The white dwarf population revealed by *Gaia*

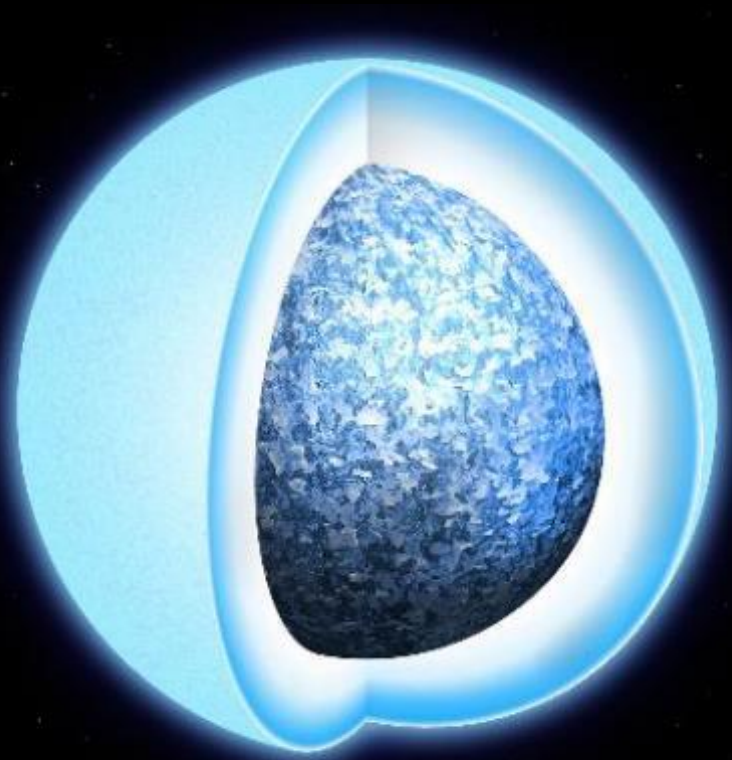
Santiago Torres

in collaboration with

A. Rebassa-Mansergas (UPC), F. Jiménez-Esteban (CAB), E.M. García-Zamora (UPC), M. Camisassa (UPC), R. Murillo-Ojeda (CAB), R. Raddi (UPC) A. Santos-García (UPC), P. Cruz (CAB), E. Solano(CAB)

MWGaia The Milky Way Revealed by Gaia – Barcelona – September 2023

White dwarfs: the most common remnant



- More than 90% of all main sequence stars ($M<8\text{-}10M_{\odot}$) will finish their lives as white dwarfs.
- WD radius ~ Earth radius
- WD mass ~ [0.2-1.4] $M_{\odot}$, typical 0.6 $M_{\odot}$
- Core: He, C/O, O/Ne
- Density 10 Tn/cm^3.
- Degenerate matter

White dwarfs atmospheres

- Thin layer made of He (~20% of WDs)
- Thinner layer of H (~80% of WDs)

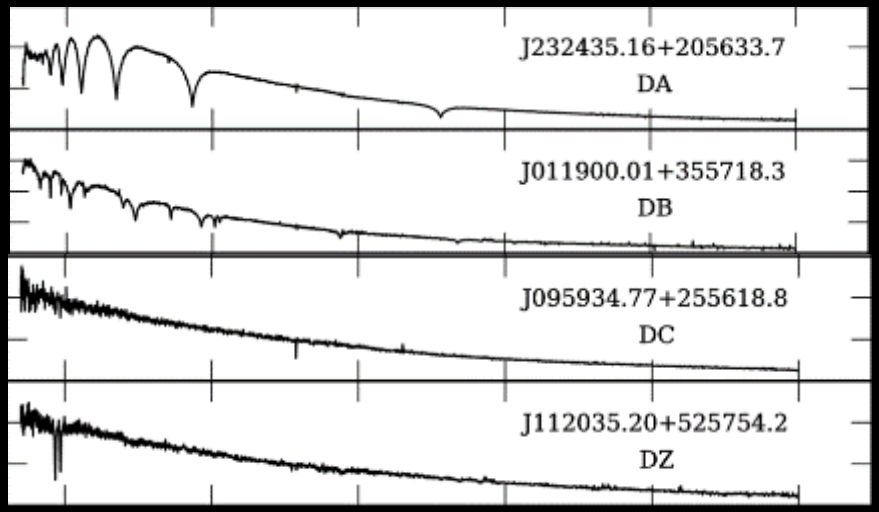
- Determinant in the estimation of stellar parameters:
- Mass, temperature, cooling age and luminosity

White dwarf spectral types:

- DA: Only Balmer lines

and non-DA:

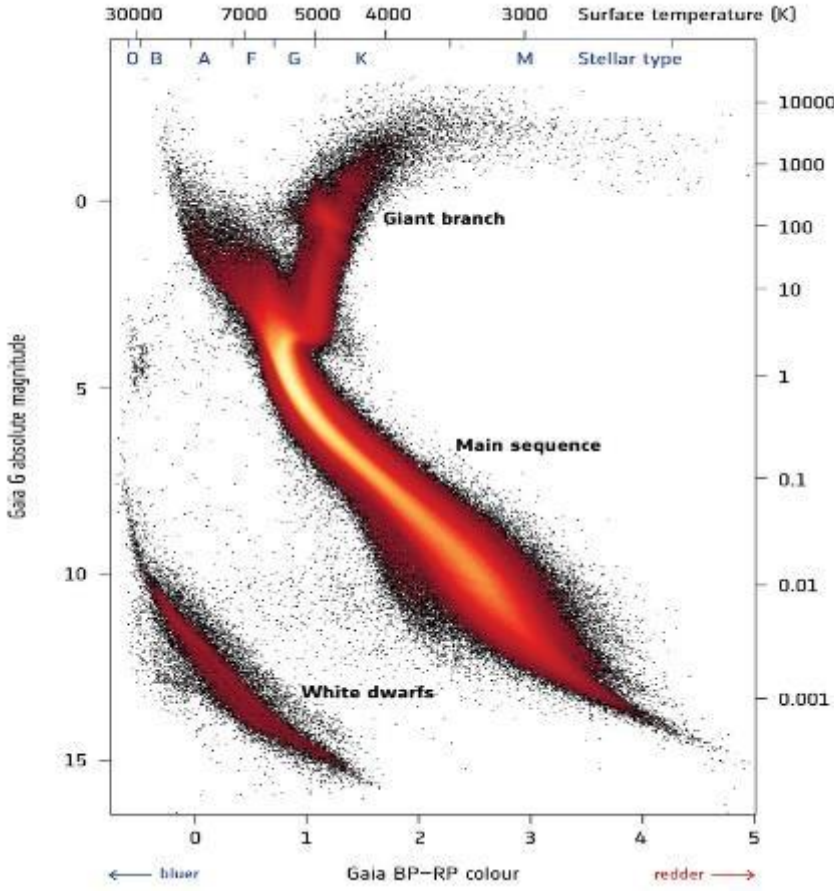
- DB: He I lines
- DZ: metal lines only
- DQ: carbon features
- DC: continuous spectrum

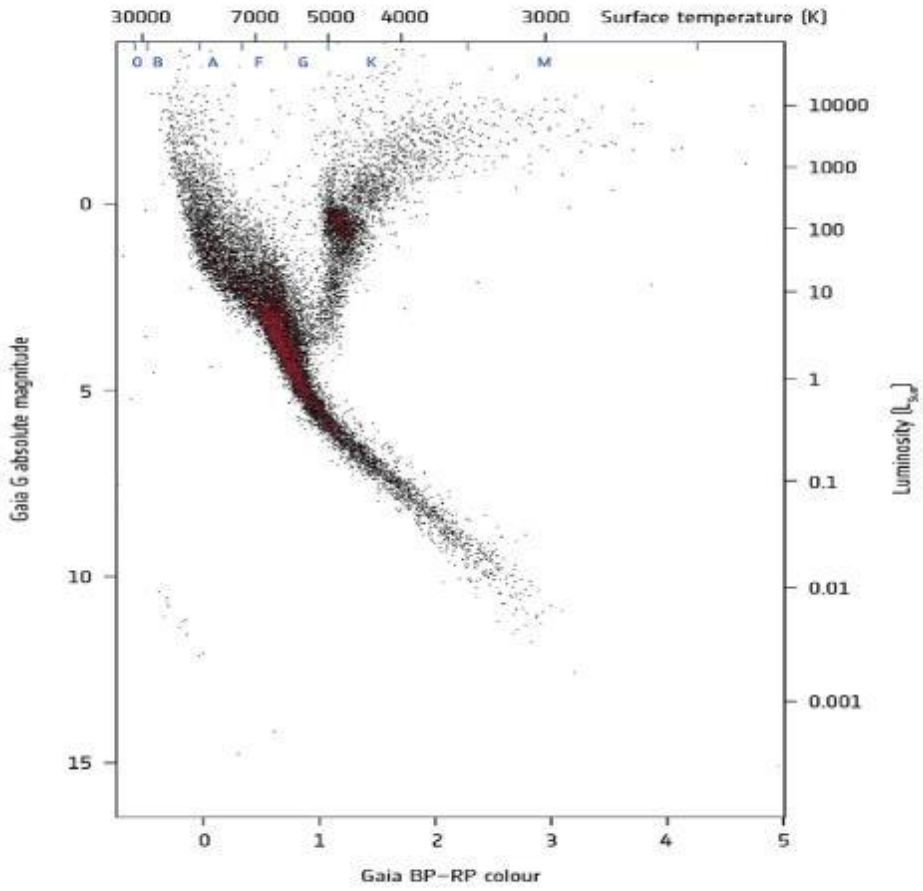


Do the *Gaia* spectra have sufficient resolution to identify WD spectra?

