HST/COS Ultra-Violet high-resolution spectroscopic survey of 307 DA White Dwarfs

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Research Fellow

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November 14, 2022

Collaborators- Boris Gänsicke, Pier-Emmanuel Tremblay, Detlev Koester

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Kavli Institute for Theoretical Physics

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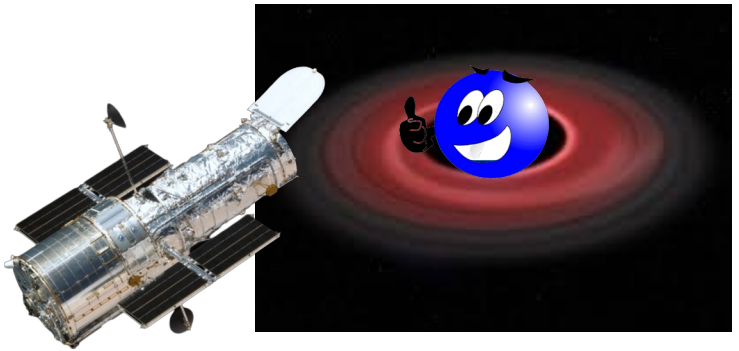
HST UV Survey of WDs

- COS ultraviolet snapshot survey- investigate the **fraction of planetary systems** around young WDs

  (Gänsicke+2012, Koester+2014...)

  HST/COS data using G130M grating
  R ~18000, 1130–1430 Å



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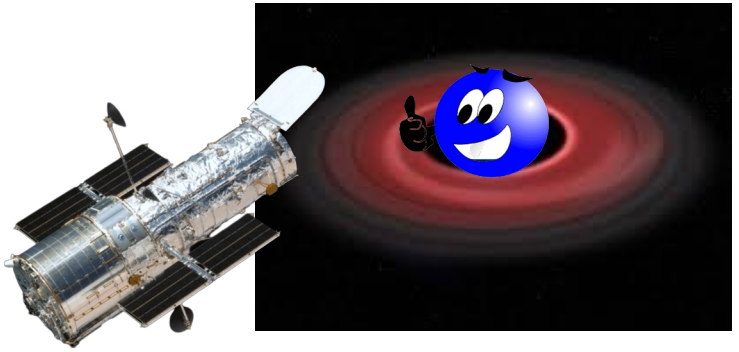

AIM of the survey

- Check the internal consistency between UV and optical parameters.
- correlate the *presence of planetary debris* with WD mass and cooling age.
- detemine the relative *abundances (Si,C, N, O, Fe etc.)* of the debris.

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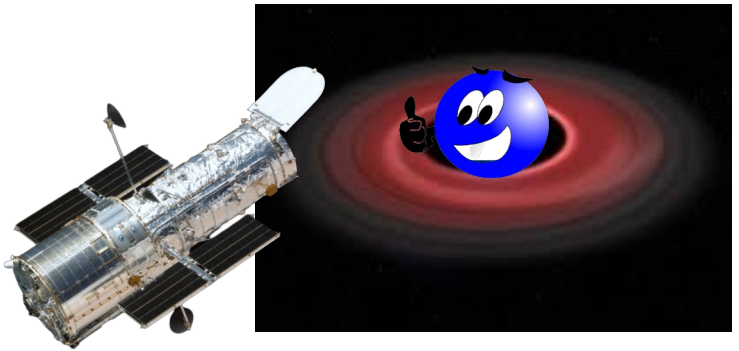

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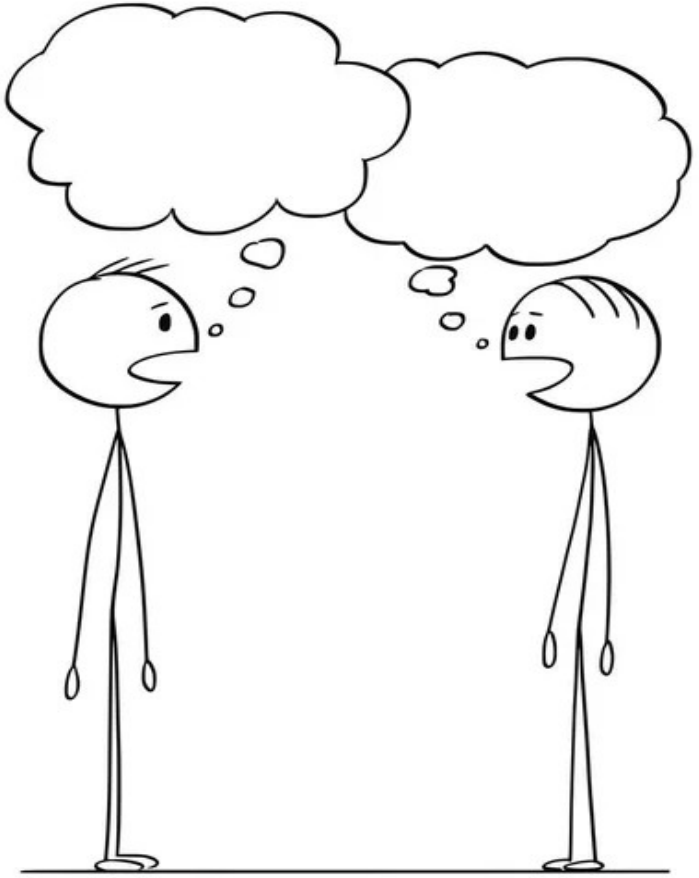
In this work: UV Spectroscopy and Comparative analysis of 307 DA WDs.
(Sahu et al. 2022; in prep)

Model fit to HST/COS spectra

Fitting method

- Koester Models (updated)
- Gaia EDR3 parallaxes
- Masked ISM and photospheric lines
- Two WD Mass-radius relations



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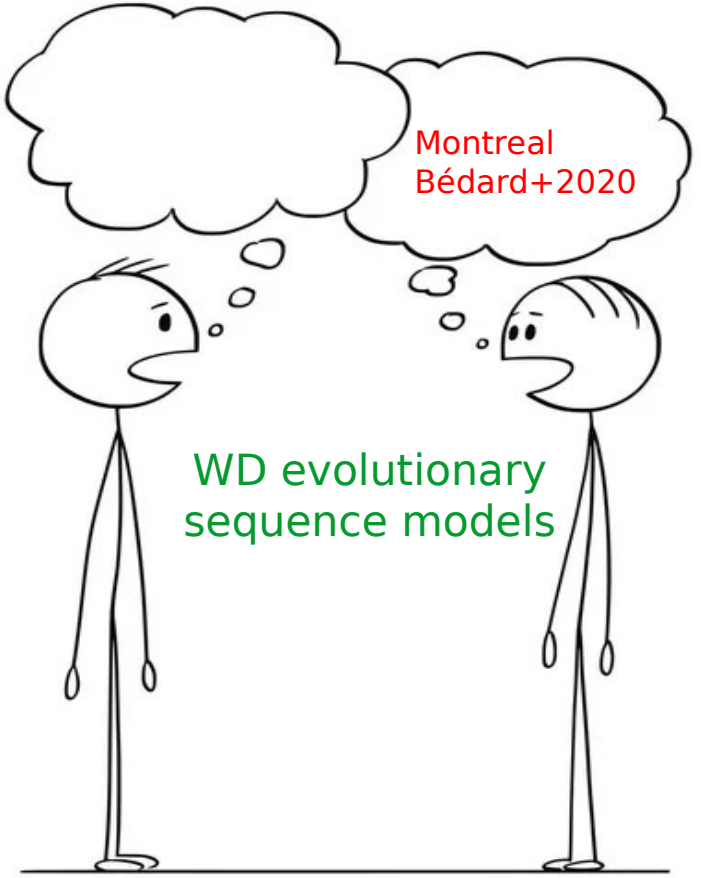

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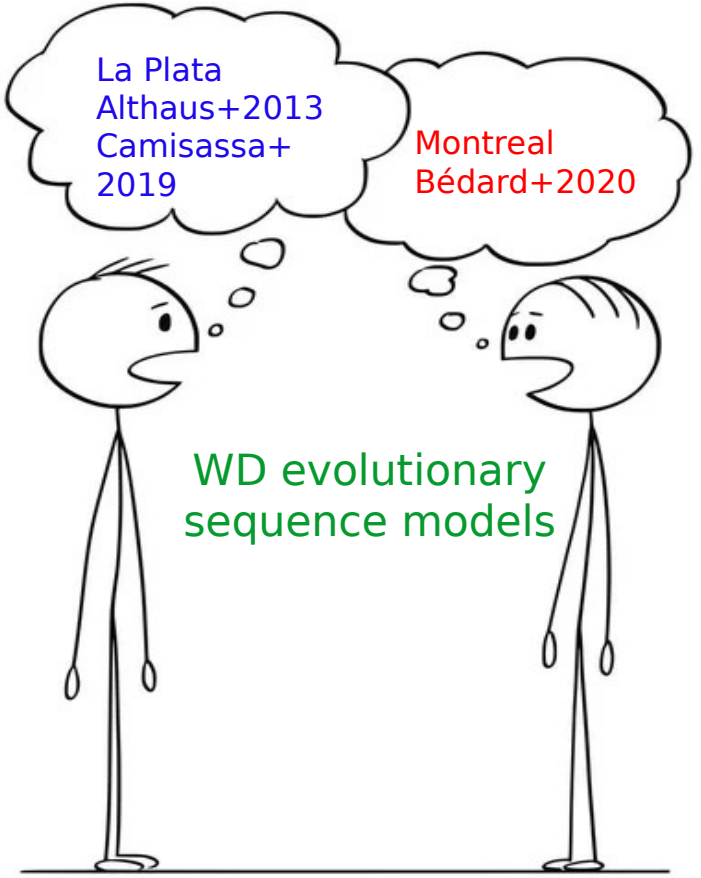

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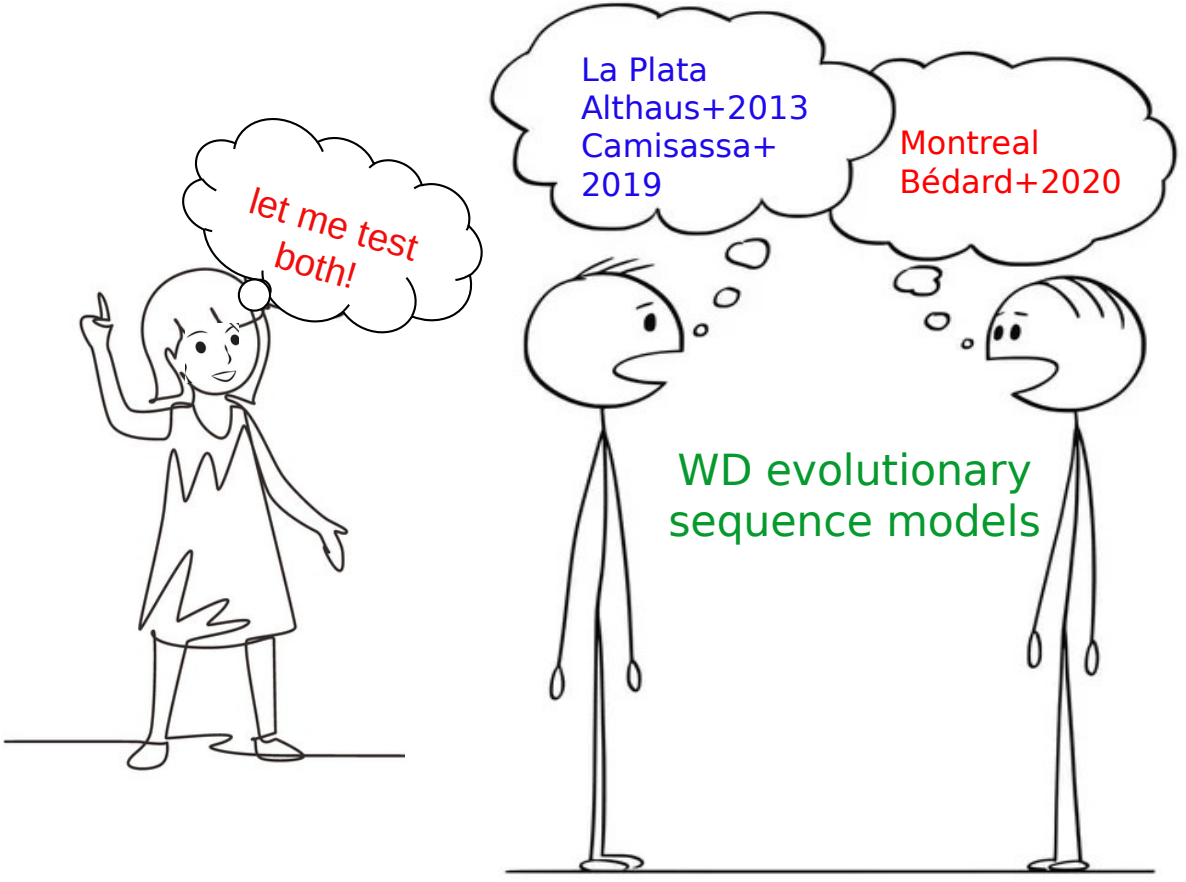

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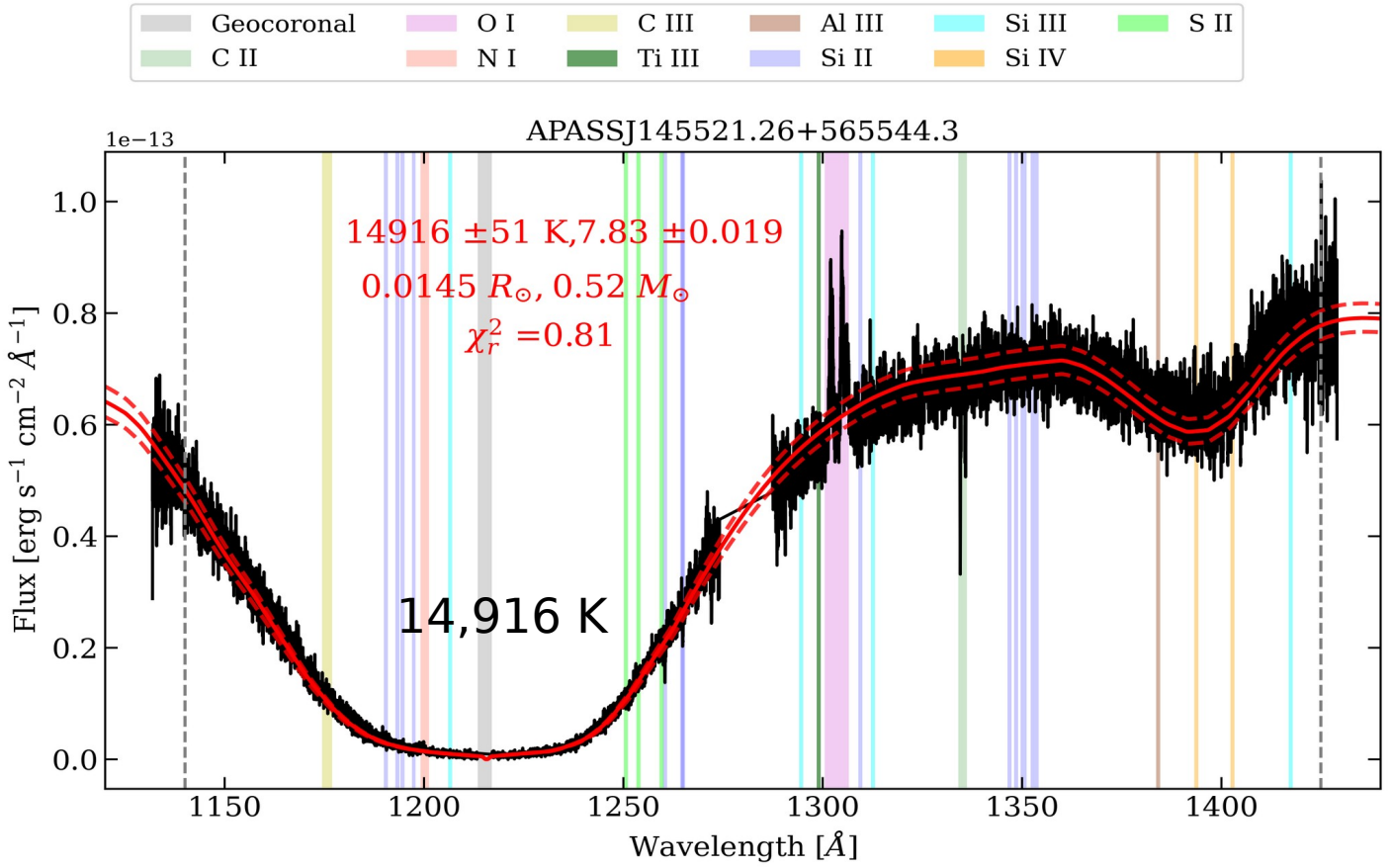

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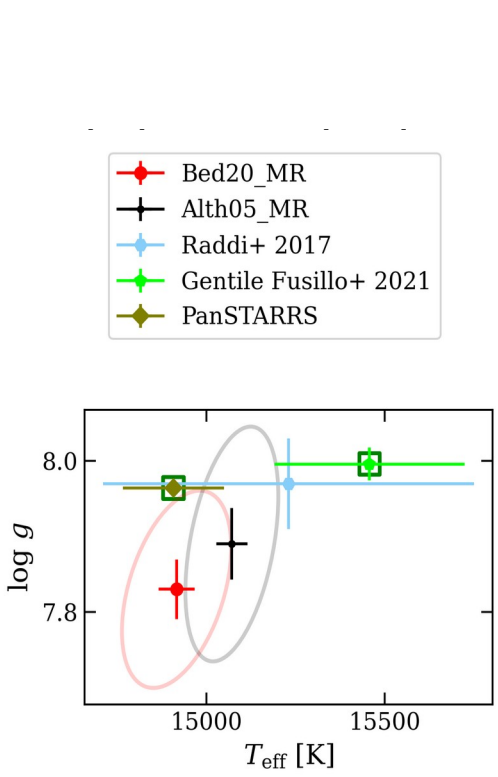

