PAVO Follow-Up of Kepler Stars

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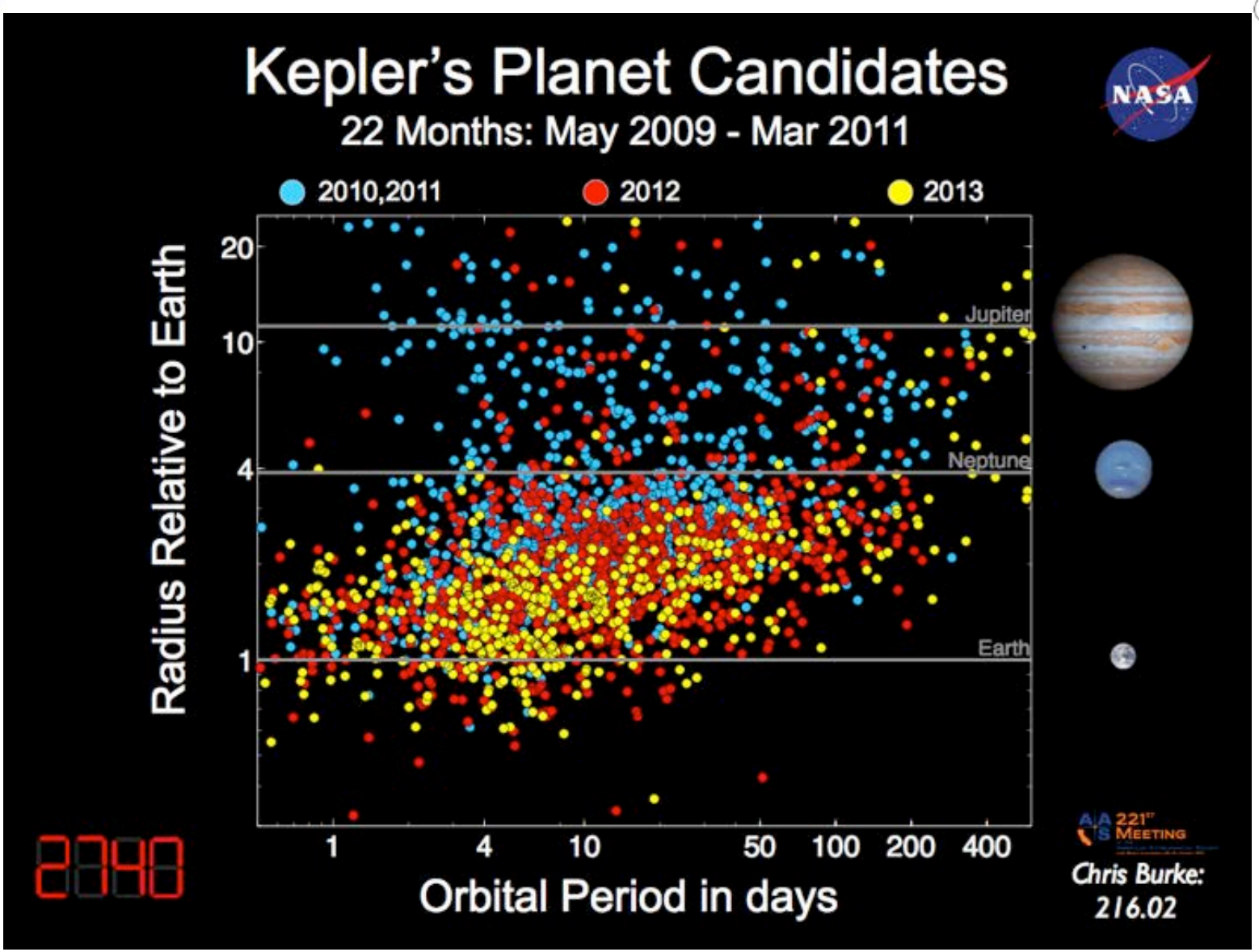
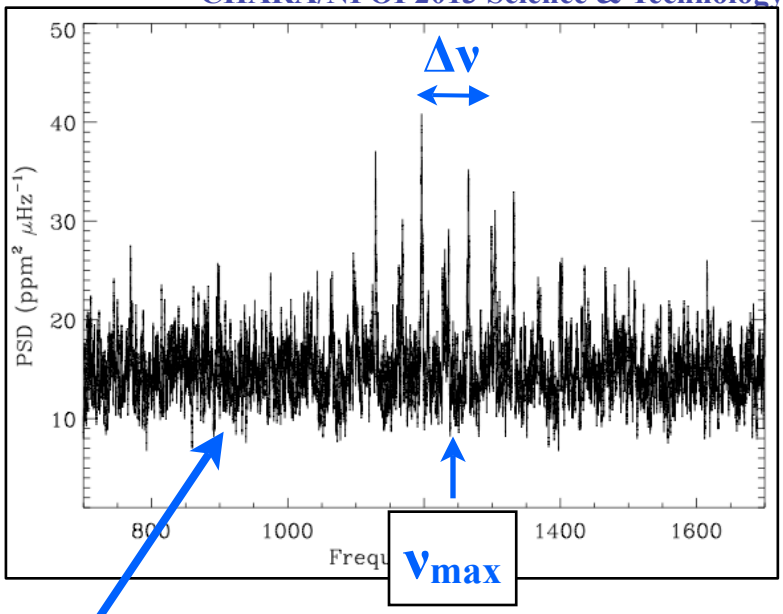
and the CHARA team

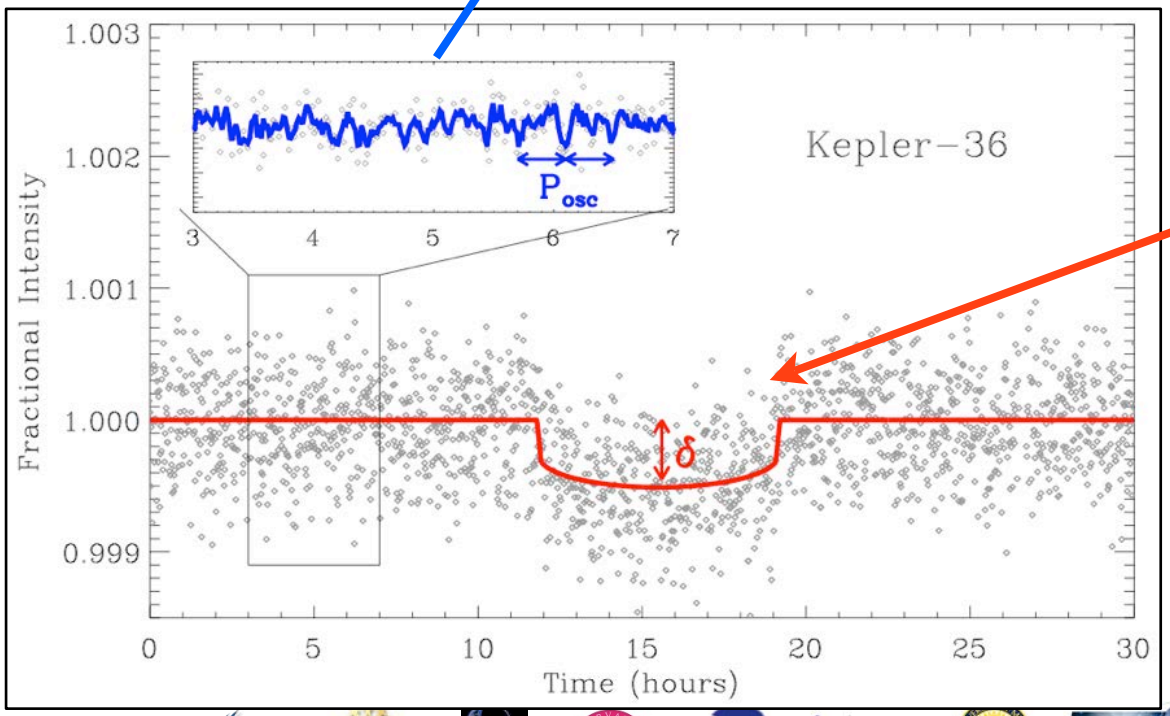

Kepler's Planet Candidates
22 Months: May 2009 - Mar 2011
2010,2011
2012
2013
Radius Relative to Earth
20
10
4
1
Jupiter
Neptune
Earth
1
4
10
50
100
200
400
Orbital Period in days
2740
NASA
221st Meeting
Chris Burke:
216.02



scaling relations

$$\Delta\nu \propto M_*/R_*^3$$

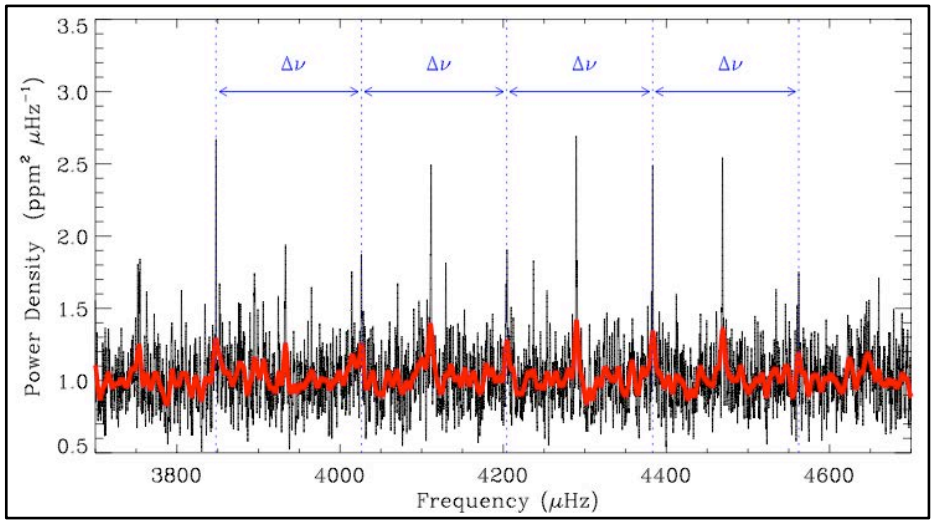
$$\nu_{max} \propto M\, R^{-2}\, T_{eff}^{0.5}$$



