Compact binaries in the TESS era

Ingrid Pelisoli
TESS WG8.4

Universität Potsdam
DFG

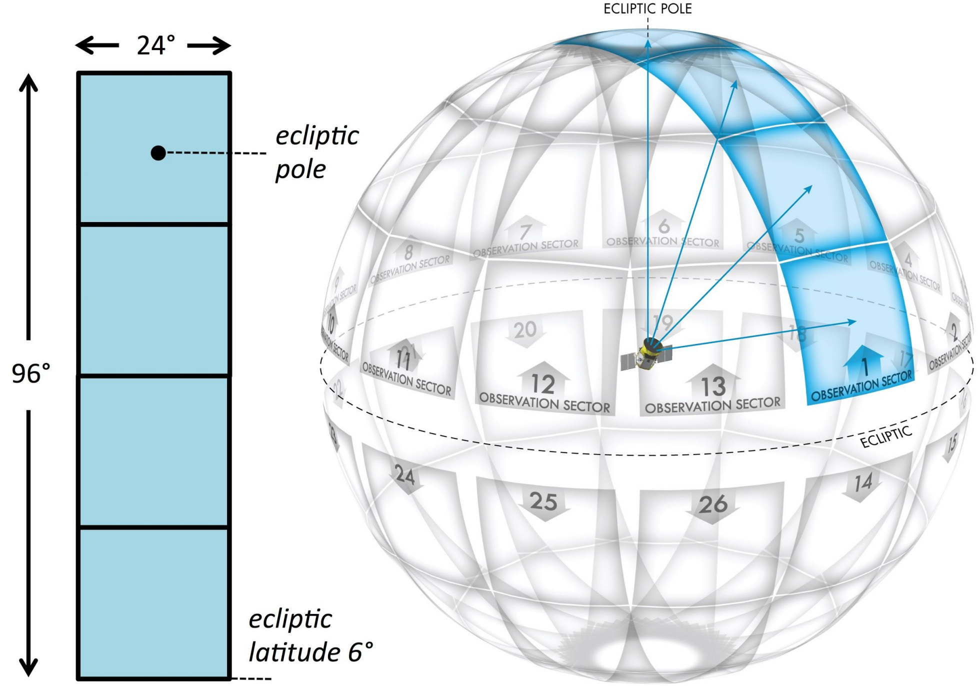
TESS

Transiting Exoplanet Survey Satellite

Goal = find nearby, Earth-sized planets

→ **So that they can be fully characterized**

TESS Observing strategy

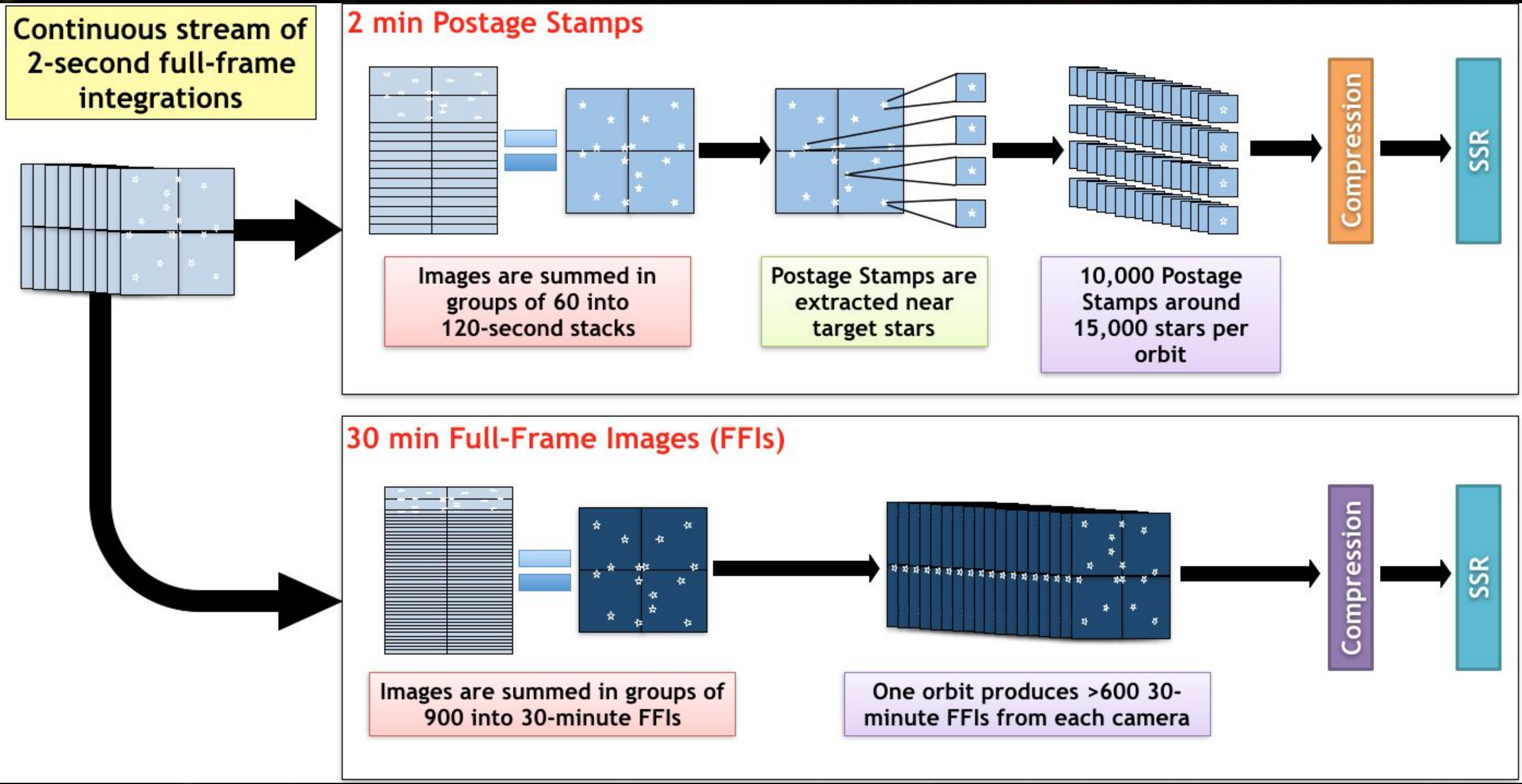


- Baseline: 27 days

  → sensitivity to periods shorter than 13 days
- 50 ppm photometric precision (9-15 mag)
- 21 arcsec/pixel

  → one must be careful when interpreting data from crowded fields!

TESS
Data Products



TESS Working groups

WG-1: Asteroseismology of TESS exoplanet hosts

WG-2: Oscillations in solar-type stars

WG-3: Oscillating stars in clusters

WG-4: Main Sequence AF "classical" pulsators

WG-5: Main Sequence OB "classical" pulsators

WG-6: RR Lyrae stars and Cepheids

WG-7: Red Giant oscillations

WG-8: ~~Compact pulsators~~ Evolved Compact Stars
Chairs: Stéphane Charpinet, JJ Hermes.