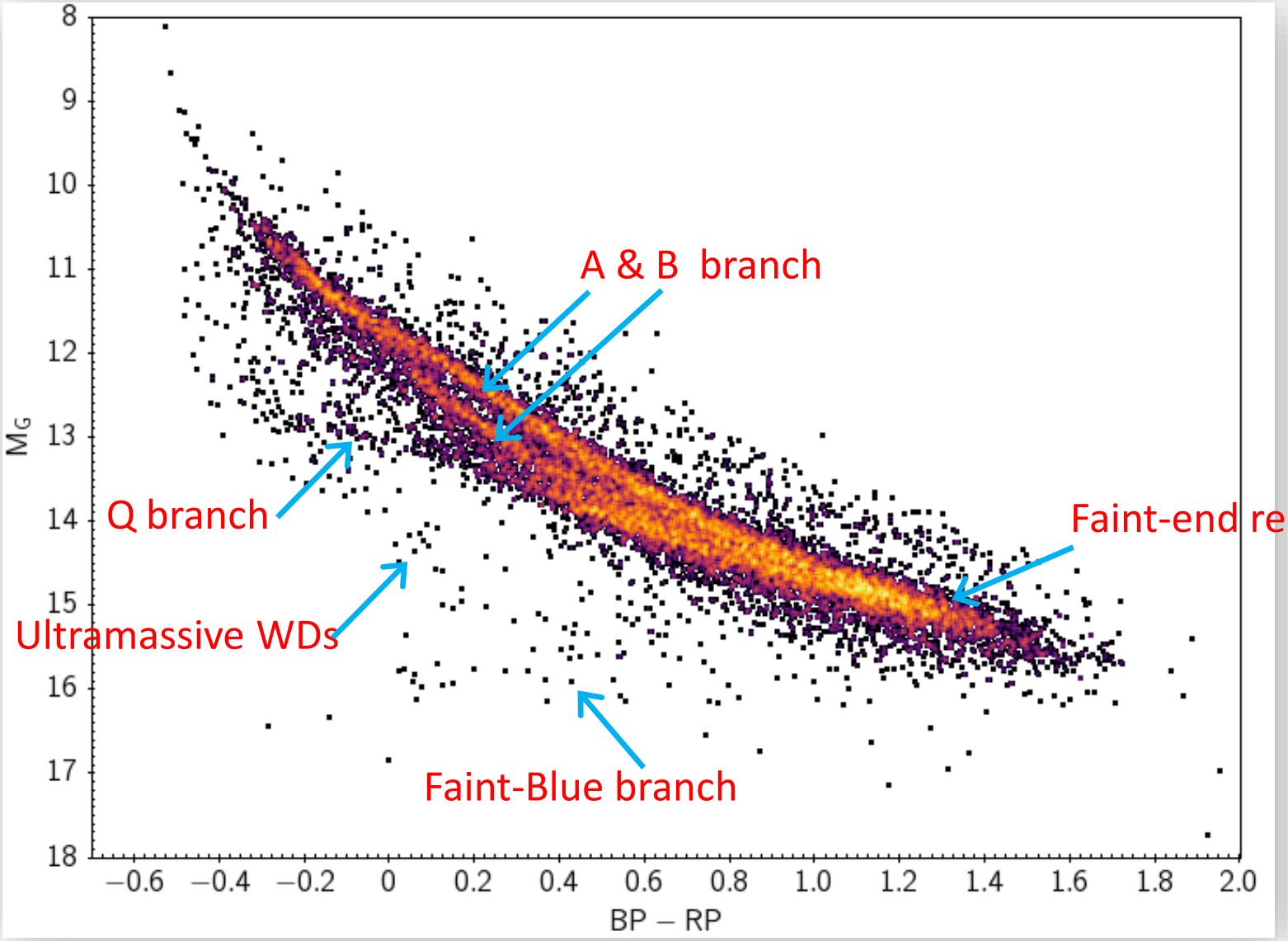
The HR diagram

Gaia vs. *Hipparcos*





The *Gaia* white dwarf HR-diagram



Classification DA.vs.non-DA 100 pc

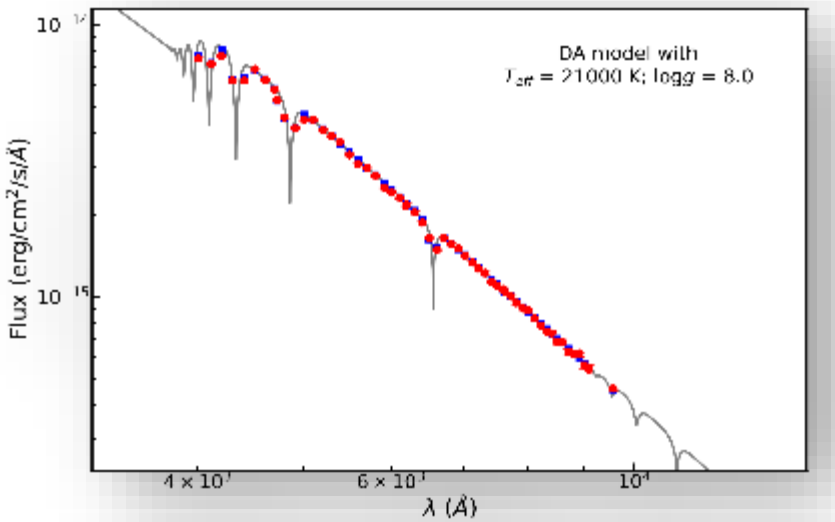
Spectral classification of the 100 pc white dwarf population from *Gaia*-DR3 and the Virtual Observatory

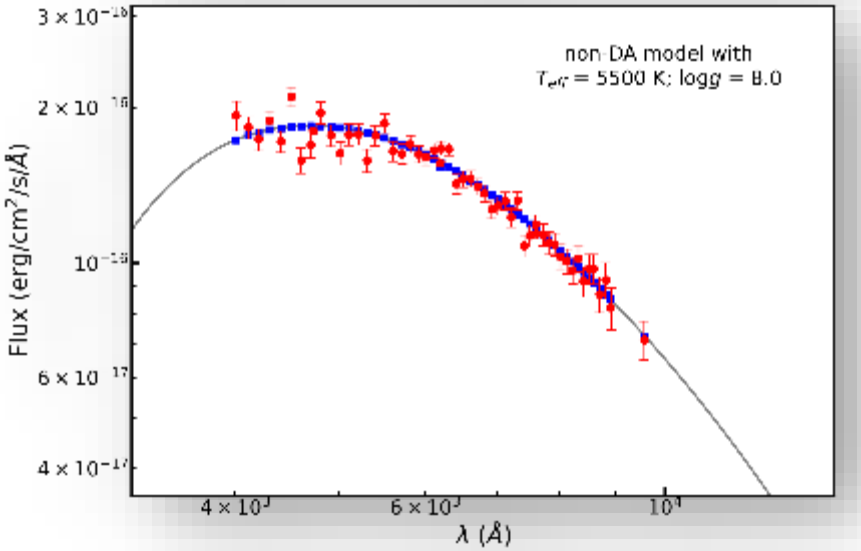
F M Jiménez-Esteban, S Torres, A Rebassa-Mansergas, P Cruz, R Murillo-Ojeda, E Solano, C Rodrigo, M E Camisassa

Monthly Notices of the Royal Astronomical Society, Volume 518, Issue 4, February 2023

Methodology:

- Build synthetic SEDs from *Gaia* spectra using JPAS photometry
- Fitting DA and DB WD atmosphere models
- Obtain a probability of being DA

