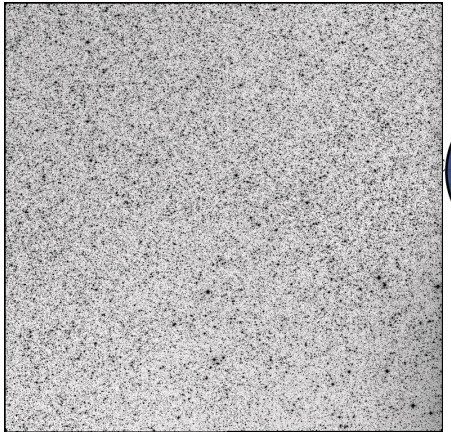
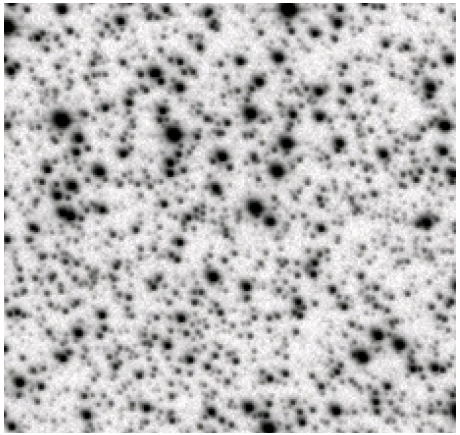
Galactic science working group update

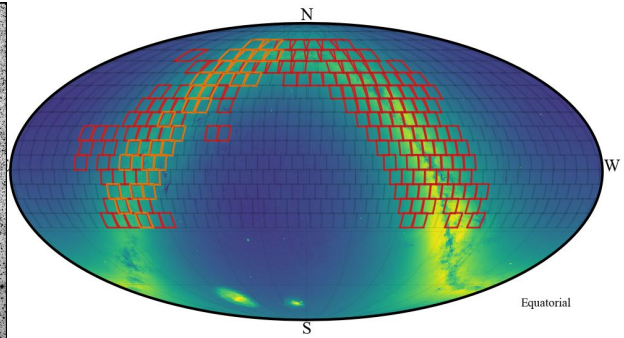
Jan van Roestel, Galactic Science WG

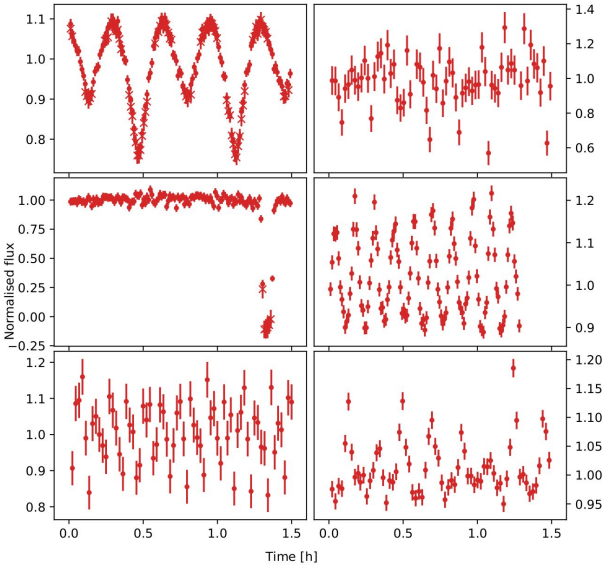
Stellar science with ZTF:

- White dwarfs
  - Double degenerates
  - Rapid rotators
  - Eclipsing population
  - Planetesimals
- Cataclysmic variables
- Microlensing
- X-ray binaries
  - Fermi counterparts
- Young Stellar objects
- RR lyrae
- Classification of all variables
- Deep-drilling observations
- ...









~~Galactic science working group update~~

Jan van Roestel, Postdoc at Caltech

Dark companions of white dwarfs

Exploring the population of compact binaries with the Zwicky Transient Facility

Jan van Roestel, Postdoc at Caltech

Collaborators; Thomas Kupfer, Kevin Burdge, Tom Prince,
Michael Coughlin, Matthew Graham, Dima Duev, Ashish Mahabal
& The ZTF team

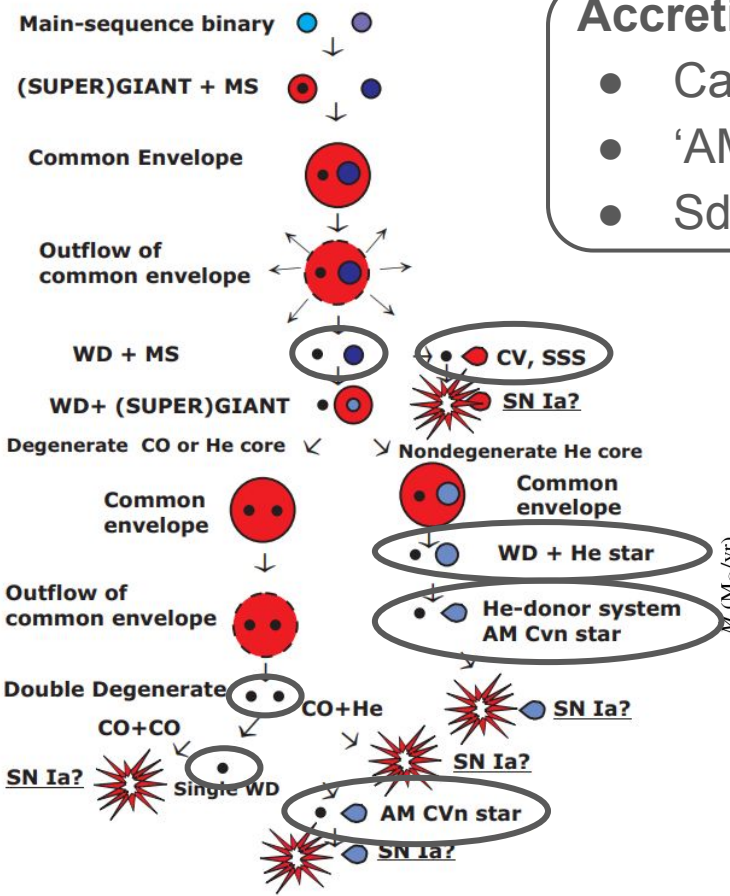
Formation channels and overview of PCEBs