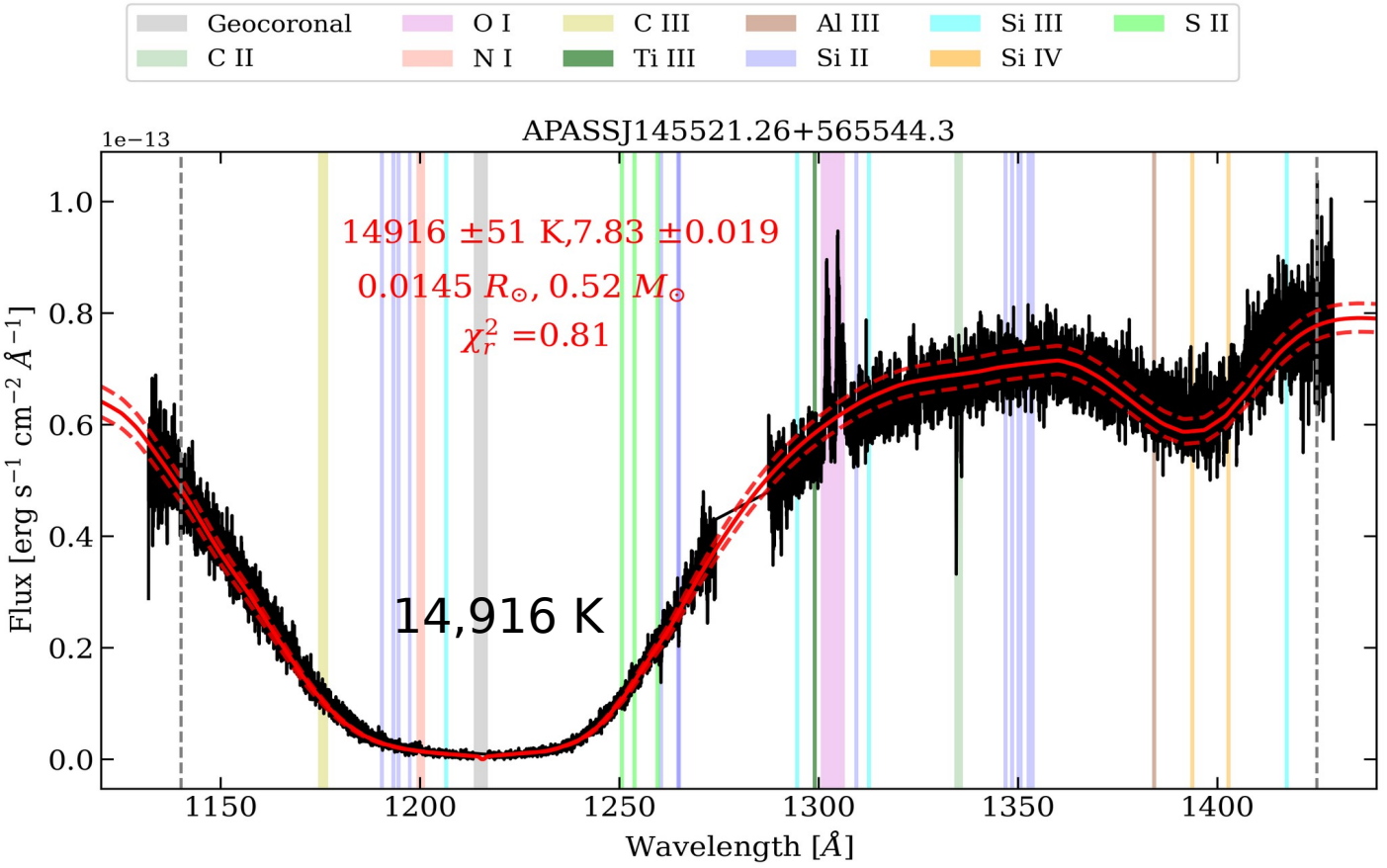

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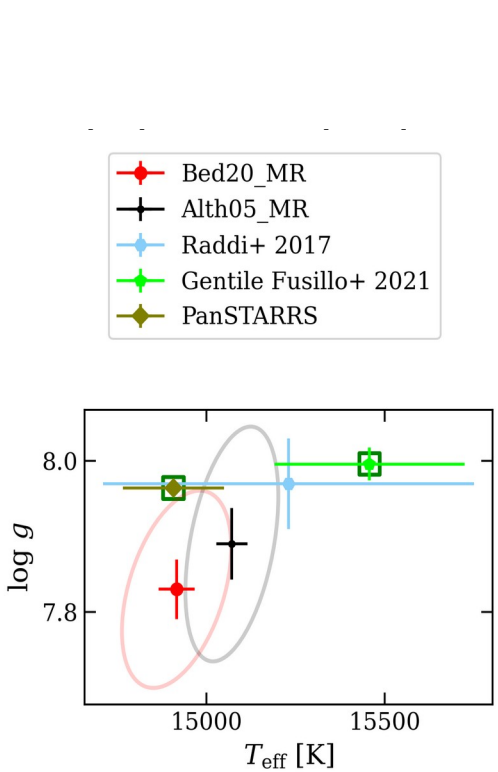
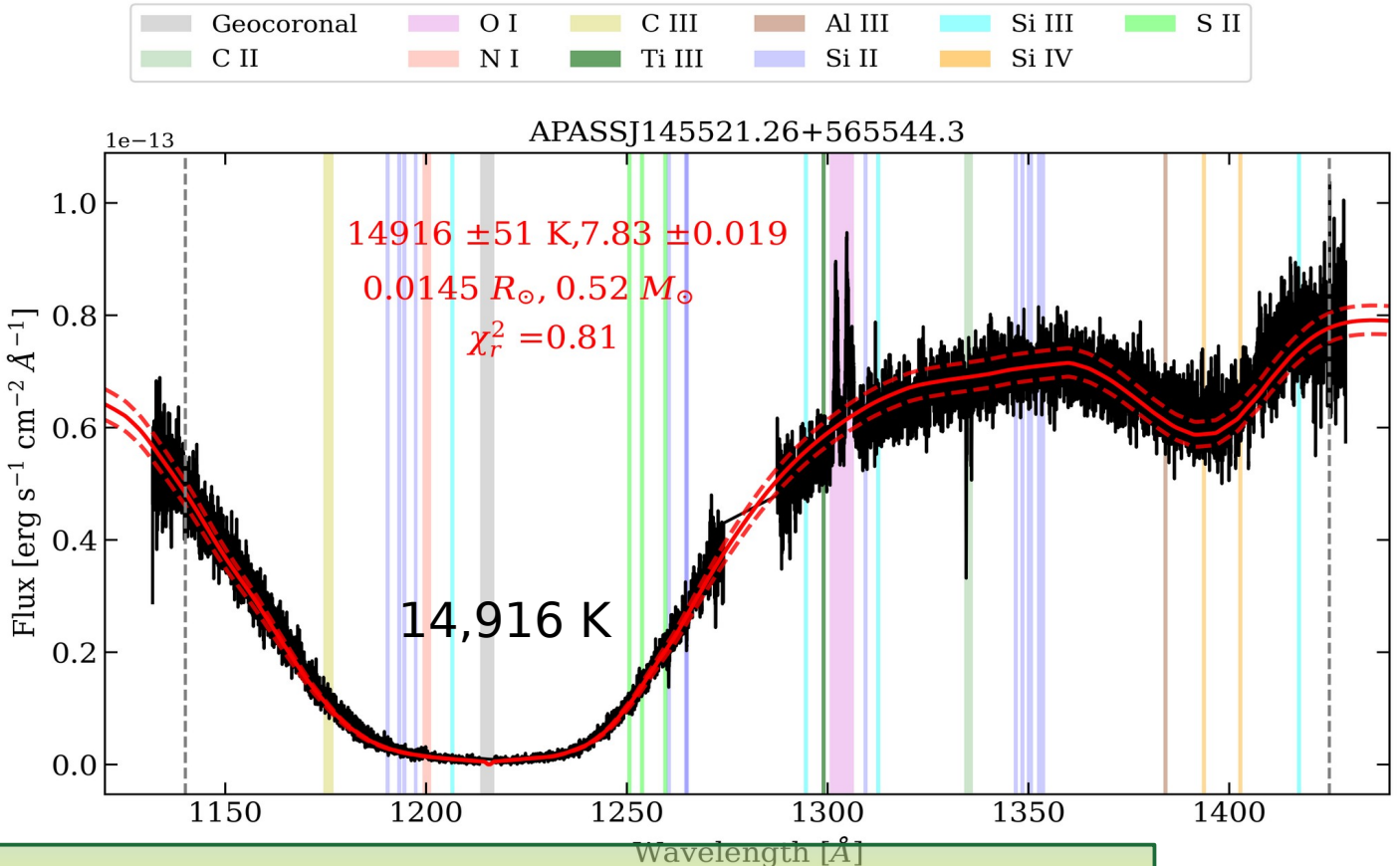
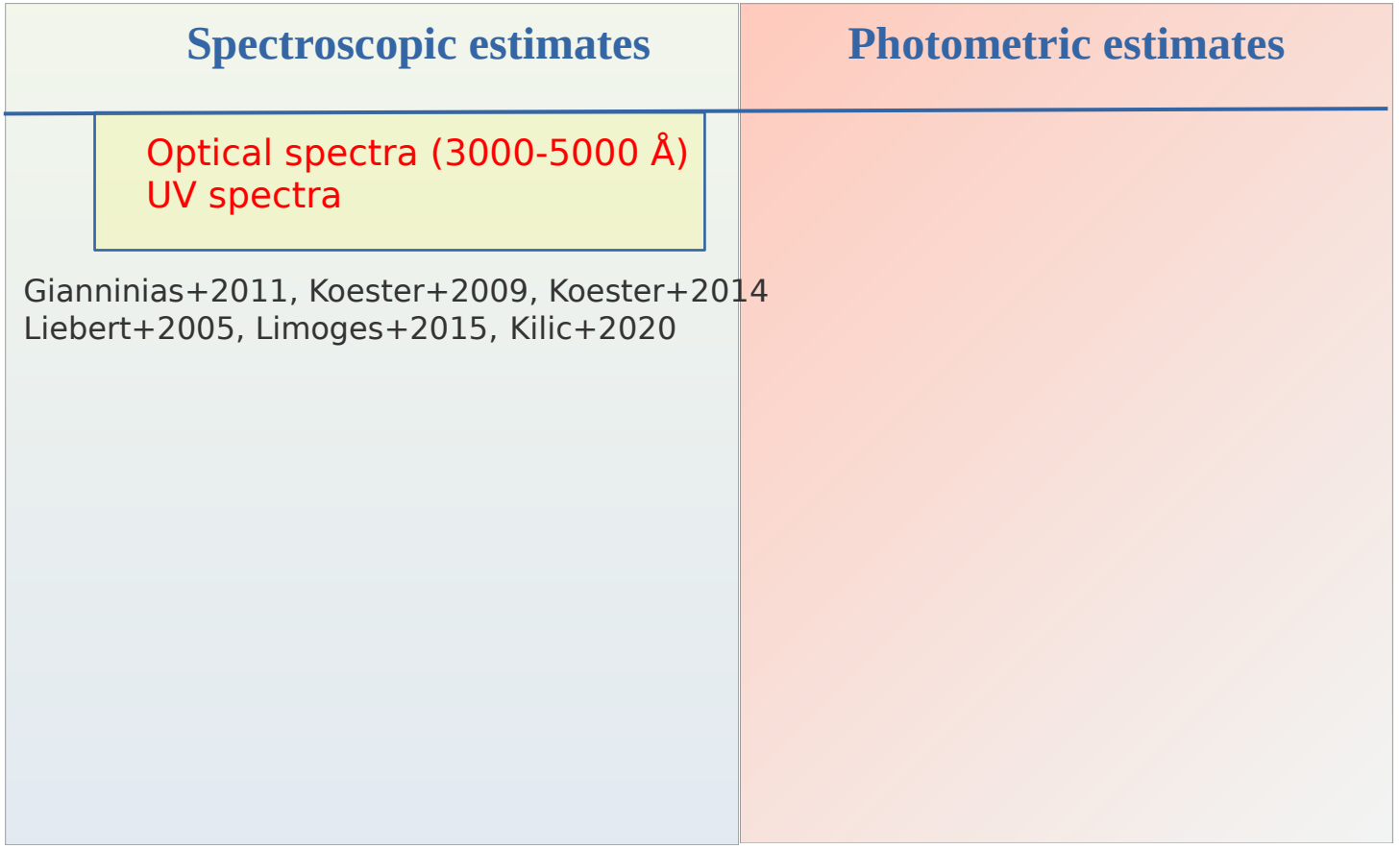




We report the first spectroscopic observations of **49** DA WDs discovered by Gaia.

Comparisons with the Published results



Comparisons with the Published results

Spectroscopic estimates

Optical spectra (3000-5000 Å)
UV spectra

Gianninias+2011, Koester+2009, Koester+2014
Liebert+2005, Limoges+2015, Kilic+2020

Photometric estimates

- Gaia passbands (G, G_{BP}, G_{RP}) (Gentile Fusillo+2021)
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Stark Broadening profiles
Tremblay+ 2009, Tremblay+ 2011

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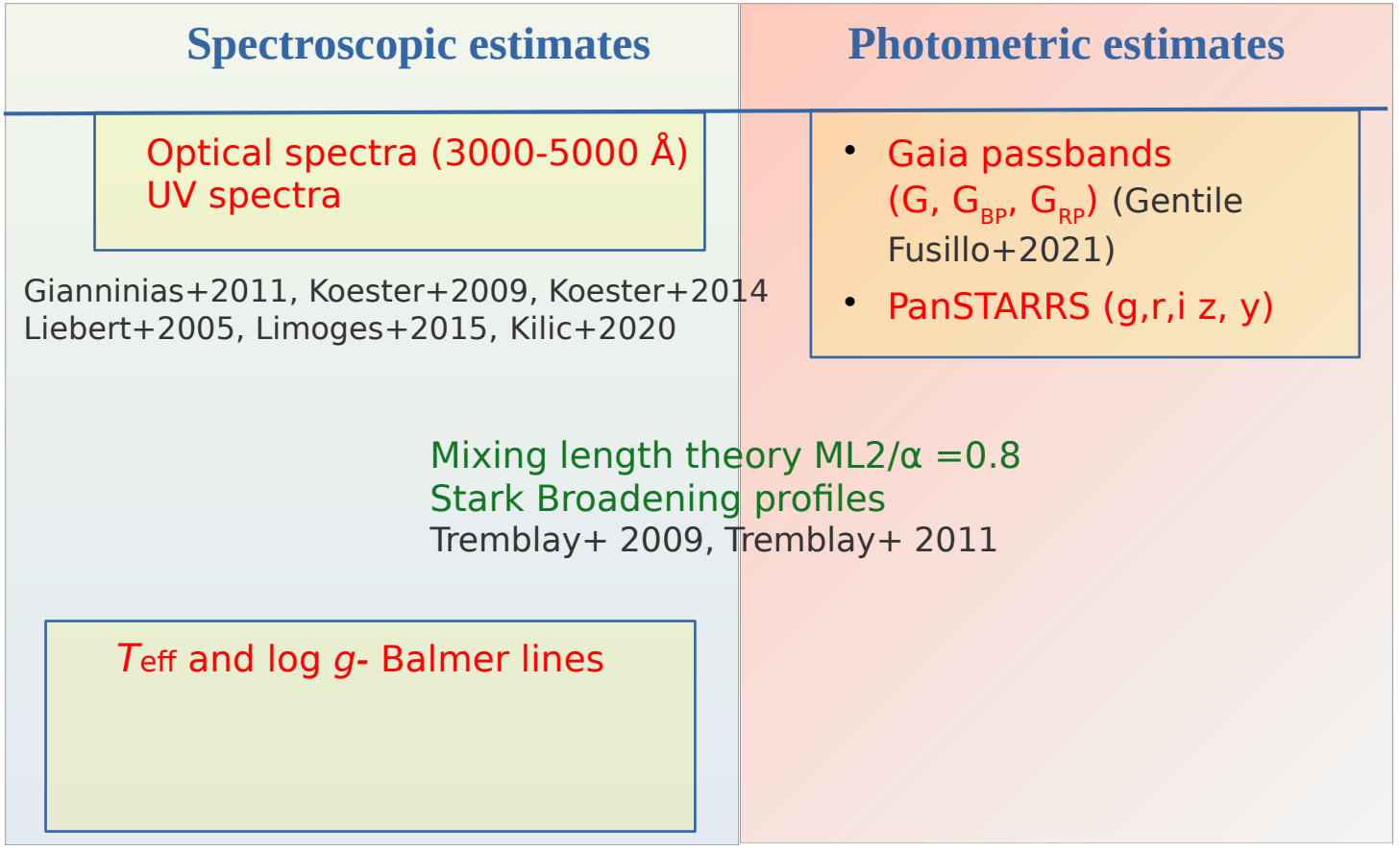

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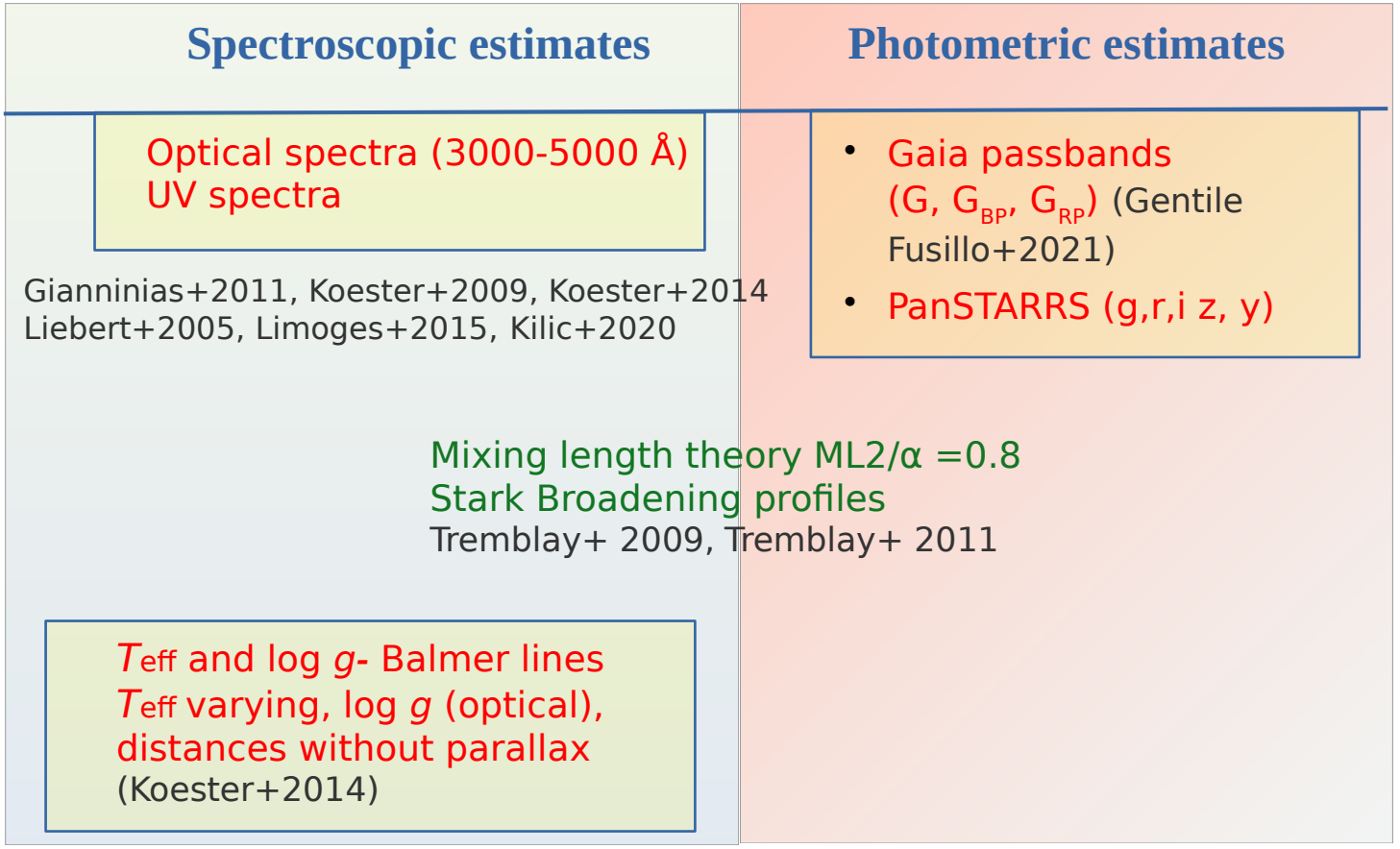

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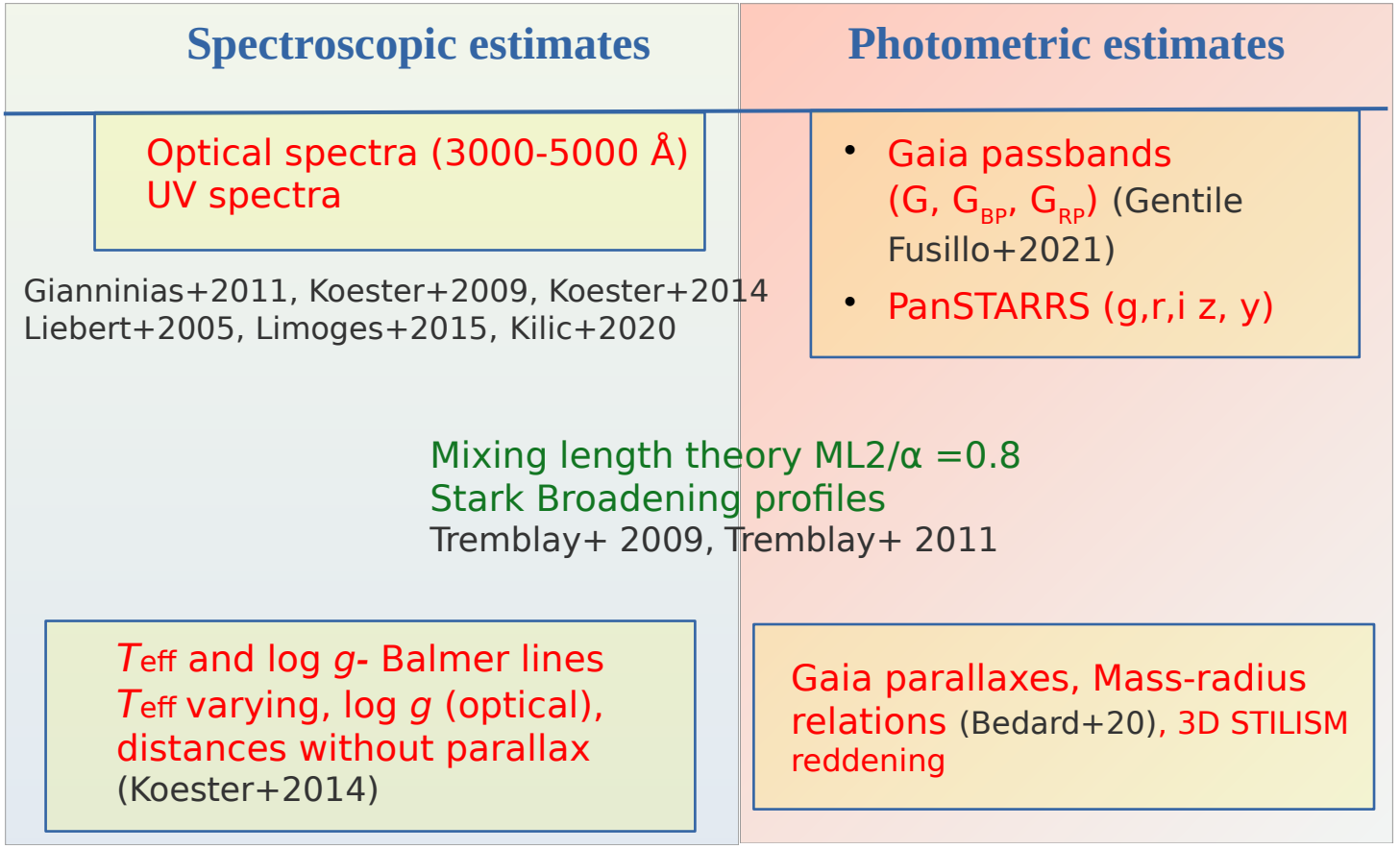

Comparisons with the Published results

In our method

- Absolute fluxes (no normalisation)
- Parallaxes from Gaia
- E(B-V) from STILISM (Gentile Fusillo+2021)

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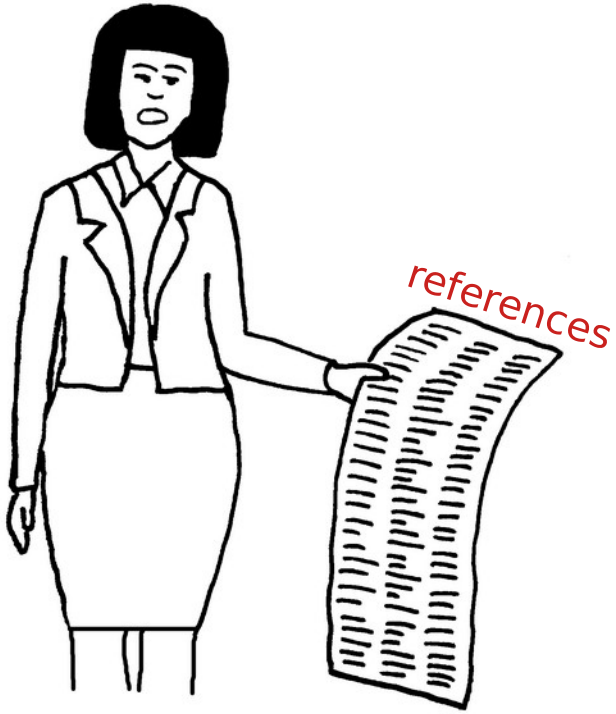
T_{eff} and log g- Balmer lines
T_{eff} varying, log g (optical), distances without parallax (Koester+2014)