- **WG-8.4: Binaries**
- **Coordinators: I. Pelisoli, S. Geier**

See how to join at https://tasoc.dk/

Evolved Compact Stars

White dwarfs

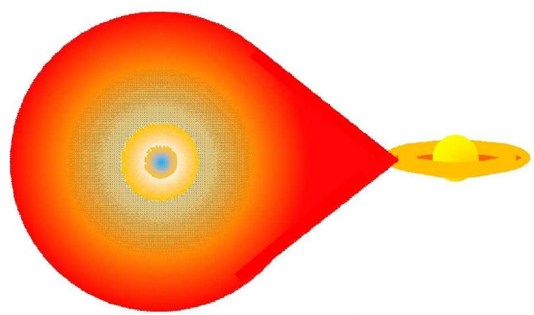
Single stellar evolution (> 95% of stars)

Binary evolution

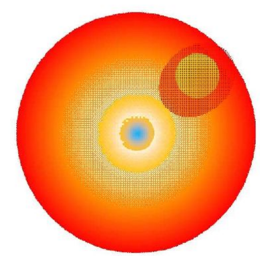
➔ 10-30% result from mergers (Toonen et al. 2017)

➔ Extremely-low mass white dwarfs (ELMs)

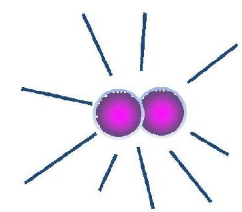
Hot subdwarfs



Stable RLOF



Common envelope

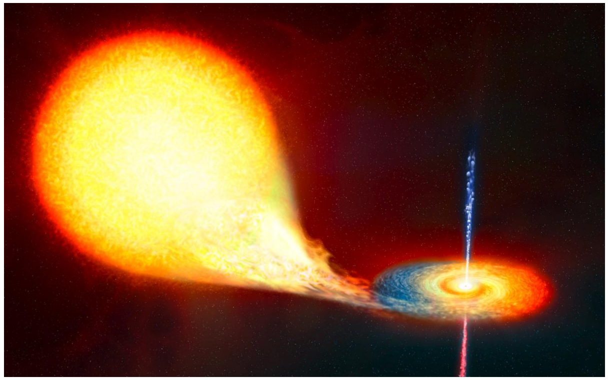


Mergers

Neutron stars, black holes

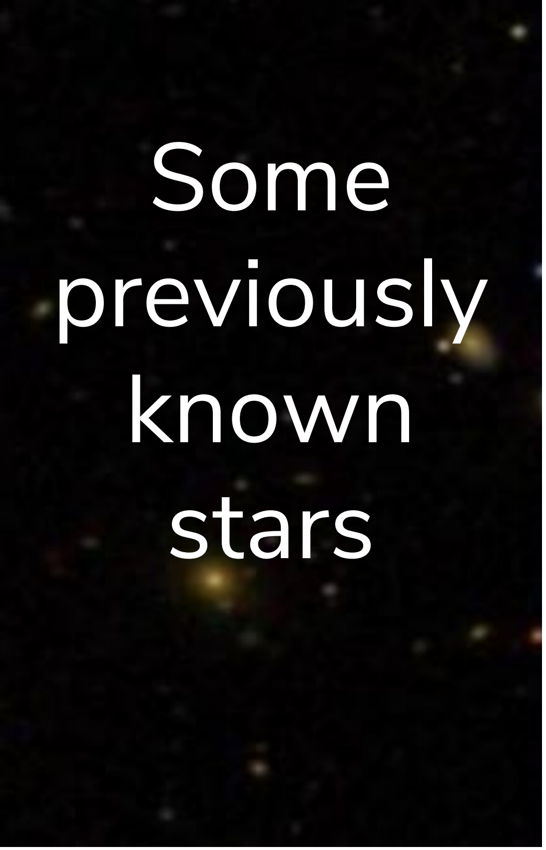
Compact binaries

- ★ (Possibly normal) star + compact object

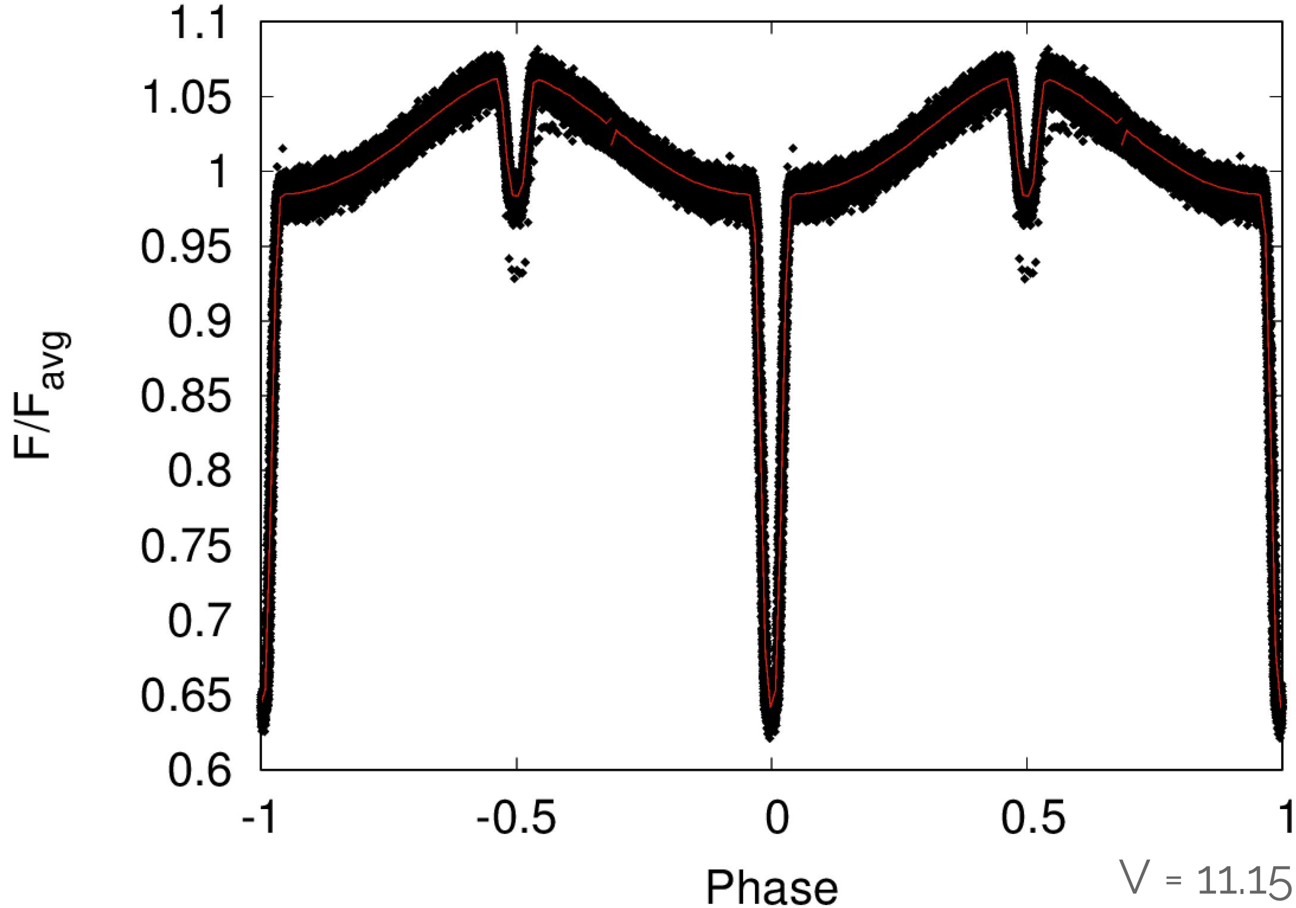


- ★ Several applications, e.g.:
  - Precise mass and radius
  - Constraints to common-envelope evolution
  - Laboratory for studying accretion
  - Accurate ages
  - Multi-messenger astronomy

AA Dor (HW Vir-type binary)



