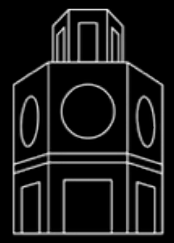

UC SANTA BARBARA
Kavli Institute for
Theoretical Physics

White Dwarfs from
Physics to Astrophysics

November 14, 2022

Merger remnants, double-faced stars and other curiosities

Ilaria Caiazzo

Burke Fellow

Caltech

- A (maybe?) moon sized white dwarf
  ~2000 km in radius
  -> ~1.35 Msun

- Rapidly rotating – 7 minute period

- Highly magnetized

-> Poster child for a double white dwarf merger remnant

Image by Giuseppe Parisi

Article

A highly magnetized and rapidly rotating white dwarf as small as the Moon

https://doi.org/10.1038/s41586-021-03615-y

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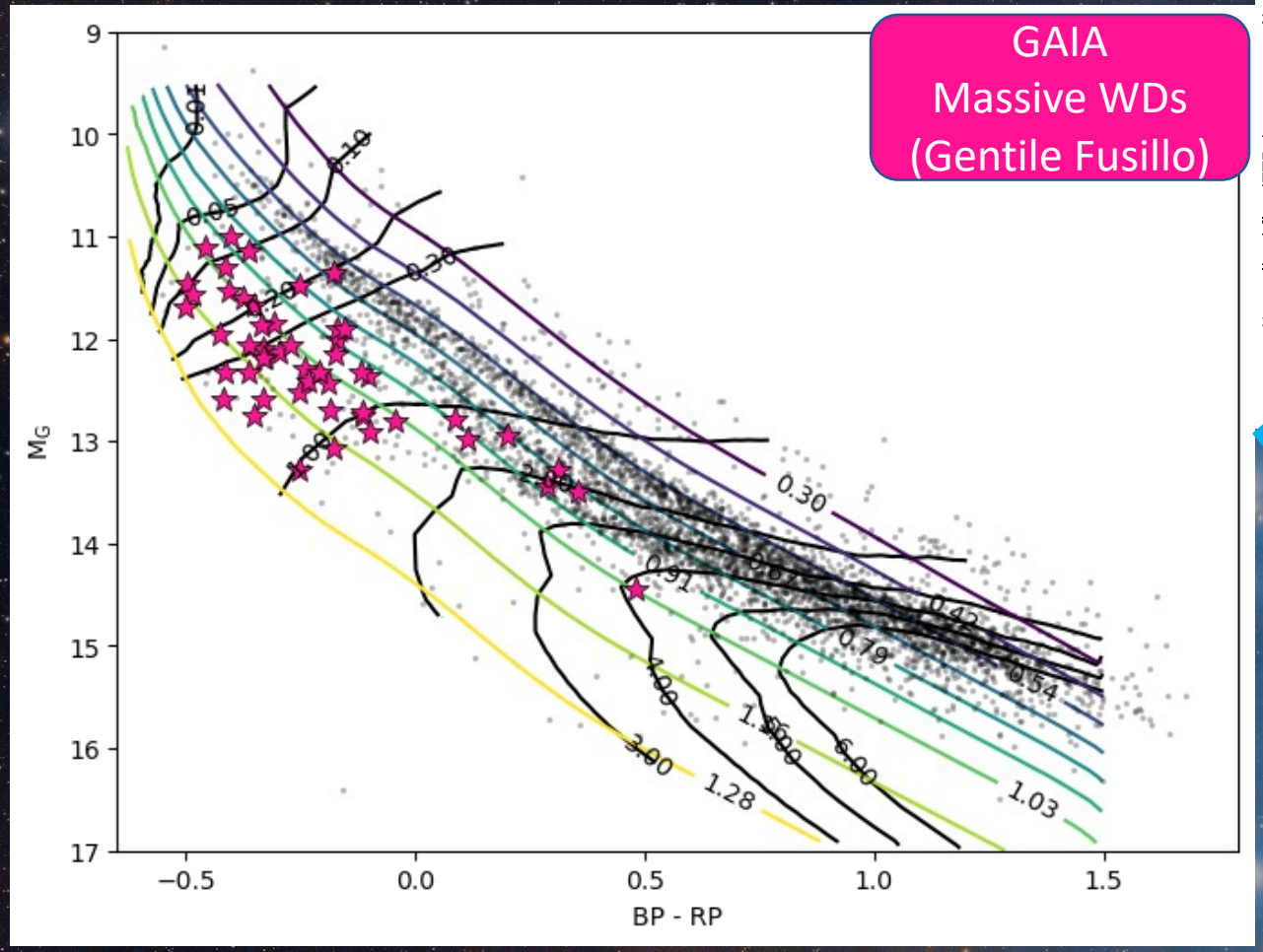
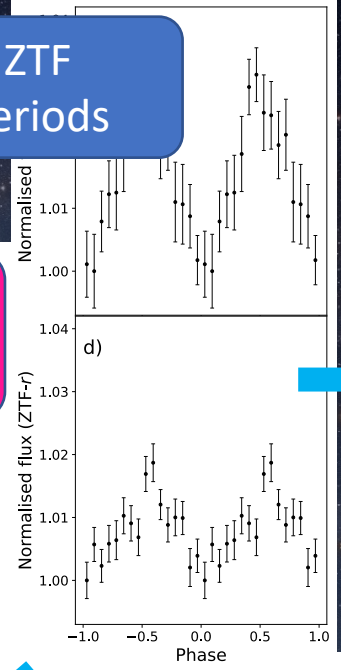
How we found her

