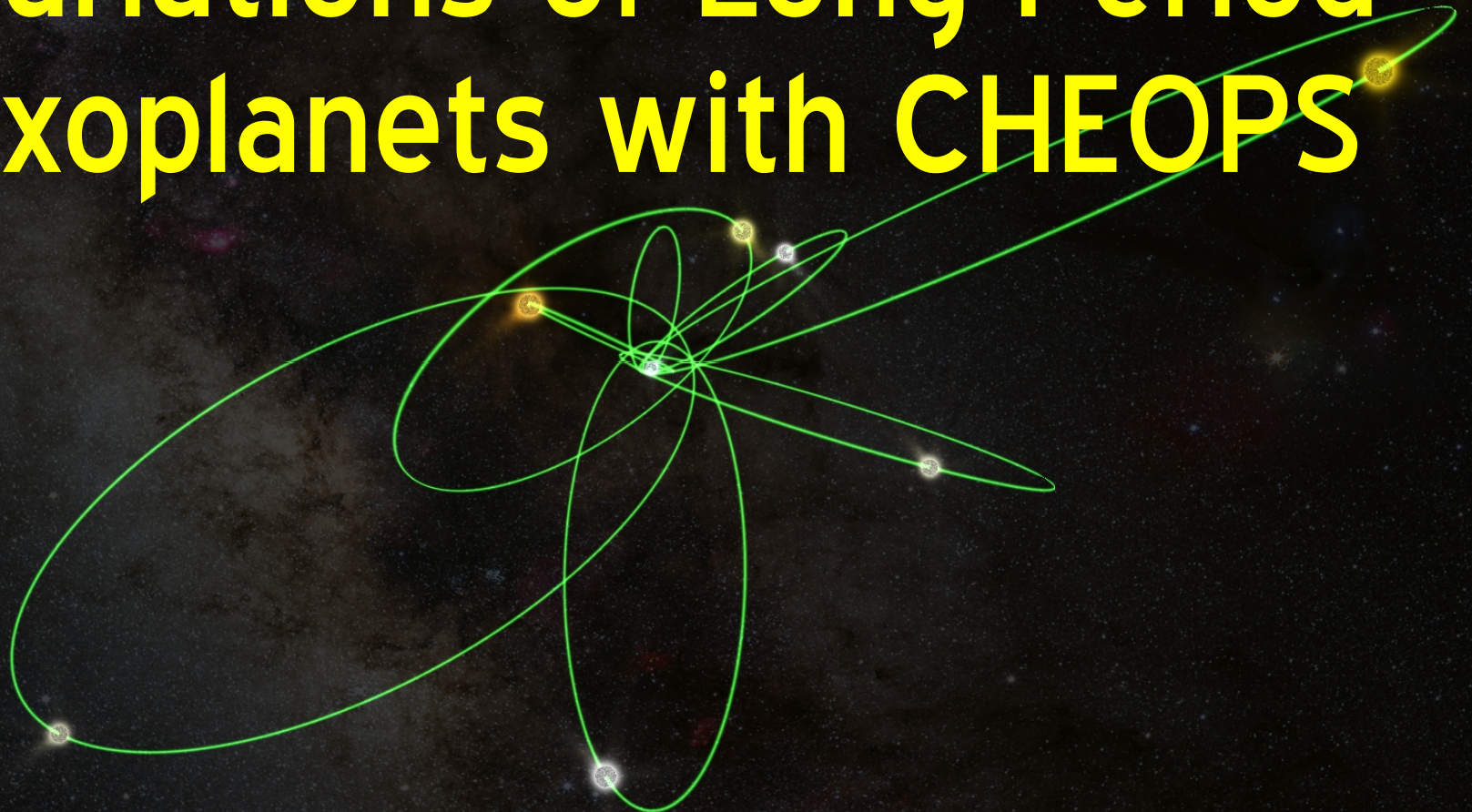


Detecting Transits and Phase Variations of Long-Period Exoplanets with CHEOPS



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Dawn Gelino

David James

Hugh Jones

Gaspare Lo Curto

Christophe Lovis

Jaymie Matthews

Dominique Naef

Simon O'Toole

Arpita Roy

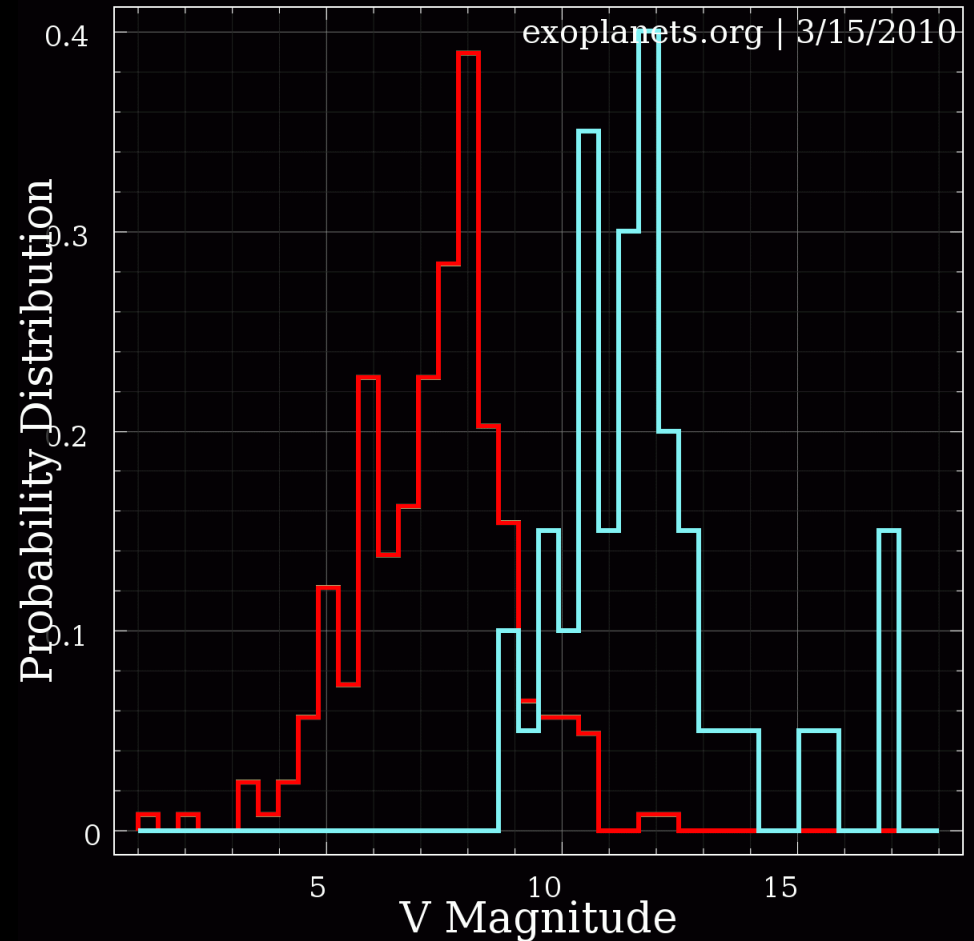
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Stephane Udry