Some previously known stars

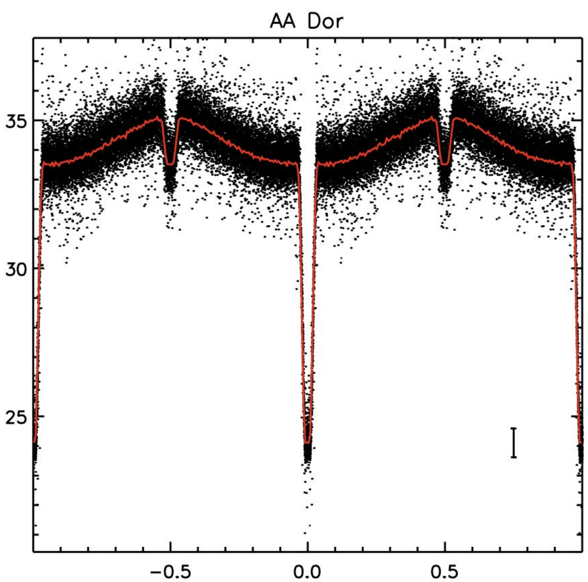


$V = 11.15$

$M_1 = 0.46\ M_\odot$

$M_2 = 0.079 M_\odot$

(Vuckovic et al 2016)

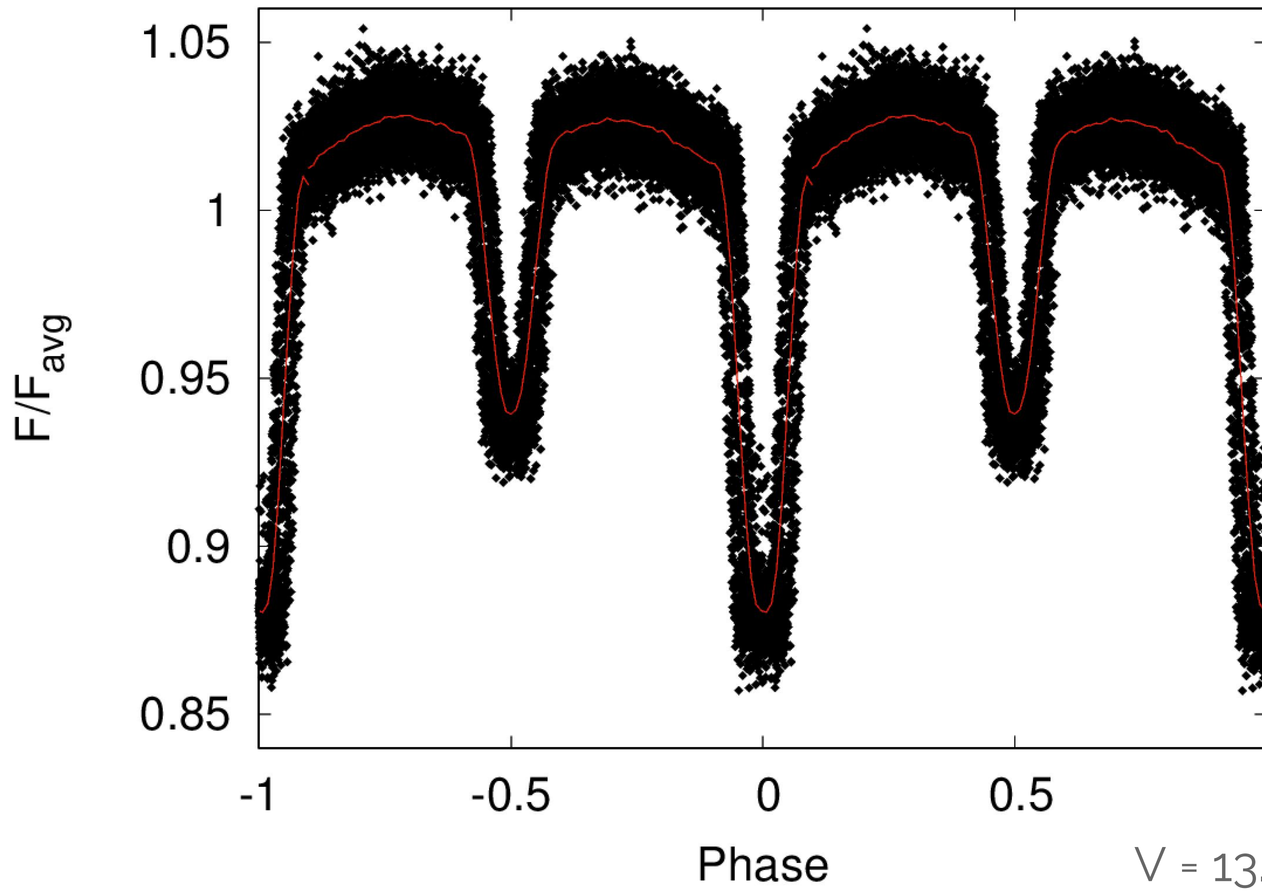


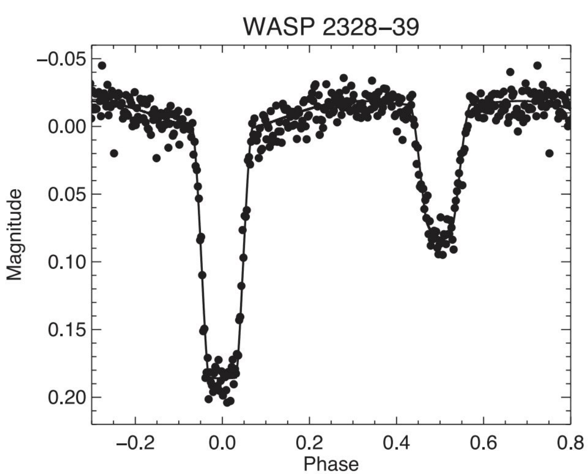
Previous data: SuperWASP

Lohr et al.

A&A 566, A128 (2014)

1SWASP J232812.74-395523.3 (EL CVn-type)