$$\delta = (R/R^*)^2$$

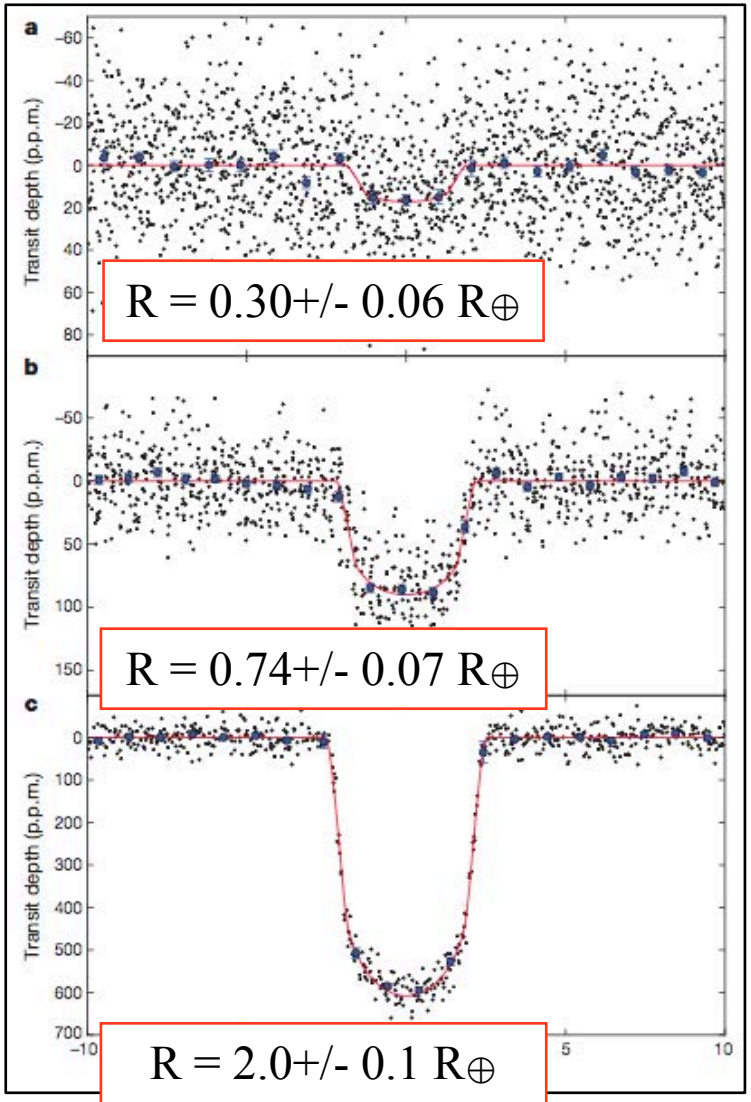
A sub-Mercury sized Exoplanet

Oscillation Spectrum of Kepler-37

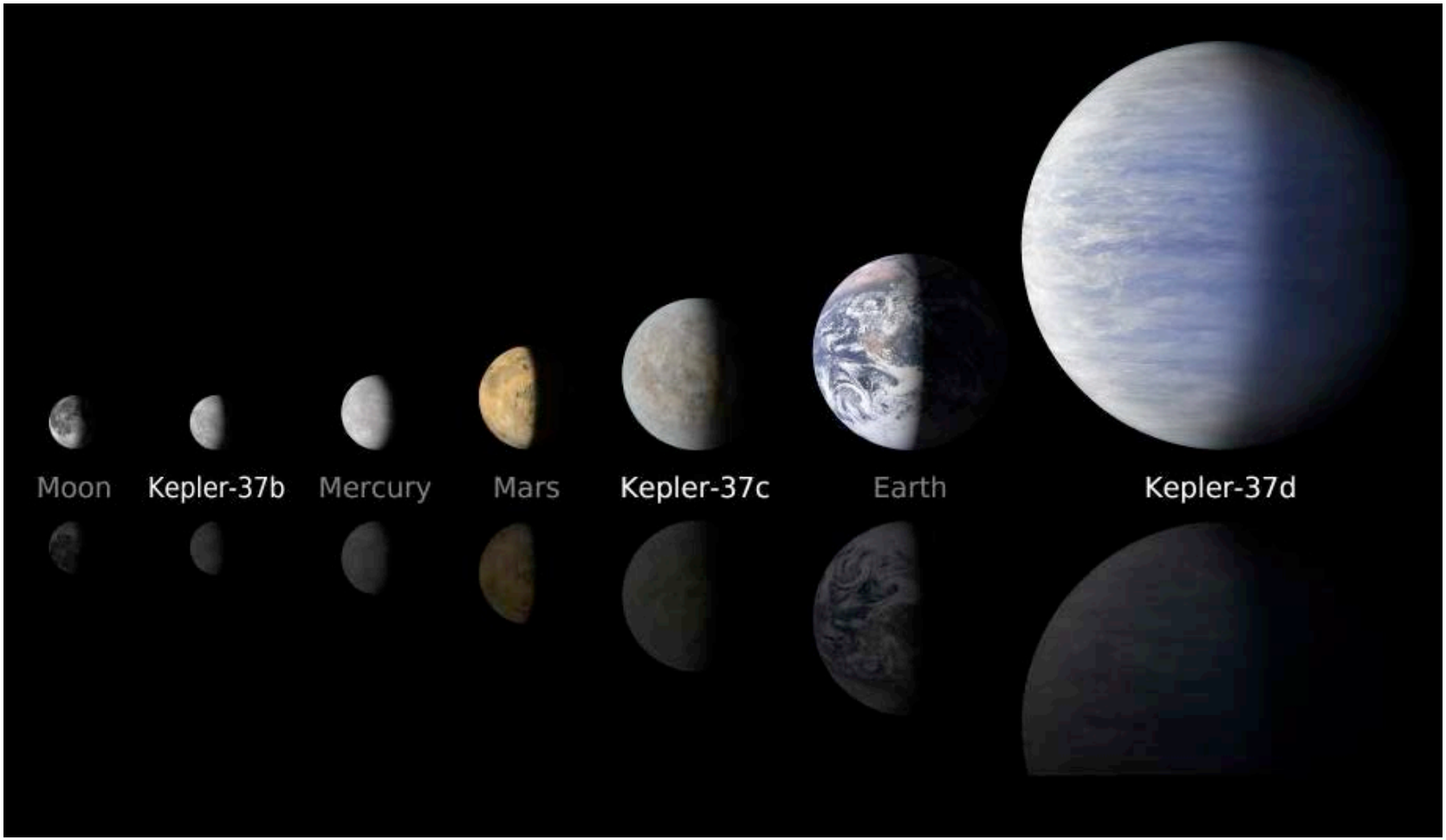


R = 0.772+/- 0.026 R⊕

Barclay et al. 2013



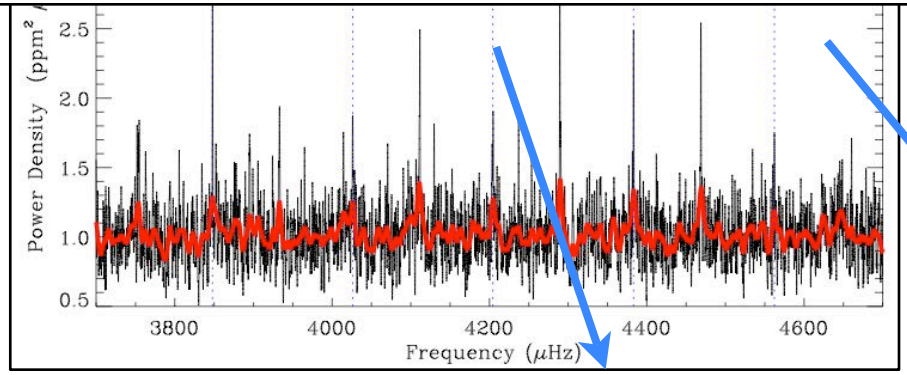
A sub-Mercury sized Exoplanet



Barclay et al. 2013

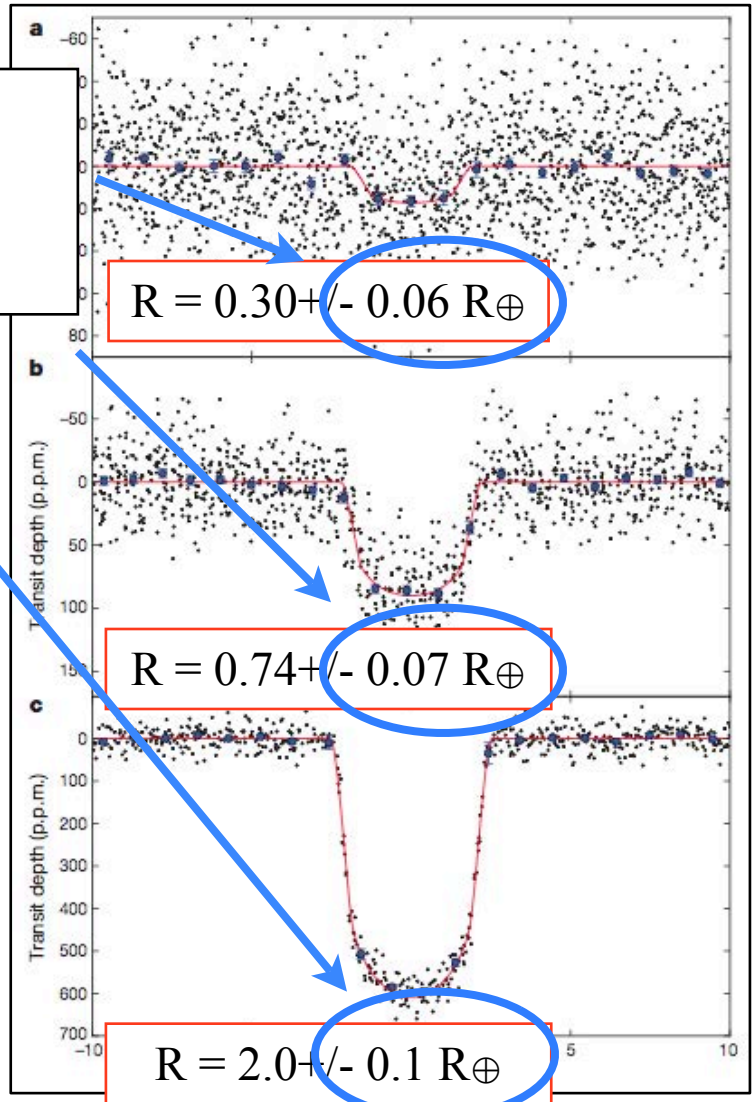
A sub-Mercury sized Exoplanet

