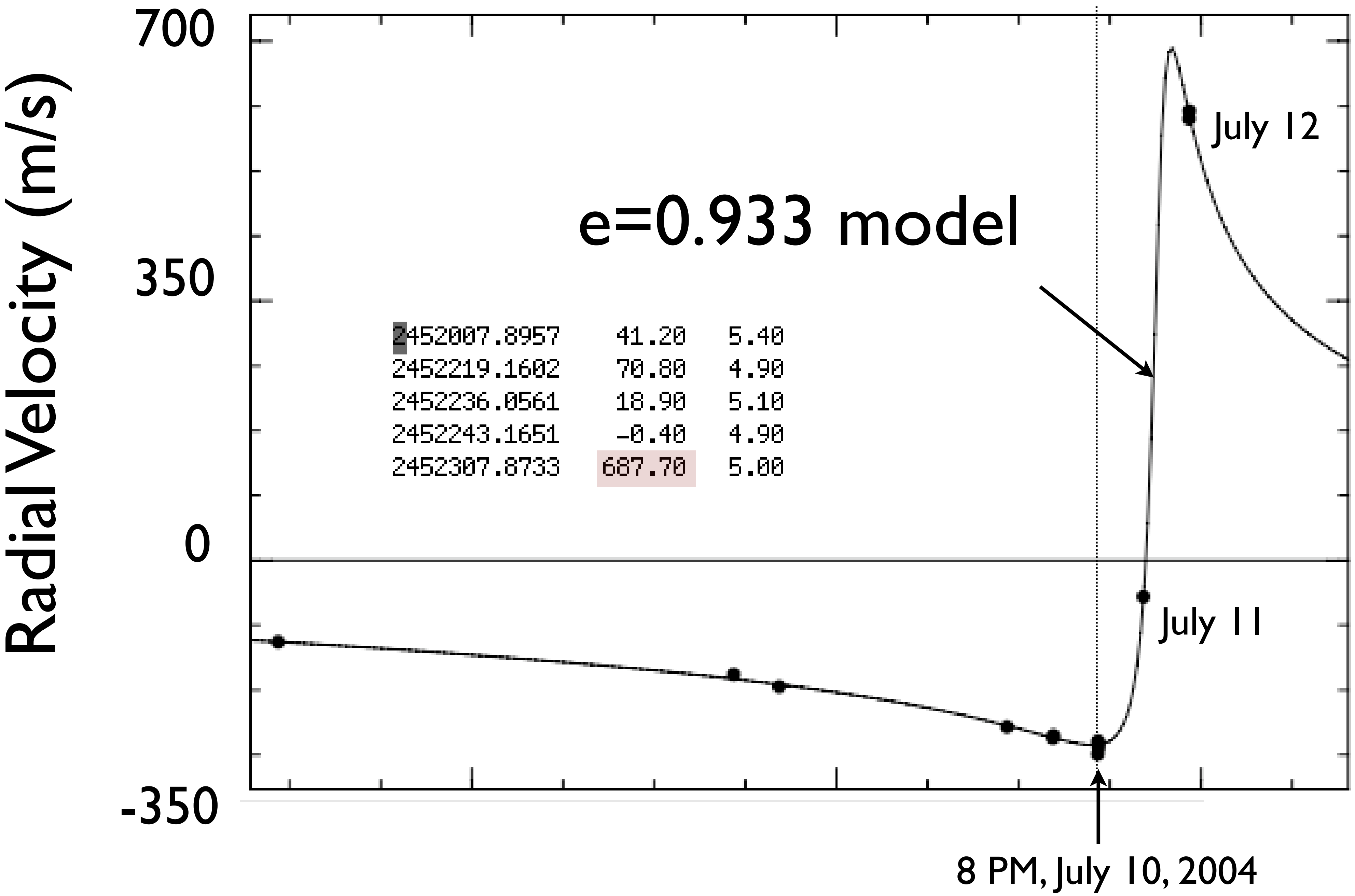


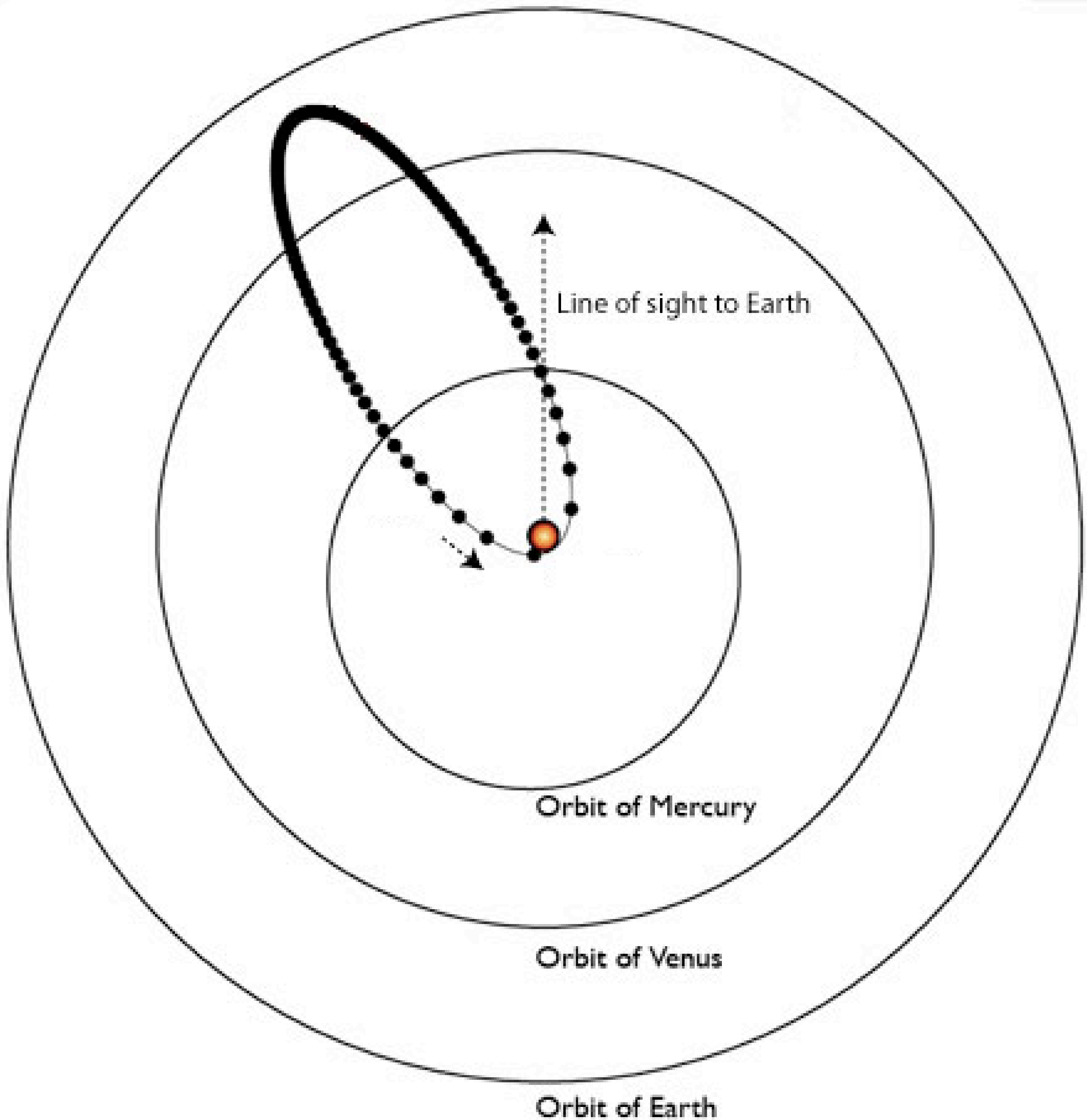
700
350
0
-350
Radial Velocity (m/s)
e=0.971 model
dv/dt=700 m/s/hr
8PM Hawaii time, July 10, 2004



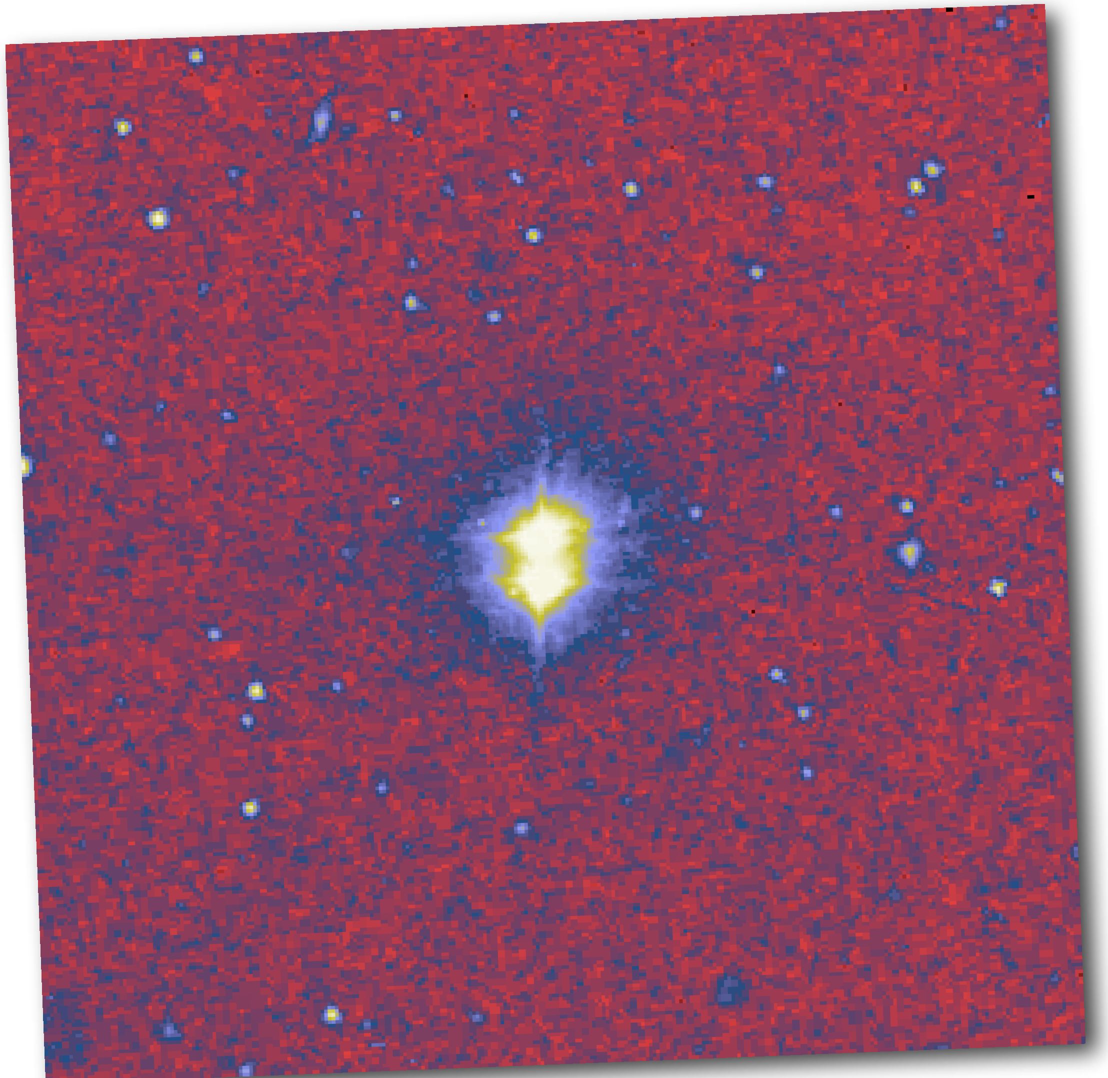
Radial Velocity (m/s)
700
350
0
-350
e=0.971 model
July 12
July 11
disappointment
8 PM, July 10, 2004

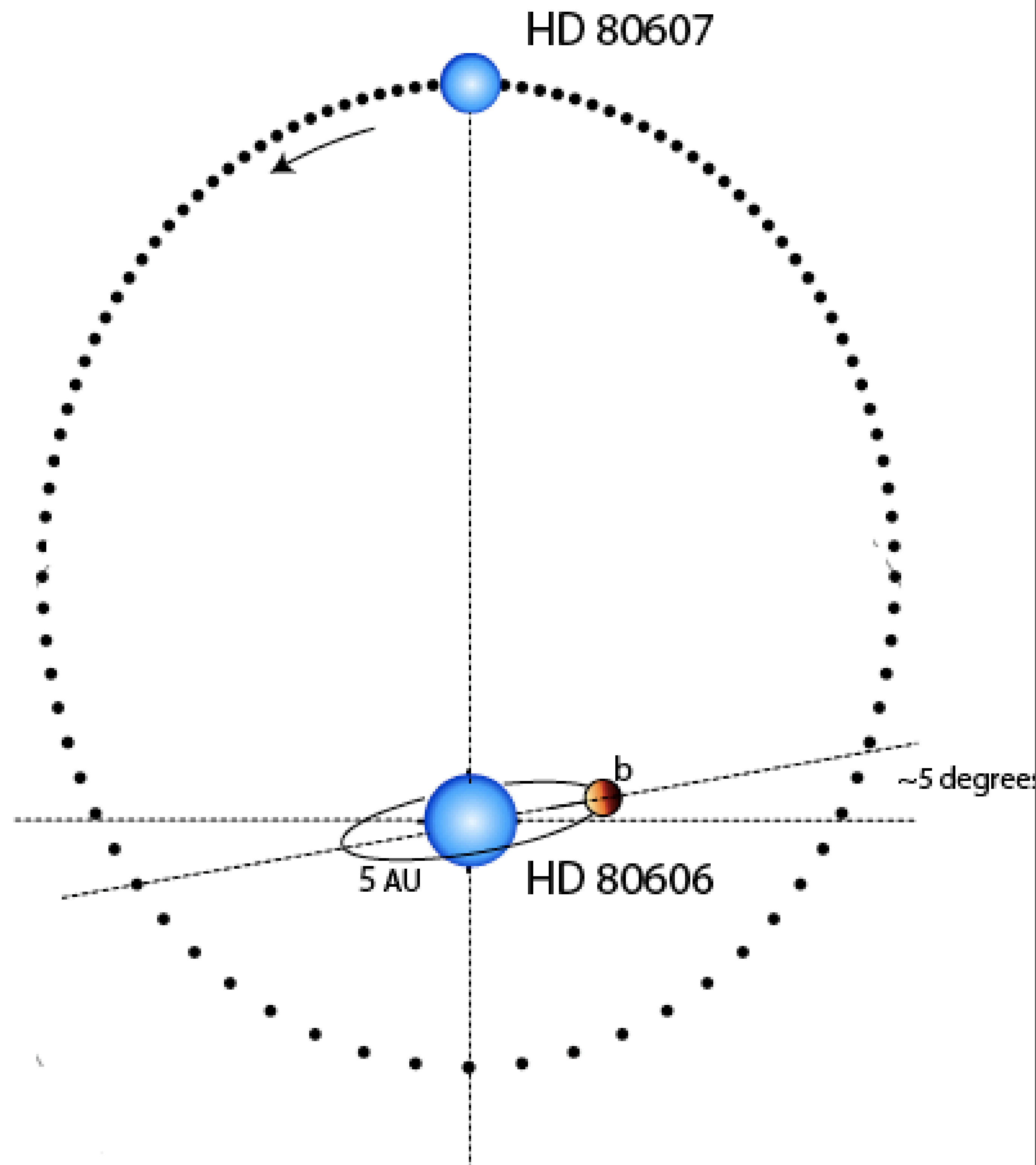
The best fit to the data has an eccentricity of "only" 0.933. A random observation has a less than 1 in 2000 chance of seeing radial velocity as high as 687 m/s (5th Keck velocity).





HD 80606b has a P=111.4 day orbital period, a semi-major axis, a=.45 AU, e=0.934, $M\sin(i)$=4 Mjup, and a periastron distance, $a(1-e)$~7 stellar radii. A "lukewarm Jupiter" is being hauled in periodically for detailed inspection...





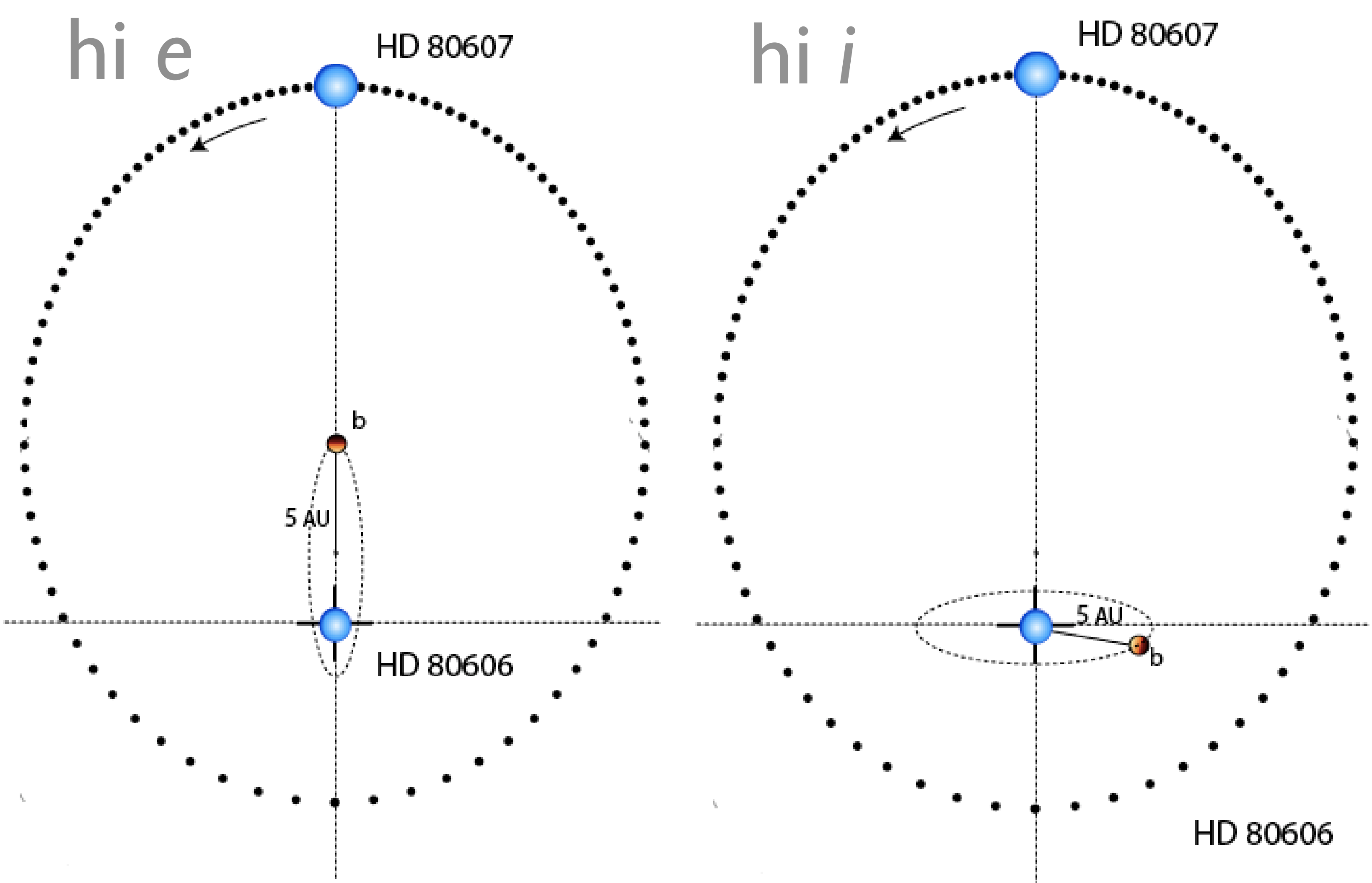
HD 80606 & HD 80607

~1000 AU Separation

In the Wu & Murray (2003) theory, the planet forms in a disk at ~5AU with a modest eccentricity of e~0.1 The disk is within 5 degrees of being perpendicular to the e~0.5 binary orbital plane.

The Kozai effect

If we neglect the mass of the planet, then the planet conserves $\Theta = (1 - e_p^2)^{1/2} \cos I$ during its motion. (This *Kozai integral* is related to the Jacobi energy and the Tisserand relation in the circular restricted 3-body problem.)

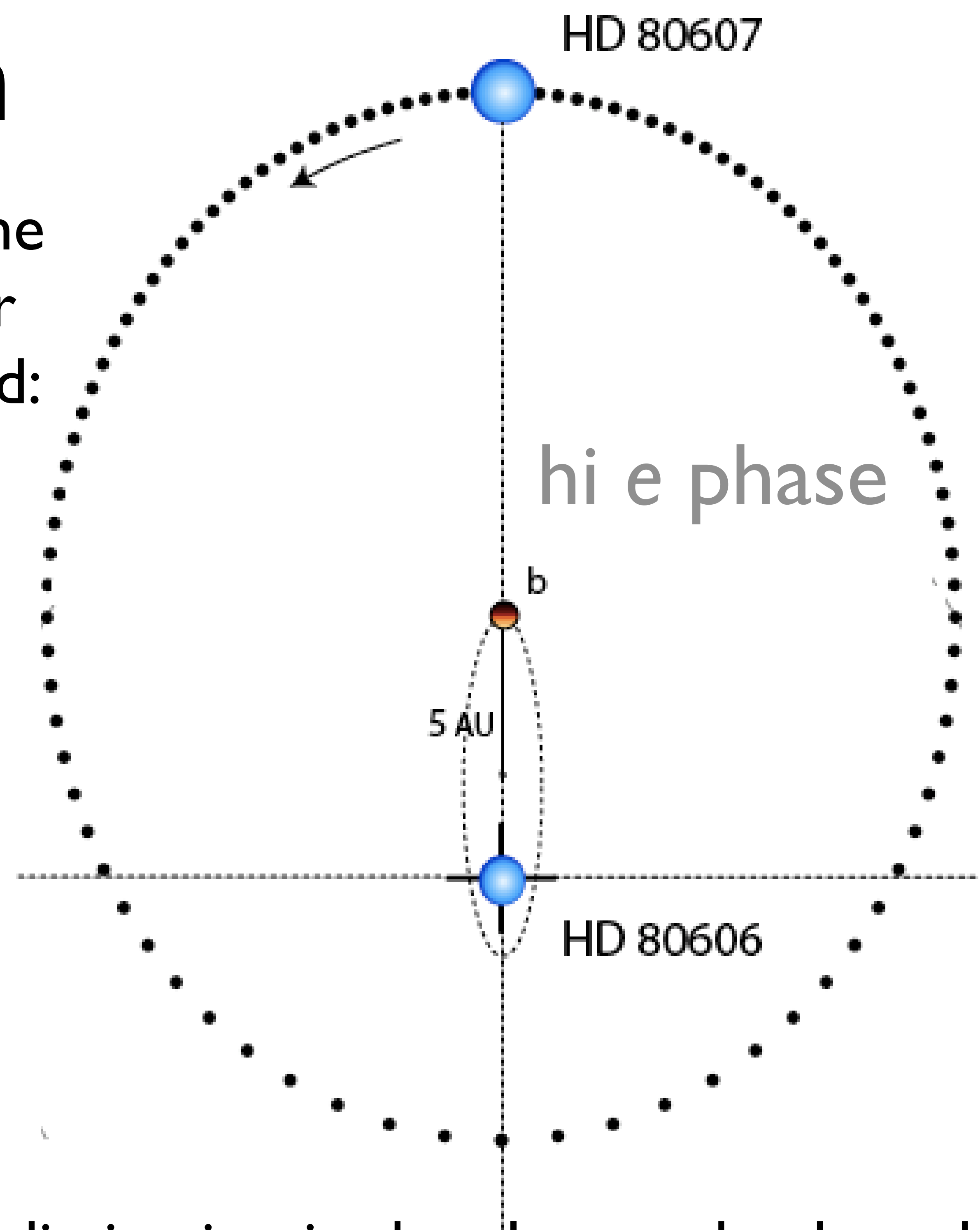


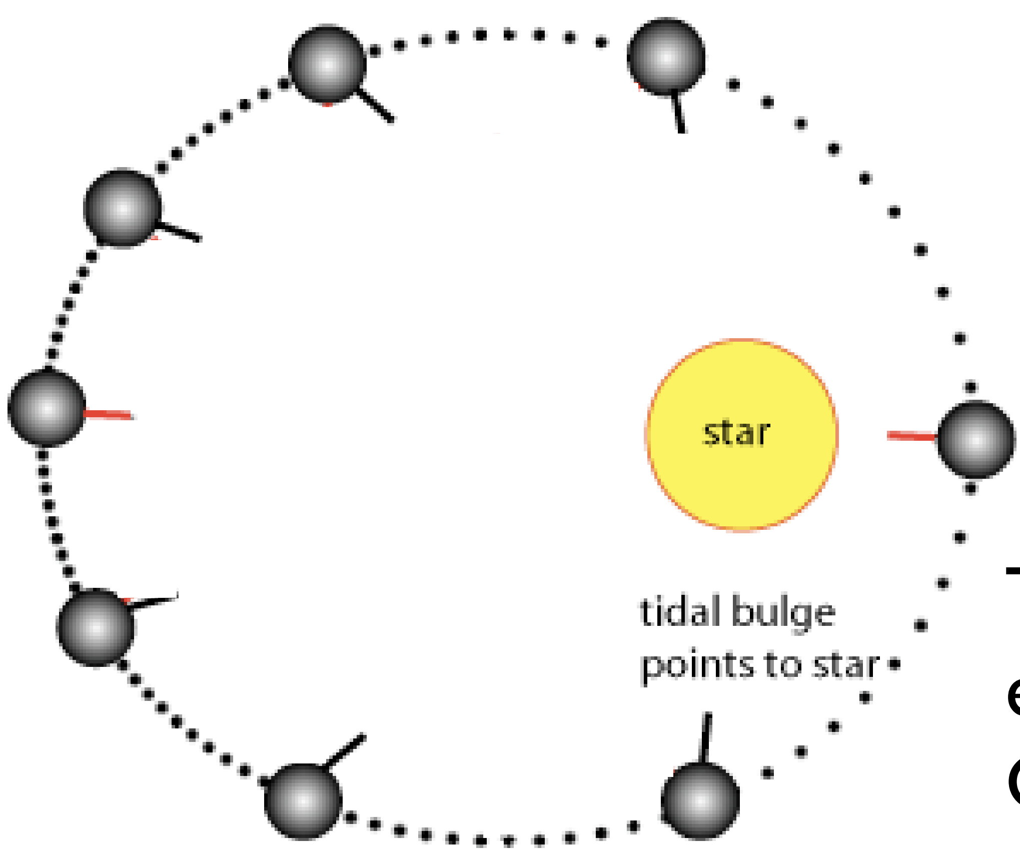
Stability analysis shows that if the initial inclination of the planetary to binary orbit is greater than *I=39*.5 deg, then large oscillations in e and *I* occur over secular time scales.

Tidal Circularization

During high-e phase, the component of the planet's angular momentum perpendicular to the binary plane is fairly well conserved:

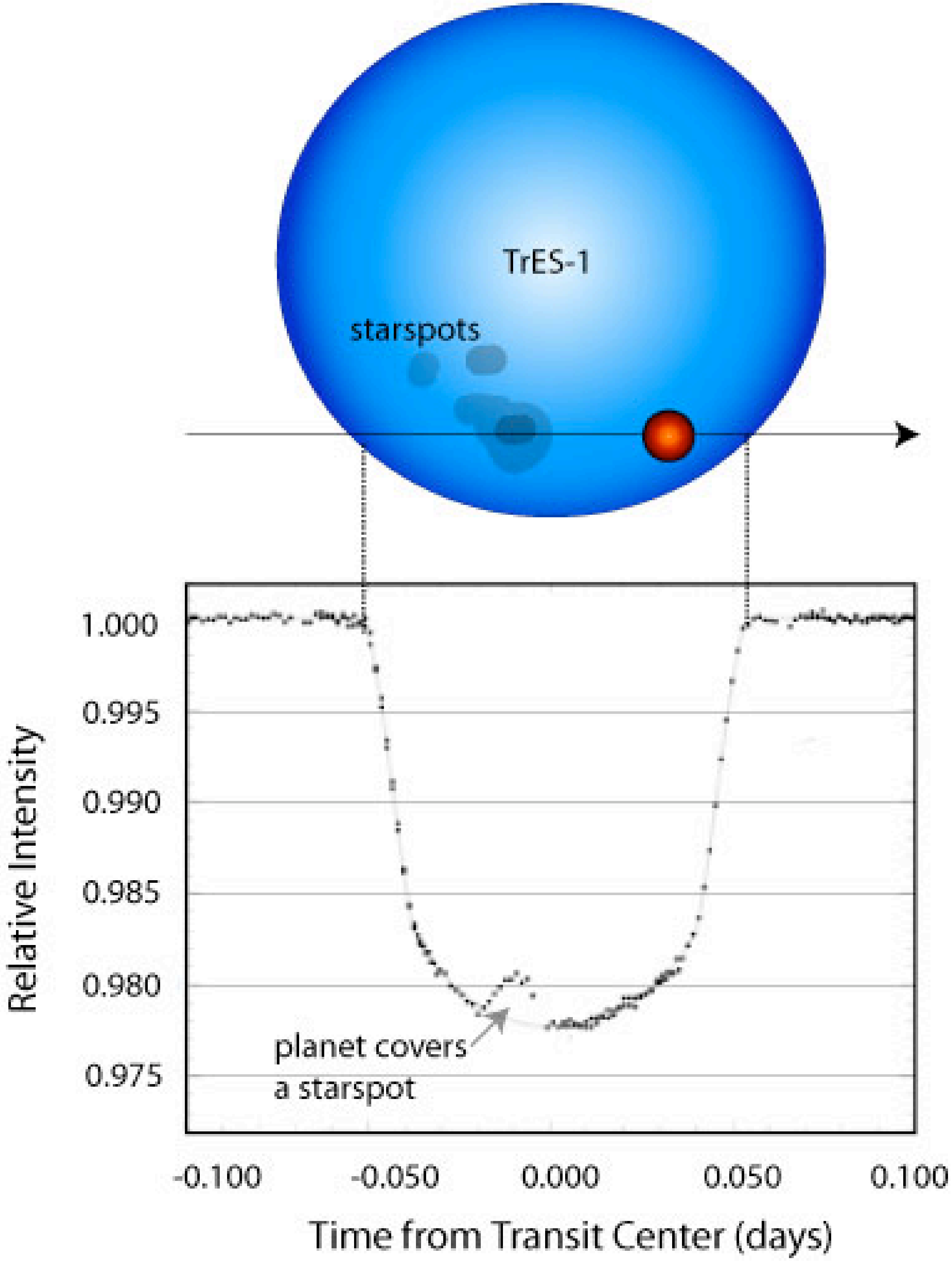
$$J = (GM_\star a_p)^{1/2} M_p (1 - e_p^2)^{1/2}$$





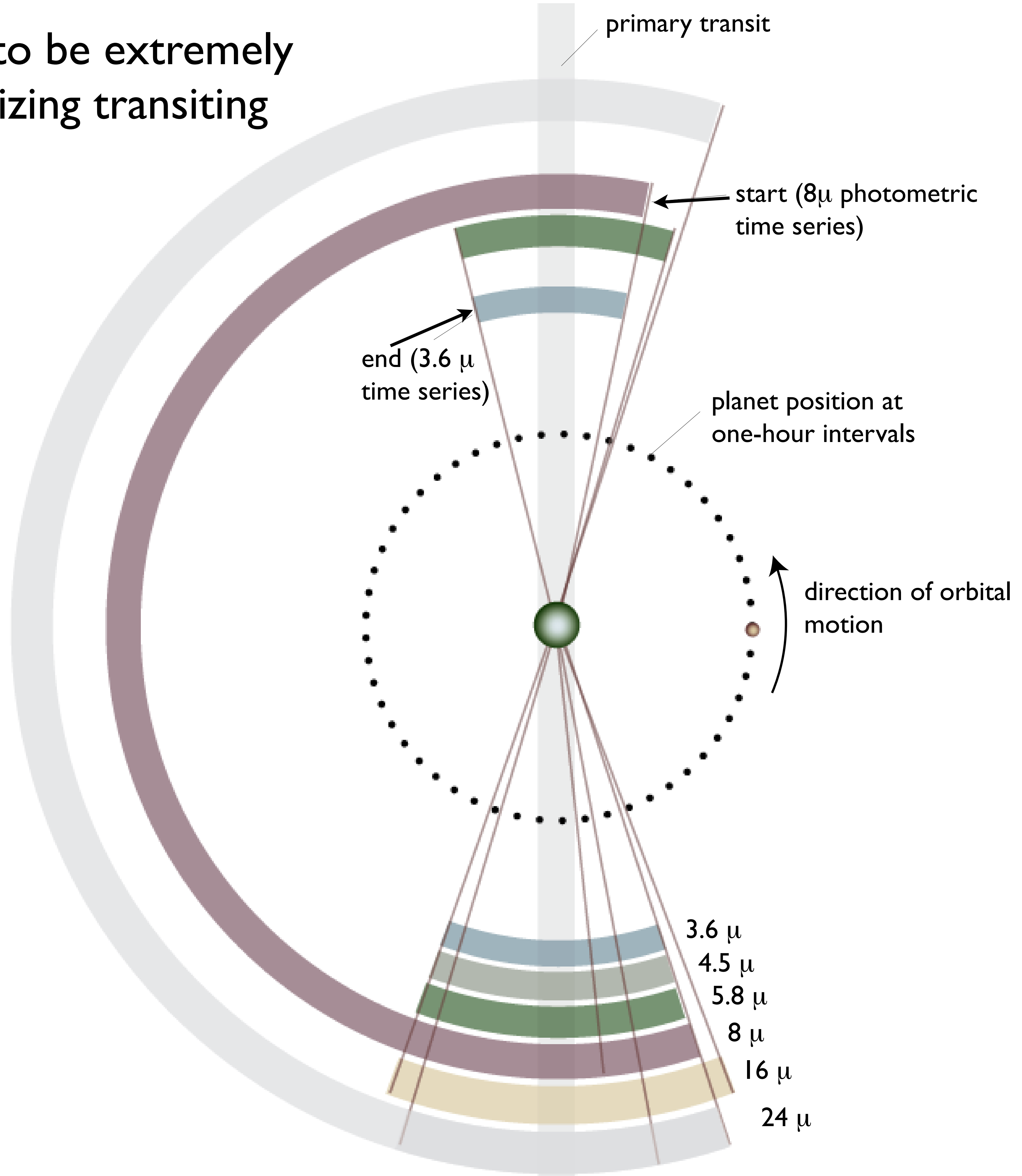
Tidal dissipation in the planet robs the orbit of energy, and hence decreases *a* when e is high. Conservation of *J* enforces a constant *a*(1-*e*) at each successive hi-e cycle.