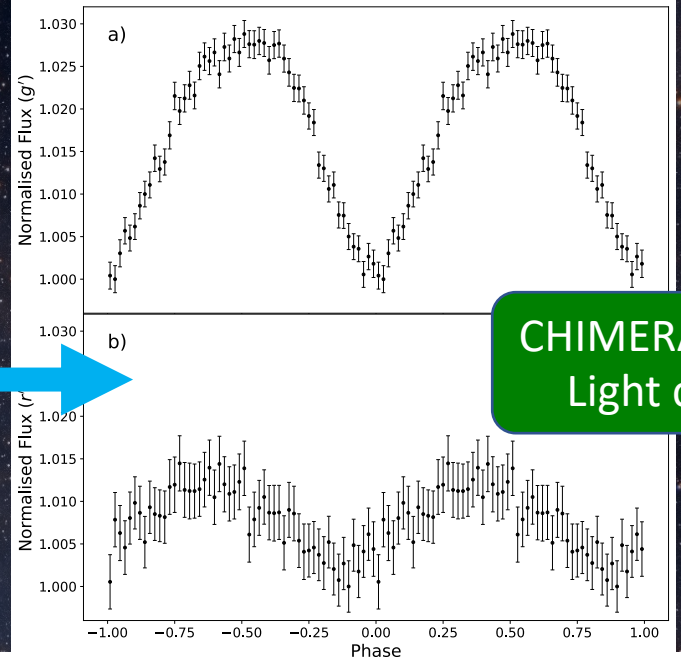
ZTF Periods

+

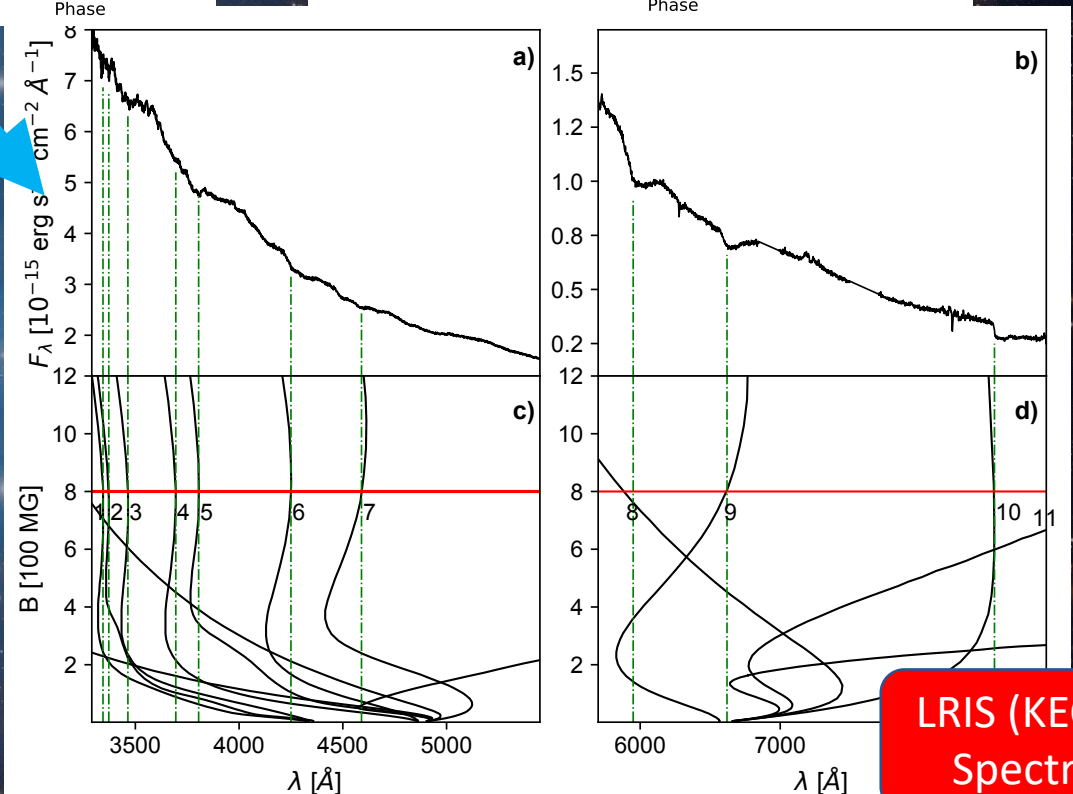
GAIA Massive WDs (Gentile Fusillo)