Gaia parallaxes, Mass-radius relations (Bedard+20), 3D STILISM reddening

collected all the published results



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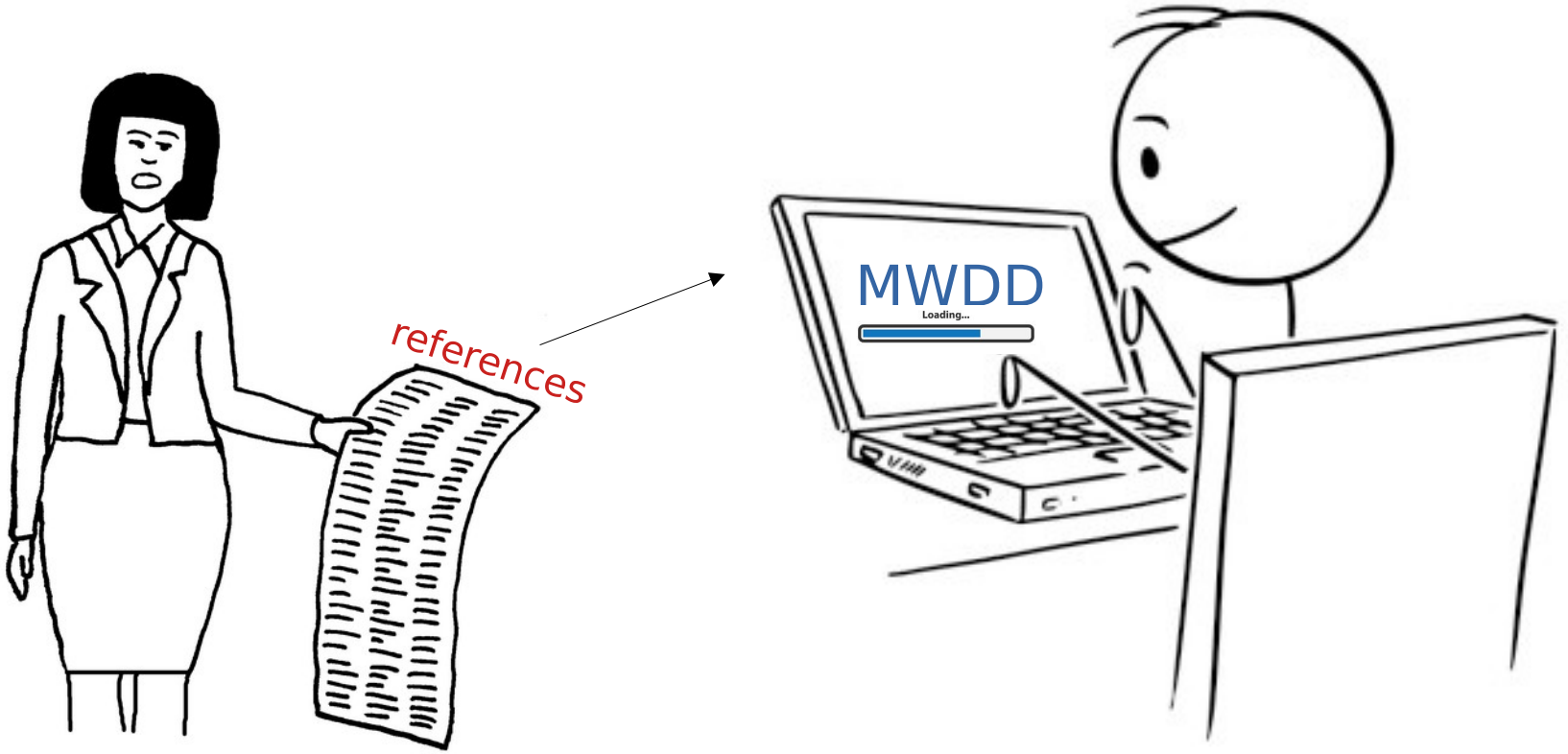
Montreal White Dwarf Database



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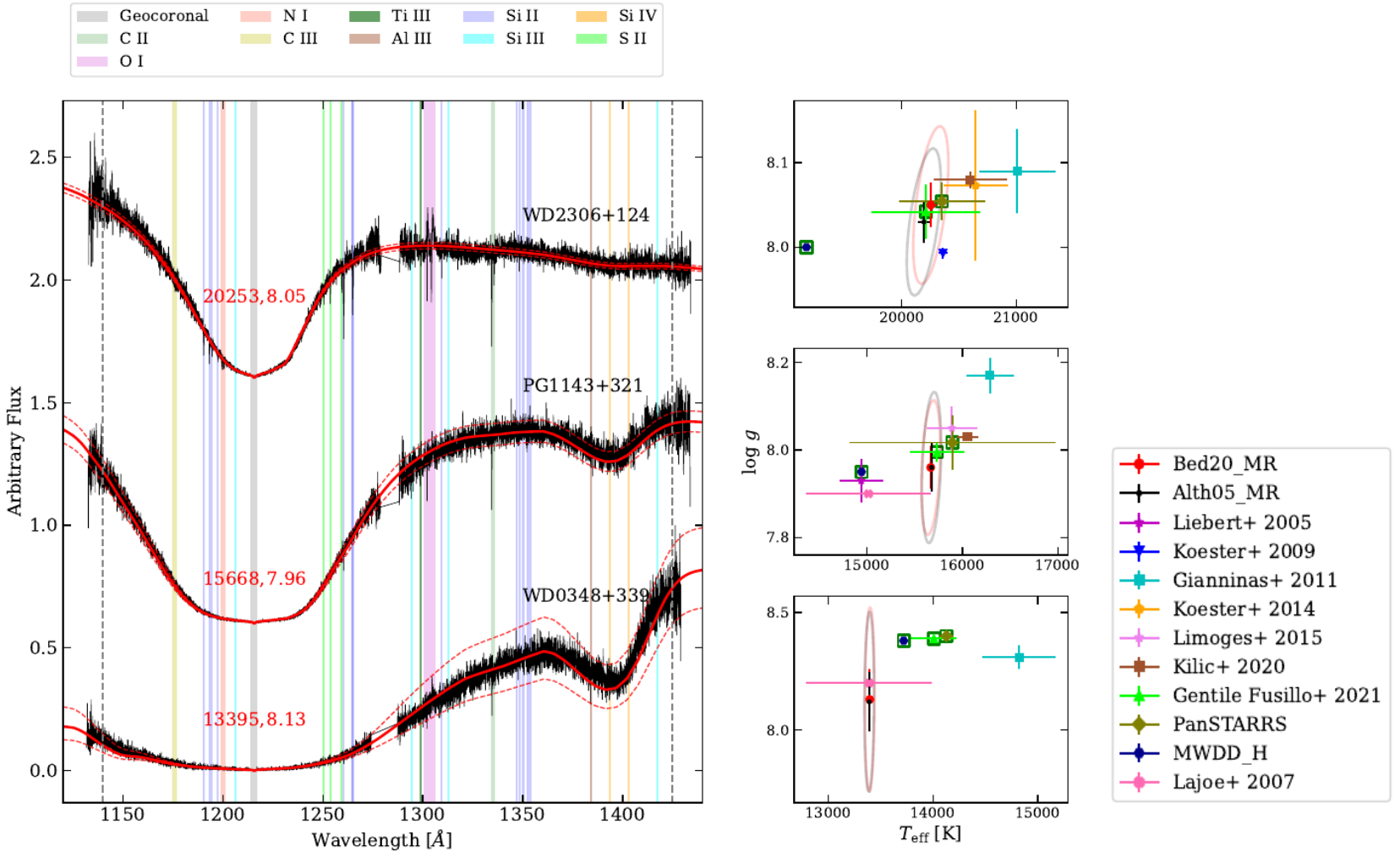

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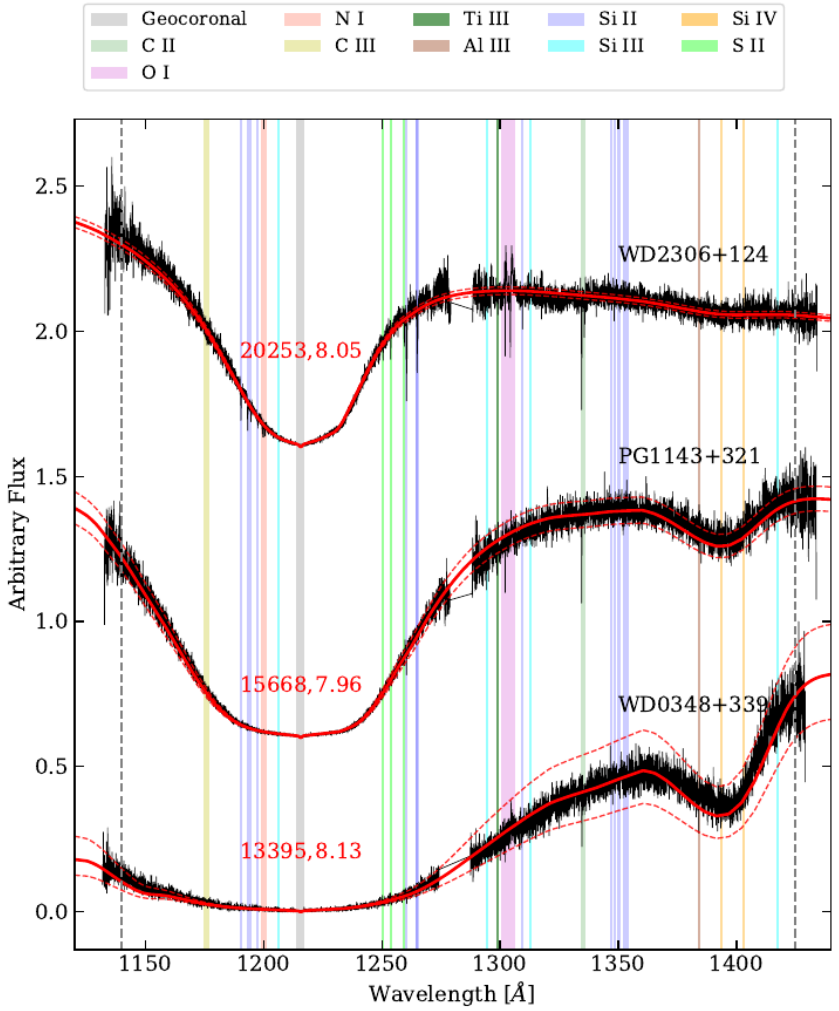
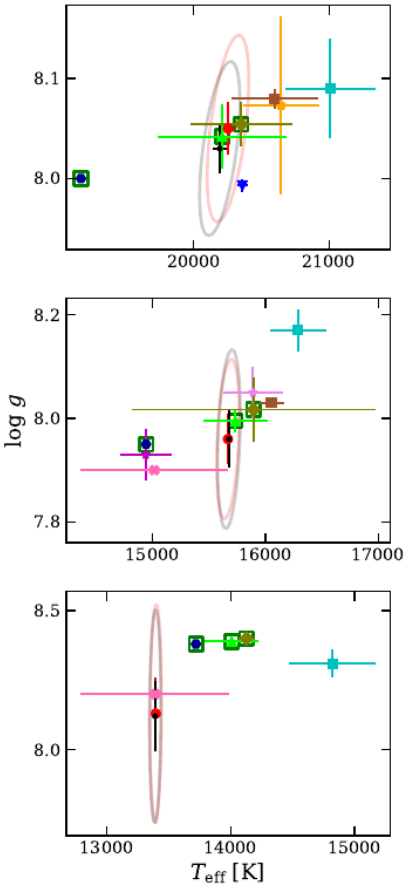
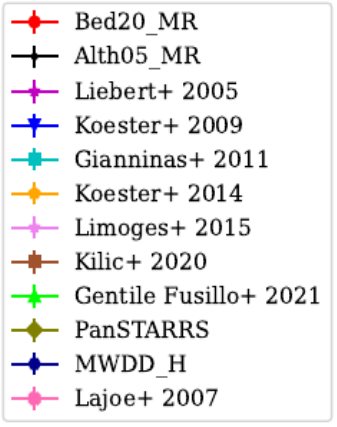


parameters span a wide range





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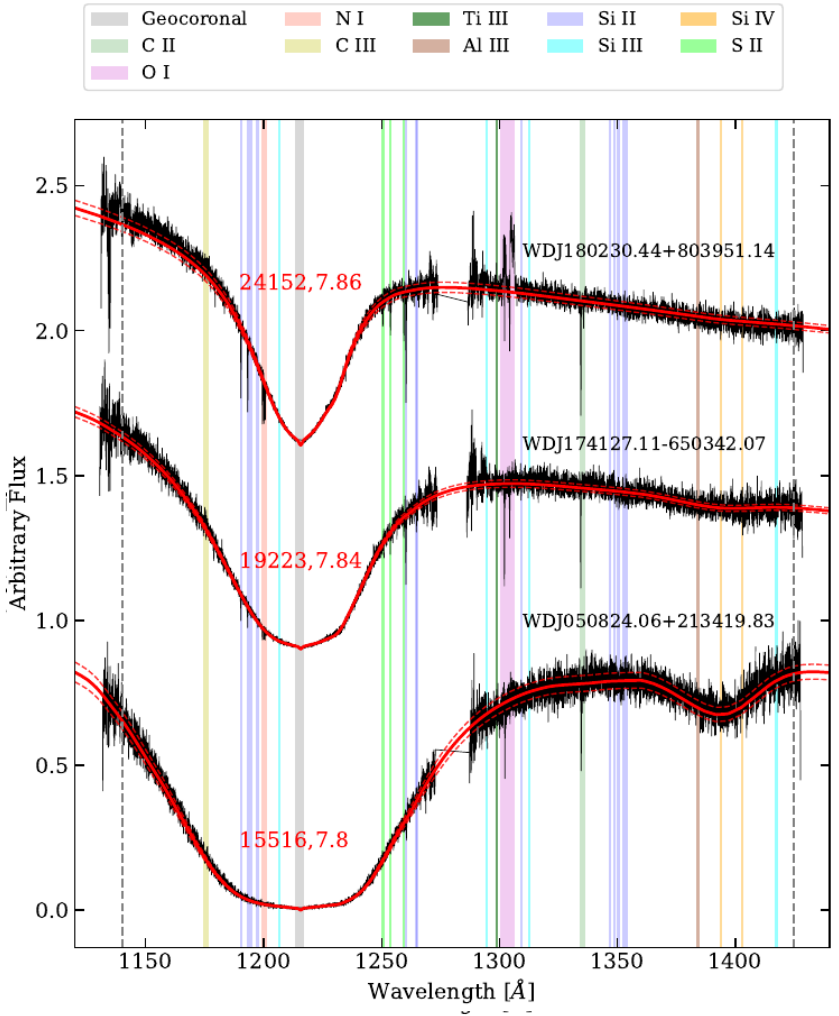

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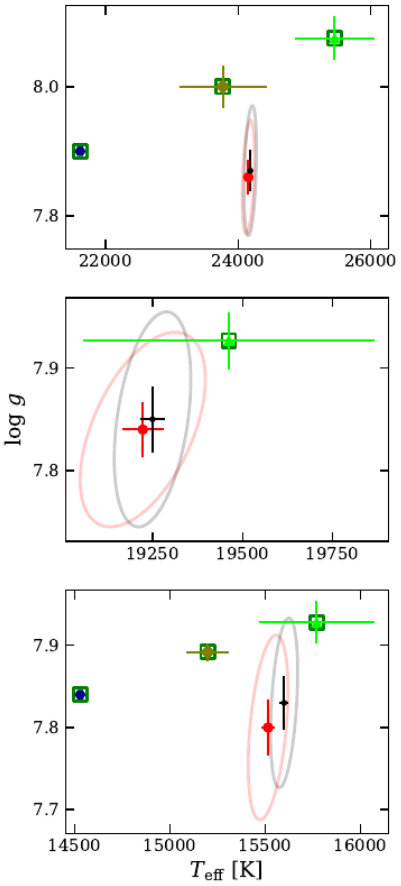

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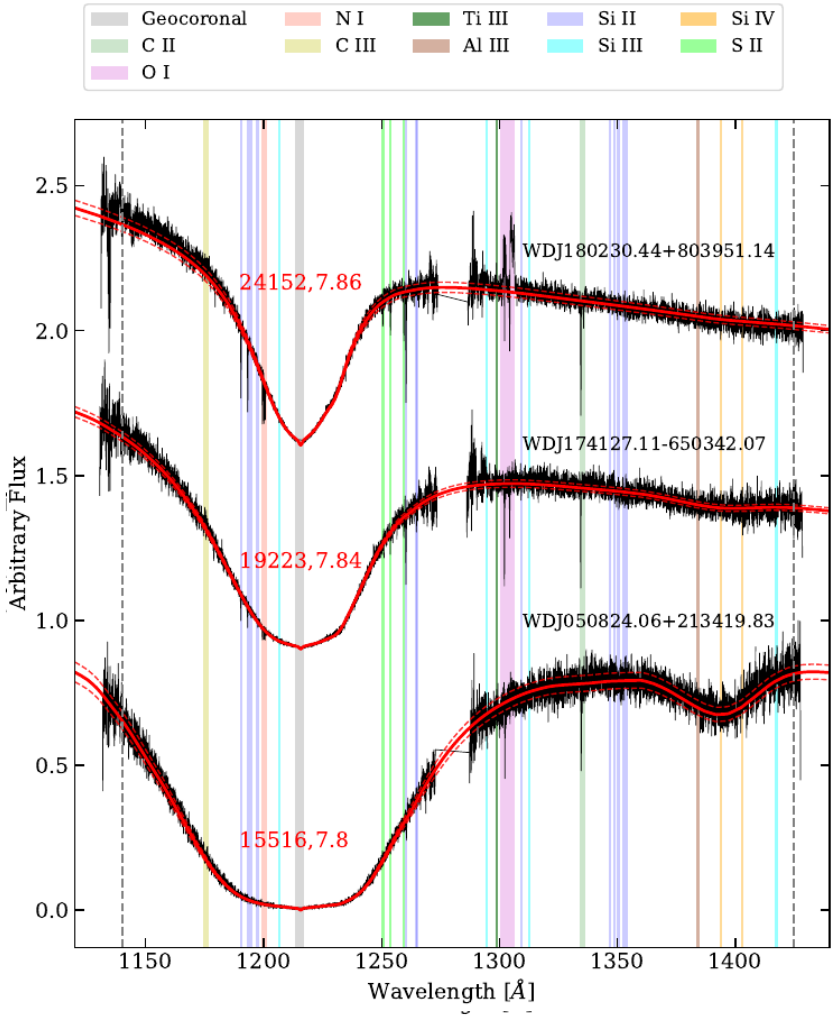

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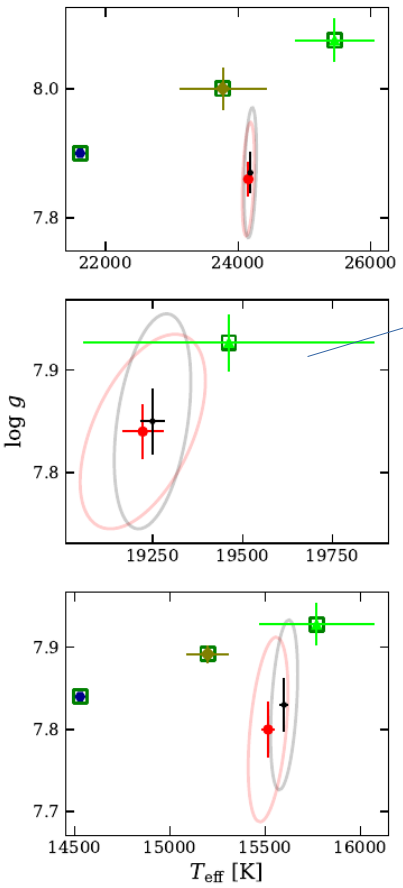