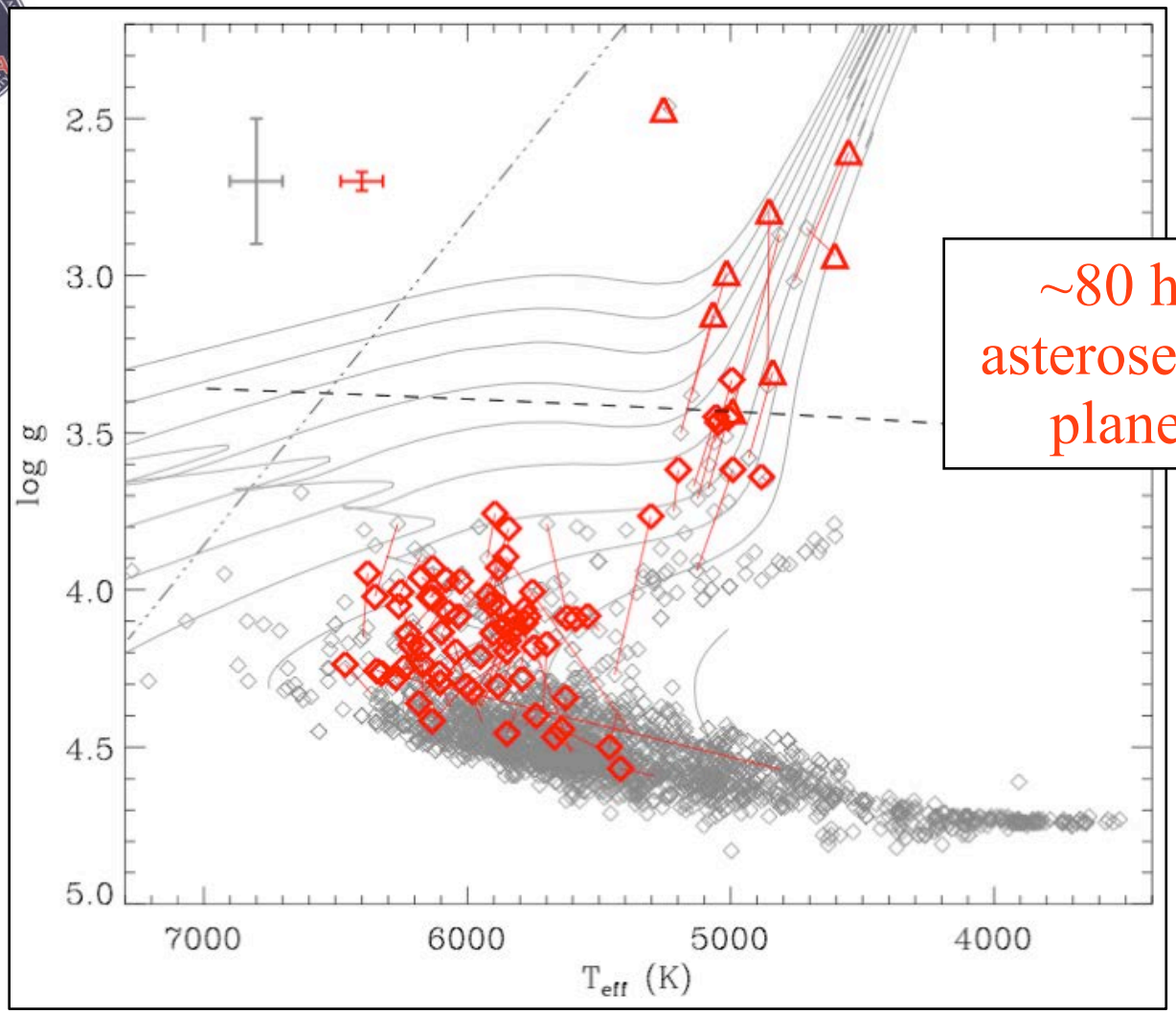
How much can we trust these error bars?



R = 0.772+/- 0.026 R⊙

Barclay et al. 2013



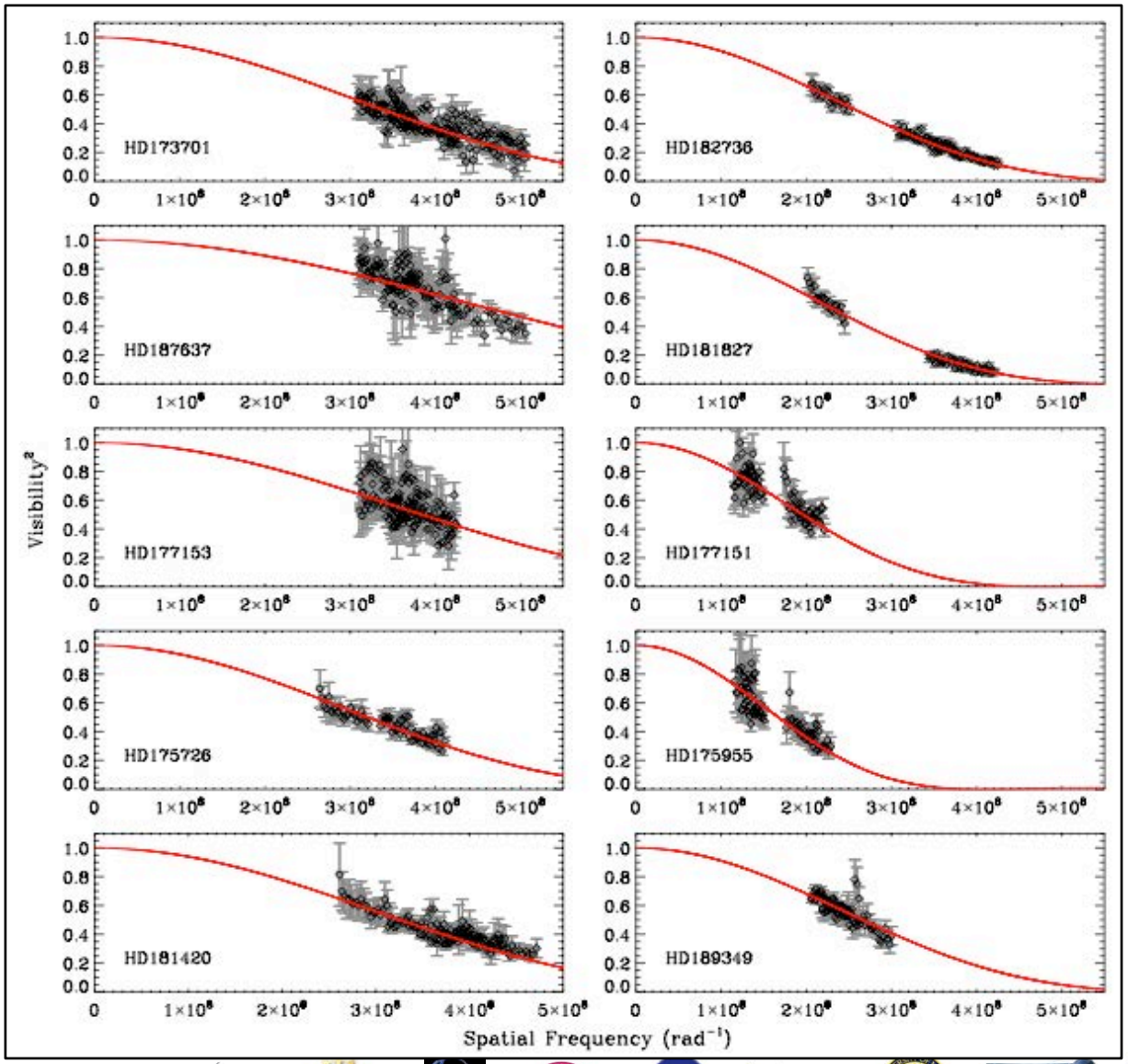


~80 host stars with asteroseismology (~110 planet candidates)

Huber et al. 2013

Seismology now regularly provides radii for Kepler exoplanets - need to validate accuracies using independent methods

