Eclipsing binaries in PLATO SPF from TESS

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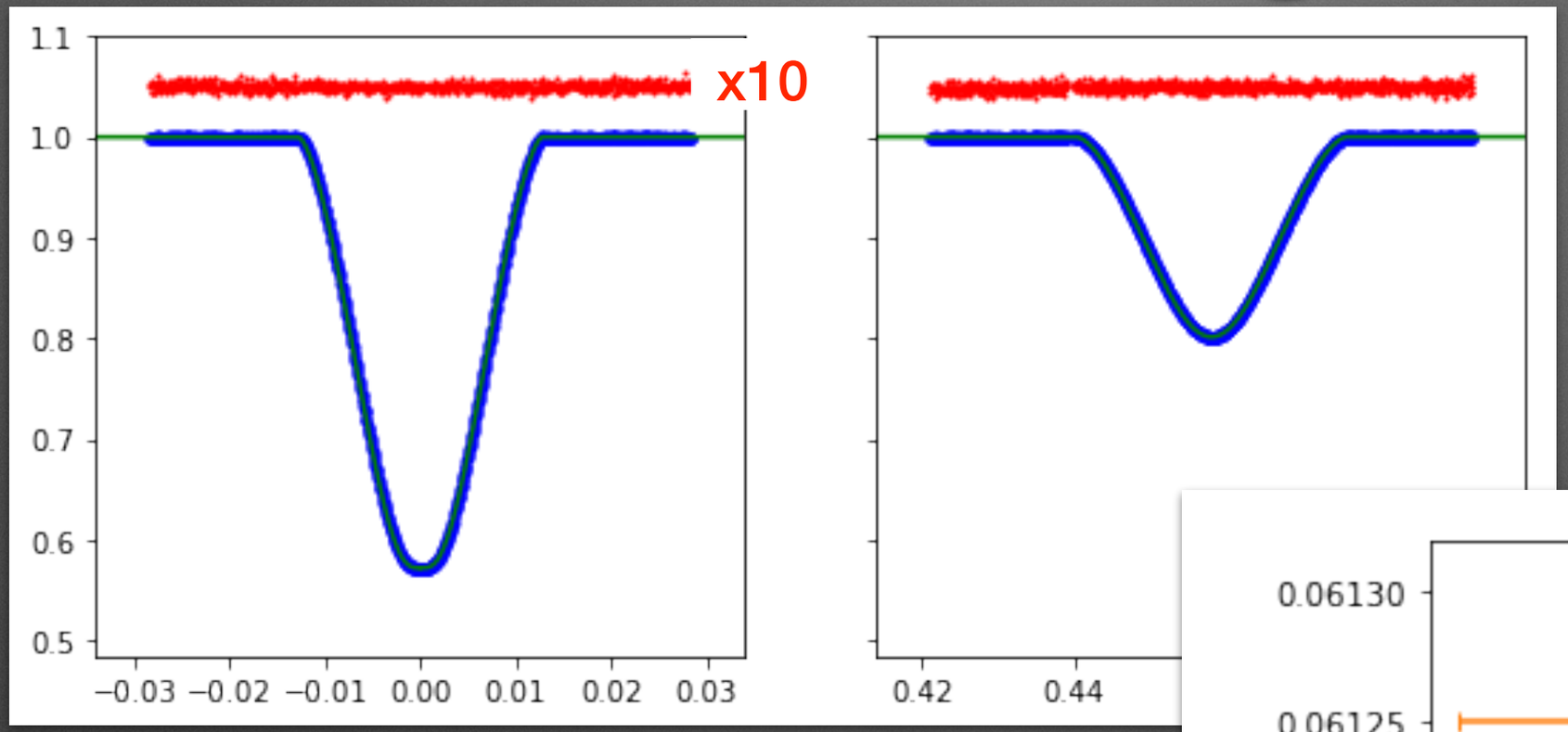