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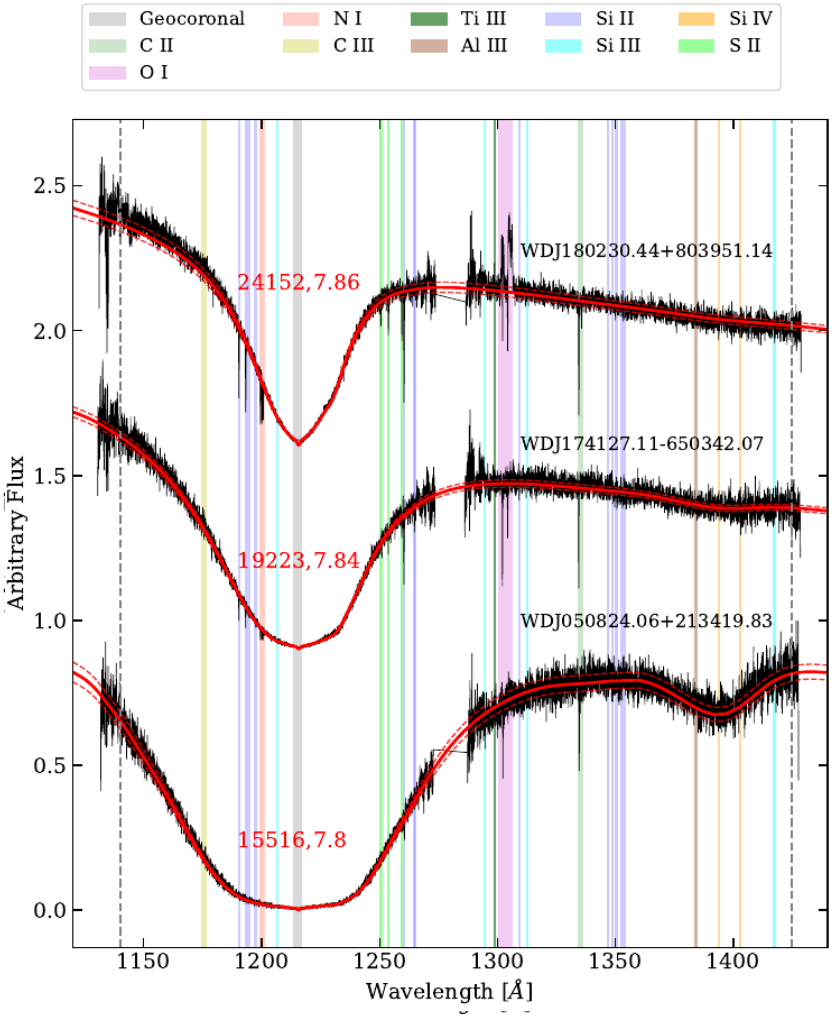
Model fit to HST/COS spectra

Good model fits and agreement with the published results



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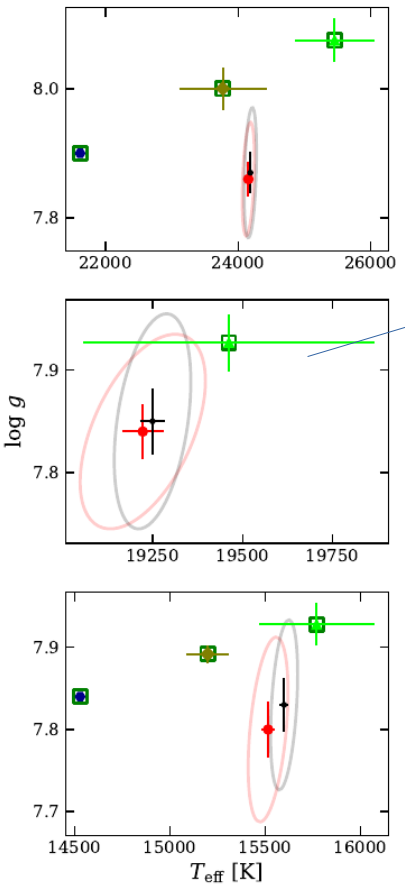

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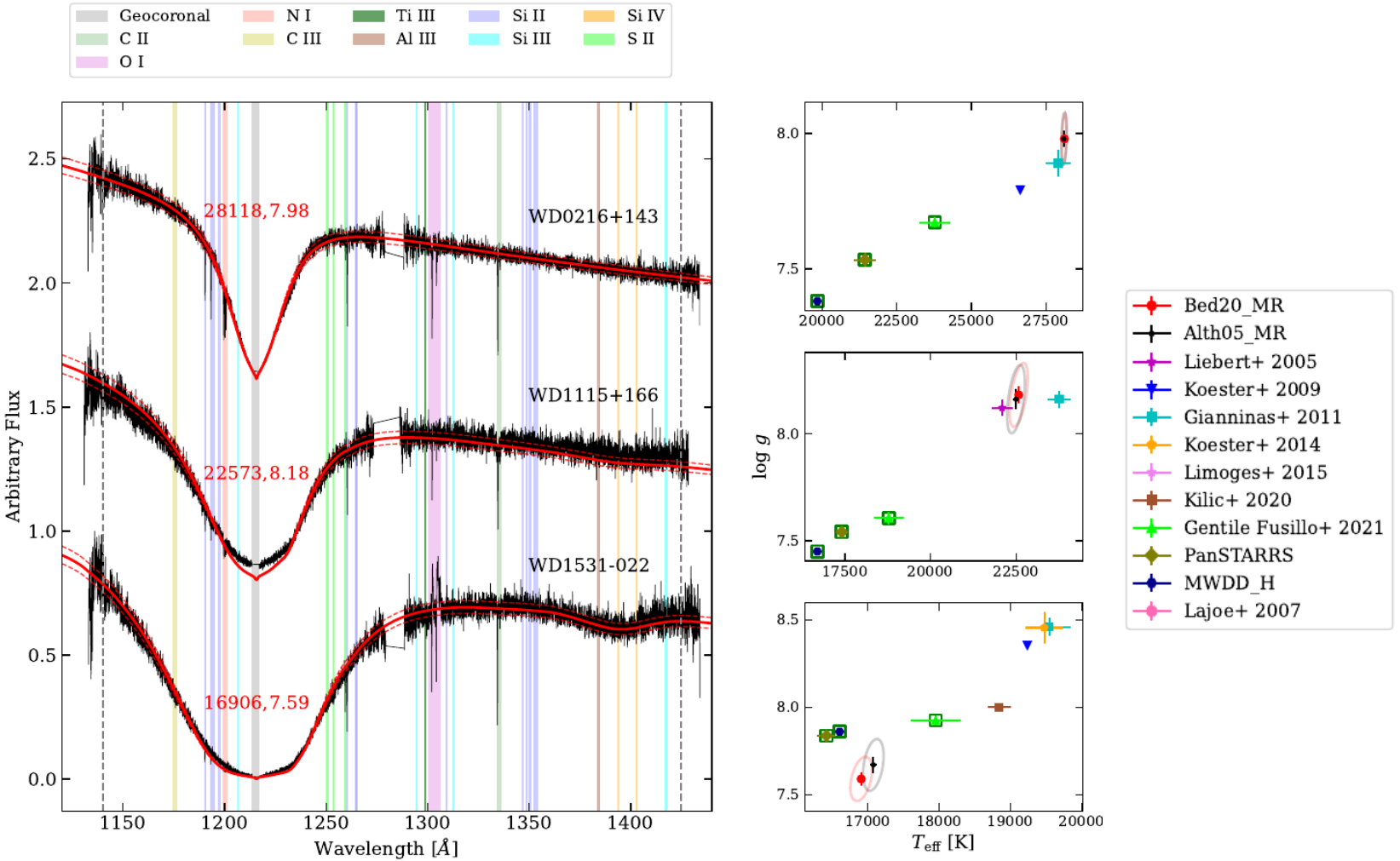

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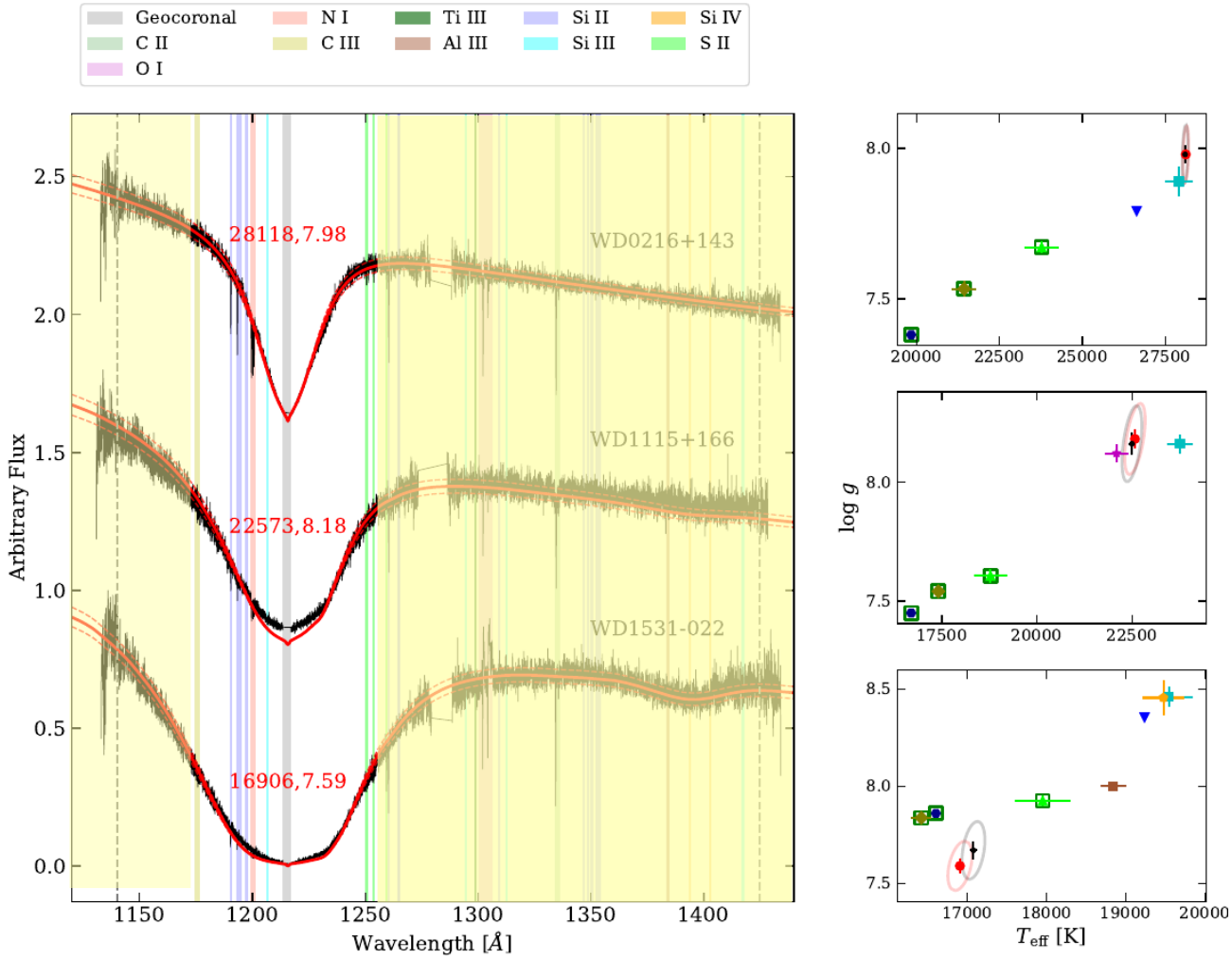

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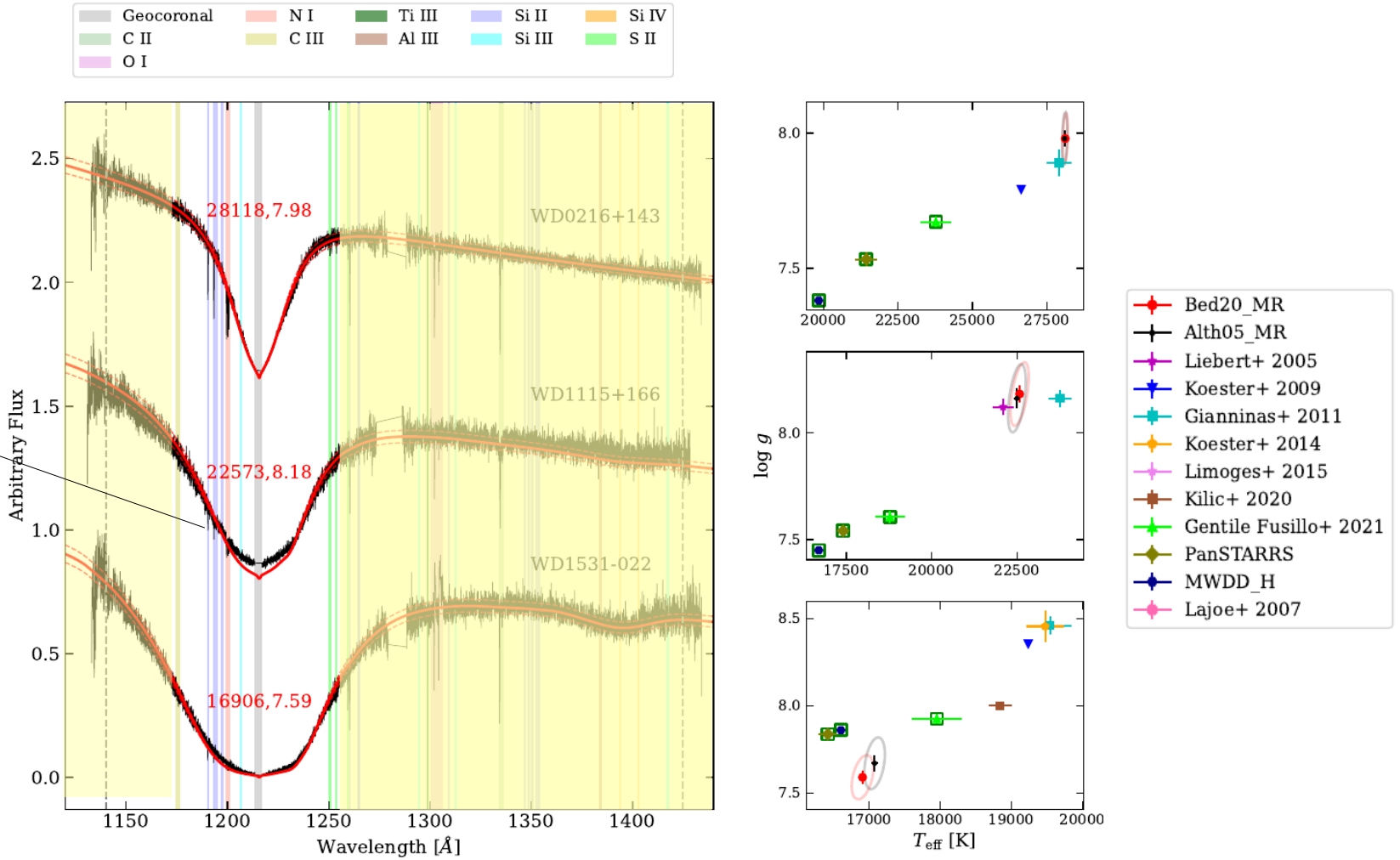

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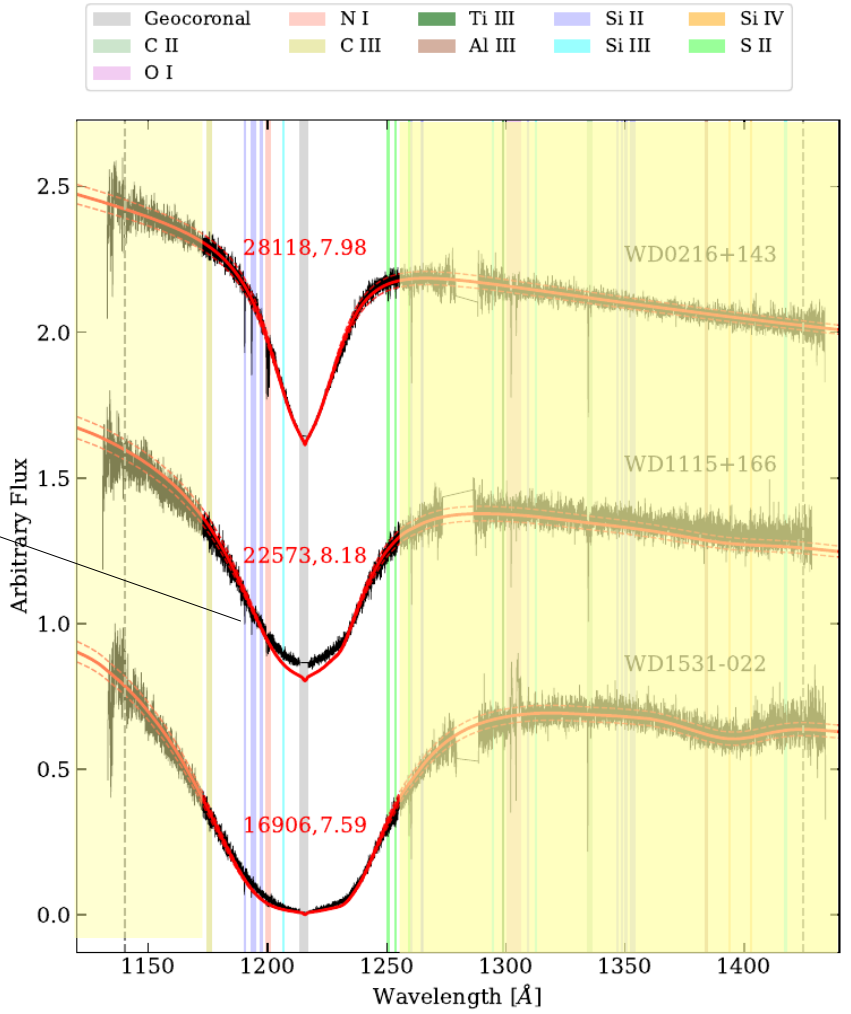

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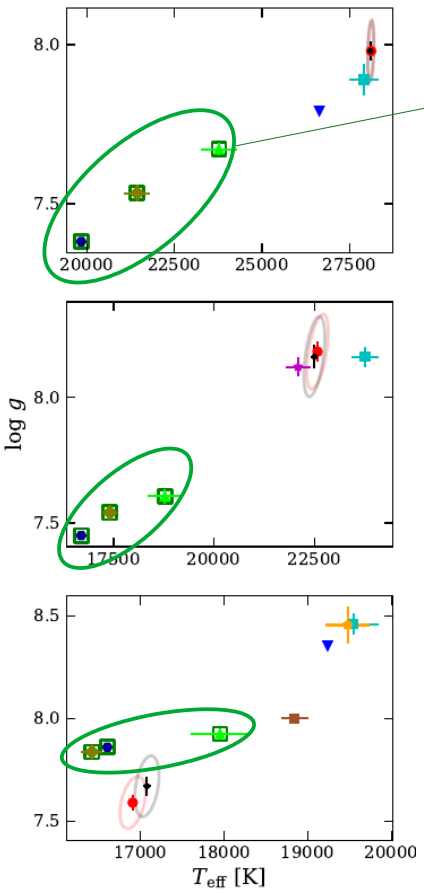

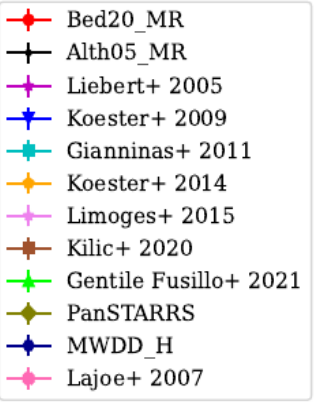

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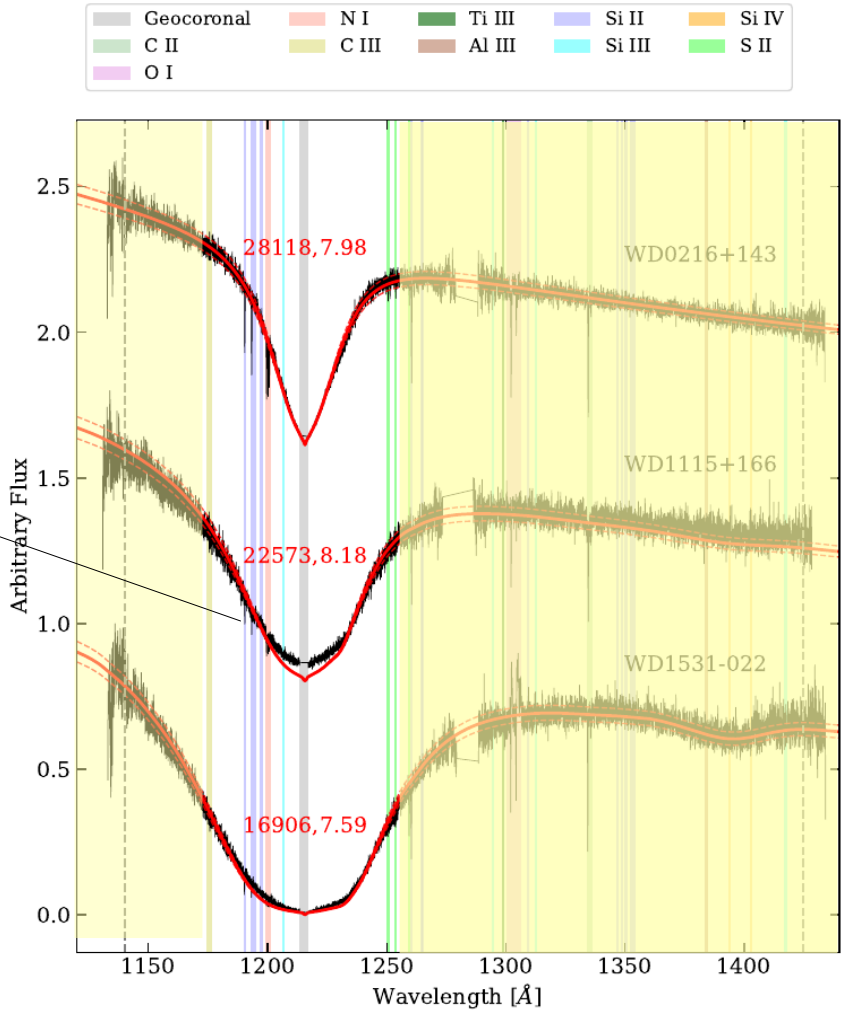