PAVO Kepler & CoRoT Sample

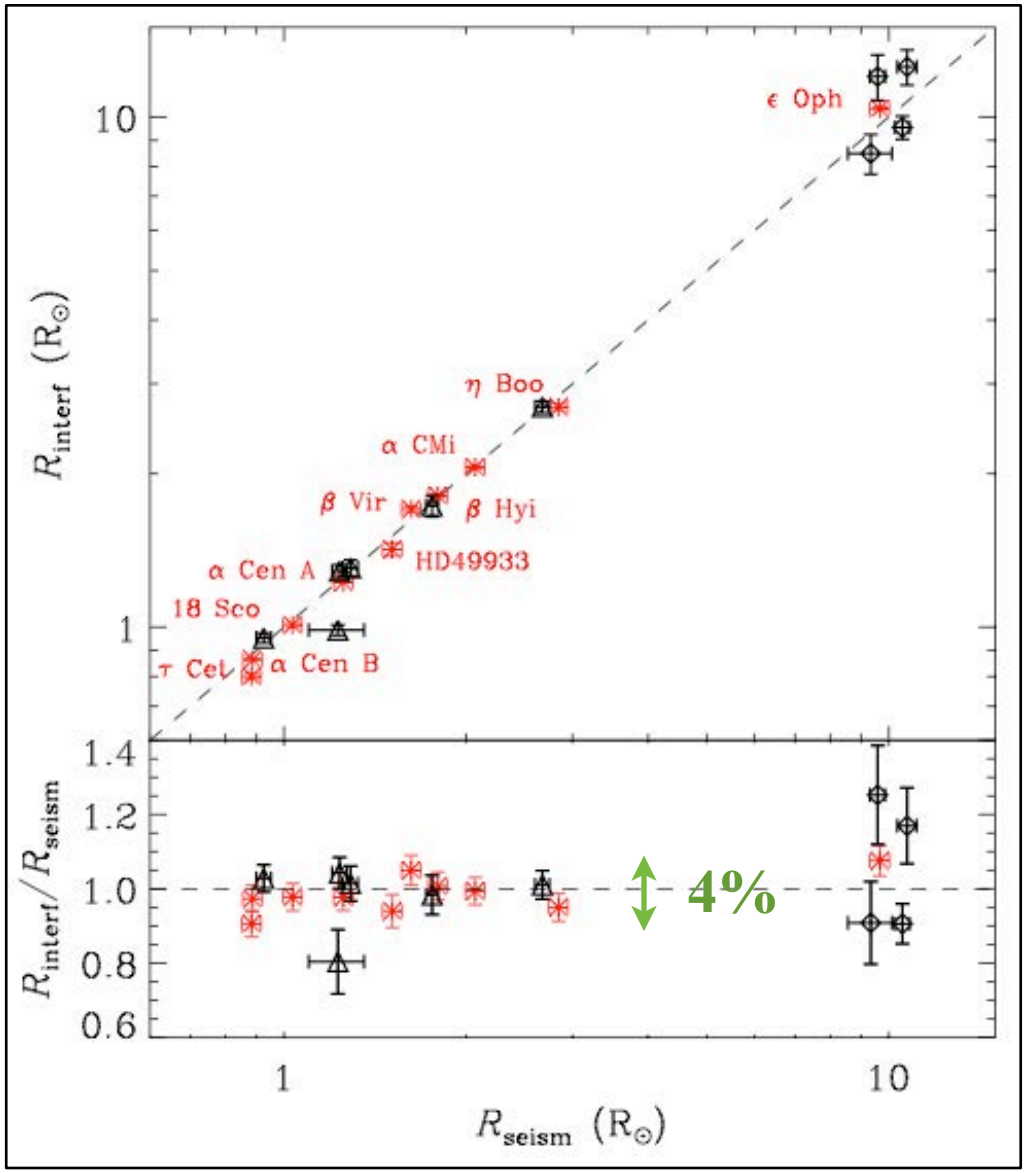


5 main-sequence, 1 subgiant and 4 giant stars observed by Kepler or CoRoT

typical σ_Θ/Θ ~ 2-3%

Huber et al. 2012

interferometric Radii



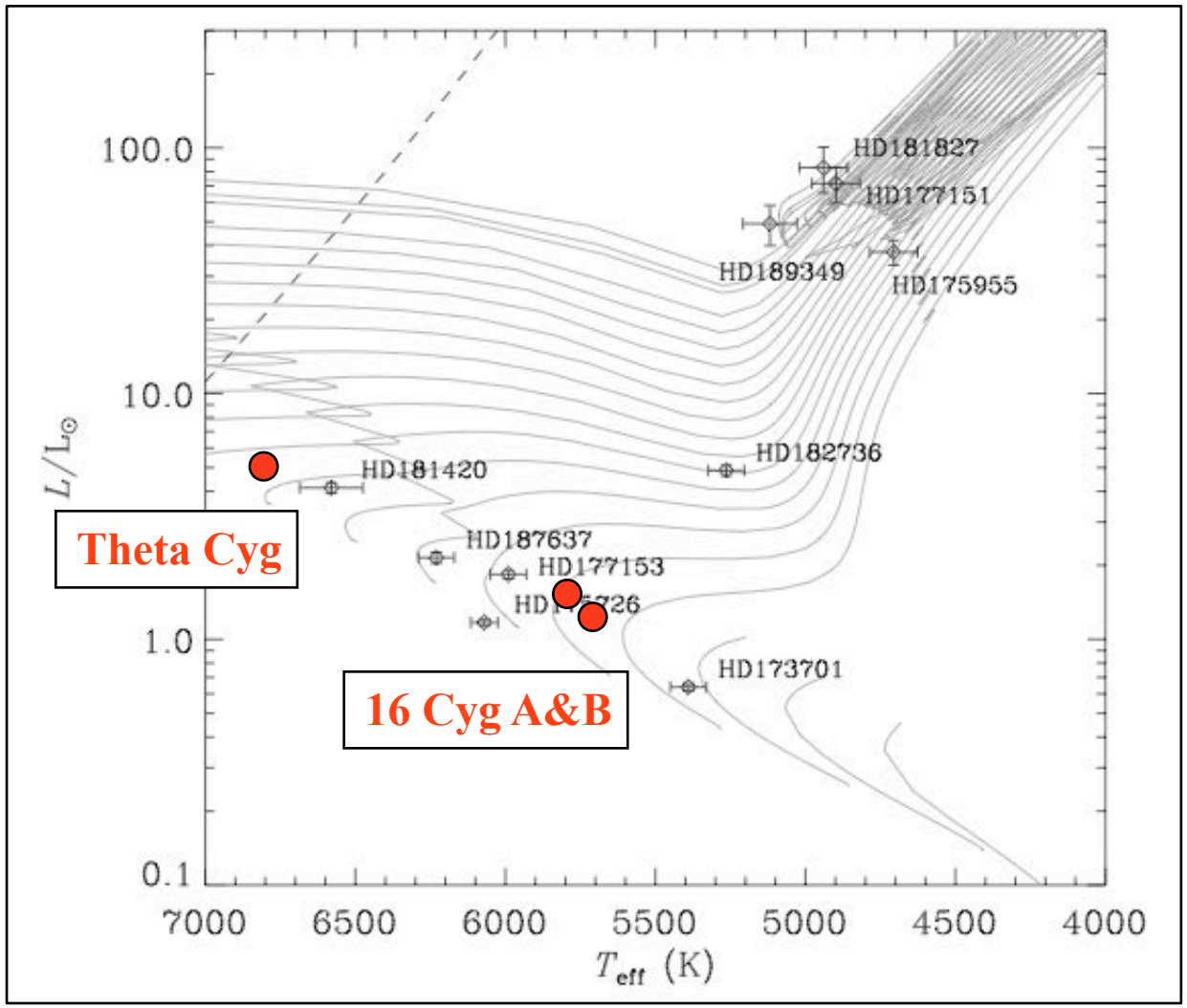
seismic Radii

seismic and interferometric radii agree to <~4% for dwarfs

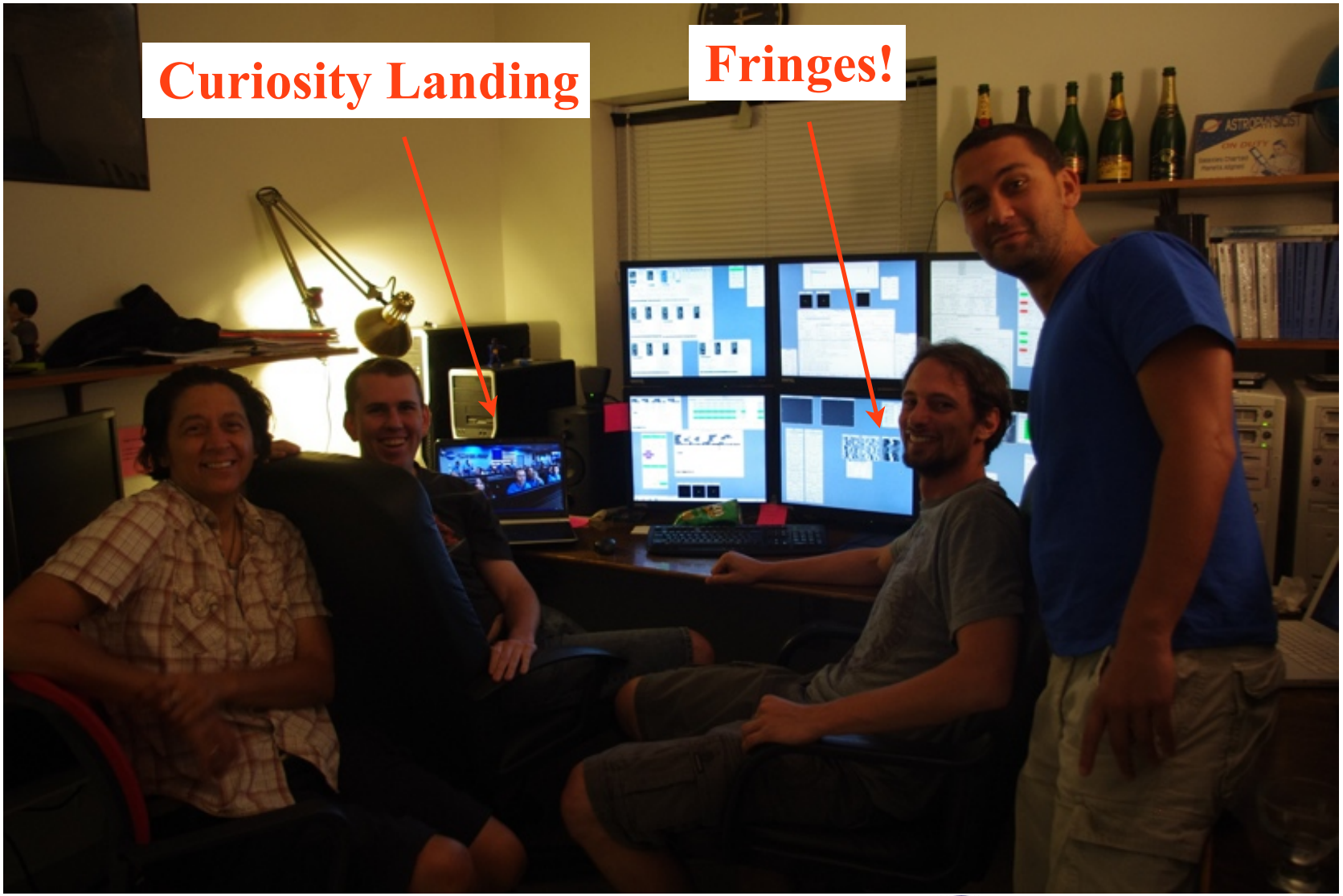
giants dominated by errors in parallax

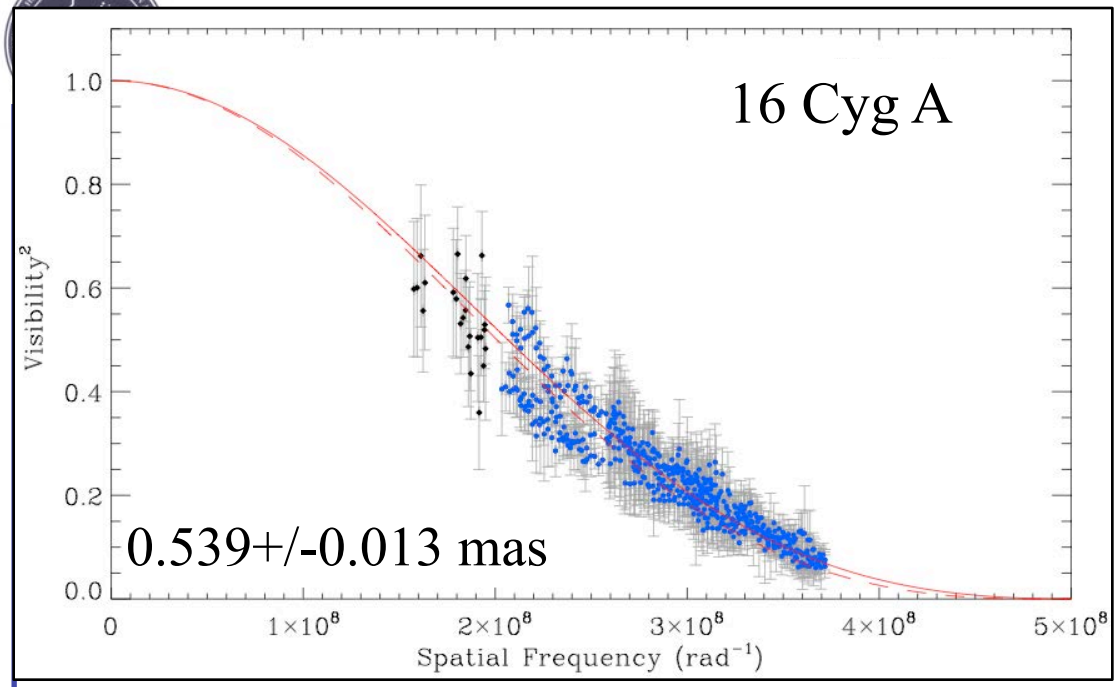
Huber et al. 2012

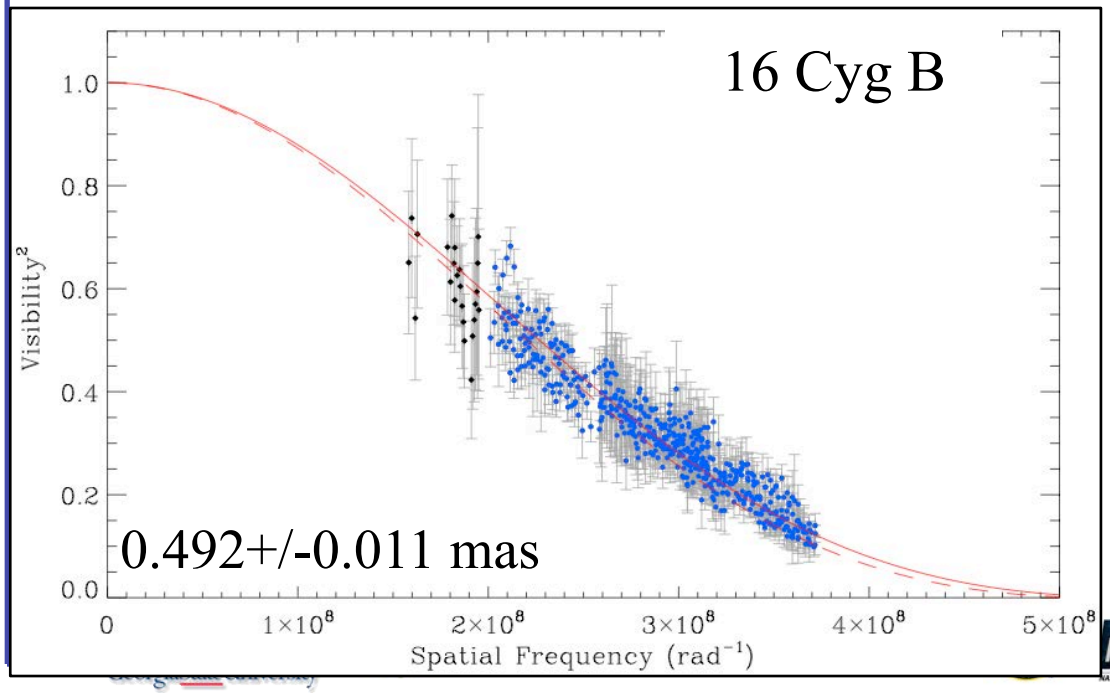
PAVO Kepler & CoRoT Sample