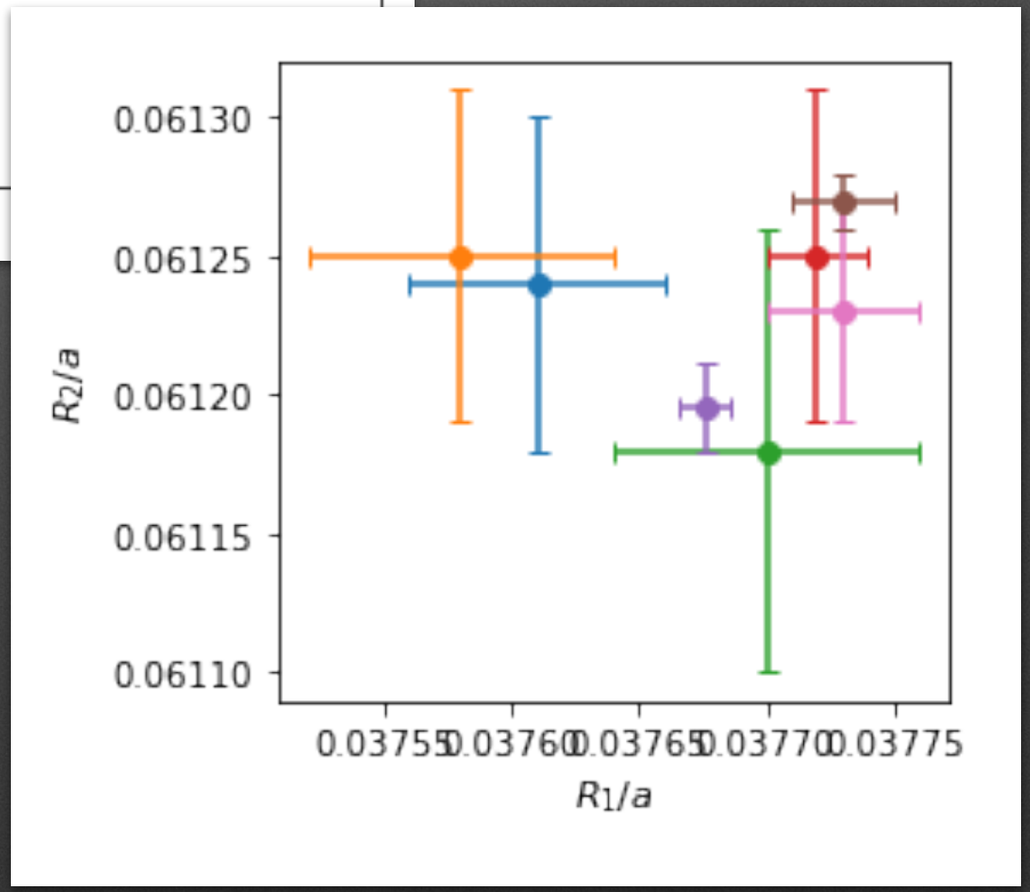
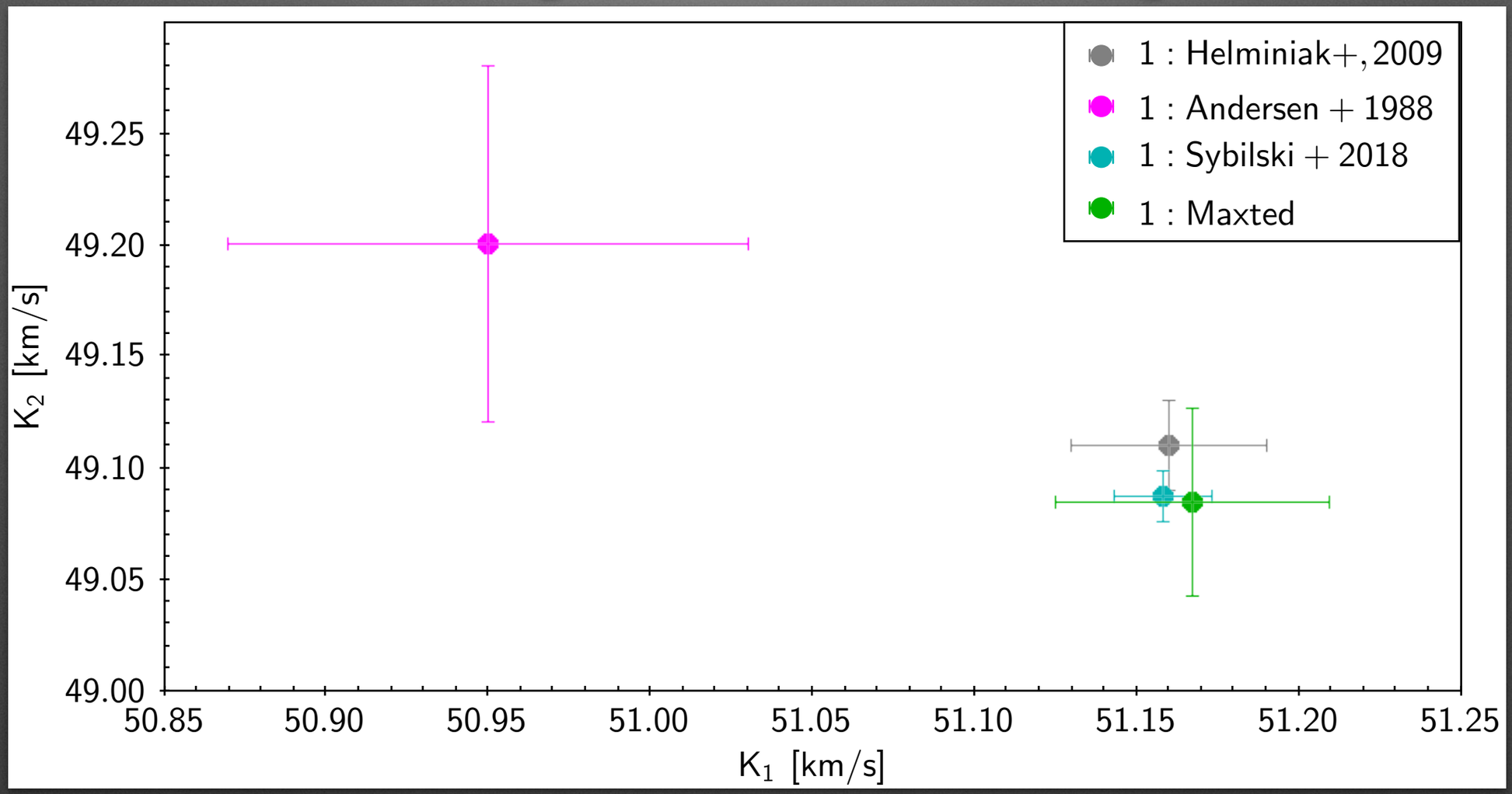
AI Phe - TESS light curves