V = 13.3

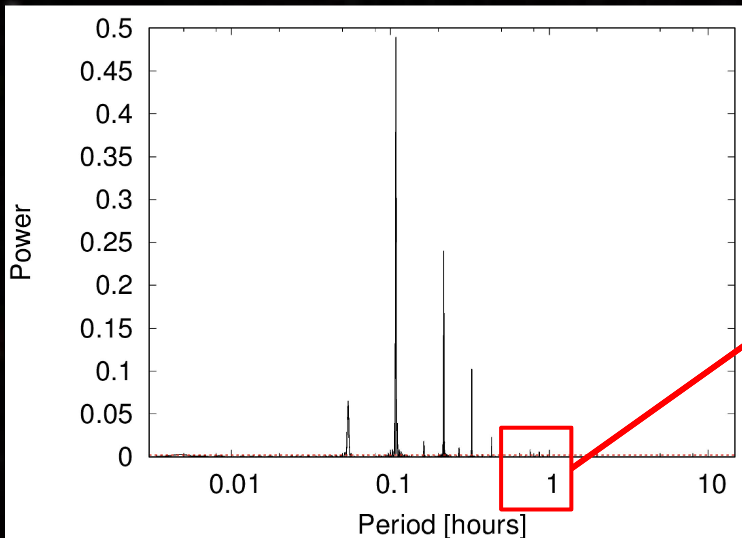
A-type MS star + pre-ELM

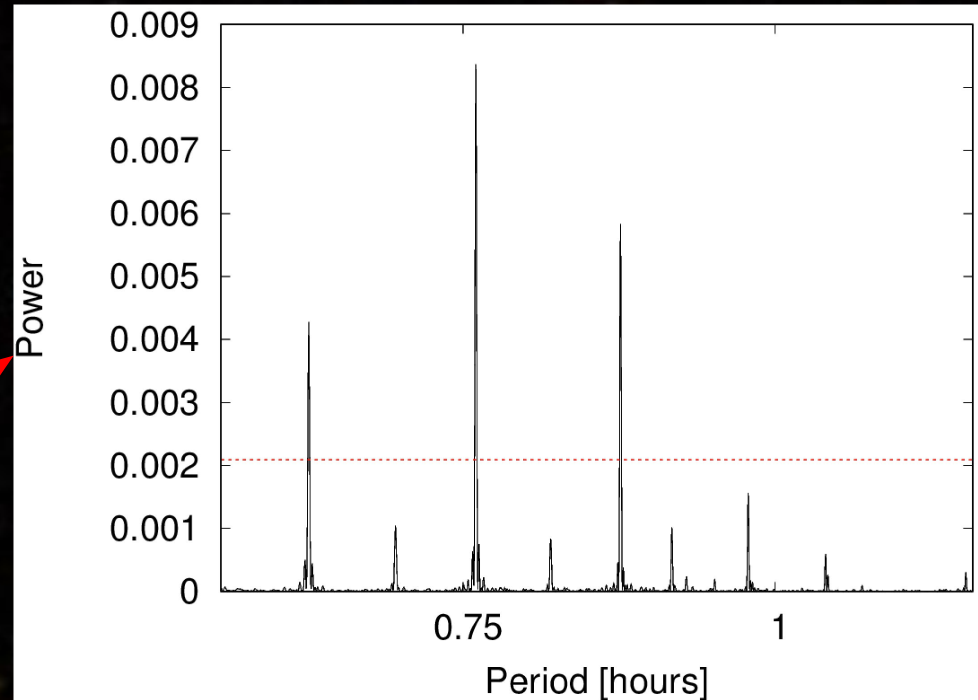
Previous data: SuperWASP

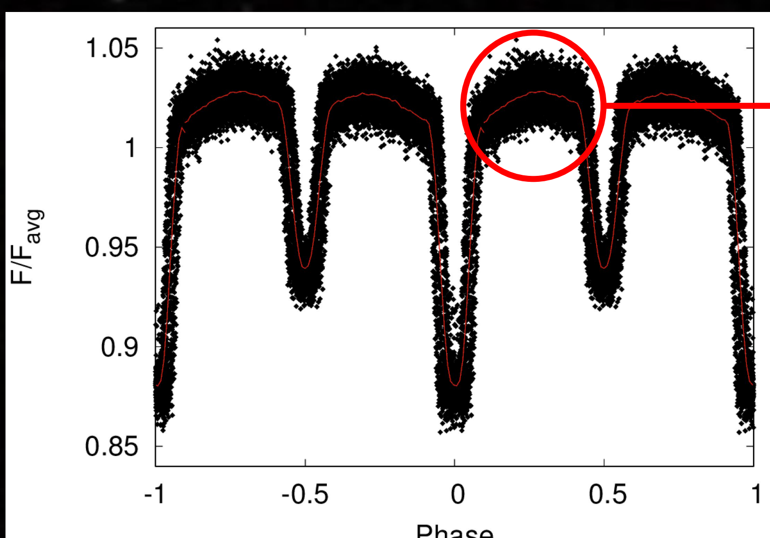
Maxted et al. 2014

MNRAS, 2014, 437, 1681

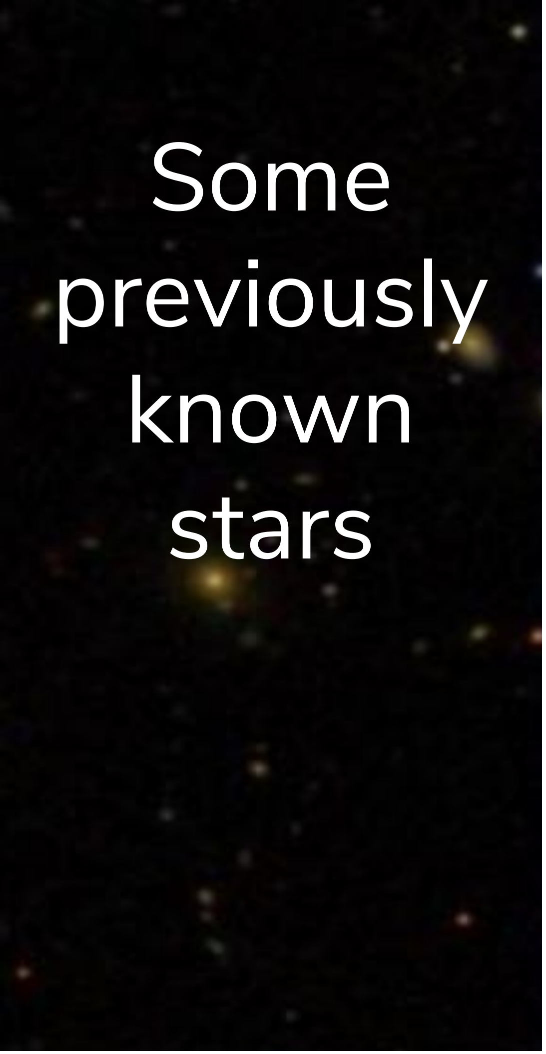
1SWASP J232812.74-395523.3 (EL CVn-type)



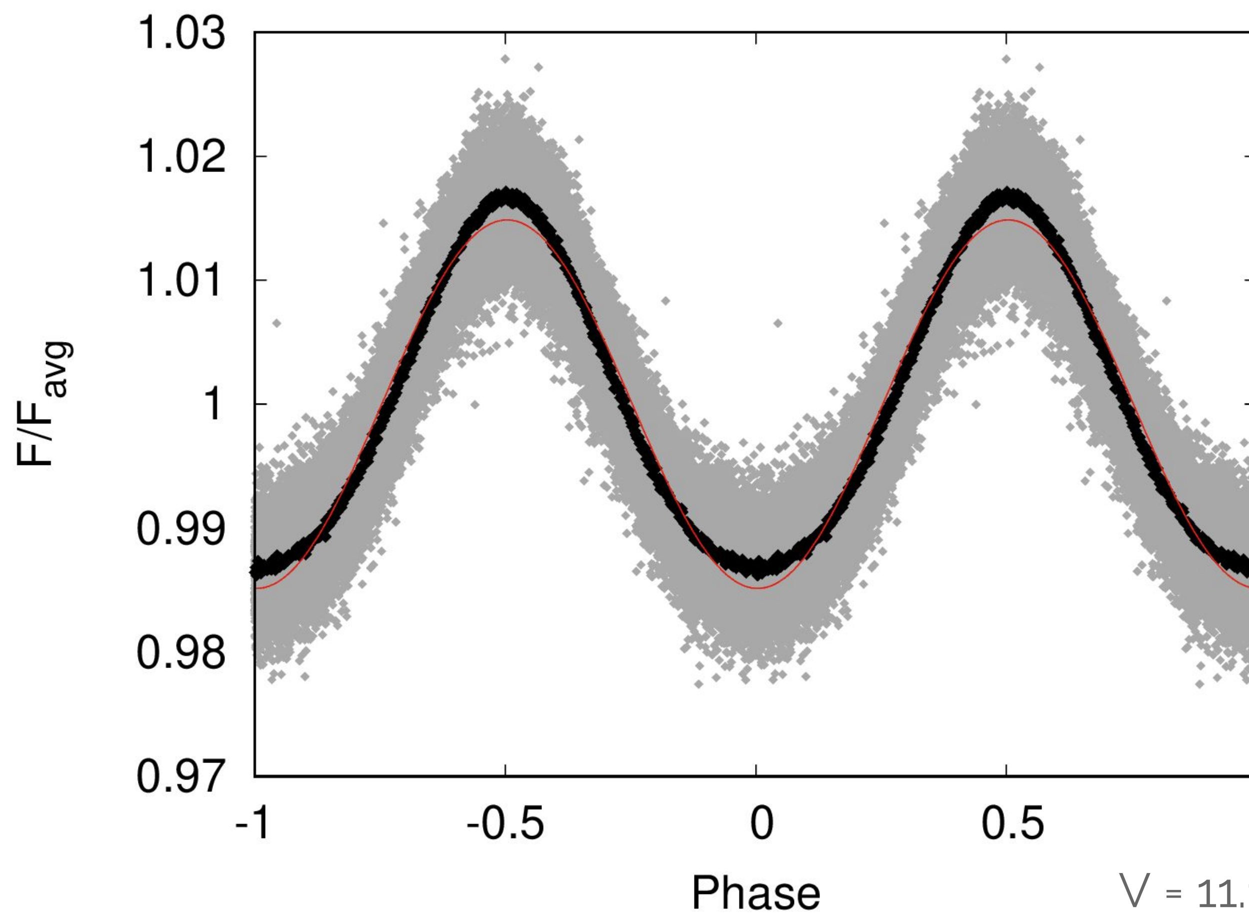




Pulsations!