Keep HD 80606b in mind. I’ll come back to it.

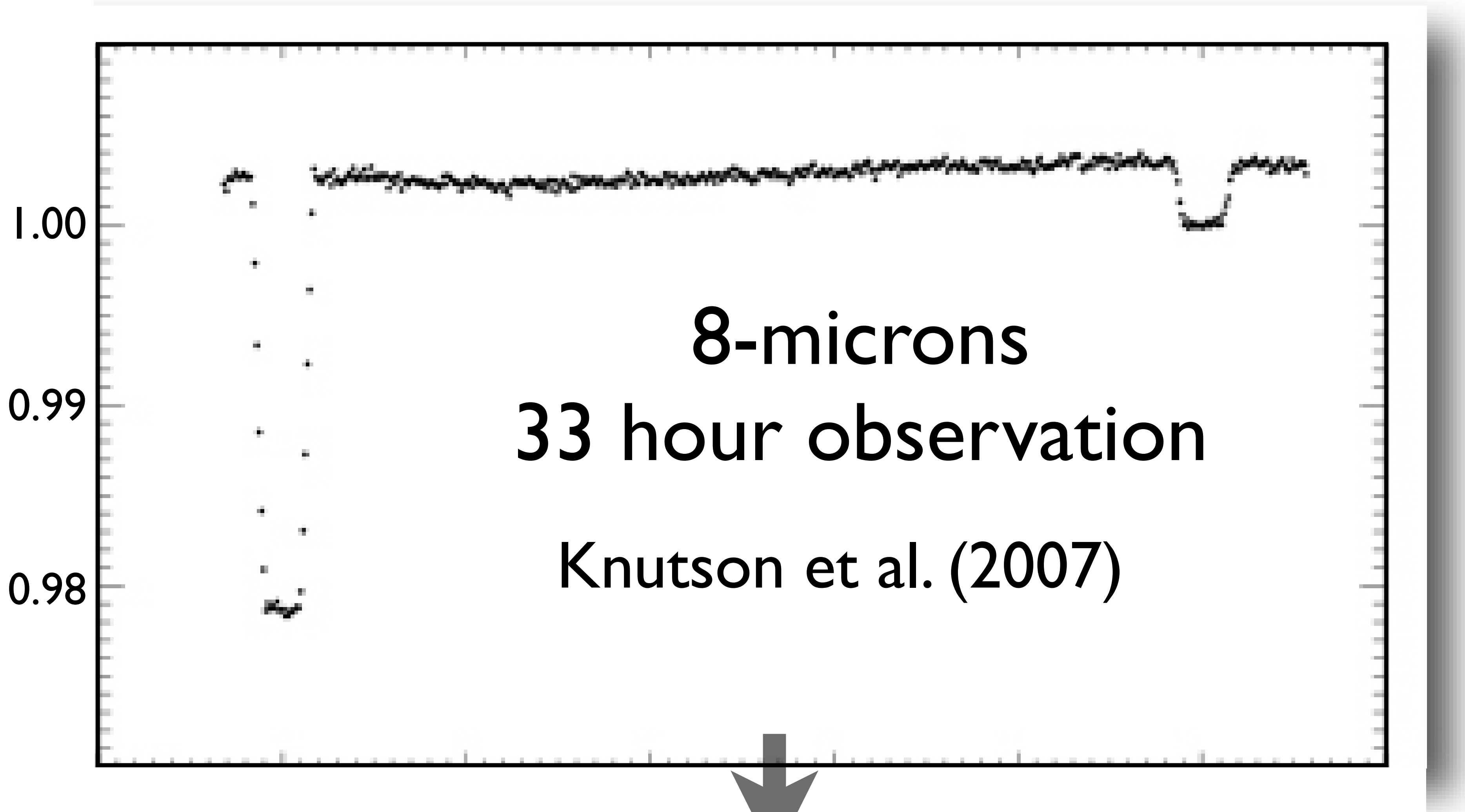


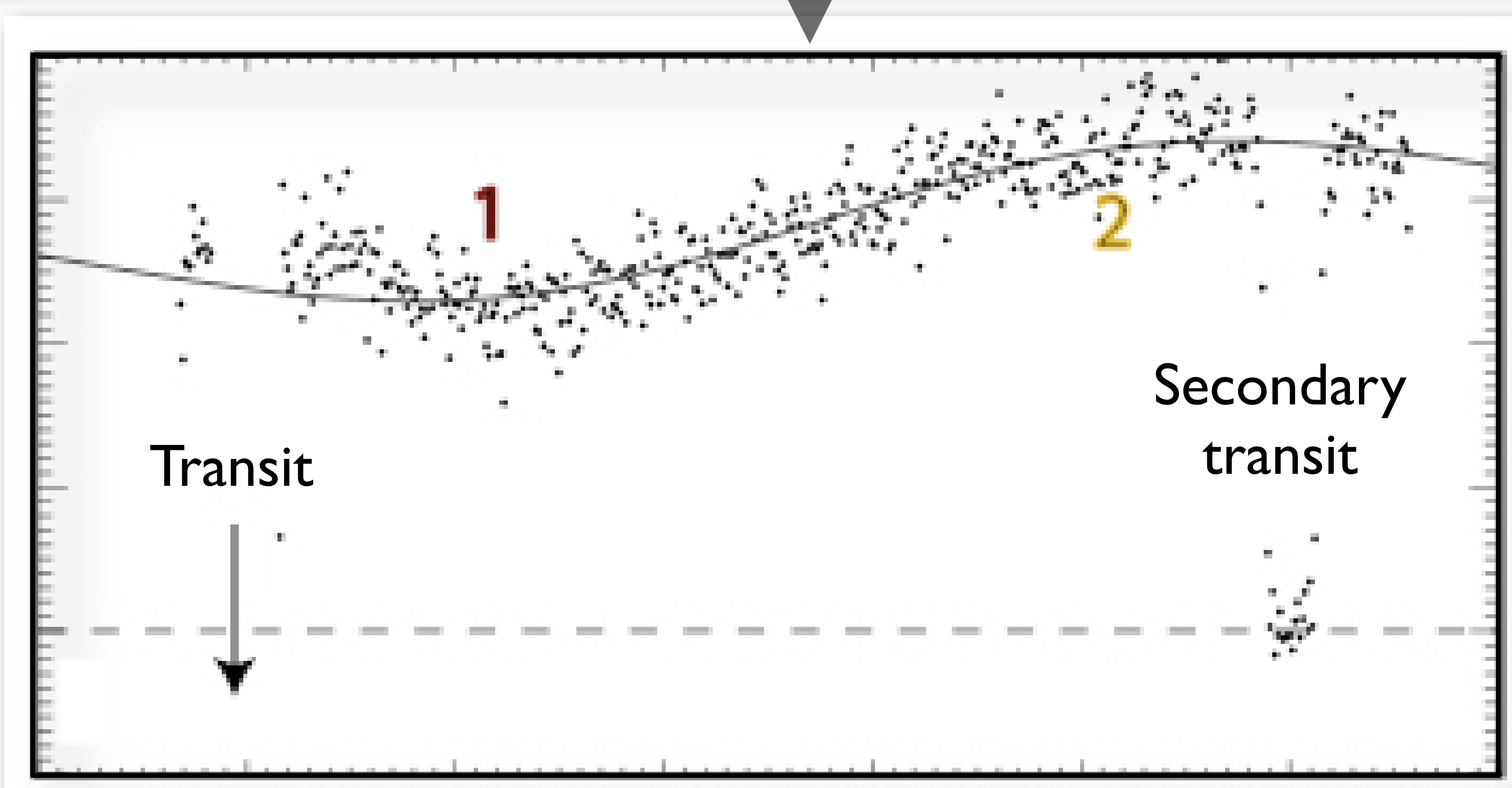
Transiting planets are now responsible for ~50% of the detection rate.

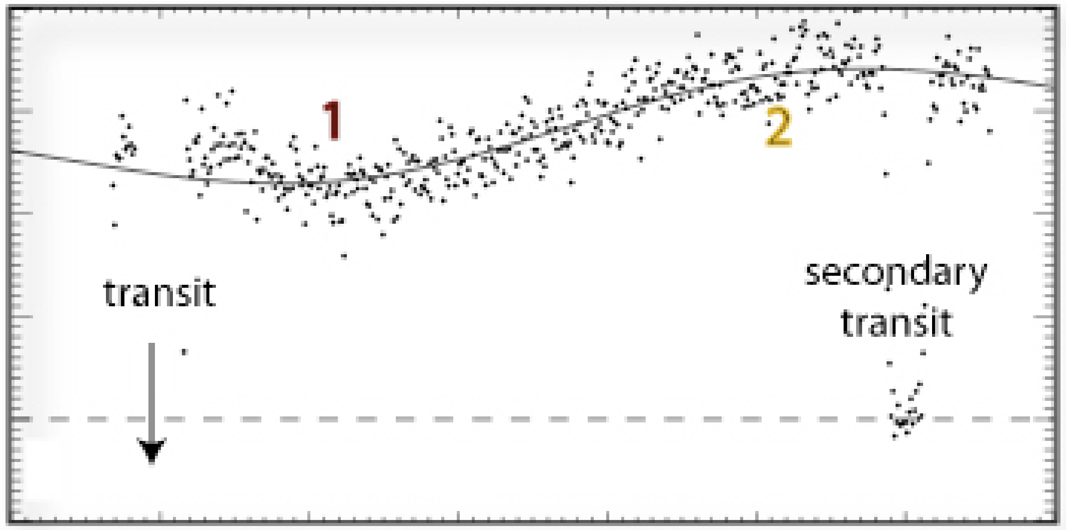
Spitzer has proved to be extremely useful for characterizing transiting exoplanets

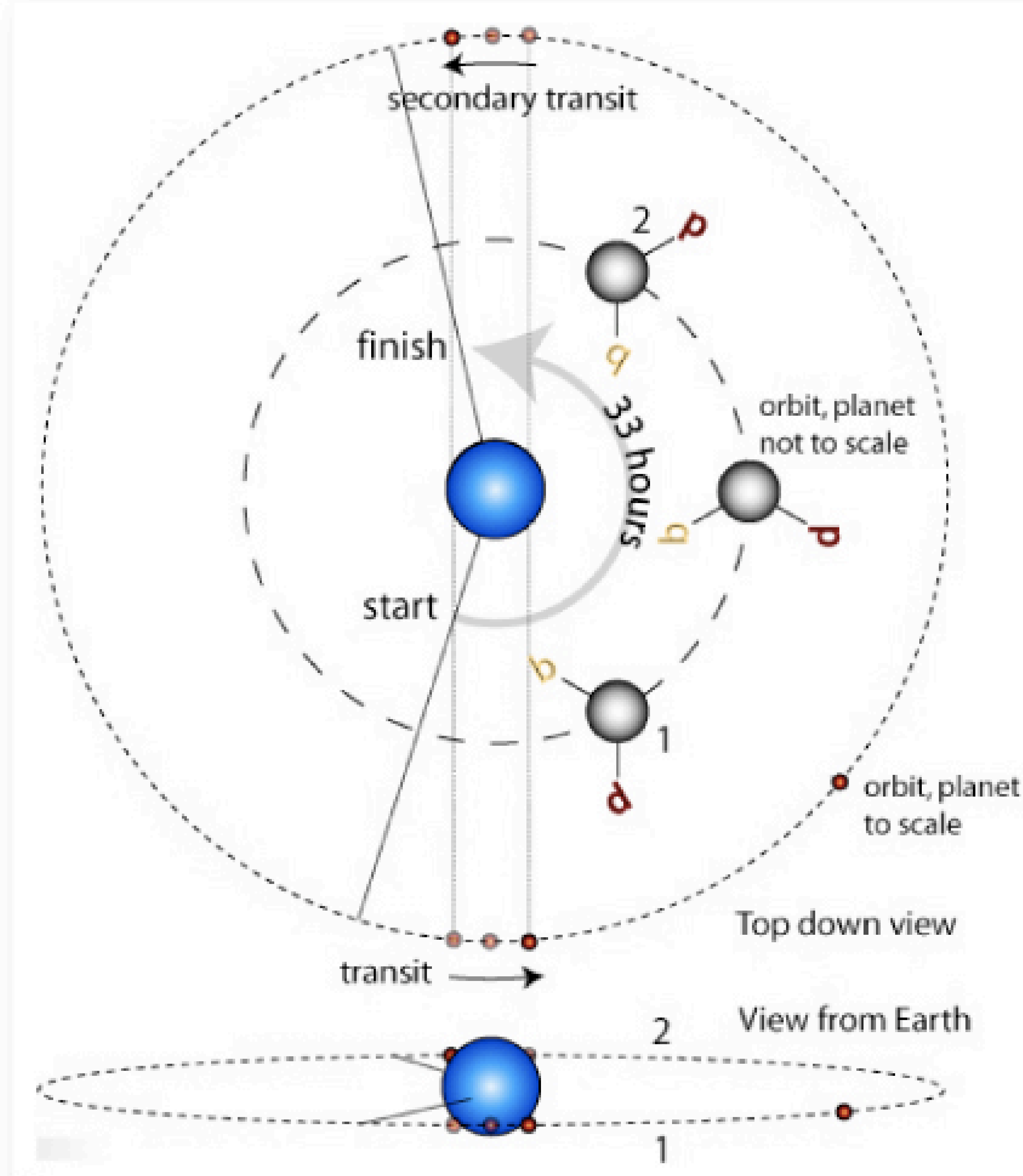


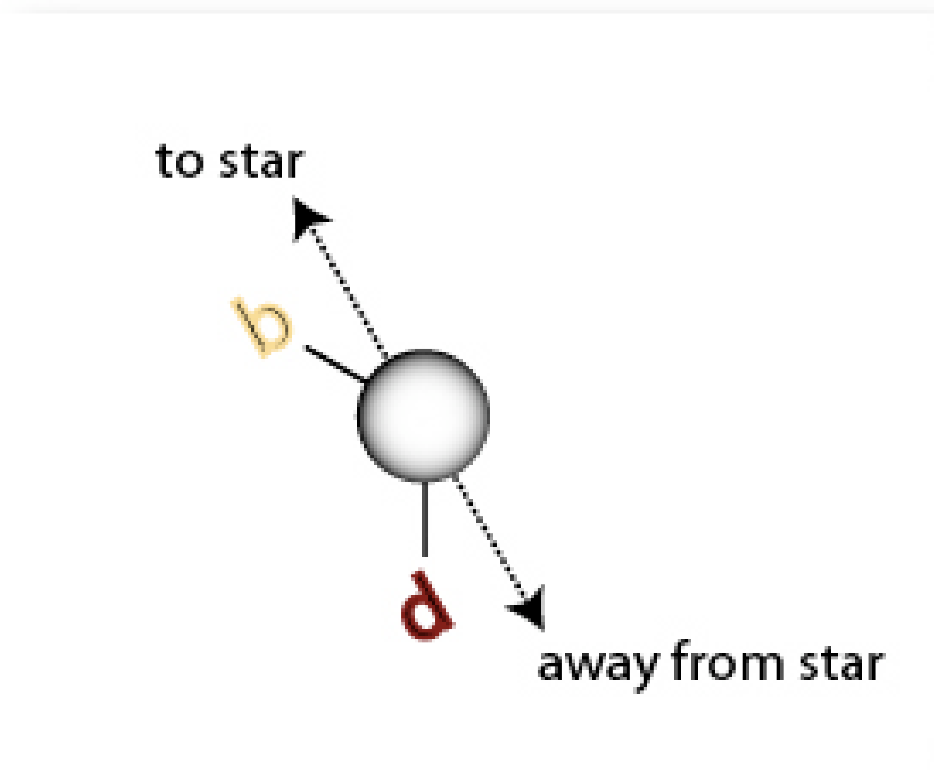
HD 189733


1.00
0.99
0.98
8-microns
33 hour observation
Knutson et al. (2007)

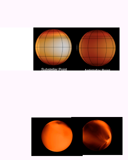

1
2
Transit
Secondary
transit







Interpretation of the result: Hottest and coldest spots are on the same side of the planet. First resolved "image" of an extrasolar planet. →



We think this is a reasonable back-of-the-envelope description of what's happening at the infrared photospheres of strongly irradiated planets:

$$\frac{\partial \mathbf{v}}{\partial t} = -\mathbf{v} \cdot \nabla \mathbf{v} - \left(\frac{\alpha_2(1-\alpha_2/2)}{(1-\alpha_2)^2} \right) \mathbf{v} \nabla \cdot \mathbf{v} - R\alpha_1 \nabla T - 2\Omega_{\mathrm{rot}} \sin\theta (\hat{n} \times \mathbf{v})$$

$$\frac{\partial T}{\partial t} = -\mathbf{v} \cdot \nabla T - k \left(\frac{1-\alpha_2/2}{1-\alpha_2} \right) T \nabla \cdot \mathbf{v} + f_{\mathrm{rad}}.$$

$$\alpha_1 \equiv \ln(p_b/p)$$

$$\alpha_2 \equiv 1/(1+\alpha_1)$$

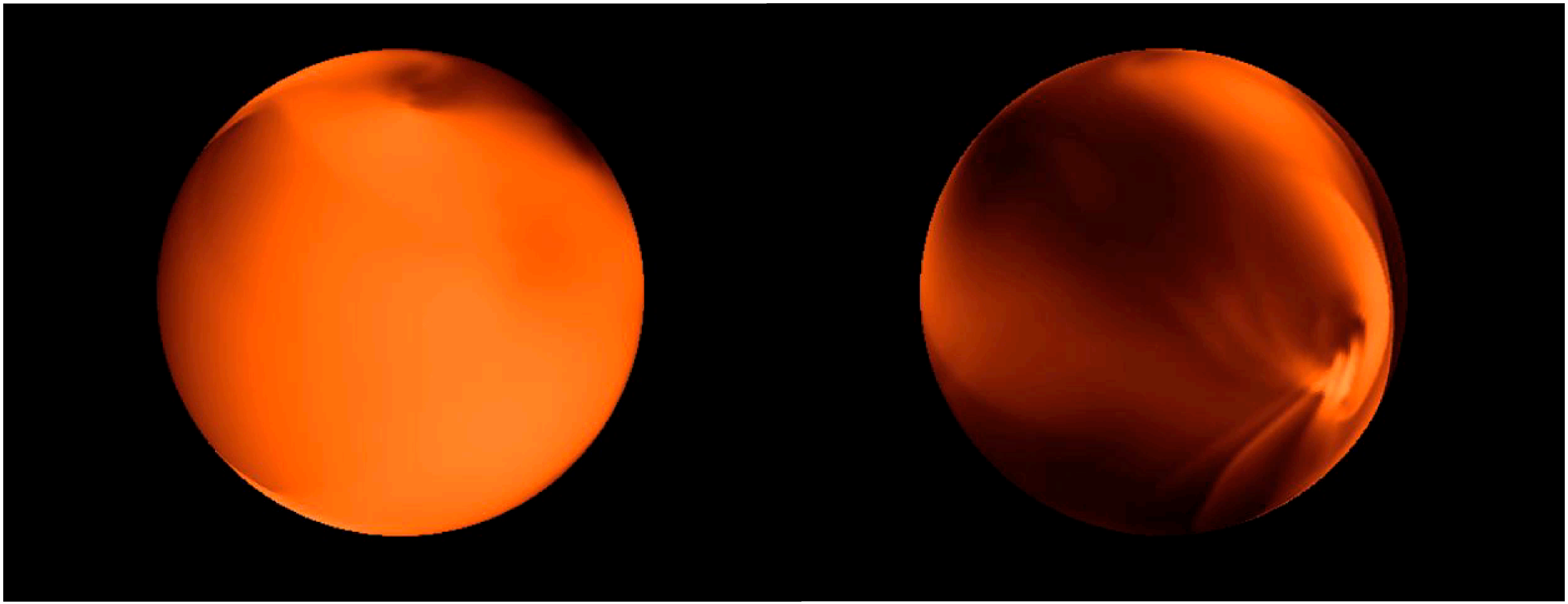
$$F_{\mathrm{pen}} = (1-A)(1-X) \left(\frac{L_*}{16\pi a^2 \sqrt{1-e^2}} \right)$$

$$T_{\mathrm{n}} = \left(\frac{F_{\mathrm{pen}}}{\sigma} + T_{\mathrm{int}}^4 \right)^{1/4}$$

$$f_{\mathrm{rad}} = \left(\frac{\sigma g}{p c_p} \right) \left(X(1-A) \left(\frac{L_*}{4\pi\sigma a^2} \right) \cos\alpha + T_{\mathrm{n}}^4 - T^4 \right).$$

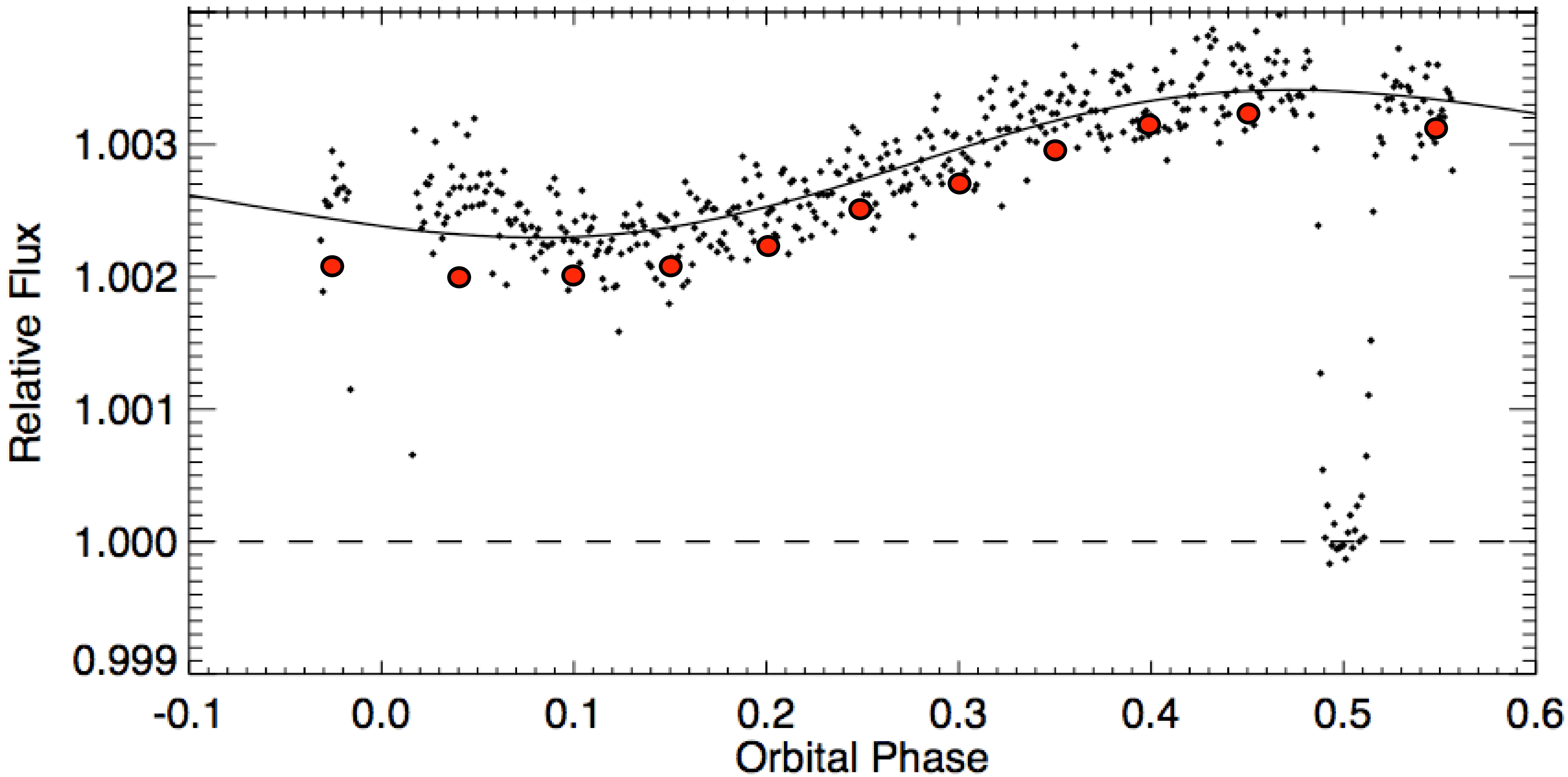
X = fraction of incoming flux absorbed at or above the IR photosphere.

p = atmospheric pressure at the IR photosphere



Day Side

Night Side



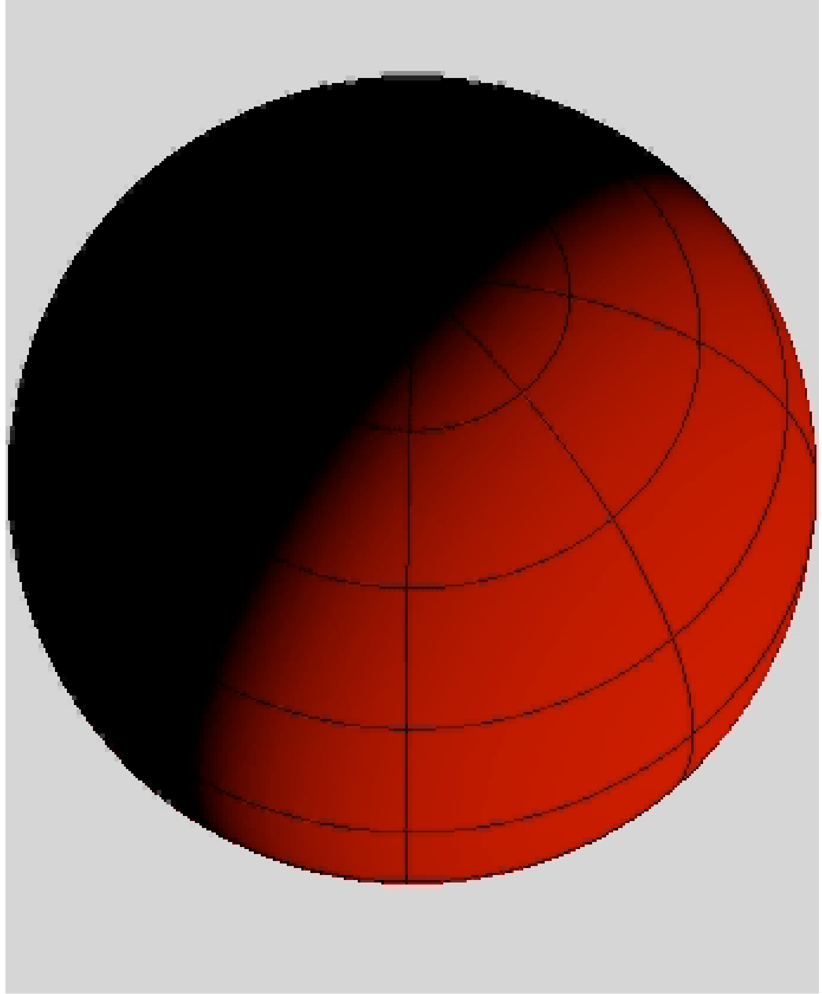
Our model, plotted in red, gives a reasonable fit
to the Knutson et al HD 189733 8-micron
if the 8-micron photosphere lies at 150 mbar, and 1/2 of the
incident starlight has been absorbed at this pressure depth.

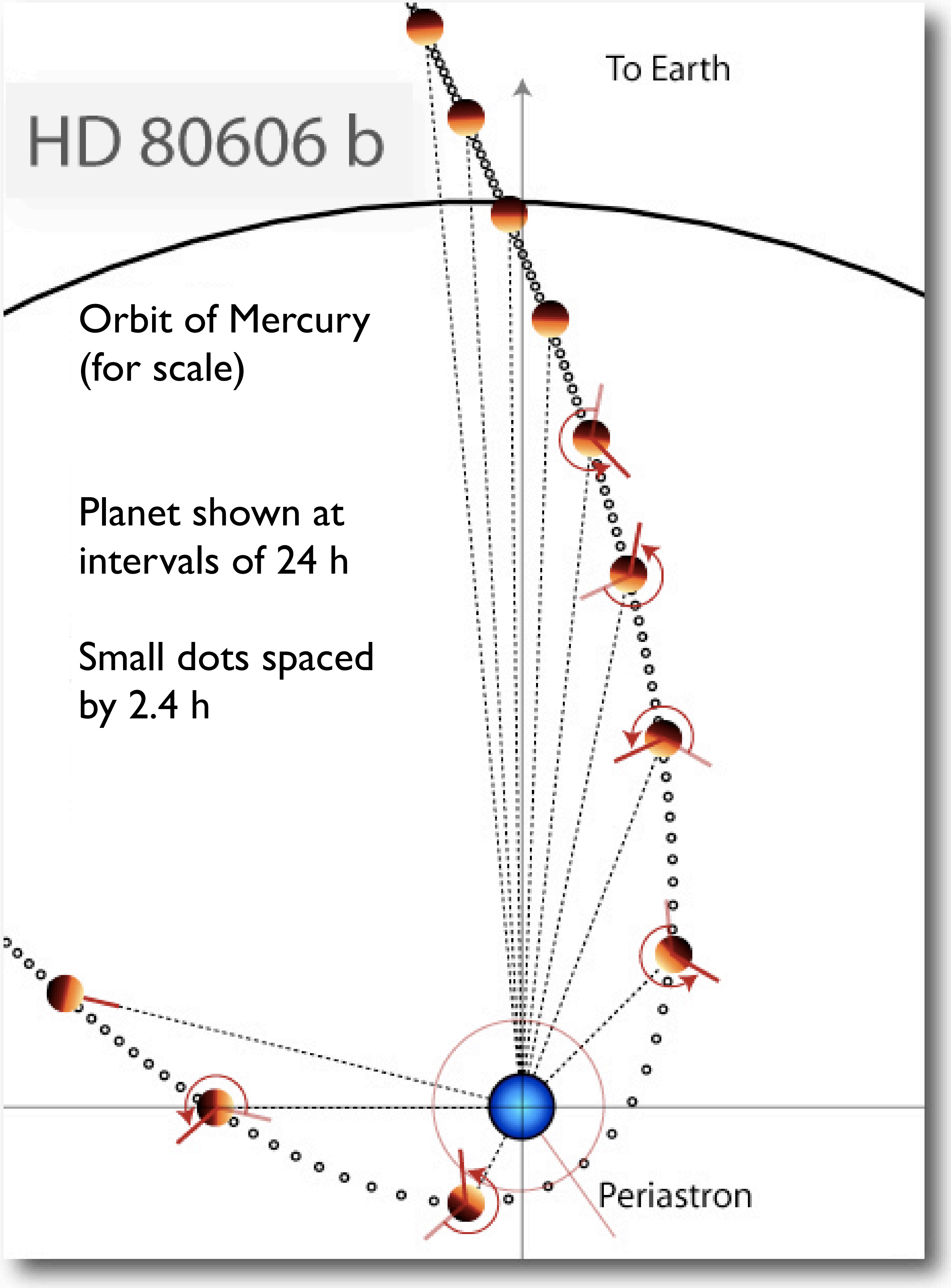
It would be interesting to test radiation-hydrodynamical models on planets that are *not* in steady state.