- $R_1/a = 0.037\ldots \pm 0.00006$ (0.15%)
- $R_2/a = 0.061\ldots \pm 0.00003$ (0.05%)
- $i = 88.3??$ 0.006
- $e \cos \omega = -0.065\ldots \pm 0.00001$
- $e \sin \omega = +0.175\ldots \pm 0.00044$

Al Phe — spectroscopic orbit



- K_1= 51.1… ± 0.013 km/s
- K_2= 49.0… ± 0.009 km/s

- M_1 = 1.1… +/- 0.0006 $M_\odot$
- M_2 = 1.2… +/- 0.0007 $M_\odot$
- a = 47.8… +/- 0.0084 $R_\odot$

The plan …

- Find more systems like AI Phe using TESS+WASP
- Measure mass and radius to high accuracy
- Estimate T_{eff} and [Fe/H]
- Calibrate stellar models
- Predict asteroseismic signal with best-fit models
- Compare predicted pulsation frequencies to PLATO

How many DEBS like AI Phe where asteroseismology of the main-sequence star is feasible with PLATO?

Known DEBS in/near nominal SPF/NPF

Start from DEBCat list of 233 DEBS with accurate masses radii

- Remove stars >5° from ***nominal*** SPF/NPF fields
- Remove (sub-)giants ($R/R_\odot > 2 \times M/M_\odot$)
- Remove massive/hot stars ($T_{eff} > 7000K$, $M > 1.7M_\odot$)
- Remove K-/M-dwarfs ($L < 0.6L_\odot$)
- Remove faint stars ($V < 11$)
- Remove short-period systems (P<3 days)
  - non-spherical stars with forced rapid rotation

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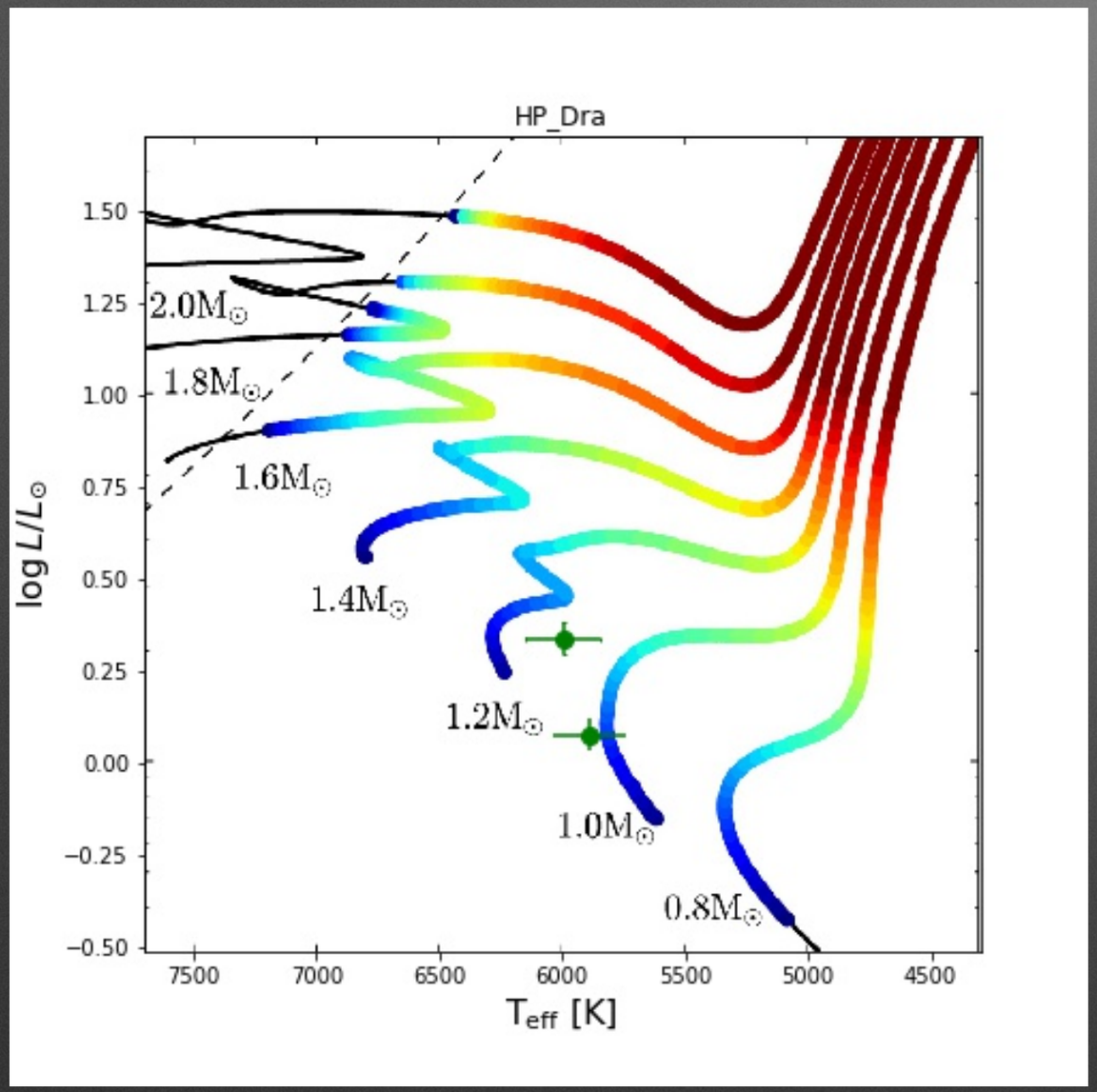
Leaves only 5 systems where one or both stars are ok