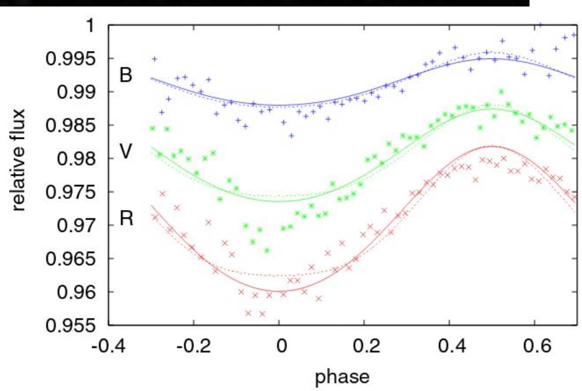


CPD-64°481 (reflection effect)



V = 11.17

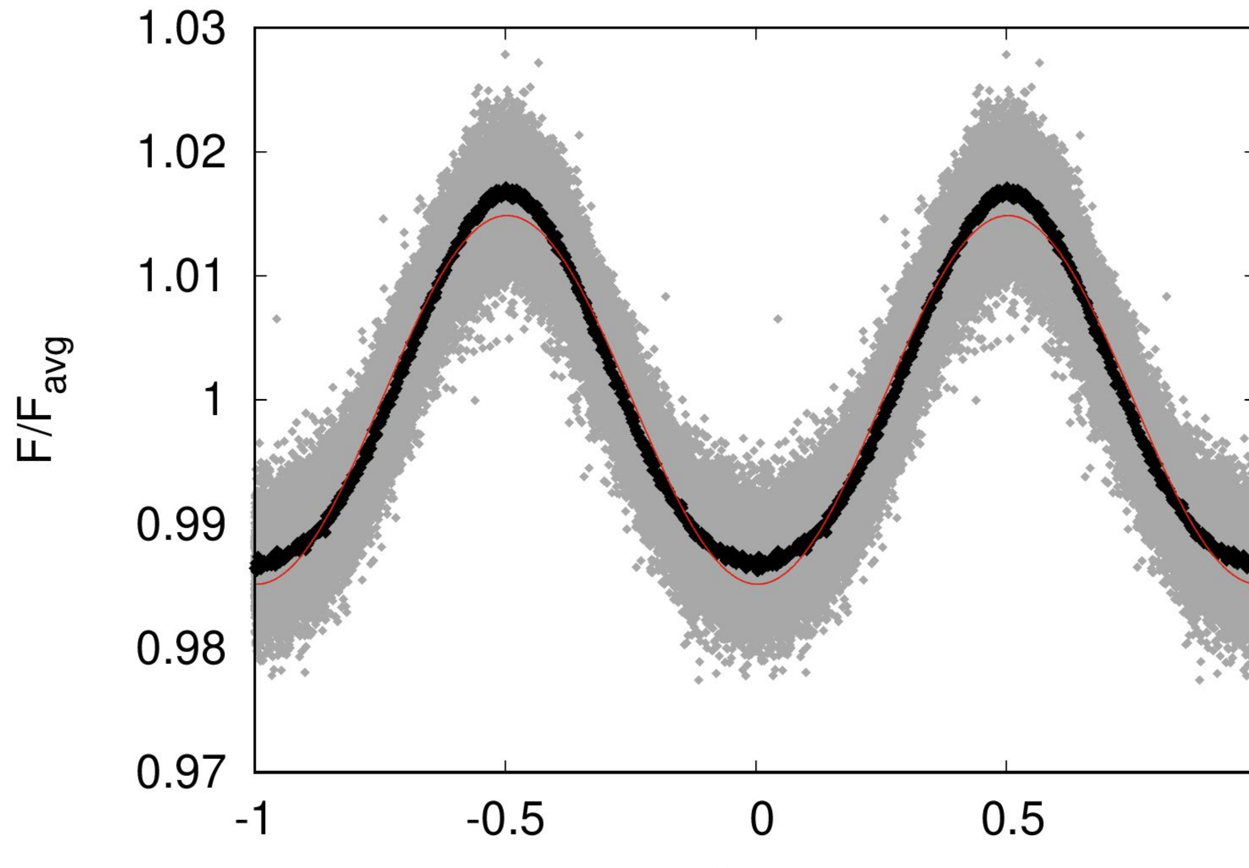
sdB (0.47 $M_\odot$) + candidate brown dwarf



Previous data: SAAO
Sahaffenroth et al. 2014
A&A, 2014, 570, A70

Some previously known stars

CPD-64°481 (reflection effect)



It seems that with TESS data we can **constrain the inclination**!
→ Companion could be consistent with low-mass MS star (Schaffenroth et al. in prep.)

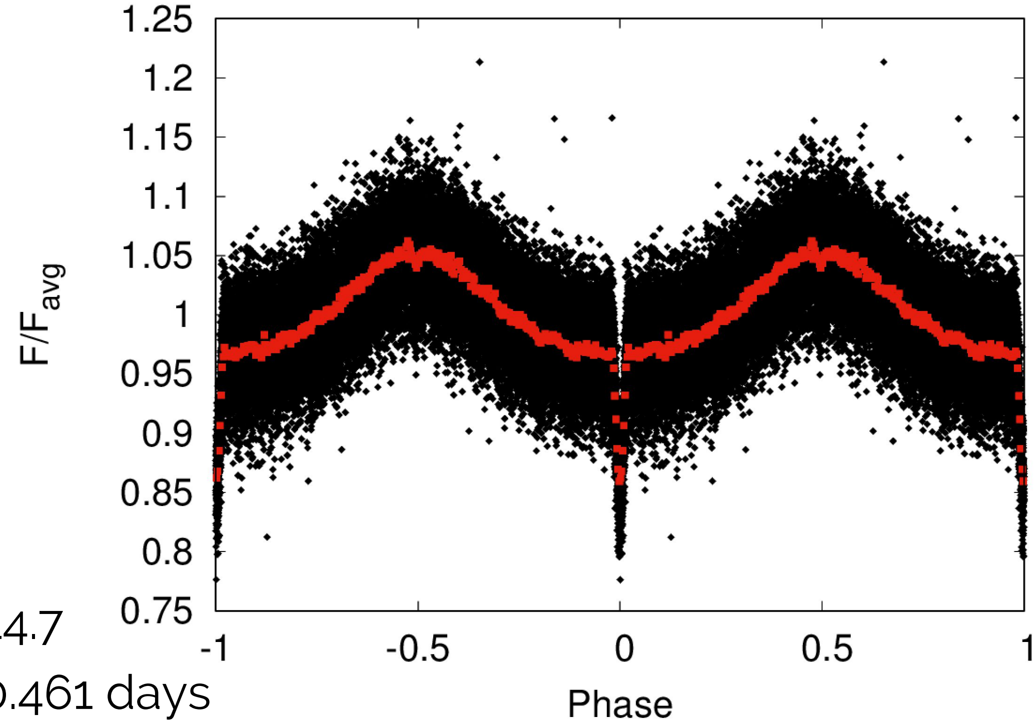
V = 11.17

sdB (0.46 $M_\odot$) + ~~candidate brown dwarf~~

Some TESS discoveries (so far)