The Olympic PAVO Run 2012





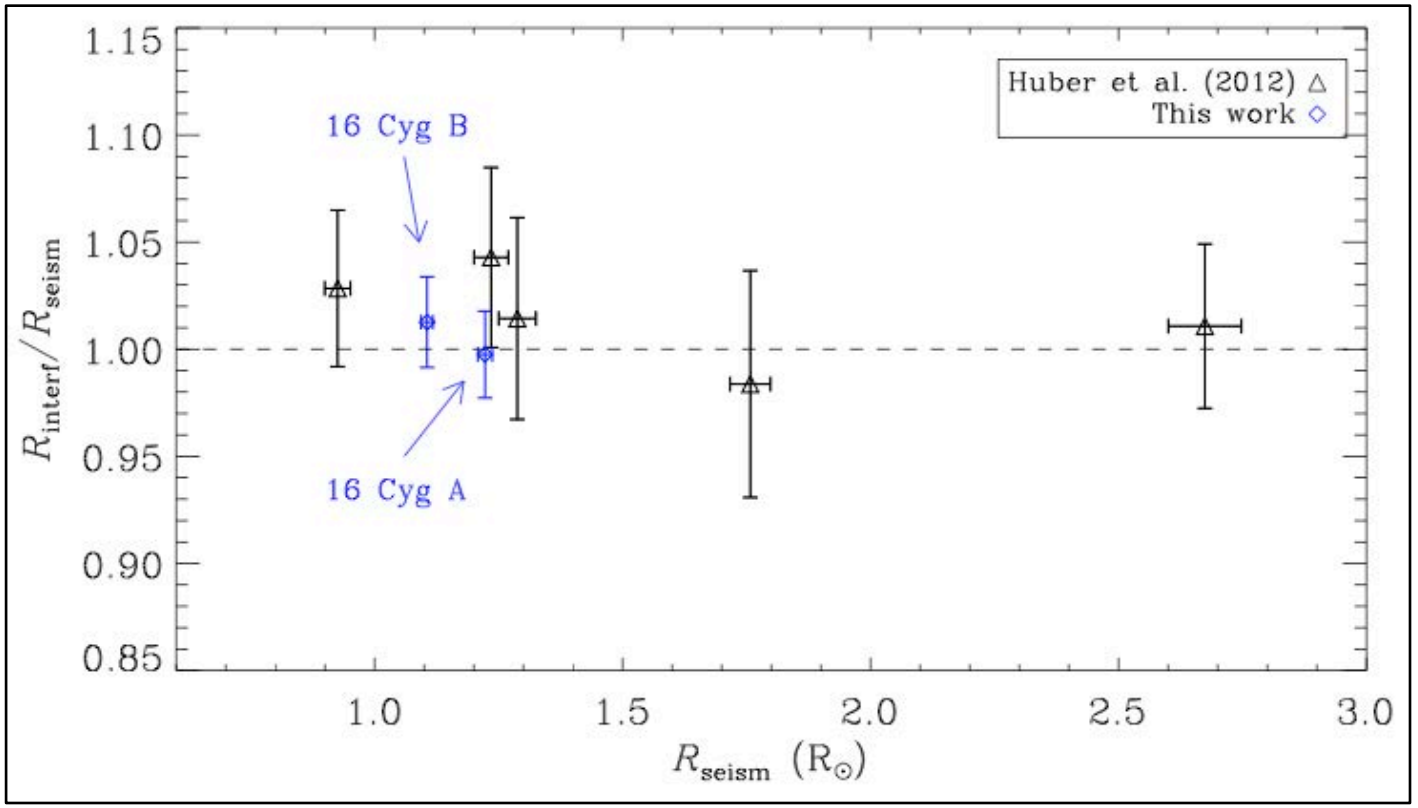


CLASSIC	PAVO
4 nights	9 nights
23 scans	24 scans
3 baselines	4 baselines

4 nights	8 nights
24 scans	23 scans
3 baselines	4 baselines

White et al. 2013, in prep

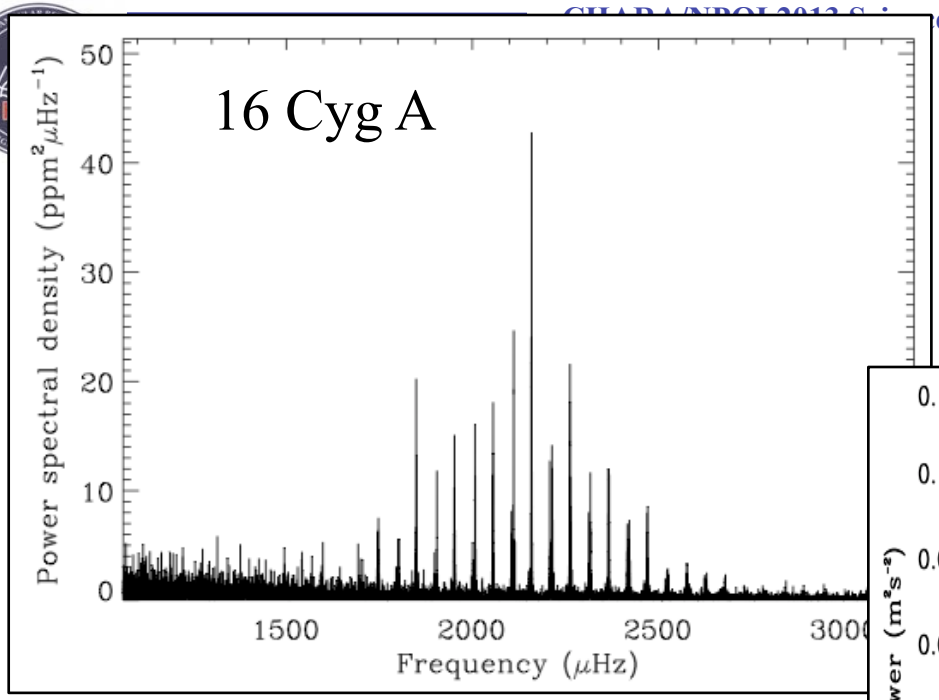
Testing Scaling Relations

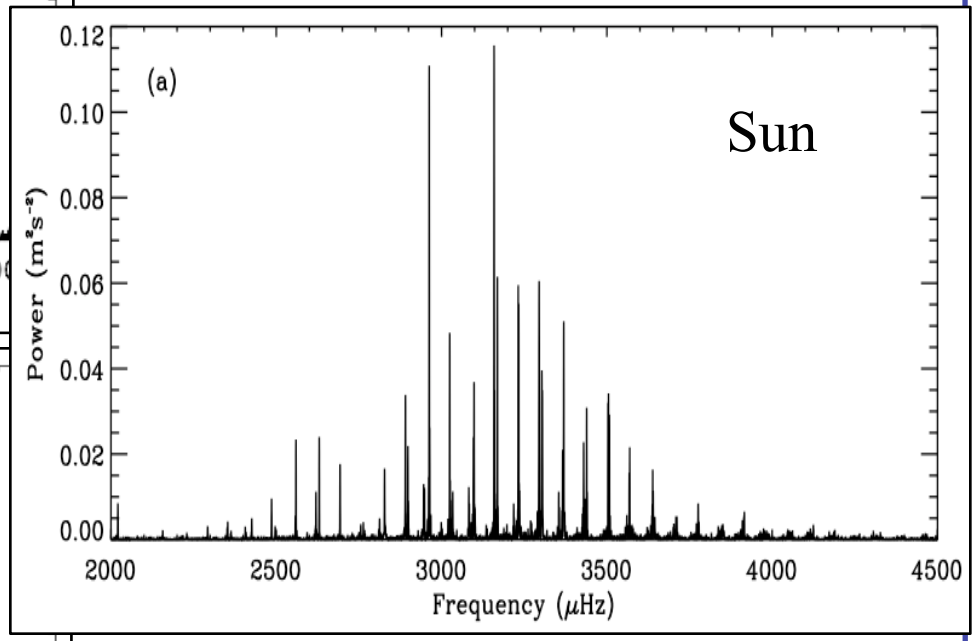


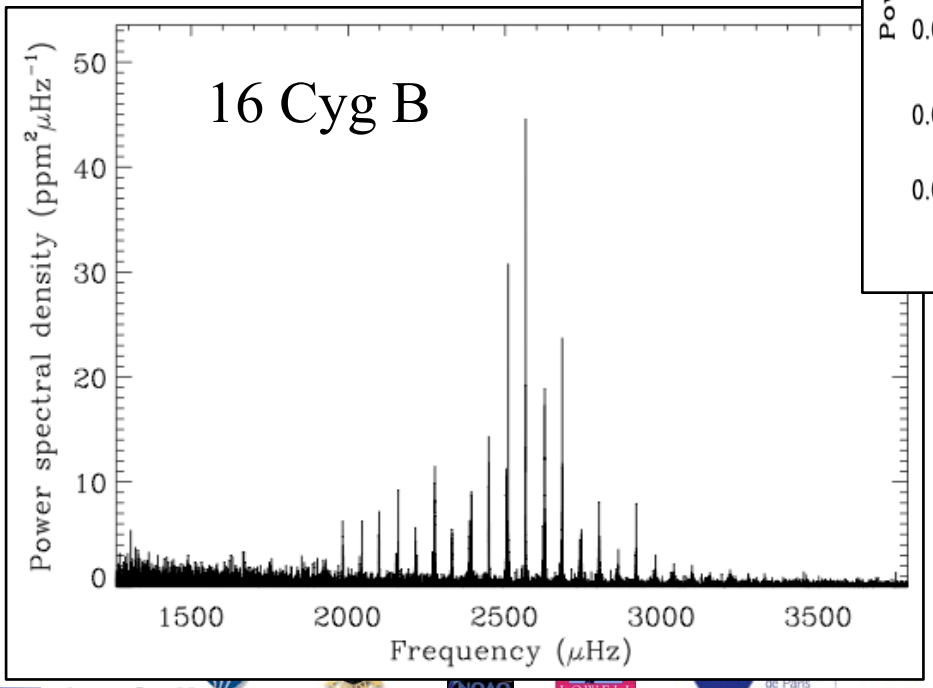
interferometric/seismic Radii

seismic Radii

White et al. 2013, in prep

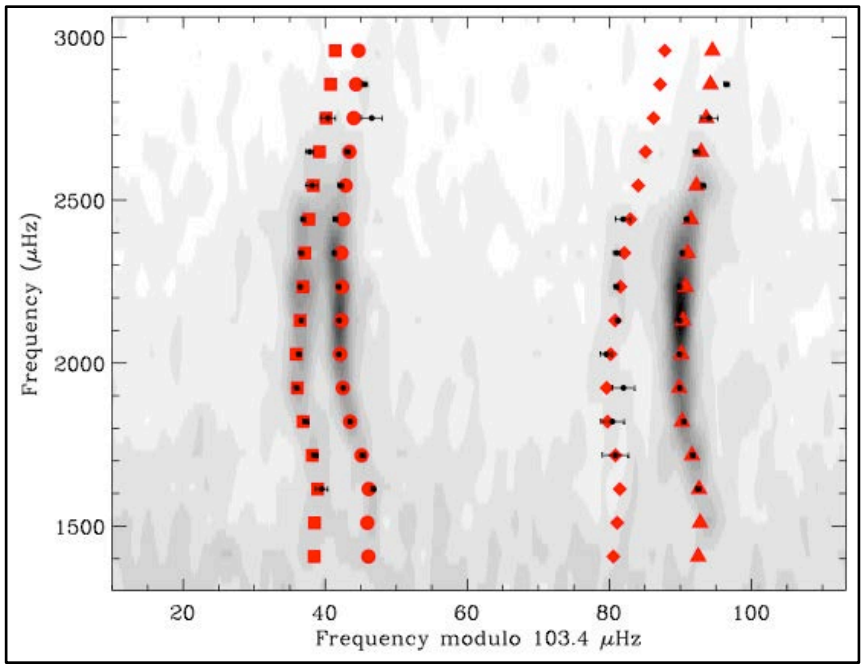






Metcalfe et al. 2012