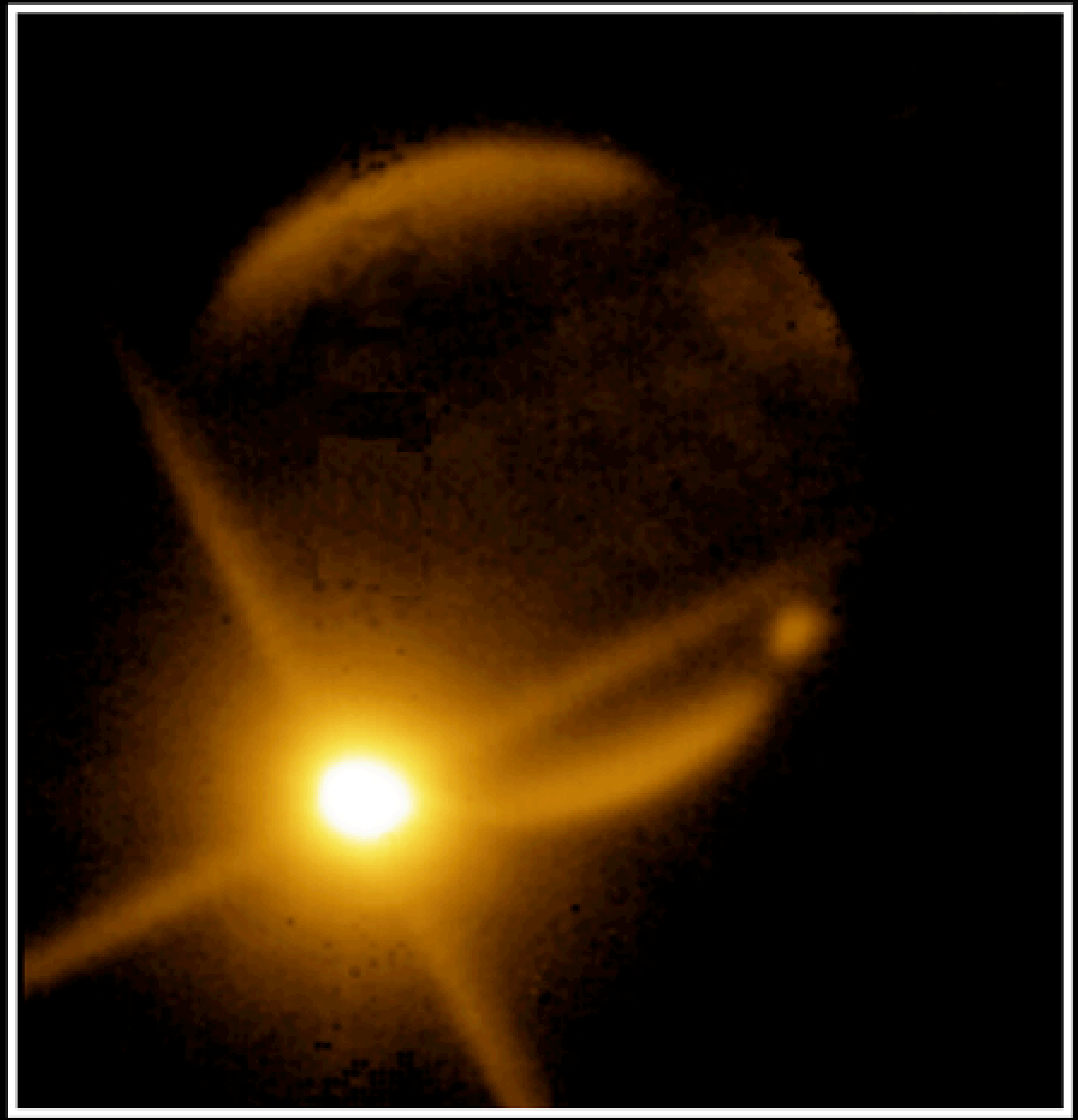
This would allow a clear distinction to be made between the effects of advection (wind) and the radiative time constant in the atmosphere.

Back to HD 80606b.

Irradiation at Periastron

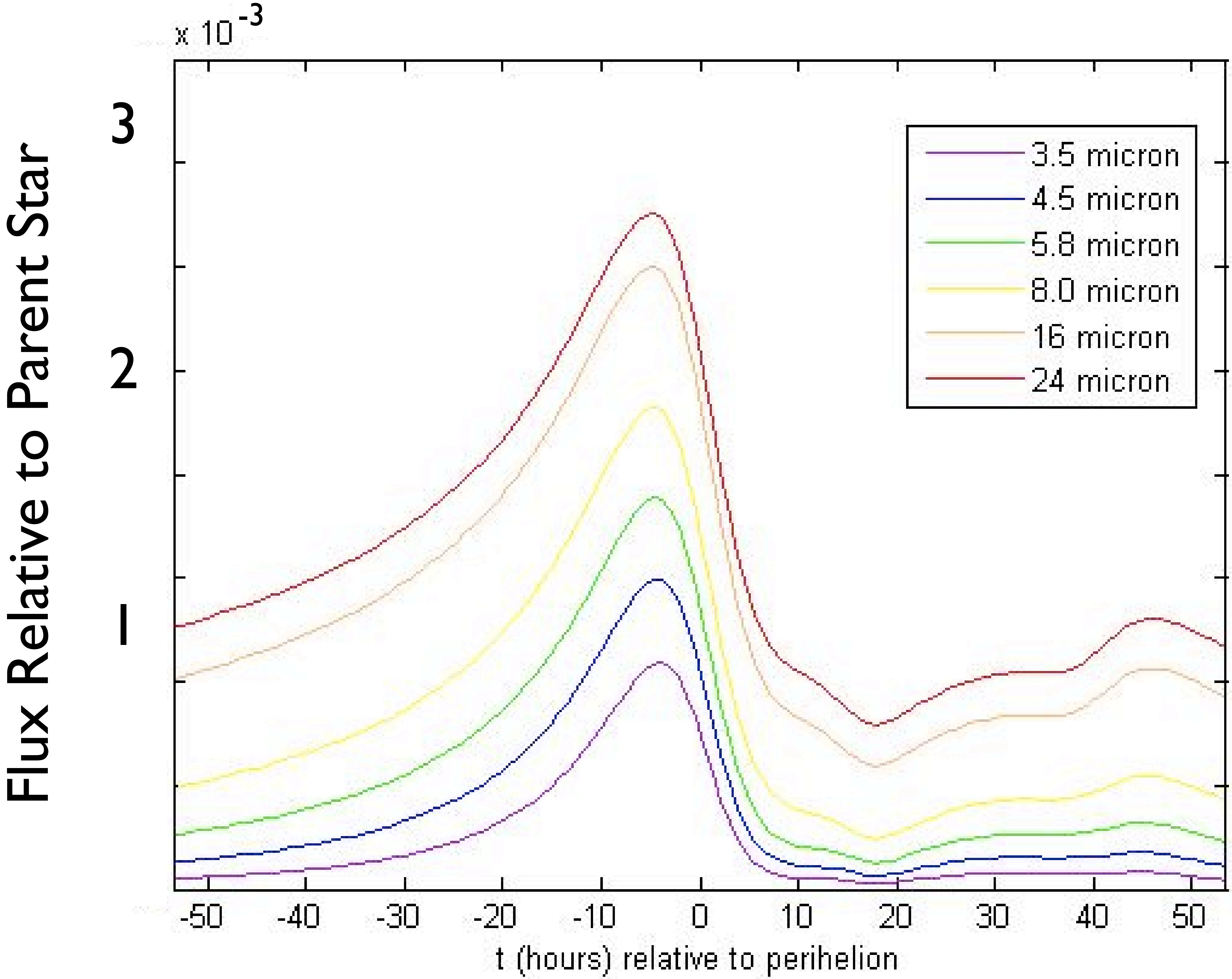






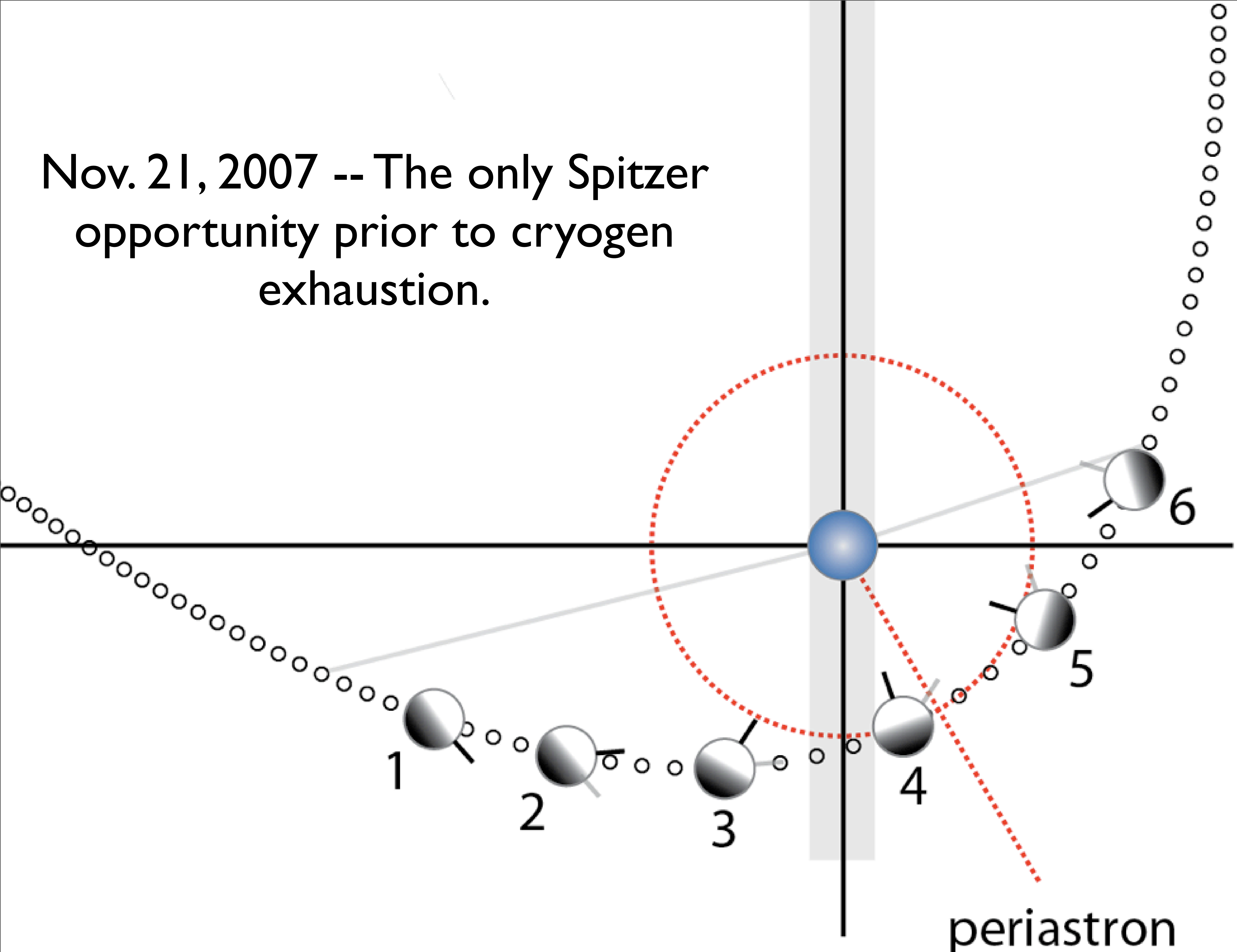
Impact of Fragment G of Comet Shoemaker-Levy on Jupiter
The fireball is seen 12 minutes after impact at 2.34 microns.
The impact A site is seen on the opposite limb of the planet.

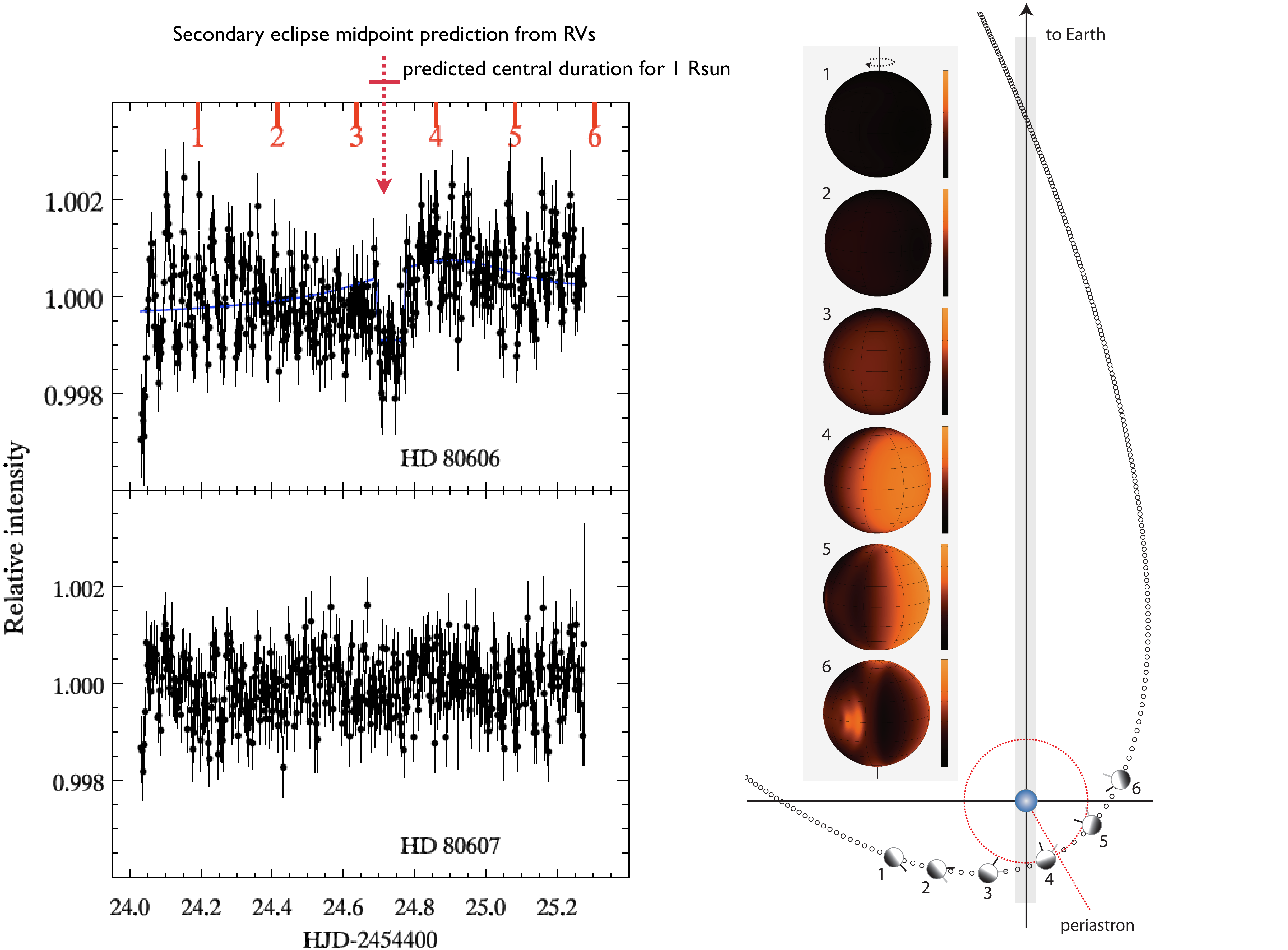
Image at 2.34 microns with CASPIR by Peter McGregor
ANU 2.3m telescope at Siding Spring

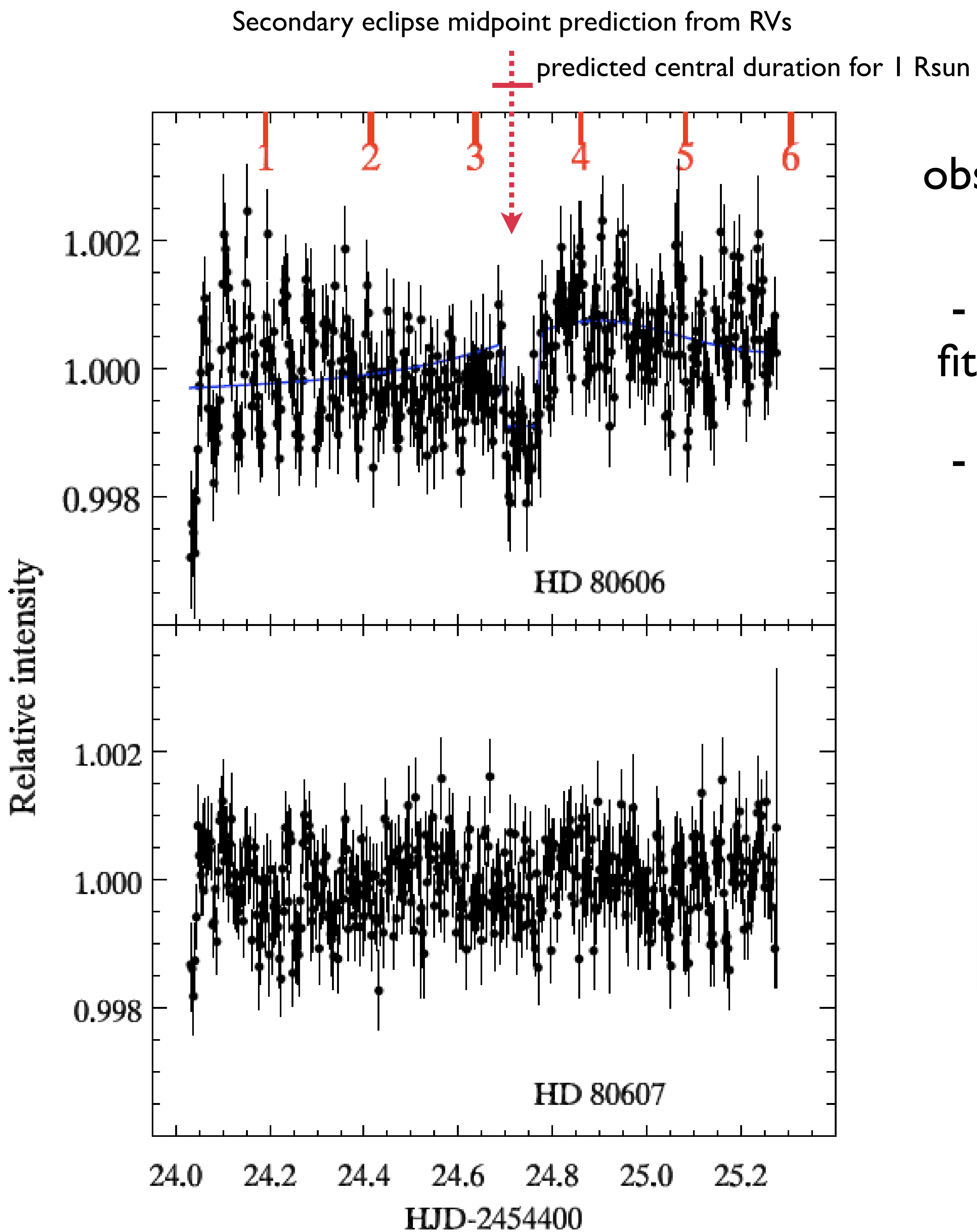


Predicted light curves in Spitzer Bands

Nov. 21, 2007 -- The only Spitzer opportunity prior to cryogen exhaustion.



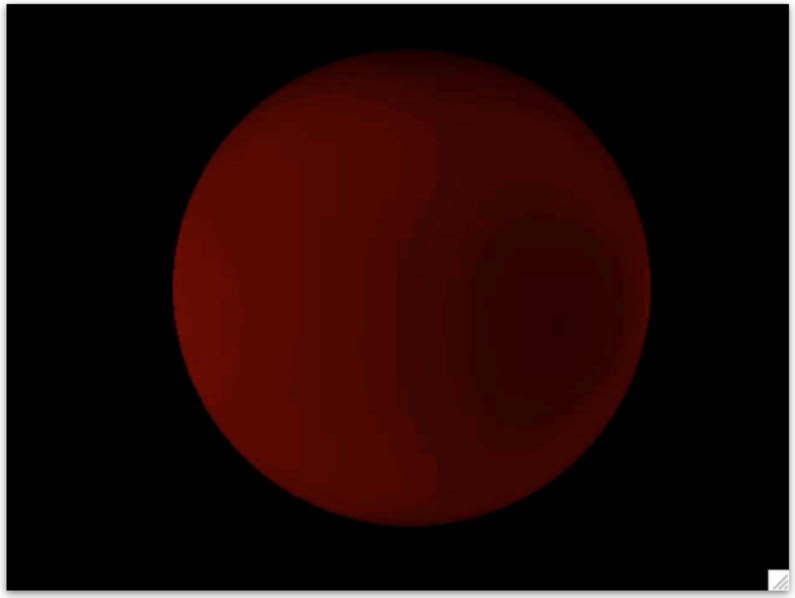

Secondary eclipse midpoint prediction from RVs
predicted central duration for 1 Rsun
1
2
3
4
5
6
1.002
1.000
0.998
HD 80606
Relative intensity
1.002
1.000
0.998
HD 80607
24.0
24.2
24.4
24.6
24.8
25.0
25.2
HJD-2454400
to Earth
periastron



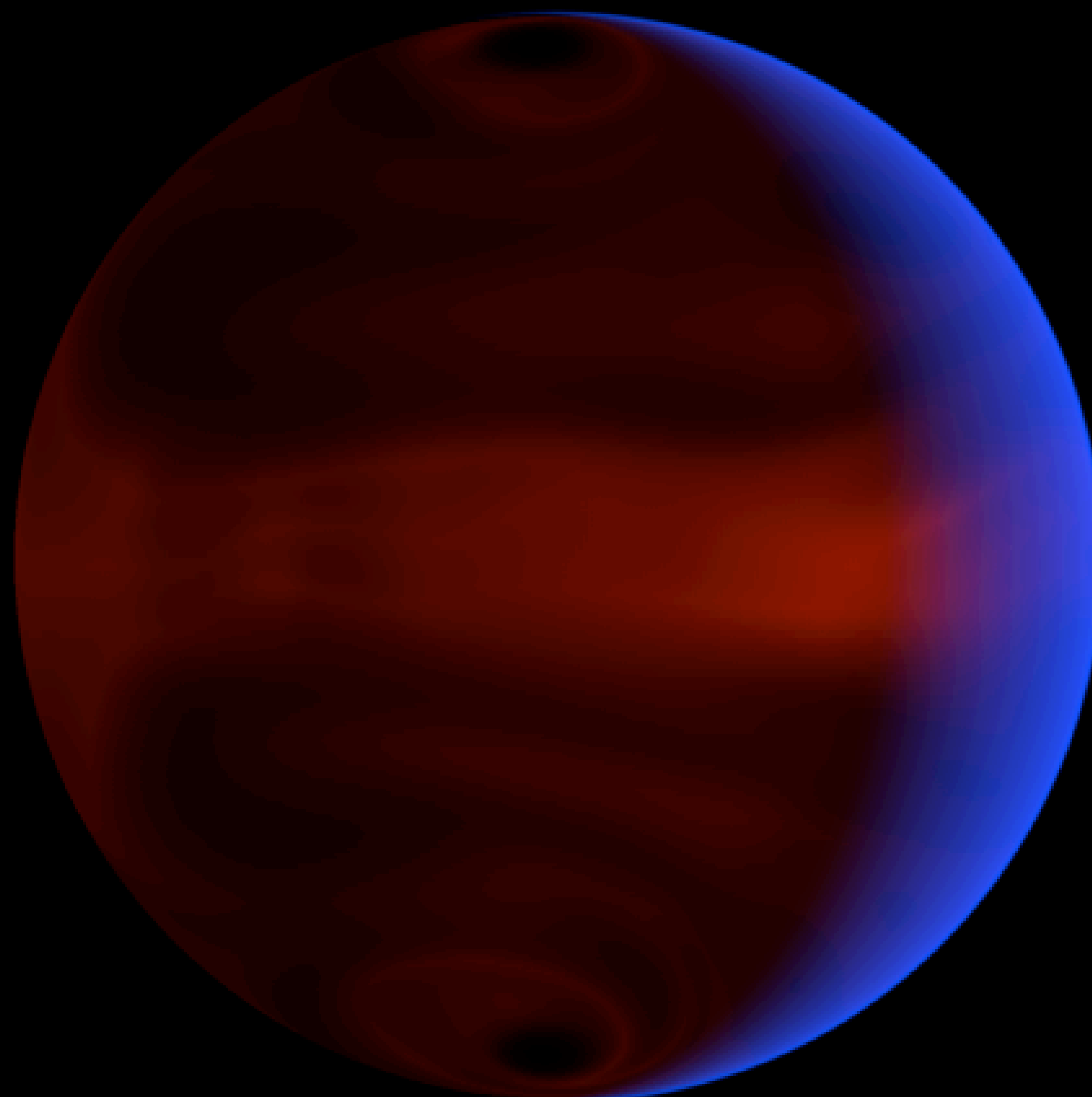
- Secondary Transit observed! Consistent with a central eclipse.

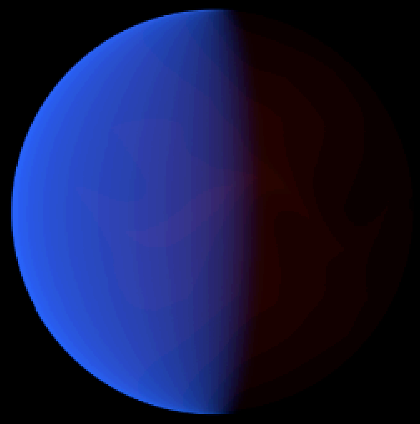
- Model calibrated to 189733 fits reasonably well. (Blue line).

- Heating from 800 to 1500K in only 6 hours.