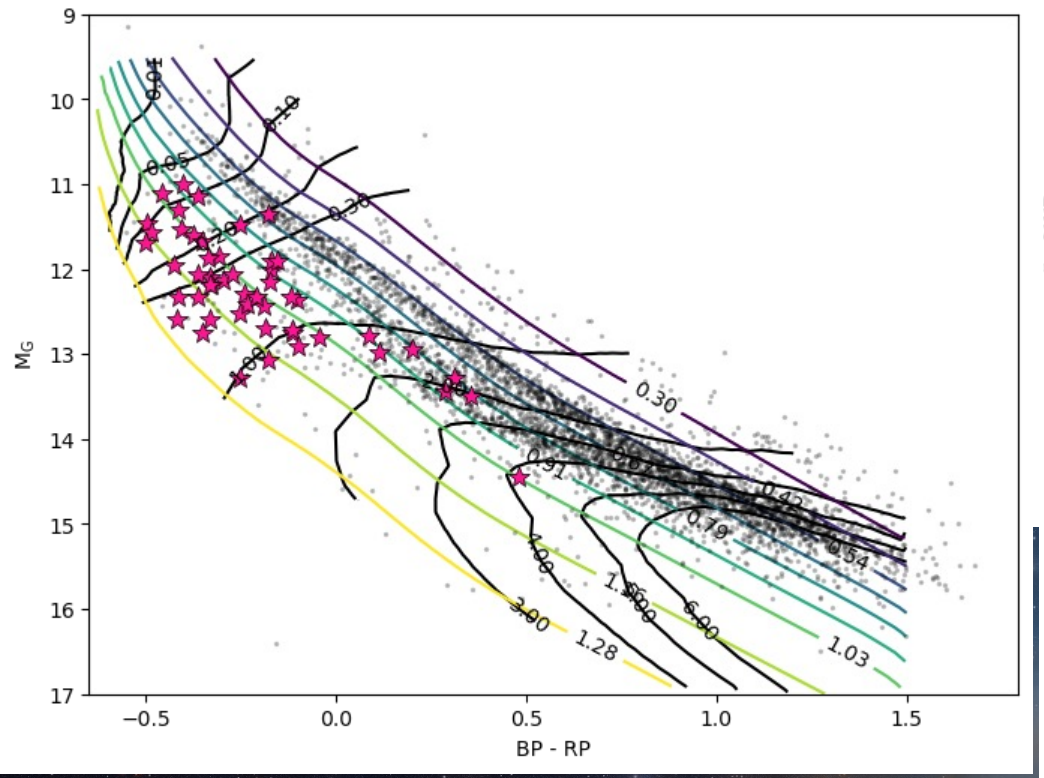
CHIMERA (HALE) Light curves

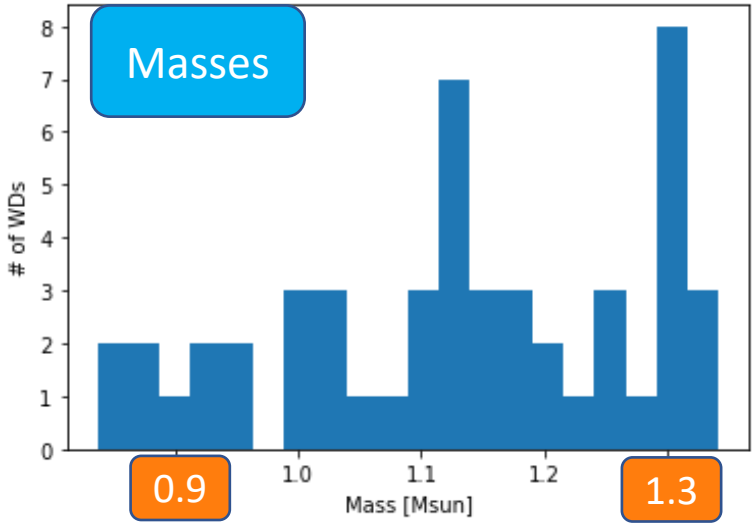


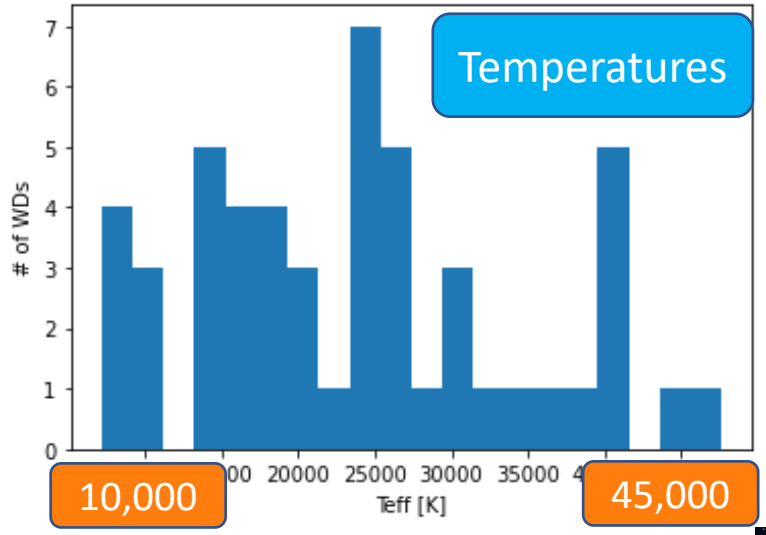
LRIS (KECK) Spectra

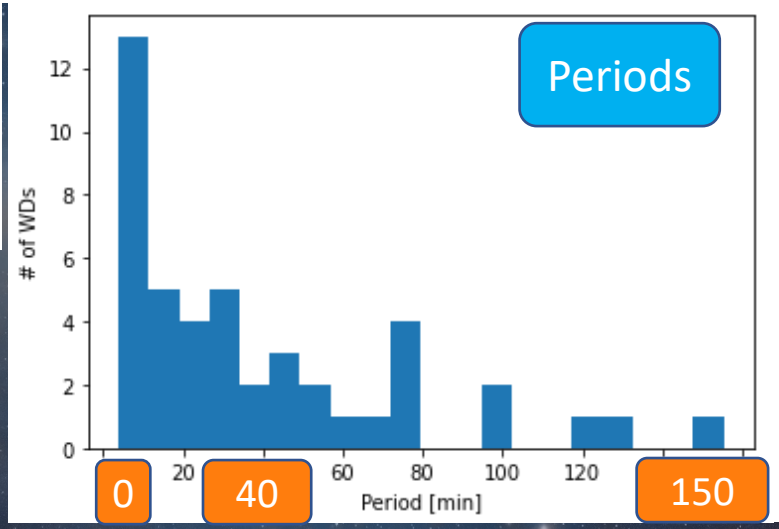
And we are finding many others!

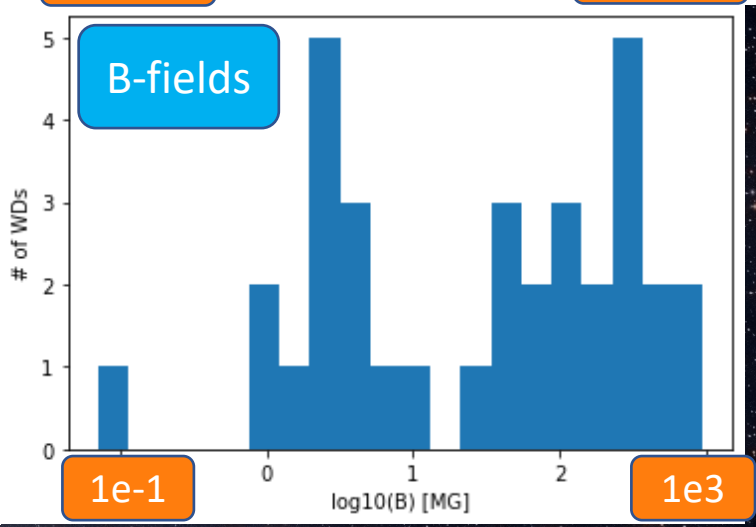
A large sample (~60) of candidate merger remnants!





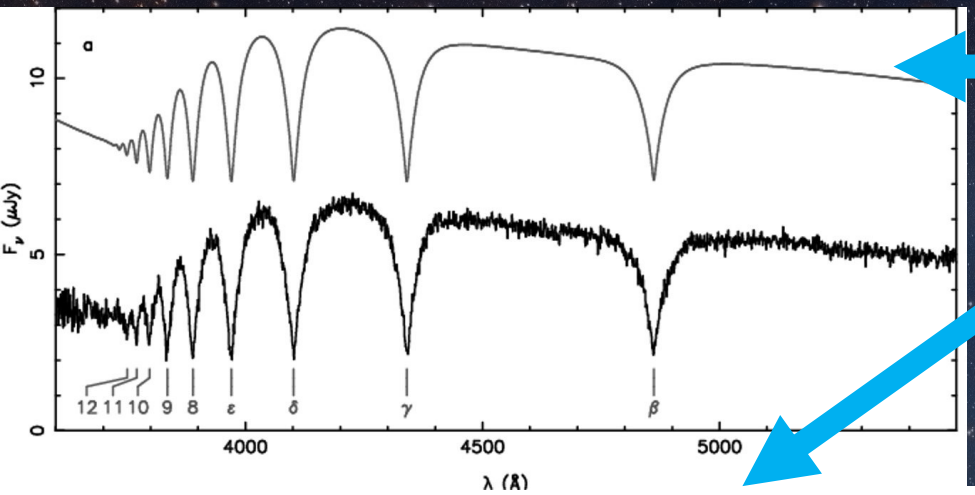






- Massive
- Rapidly Rotating
- Warm-Hot
- Many obviously magnetic
- Many featureless or strange

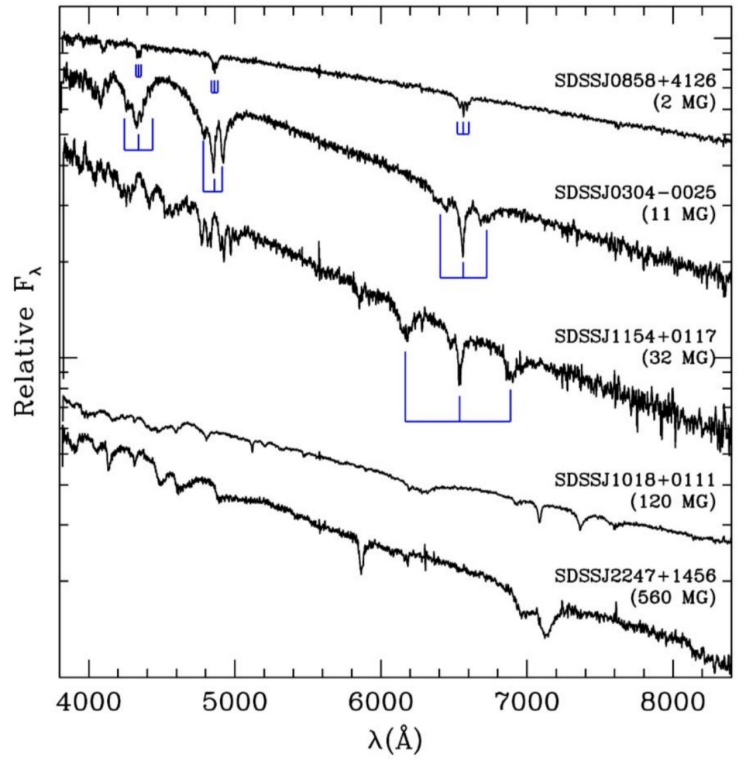
Are they magnetic?