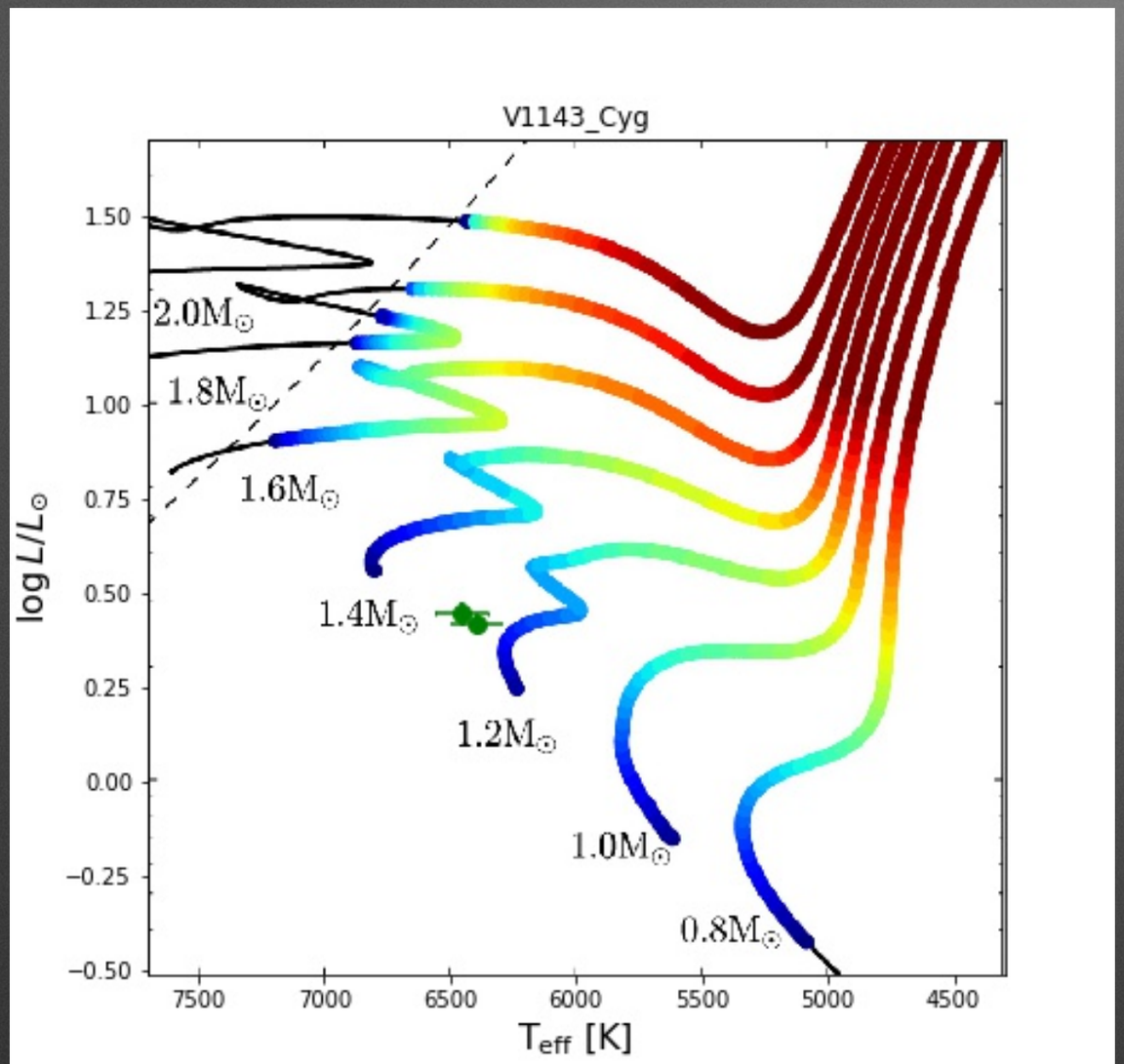
HP Dra



- P = 10.76 days
- V = 7.94
- M_1 =1.13 $M_\odot$
- R_1 = 1.37 $R_\odot$
- M_2 = 1.09 $M_\odot$
- R_2 = 1.05 $R_\odot$
- [Fe/H] = ?

Ideal benchmark
Needs [Fe/H] measurement.