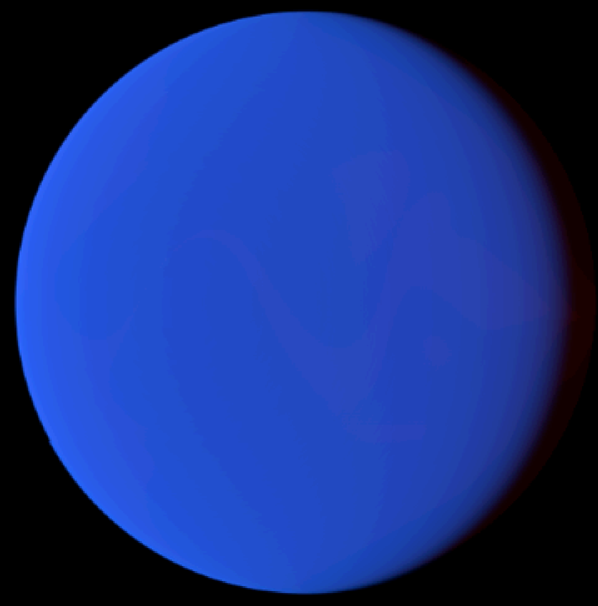


Model (Earth view, 30h)
Tmin=750K, Tmax=1500K

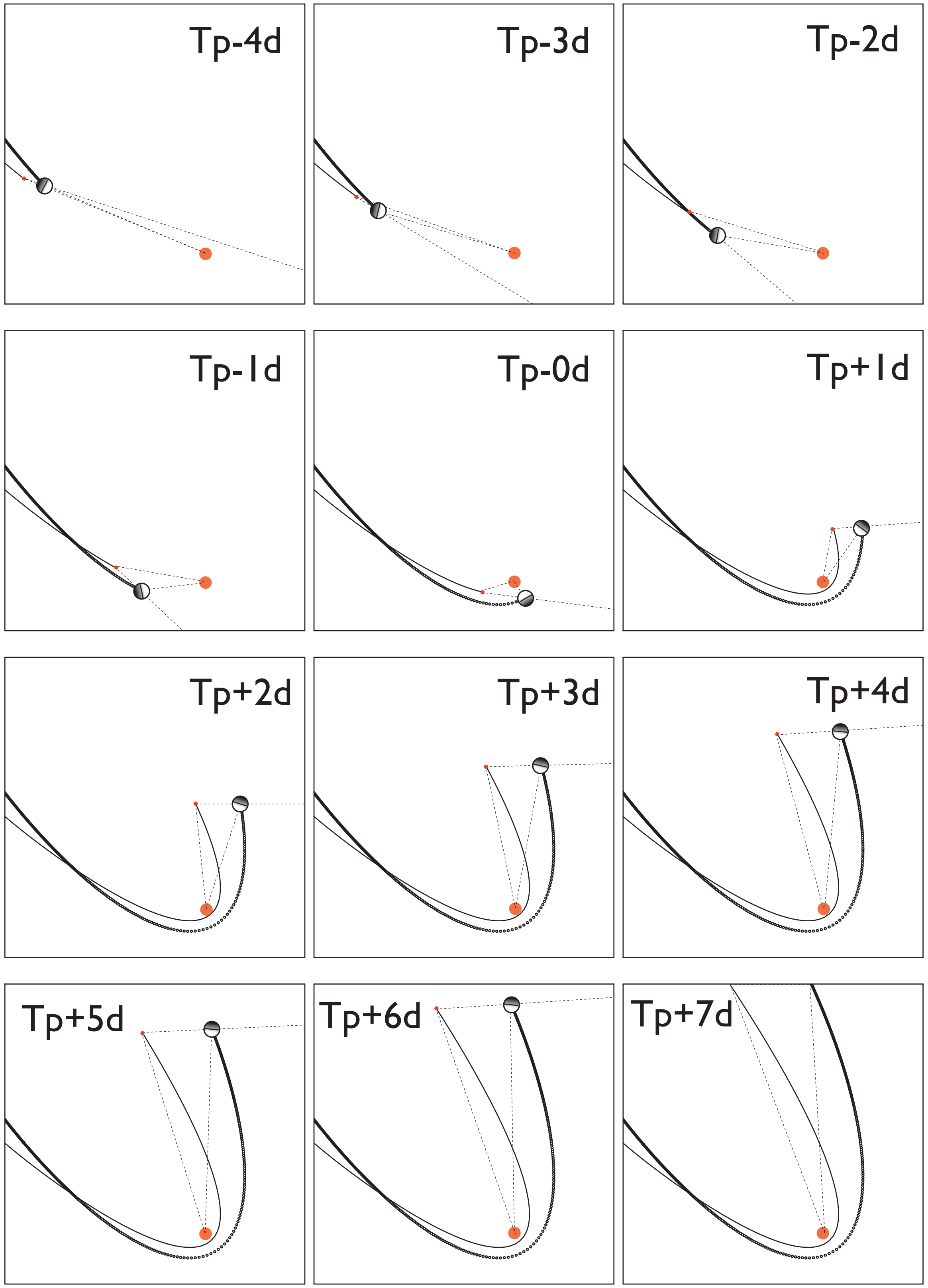


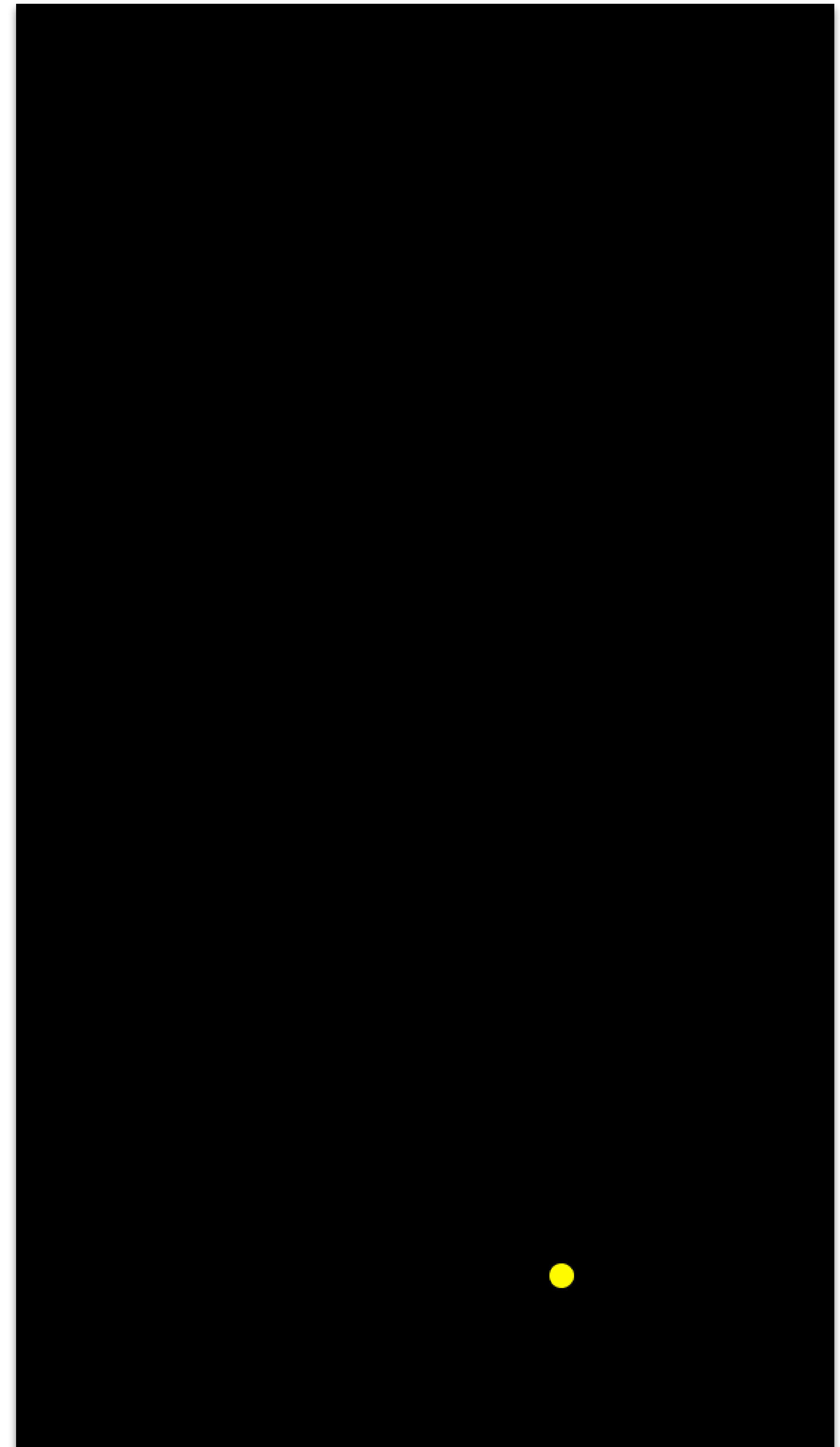


View from Earth Direction



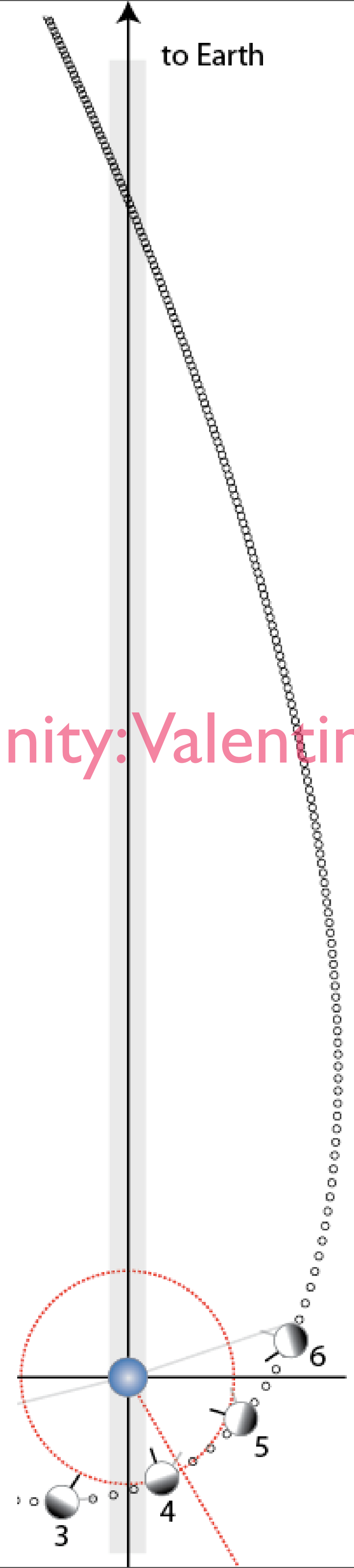
View from anti-Earth Direction

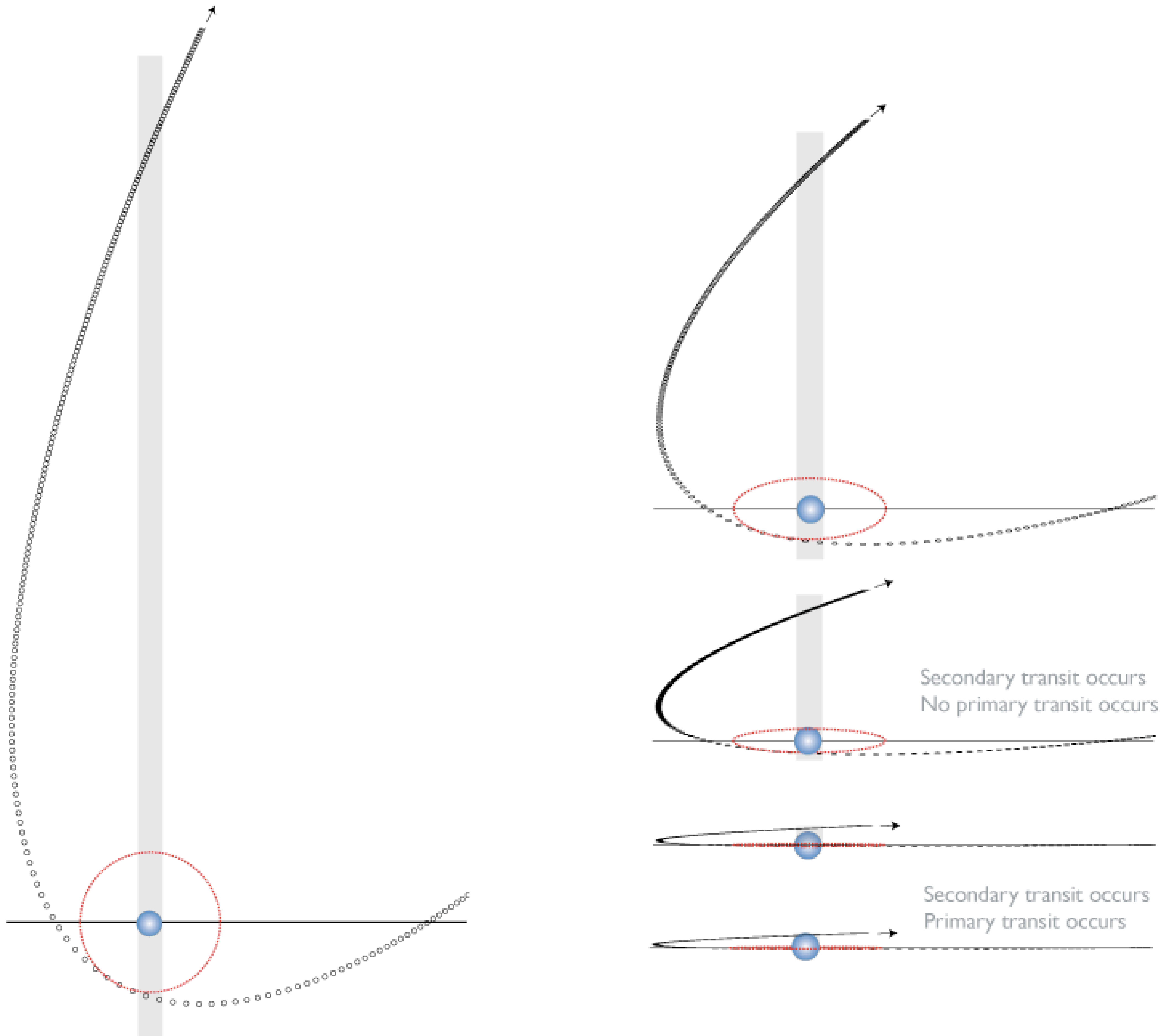




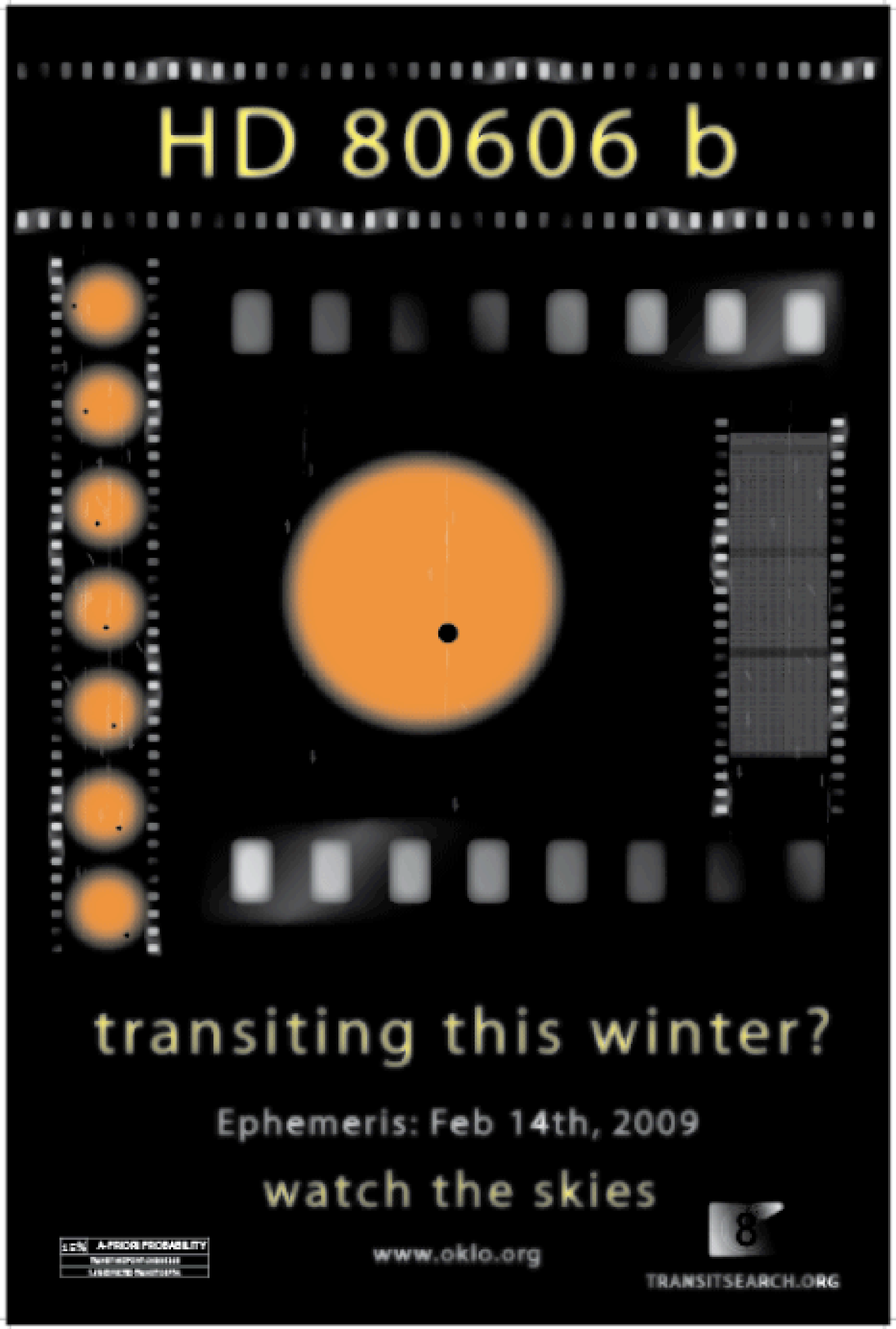
Synthetic “Missions” to HD 80606b

Transit opportunity: Valentines Day 2009

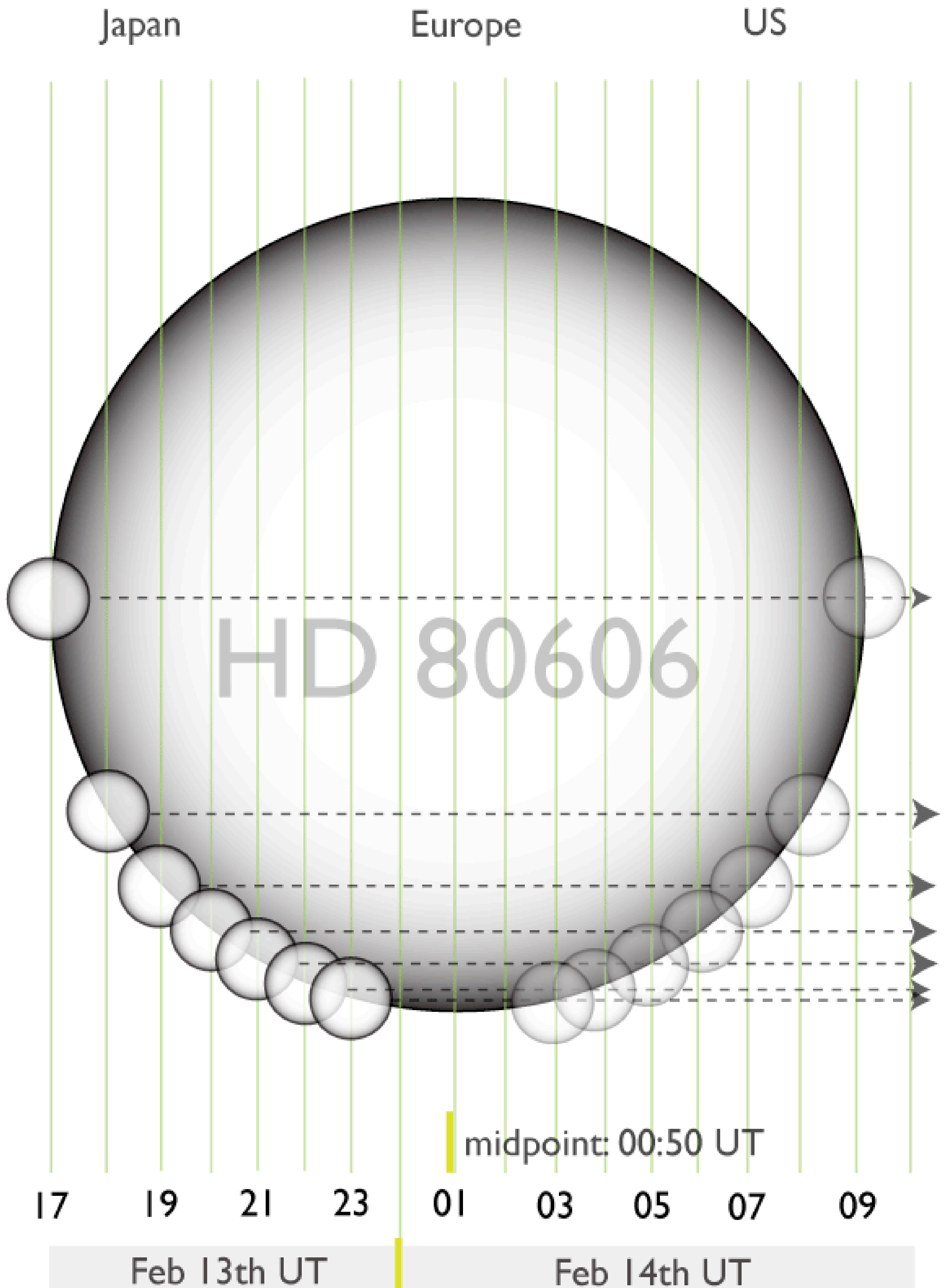




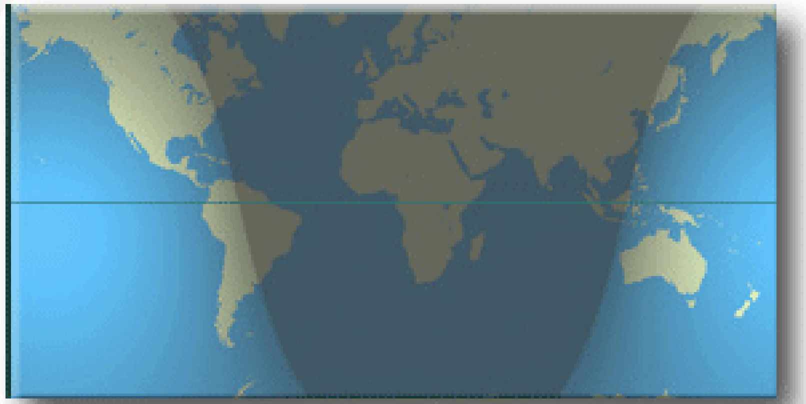
Secondary transit occurs
No primary transit occurs
Secondary transit occurs
Primary transit occurs


HD 80606 b
transiting this winter?
Ephemeris: Feb 14th, 2009
watch the skies
A-PRIORI PROBABILITY
www.oklo.org
8
TRANSITSEARCH.ORG


The
global


Japan
Europe
US
HD 80606
midpoint: 00:50 UT
17
19
21
23
01
03
05
07
09
Feb 13th UT
Feb 14th UT

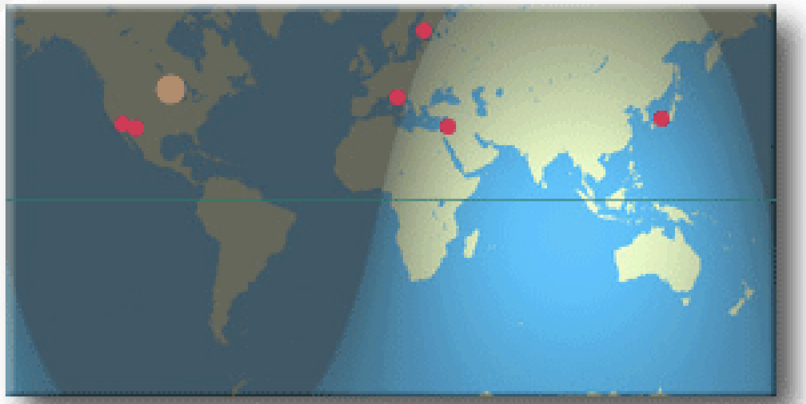
Update 0 : Feb. 12 2009, 22:47:40 UT



I'll be posting updates on the global HD 80606b transit campaign as I get them, with newer updates going to the top of this post.

A number of observers have indicated that they'll be on the sky. Right now, it looks like telescopes are confirmed for Finland, Israel, Italy, Japan and the US. Given the vagaries of the weather, however, it would be great if we can get as much coverage as possible. As Vince Lombardi would have put it, "We're looking at 15%, so if you can get 1%, get out there and give 110%!"

Update 1 : Feb. 13 2009, 06:03:03 UT

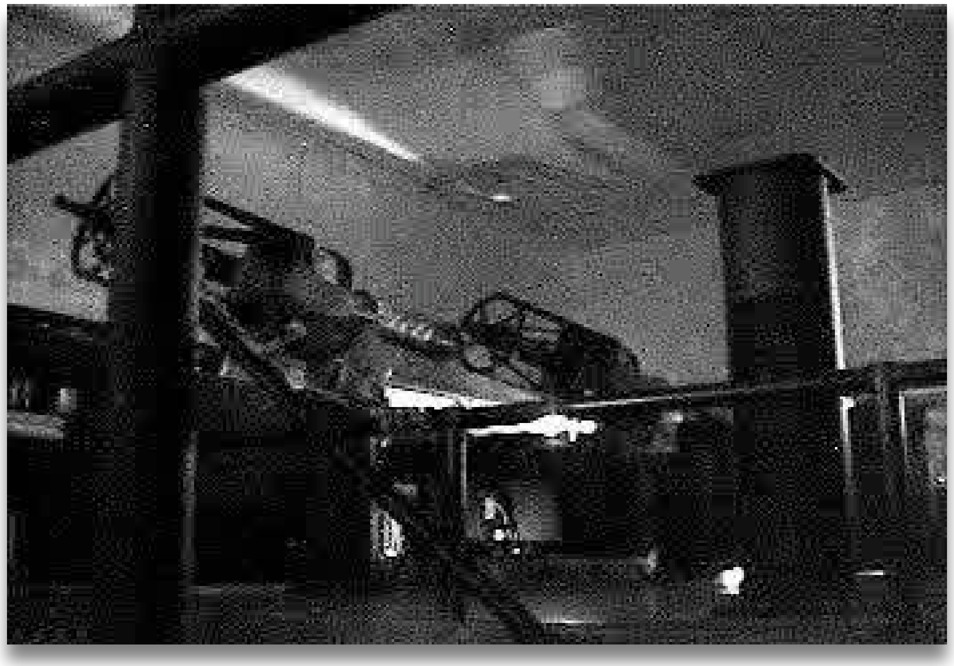


There's about a half-day left until the possible start of the ingress. On the map above, I've marked the locations of confirmed observers with small red dots. HD 80606b is 190 light years above the spot labeled with the orange circle.

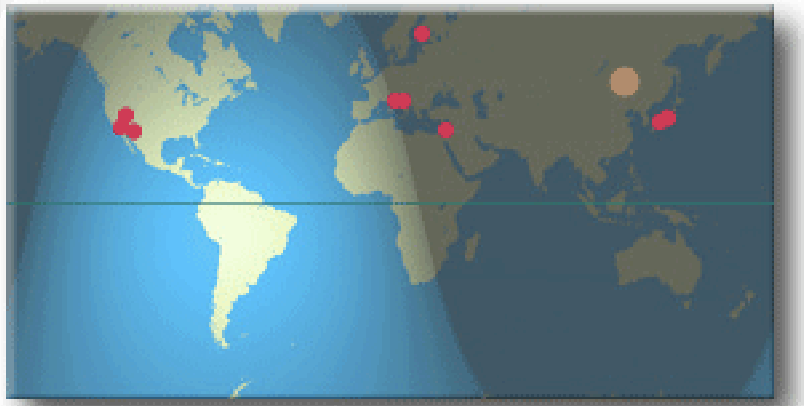
Observers in the US are currently taking data of both HD 80606 and its binary companion, HD 80607. It's always good to have an out-of-transit baseline photometric time series.

Dave Charbonneau checked in with a status report:

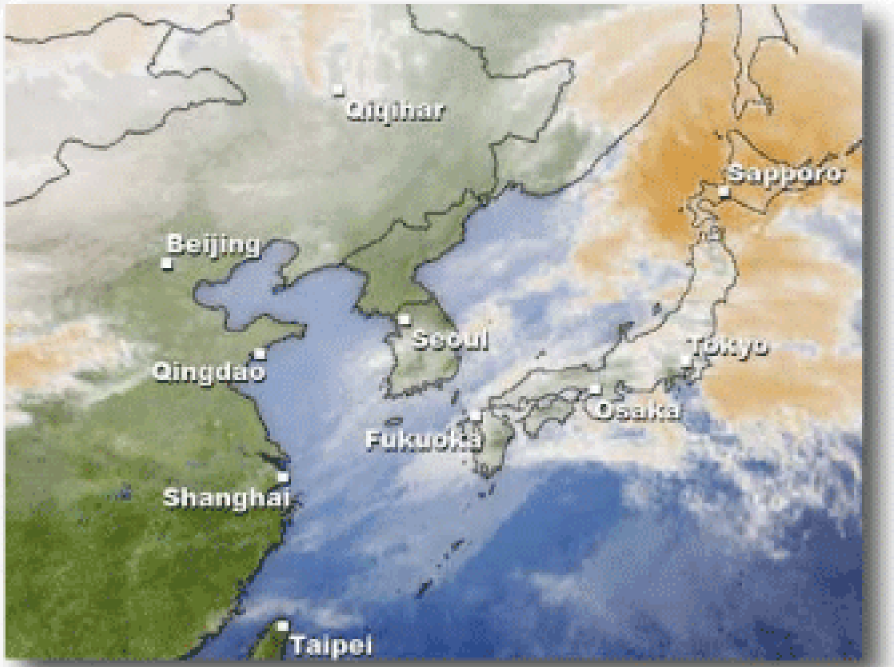
> MEarth is ready. You can watch us in real time at http://mearth.sao.arizona.edu/live/
>
> If the roof is closed, it is cloudy.



Update 2 : Feb. 13 2009, 17:04:00 UT



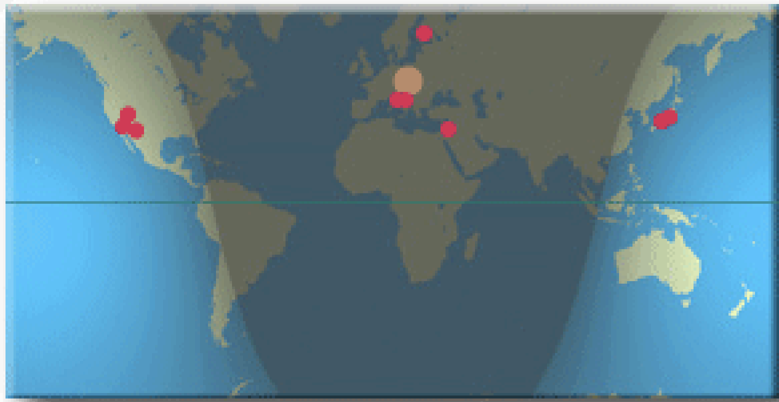
It's now the middle of the night in the Far East, and the transit window has opened. The weather in Japan looks a little spotty, but Southern China is in the clear.



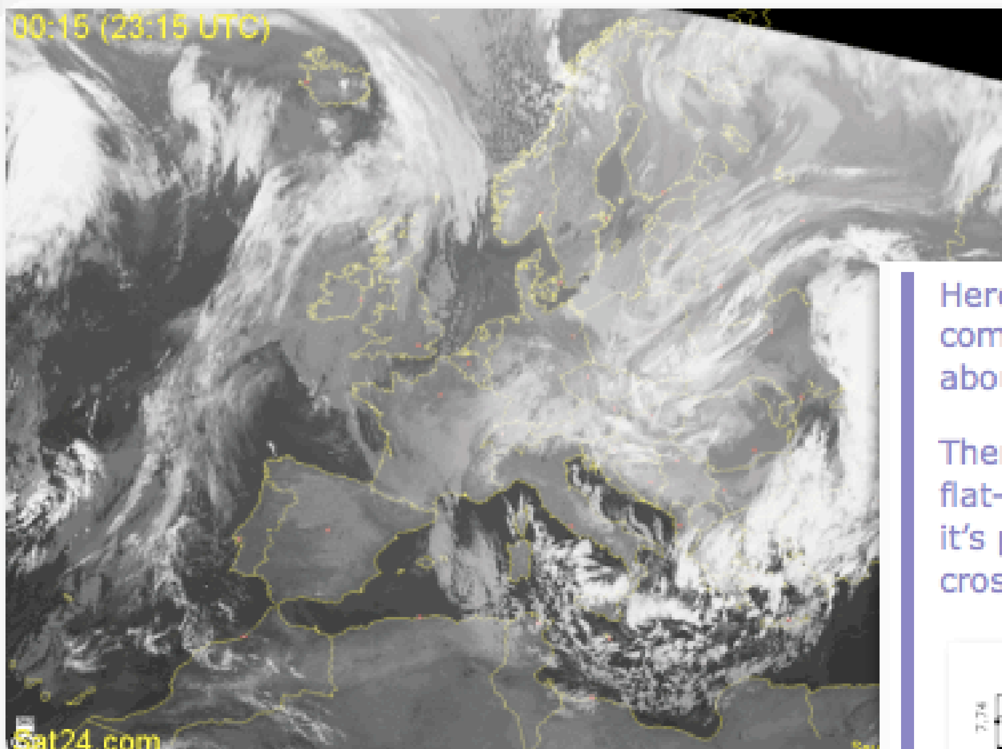
Observers in Arizona reported good weather last night, but the forecast is a little iffy for tonight.

In addition, I just got an e-mail (UT 17:48) from Gregor Srdoc in Croatia, who is on the sky under quite good conditions just after nightfall...

Update 3 : Feb. 13 2009, 23:29:00 UT

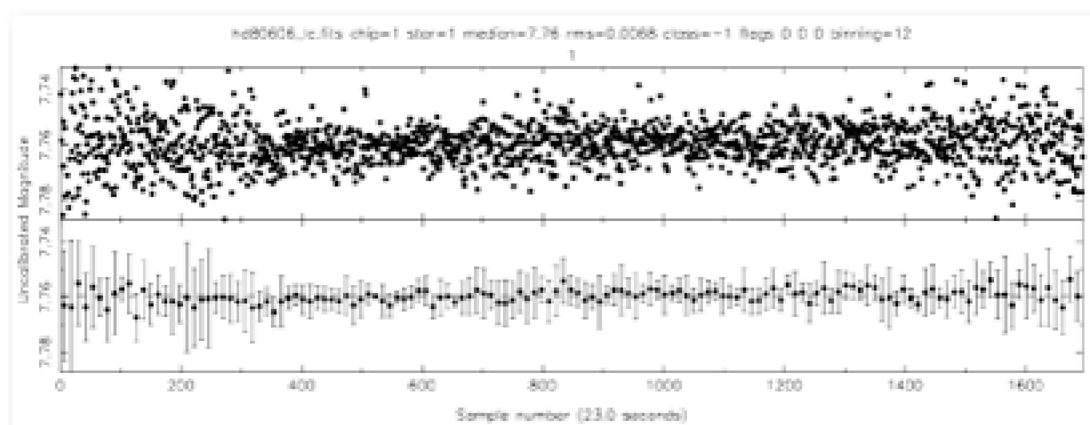


We're now closing in on the moment of inferior conjunction, which hopefully will wind up being the midpoint of a central transit. The current weather in Europe looks like it's clear for observers in Finland and Northern Italy, so it's now quite likely that we'll get a definitive answer from the campaign.



Here's our entire night of data (about 11 hours) from one telescope, using 80607 as the comparison star. Raw and binned x12 (about 5 minutes per bin). We are getting rms scatter of about 1.6 times Poisson with this fairly quick reduction.

There is usually a slight offset when the target crosses the meridian (data point 777) due to flat-fielding error, that I have not removed in this - over the ~20 arcsec separation of the pair it's pretty small. There is also a bit of a blip there as my guide loop recovers its lock after crossing - still needs a little tuning :)



Fingers crossed for tonight!

From: Steve Fossey
Subject: **HD80606 observations from the UK**
Date: February 14, 2009 4:23:10 PM PST
To: laughlin@ucolick.org
Cc: Ingo Waldmann <i.waldmann@ucl.ac.uk>
1 Attachment, 216 KB Save Quick Look

Dear Greg

I have been a reader of oklo.org for some time now, though I don't think I have officially "signed up" or contributed comments to your site. But it has always proved a good read, and a source for ideas and inspiration. Indeed, I followed the news on your recent campaign to search for a transit event for HD80606b on Feb 13/14; and, given a favourable weather forecast for the UK, I marshalled a number of students at UCL's observatory in Mill Hill, North London (ULO), to monitor the event. Present and observing were me, my current final-year undergraduate project student, Ingo Waldmann, and several of his undergraduate colleagues.

I'm writing to let you know some preliminary results: near-perfect weather conditions in the southern UK meant we could follow the target for about 10 hours from dusk at about 1800 UT to ca. 0400 UT, when cloud forced us to stop. We used a Celestron 14-inch telescope + SBIG STL6303E CCD, with another smaller instrument + camera securing a "backup" dataset to help confirm the reality, or otherwise, of any signal. (Unfortunately, our 24-inch instrument was not available on the night due to a motor failure.)

In short, we *may* have detected an egress signal in the C14 dataset - the "backup" dataset is not yet reduced - in the direct comparison between HD80606 and HD80607, though with some caveats; so this result remains tentative until we can re-reduce the dataset and check more throughly for systematic problems, etc. However, we thought it worth advising you of the results in case you have any others coming in from Europe or Asia which would confirm what we see. But the signal implies the transit occurred somewhat earlier than your predicted time of 0050 UT, and we see no sign of ingress.