Robert Wittenmyer

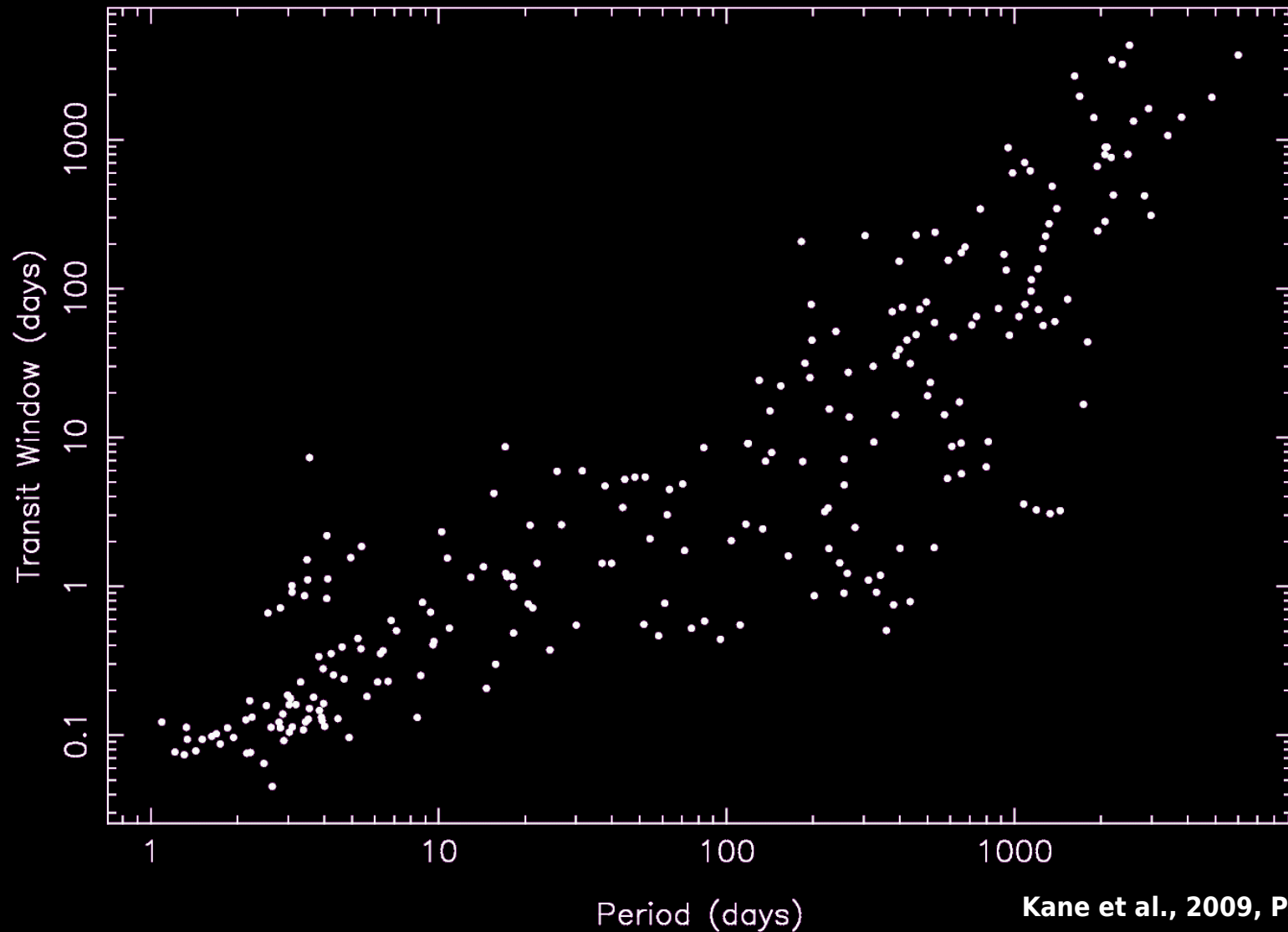
The brightest transiting planet host stars

- HD 209458 b
 - HD 149026 b
 - HD 189733 b
 - GJ 436 b
 - 55 Cancri e
 - GJ 3470 b
 - HD 17156 b (P = 21 days)
 - HD 80606 b (P = 111 days)
- These tend to be the brightest of the known transiting planet host stars
 - This has allowed further access to characterization (atmospheres)



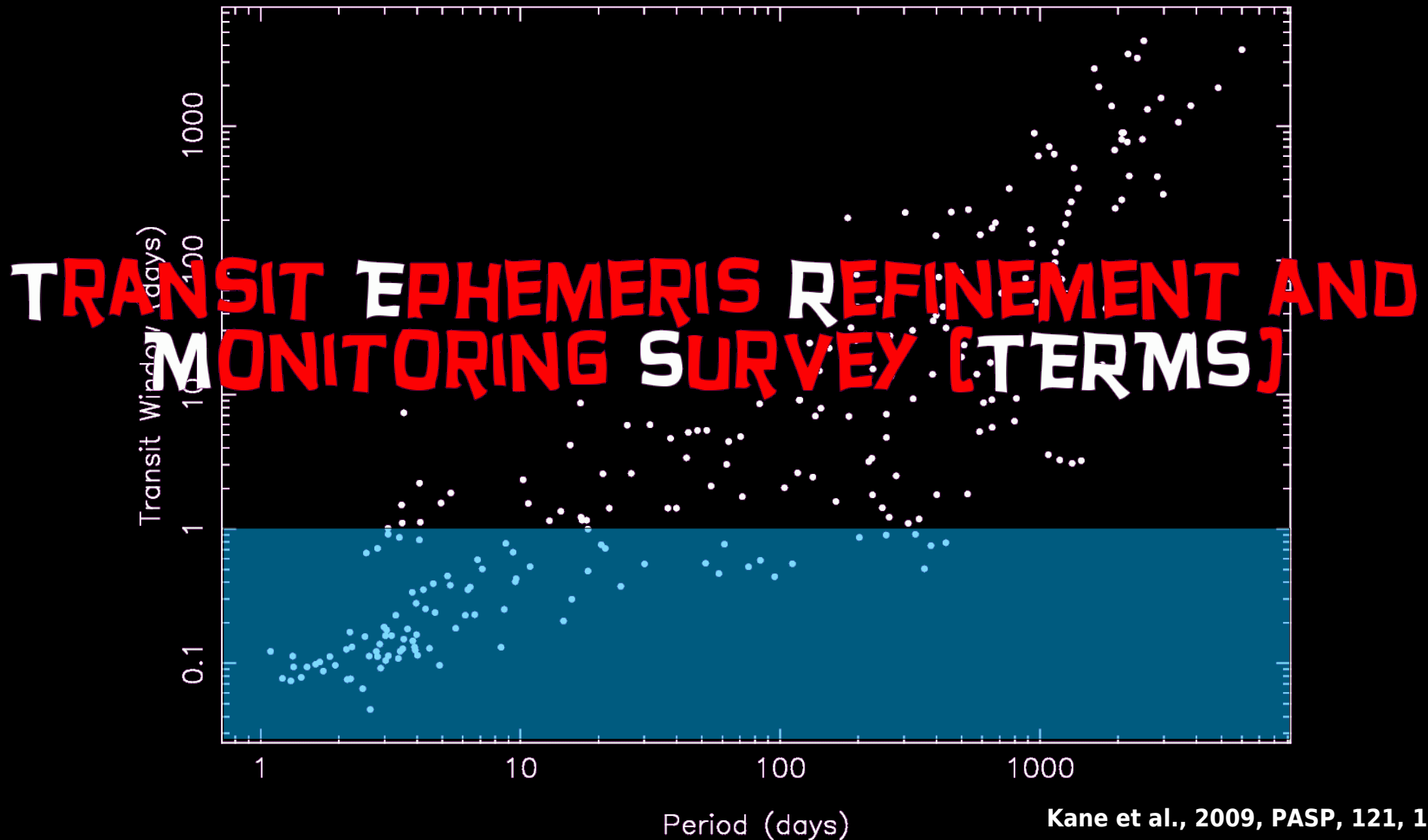
Transit Ephemerides

The quality of a transit window depends upon the uncertainties in the orbital fit parameters