Accreting systems

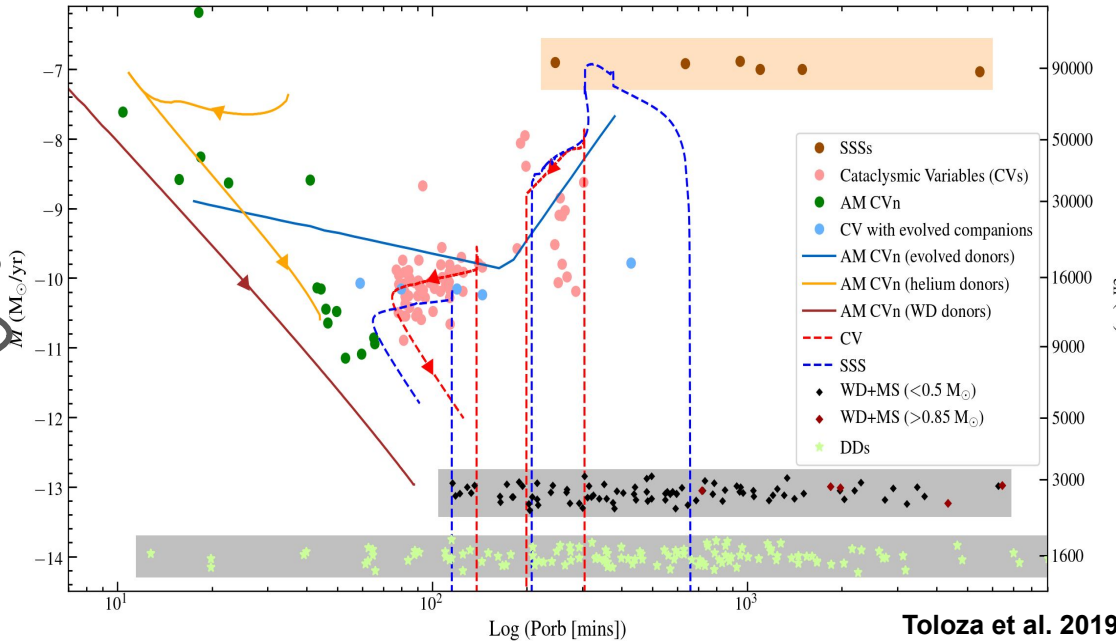
- Cataclysmic Variables
- ‘AM CVn’-systems
- SdB-WD

Detached

- WD - WD
- WD - dM/BD binaries

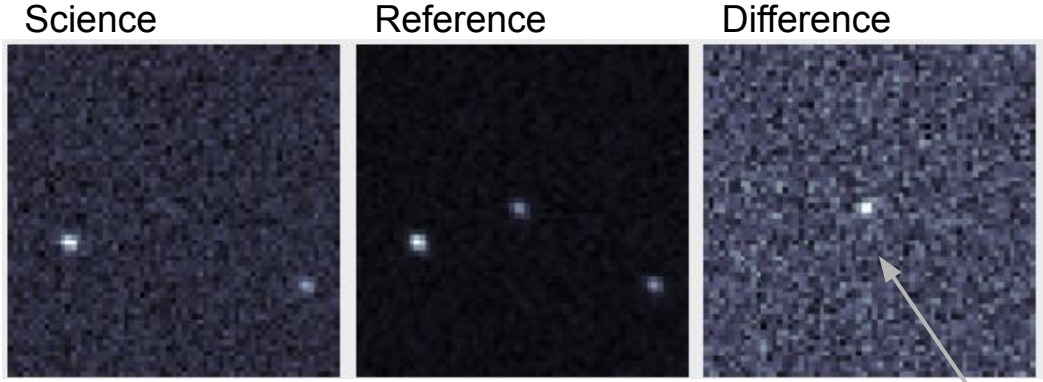


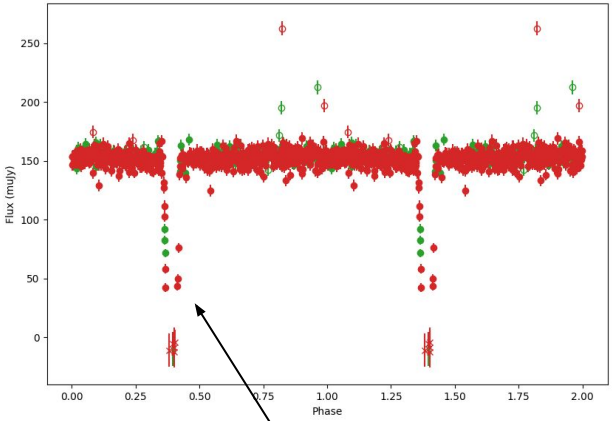
Postnov & Yungelson 2014

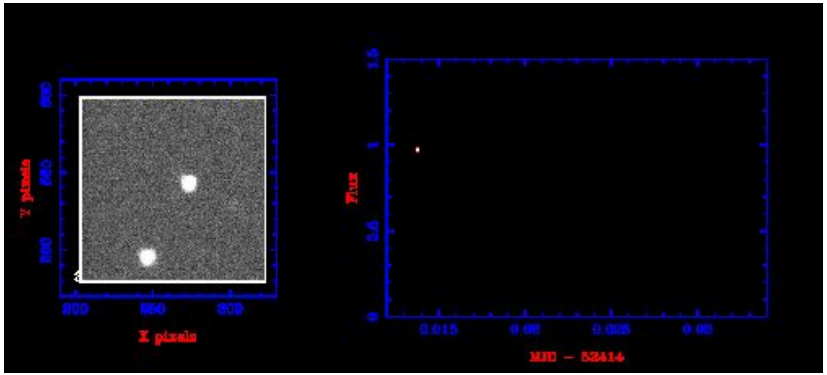


Toloza et al. 2019

A search for dark companions of white dwarfs

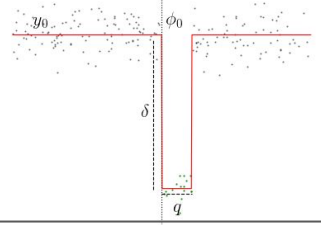






‘Real-Bogus’ vetting
Neural networks
Duev et al. 2019

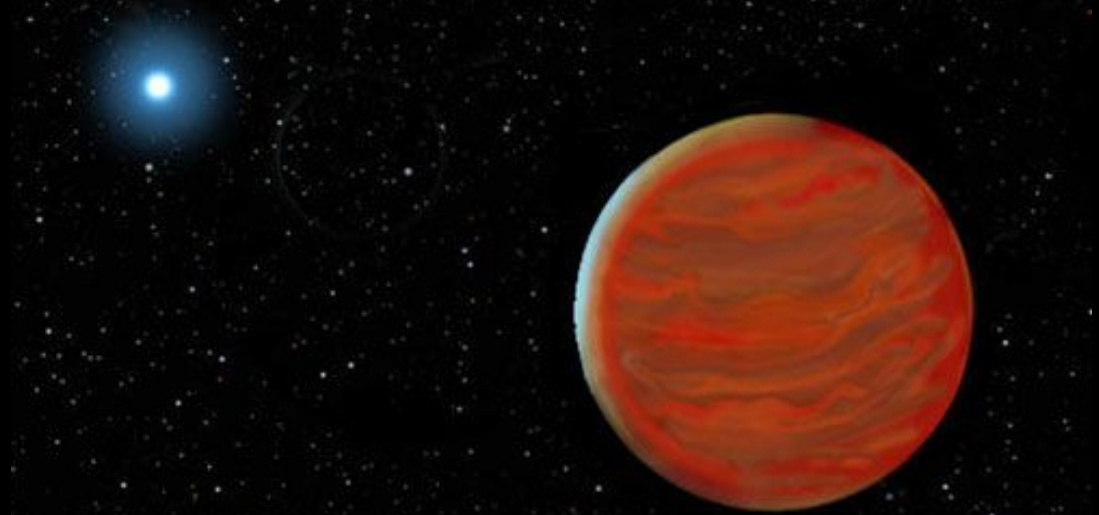
Boxed-least-squares
(Kovacs 2002)