I have noted your reports of null results thus far from some of the US sites, and as far as I can tell, they seem to report observations from about 0200 UT onwards.

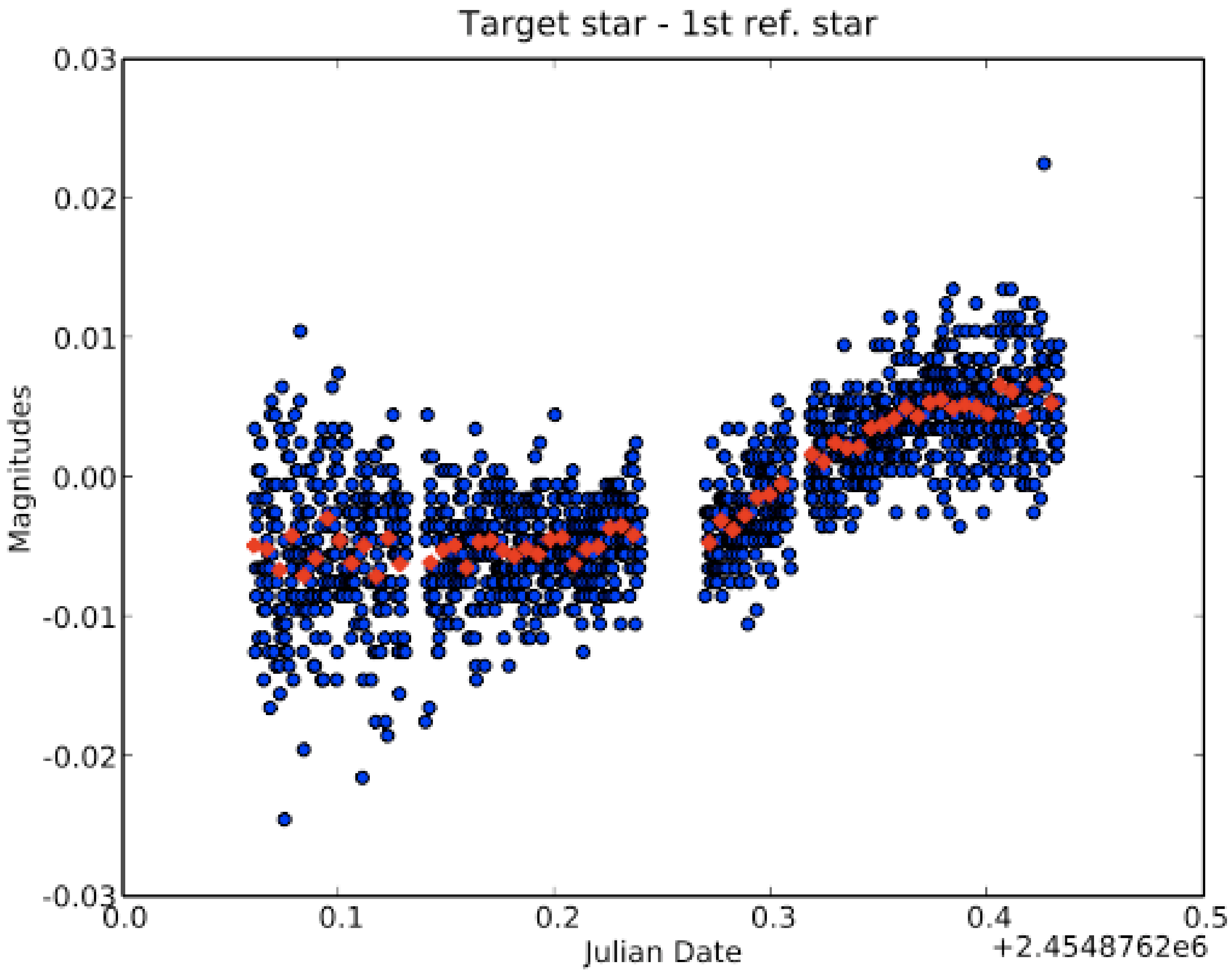
In our data series, which starts several hours earlier than the US observations, we see a featureless, flat, magnitude difference between HD80607 and 80606 for several hours, until at about 2300 UT the data appear to rise, as if marking the beginning of an egress. The rising trend continues until about 0200 UT, when the trend flattens again to our close of session at 0400. If this is an egress event, the total transit depth appears to be about 10 mmag. Ingo has prepared some plots, and I attach one of his early reductions for your information: the y-axis scale is reduced mag. diff (HD 80607 minus HD 80606 - and *not* "Target minus ref1", as labelled on the plot), and the x-axis is HJD (but beware of the non-standard labelling in this plot - 0h UT is actually at 0.3).

We have enough experience of noise and systematic errors to know how easily we can be fooled into thinking we have a signal when there really is nothing there, and there are two important things to consider in our own dataset: the first is that, just before the "rise", we had a system crash - hence the large gap in the data at 0.25 on the x-axis (=.45 in the HJD) - and we had to reboot the telescope and camera and reacquire the target; we tried to place the stars back on the same pixels, as we usually autoguide to maintain all stars in the same place on the chip.

The second issue is that part-way through the "egress" event (at about 0.31 on the x-axis, or .51 in the HJD), we had to reverse the German equatorial telescope mount as the target crossed the meridian (hence the second, short gap). This procedure normally leads to systematic differential offsets as the field is rotated on the chip: but it appeared that this might not be too bad for this pair of stars as they are so close together. We still need to investigate more closely the light curves obtained relative to other comparison stars in the field to explore our systematics.

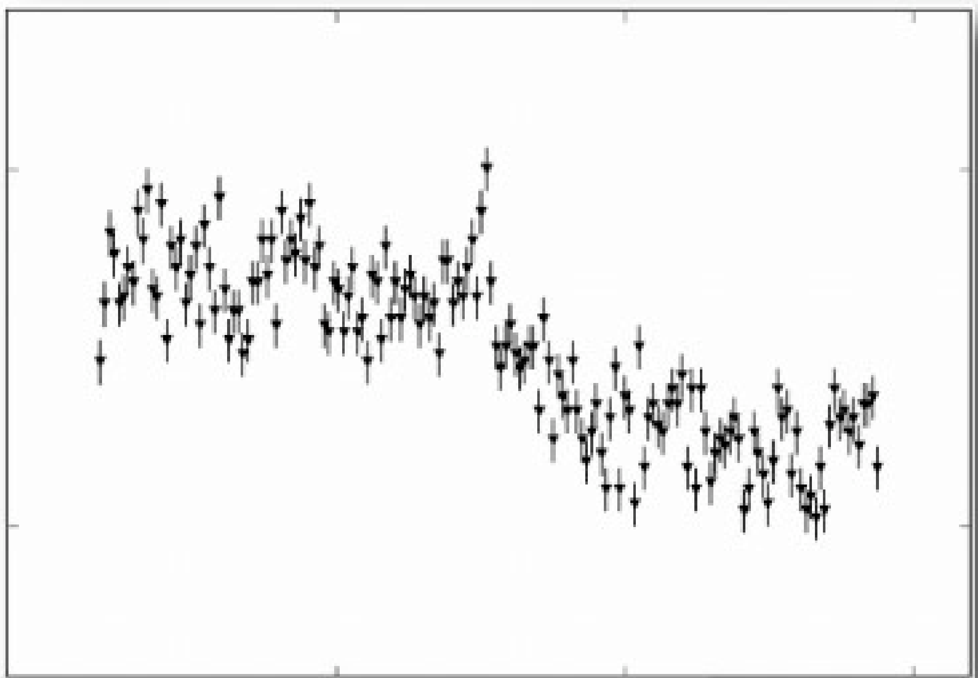
We would, of course, be very interested to know if you receive other reports which would corroborate our results - in the meantime, given the preliminary stage of our analysis, we are trying carefully to tread the line between "egg on our face" and "this is interesting enough to talk about"; we'd prefer not to go public just yet with anything until there is an independent confirmation, or we have managed to rule out all other possible sources of error. We have yet to reduce our backup dataset from the second instrument.

We'd be very interested in your opinion of the possibility that the transit could have occurred a few hours earlier - but it's late on Sat night here, we slept little last night (!), and we have not had time to recheck the likely uncertainties on the ephemerides to see if this "event" is just too far outside the range of possibilities. On the other hand, this field is so full of surprises, who knows what might emerge!

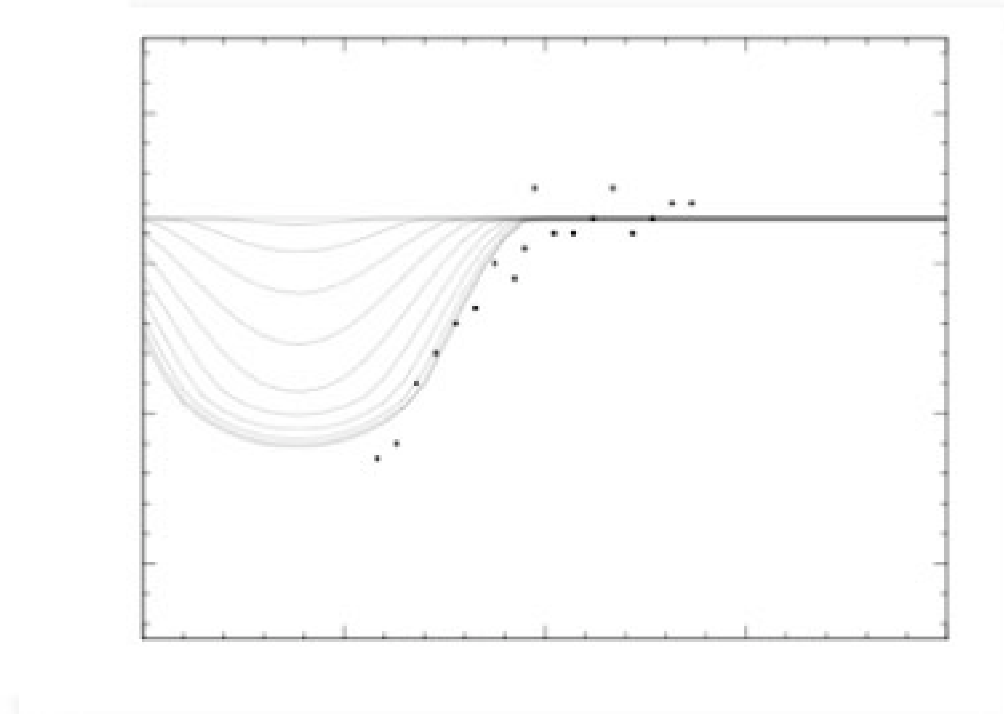


The first Fossey et al. Photometry

Two virulent strains of transit fever



Ingressia



Egressia

The Suspected Intra-Mercurial Planet.

The Astronomer Royal has requested me to append to the Annual Report of the Council the following letter recently received from M. Le Verrier, relating to the approaching possible conjunction of the supposed intra-Mercurial planet with the Sun on March 21, 22, and 23 next. It is of extreme importance that a *continuous* scrutiny of the solar disk should be kept up, both in the northern and southern hemispheres, during these three days, as after 1877 no other opportunity will be afforded for many years of observing a possible transit of the planet. The Sun's disk should therefore be watched for a small planet at every two hours or more on the three days mentioned above. Photographs should be obtained when practicable, as they are far preferable to eye-views. E. DUNKIN.

PARIS : 15 *Février* 1877.

" MONSIEUR ET HONORÉ COLLÈGUE,

" Vous n'aurez pas oublié qu'au commencement de l'automne dernier une discussion s'éleva des observations faites à diverses époques et attribuées aux passages d'une ou de plusieurs planètes sur le disque du Soleil.

" Après une élimination attentive des observations inconciliables, il fut reconnu que cinq observations pouvaient effectivement appartenir aux passages d'une planète sur le disque du Soleil, savoir :—

Fritsch	1802	Octobre	10
Decuppis	1839	Octobre	2
Sidebotham	1849	Mars	12
Lescarbault	1859	Mars	26
Lummis	1862	Mars	20.

(*Comptes Rendus de l'Académie*, 2 Octobre 1876, p. 649.)

" Il parut dès lors difficile d'admettre que des observateurs qui n'avaient eu aucune relation entre eux, ni aucune connaissance des périodes en discussion, fussent ainsi tombés par hasard sur cinq époques précises d'un phénomène explicable par le mouvement d'une même planète.

" Le savant directeur du *Nautical Almanac*, M. Hind, ajouta beaucoup à l'autorité de ces conclusions, en montrant qu'une sixième observation (Stark, 1819, Octobre 9) était également représentée par la même orbite. (*Comptes Rendus*, 30 Octobre 1876, p. 809.)

An Early Case of Transit Fever (MNRAS 1877)

A follow-up e-mail:

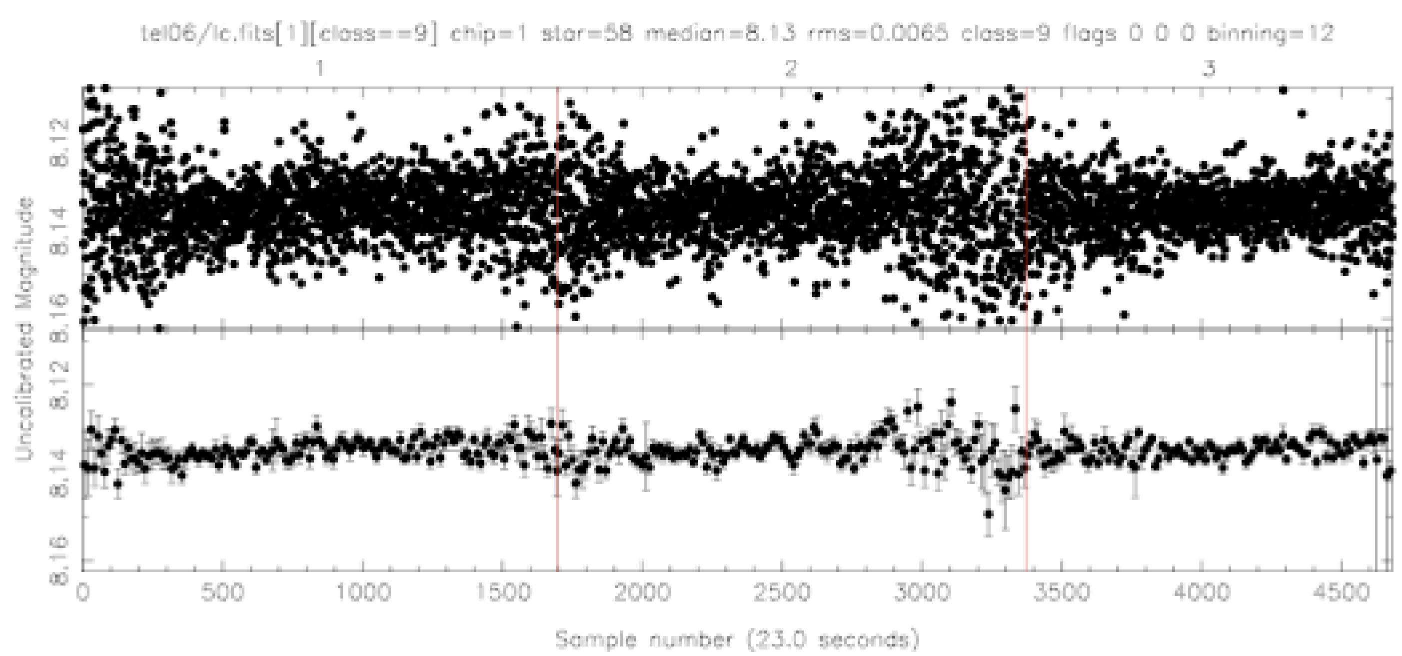
From: Steve Fossey
Subject: **Re: HD80606 observations from the UK**
Date: February 14, 2009 11:44:56 PM PST
To: Greg Laughlin <laugh@ucolick.org>

Hi Greg

Many thanks for prompt reply, it'll be very interesting to see what comes up.

Of course, as soon as I hit the "send" button and climbed into bed, I realised we *really* need to check our sky subtraction ... a schoolboy error: in our haste, we processed the aperture photometry with our typical sky-annulus parameters and forgot to allow for the proximity of the companion. (Our routines may indeed be robust, but we really need to check.) There are at least a couple of other systematics too that we need to check out and pin down.

Arizona Photometry



Feb 11/12 Feb 12/13 Feb 13/14

From: Steve Fossey
Subject: **HD 80606 publication**
Date: February 25, 2009 5:29:34 AM PST
To: Greg Laughlin <laugh@ucolick.org>
Cc: Ingo Waldmann <i.waldmann@ucl.ac.uk> , Dave Kipping <kippingdavid@googlemail.com>

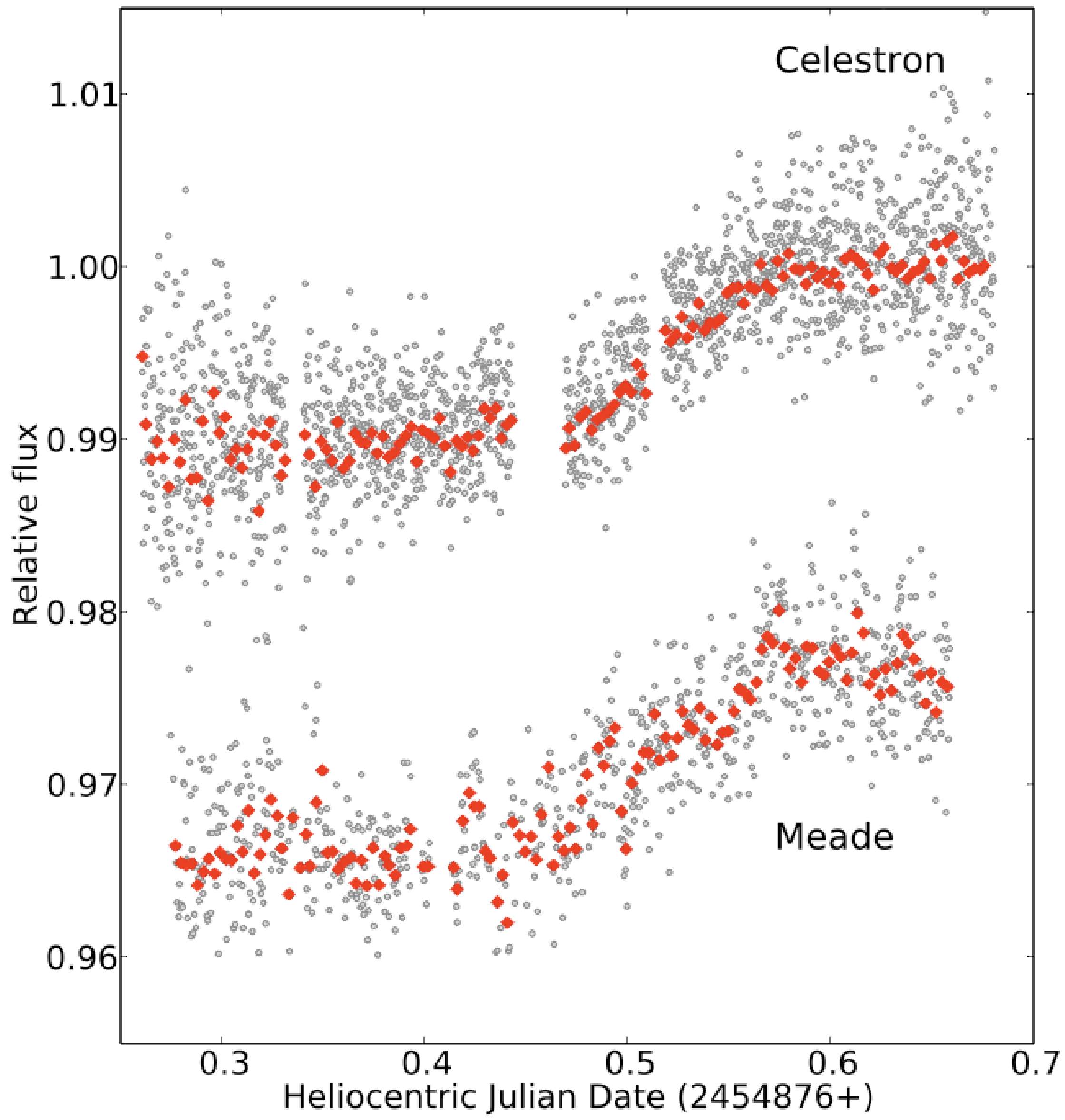
Hi Greg

I have been working with Ingo and another colleague at UCL, Dave Kipping, on our recent data on HD80606. We are pretty confident that we have a real astrophysical signal, and after some exploratory modelling with a transit-fitting code for an elliptical orbit, we've decided we want to go ahead and publish our observation and suggestion that this is indeed an egress event.

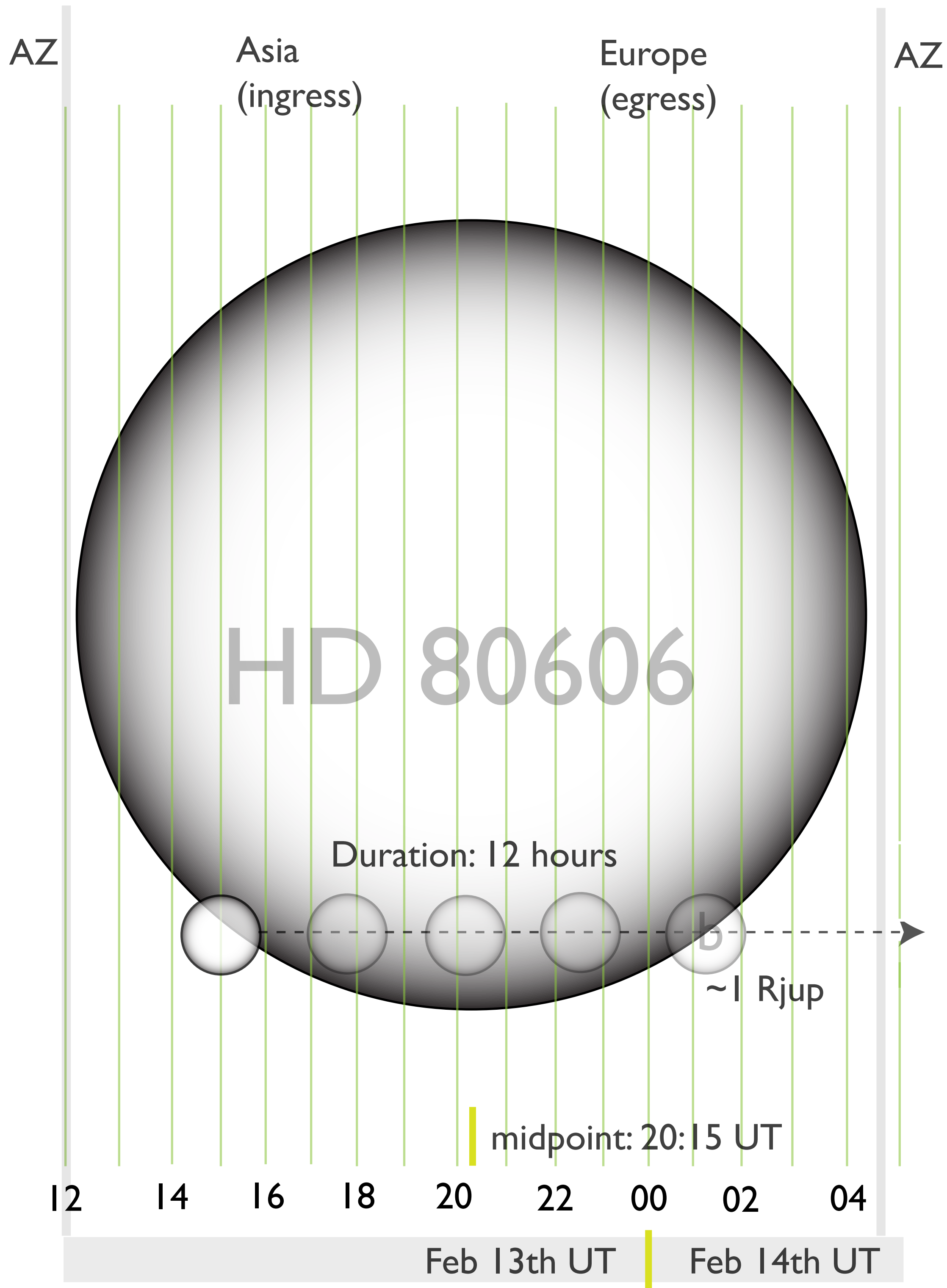
From: Steve Fossey
Subject: **Re: HD 80606 publication**
Date: February 25, 2009 11:47:32 AM PST
To: Greg Laughlin <laugh@ucolick.org>
1 Attachment, 1.1 MB Save Quick Look

I have to finish up here for today, and our intended submission deadline will obviously slip. But we'll keep working on it tomorrow and I will hope to send you something during the day if we can.

In the meantime, I attach a figure to illustrate our two data sets, which convinces us this is real.


Celestron
Meade
Relative flux
1.01
1.00
0.99
0.98
0.97
0.96
0.3
0.4
0.5
0.6
0.7
Heliocentric Julian Date (2454876+)

→


AZ
Asia (ingress)
Europe (egress)
AZ
HD 80606
Duration: 12 hours
b
~1 Rjup
midpoint: 20:15 UT
12
14
16
18
20
22
00
02
04
Feb 13th UT
Feb 14th UT

Subject: **Re: HD 80606 publication**
From: Greg Laughlin <laugh@ucolick.org>
Date: February 25, 2009 12:56:27 PM PST
To: Steve Fossey

Hi Steve,

Your ~2.5 hour egress is pointing toward a total duration 12 hours. This means that the ingress would have started at ~14 UT on Feb. 13th.

Amazingly, your event was perfectly bracketed by the flat, high-quality Arizona photometry:

Night 1 = JD 2454875.59 - 2454876.05 = UT 2009-02-13 02:10 - 13:10
Night 2 = JD 2454876.59 - 2454877.05 = UT 2009-02-14 02:10 - 13:10

The fact that the transit implied by your observations was four hours early _and_ had a sufficiently large impact parameter to reduce the duration from ~17 hours to ~12 hours made it "maximally unobservable" from Arizona.

Assuming things hold up, I think you'll be on deck to buy your countryman Jonathan Irwin (who did the Arizona observations) a pint of British Ale the next time he's in London! This is, in fact, just about good enough to atone for British inaction during the pursuit of Neptune back in 1846...

cheers,
Greg

From: Claire Moutou
Subject: **HD 80606: egress detected!**
Date: February 25, 2009 2:29:53 PM PST
To: laugh@ucolick.org
1 Attachment, 416 KB Save Quick Look

dear Greg,
We are happy to inform you that we caught the egress of HD 80606 at observatoire de Haute Provence, South of France.
We performed simultaneous observations with the 193cm/SOPHIE spectrograph and with the 120cm/CCD camera and detected the egress both in photometry and through the Rossiter effect!!
The paper describing our observations and analysis is attached; it was just submitted and will be posted on astroph tomorrow.
Best regards,
Claire Moutou and co-authors

!DSPAM:19,49a5c66d19505021468!

hd80606_v6....pdf (416 KB)

Letter to the Editor

Photometric and spectroscopic detection of the primary transit of the 111-day-period planet HD 80606 b*

Moutou, C.[1], Hébrard, G.[2], Bouchy, F.[2,3], Eggenberger, A.[4], Boisse, I.[2], Bonfils, X.[4], Gravallon, D.[3], Ehrenreich, D.[4], Forveille, T.[4], Delfosse, X.[4], Desort, M.[4], Lagrange, A.-M.[4], Lovis, C.[5], Mayor, M.[5], Pepe, F.[5], Perrier, C.[4], Pont, F.[6], Queloz, D.[5], Santos, N.C.[7], Ségransan, D.[5], Udry, S.[5], and Vidal-Madjar, A.[2]

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[3] Observatoire de Haute-Provence, 04870 Saint-Michel l'Observatoire, France
[4] Laboratoire d'Astrophysique, Observatoire de Grenoble, Université J. Fourier, BP 53, 38041 Grenoble, Cedex 9, France
[5] Observatoire de Genève, Université de Genève, 51 Chemin des Maillettes, 1290 Sauverny, Switzerland
[6] School of Physics, University of Exeter, Exeter, EX4 4QL, UK
[7] Centro de Astrofísica, Universidade do Porto, Rua das Estrelas, 4150-762 Porto, Portugal

Received ; accepted

ABSTRACT

We report the detection of the primary transit of the extra-solar planet HD 80606 b, thanks to photometric and spectroscopic observations performed at Observatoire de Haute-Provence, simultaneously with the CCD camera at the 120-cm telescope and the *SOPHIE* spectrograph at the 193-cm telescope. We observed in both datasets the whole egress of the transit and partially its central part, with the same timings. The ingress occurred before sunset and was not observed. The full duration of the transit is between 9.5 and 17.2 hours. The data allows the planetary radius to be measured ($R_p = 0.86 \pm 0.10\,R_{Jup}$) and other parameters of the system to be refined. Radial velocity measurements show the detection of a prograde Rossiter-McLaughlin effect, and provide a hint for a spin-orbit misalignment. If confirmed, this misalignment would corroborate the hypothesis that HD 80606 b owes its unusual orbital configuration to Kozai migration. HD 80606 b is by far the transiting planet on the longest period detected today. Its radius reinforces the observed relationship between the planet radius and the incident flux received from the star. Orbiting a quite bright star ($V = 9$), it opens opportunities to numerous follow-up studies.