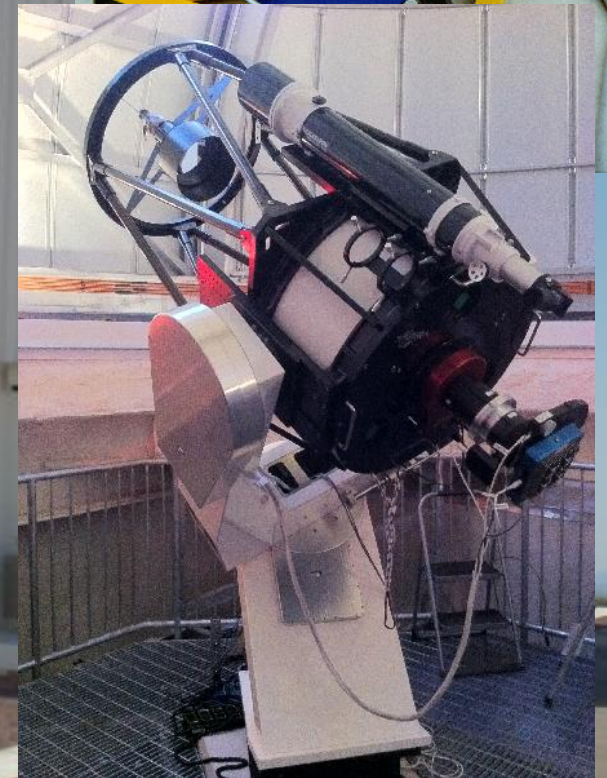
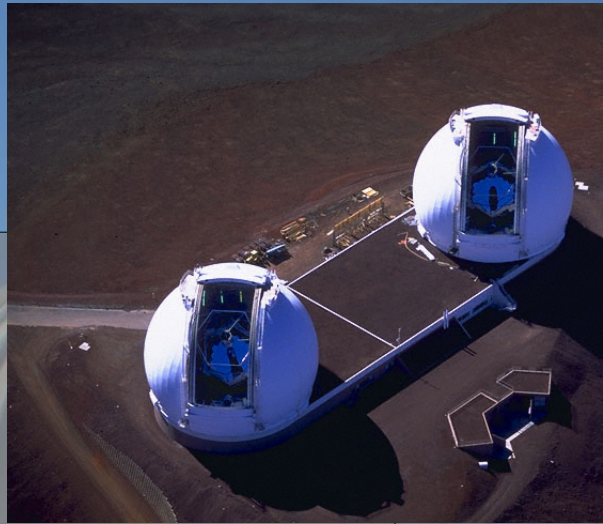
Transit Ephemerides

The quality of a transit window depends upon the uncertainties in the orbital fit parameters



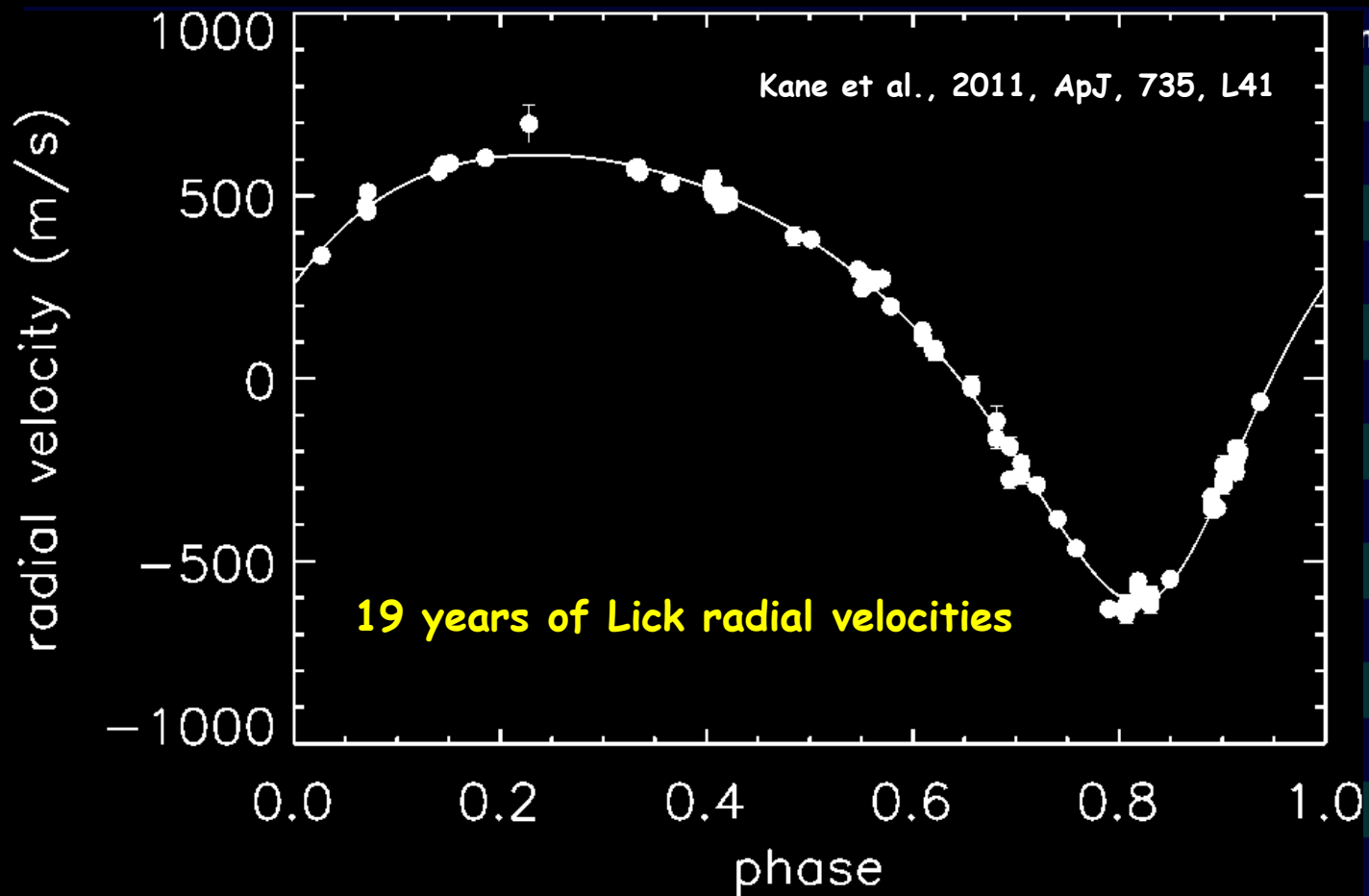
TERMS Telescopes

- CTIO 0.9m
- CTIO 1.0m
- LCO 1.0m
- LCOGT
- MOST
- Peter van de Kamp Observatory 0.6m
- APT (Fairborn Observatory)
- Keck/HIRES
- UCO/Lick 3.0m
- Hobby-Eberly Telescope
- HARPS
- CORALIE
- AAT
- Cross-matching with KELT targets
- Target selection for TESS & CHEOPS