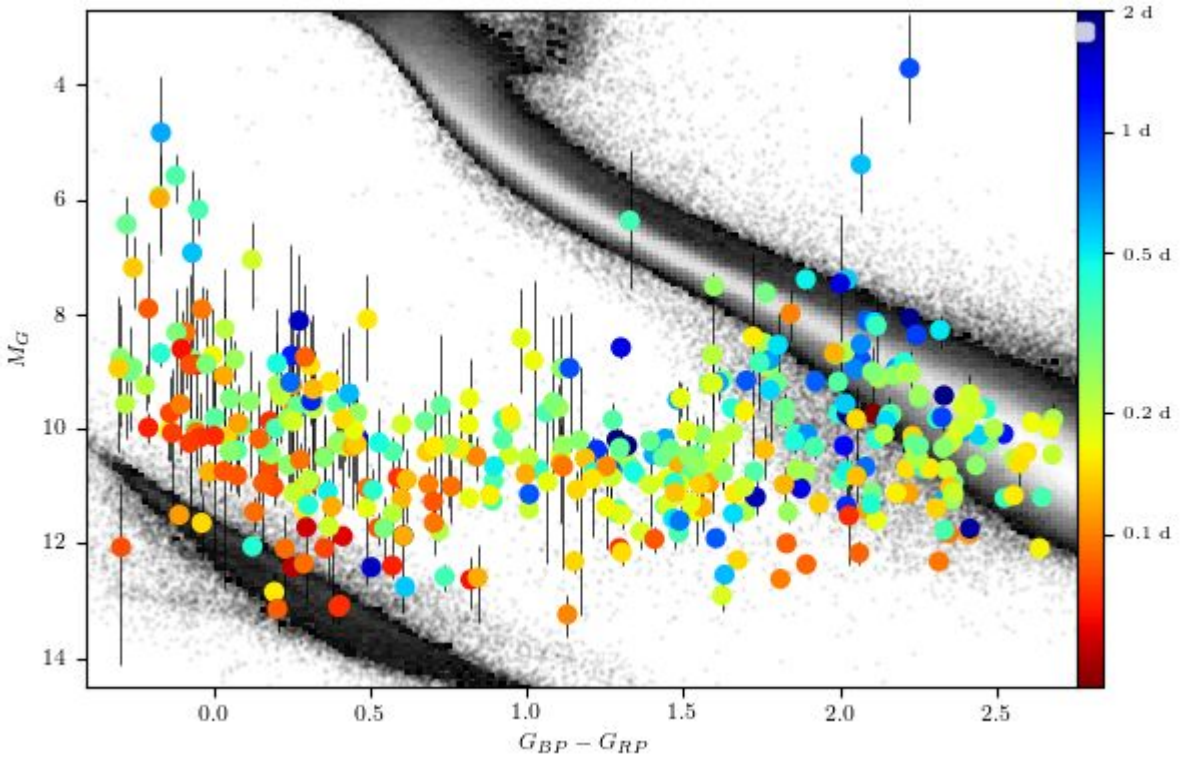
Credit: ULTRACAM

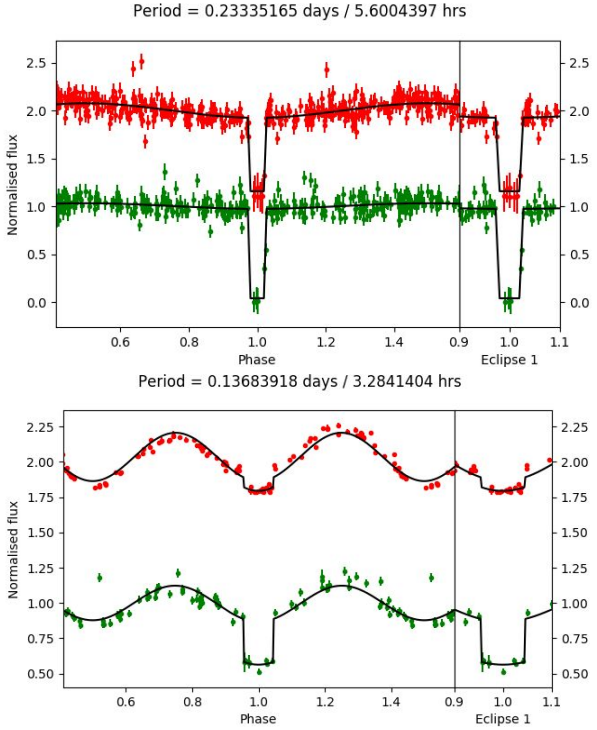
White dwarf with low-mass companions

- Red dwarfs
- Brown dwarfs
- Giant planets

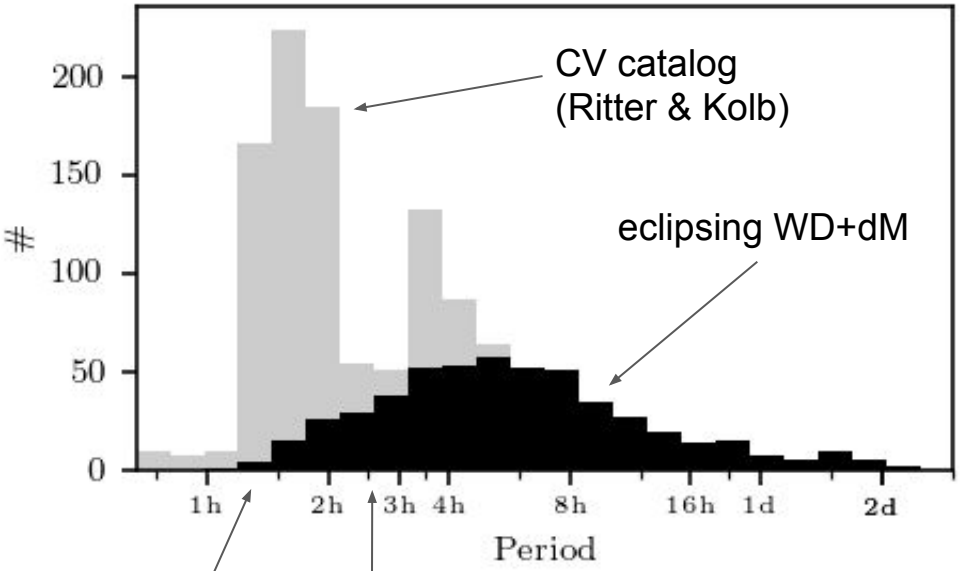


500+ eclipsing **WD+RD binaries**



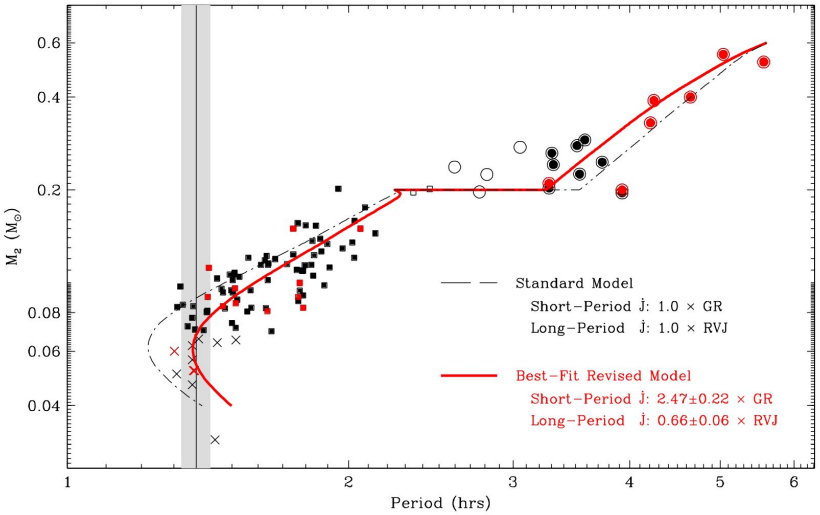


The period distribution: no period ‘spike’