Frequency Modeling



constraints on sound speed gradients in stellar interior

-> ages

-> mixing length

-> depth of convection zone

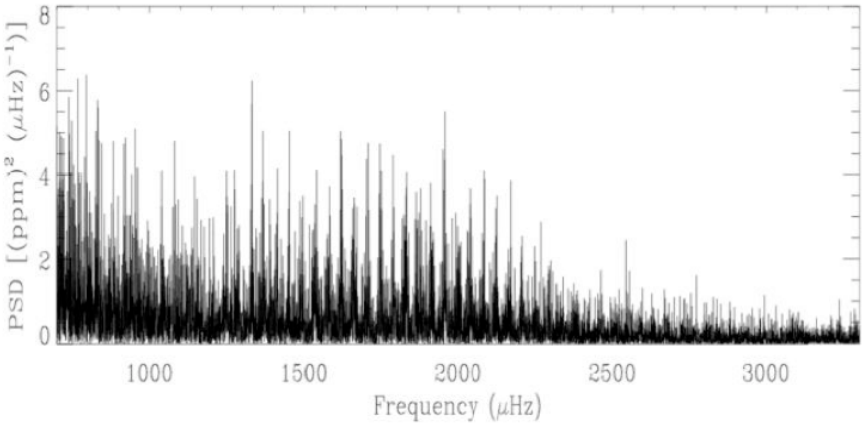
-> convective core overshoot

		modeling	interferometry
16 Cyg A:	$R/R_\odot =$	1.236-1.260	1.22 +/- 0.03
16 Cyg B:	$R/R_\odot =$	1.121-1.138	1.12 +/- 0.03

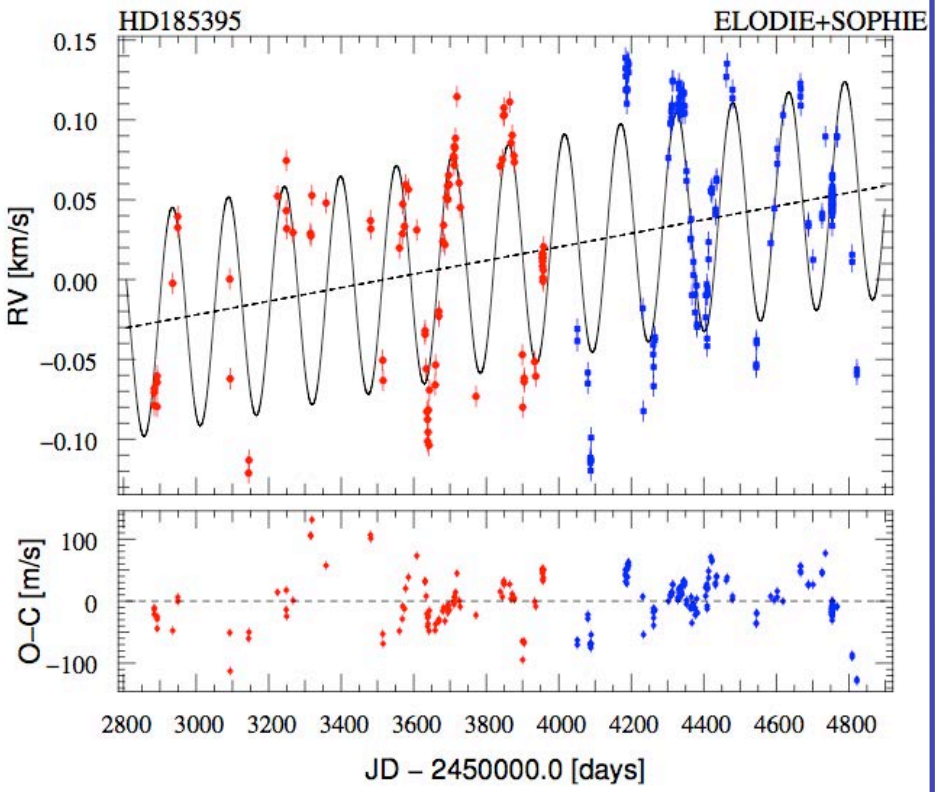
Metcalfe et al. 2012

Theta Cyg

- brightest star on silicon in the Kepler FOV (V ~ 4.5)
- suspected companion with ~150d from RV follow-up
- F4V, Teff ~ 6550-7000K