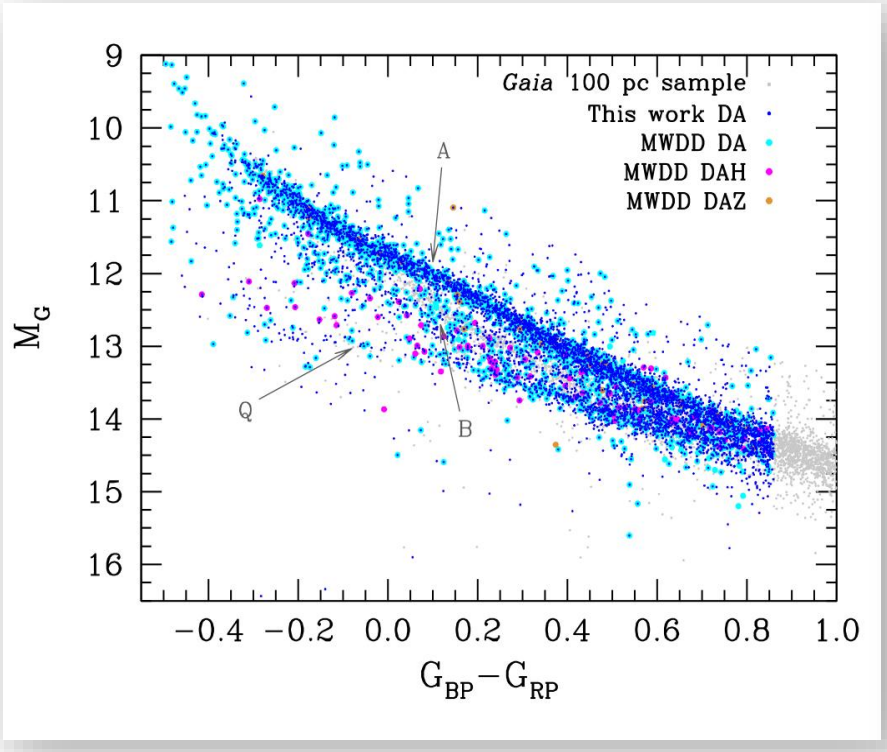


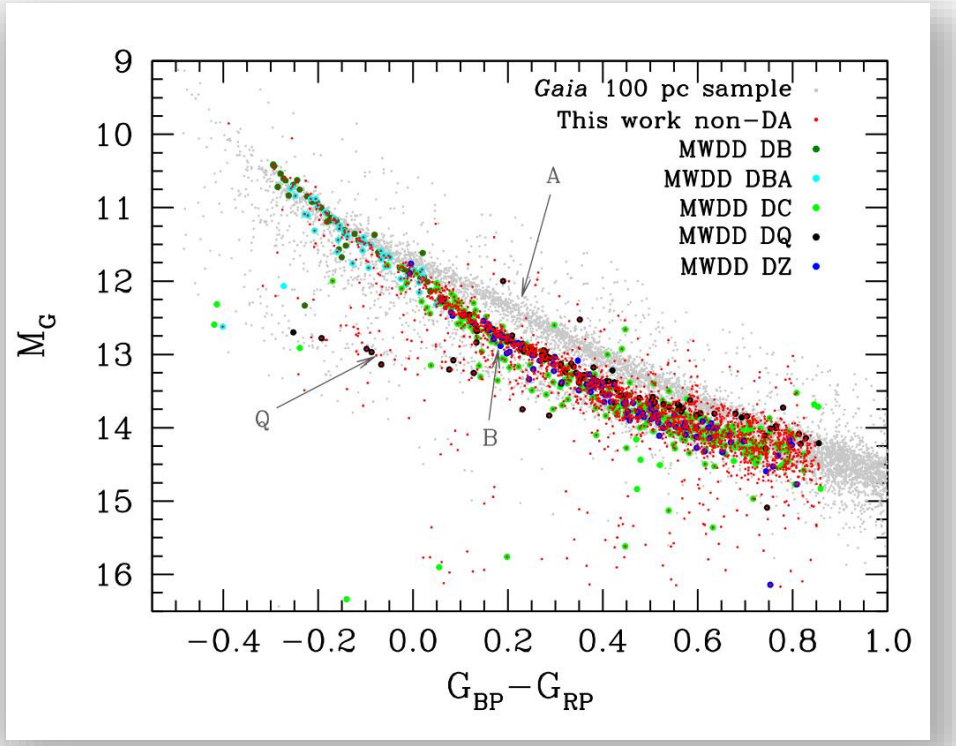


The bifurcation: the A and the B branches

A branch: 95% DA + 5% non-DA

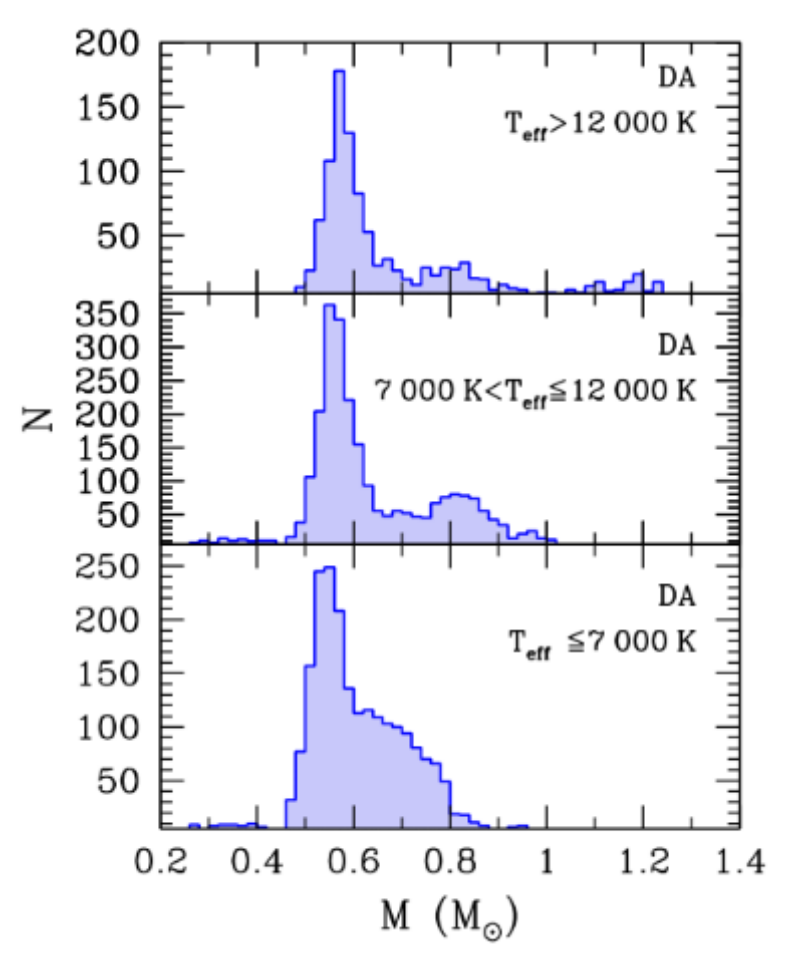
B branch: 35% DA + 65% non-DA