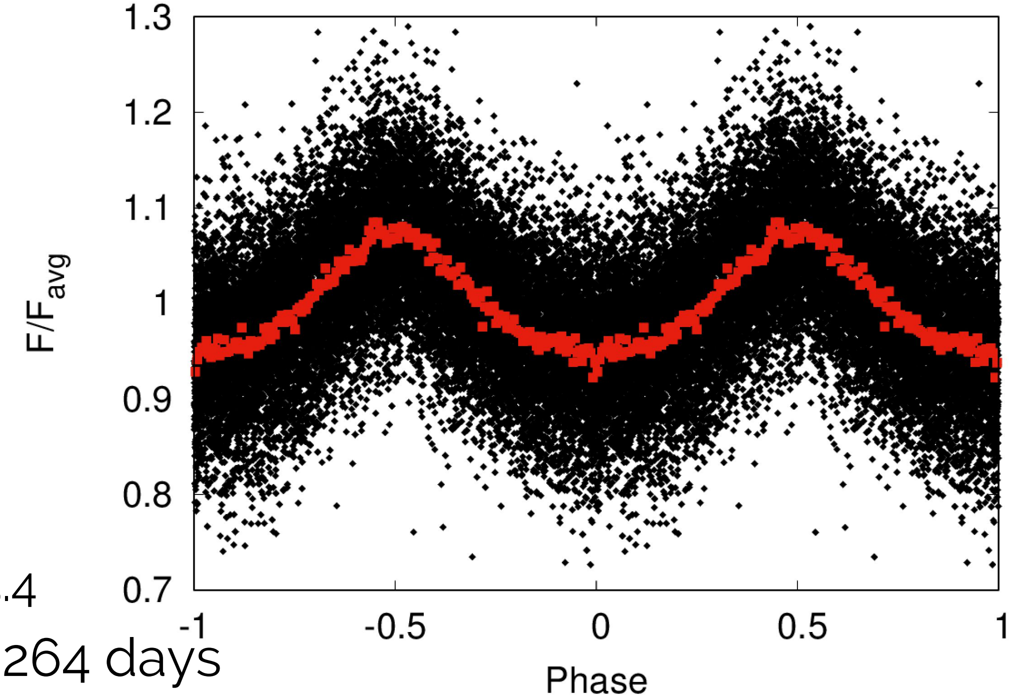
Two new HW Vir systems

Four other eclipsing stars



V = 14.7

P = 0.461 days

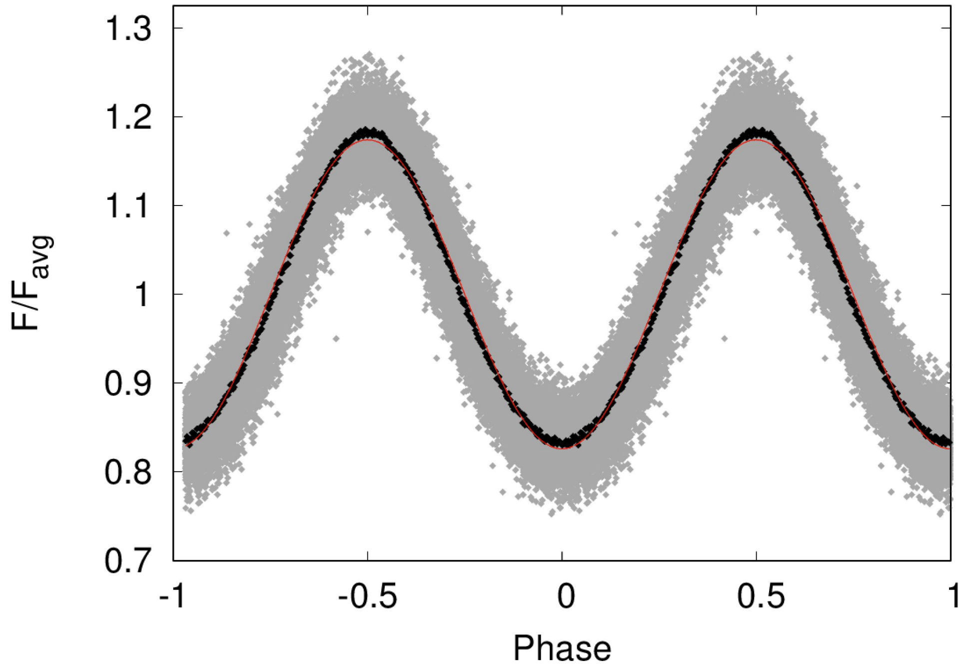


G = 15.4

P = 0.264 days

Some TESS discoveries (so far)

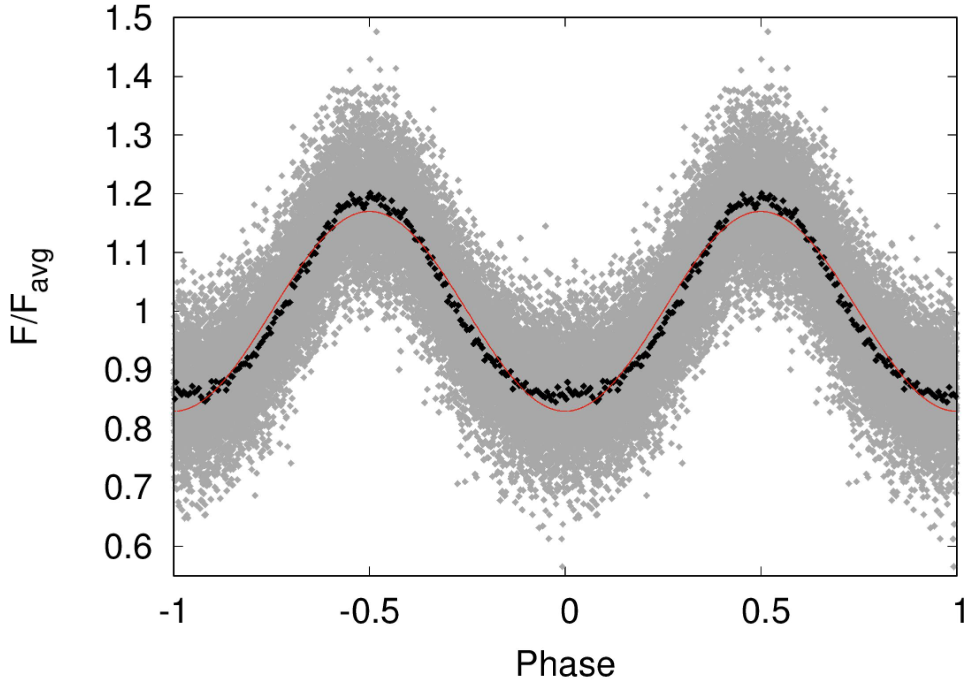
Eleven new reflection systems



Primary = sdO

V = 14.2

P = 0.424 days



Primary = DA

V = 15.9

P = 0.280 days

Some TESS discoveries (so far)