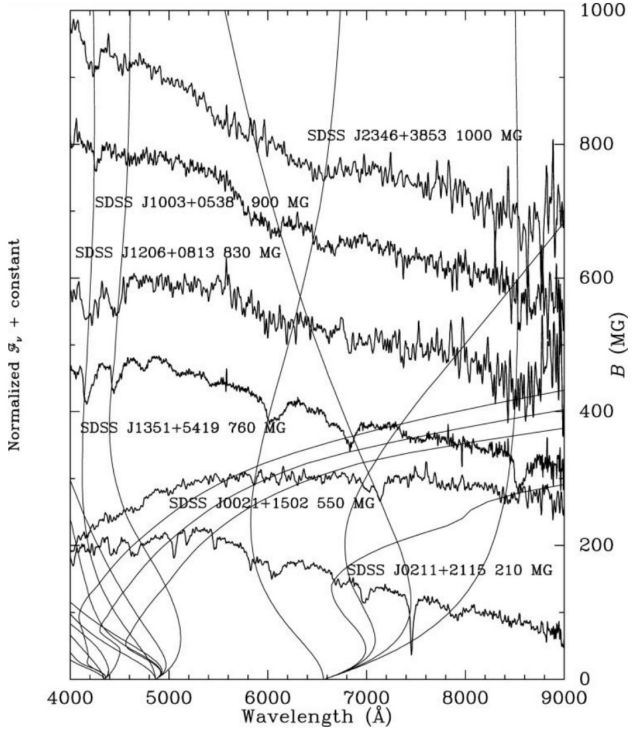


Non-magnetic spectrum

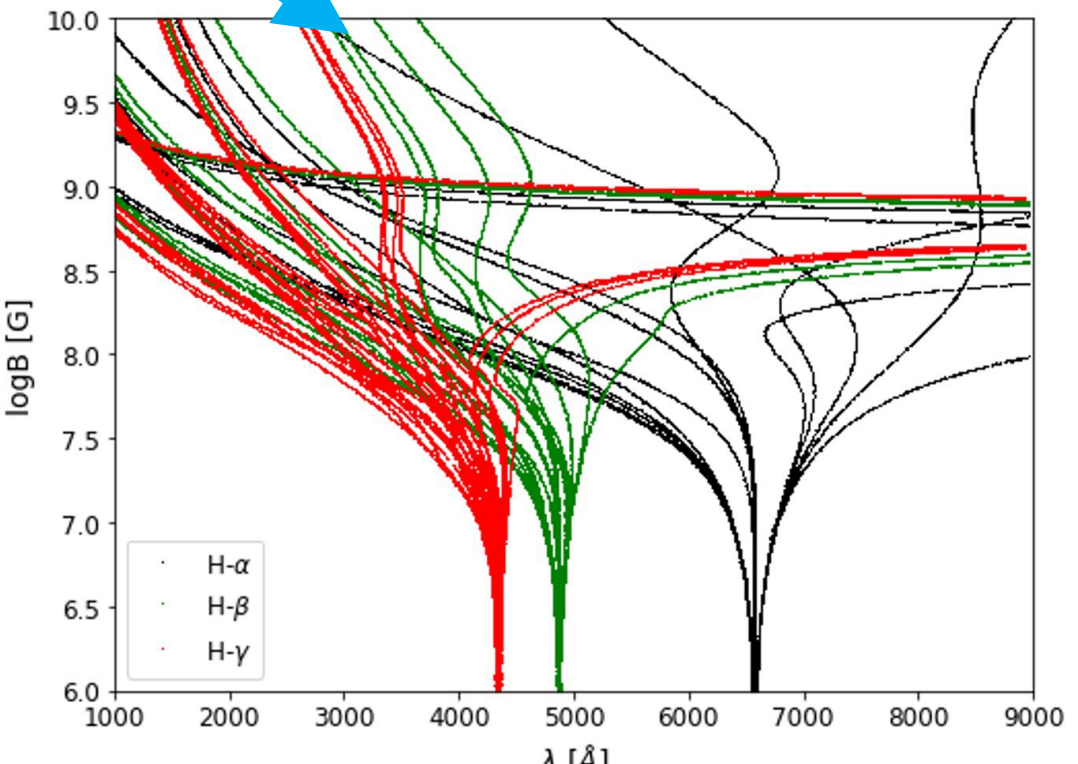
In magnetic WDs the degeneracy of the hydrogen energy levels is lifted -> Zeeman splitting

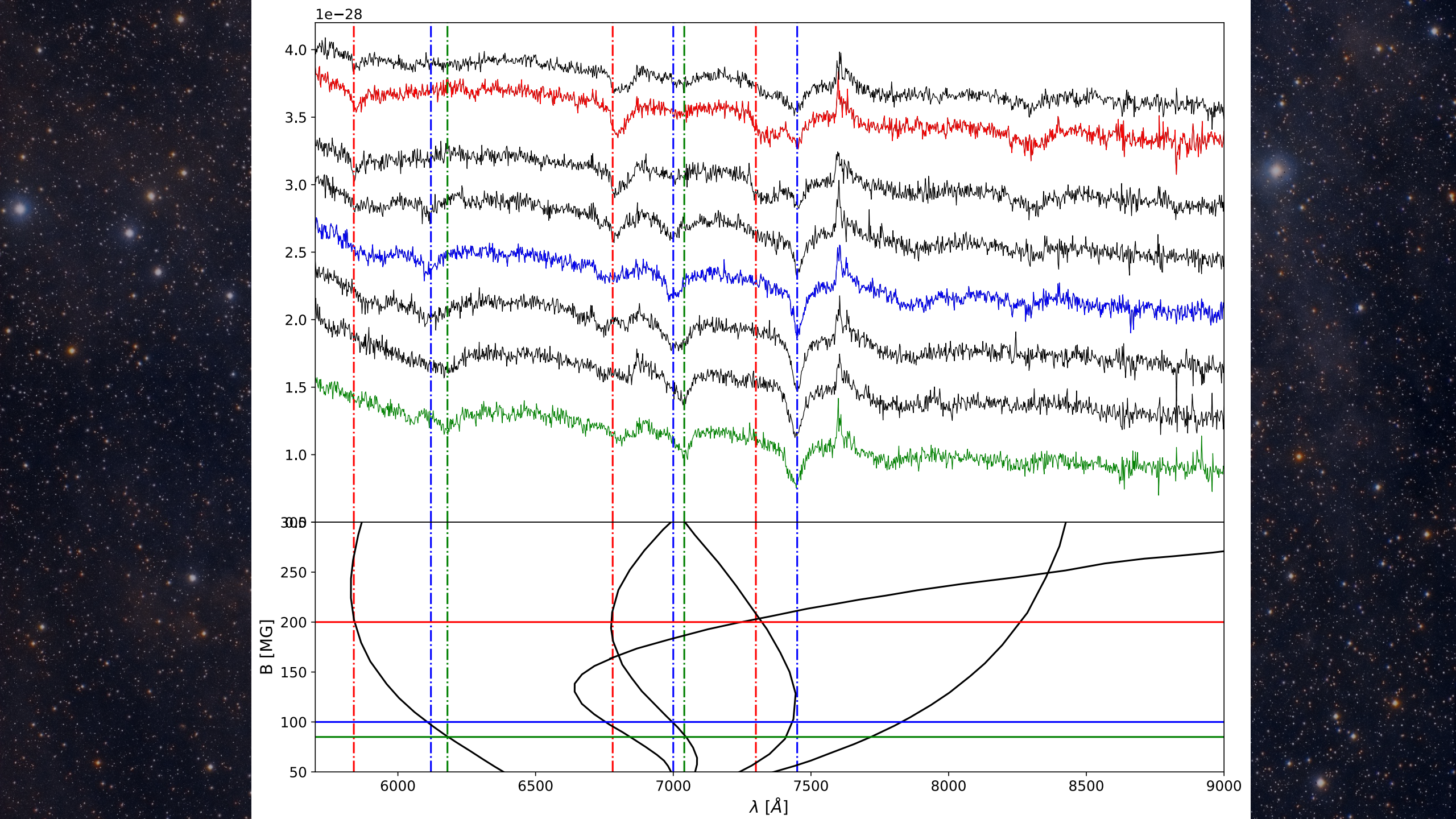
At high fields, the energy of each transition gets shifted by a large amount





(Vanlandingham et al. 2005)