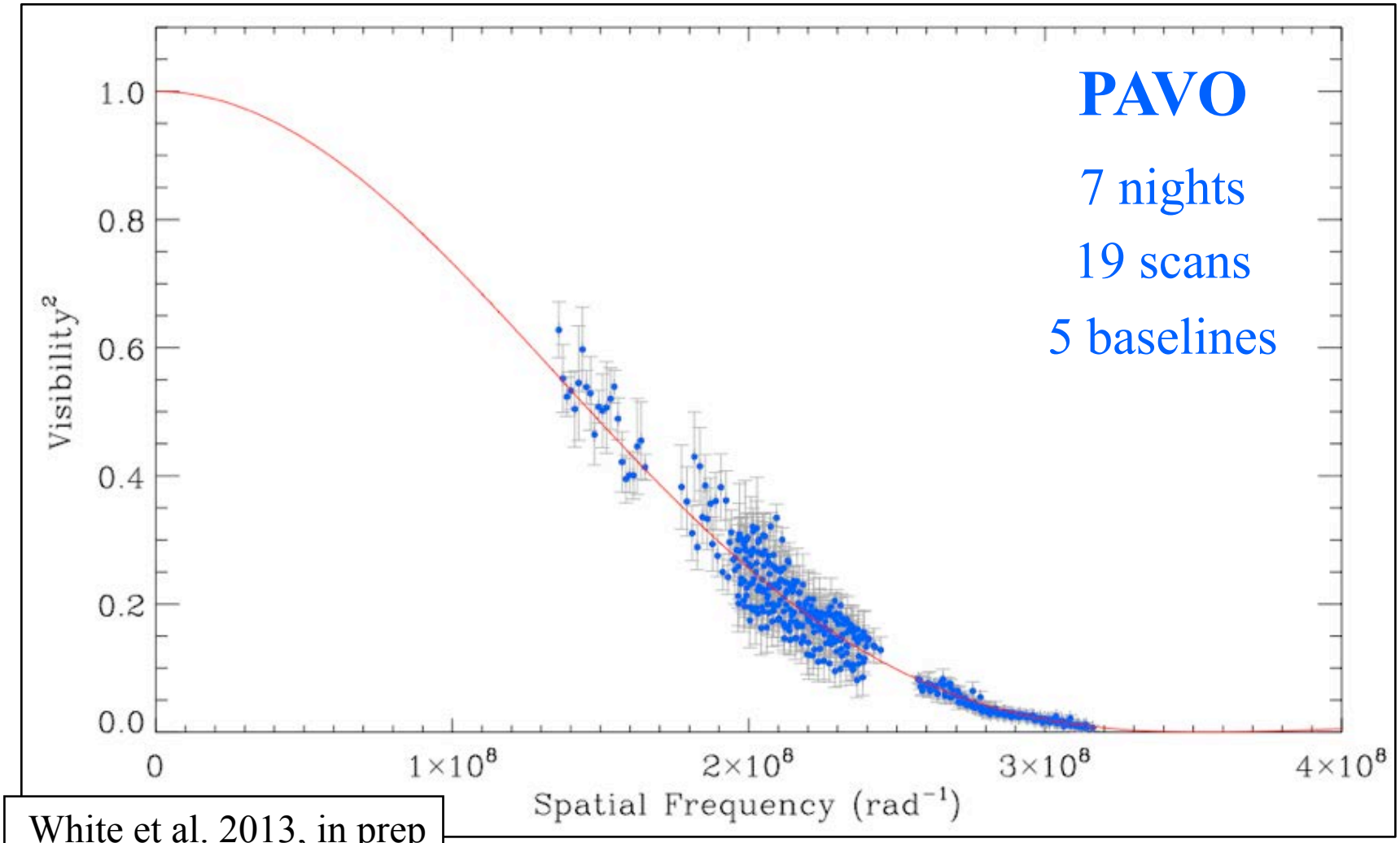


Guzik et al. 2009



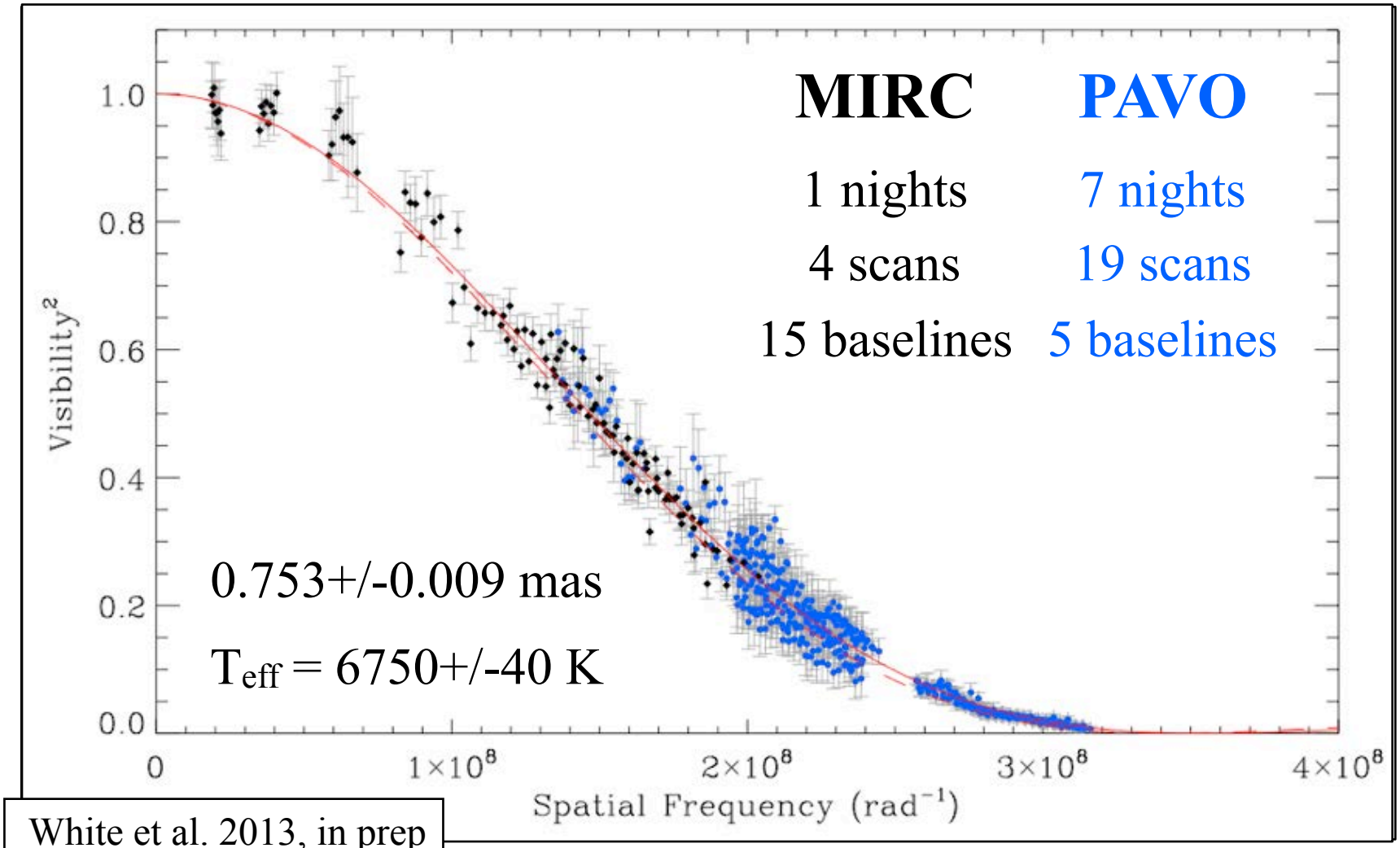
Desort et al. 2009

Theta Cyg



White et al. 2013, in prep

Theta Cyg



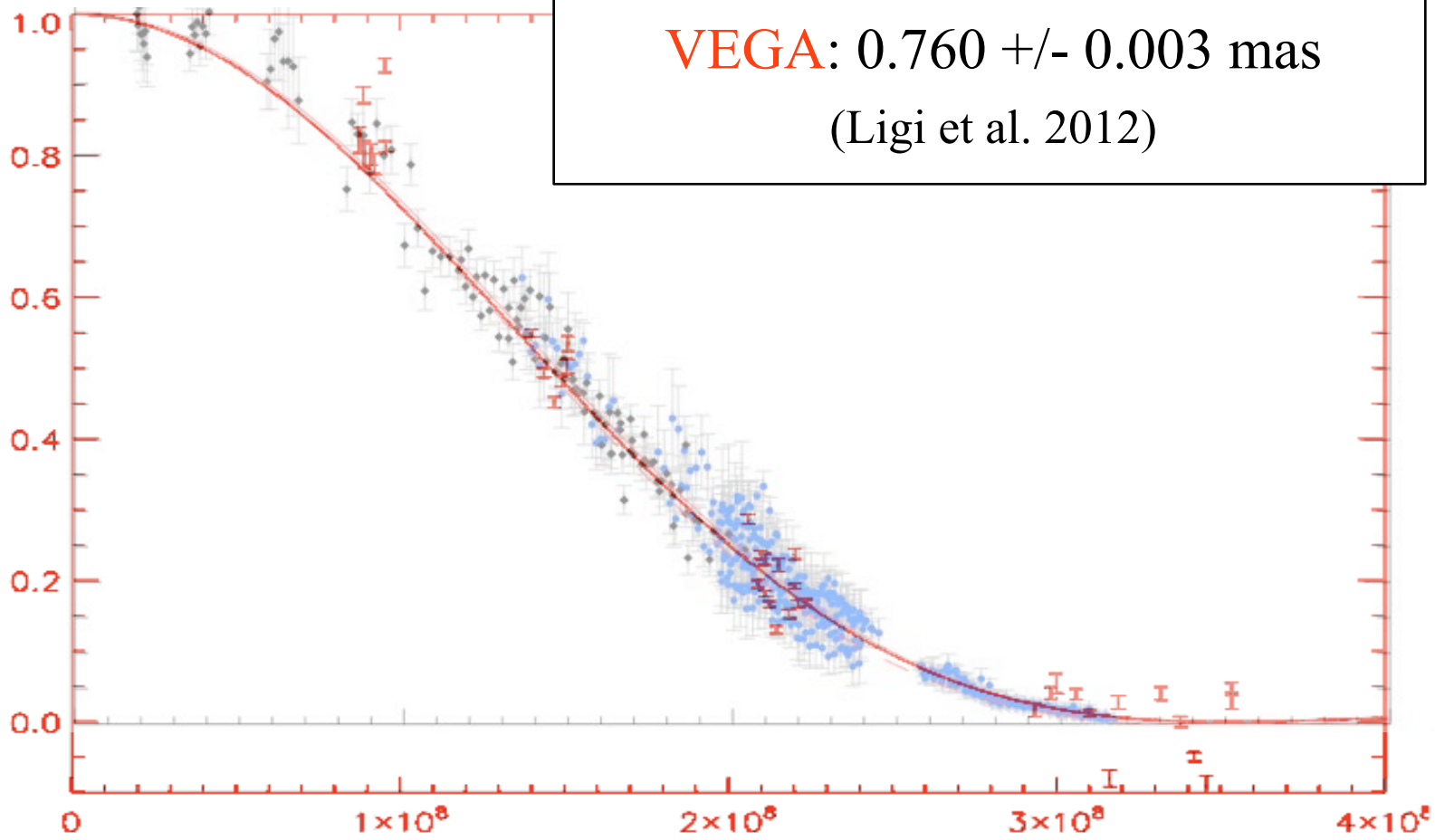
White et al. 2013, in prep

Theta Cyg

PAVO+MIRC: 0.753+/-0.009 mas

VEGA: 0.760 +/- 0.003 mas

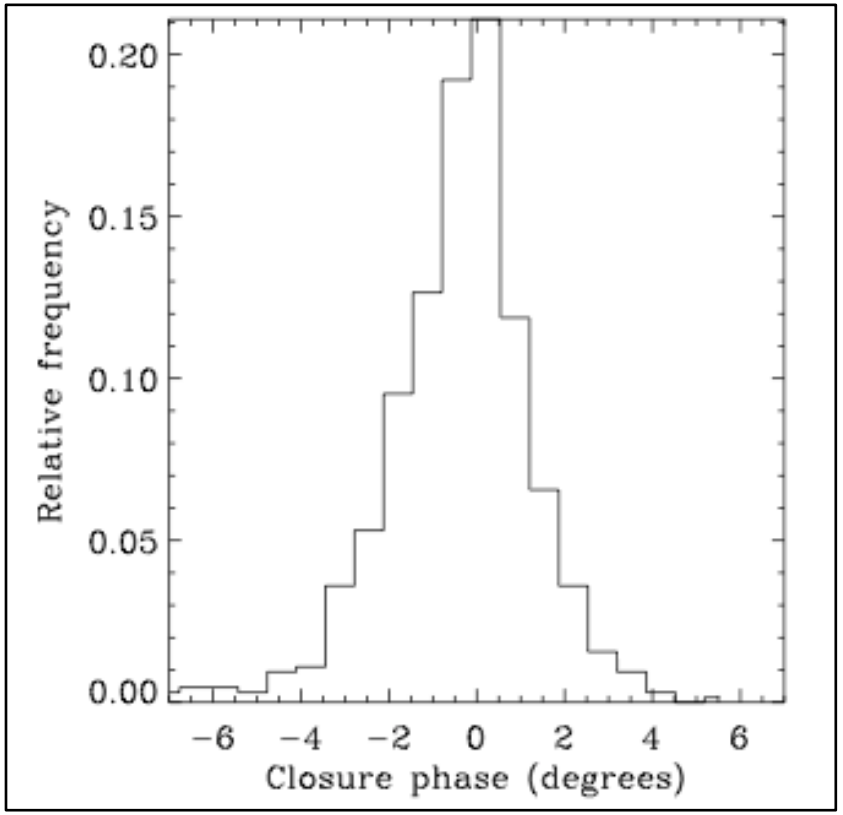
(Ligi et al. 2012)



Theta Cyg

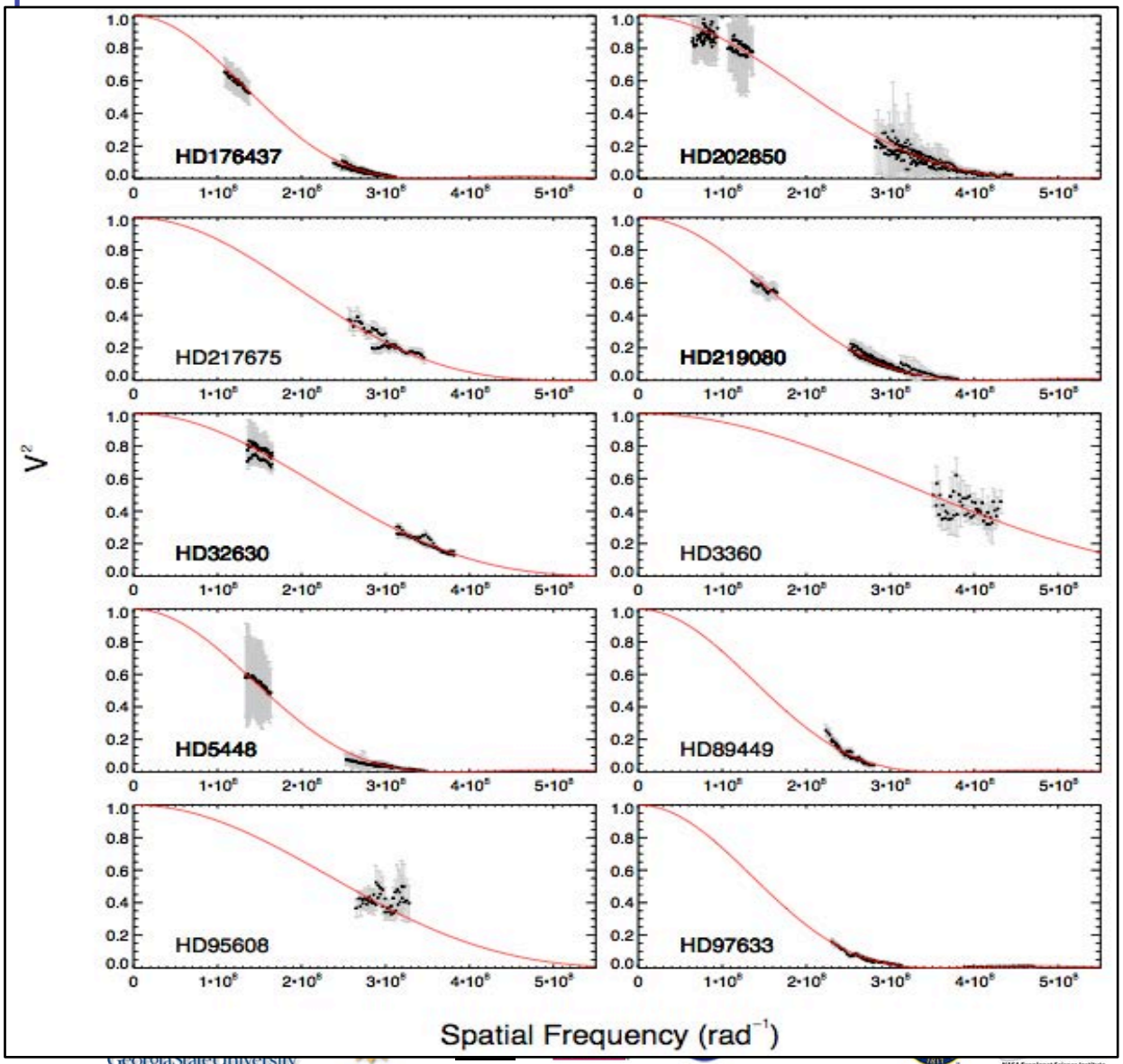
- MIRC closure phases + scatter of PAVO+MIRC visibilities consistent with single star