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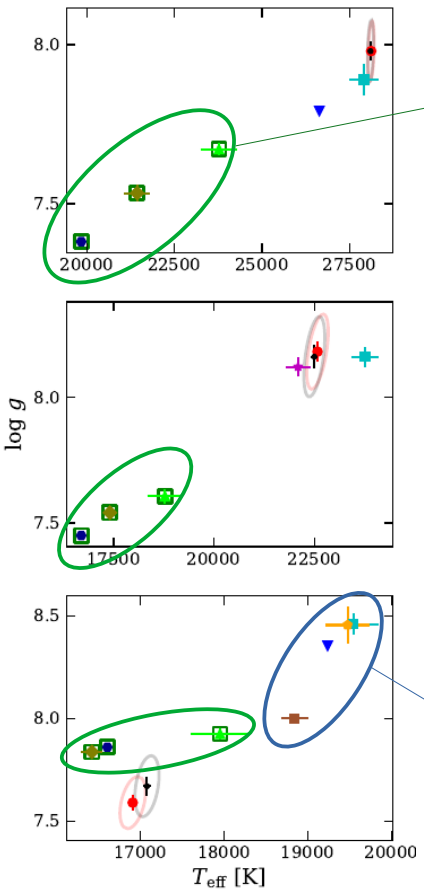

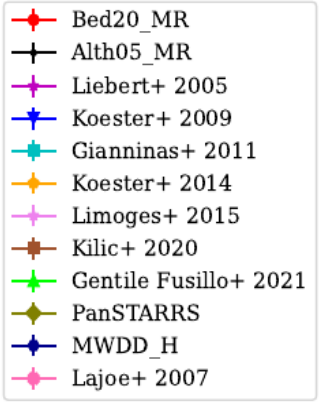

Spectroscopic estimates

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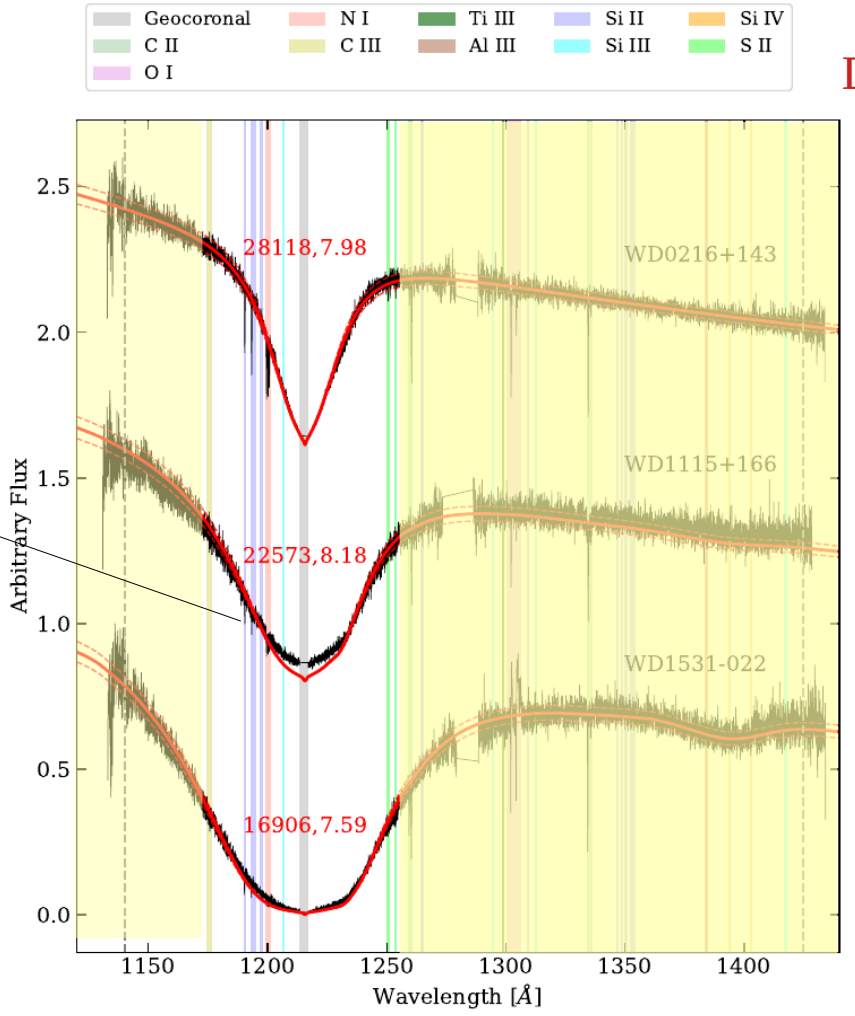
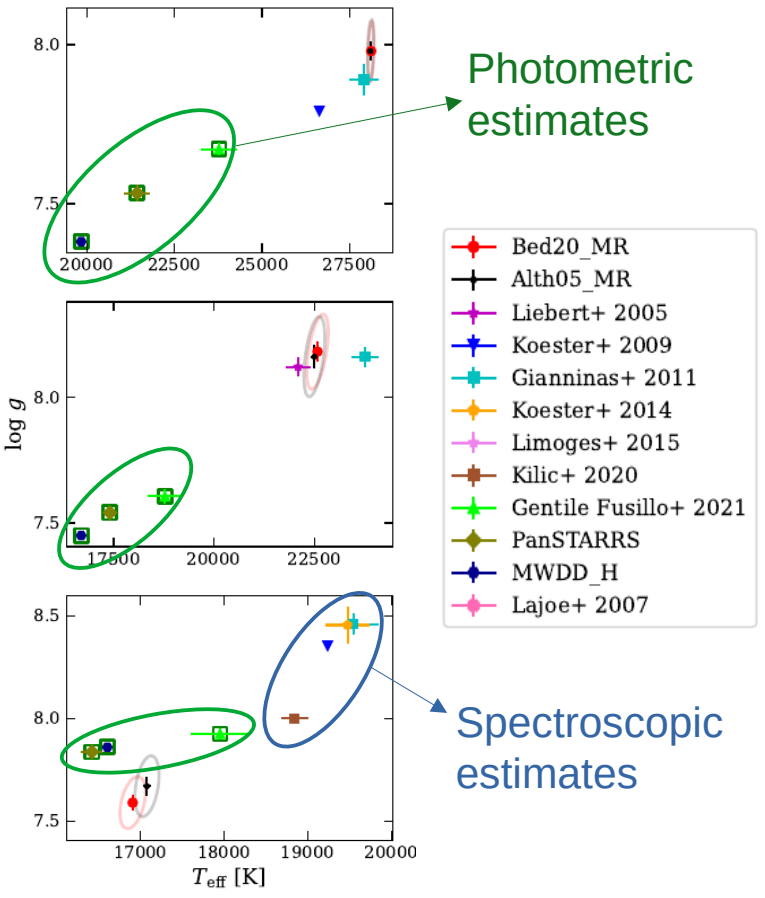
OUTLIERS??



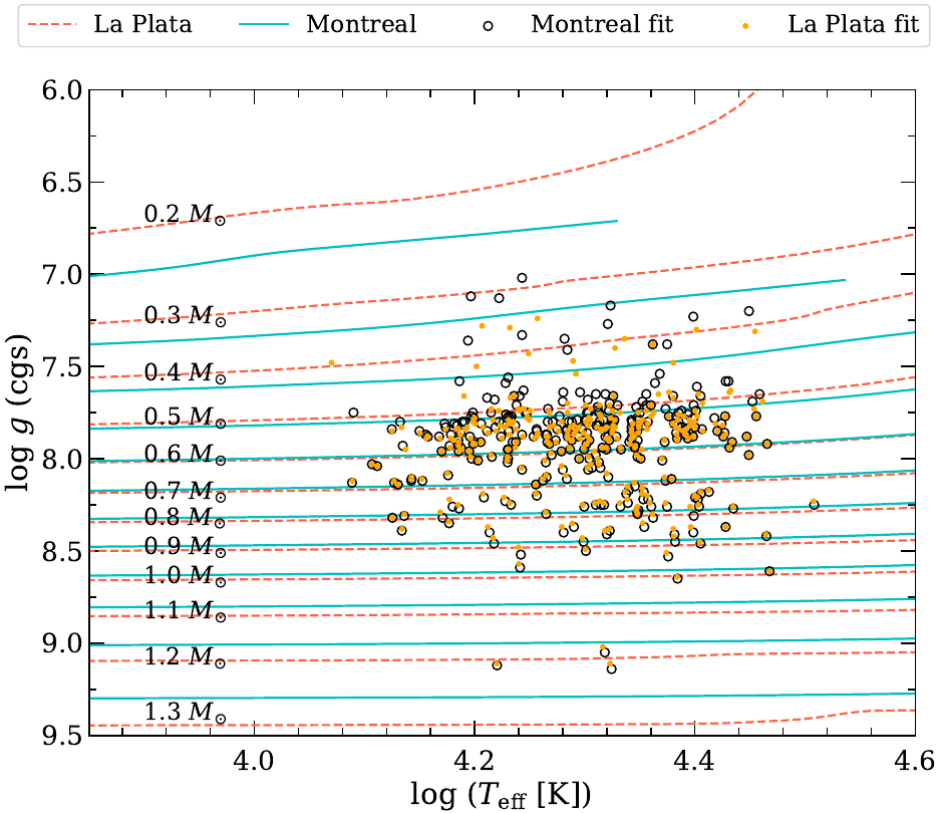
Disagreement with the published results

Photometric estimates

Spectroscopic estimates



Atmospheric parameters



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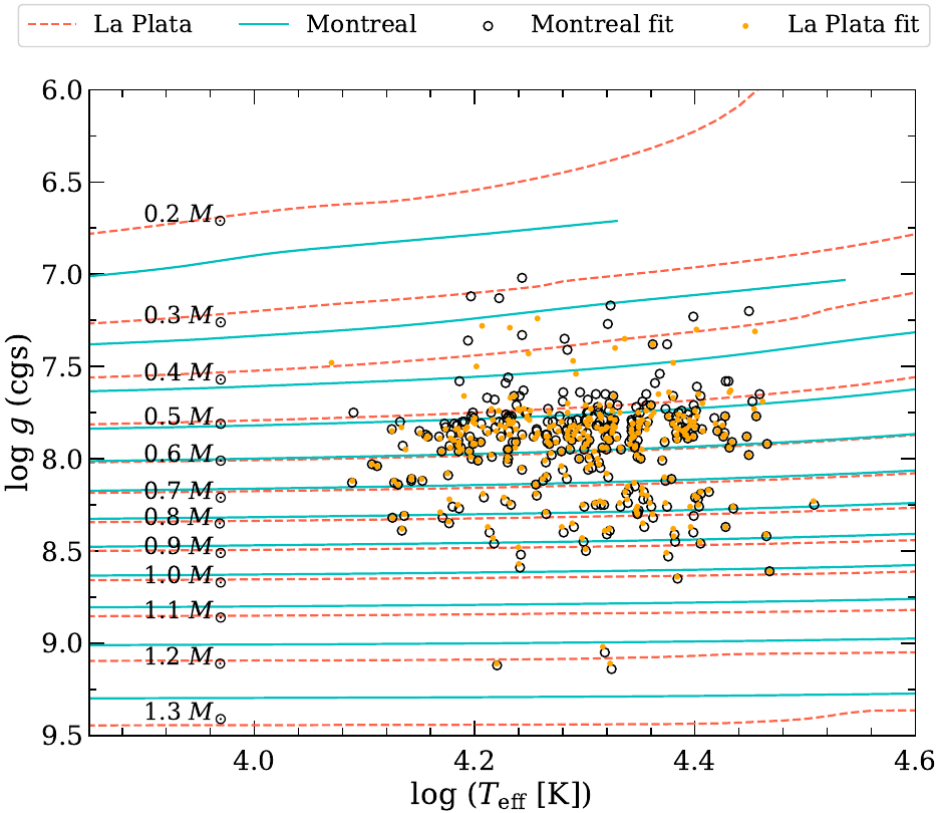
Atmospheric parameters

Mass-Distribution of DA WDs



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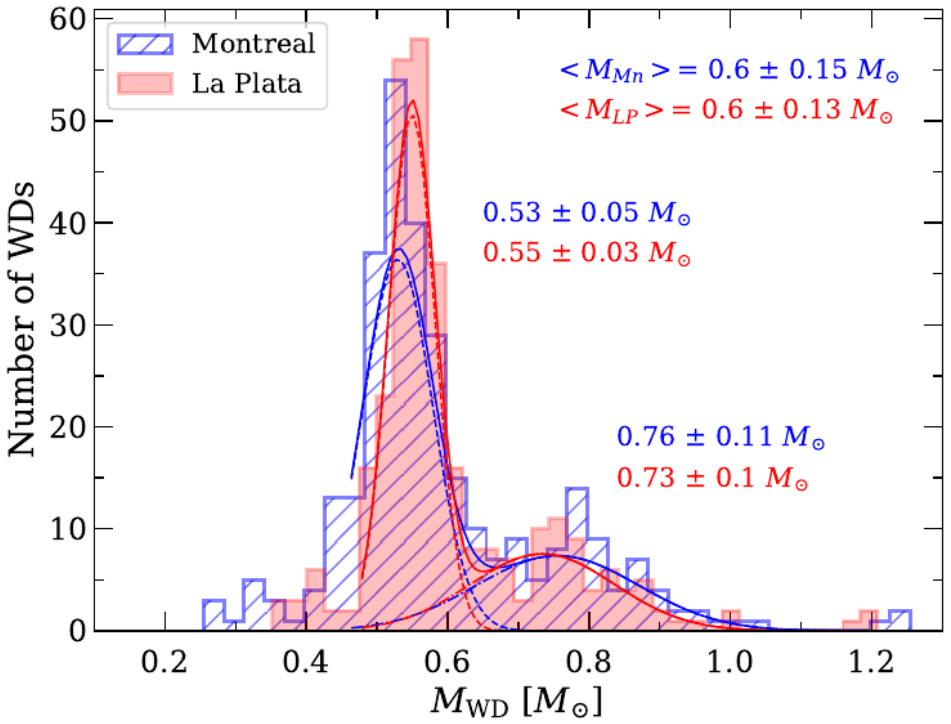

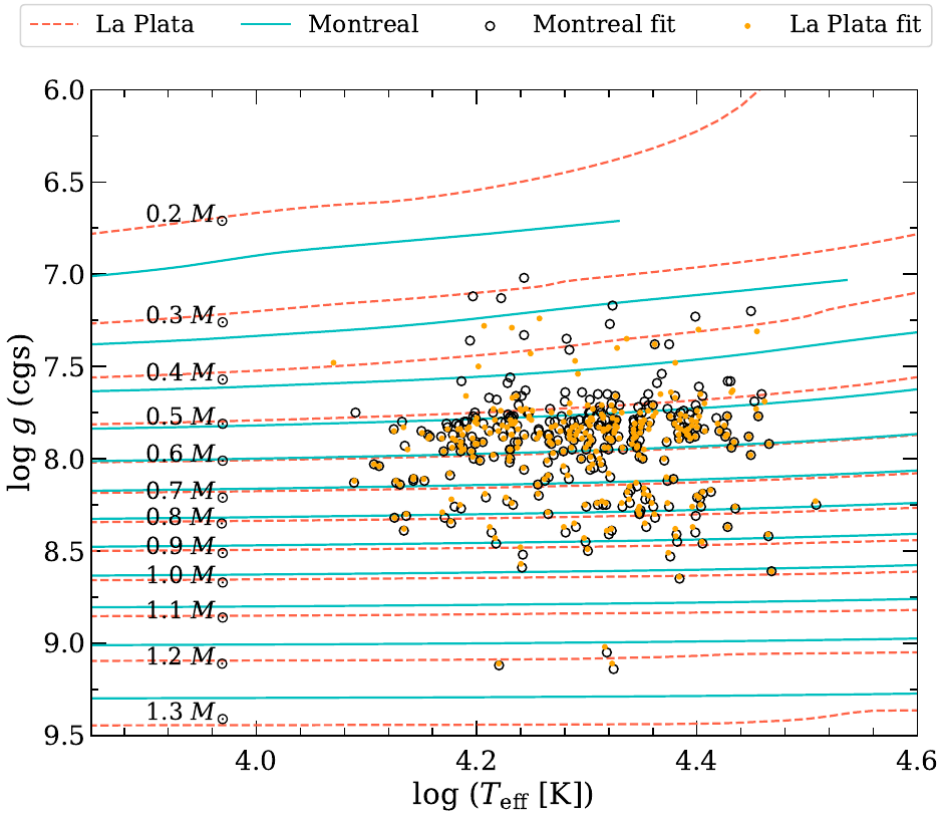

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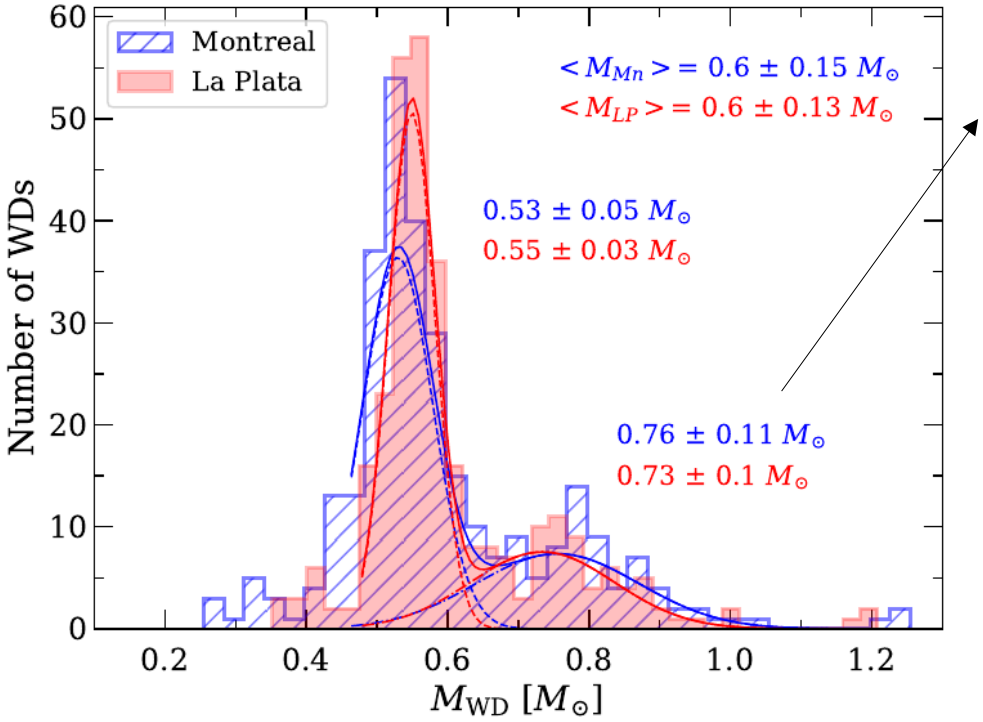

likely formed by binay mergers (Liebert+2005, Kleinman+2013)

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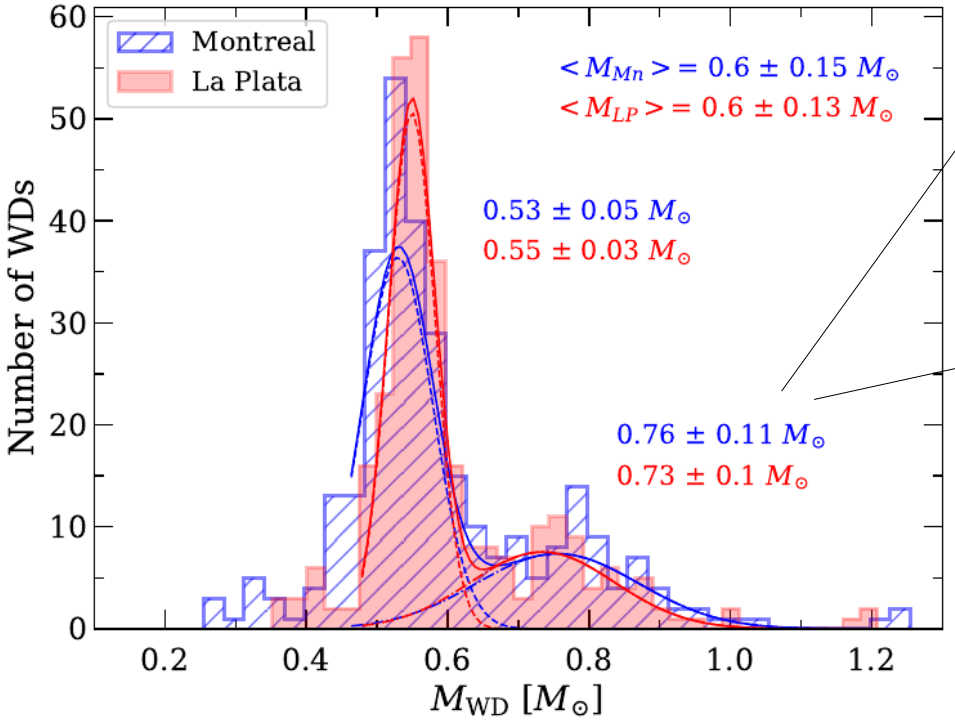