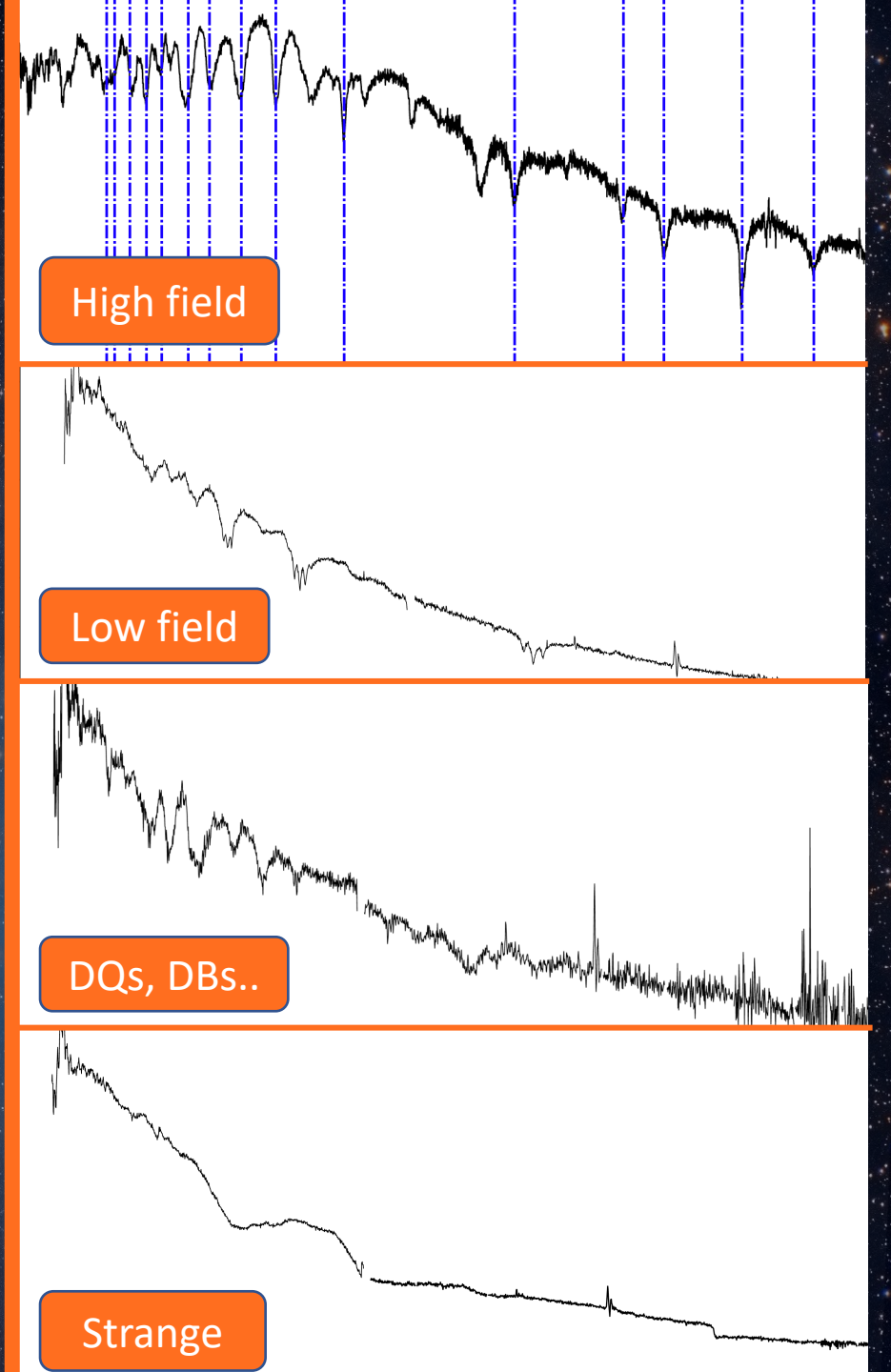

1e−28
4.0
3.5
3.0
2.5
2.0
1.5
1.0
300
250
200
150
100
50
B [MG]
6000
6500
7000
7500
8000
8500
9000
λ [Å]

Why should we care?

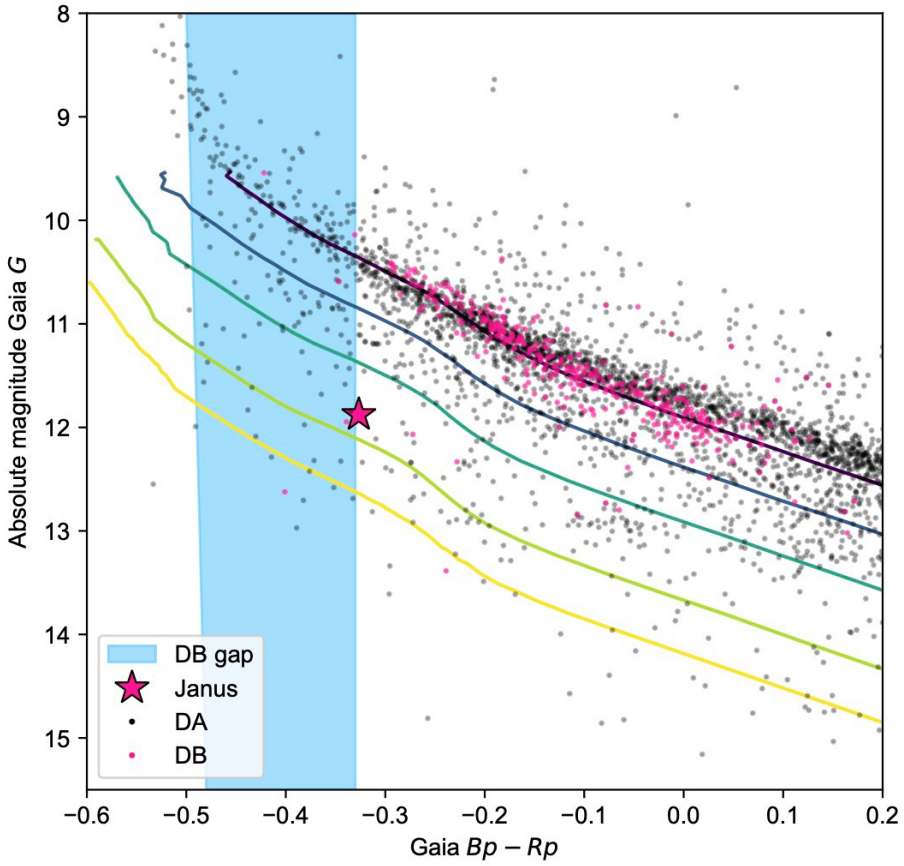
- Type Ia? These are the ones that barely exploded -> we could get a rate and a constraint on the contribution of double-degenerate to type Ia SNe
- LISA? From the rate of mergers we can constrain the population of short-period binaries
- Binary evolution? From their kinematics we should be able to constrain the delay time between the formation of the binary and the merger
- Magnetic white dwarfs? This is a nice sample of hot and warm magnetic white dwarfs at different field strengths