Planet	Period	Window	Mid-p Err	Duration	Prob(%)	Depth(%)	Ephemeris	Status
HD147018_b	44.236	0.897	0.285	0.327	2.188	1.390	Link	open
55cancri_c	44.345	8.587	4.168	0.250	2.118	1.373	Link	closed
HD107148_b	48.056	9.751	4.725	0.301	2.144	0.961	Link	open
HD74156_b	51.643	3.194	1.453	0.289	3.765	0.730	Link	open
HD37605_b	54.230	22.323	11.011	0.301	2.189	1.845	Link	open
HD168443_b	58.116	0.596	0.117	0.362	3.803	0.583	Link	open
GJ876_b	61.010	15.569	7.700	0.169	0.915	14.426	Link	open
HD3651_b	62.230	5.786	2.633	0.520	1.308	1.356	Link	open
HD121504_b	63.330	8.198	3.905	0.387	1.818	0.883	Link	open
Gl581_d	66.800	8.260	4.051	0.158	0.591	0.420	Link	open
HD109246_b	68.270	12.272	5.951	0.370	1.426	1.292	Link	open
HD101930_b	70.460	16.396	8.042	0.312	1.146	2.128	Link	open
HD178911Bb	71.487	4.295	1.931	0.434	2.054	0.829	Link	open
HD16141_b	75.560	1.682	0.691	0.300	1.662	1.166	Link	open
HD114762_b	83.914	0.928	0.274	0.380	1.318	1.378	Link	closed
HIP14810_c	95.291	0.513	0.078	0.356	1.419	1.320	Link	open
HD145377_b	103.950	3.587	1.631	0.326	1.673	1.066	Link	open
HD80606_b	111.436	0.895	0.080	0.734	100.000	1.448	Link	transit
70_Vir_b	116.689	11.817	5.713	0.391	1.330	1.138	Link	open
HD216770_b	118.450	34.430	16.941	0.548	0.738	1.576	Link	open
HD52265_b	119.290	15.776	7.609	0.558	0.884	1.058	Link	open
HD208487_b	130.000	60.243	29.950	0.344	1.560	0.945	Link	open
HD1237_b	133.710	13.631	6.511	0.609	0.616	1.798	Link	open

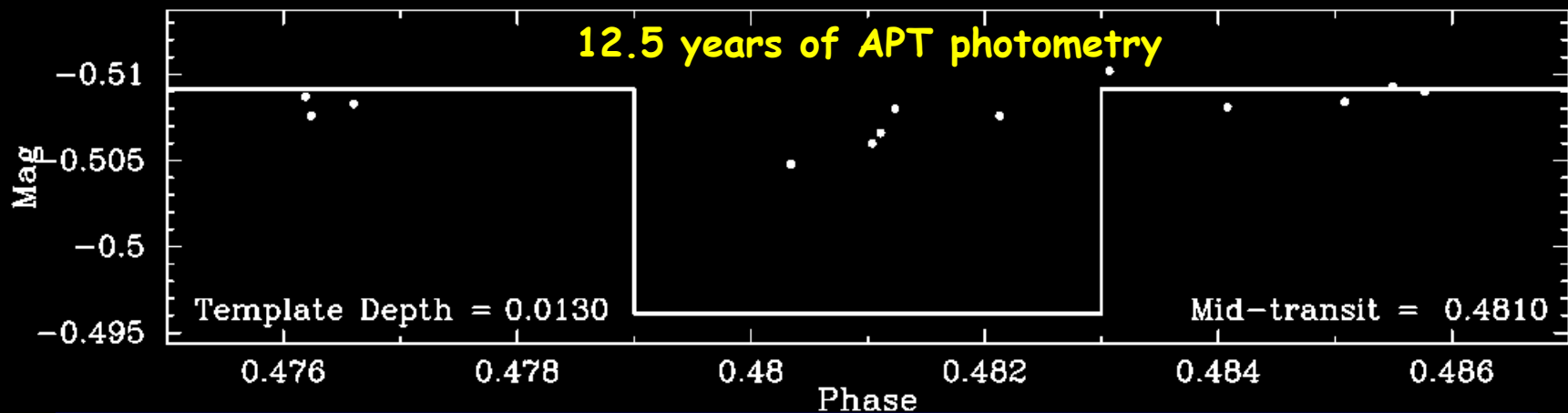
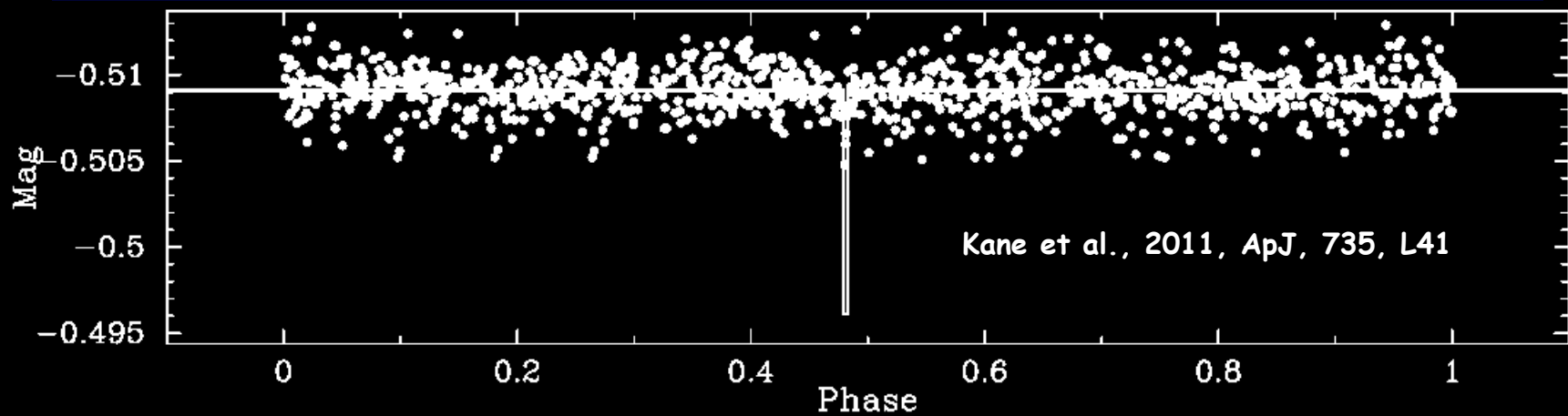




meris	Status
	open
	closed
	open
	open
	open
	open
	open
	open
	open
	open
	open
	open
	open
	open
	open