- suspected companion to theta Cyg A does not influence the MIRC and PAVO data



White et al. 2013, in prep

MIRC Calibrators



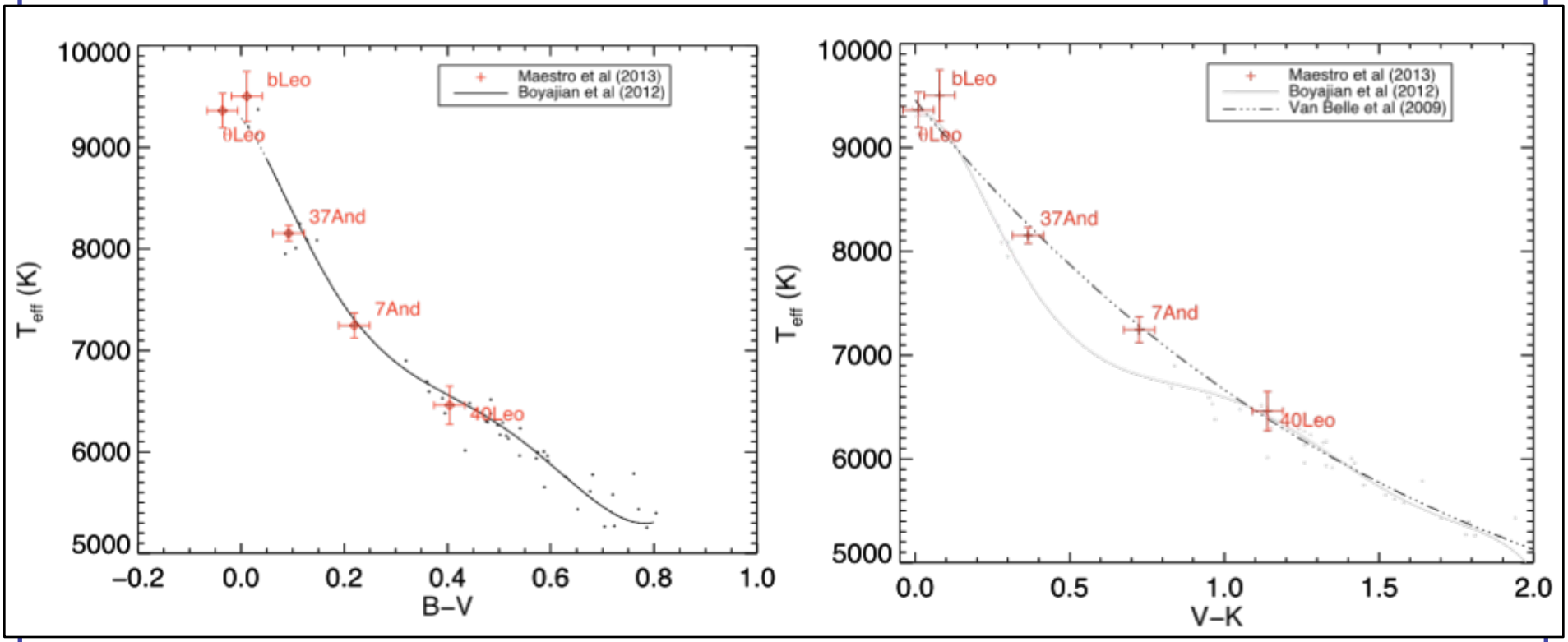
7 main-sequence stars & 3 giants

spectral types B2-F6

SED fits using UV (IUES), visible (ELODIE) spectra and U- to L-band photometry

Maestro et al. 2013, in prep

MIRC Calibrators

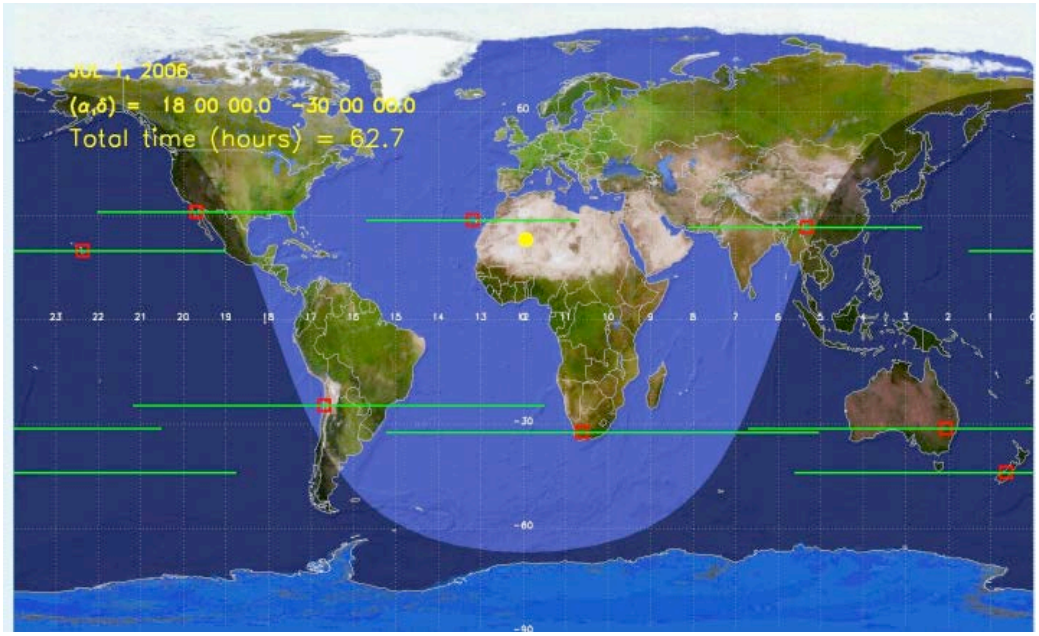


confirms 6th order color-Teff polynomials in B-V, but favors 3rd order polynomial in V-K

Maestro et al. 2013, in prep

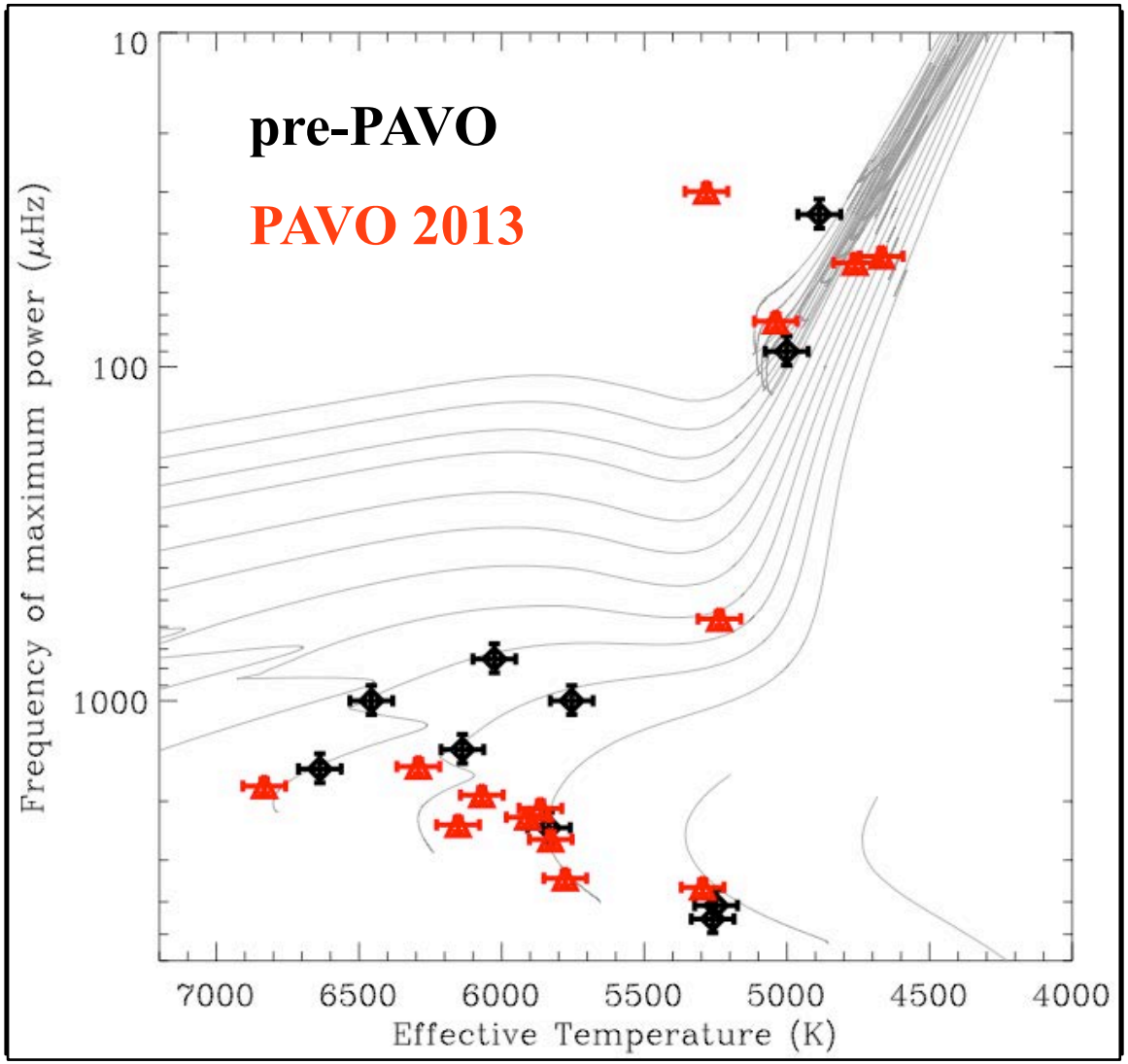
The Future: SONG

- SONG = Stellar Oscillations Network Group
- Network of 8 1-m class telescopes for asteroseismology and exoplanet detection; 2 nodes active: Tenerife & China
- bright stars -> precise parallaxes (giants!)



Grundahl et al. 2009

Stars with Asteroseismology + Interferometry



Observing Summary & Papers

2009 Semester 1/2: 7/3 nights (100/0 % clear)
2010 Semester 1/2: 4/3 nights (100/0 % clear)
2011 Semester 1/2: 5/3 nights (90/0 % clear)
2012 Semester 1/2: 6/6 nights (100/15 % clear)

- **18 Sco (Bazot et al. 2011, A&A)**
- **Trinity (Derekas et al. 2011, Science)**
- **Kepler-21 (Huber et al. 2012, MNRAS)**
- **Kepler ensemble (Huber et al. 2012b, ApJ)**
- *theta Cyg + 16 Cyg A&B (White et al., mid-2013)*
- *MIRC Calibrators (Maestro et al., mid-2013)*
- *+ non-Sydney PAVO papers!*