Key words. Planetary systems – Techniques: radial velocities – Techniques: photometry – Stars: individual: HD 80606

Mon. Not. R. Astron. Soc. **000**, 1–5 (2009) Printed 26 February 2009 (MN LATEX style file v2.2)

Detection of a transit by the planetary companion of HD 80606

Stephen J. Fossey[1]**, Ingo P. Waldmann[1] & David M. Kipping[1]
[1] *Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK*

Accepted 2009 TBC. Received 2009 XXX; in original form 2009 February XXX

Fossey, Waldmann, Kipping (London)

Submitted for publication in the Astrophysical Journal

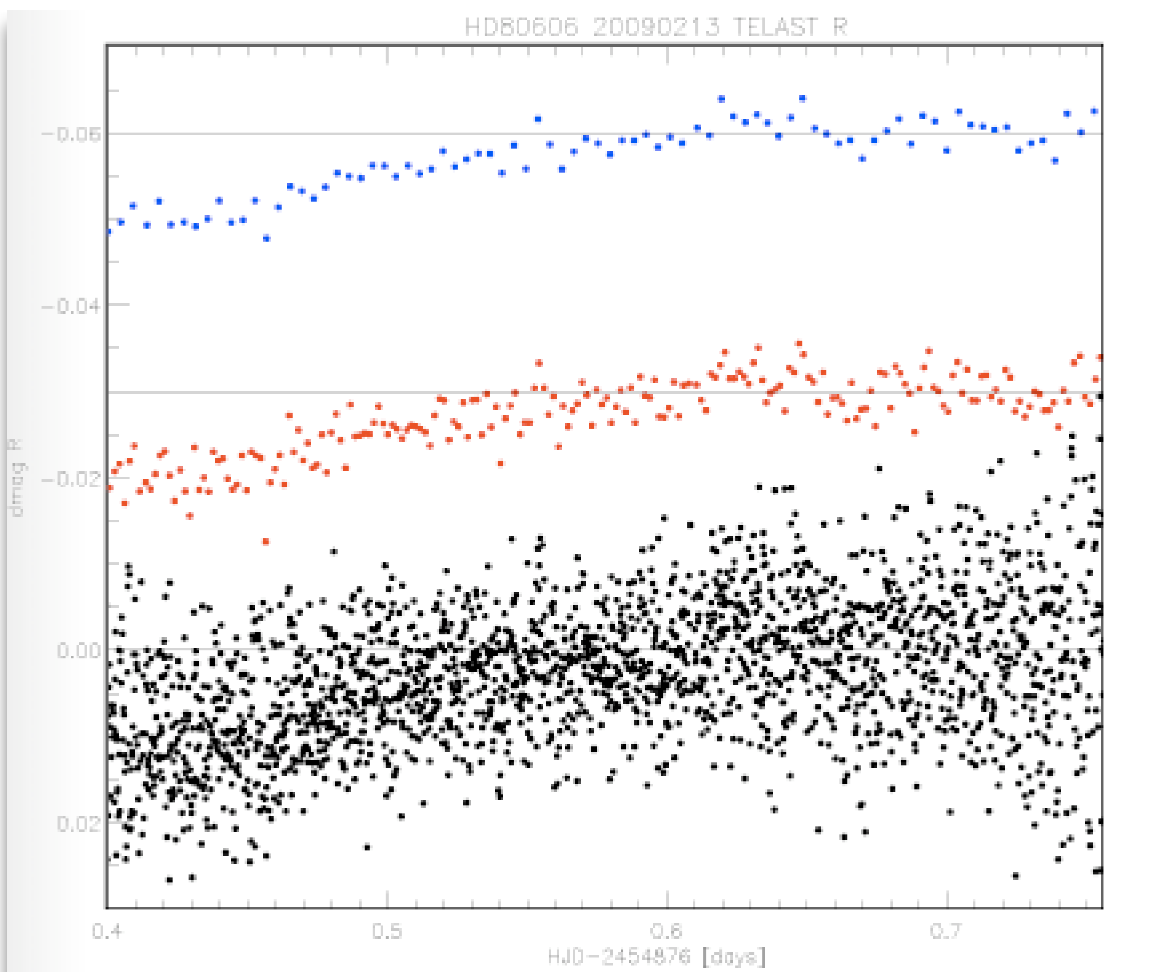
Unconfirmed Detection of a Transit of HD 80606b

E. Garcia-Melendo[1] & P. R. McCullough[2]
egarcia@foed.org

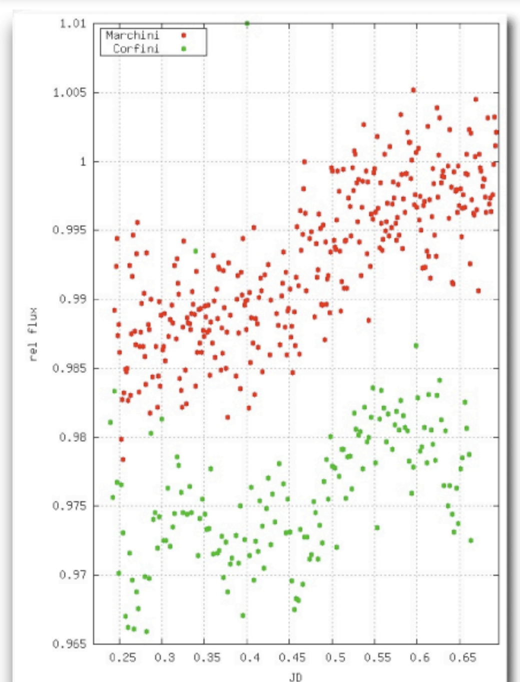
ABSTRACT

We report a times series of B-band photometric observations initiated on the eve of Valentine's day, February 14, 2009, at the anticipated time of a transit of the extrasolar planet HD 80606b. A transit model favored by the data has minimum light of 0.990 times the nominal brightness of HD 80606. The heliocentric Julian date (HJD) of the model's minimum light is 2454876.33, which combined with the orbital period $P = 111.4277 \pm 0.0032$ days, longitude of periastron, $\omega = 300.4977 \pm 0.0045$ degrees, and time of mid-secondary eclipse HJD 2454424.736 ± 0.003 (Laughlin et al. 2009), refines the eccentricity, $e = 0.9337^{+0.0012}_{-0.0004}$, and the inclination, $i = 89.26^{+0.24}_{-0.04}$ degrees. The duration of the model transit is 0.47 days, and its four contacts occur at HJD 2454876 plus 0.10, 0.24, 0.42, and 0.57 days. We observed only the last two contacts, not the first two. We obtained "control" time series of HD 80606 on subsequent nights; as expected, the "controls" do not exhibit transit-like features. We caution that 1) the transit has not been confirmed independently; 2) we did not observe the transit's ingress; 3) consequently, we cannot reliably measure the relative sizes of the planet and its star in a model-independent manner, and 4) hence, the other values derived herein are also model dependent.

Garcia-Melendo (Spain)

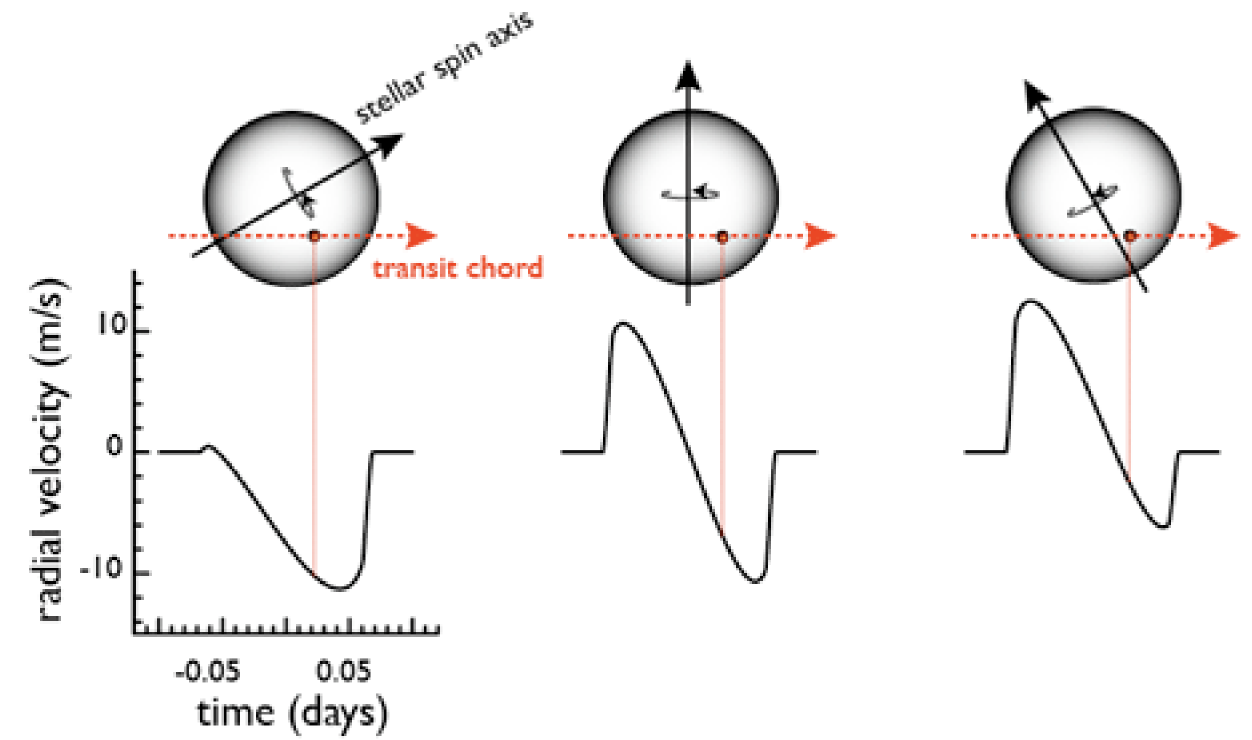


Alemenara (Canary Islands, grad student)



Marchini, Corfini (Italy, amateurs)

The Rossiter-McLaughlin Effect



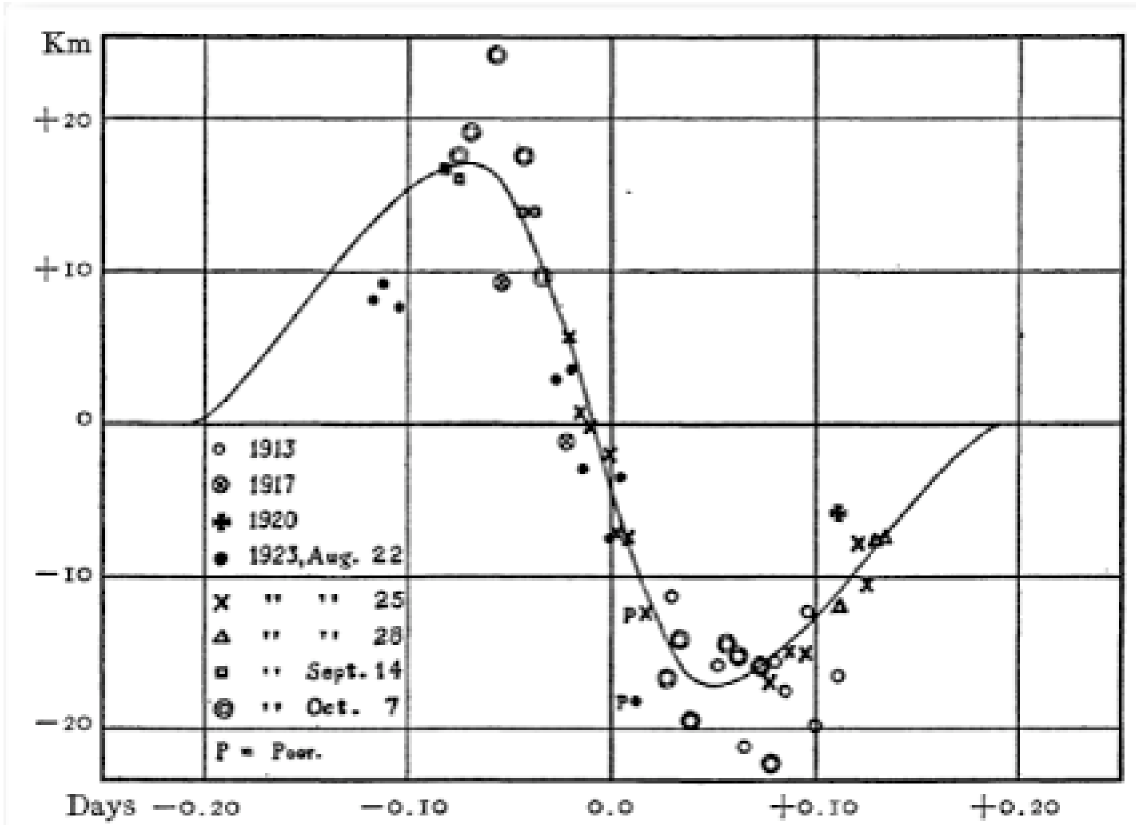
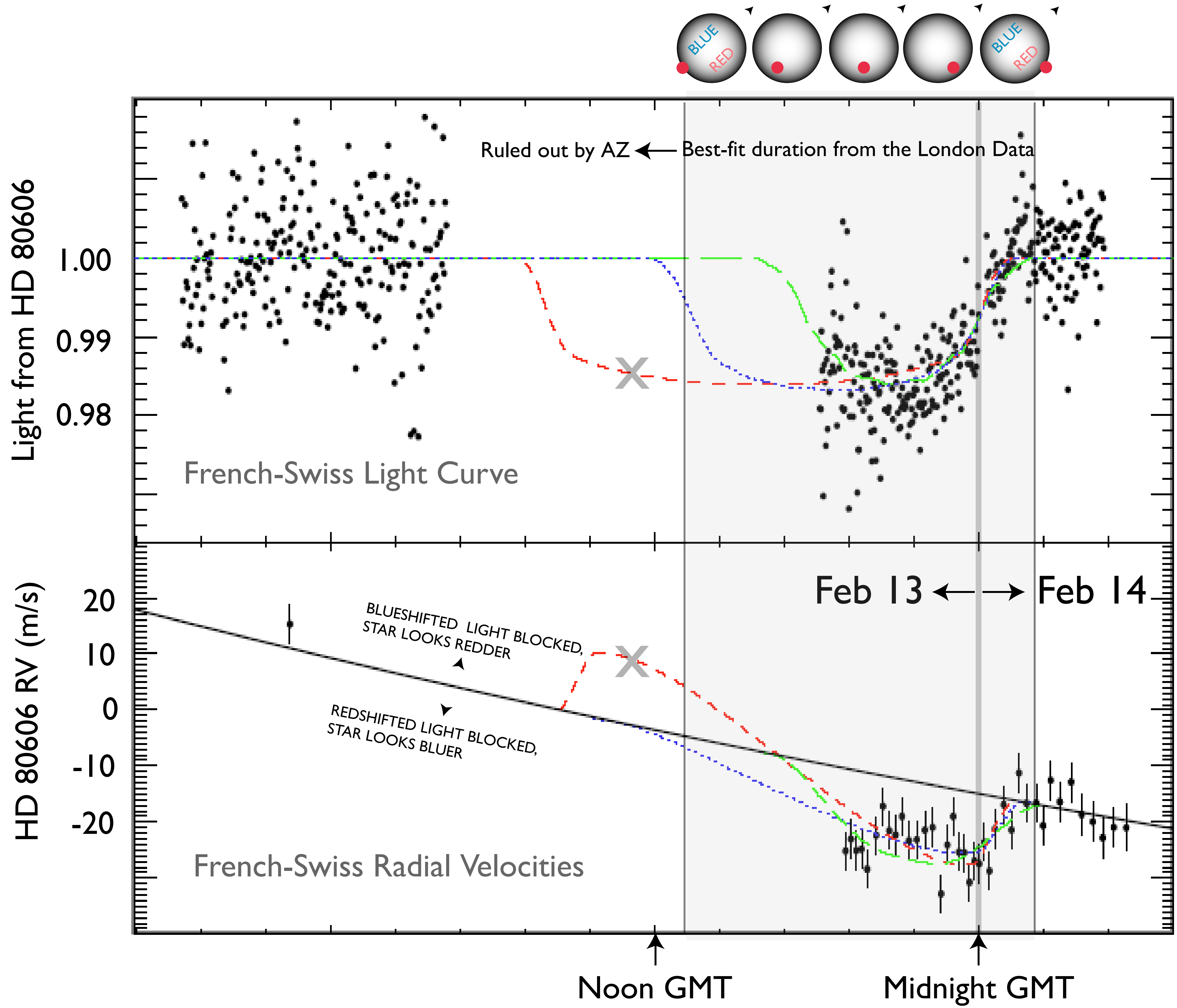


FIG. 1.—Curve of the rotational effect in Algol

Rossiter 1924 (Algol)



BLUE
RED
BLUE
RED
Ruled out by AZ
Best-fit duration from the London Data
Light from HD 80606
1.00
0.99
0.98
French-Swiss Light Curve
Feb 13
Feb 14
BLUESHIFTED LIGHT BLOCKED, STAR LOOKS REDDER
REDSHIFTED LIGHT BLOCKED, STAR LOOKS BLUER
HD 80606 RV (m/s)
20
10
0
-10
-20
French-Swiss Radial Velocities
Noon GMT
Midnight GMT

Collaborators

Konstantin Batygin, Aaron Wolf

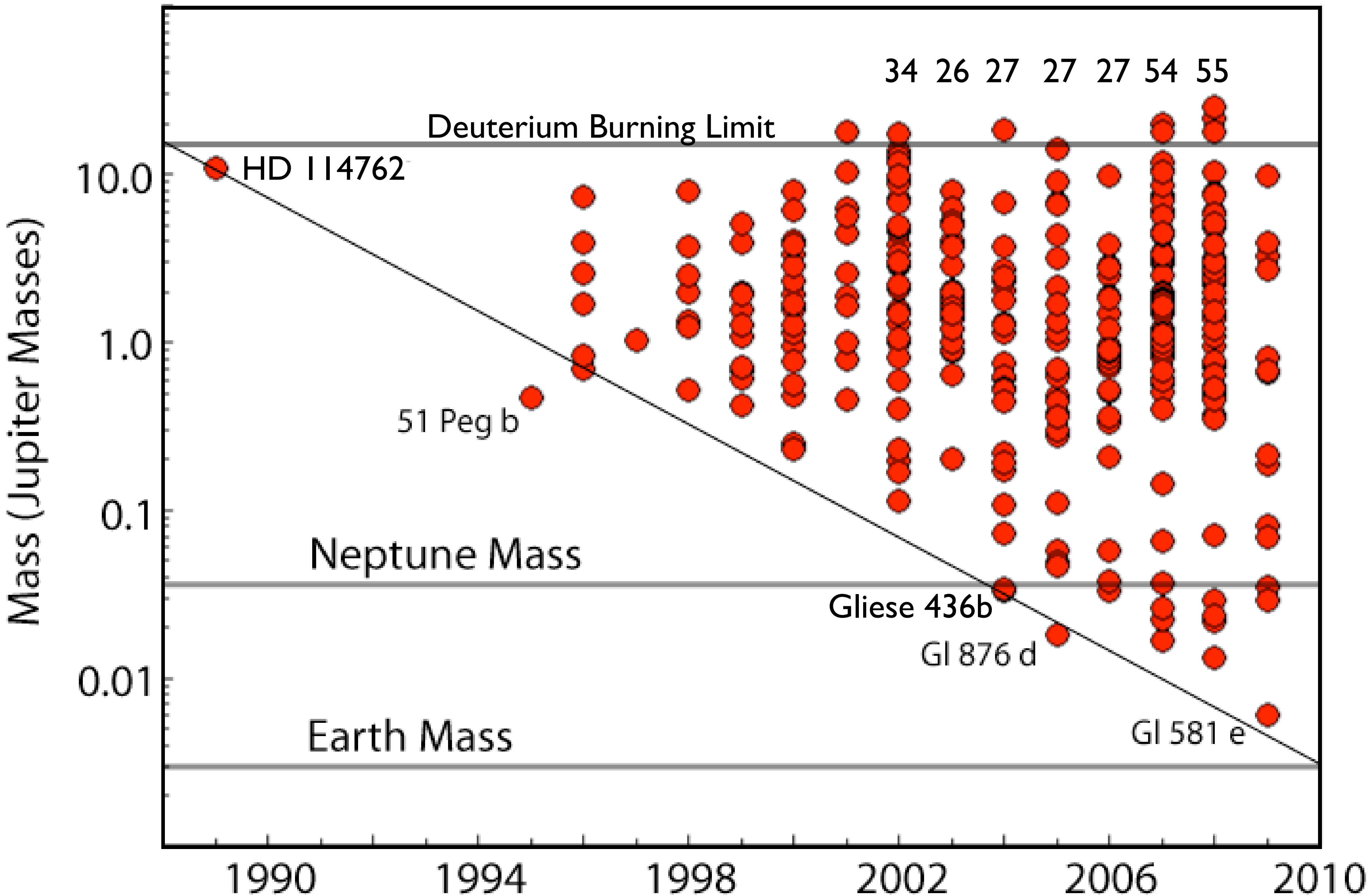
Jonathan Langton, Stefano Meschiari

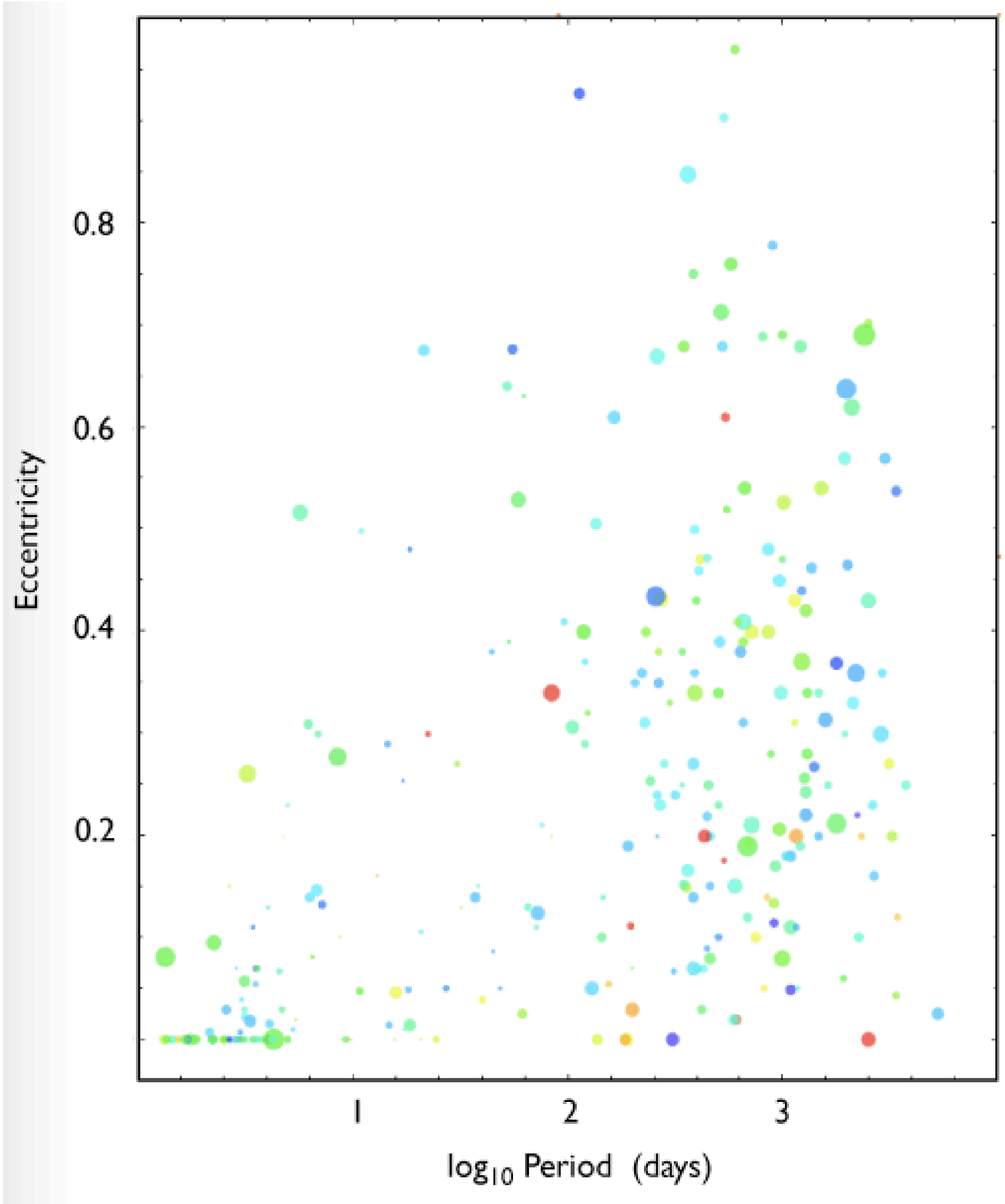
Dan Kasen, Eugenio Rivera

Steve Vogt, Peter Bodenheimer

Paul Butler, Drake Deming

Year of Discovery vs. Planetary Msin(i)



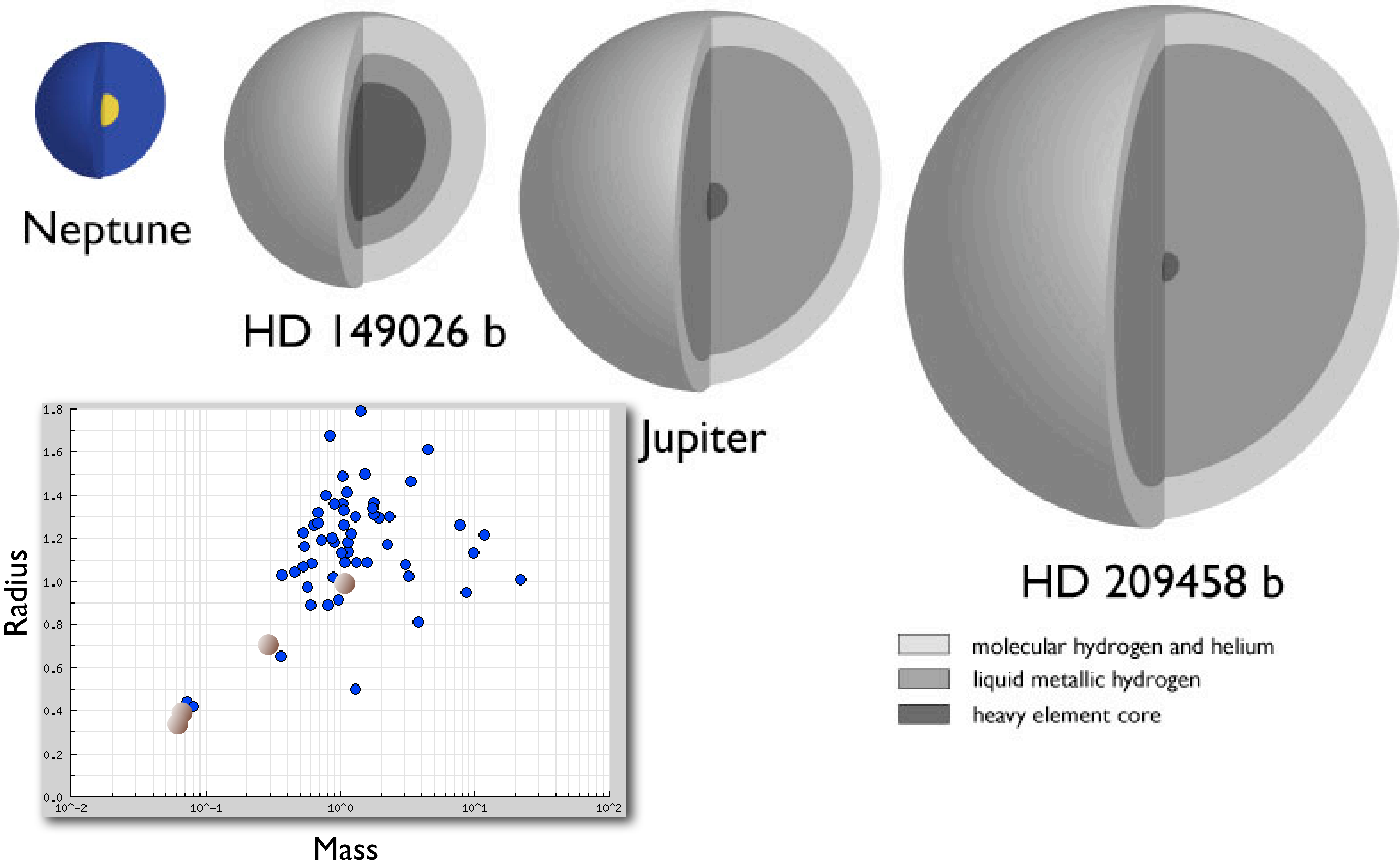


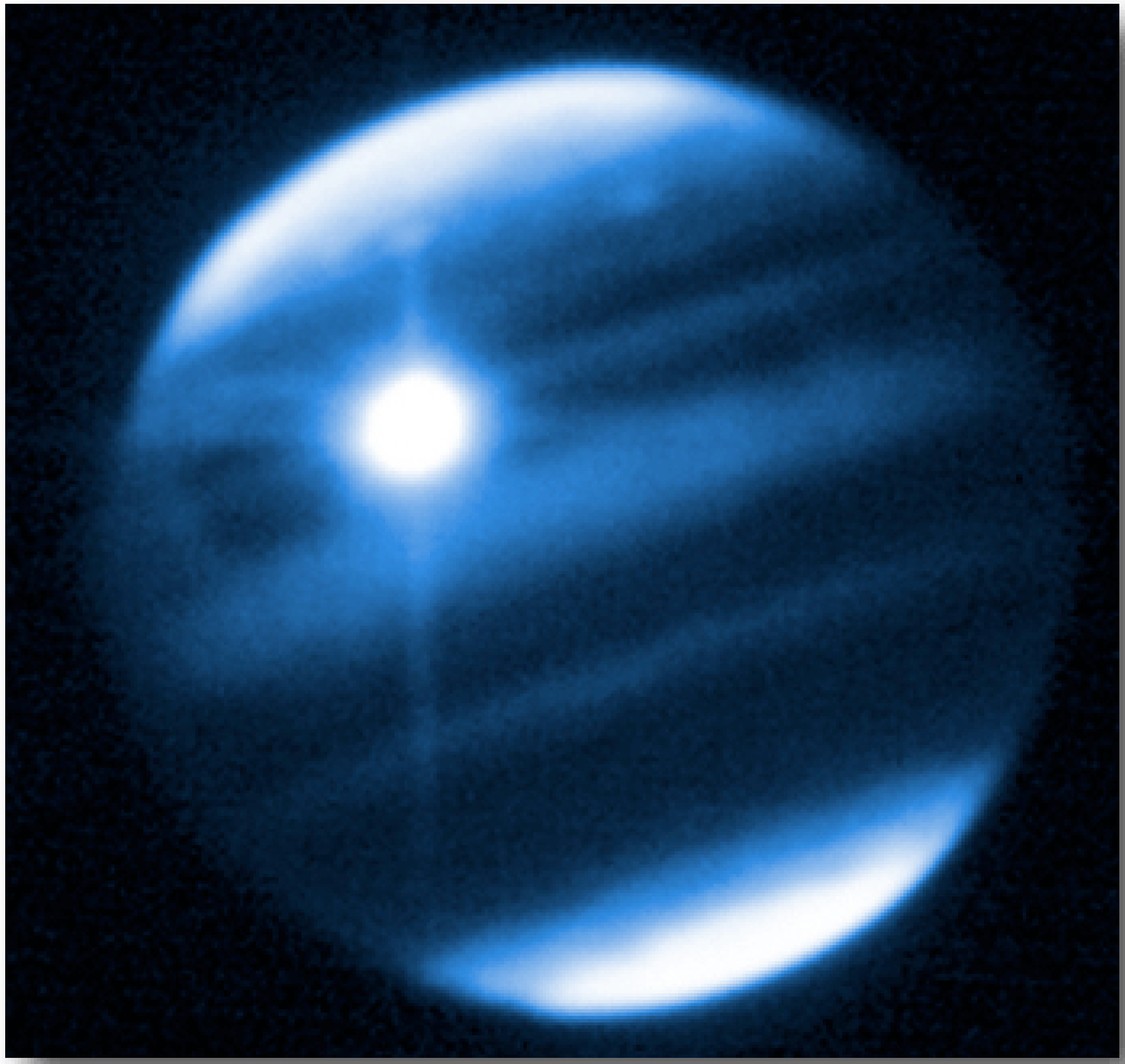
4D correlation diagram

red=[Fe/H]=-0.5 to violet=[Fe/H]=+0.5

point radii proportional to *M*sin(*i*)**0.4

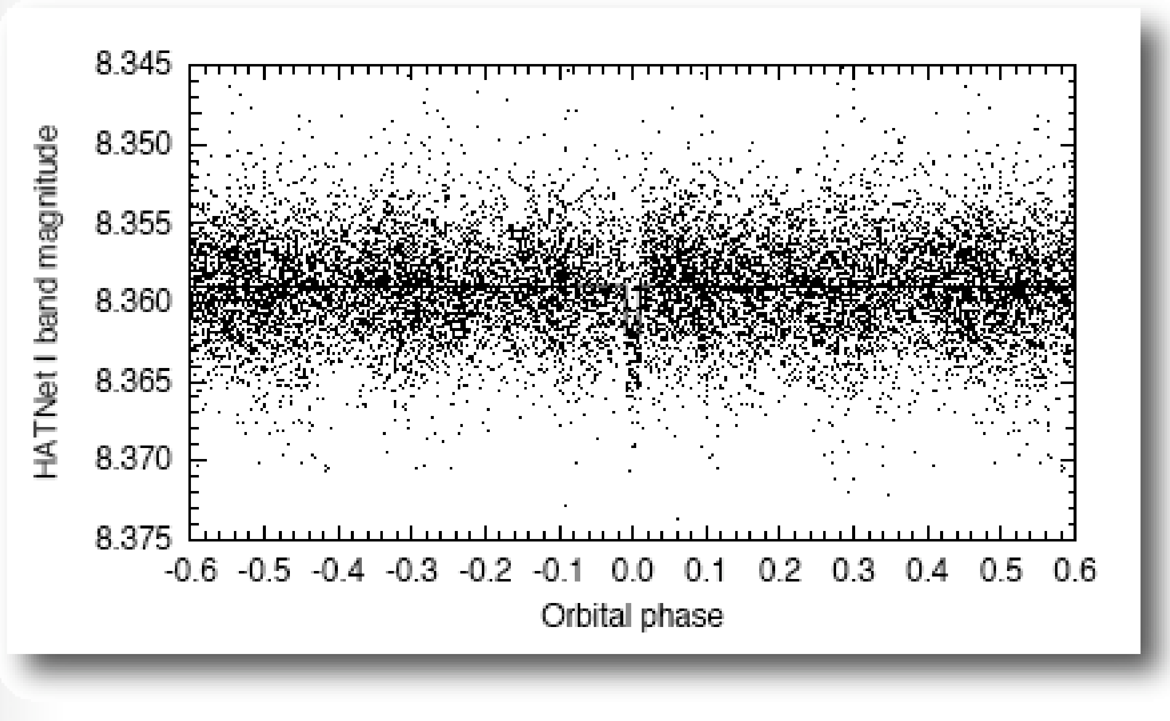
The wildly varying radii of the transiting planets indicate a large range of core masses, and varying non-stellar heat sources.