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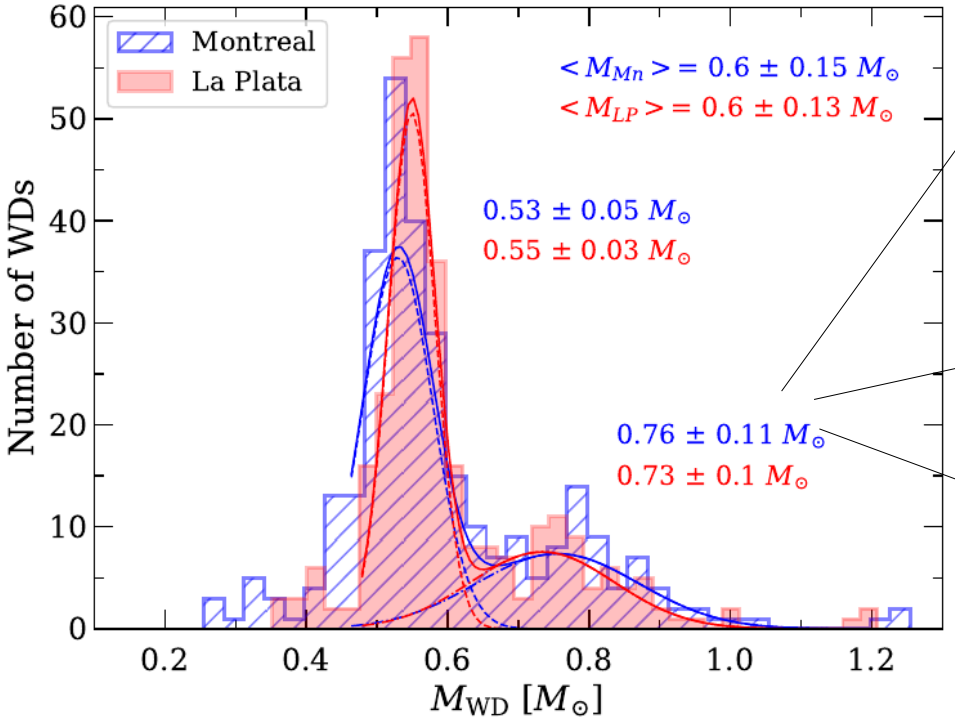
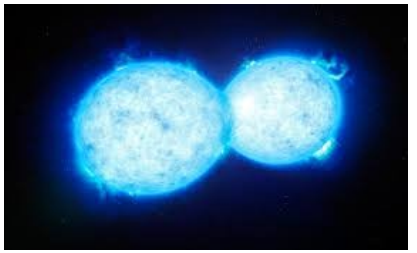
Mass-Distribution of DA WDs

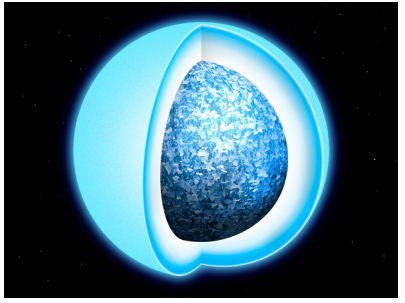




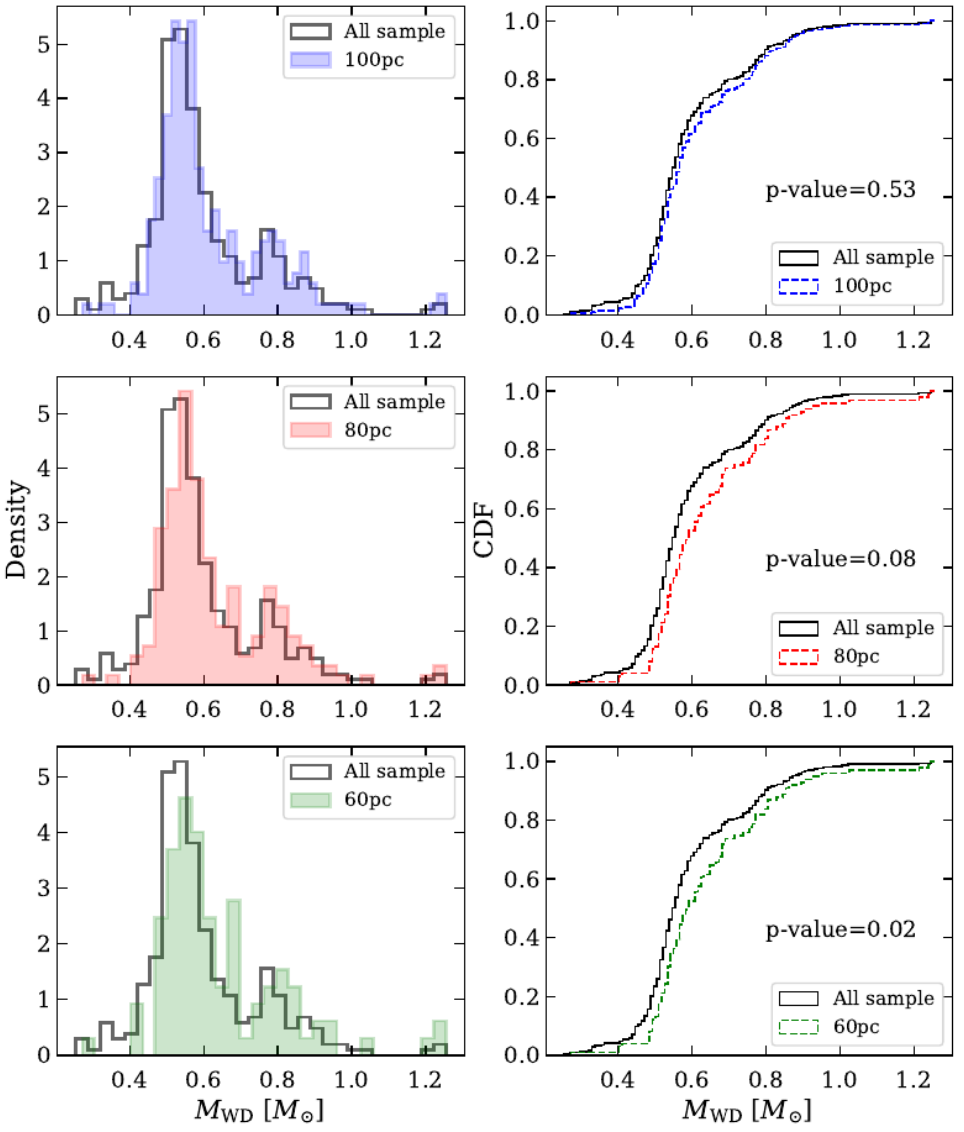
likely formed by binay mergers (Liebert+2005, Kleinman+2013)

IFMR
(Tremblay+2016, El-Badry+2018)

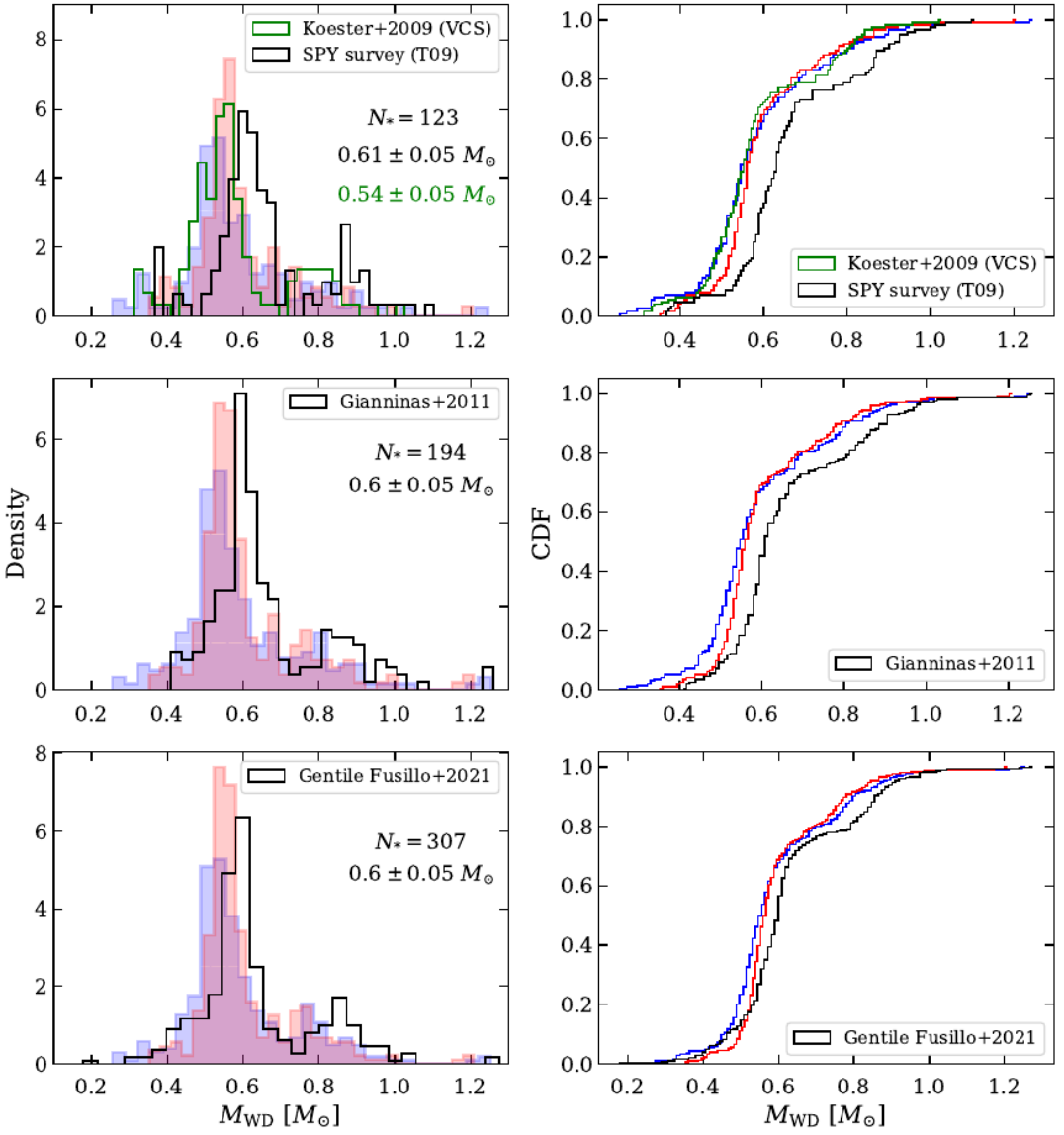
Crystallization
(Tremblay+2019, Kilic+20)



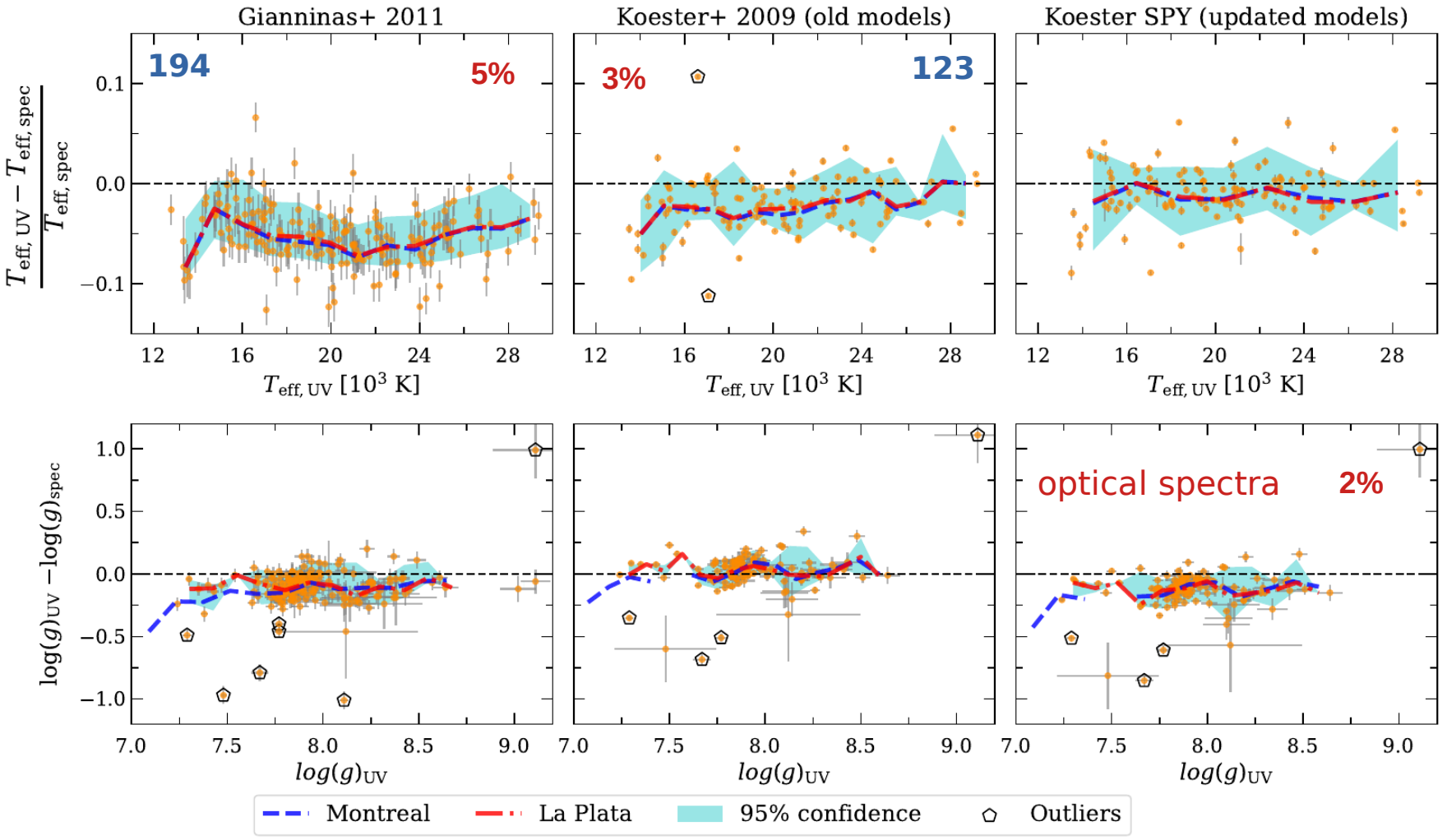
Mass distribution – how it varies with sample selection?



Mass distribution – Comaprison with previous optical studies



Comparison with spectroscopic estimates



Comparison with spectroscopic estimates

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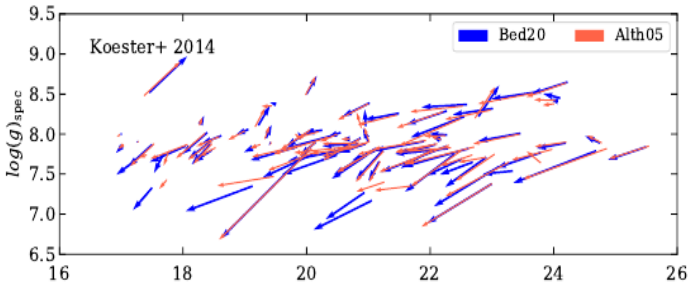
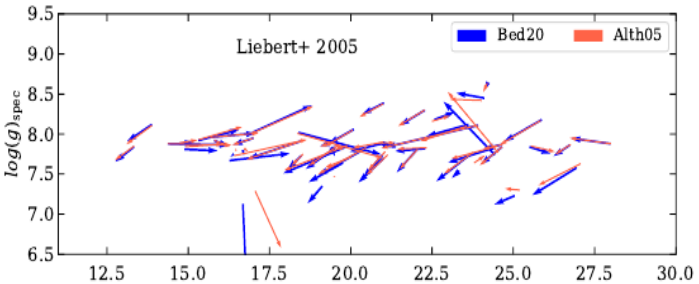
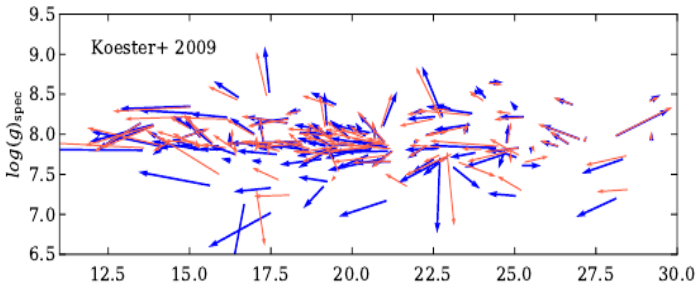
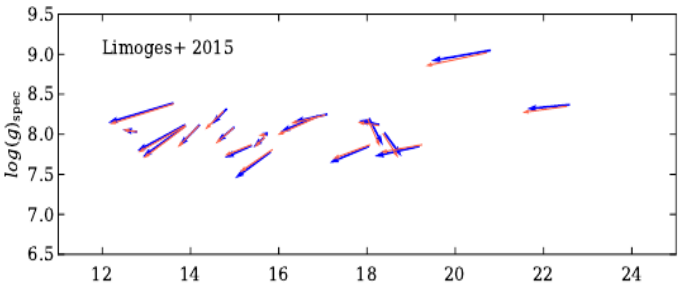