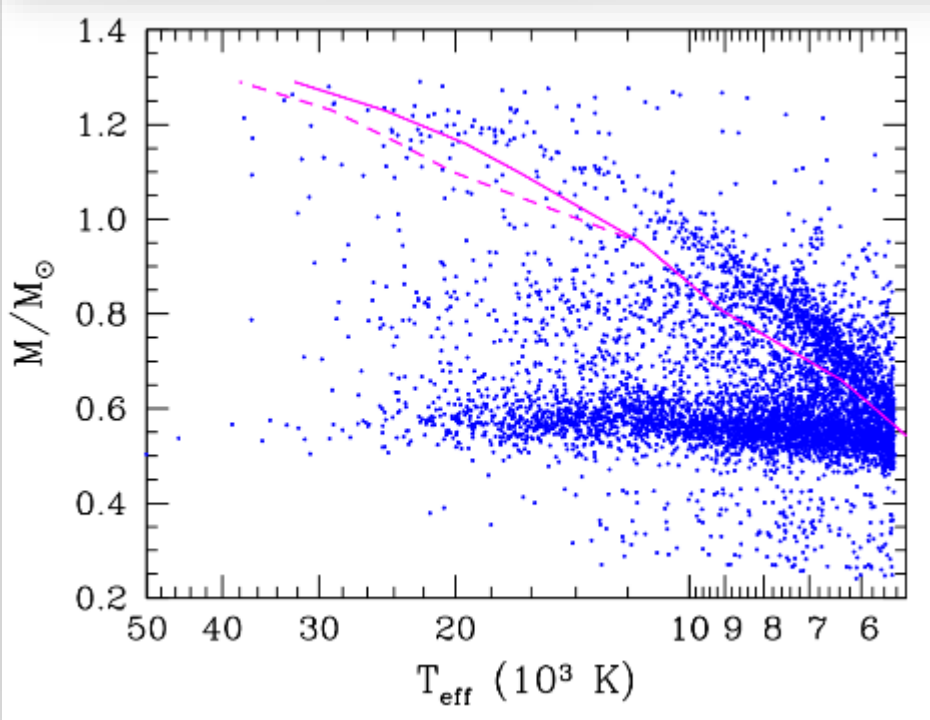


Jiménez-Esteban et al. (2023)
see also M. Camisassa's poster

The DA mass distribution



- Peaked at 0.6$M_\odot$, a bump at ~0.75$M_\odot$
- Effects of crystallization



Jiménez-Esteban et al. (2023)