HD114762_b	83.914	0.928	0.274	0.380	1.318	1.378	Link	closed
HIP14810_c	95.291	0.513	0.078	0.356	1.419	1.320	Link	open
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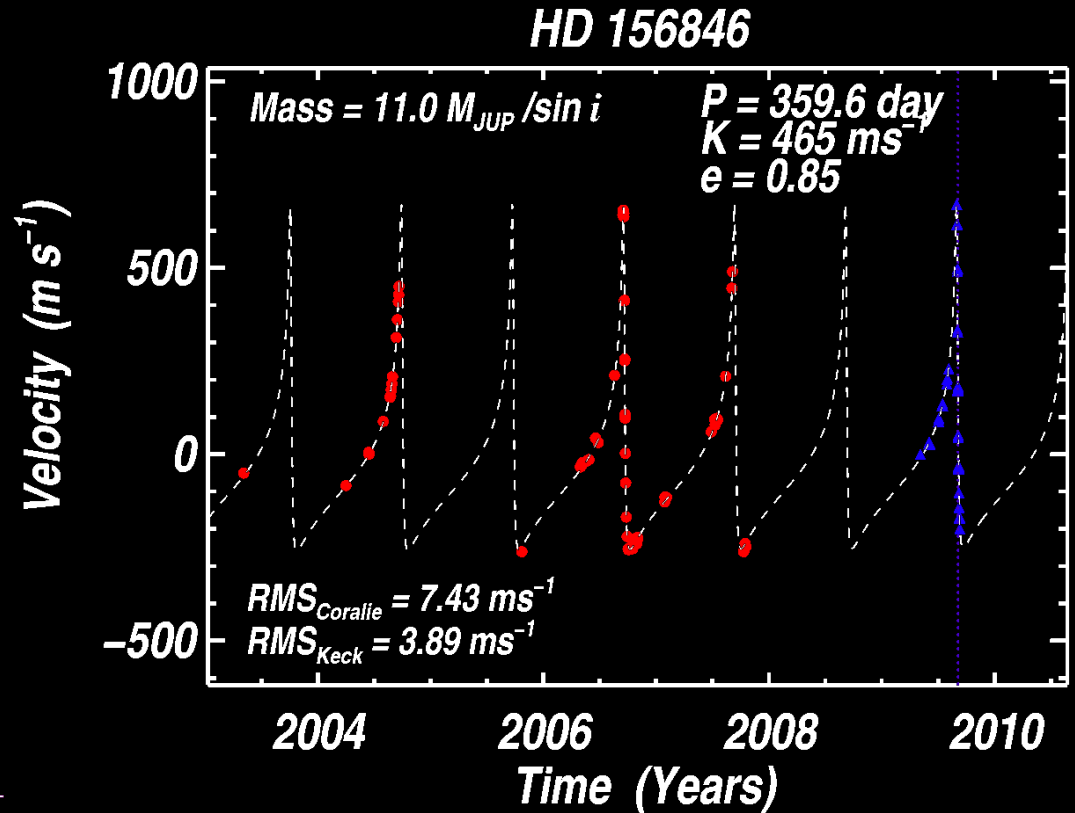
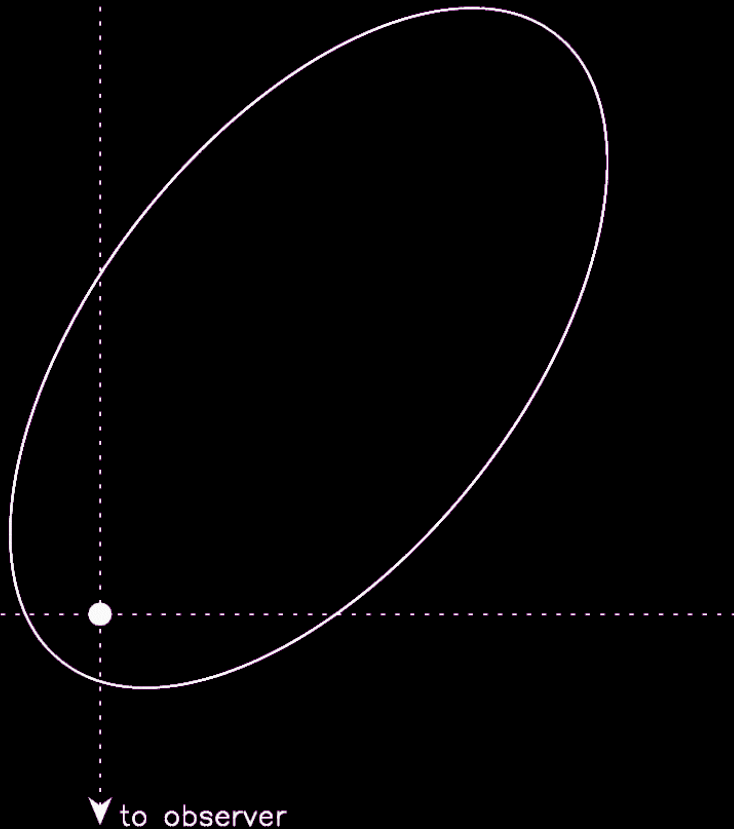


HD114762 b	83.914	0.928	0.274	0.380	1.318	1.378	Link	closed
HIP14810 c	95.291	0.513	0.078	0.356	1.419	1.320	Link	open
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HD1237 b	133.710	13.631	6.511	0.609	0.616	1.798	Link	open