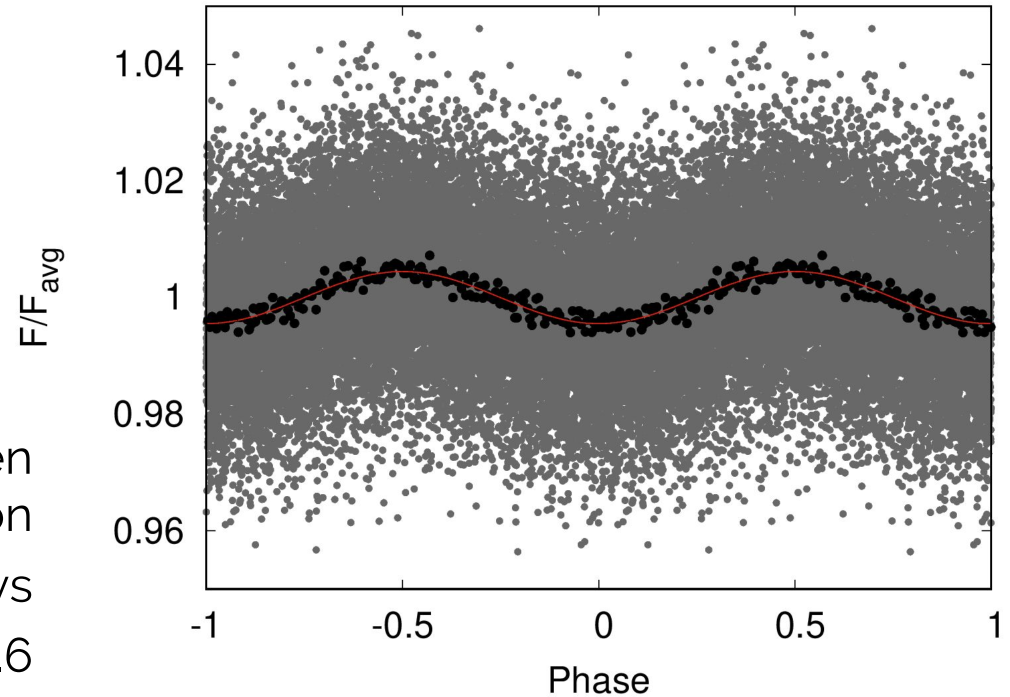
85 objects showing sinusoidal variations

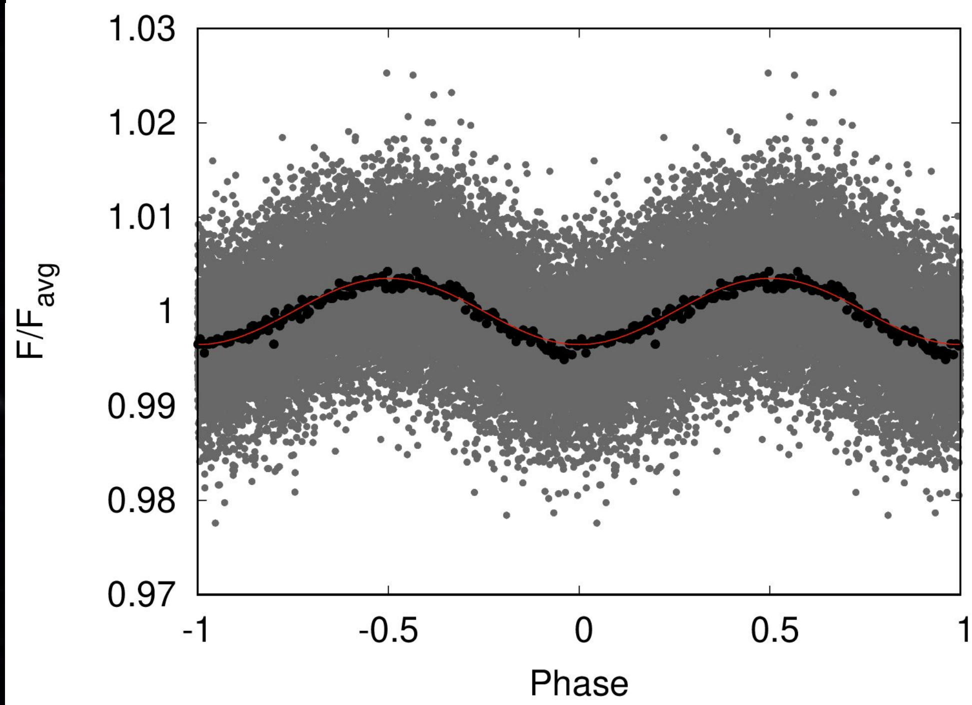
(Likely ellipsoidal systems)

sdB + yet unseen companion

P = 0.064 days

G = 13.6





DA+dM

P = 6.3 days

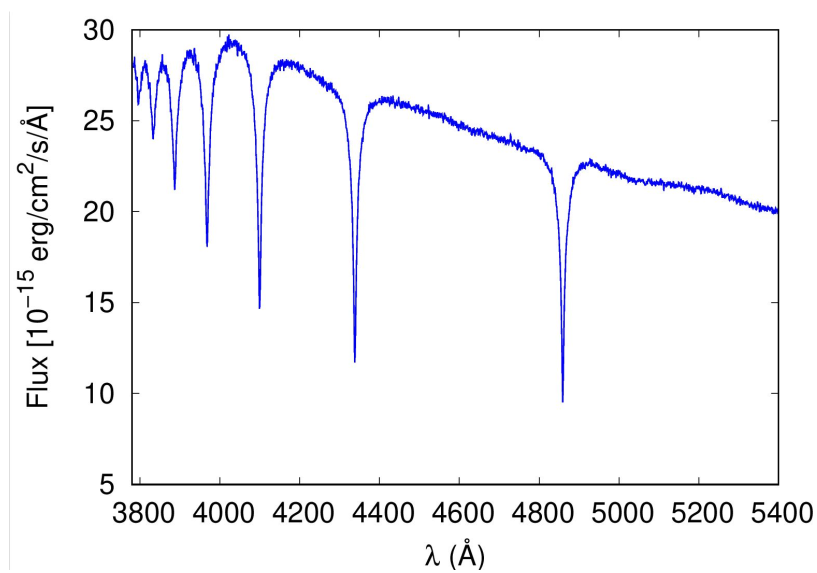
G = 13.7

Required follow-up

- SPECTRAL CONFIRMATION

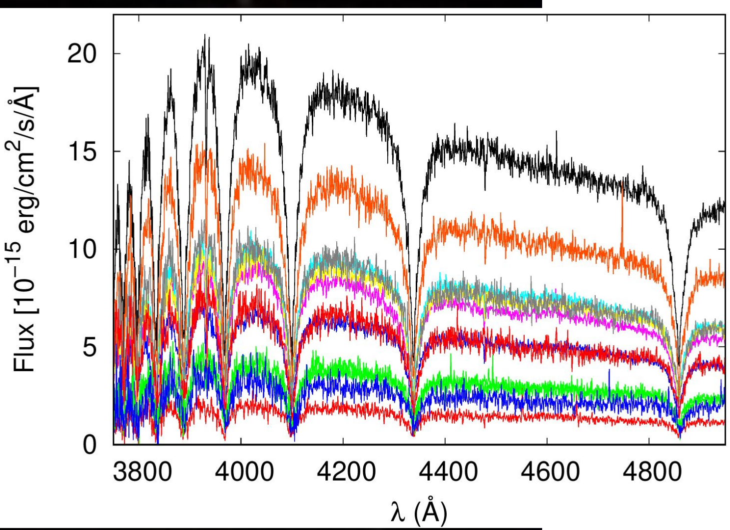
(Many objects were selected based on photometry only!)