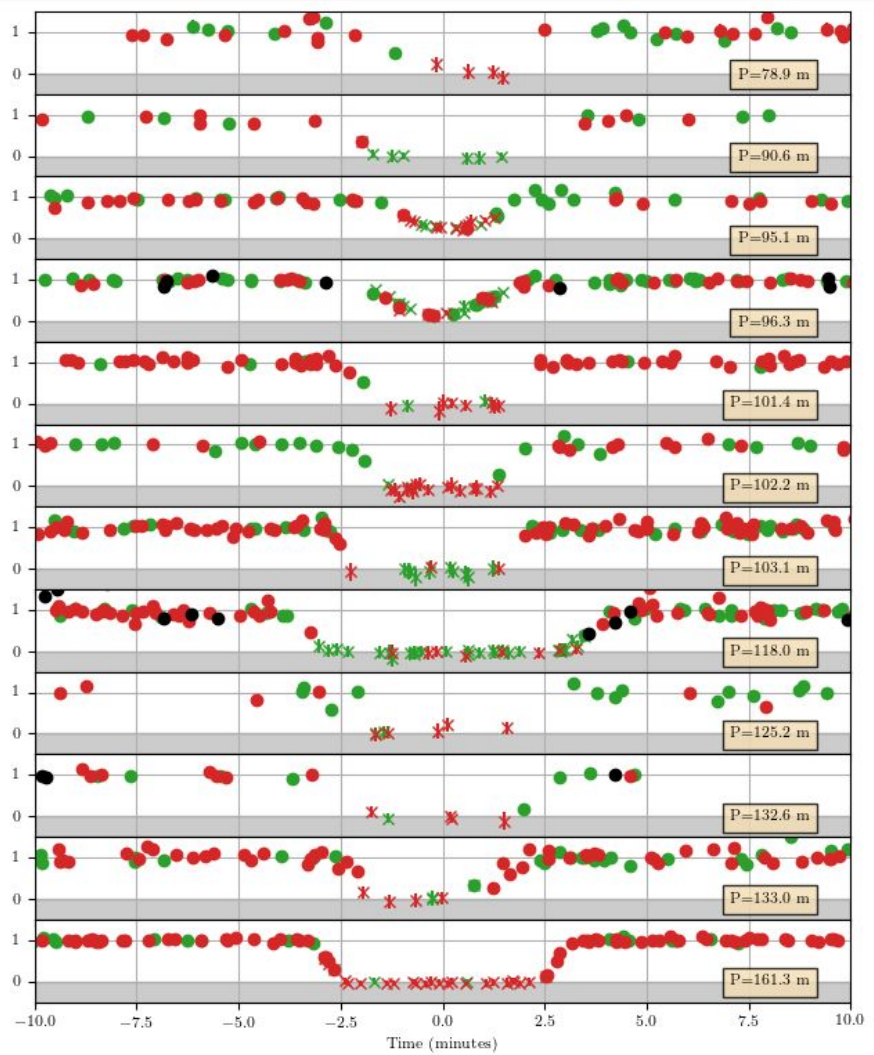
No pile-up of dead CVs?

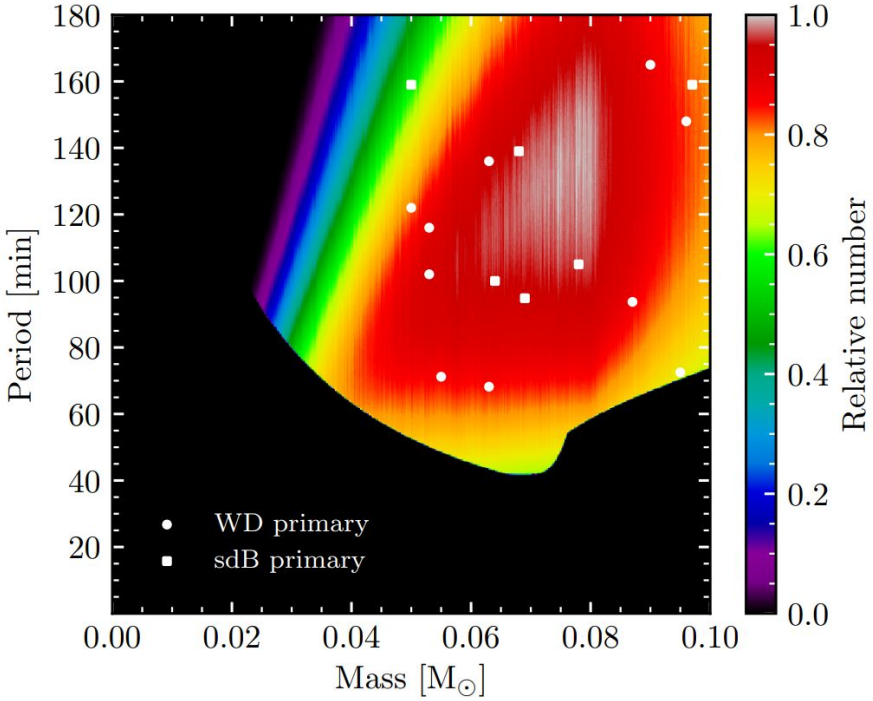
Predicted: factor 4-13 excess of detached CVs
Davis et al. 2008