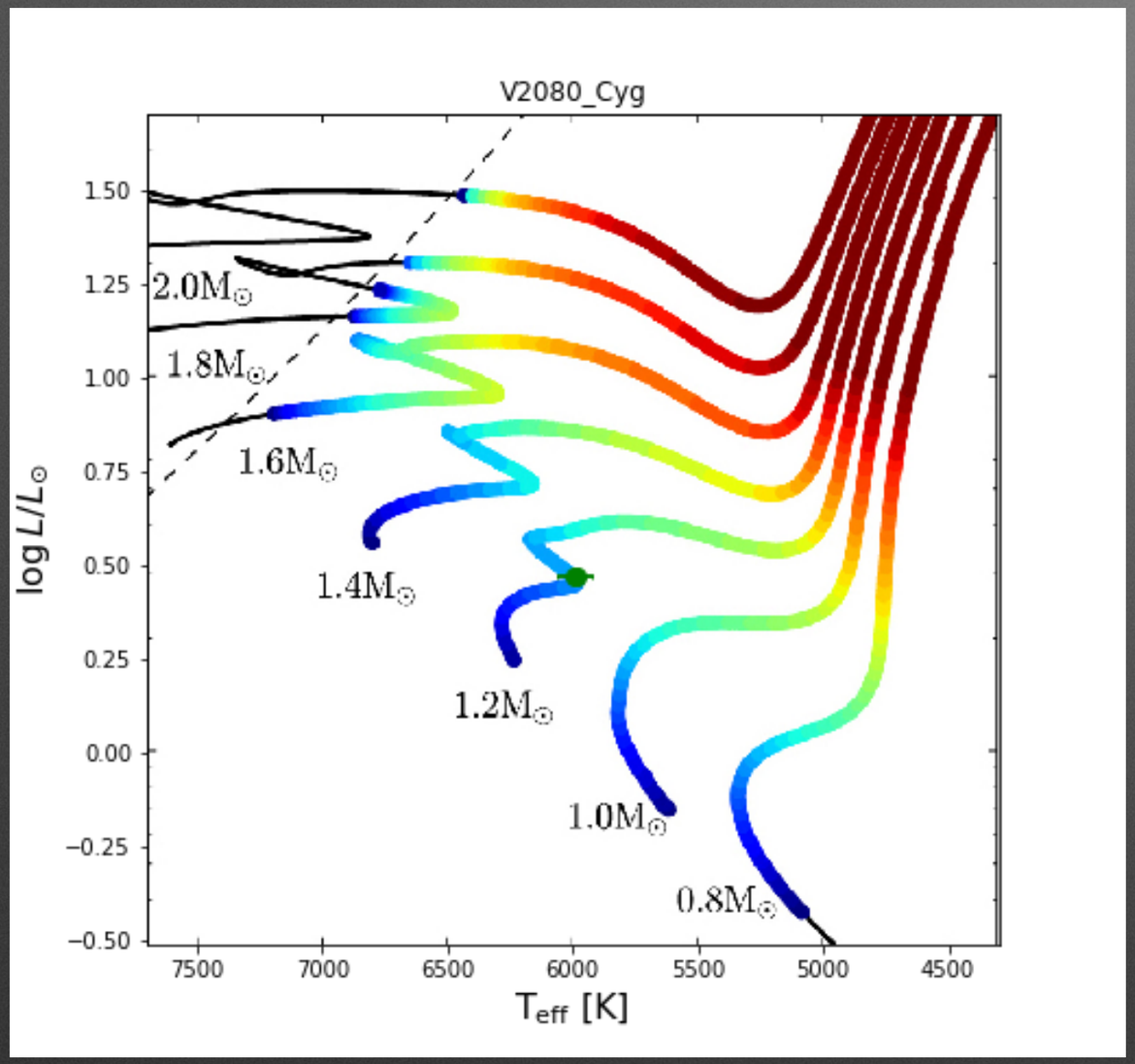
V1143 Cyg



- P = 7.64 days
- V = 5.86
- M_1 =1.35 $M_\odot$
- R_1 = 1.35 $R_\odot$
- M_2 = 1.33 $M_\odot$
- R_2 = 1.32 $R_\odot$
- [Fe/H] = ?

Overlap between asteroseismic signals and too bright?
Needs [Fe/H] measurement.