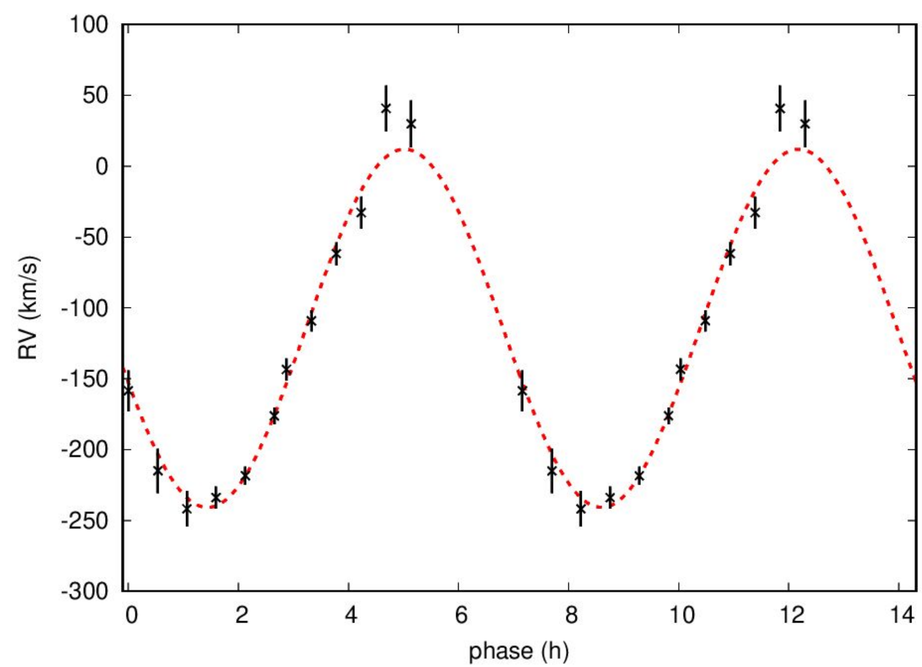
  - Low/intermediate resolution spectra (R ~ 1000-5000)
  - Optical and/or near-IR (Balmer lines) (to identify the companion)
  - S/N ≳ 5 for identification
  - S/N ≳ 30 for spectral fitting



Required follow-up

- RADIAL VELOCITY CURVES
  (Required for full-characterization of photometrically variable binaries)
  - Intermediate to high resolution spectra (R > 5000)
  - Optical (Balmer lines, He lines)
  - S/N ≳ 15



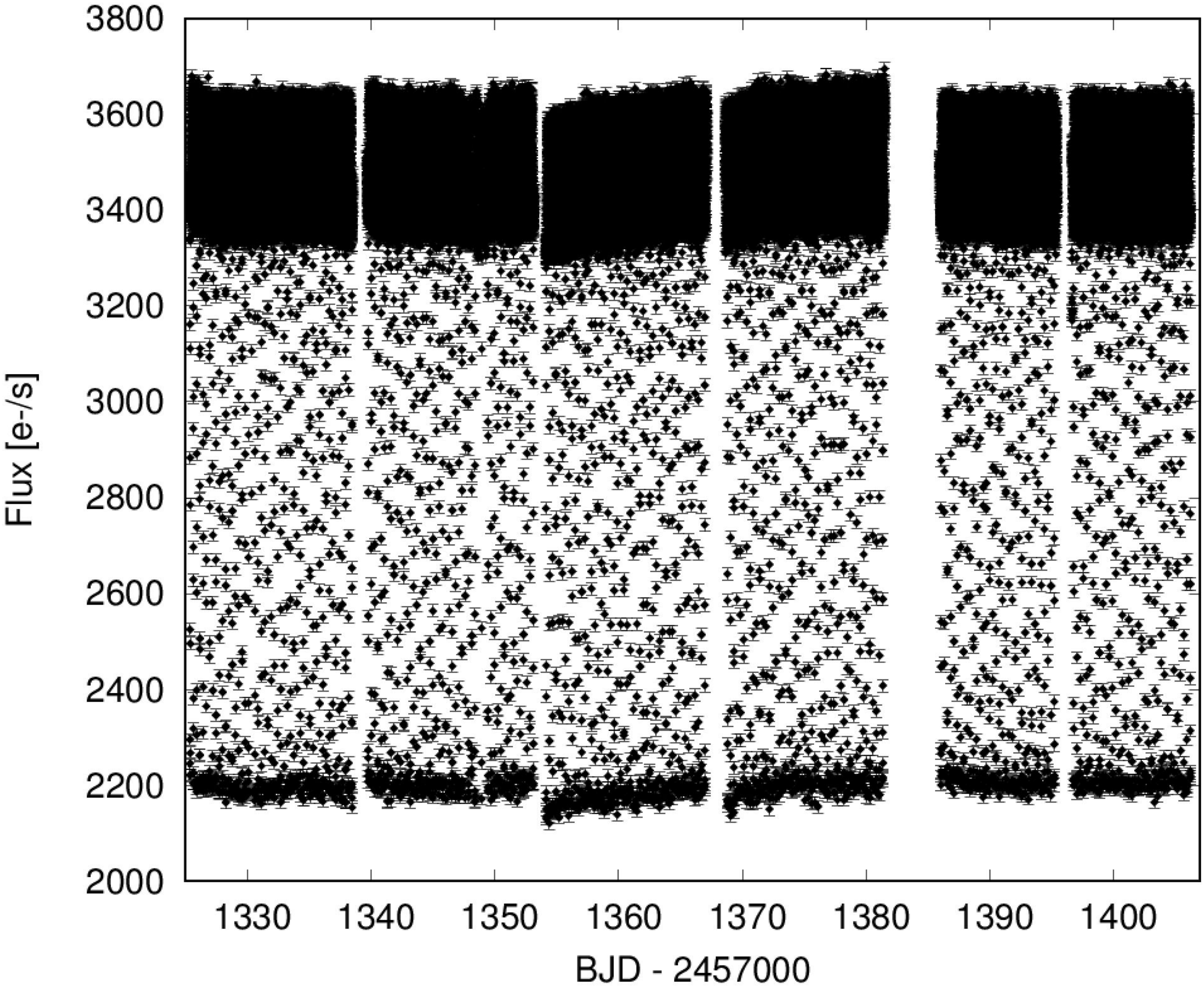


Conclusions

- TESS will vastly improve our capacity of characterizing compact binary systems
  - [Almost] all-sky! Ideal for population studies.
- Ground-based follow-up is required to take full advantage of the data
- Follow-up effort is suitable for 2-4 m class telescopes; spectra are the main requirement

Thank you!

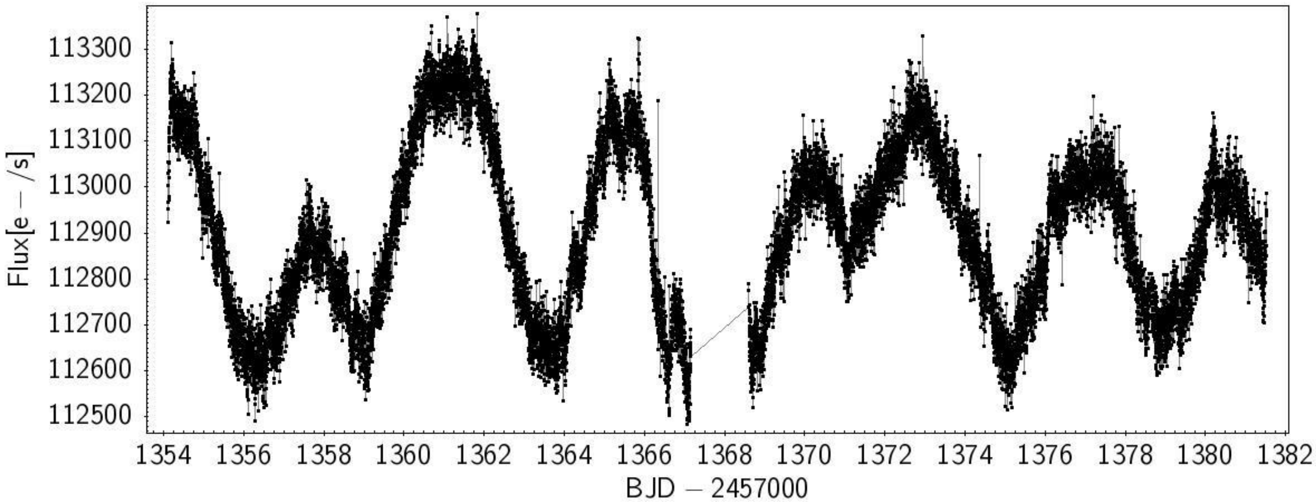
pelisoli@astro.physik.uni-potsdam.de



3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
Flux [e-/s]
1330
1340
1350
1360
1370
1380
1390
1400
BJD - 2457000

Some TESS discoveries (so far)

Variation from the companion



DA, variation from a K type companion

V = 8.4