CV evolution
Knigge et al. 2010

White dwarf - Brown dwarf
A test of CE evolution



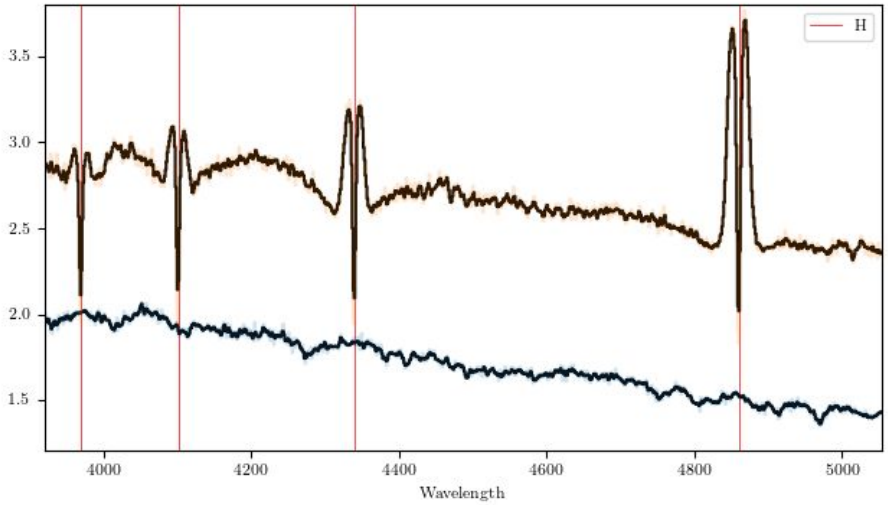


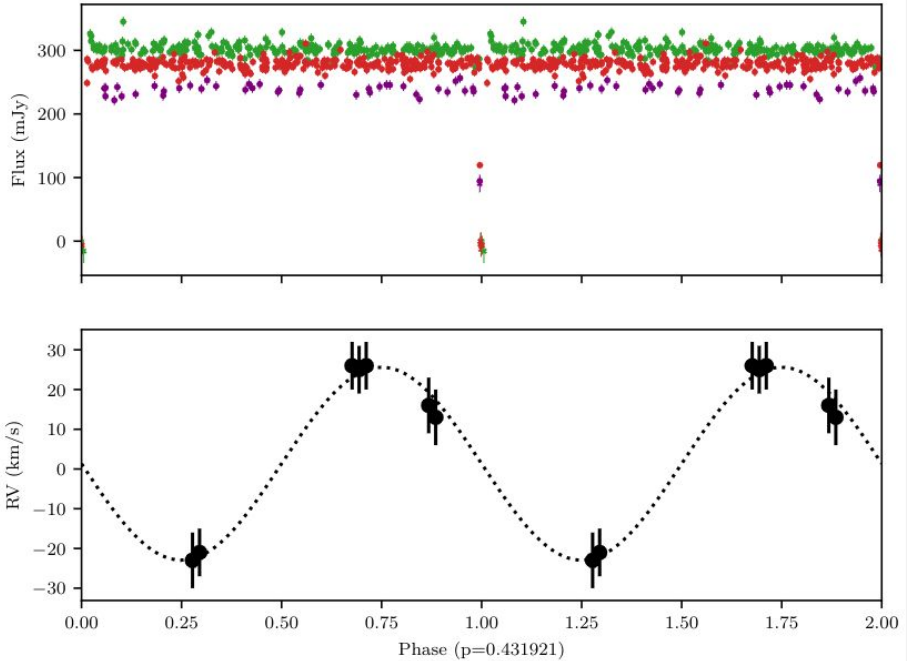
12 new WD-BD candidates

Nelson et al 2018

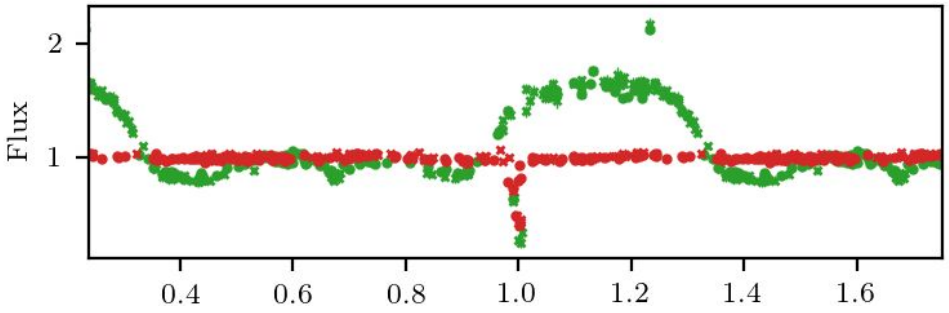
A diverse sample so far:

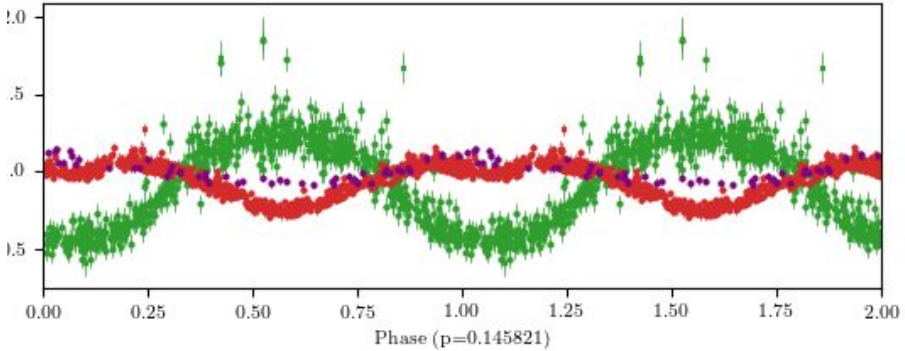
- Magnetic white dwarf + BD
- A ‘dead CV’
- Long period WD+BD