HD 156846 b

HD 156846 b

$P = 359.51$ days
 $a = 0.99$ AU
 $e = 0.85$
 $\omega = 52.2^\circ$

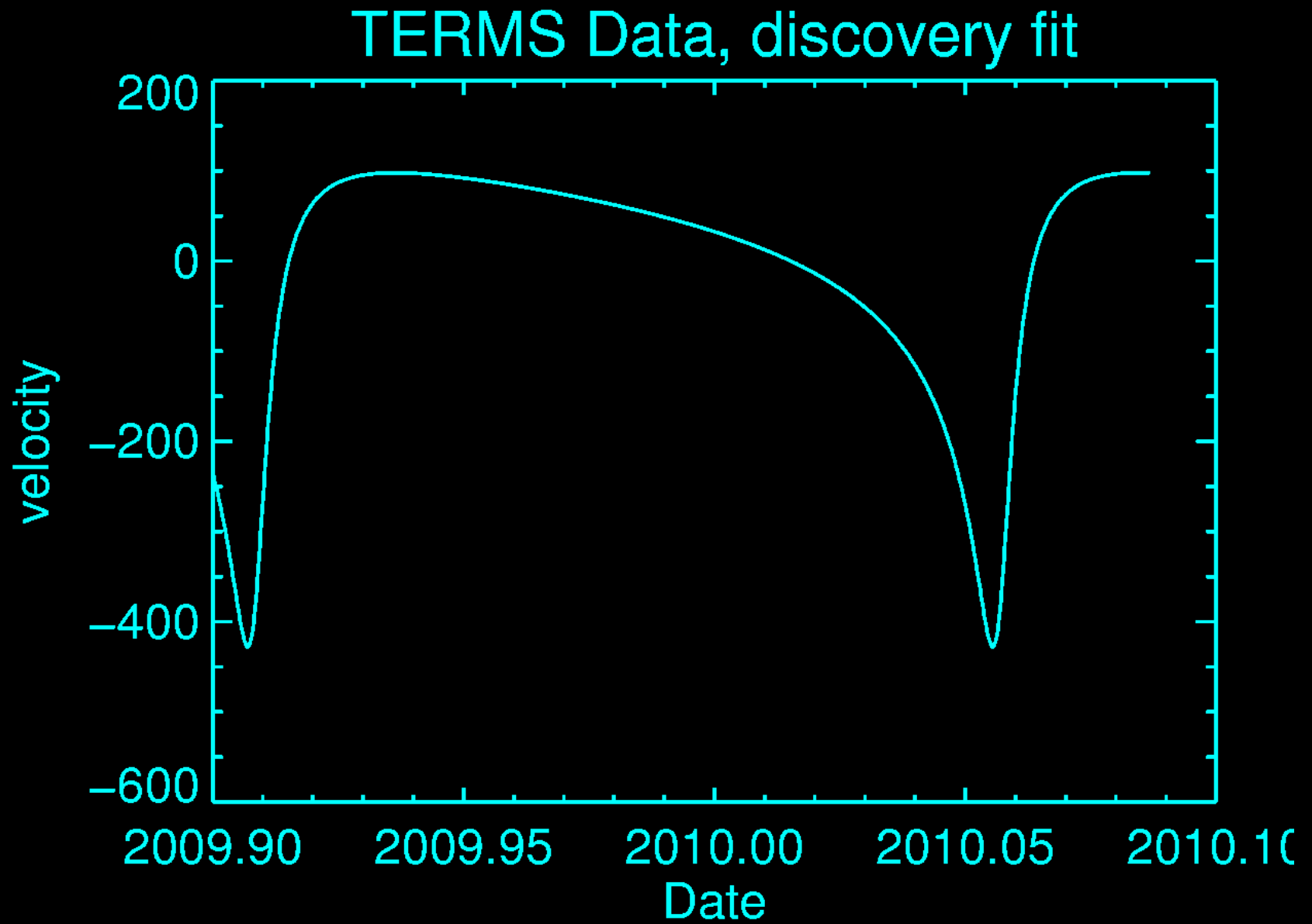


The orbital parameters resulting from the combined data yield an uncertainty in the transit mid-point of only 20 minutes!

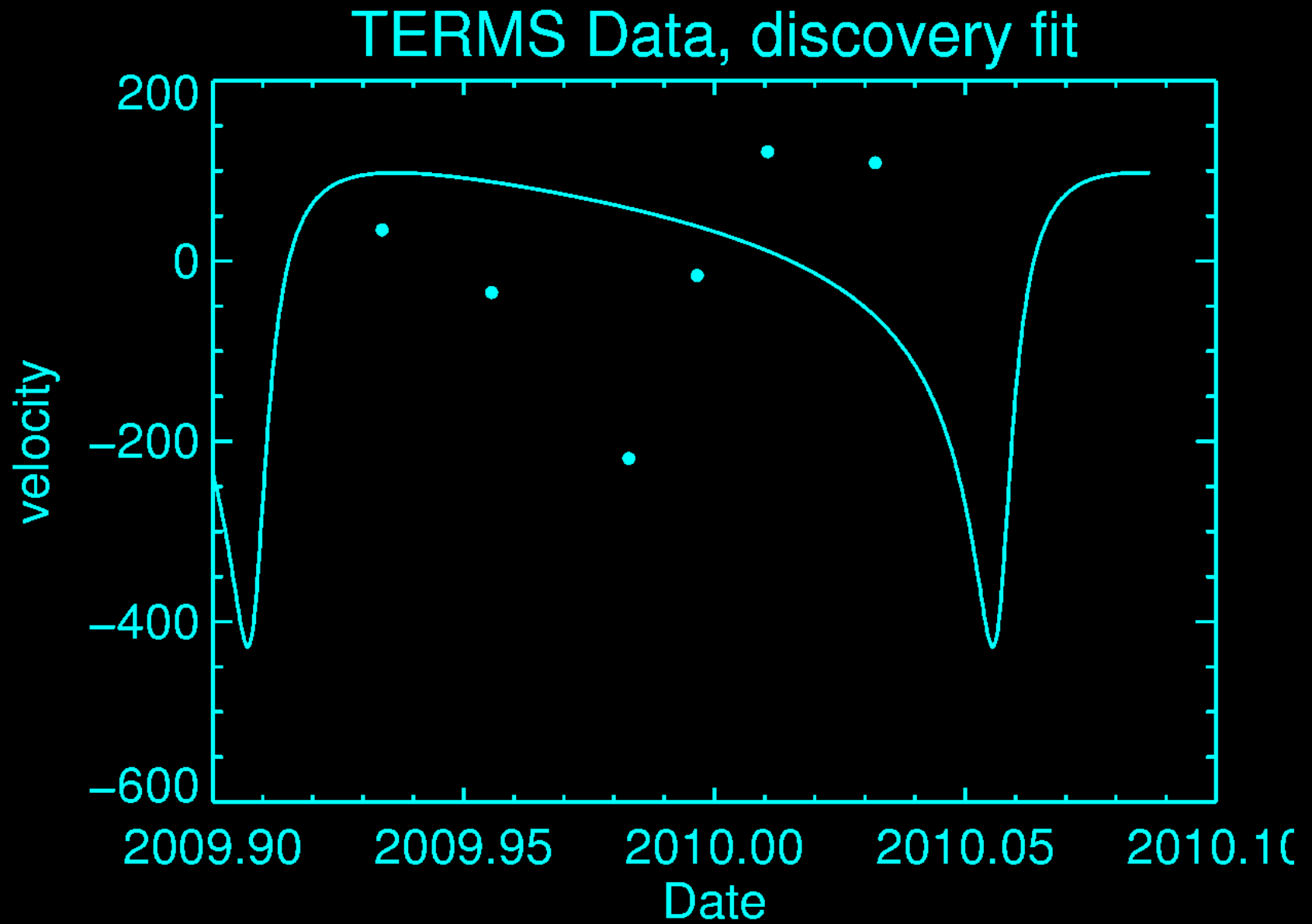
Each TERMS target results in ...

- Greatly improved orbital parameters
- Refined transit ephemeris
- Ruling out or confirmation of transit
- Improved stellar properties
- Photometric stability of host star
- Constraints on additional companions