51

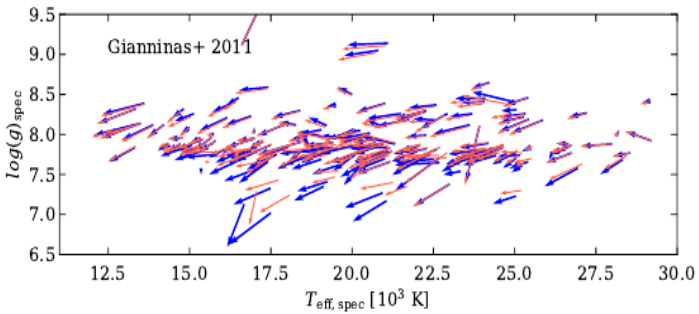
123

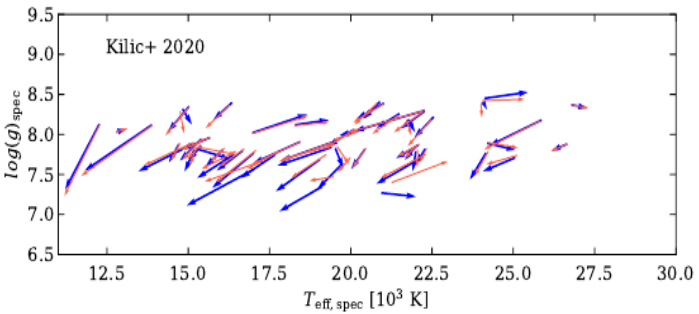




22

194

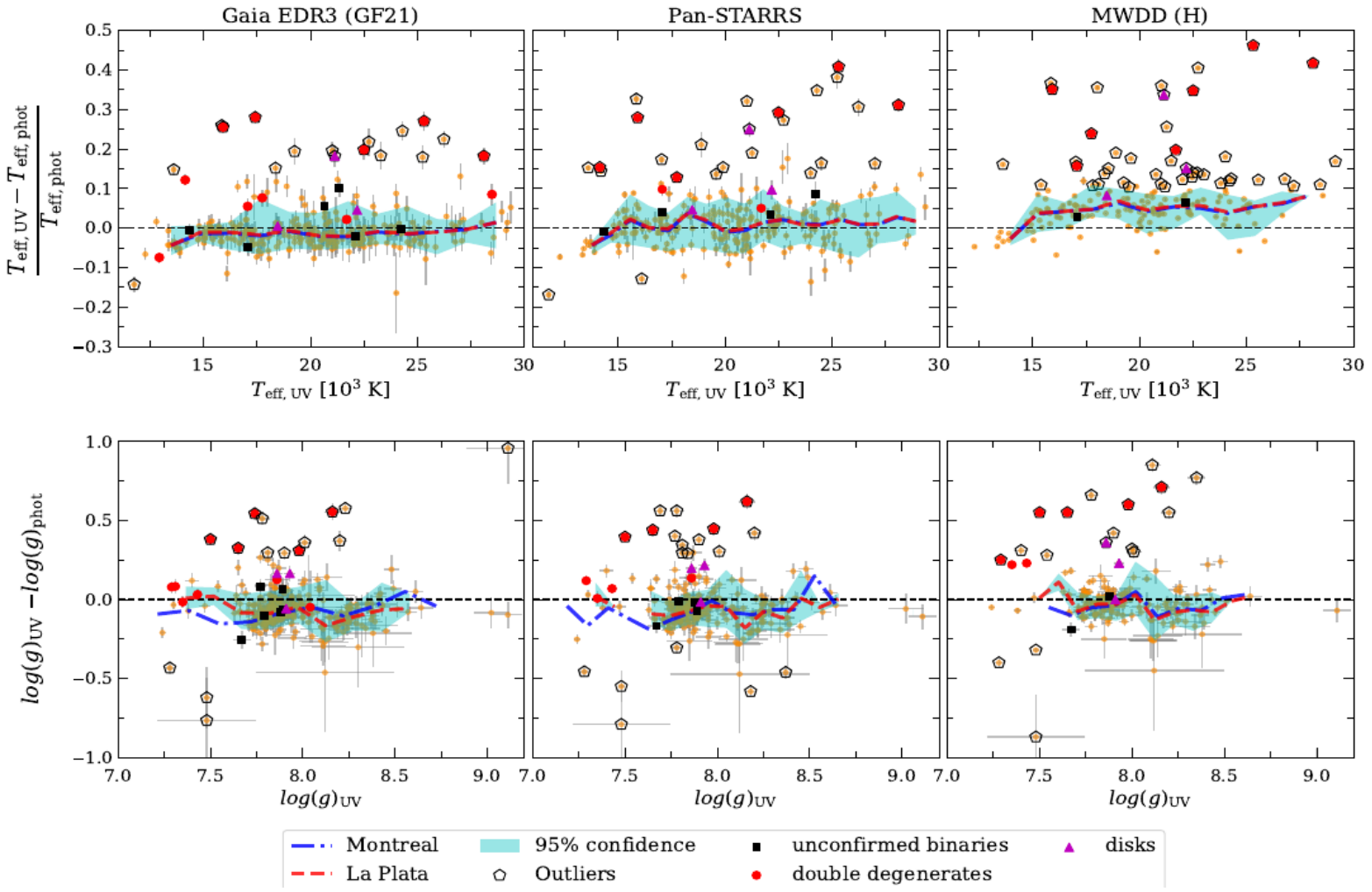




59

UV: lower *T*eff and log *g* values than published estimates

Comparison with Photometric estimates



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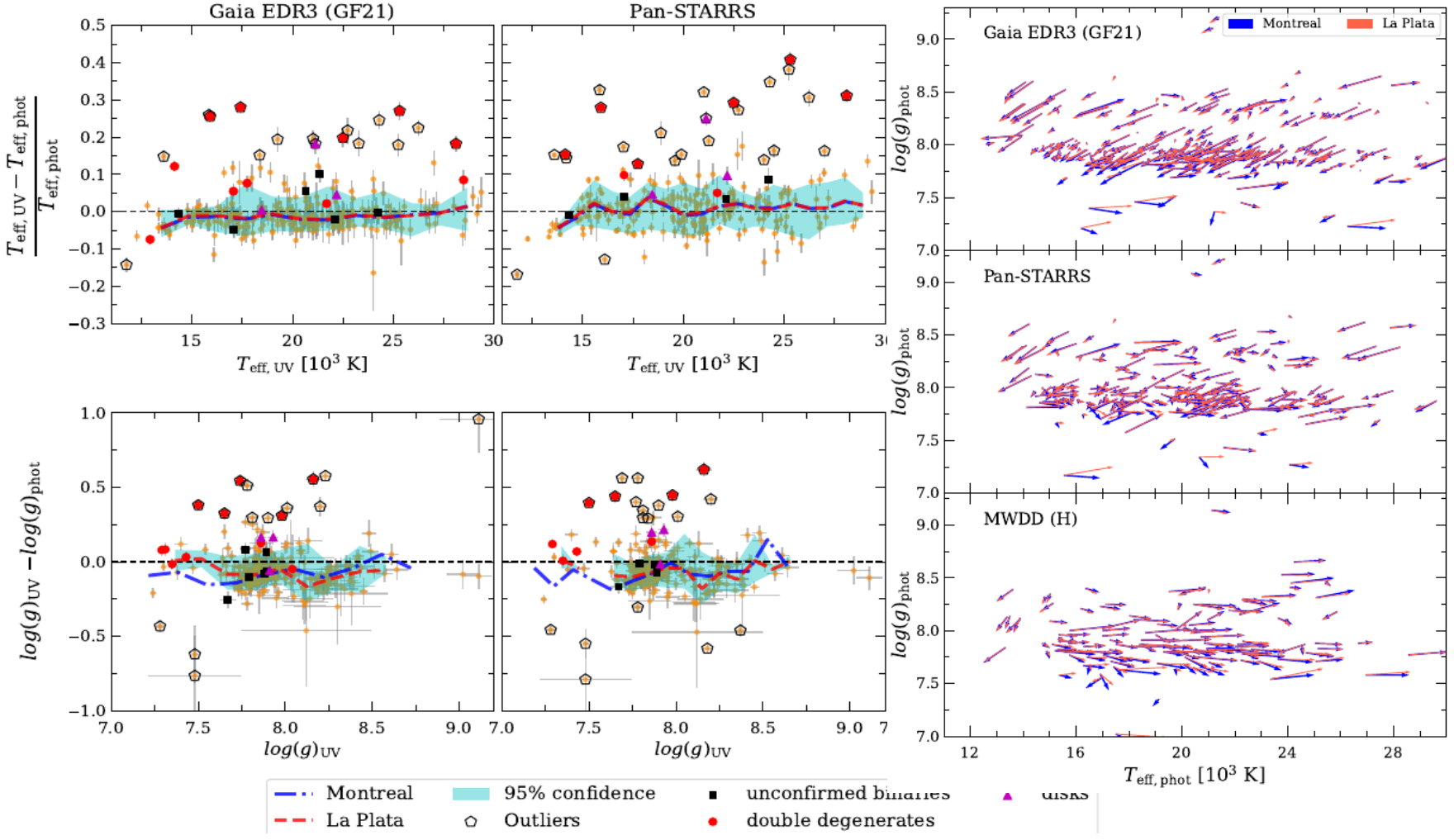

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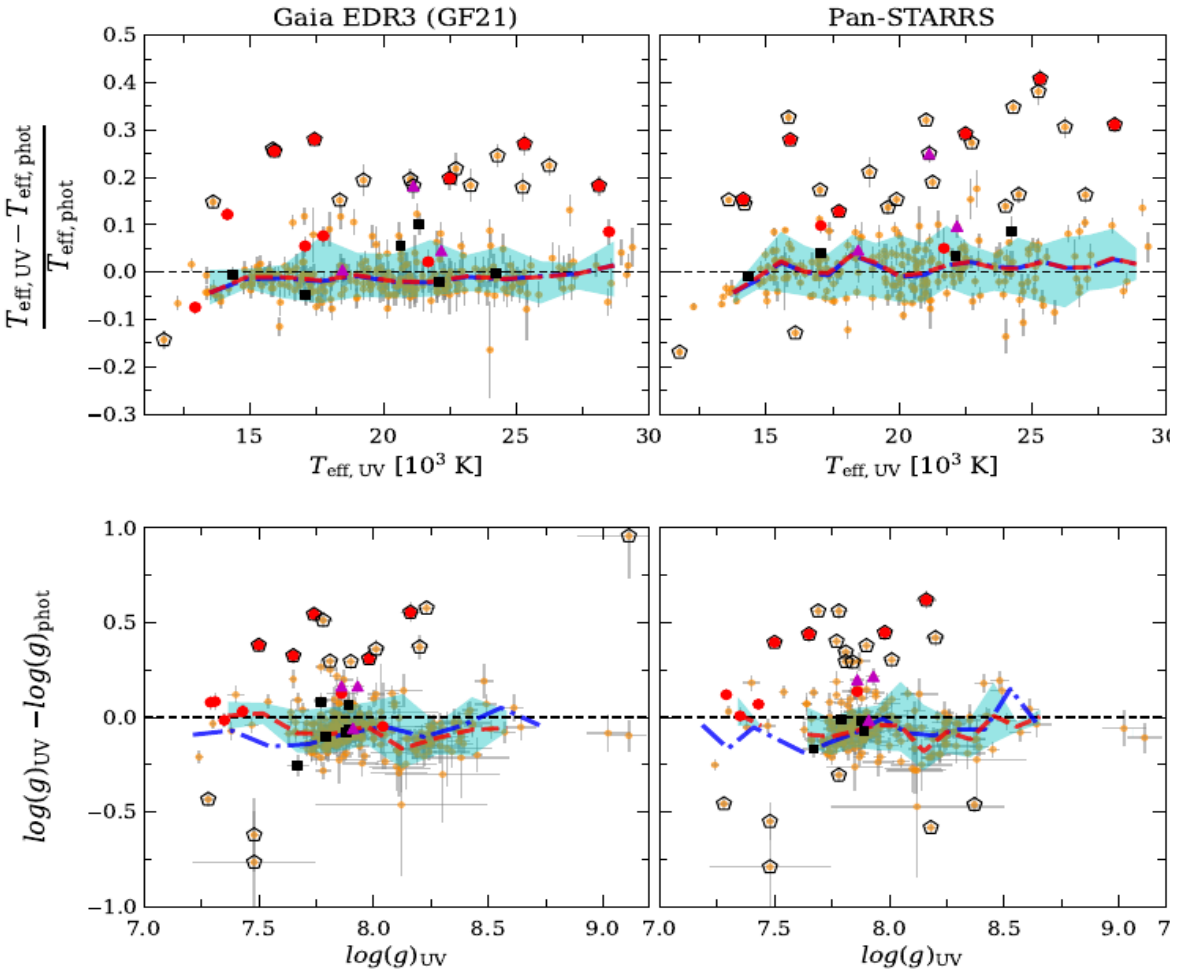

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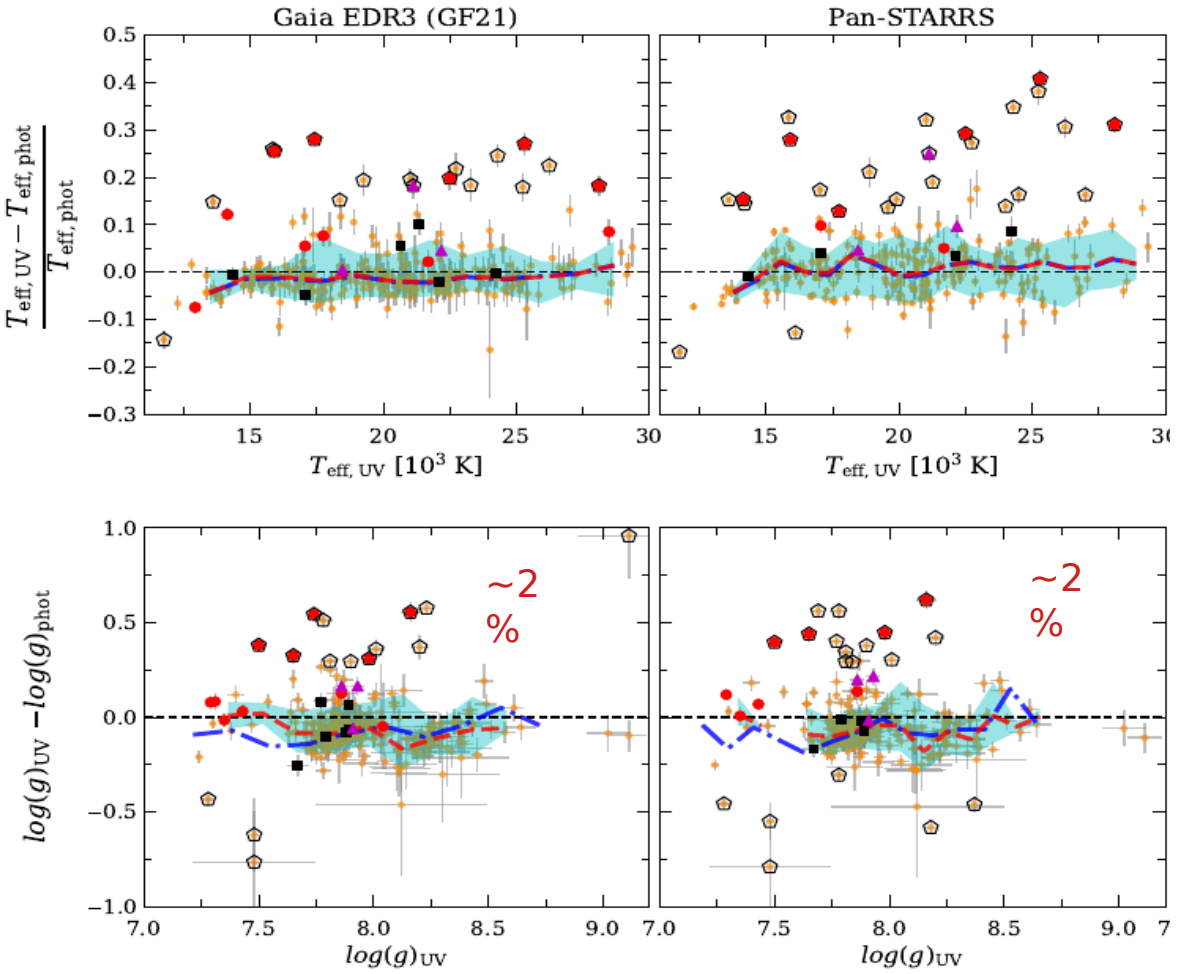
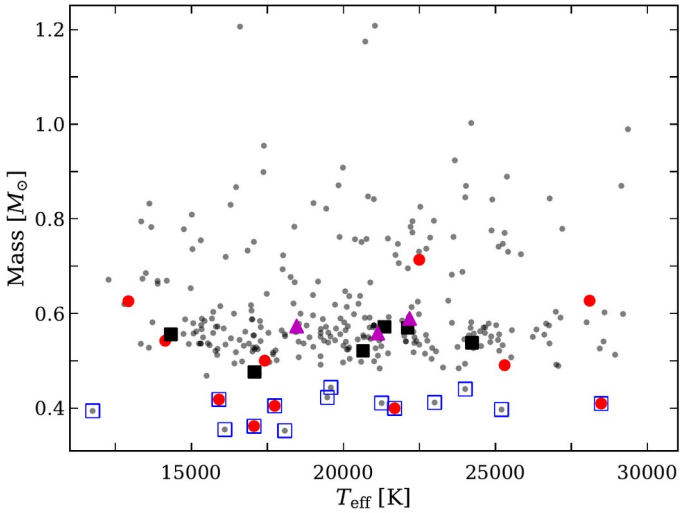
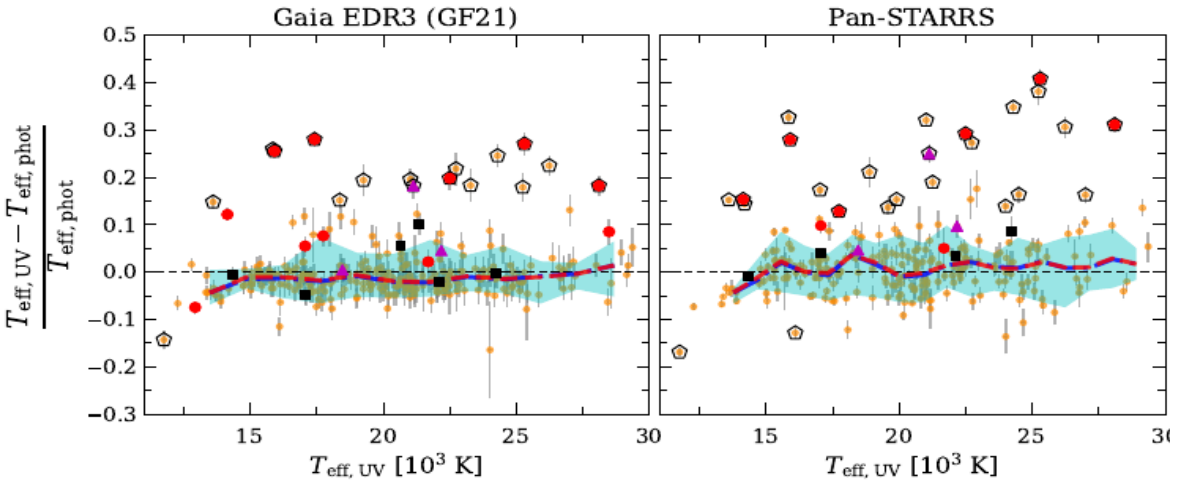
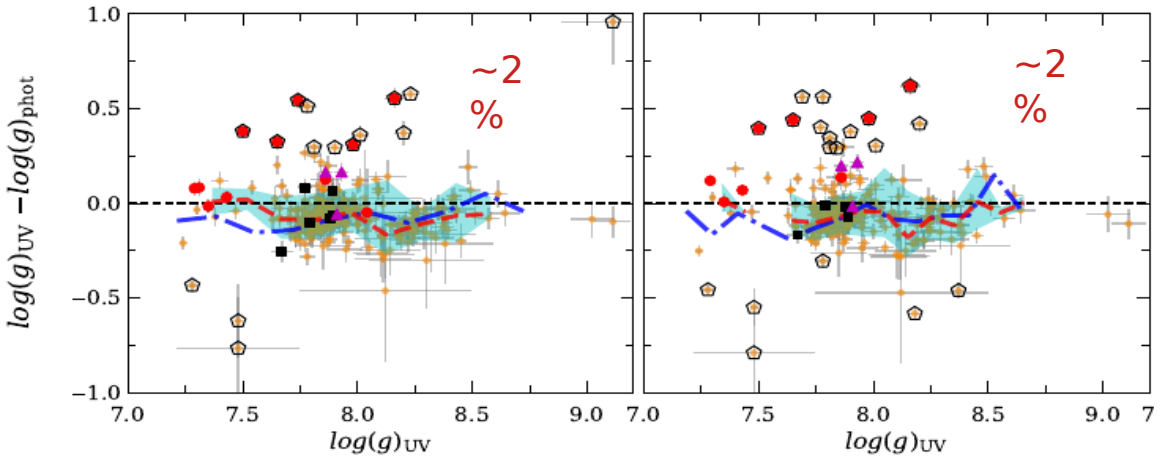


Comparison with Photometric estimates







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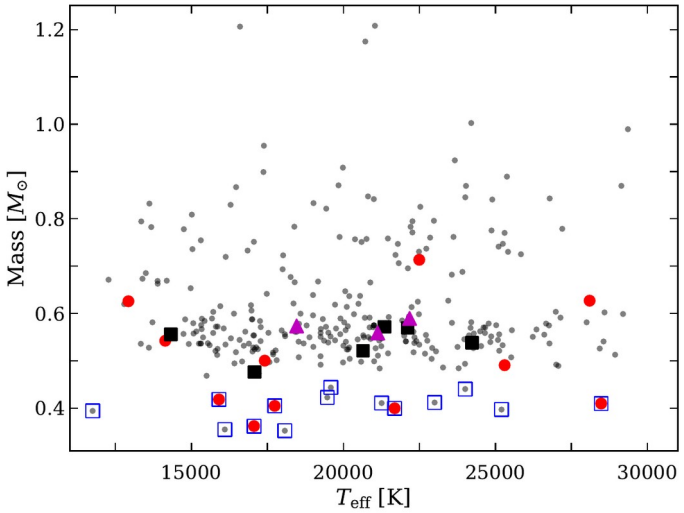
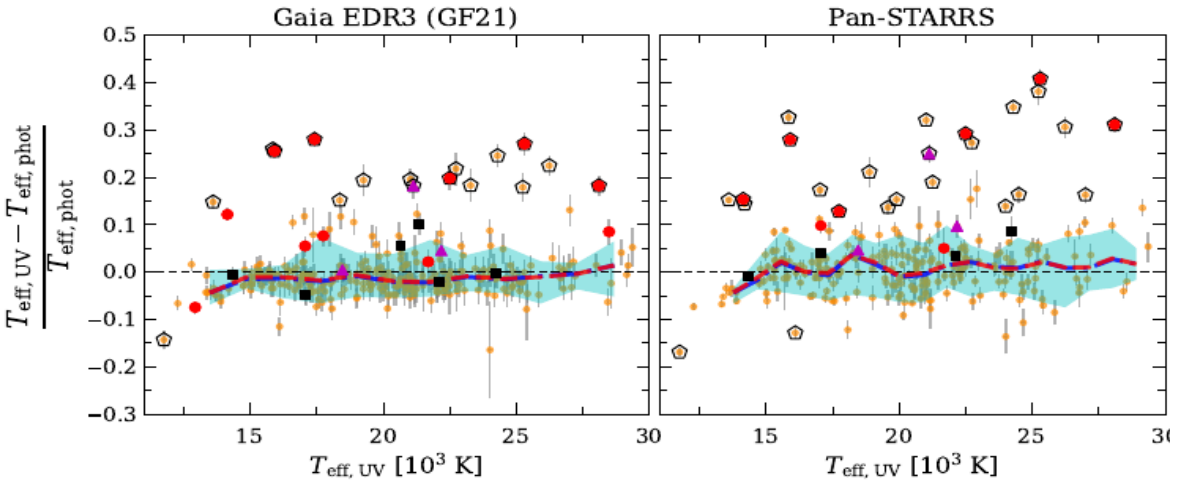
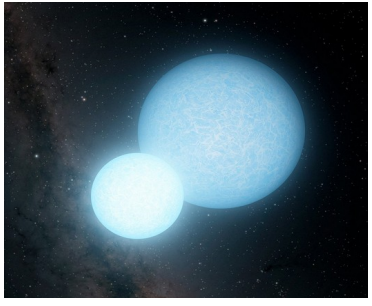


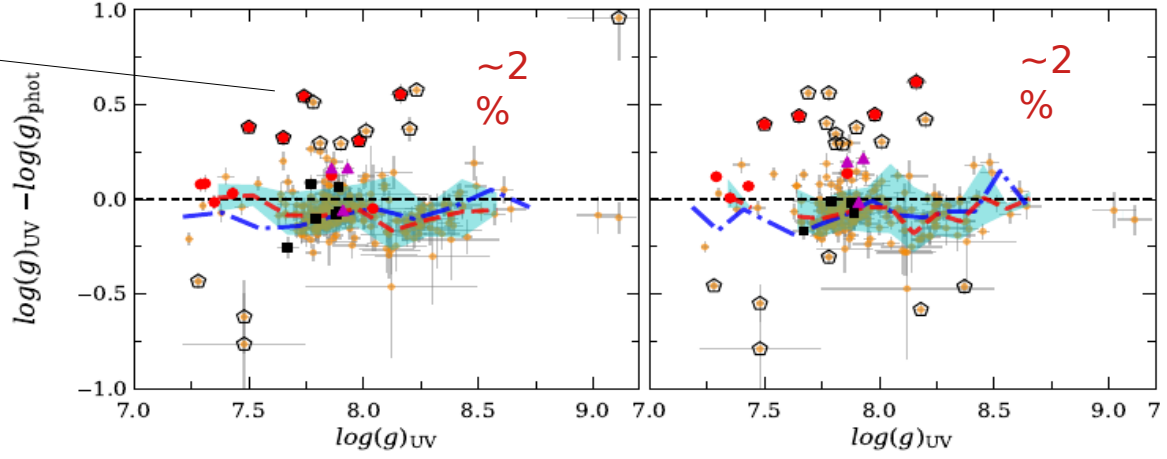


Photometric Outliers (~7%)



Binaries?
(Tremblay+2011)

Magnetic?