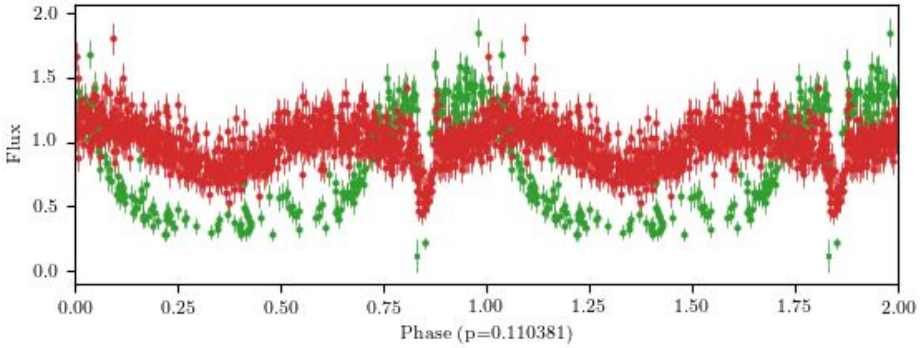


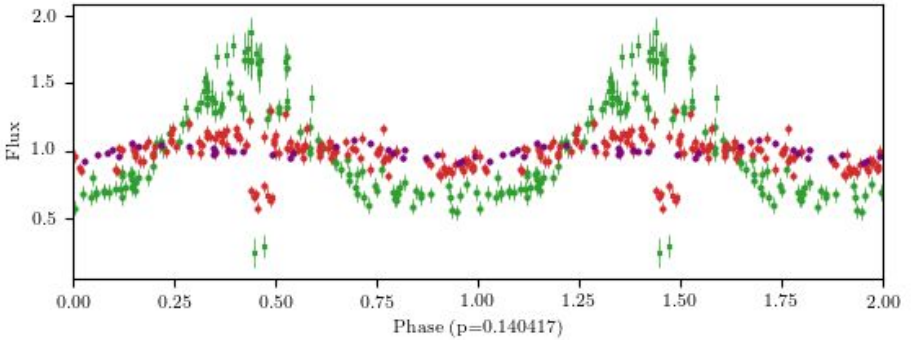


Magnetic white dwarfs in binaries

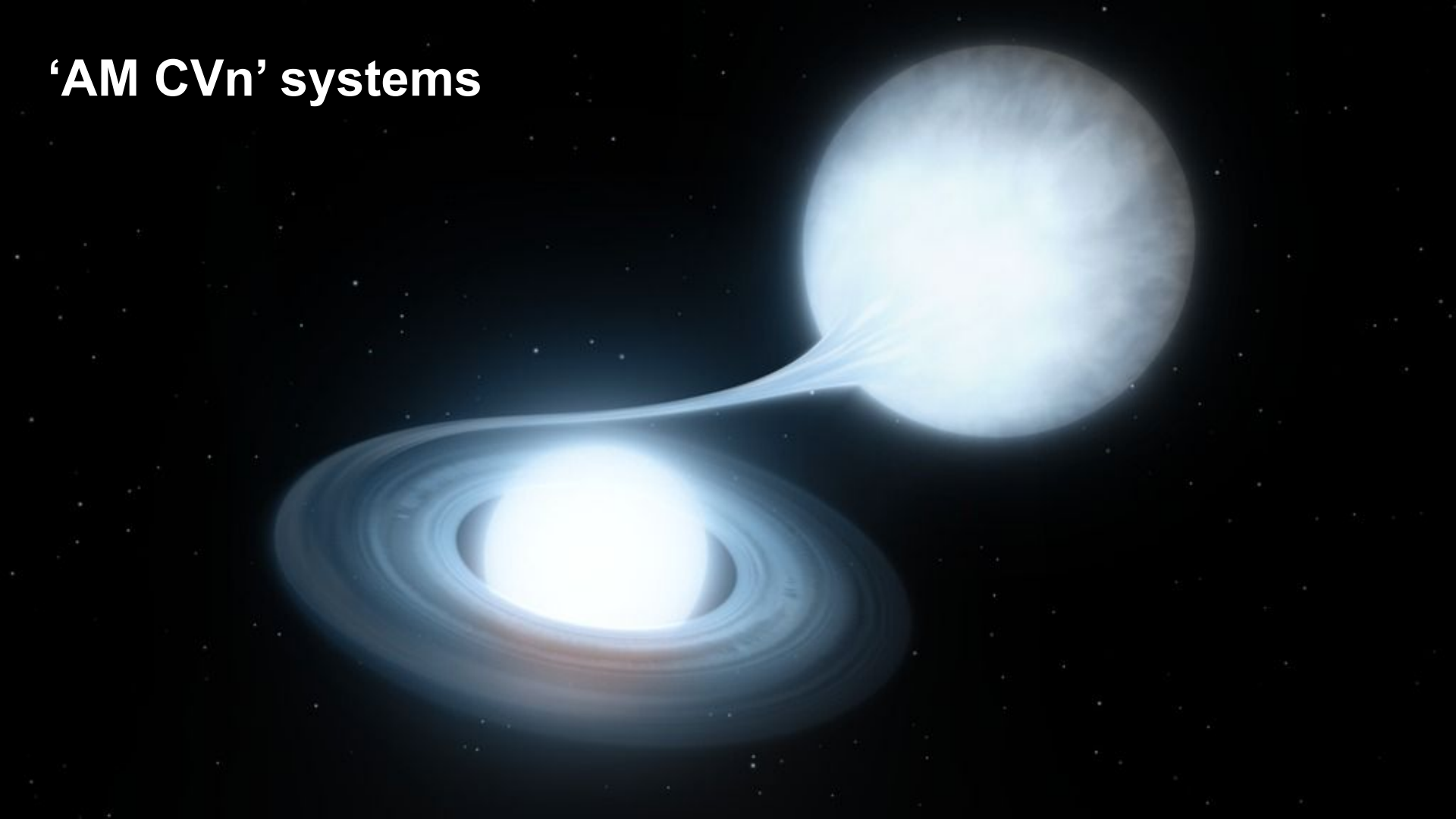