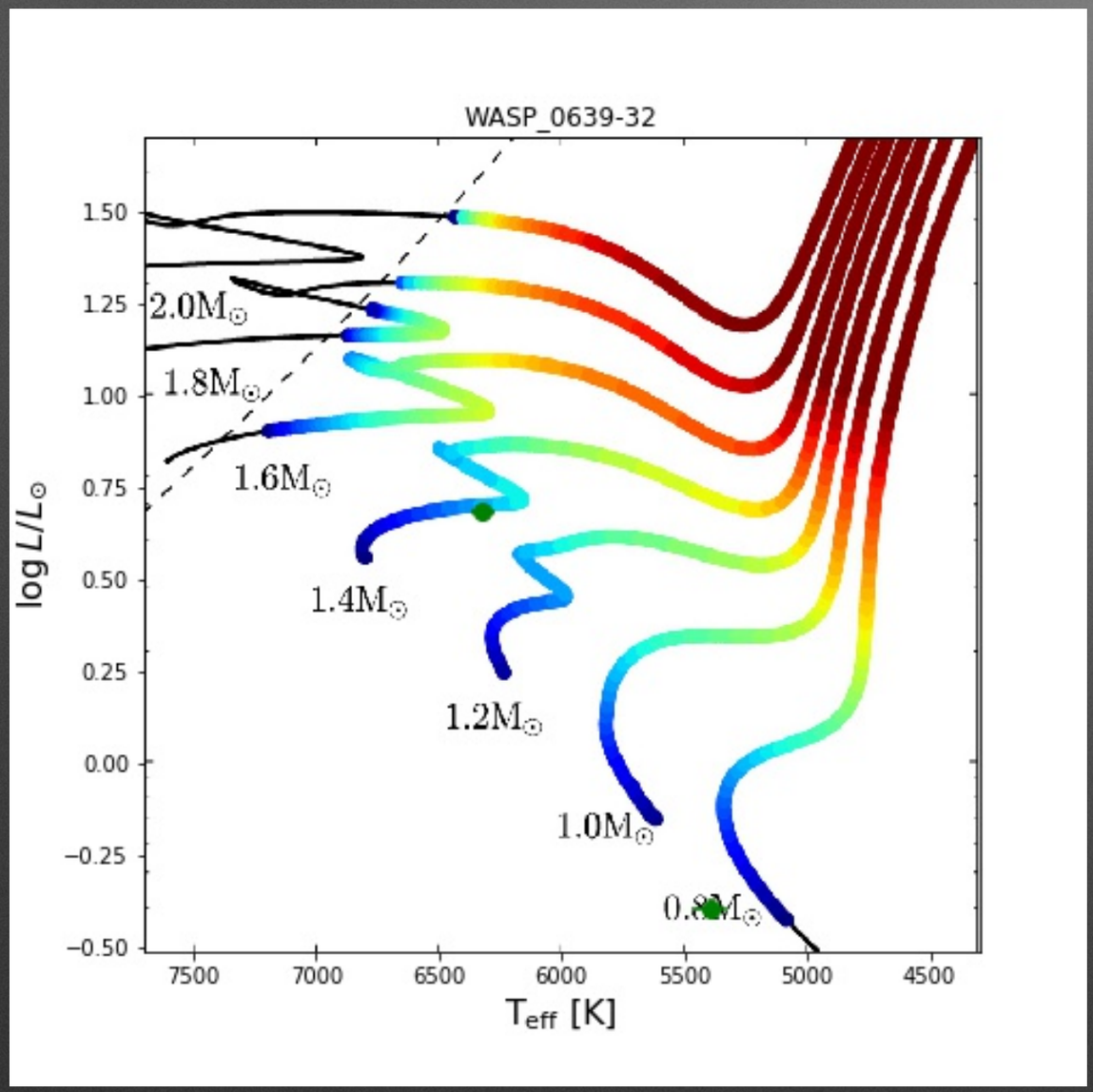
V2080 Cyg

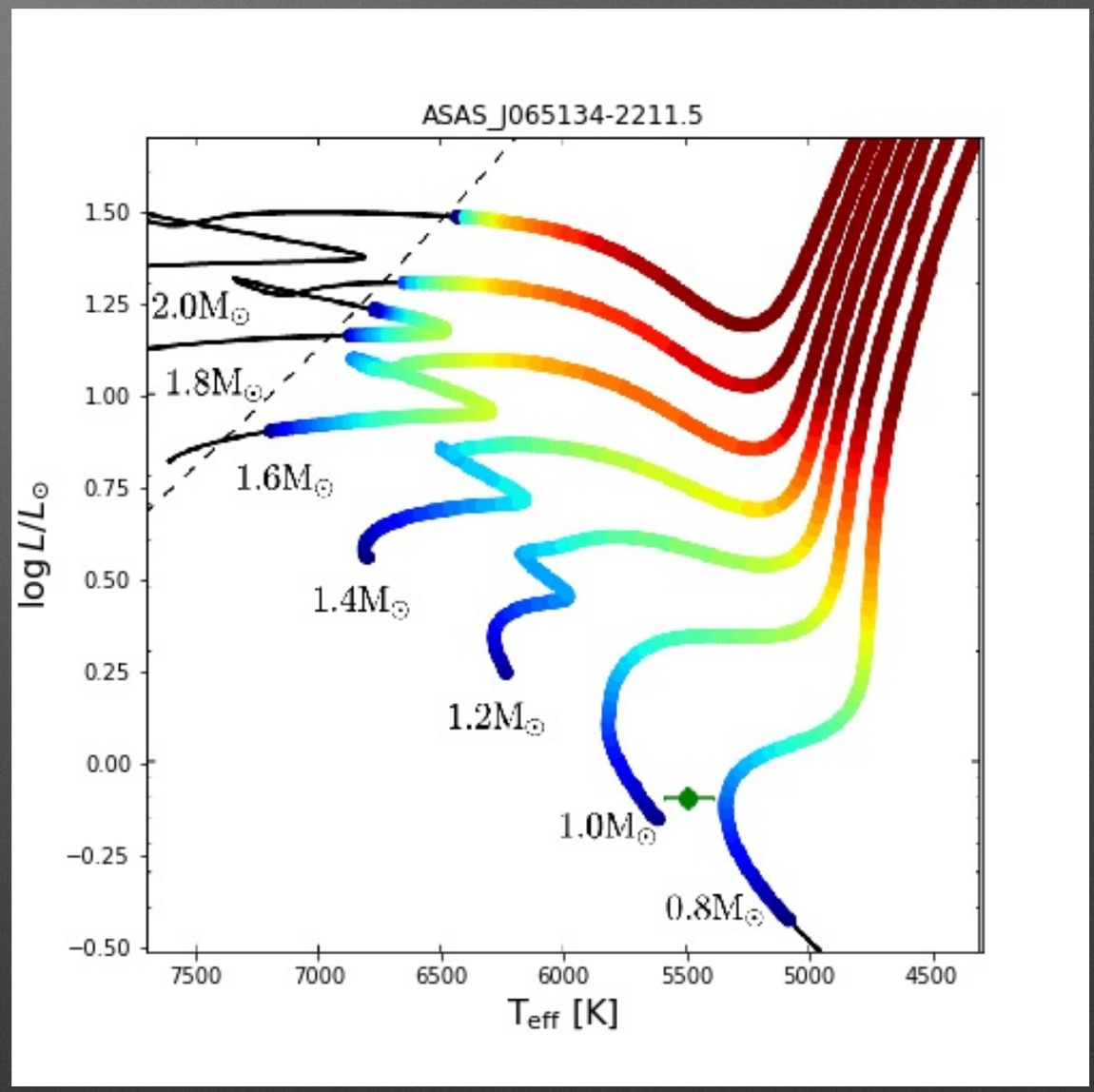


- P = 4.934 days
- V = 7.40
- M_1 =1.19 $M_\odot$
- R_1 = 1.60 $R_\odot$
- M_2 = 1.16 $M_\odot$
- R_2 = 1.60 $R_\odot$
- [Fe/H] = ?

Asteroseismic signals will overlap.
Short period — tidal effects?