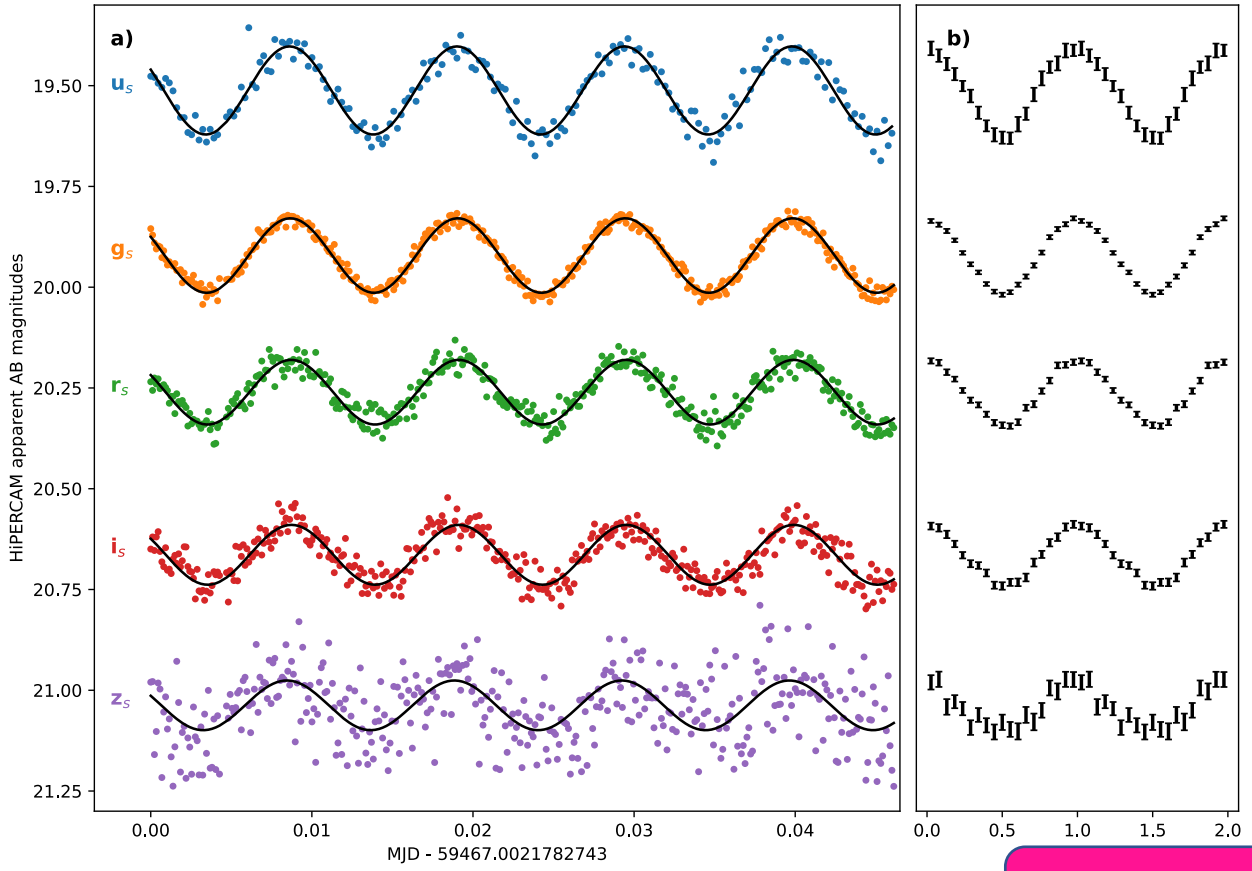
Cool! When should we expect the catalog?

- Collecting data
- Understanding selection effects and completeness
- Very variegate sample! Some objects are quite strange
- Coming soon!