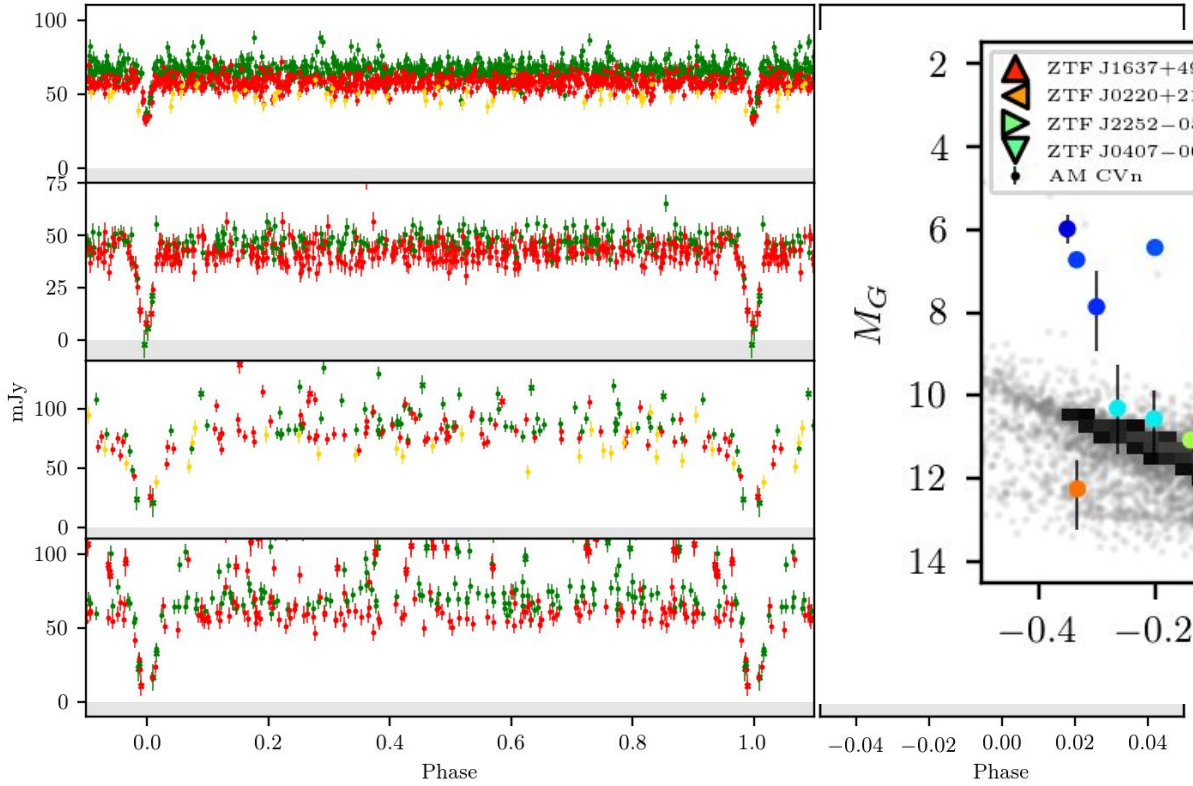


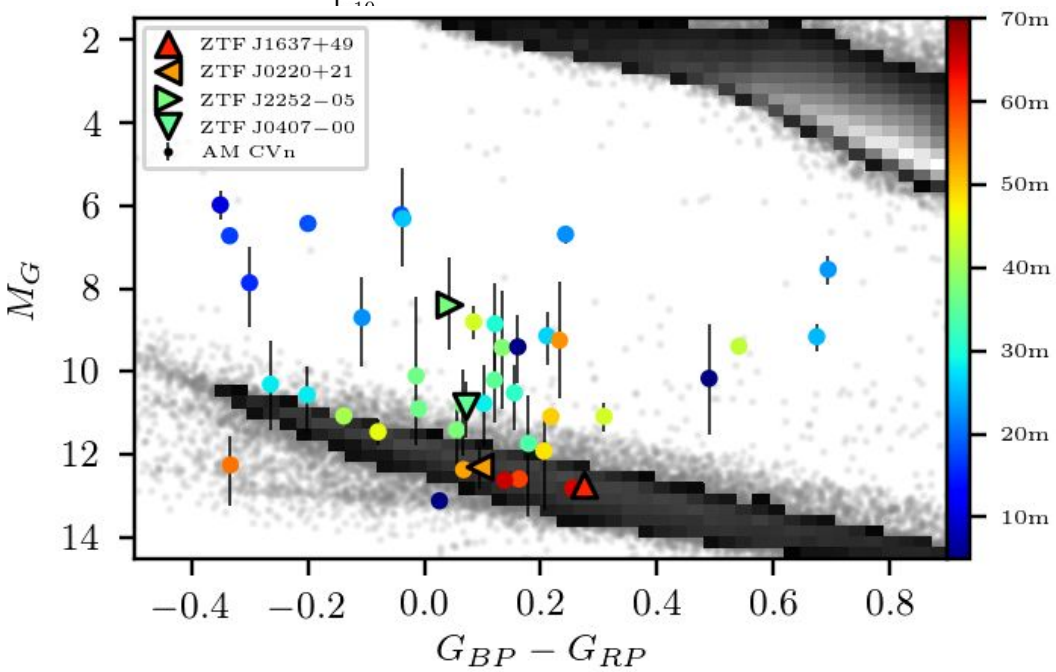


‘AM CVn’ systems



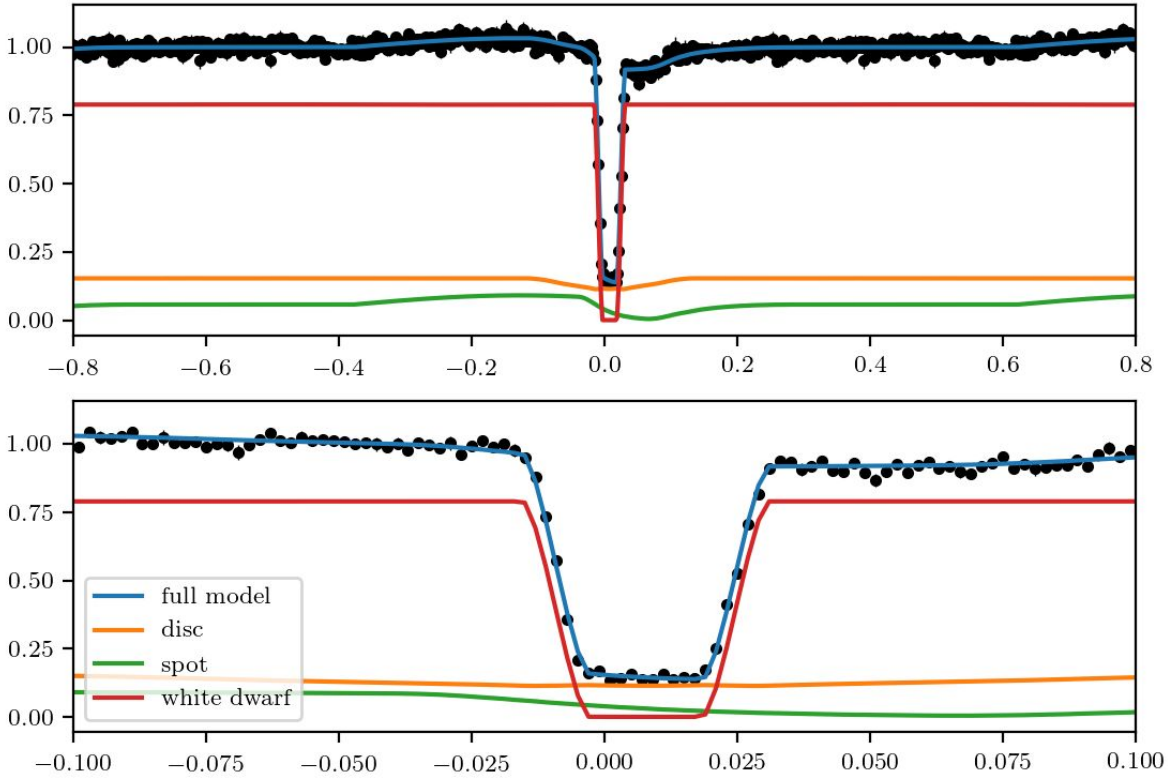
Disappearing white dwarfs: eclipsing ‘AM CVn’ binaries