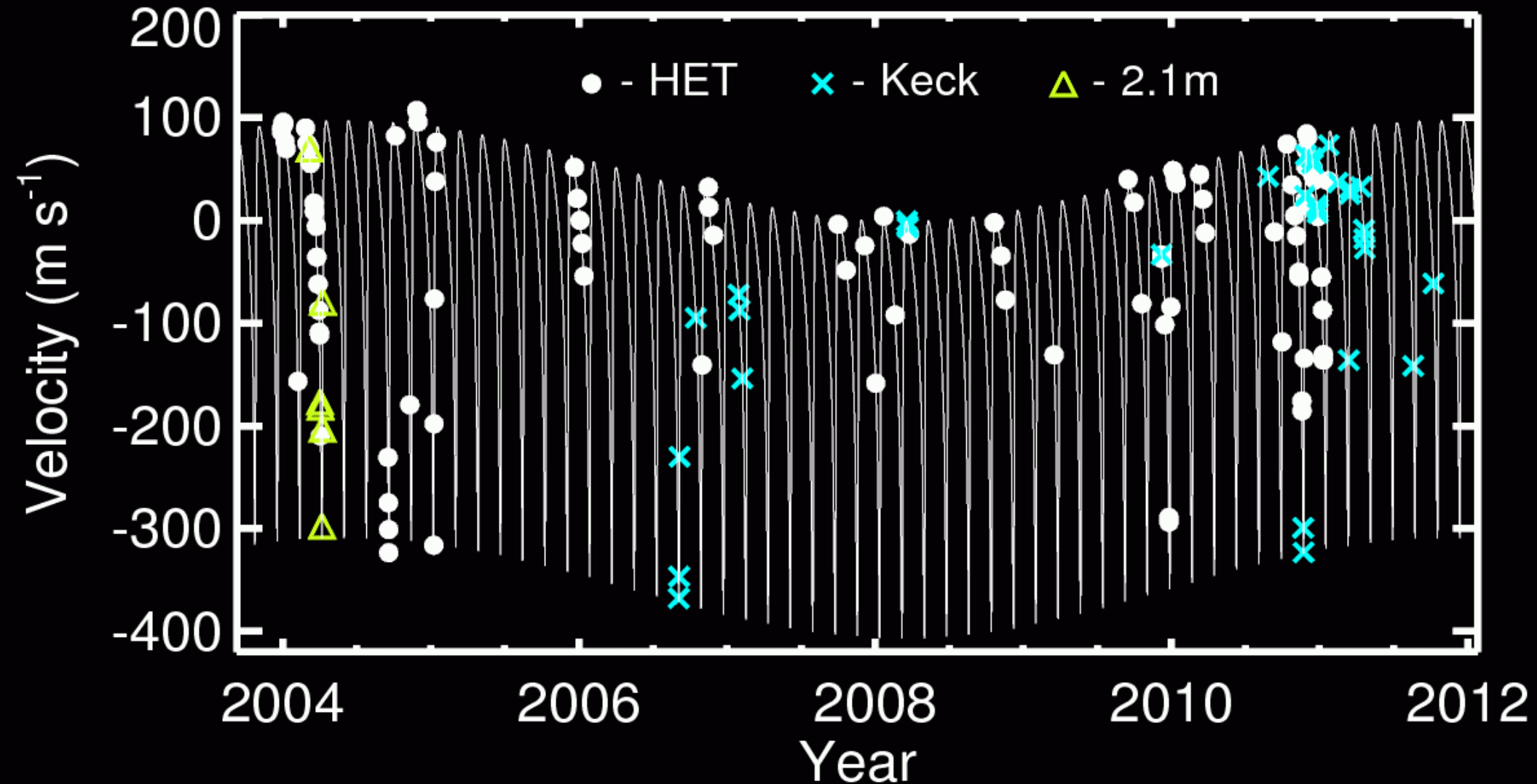
HD 37605 b



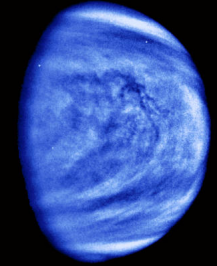
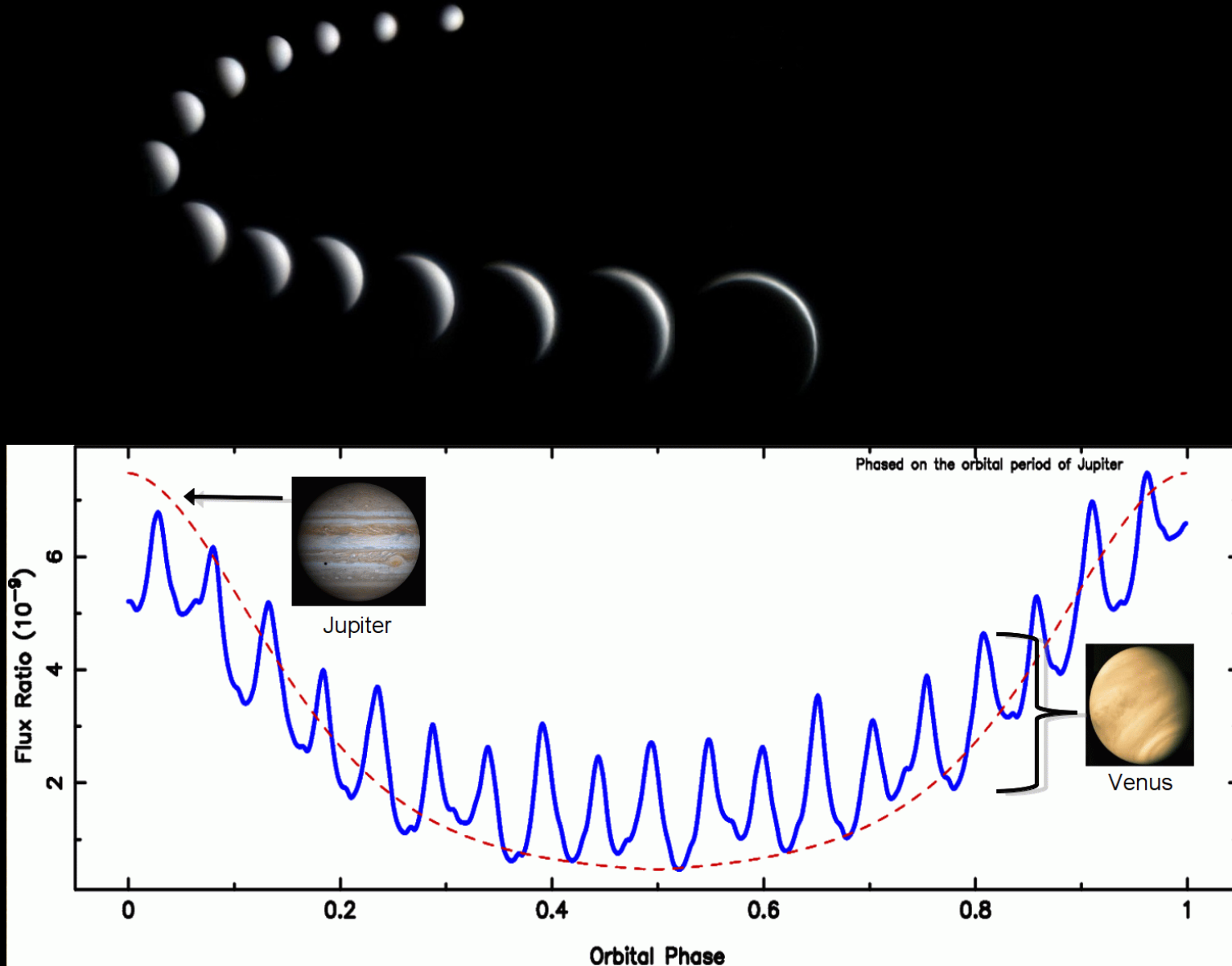
HD 37605 b