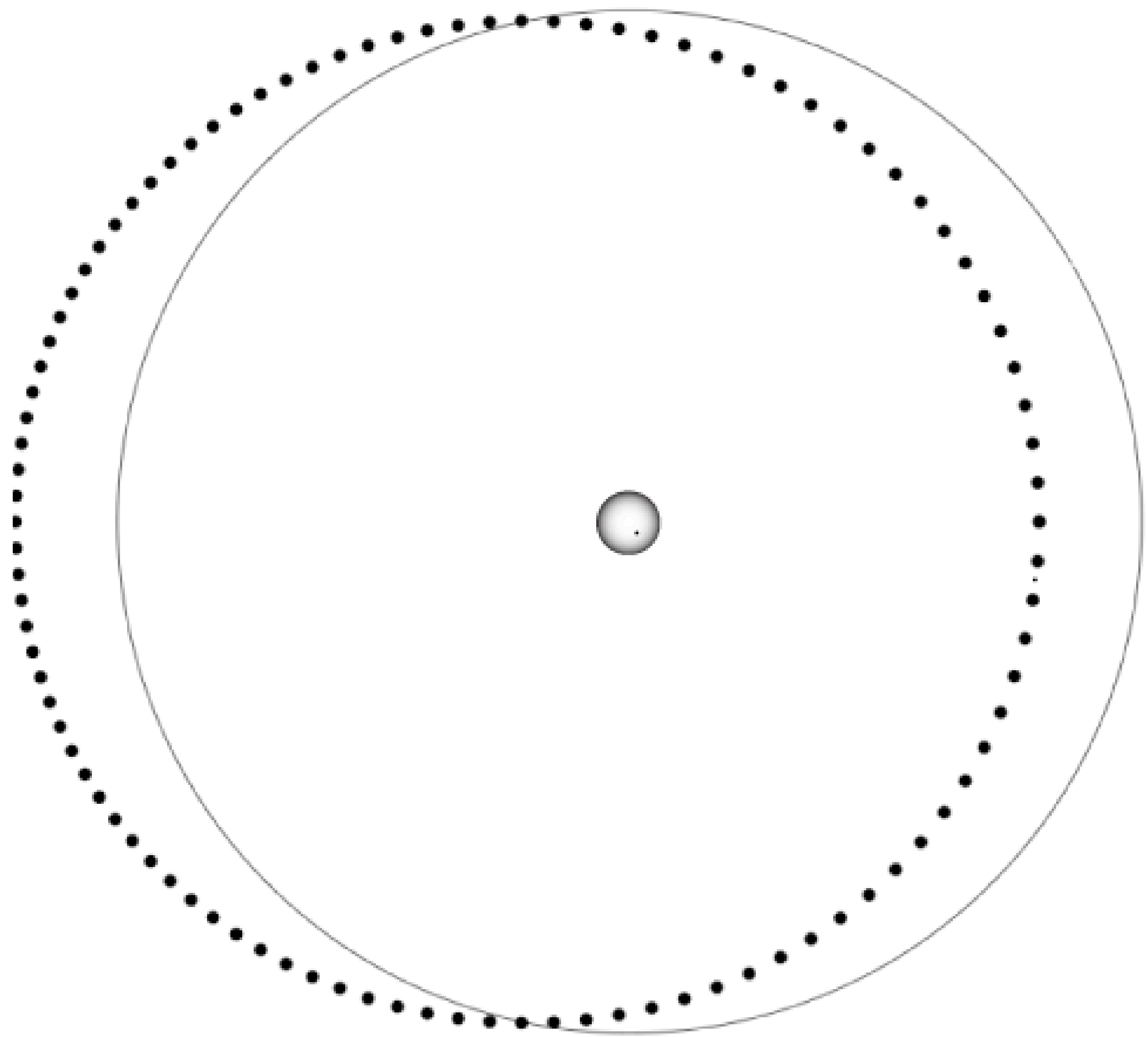


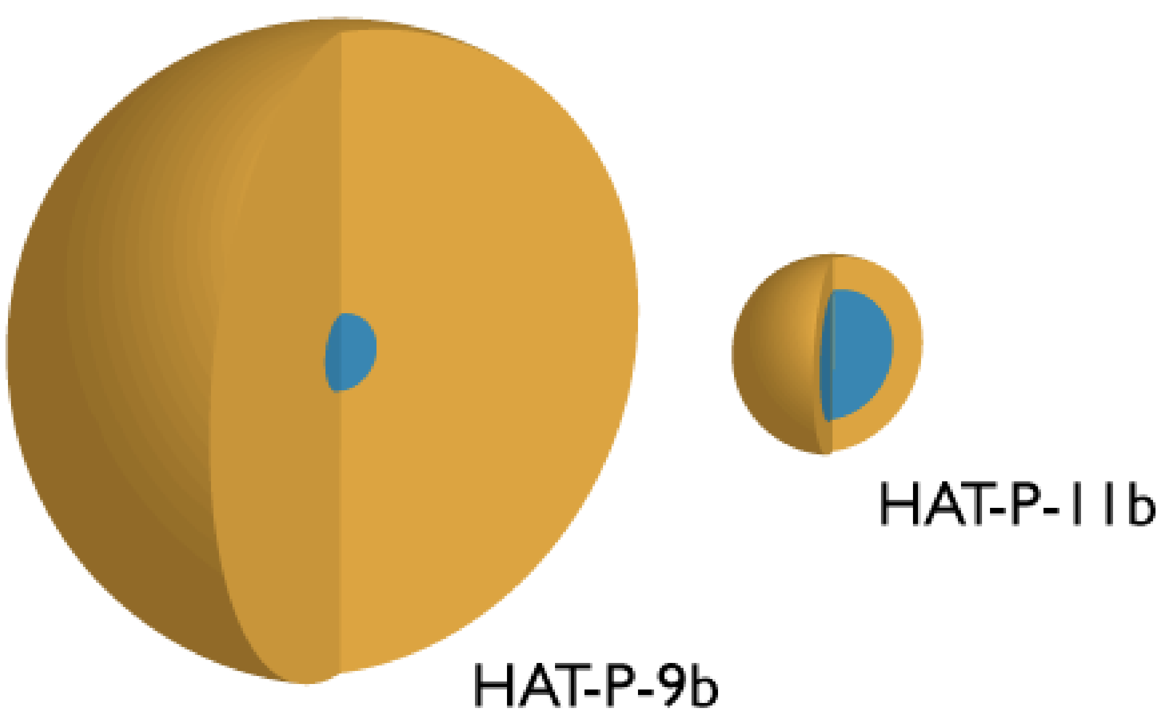


Jupiter in the K-band

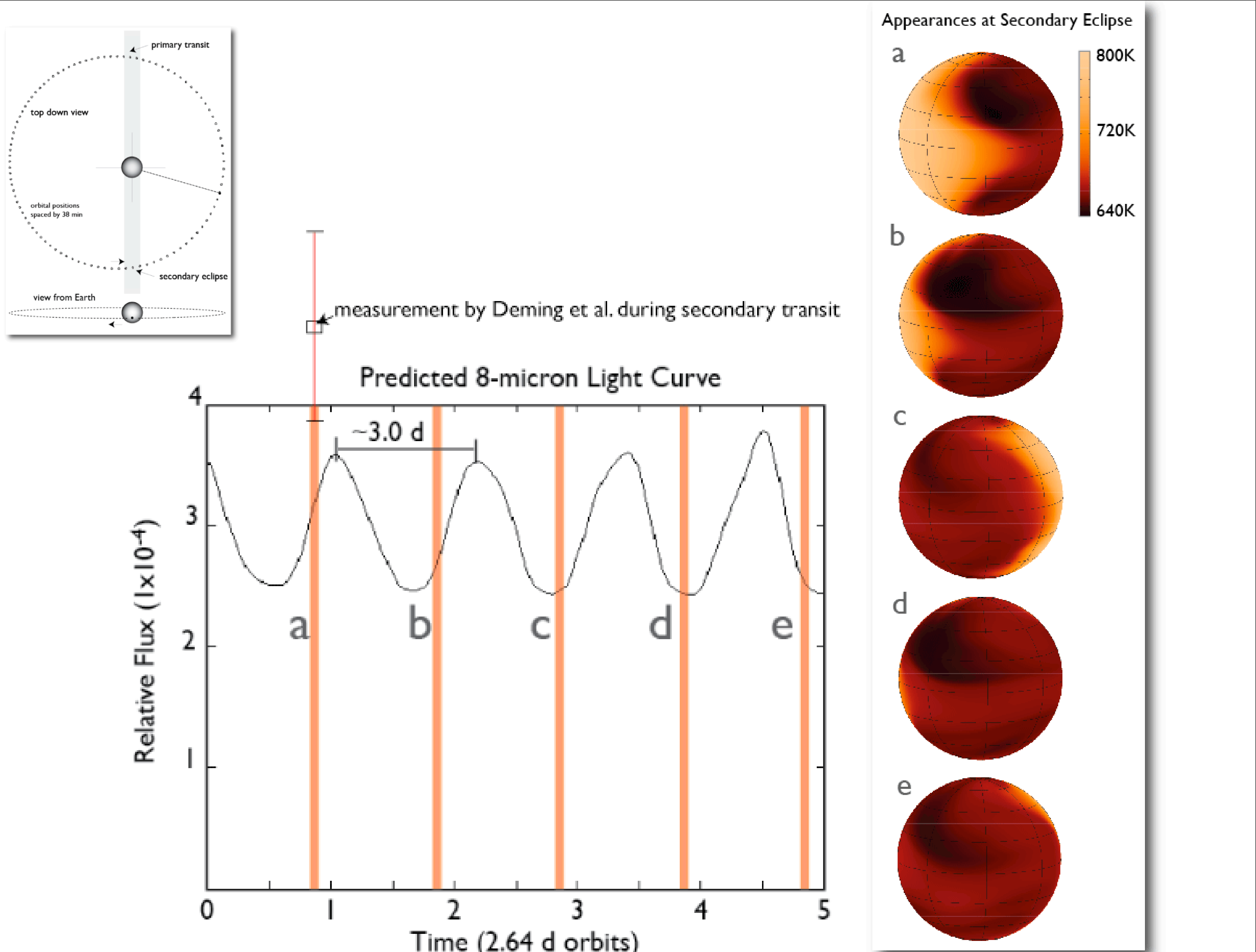
HAT-P-11b: A transiting hot Neptune





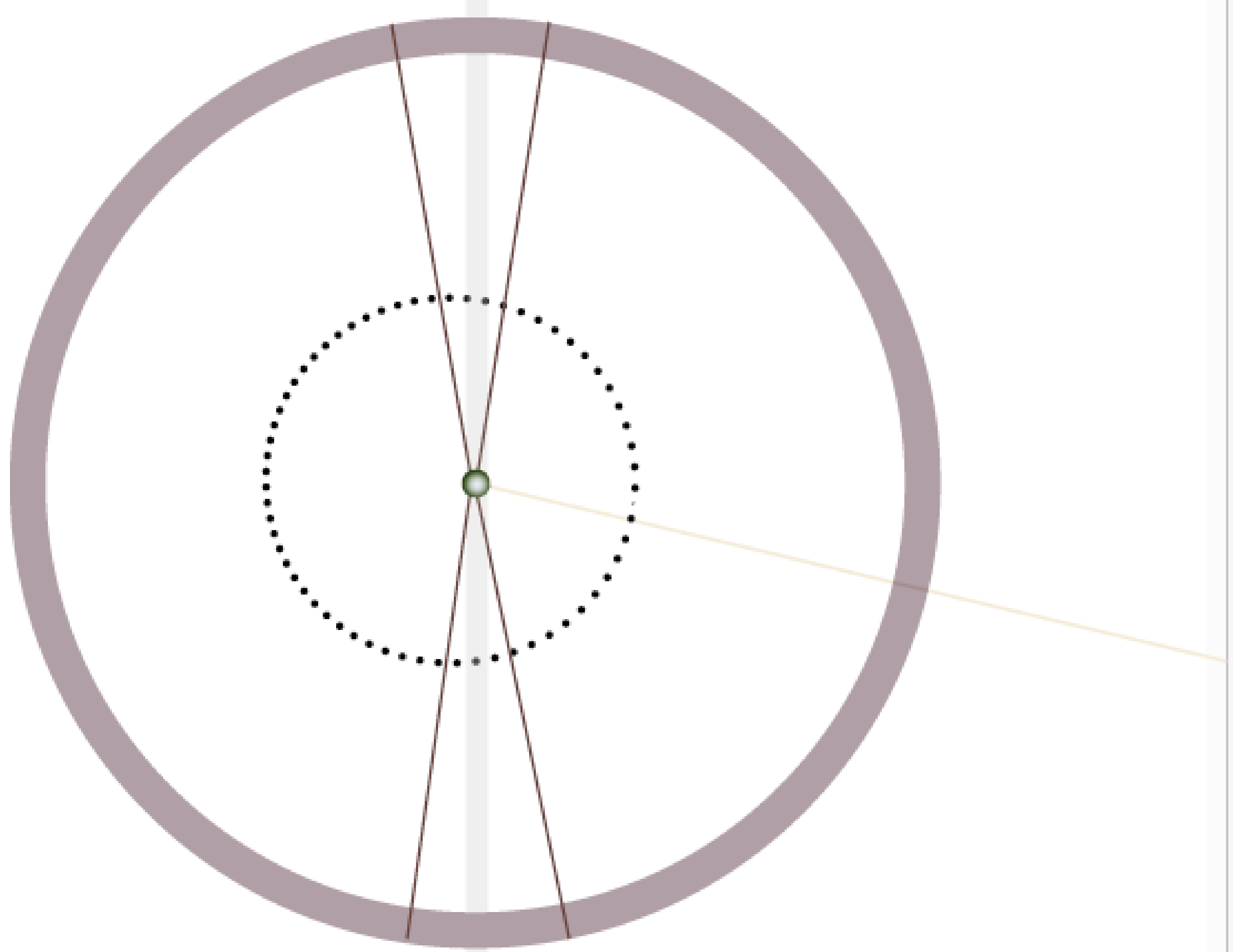


Bakos et al. 2009



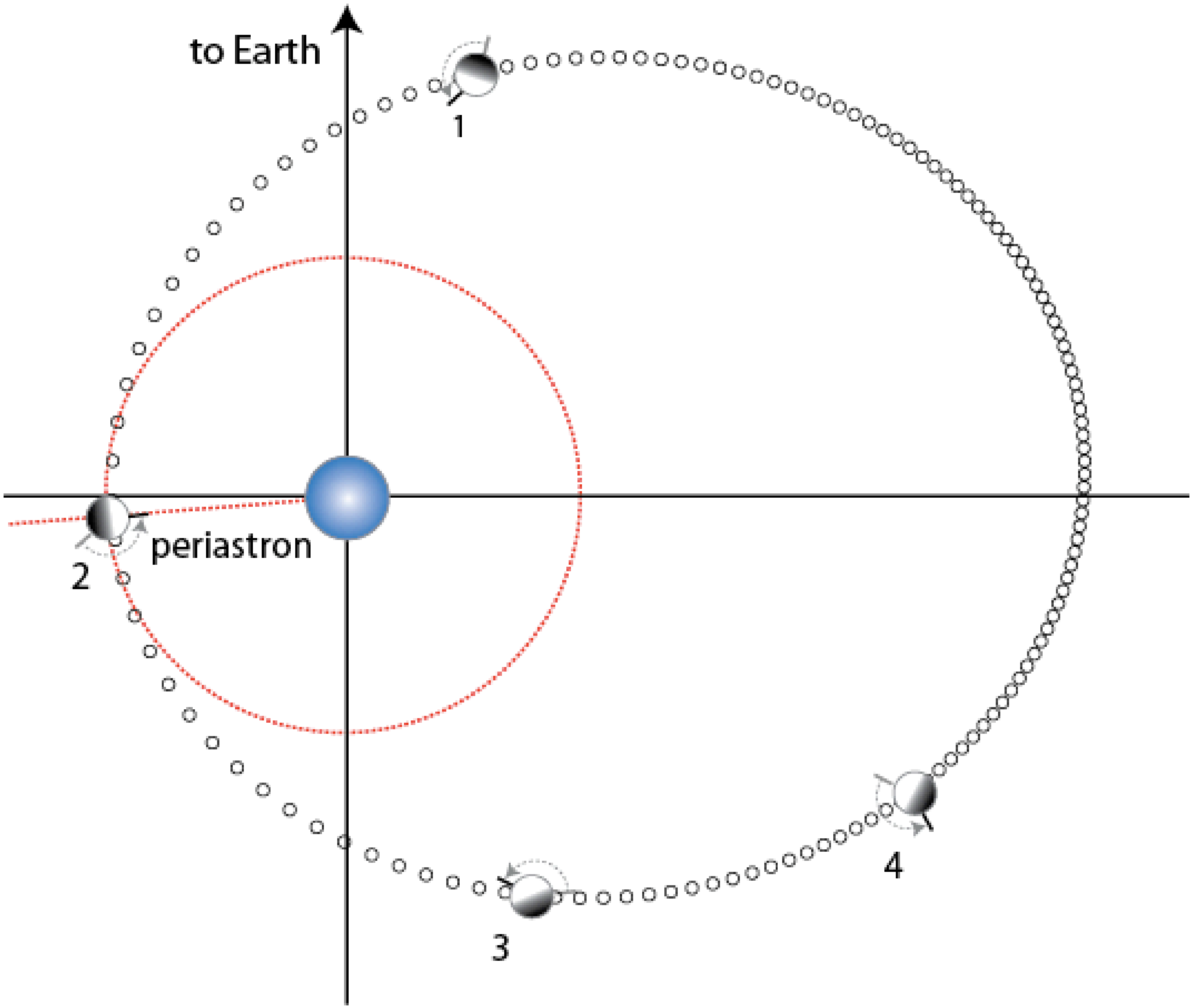
primary transit
top down view
orbital positions spaced by 38 min
secondary eclipse
view from Earth
measurement by Deming et al. during secondary transit
Predicted 8-micron Light Curve
~3.0 d
Relative Flux (1x10⁻⁴)
Time (2.64 d orbits)
0
1
2
3
4
5
a
b
c
d
e
Appearances at Secondary Eclipse
800K
720K
640K

Gliese 436

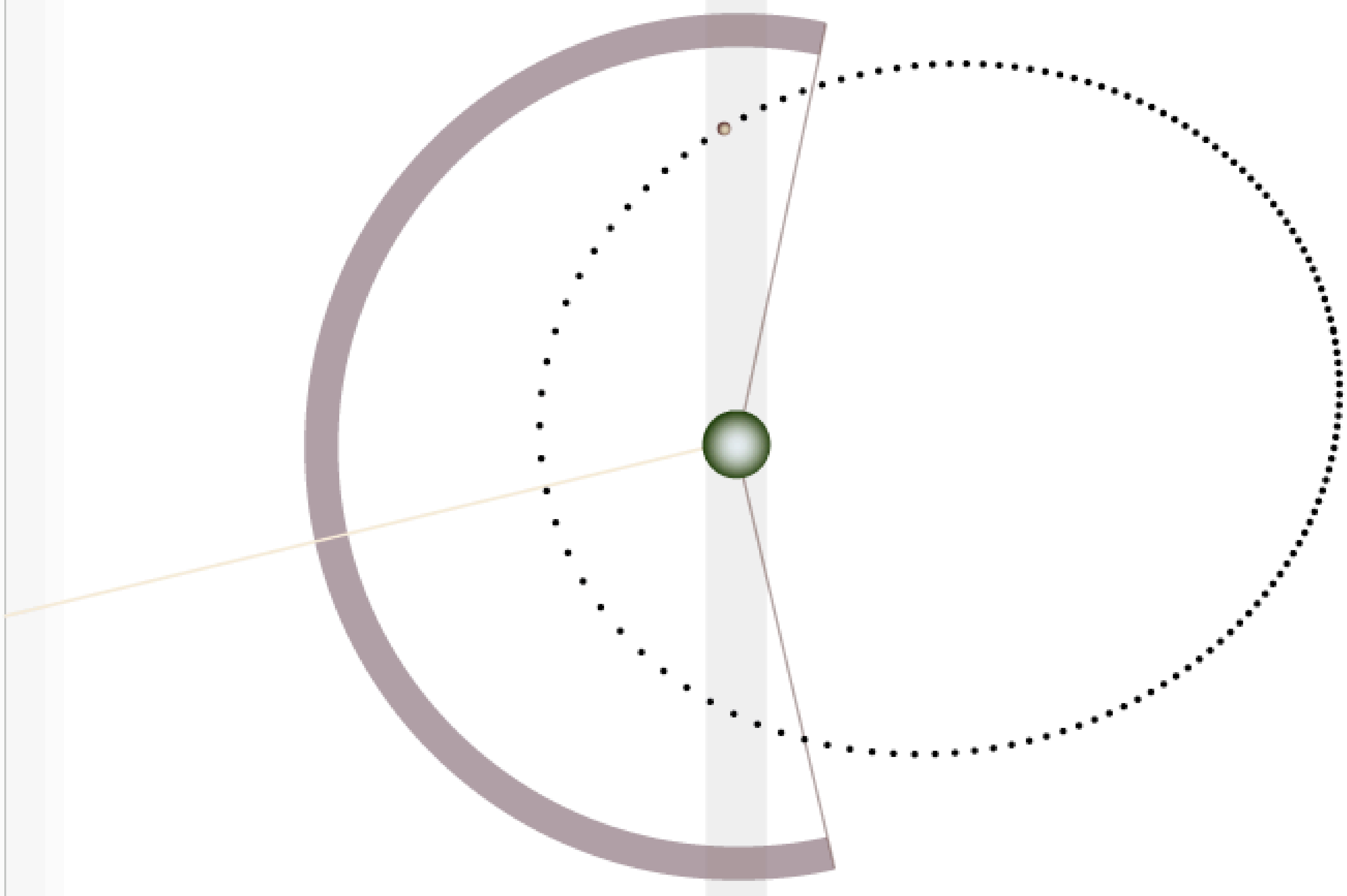


PI: Knutson

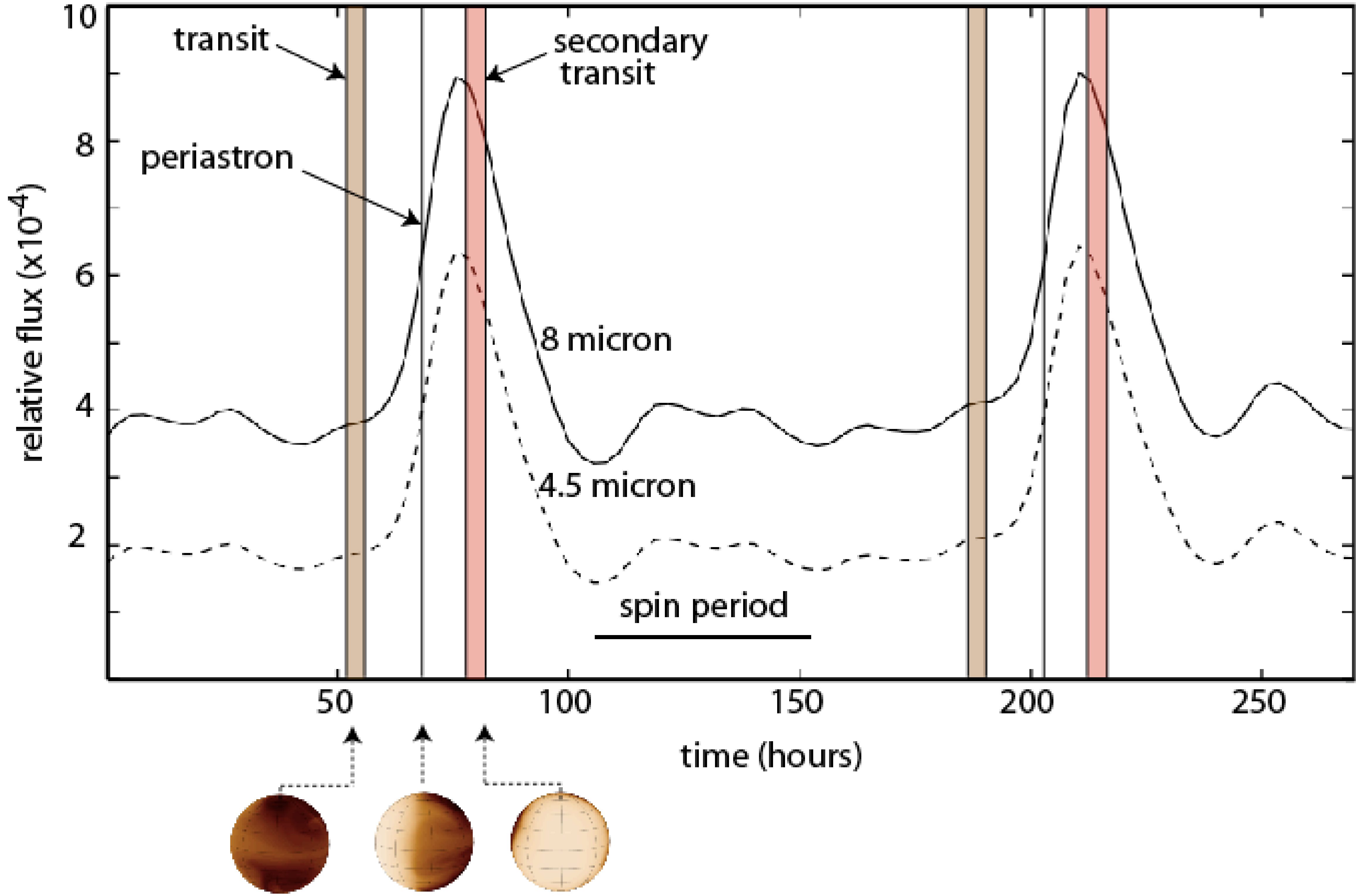
HAT-P-2b



HAT-P-2

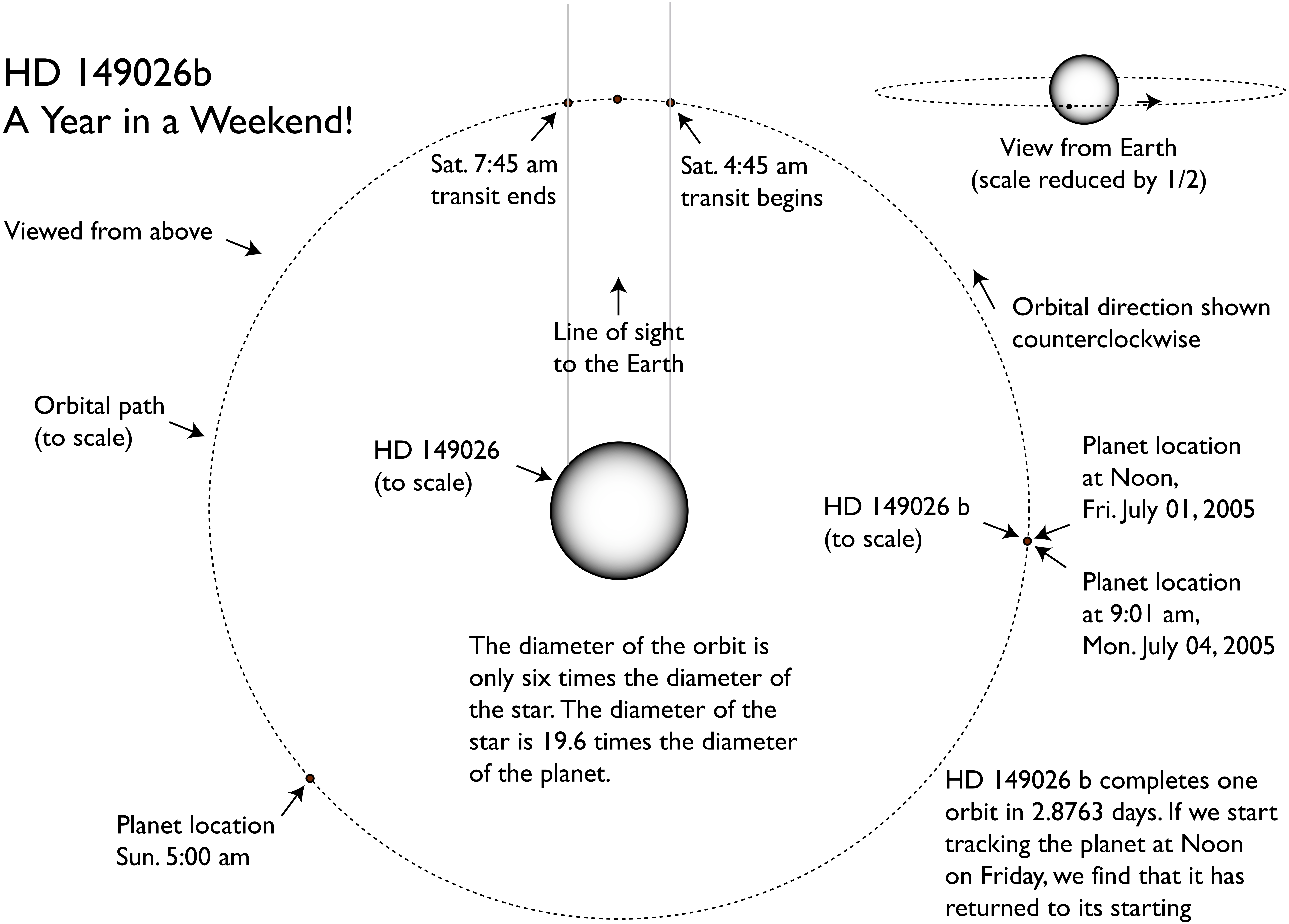


PI: Bakos



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

HD 149026b
A Year in a Weekend!

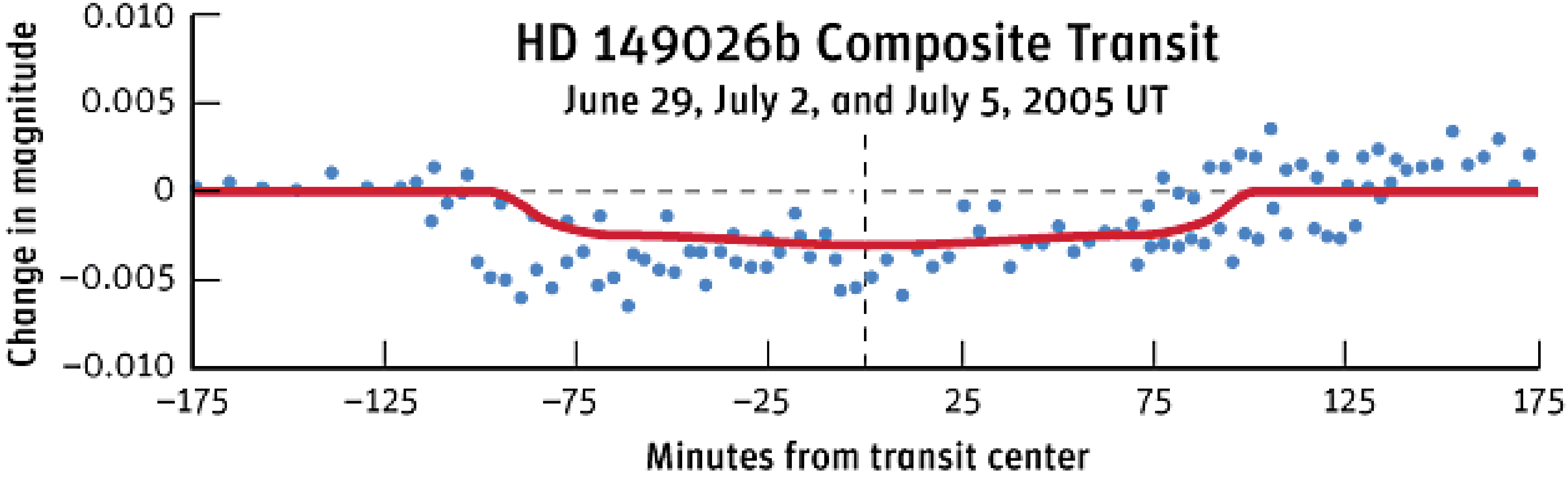


The diameter of the orbit is only six times the diameter of the star. The diameter of the star is 19.6 times the diameter of the planet.

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.