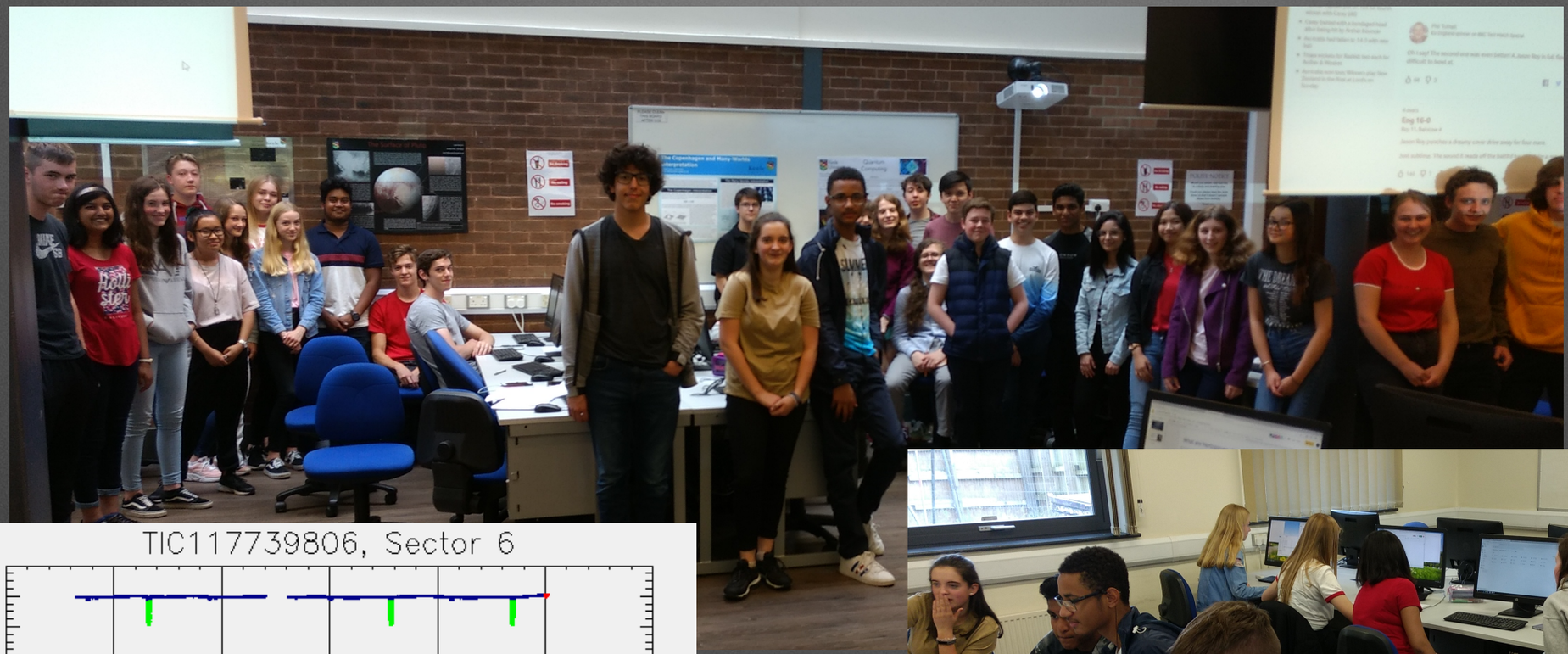
WASP 0639-32 and ASAS J065134-2211.5

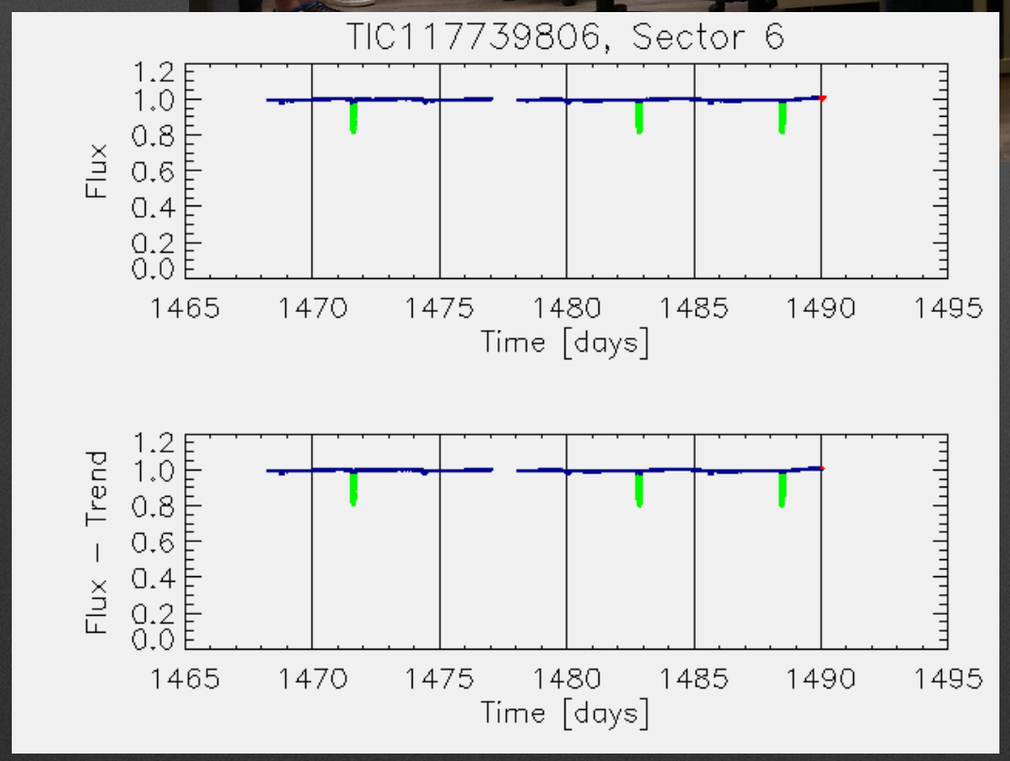




Brighter star by itself will be a useful benchmark

Keele Astrophysics work experience week, 2019

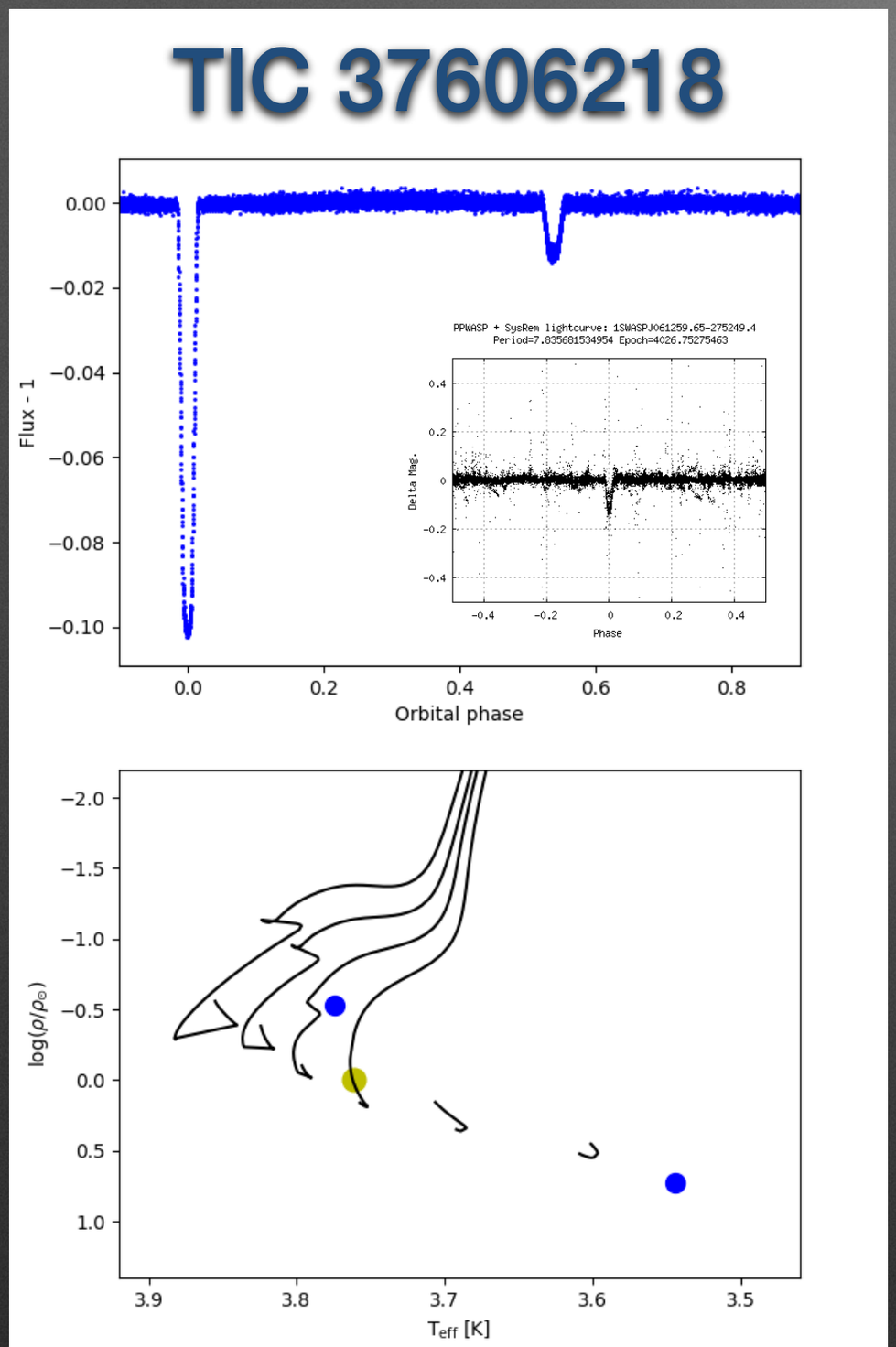




10 candidates for benchmark system in/near nominal SPF

New targets from WASP and TESS

TIC 37606218



- ✦P = 7.83 days
- ✦V = 9.8
- ✦Little spot variability
  - ✦~0.1%, similar to Sun
- ✦$T_{eff} \approx 6000$ K (G0)
- ✦$R_1 \approx 1.7\ R_\odot$, $R_2 \approx 0.5\ R_\odot$
- ✦Eccentric orbit
- ✦Flux ratio ≈ 1.2%

Summary

- AI Phe-like benchmarks are rare
  - may only have 1 or 2 such binaries in a PLATO field
- Simulations needed to test asteroseismic signal overlap
- F/G/K + M much more common
  - good for “end-to-end” tests of asteroseismic mass/ radius/age estimates
  - less stringent test but many more systems
  - and great potential for T_{eff} standards - see next talk.
- Compilation of suitable targets under way …
  - … but currently unfunded to progress is slow.