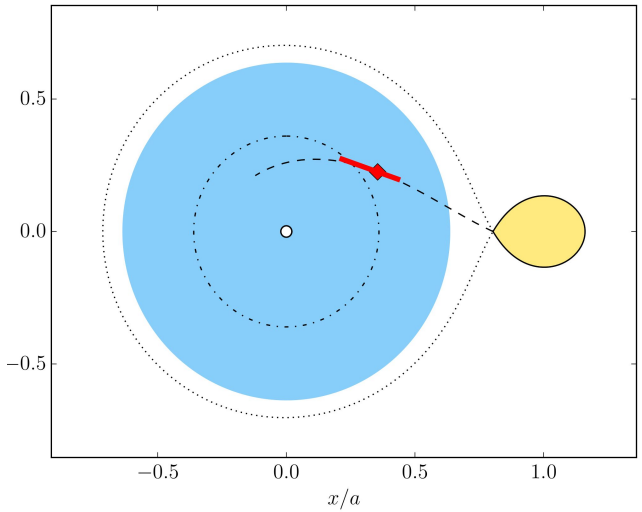




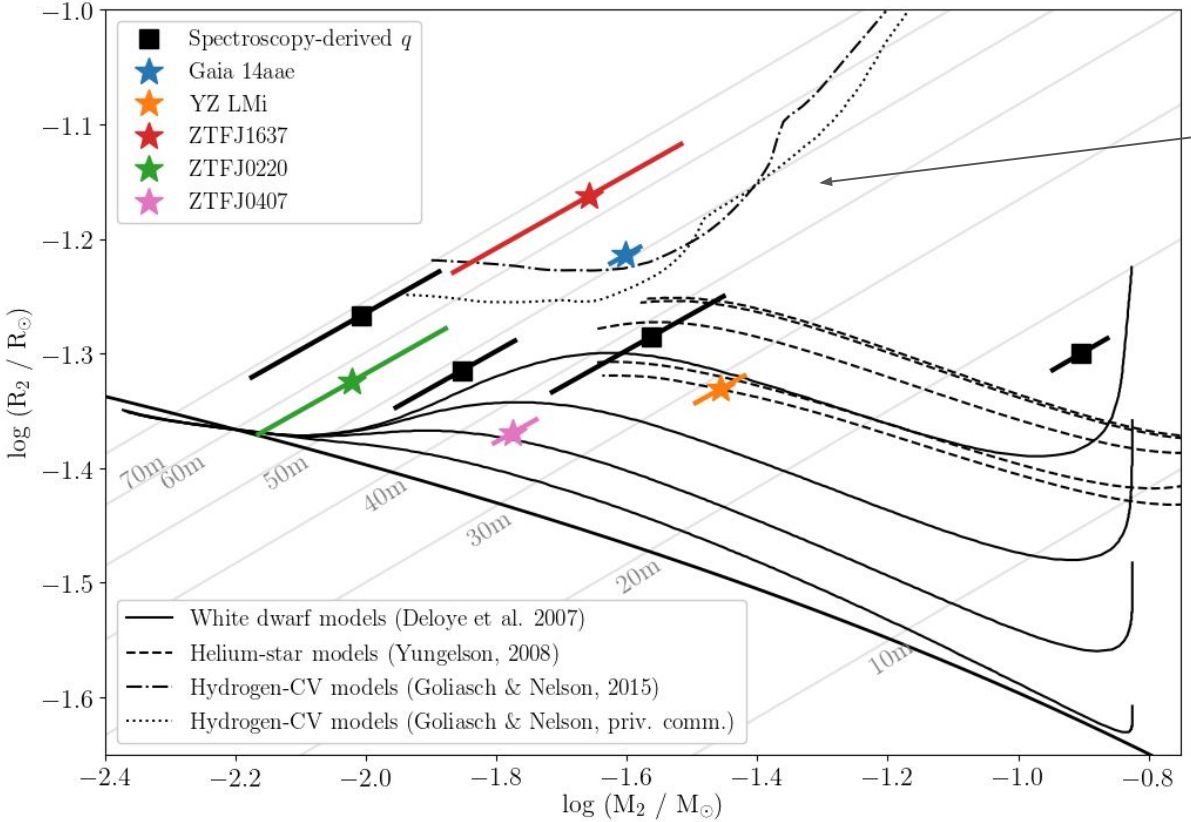
Van Roestel et al 2020, in prep

Measuring masses and radii





ZTF is solving the formation channel question:

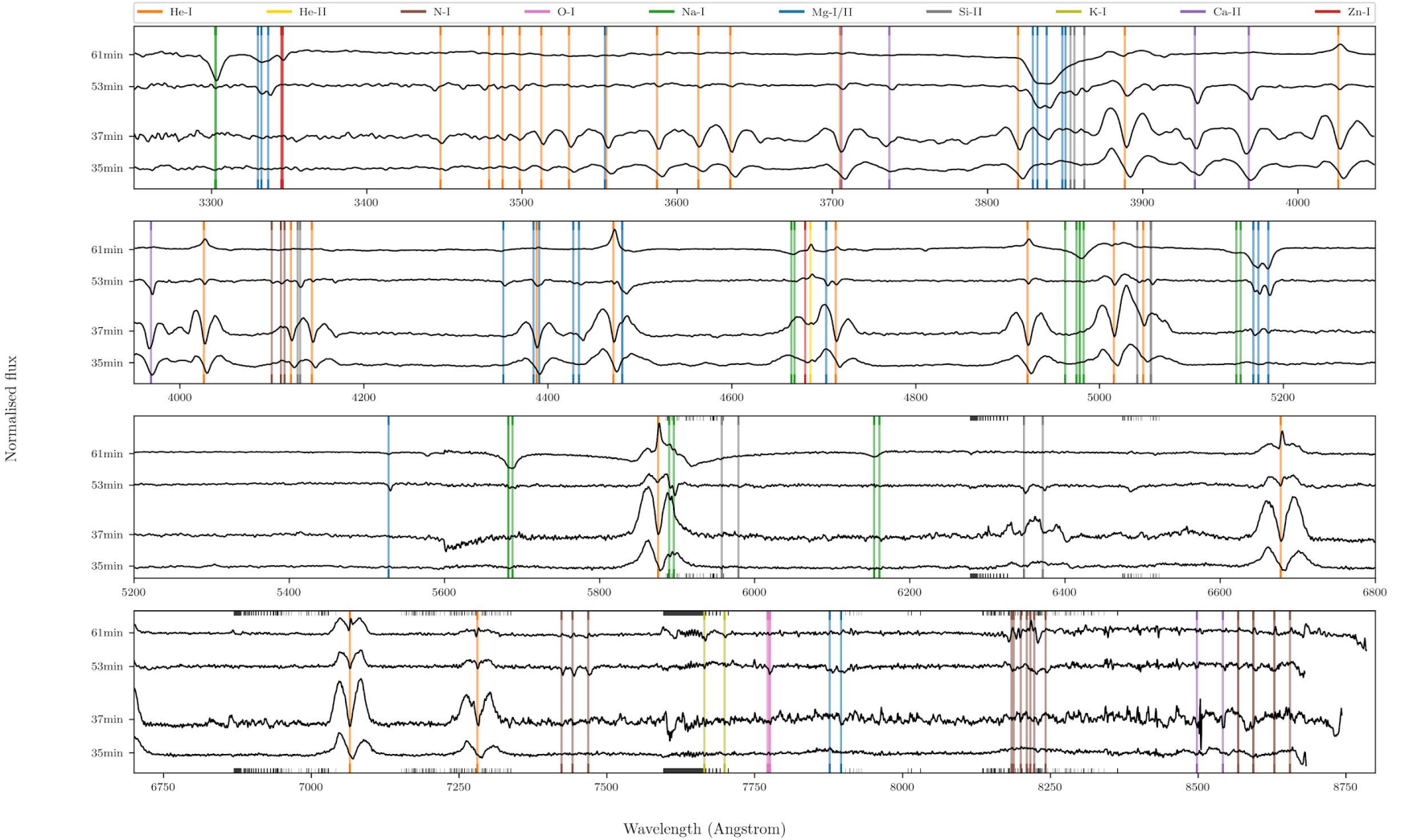


Formation channels

1) ‘Evolved CVs’ channel

2) ‘Helium star’ channel

3) ‘white dwarf’ channel


He-I
He-II
N-I
O-I
Na-I
Mg-I/II
Si-II
K-I
Ca-II
Zn-I
61min
53min
37min
35min
3300
3400
3500
3600
3700
3800
3900
4000
4000
4200
4400
4600
4800
5000
5200
5200
5400
5600
5800
6000
6200
6400
6600
6800
6750
7000
7250
7500
7750
8000
8250
8500
8750
Normalised flux
Wavelength (Angstrom)

He-I
He-II
N-I
O-I
Na-I
Mg-I/II
Si-II
K-I
Ca-II
Zn-I
61min
53min
37min
35min
3300
3400
3500
3600
3700
3800
3900
4000
4200
4400
4600
4800
5000
5200
5800
6000
6200
6400
6600
6800
sed flux

Summary

- ZTF is very good at finding deep eclipsing white dwarfs
- **Order of magnitude** increase in eclipsing **WD-RD** and **WD-BD** systems
- With **four new eclipsing AM CVn** systems, ZTF is solving the formation channel problem
- With more epochs, more discoveries are to follow

ZTF phase II