(All times UT)

Amateur astronomer Ron Bissinger observed the transit from his backyard in Pleasanton California starting only hours after we announced the discovery



FastLane

PI/CO-PI Management -

Proposal Functions | HOME

Proposal Status | MAIN

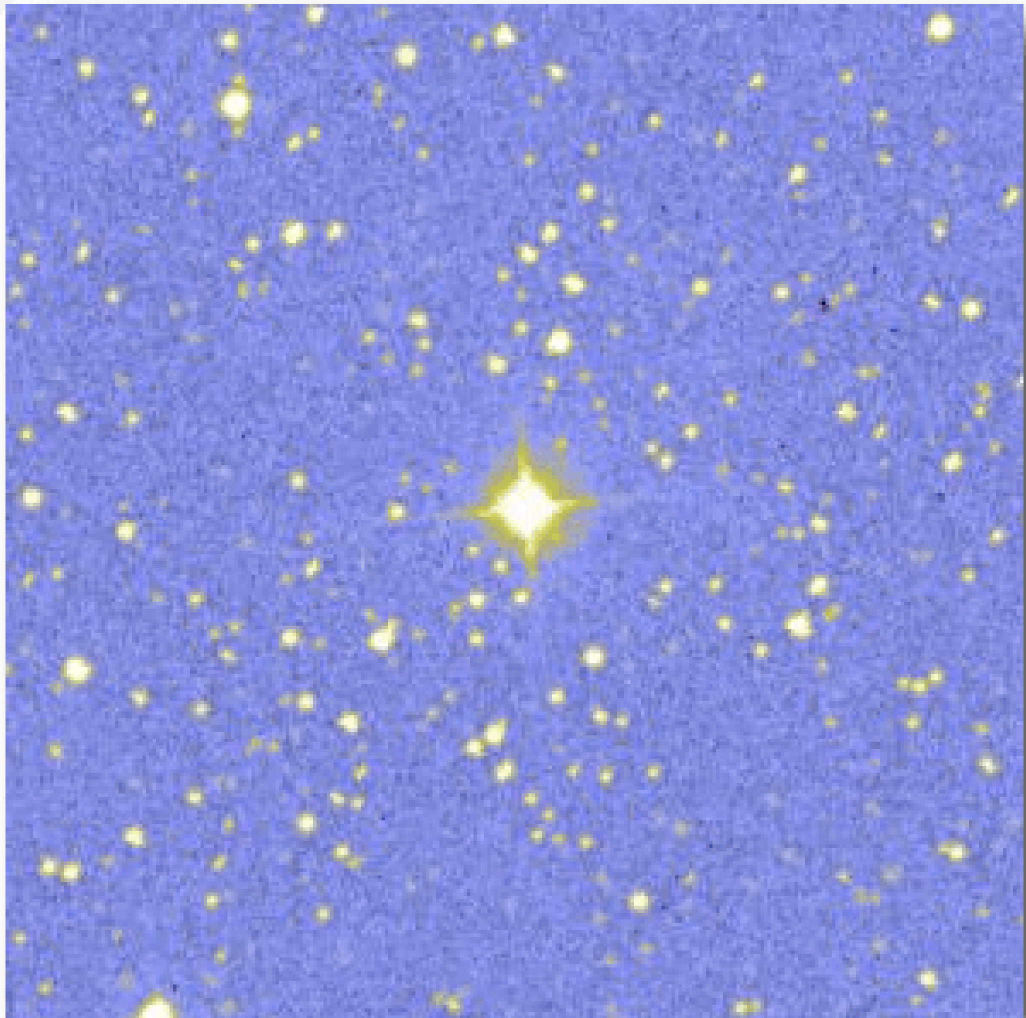
Organization: University of California-Santa Cruz

Panel Summary #1

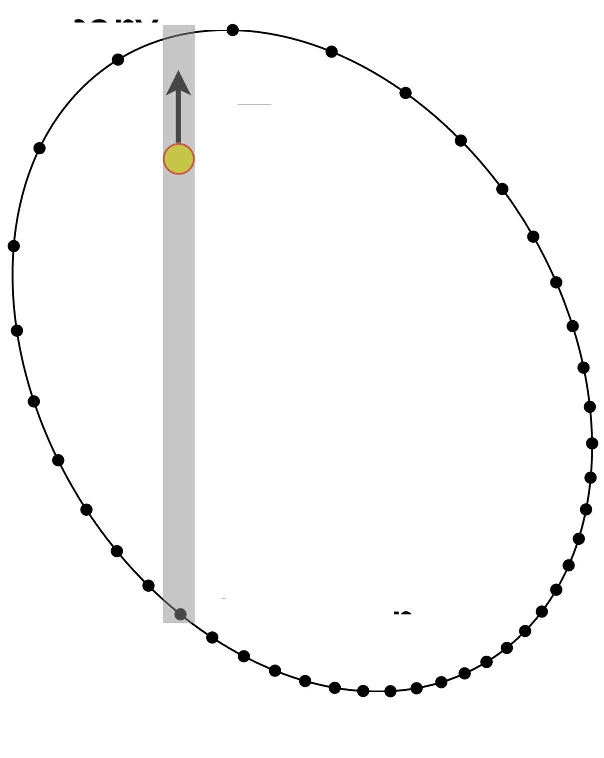
Proposal Number: 0206021

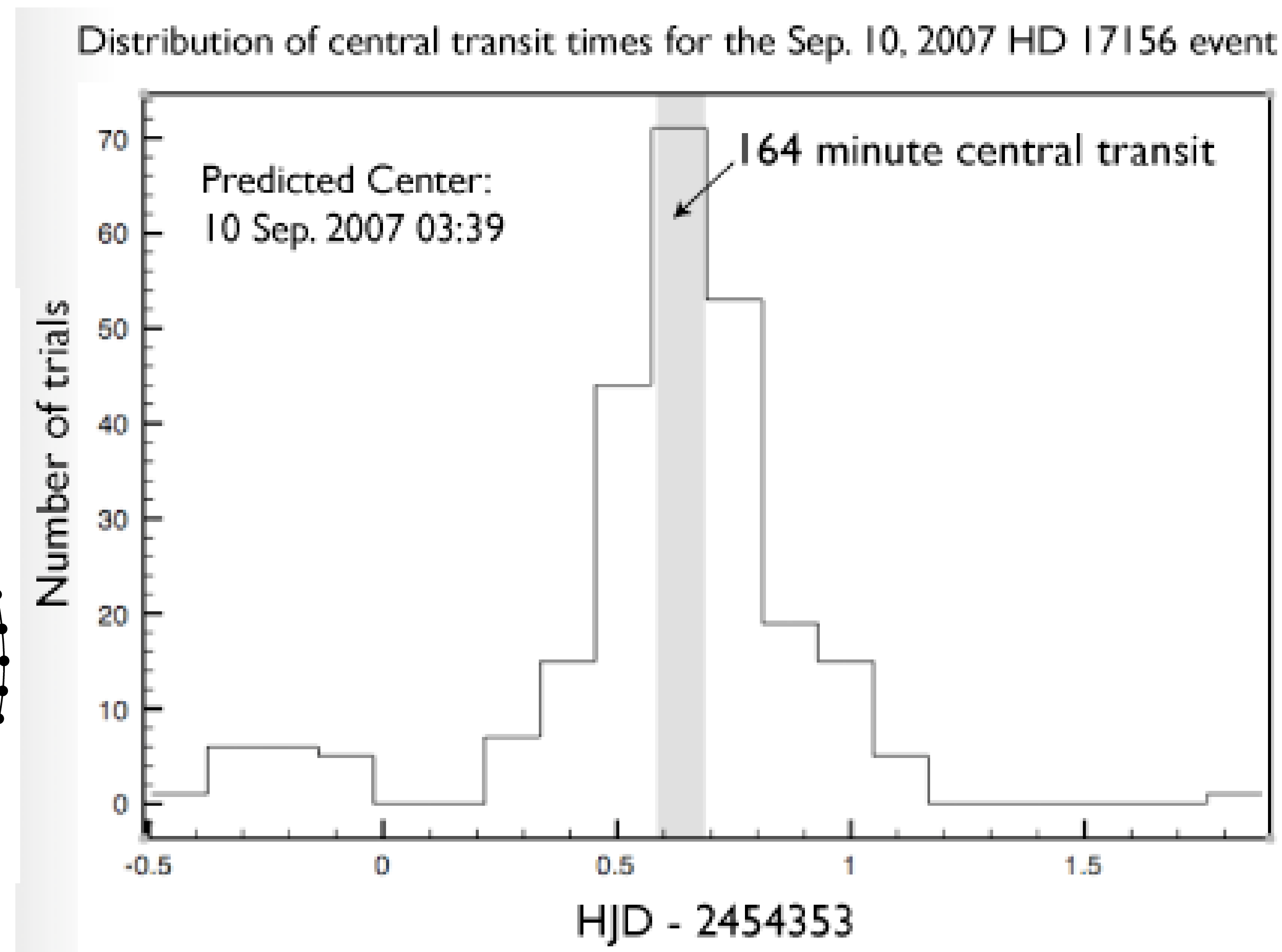
Panel Summary:
The proposal is terribly overambitious with too many tasks requiring too much effort and time for the given commitment by the PI. It is unrealistic to believe that a fraction of the proposed tasks could be accomplished in the time allocated. The proposal would have benefitted from focussing on a few of the more promising lines of research. The network of amateur telescopes was the weakest component of the proposal. The effort to establish such a network, to combine the disparate observations and obtain a reliable photometric data set was underrated, under-described, and seemingly un-feasable as part of this myriad of activities. Moreover, while representing a great opportunity for EPO, the danger of raising a participant's expectations to unrealistic levels through an ill-managed program might backfire. This is a shame considering the subject matter is of great interest -- the general public understands and is interested in hearing about extrasolar planets. In particular, the graphic of the test data

HD 17156b

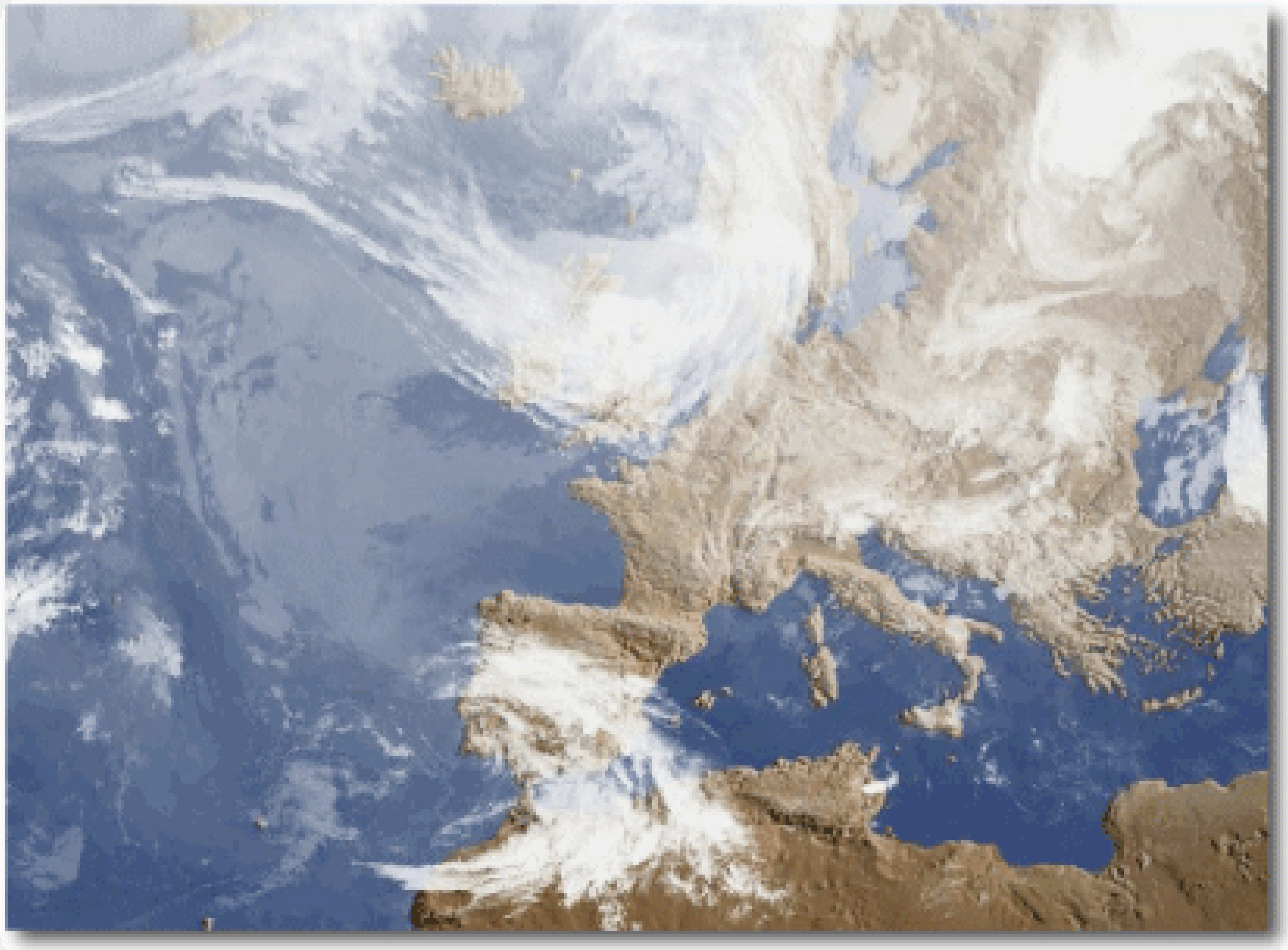


$$
\begin{aligned}
e &= 0.67 \\
a &= 0.15\text{A.U.} \\
i &= 87.89^\circ \\
P_{orb} &= 21.2\text{d} \\
P_{rot} &= 3.8\text{d} \\
M &= 3.08 M_J \\
R &= 1.15 R_J \\
L_* &= 2.6 L_\odot
\end{aligned}
$$

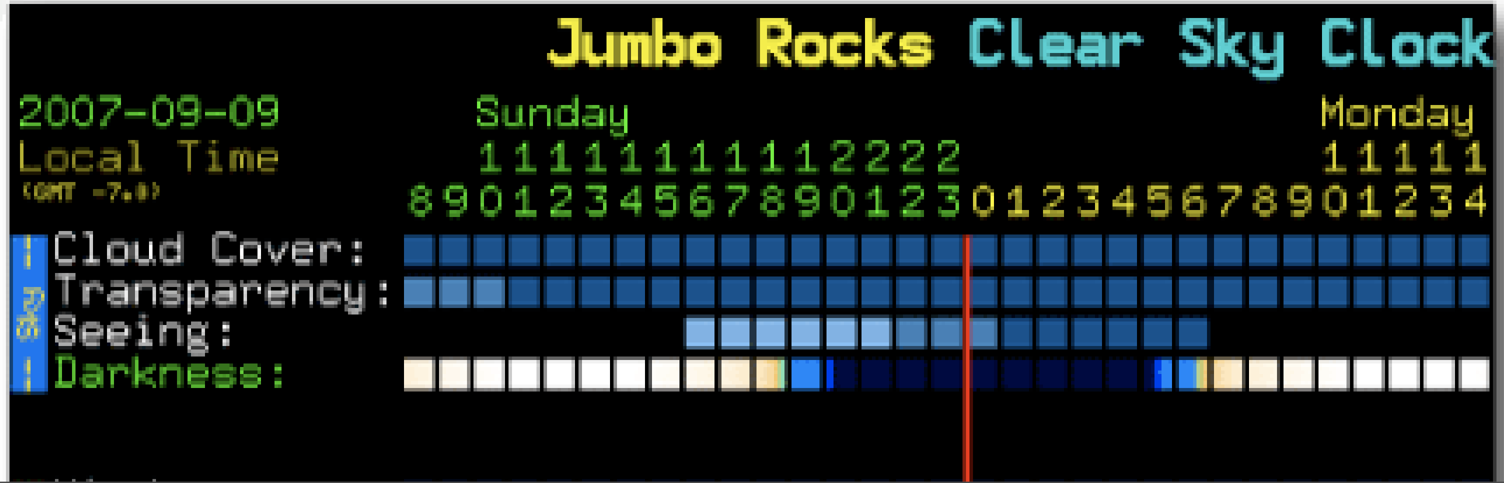




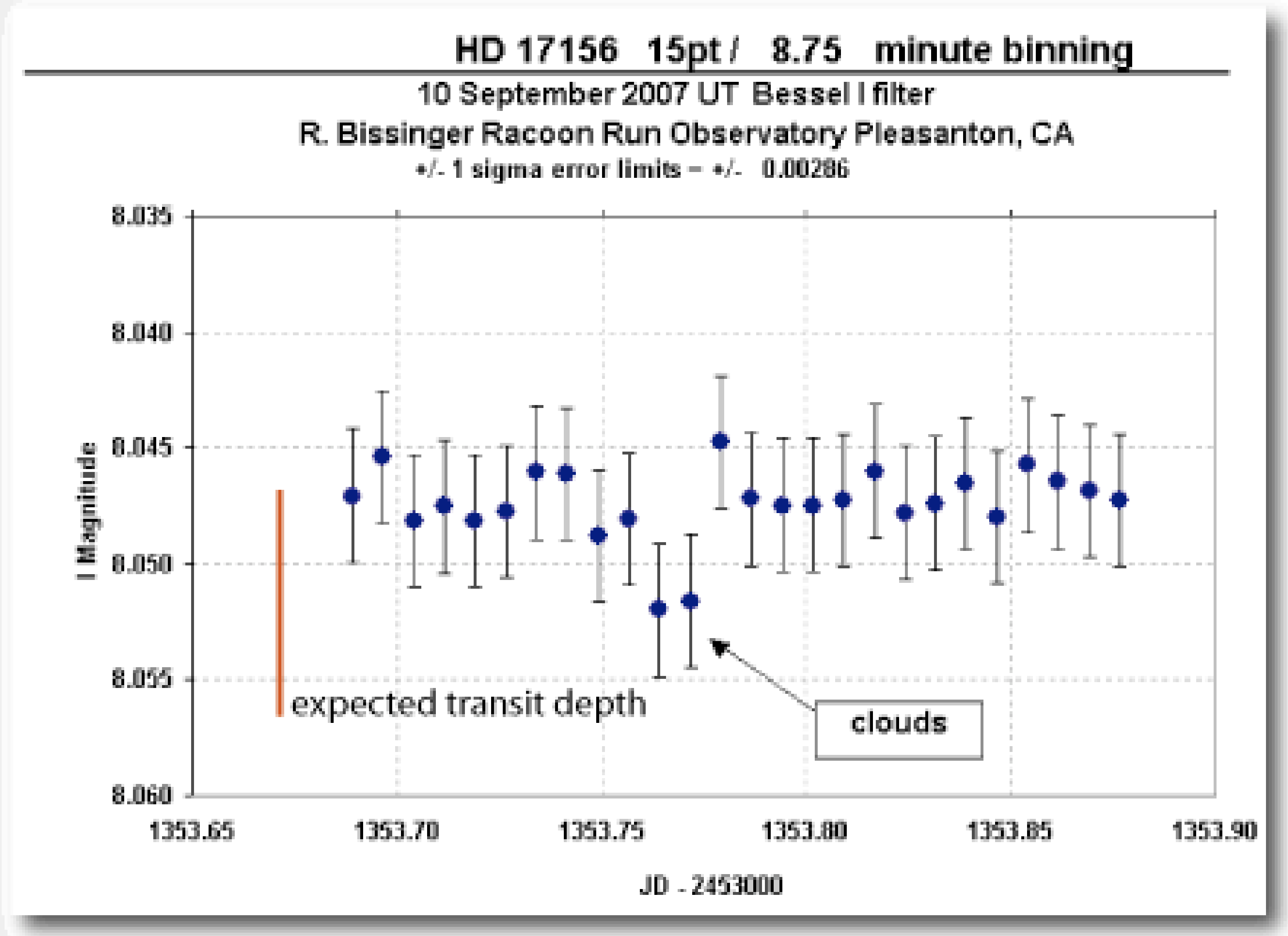
It's 01:58 UT Sep. 10, and HD 17156 has moved into its transit window. Hopefully photometric transit observers across Europe have clear skies. If you're collecting data, drop us a note on the comments page!



Most of California looks pretty good for catching the latter part of the transit window once it gets dark tonight. I was up on Mt. Hamilton last night, and even though it was clear, there was a strong smell of smoke in the air. Bits of gray ash from the nearby forest fires were floating down like snow, and so they couldn't open the dome of the 36-inch.

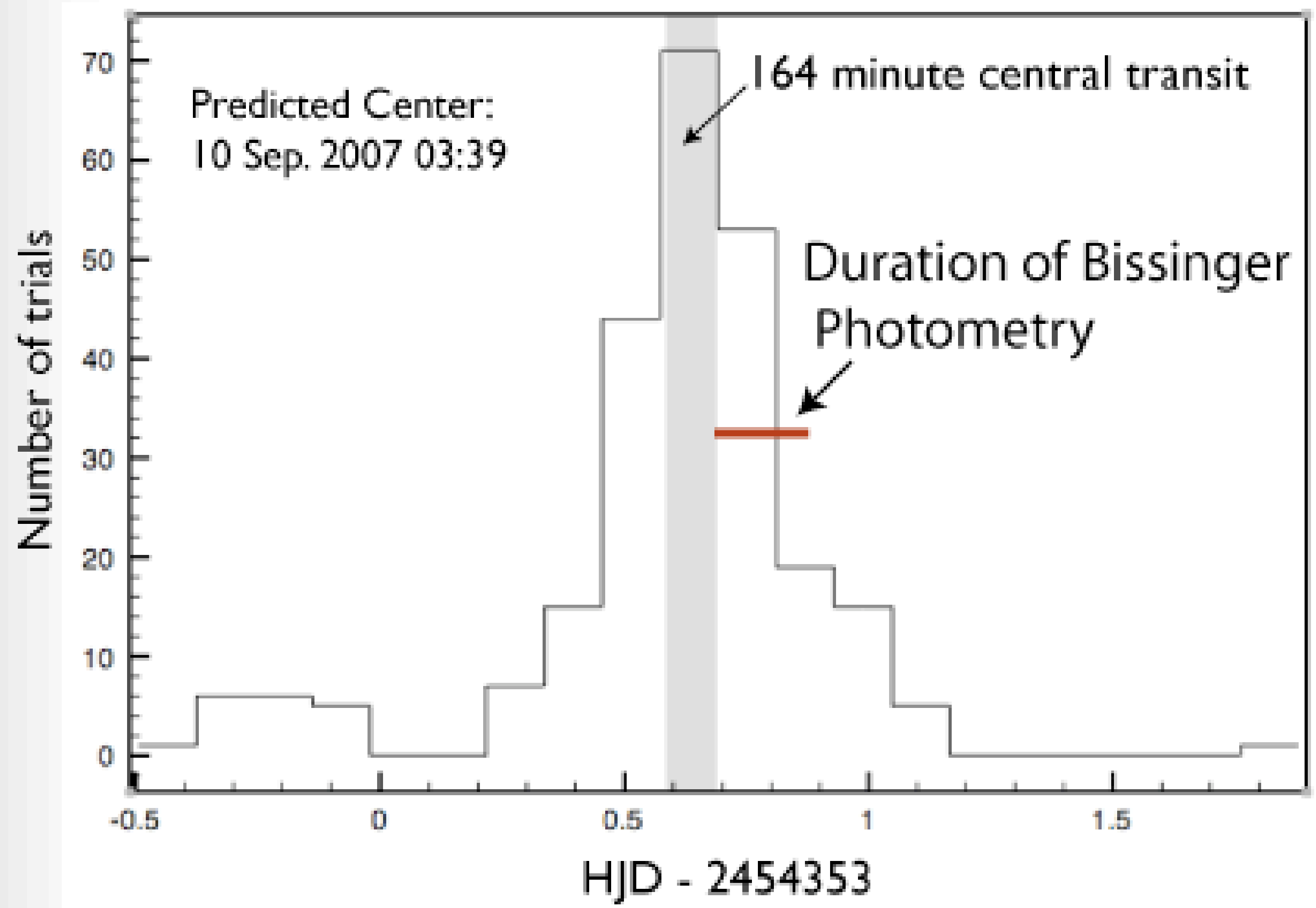


It's not looking good for transits by HD 17156 b. Ron Bissinger of Pleasanton, California obtained a block of photometric data that covered a significant chunk of the transit window. His time series lasts from JD 2454353.68 through 2452353.88, and shows no hint of an event:



His observations were taken just after the peak of the transit midpoint histogram:

Distribution of central transit times for the Sep. 10, 2007 HD 17156 event



No word yet on whether anyone in Europe or the eastern US were able to observe during the first half of the window. If you got data, let me know.

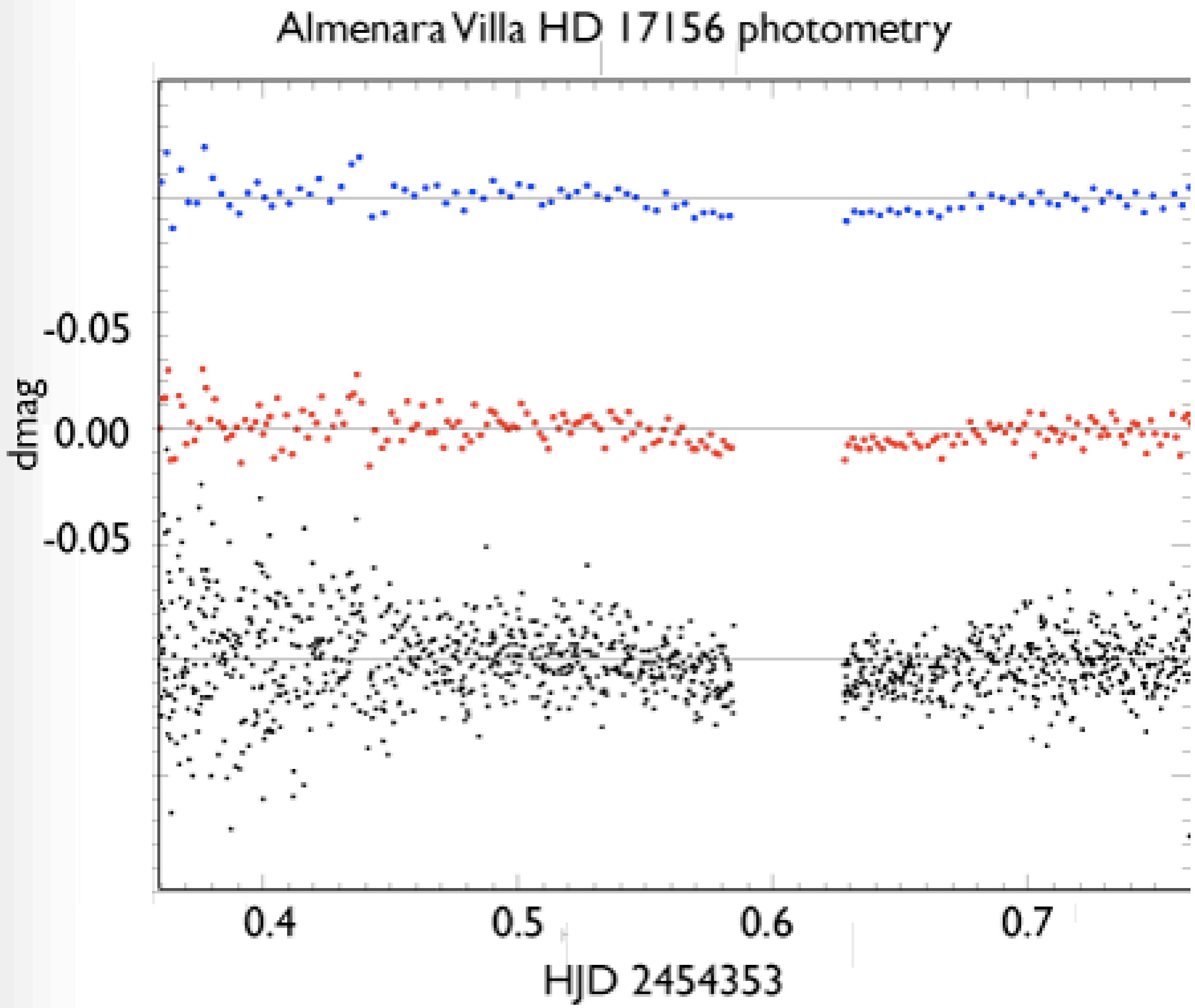
Hi Greg,

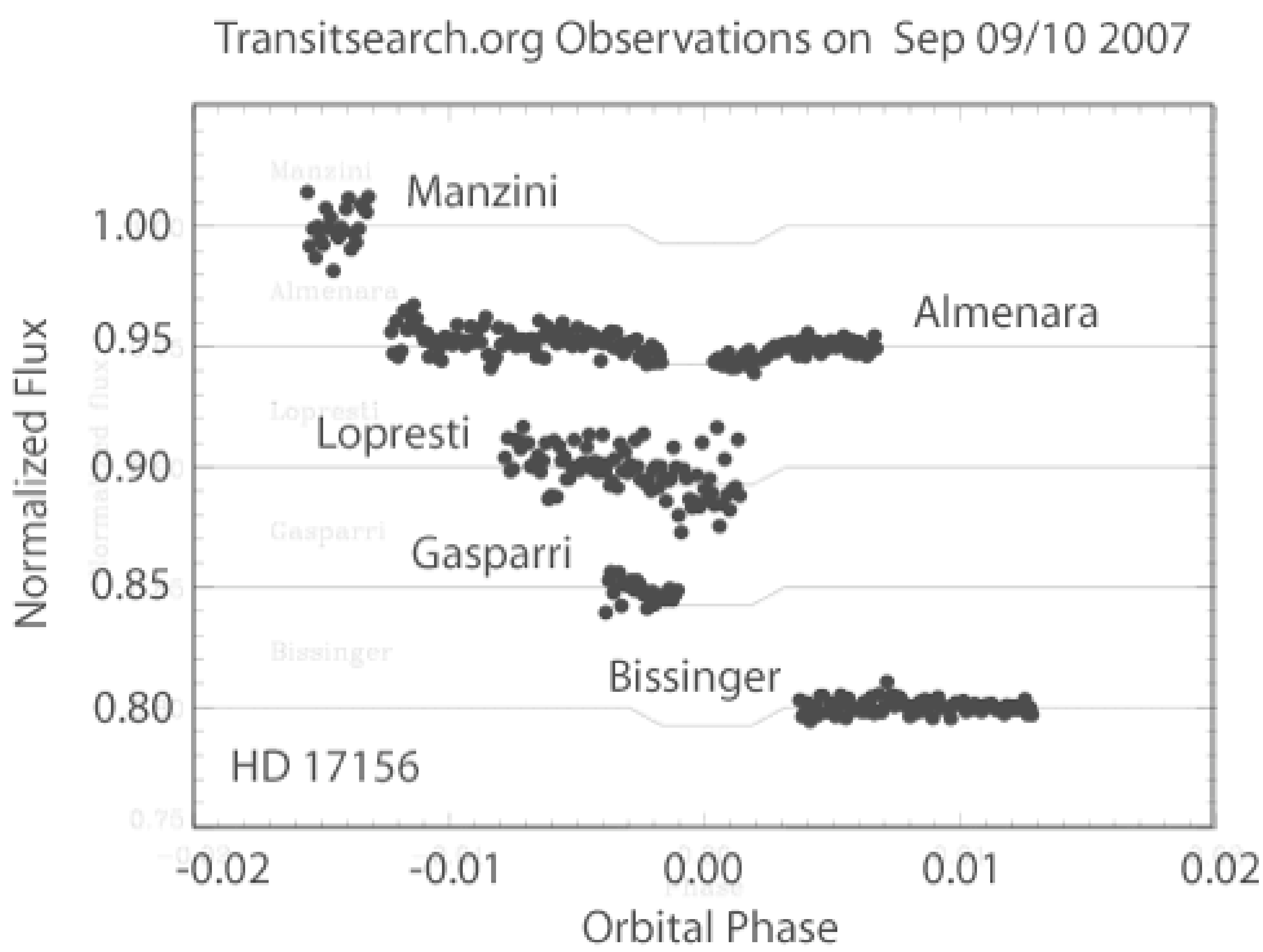
I observed HD17156 in the transit window. Unfortunately the night was windy, affecting the small telescope so the photometry is not so clear as we would wish. Anybody else observe?

It's possible that I have a central transit. I can show you some plots if you want. I will try to observe again on December 3 (I think that is my next opportunity).

Regards,
Jose

On Saturday, Jose sent me his photometric plots, I should point out that he emphasized once again that the night was windy. In his plots (I've rewritten the labels in illustrator so that they show up better on the narrow blog-page format) the black dots are individual observations (R filter, 7 s exposures), the red dots bin 6 observations, and the blue dots bin 12 observations.





(The transit was confirmed on Oct. 1 by Dave Charbonneau)