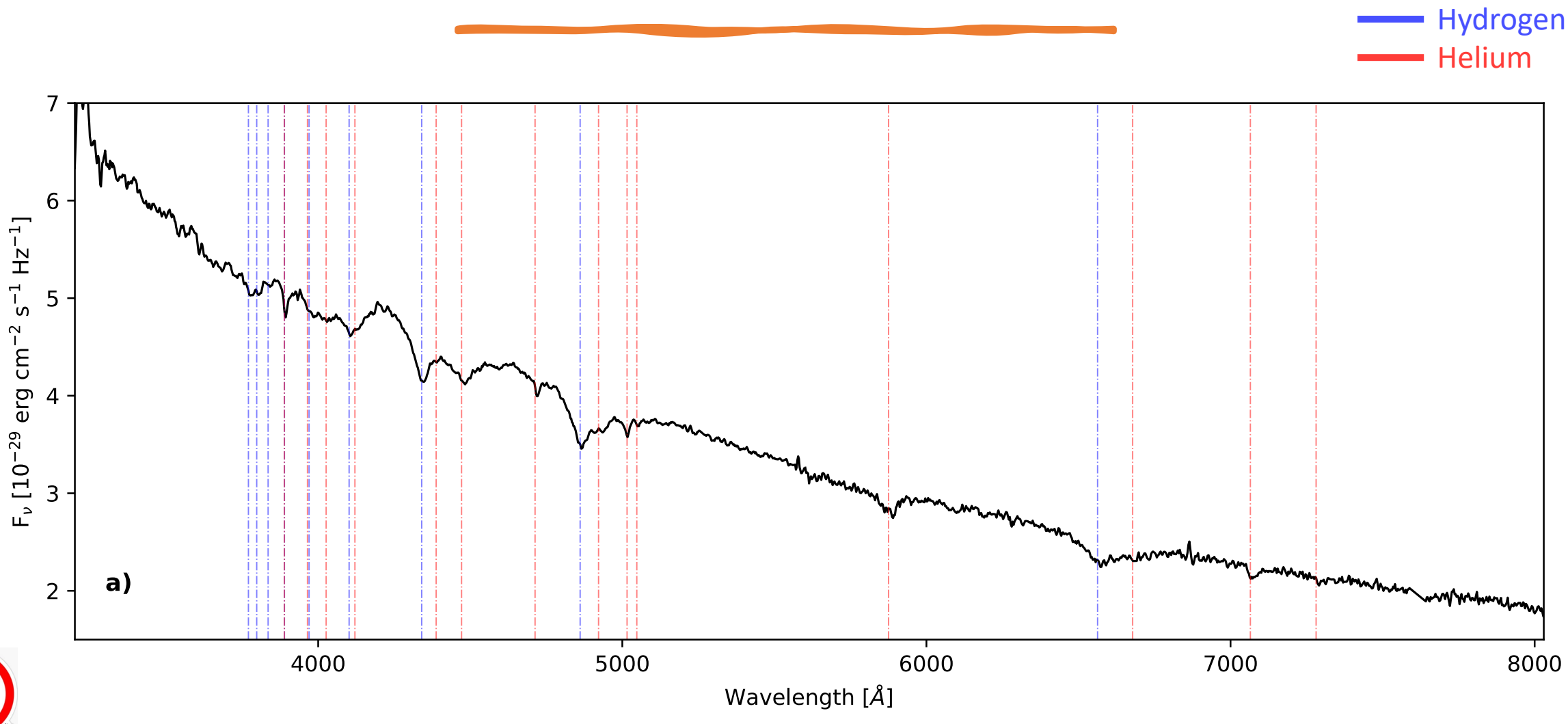
Janus, a new class of variables WDs



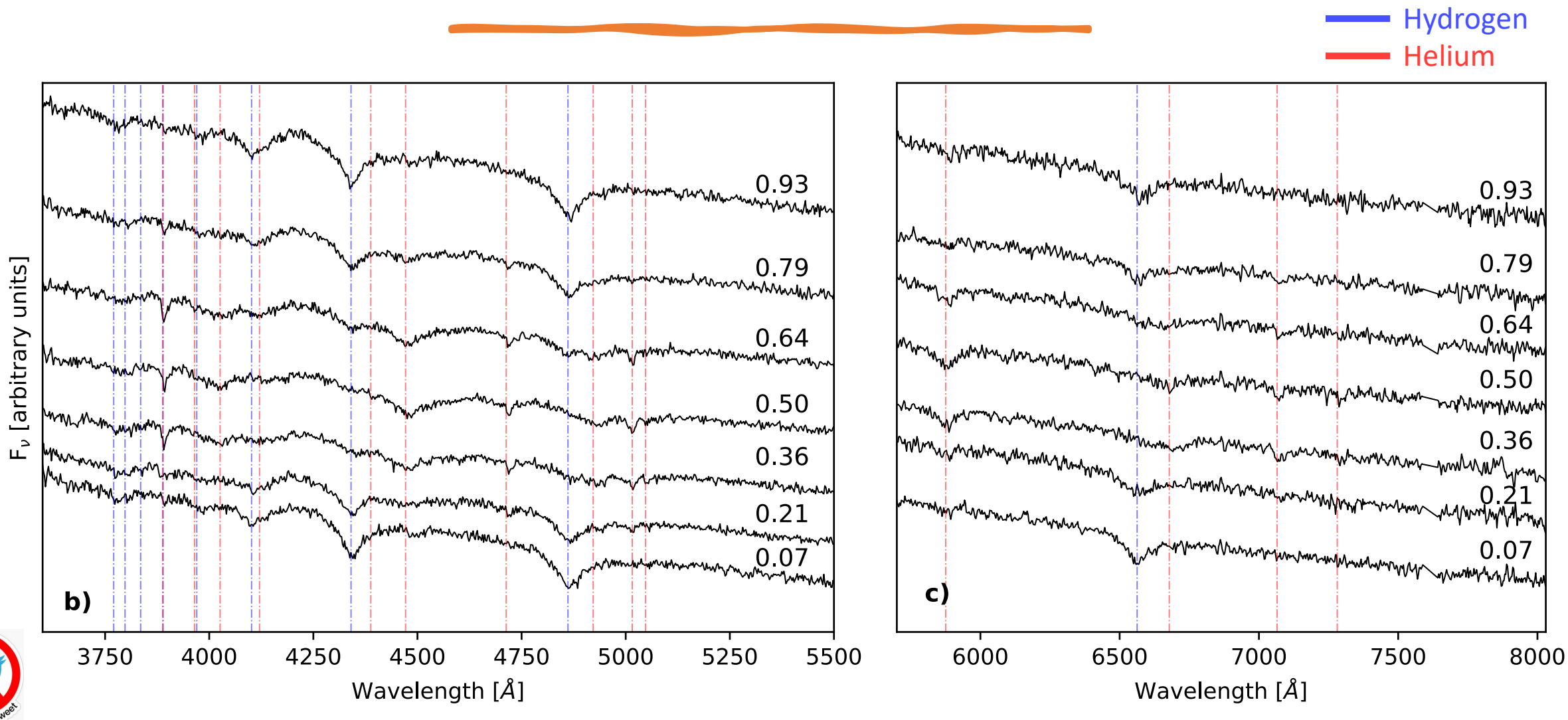


HiPERCAM

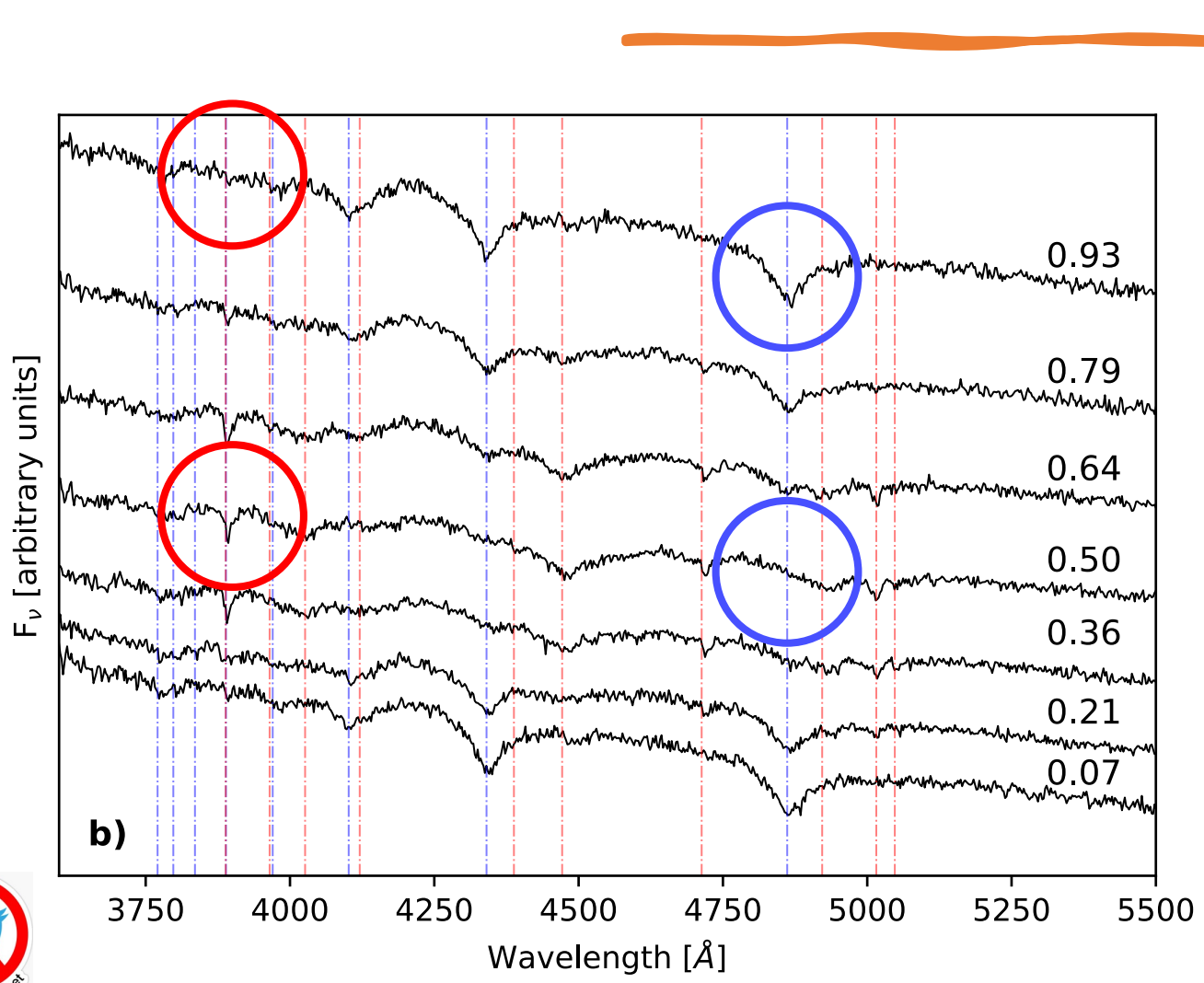
Phase-averaged spectrum

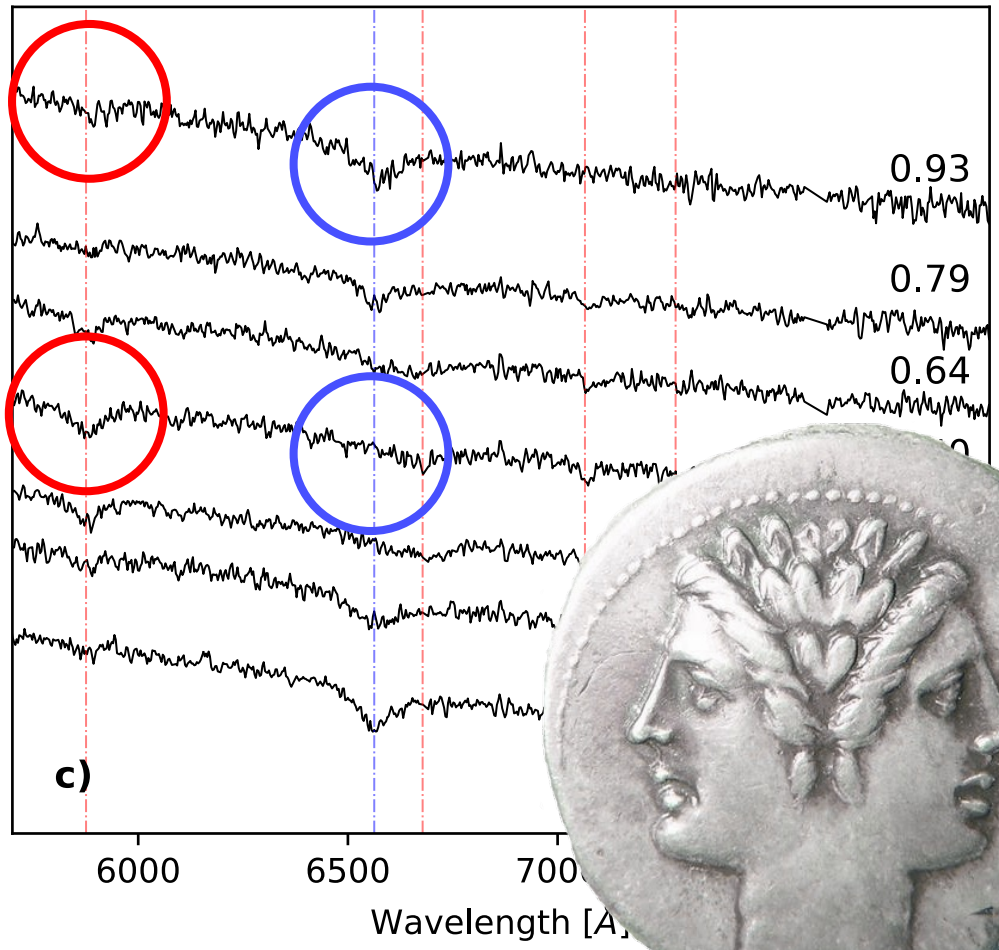


Phase-resolved, a double-faced WD!



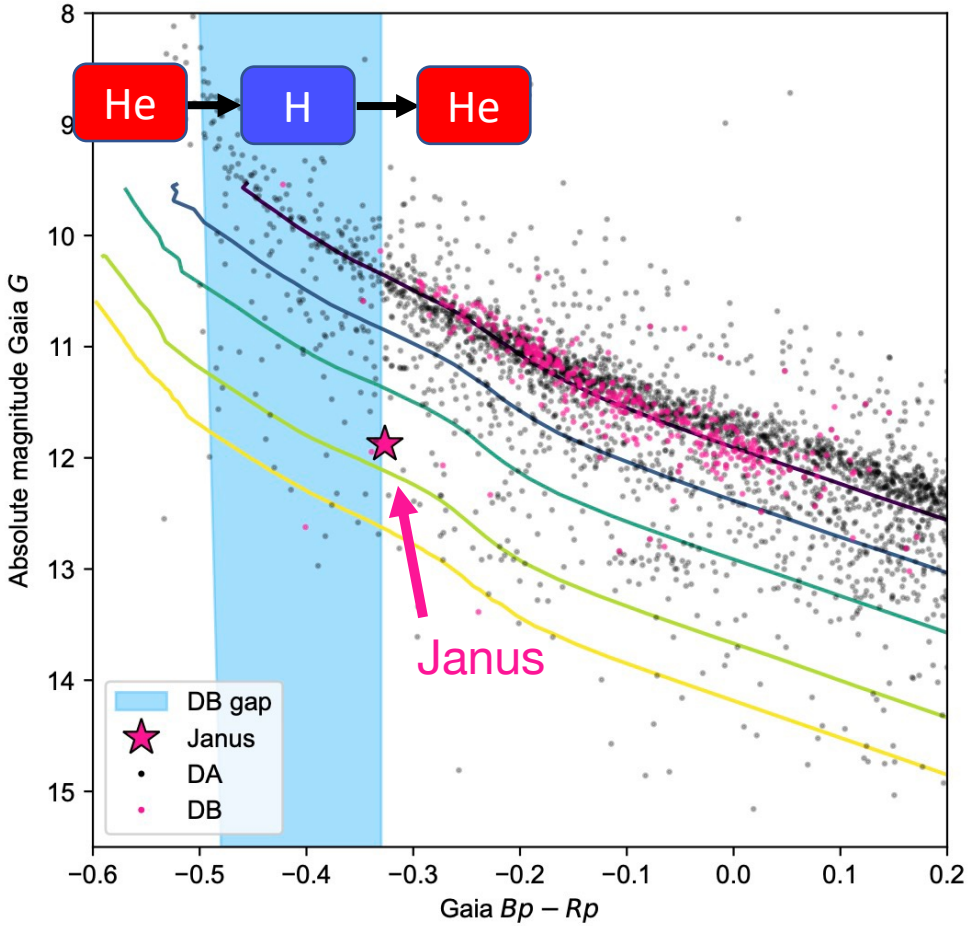
Phase-resolved, a double-faced WD!