The HD 37605 System

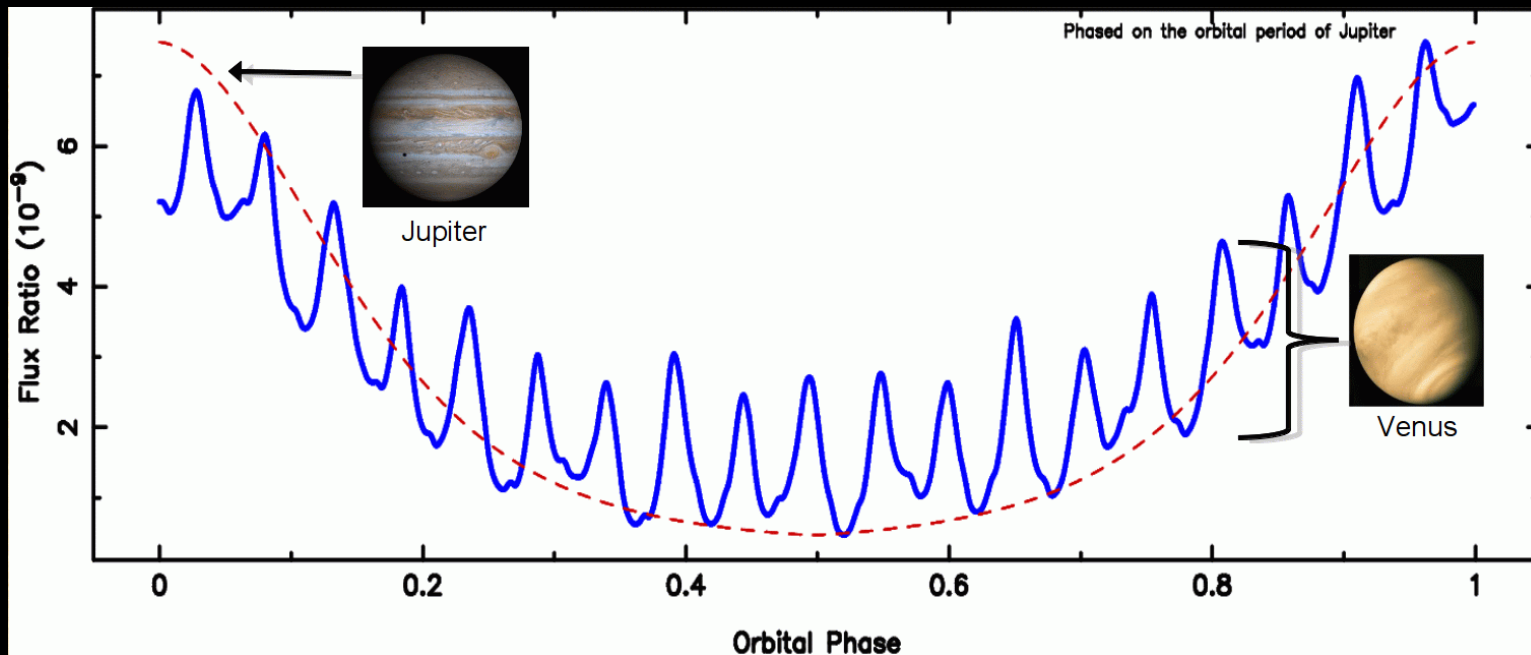
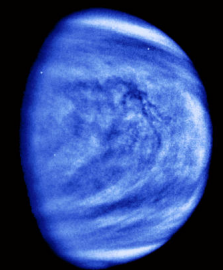
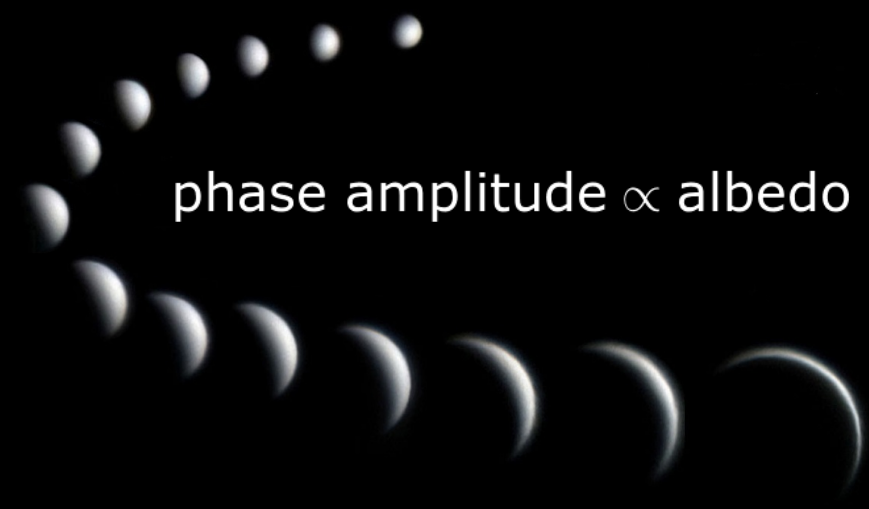


Studying Planetary Atmospheres



Studying Planetary Atmospheres

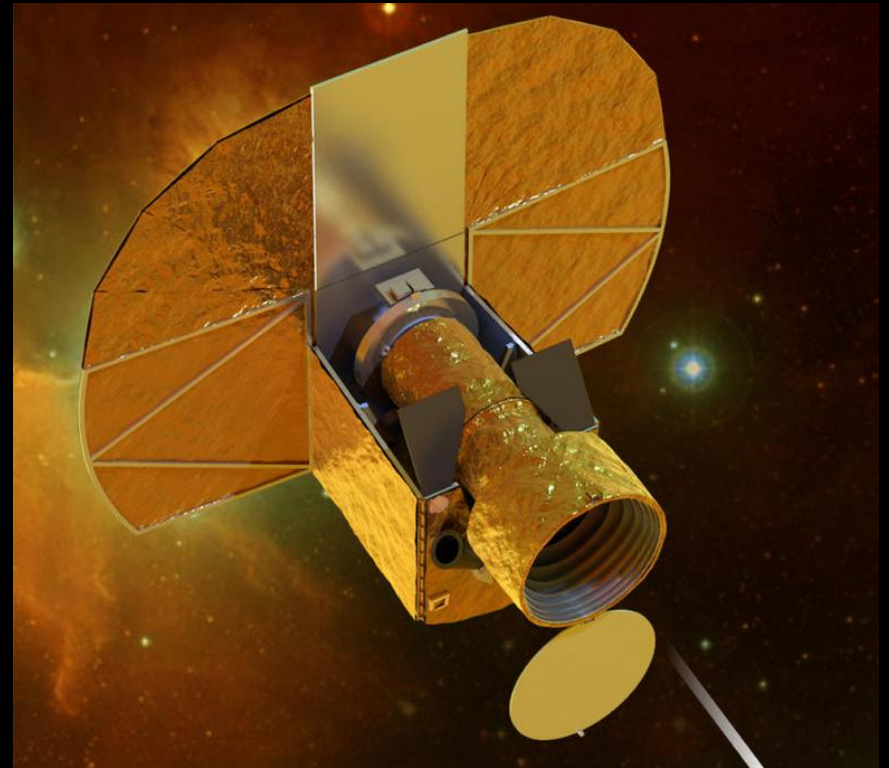
phase amplitude \propto albedo $\times \left(\frac{\text{planet radius}}{\text{semimajor axis}} \right)^2$





**Transiting Exoplanet
Survey Satellite (TESS)**

**CHaracterising
ExOPlanet Satellite
(CHEOPS)**



The TERMS-CHEOPS Connection

- **The TERMS project has been operating for ~6 years and has monitored ~200 targets.**
- **Additional RVs are crucial for follow-up of long-period planets.**
- **The transit window should be dominated by the transit duration.**
- **Eccentric orbits provide high probability opportunities.**
- **Transits and phase variations of eccentric orbits will provide windows into atmosphere dynamics and formation scenarios.**