Conclusion

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  - First spectroscopic parameters of 49 **WDs**.
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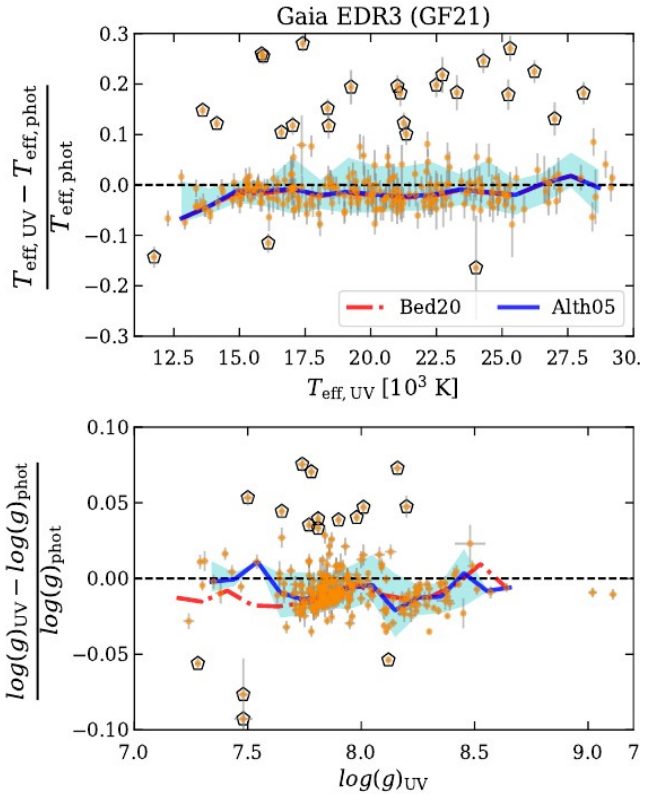
email: Snehalata.Sahu@warwick.ac.uk

Comparison with Photometric estimates



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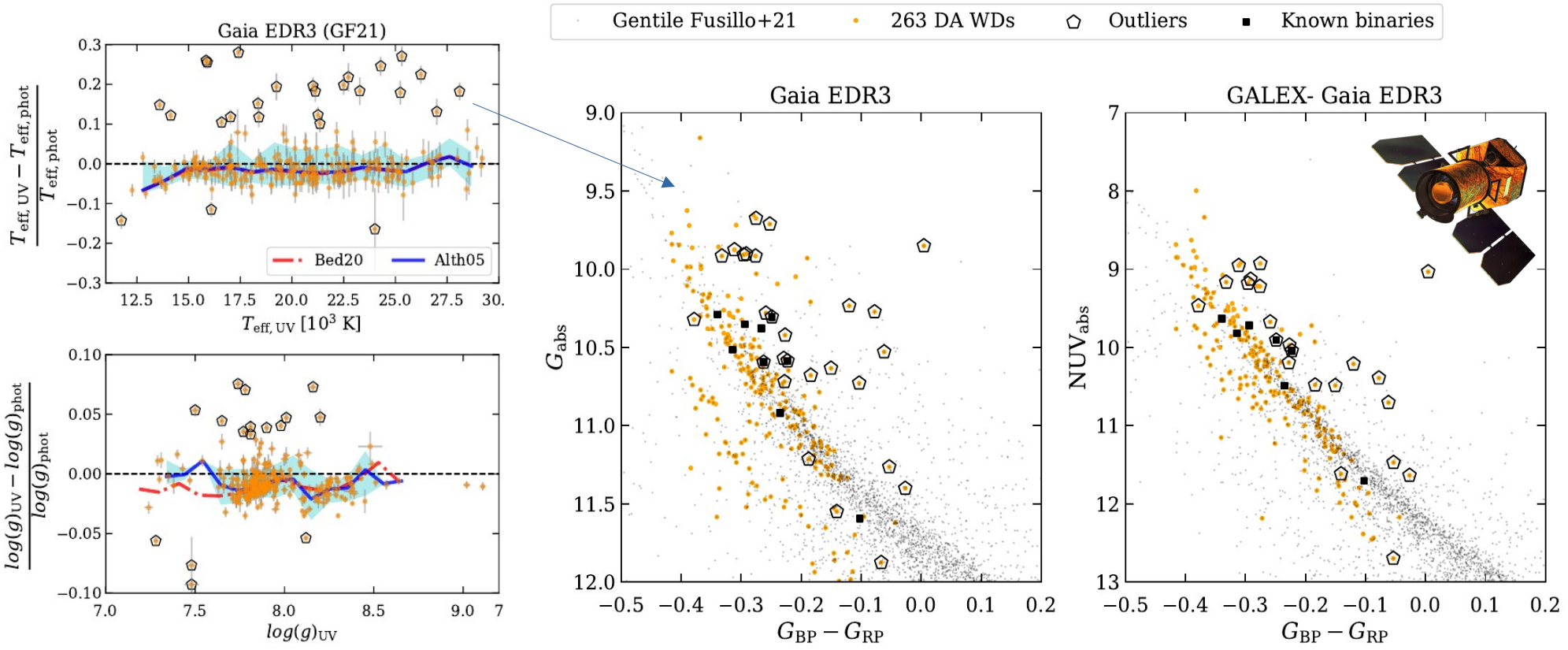

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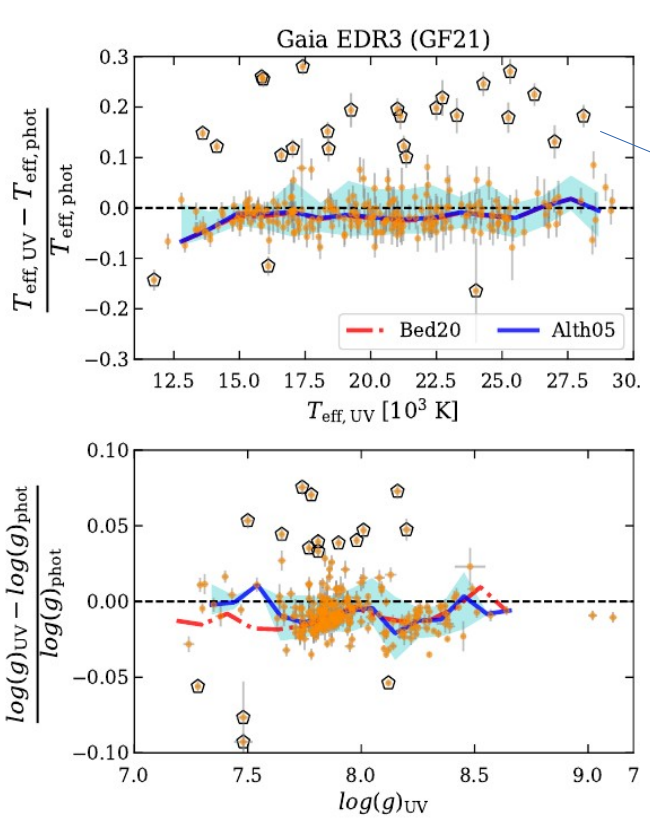
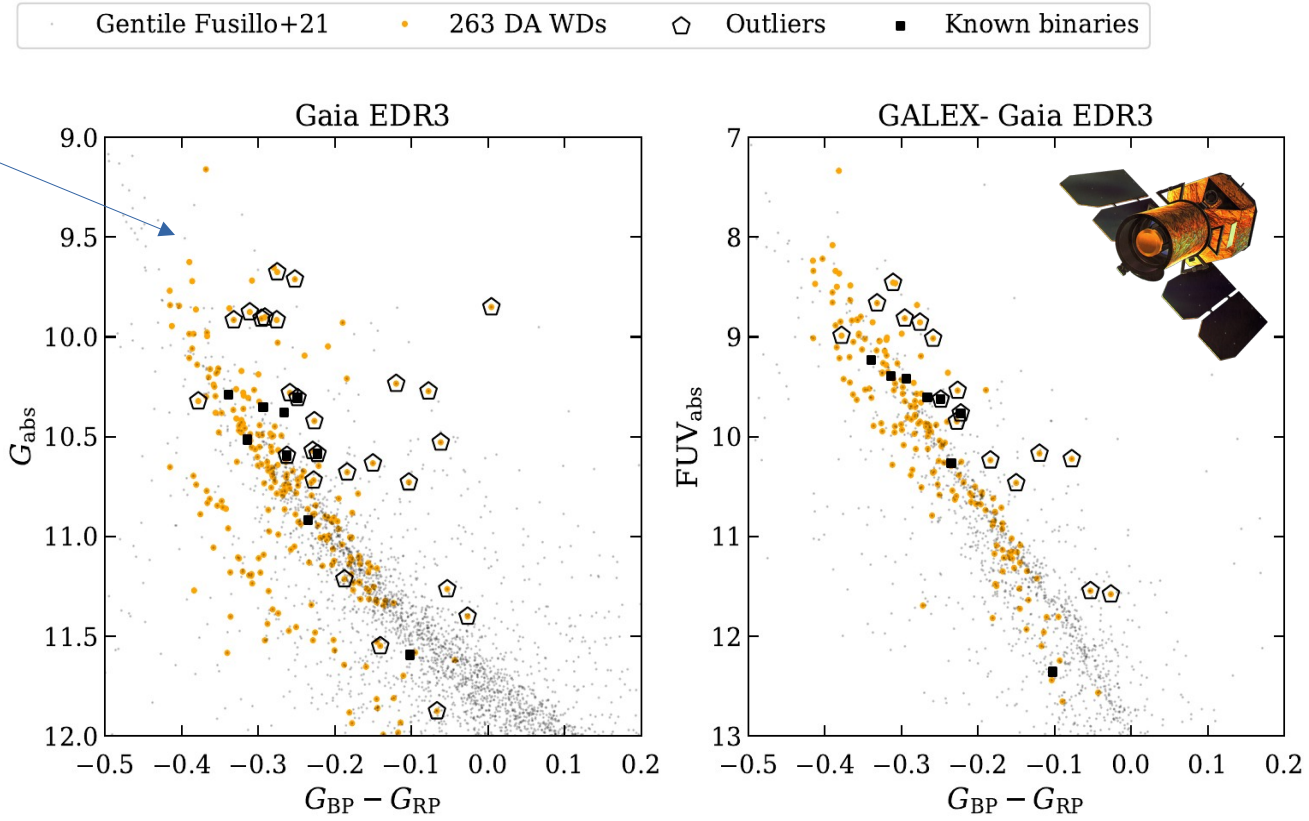
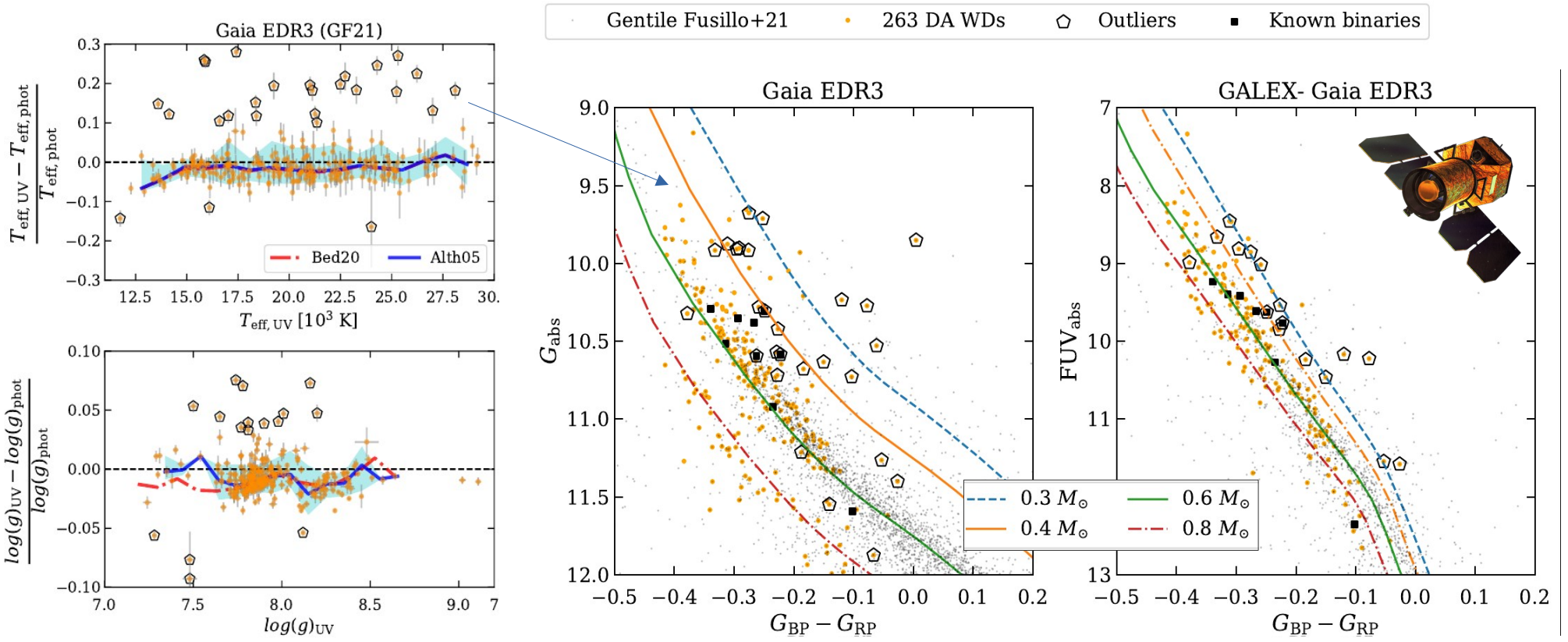
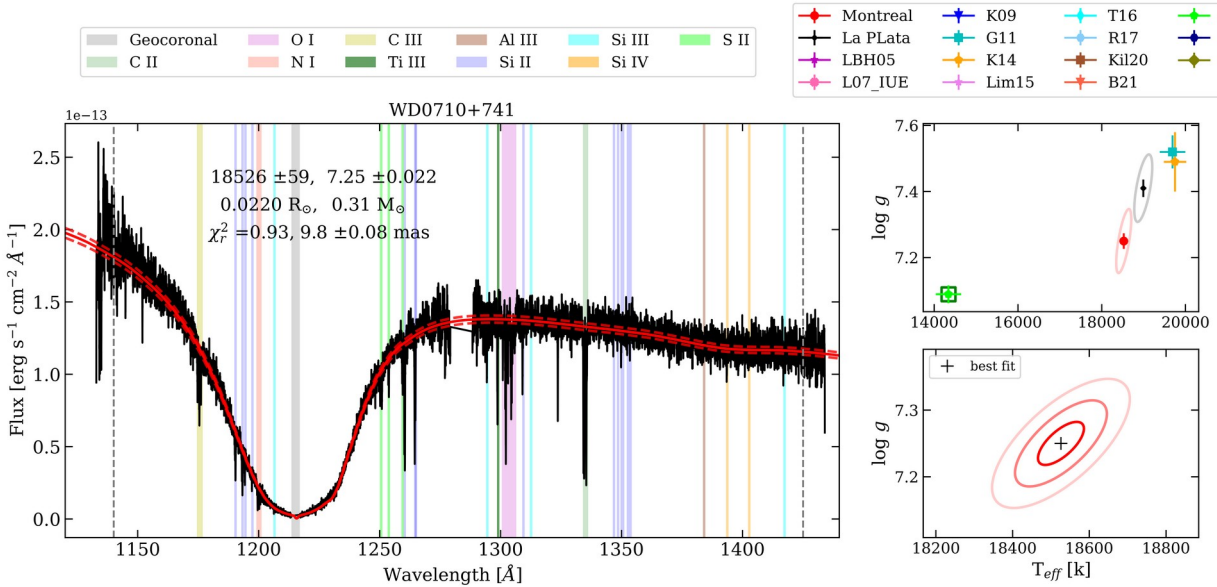


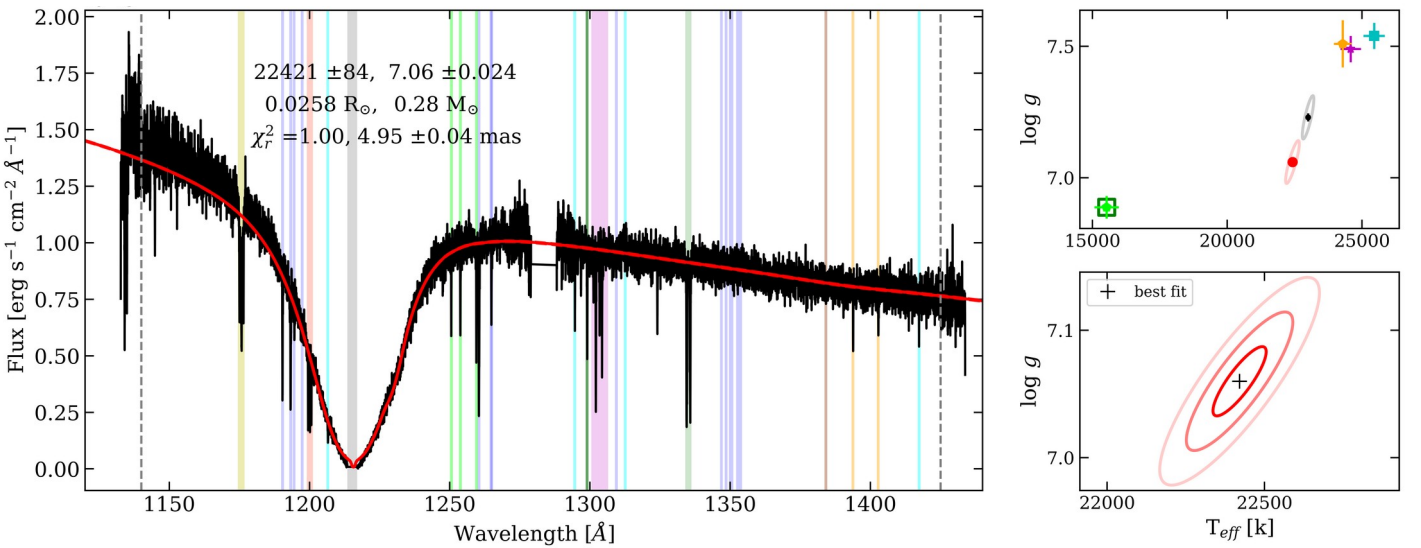


Comparison with Photometric estimates

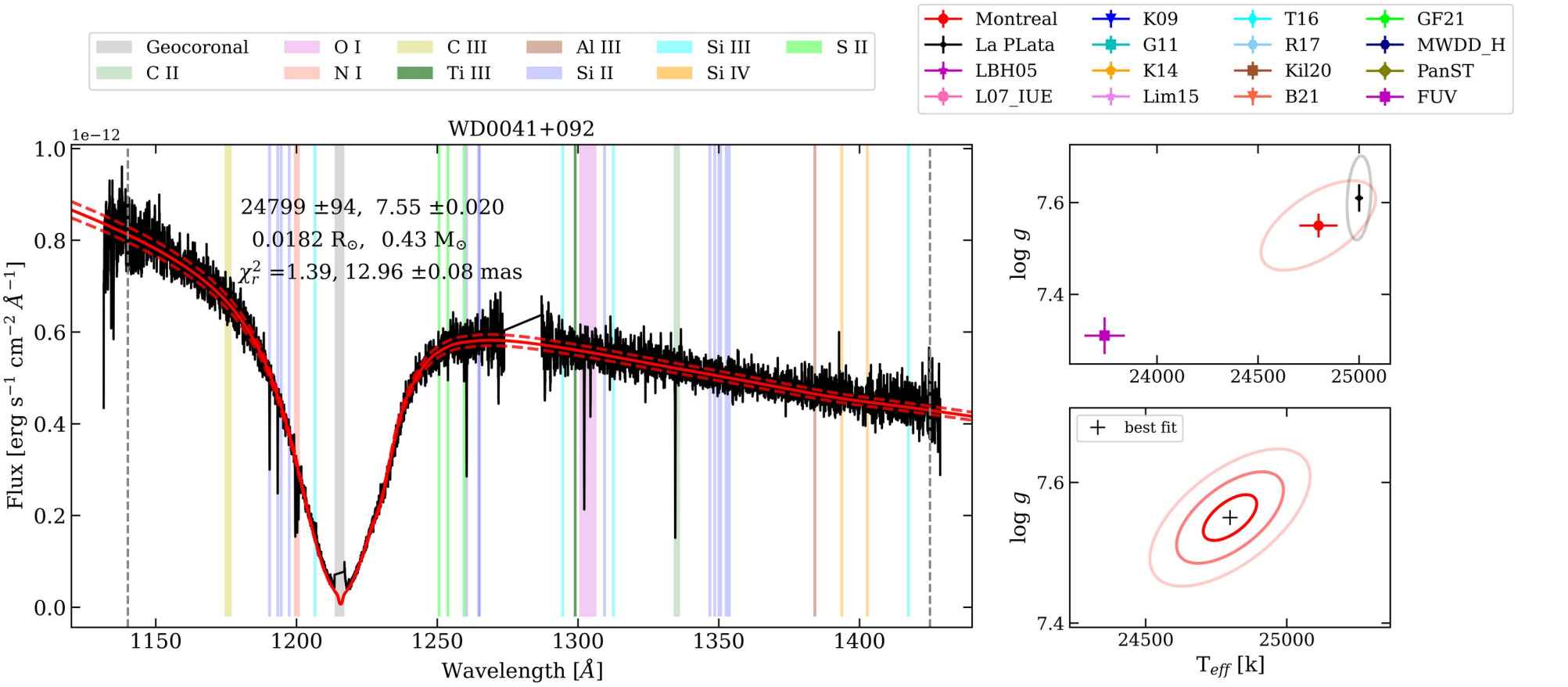


Known PCEBs


Geocoronal
C II
O I
N I
C III
Ti III
Al III
Si II
Si III
Si IV
S II
Montreal
La PLata
LBH05
L07_IUE
K09
G11
K14
Lim15
T16
R17
Kil20
B21
GF21
MWDD_H
PanST
WD0710+741
1e−13
18526 ±59, 7.25 ±0.022
0.0220 R⊙, 0.31 M⊙
χ^2_r =0.93, 9.8 ±0.08 mas
Flux [erg s^{-1} cm^{-2} Å^{-1}]
Wavelength [Å]
log g
best fit
T_{eff} [k]


22421 ±84, 7.06 ±0.024
0.0258 R⊙, 0.28 M⊙
χ^2_r =1.00, 4.95 ±0.04 mas
Flux [erg s^{-1} cm^{-2} Å^{-1}]
Wavelength [Å]
log g
best fit
T_{eff} [k]

WDs with no Gaia data



Comparison with UV spectroscopic estimates