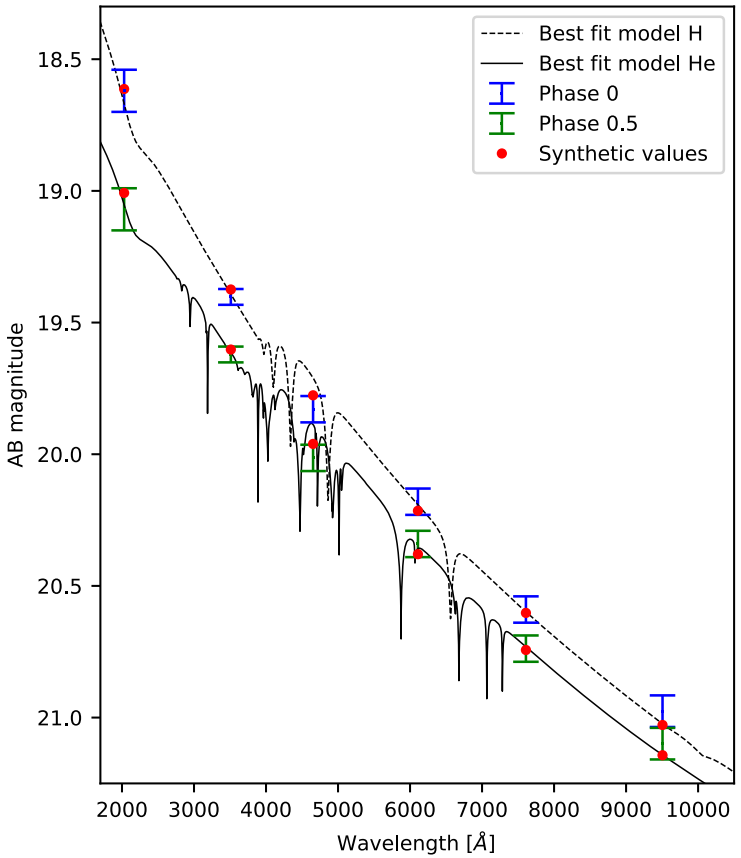




Janus, a transitioning WD?

- At the the low end of the DB gap, strong mixing in the helium layer dilutes the hydrogen: DBs and DBAs appear
- If there is a magnetic field strong enough to inhibit convection on part of the surface, we can still see hydrogen





Janus, a hydrogen ocean?