Classification DA.vs.non-DA 500 pc

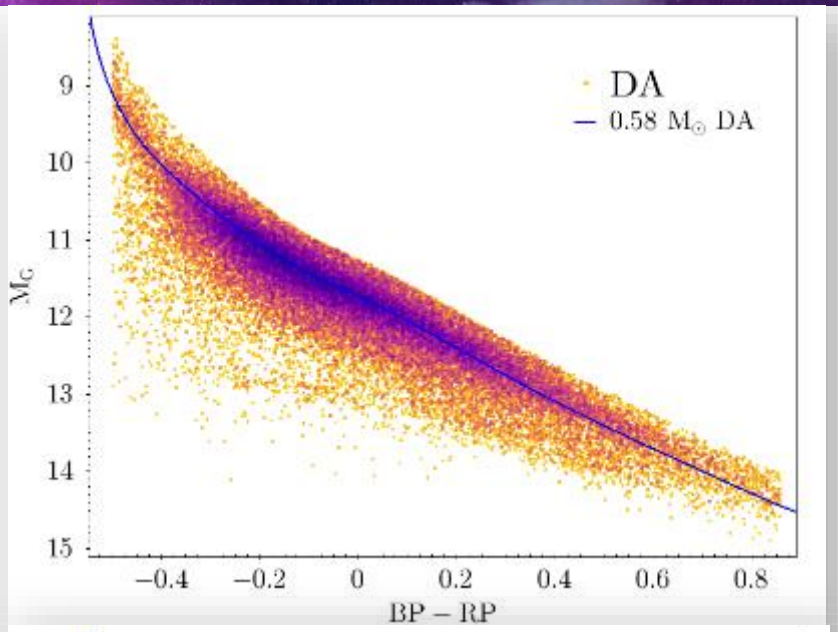
White dwarf spectral type–temperature distribution from Gaia-DR3 and the Virtual Observatory

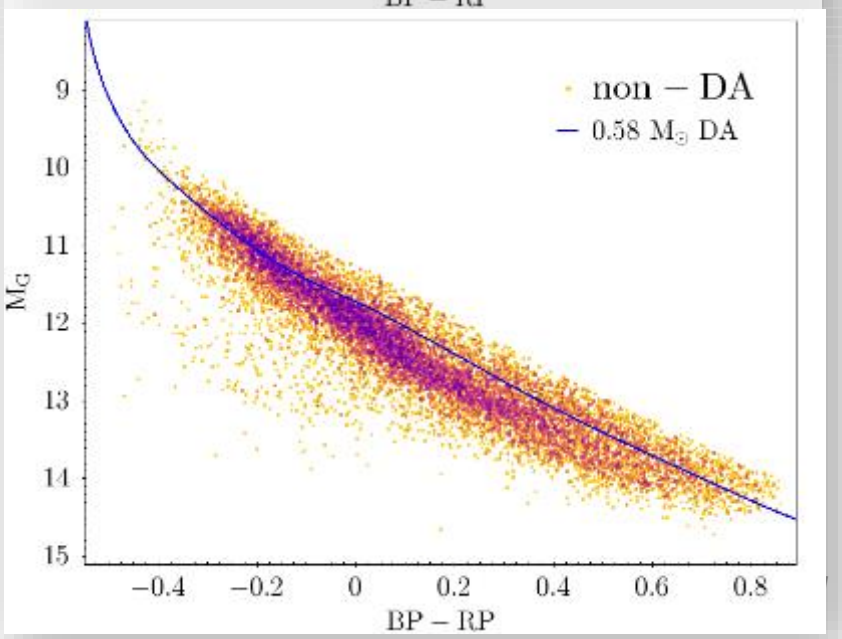
S. Torres, , P. Cruz, R. Murillo-Ojeda, , F. M. Jiménez-Esteban, , A. Rebassa–Mansergas, E. Solano, M. E. Camisassa, R. Raddi, and J. Doliguez Le Lourec

Astronomy & Astrophysics, in press, August 2023

Methodology:

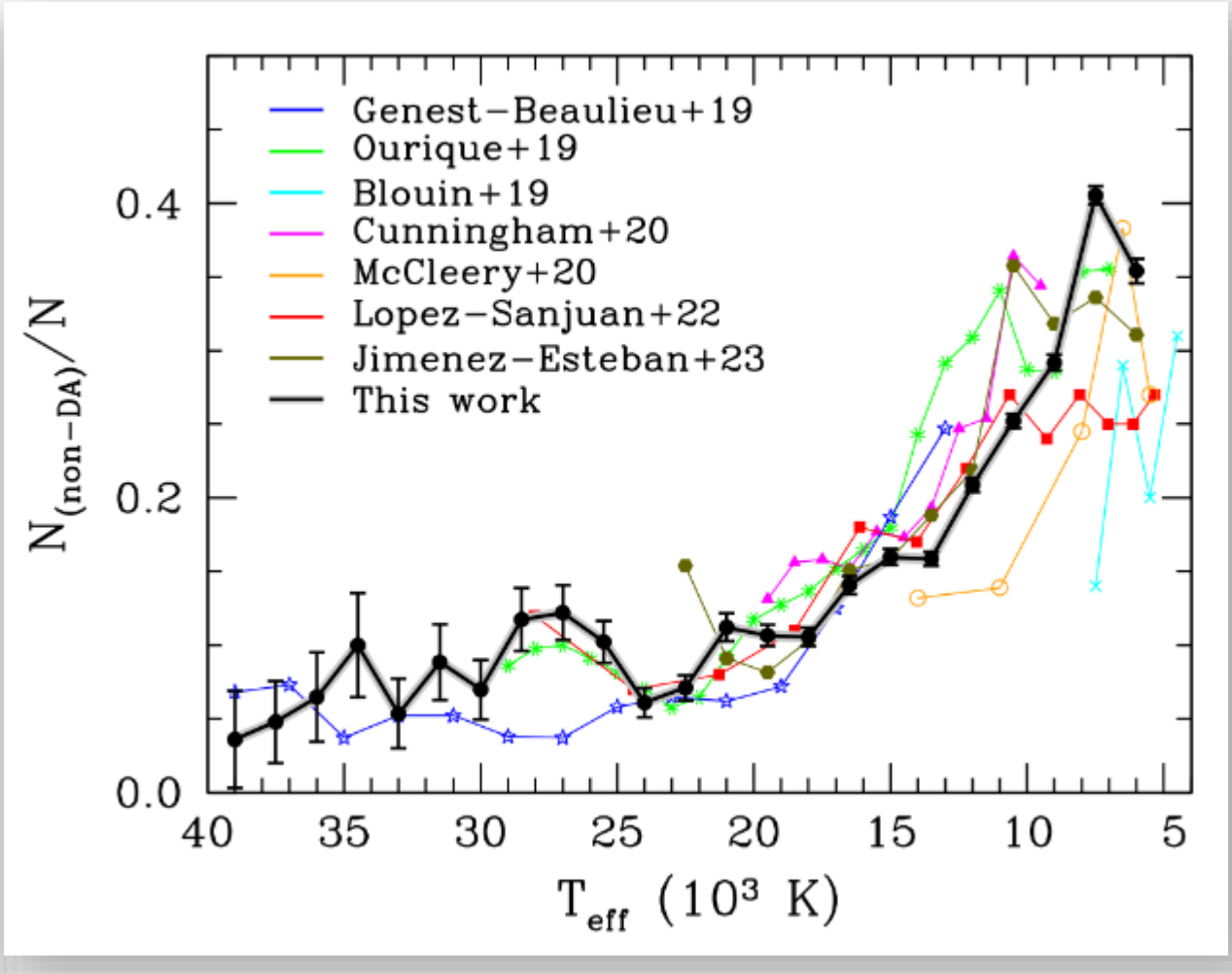
- Same methodology as in the previous work
- We extended our analysis up to 500 pc
- We classified a total of 65 310 white dwarfs into DAs and non-DAs
- Accuracy of 94%.





Spectral type–temperature distribution

- Thanks to *Gaia:* largest spectral distribution, 34,000 WDs from 5500 to 40000 K
- Fraction of non-DA w.r.t. DA depens on Teff
- Spectral evolution driven by processes like convective mixing and convective dilution



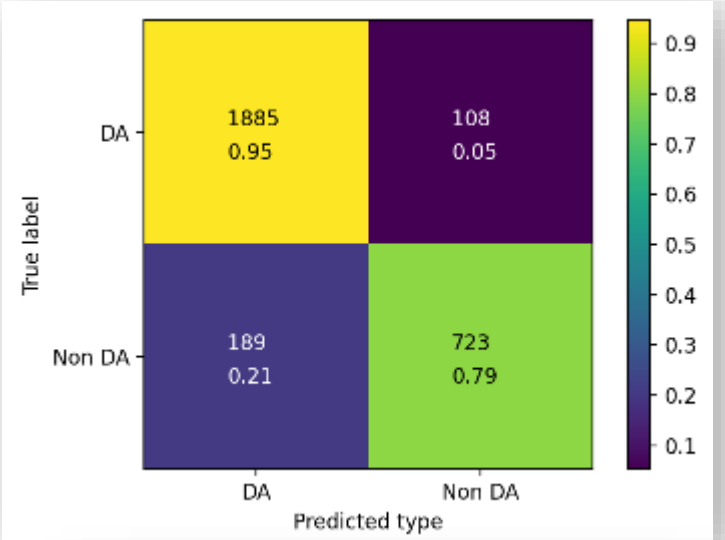
Torres et al. (2023)

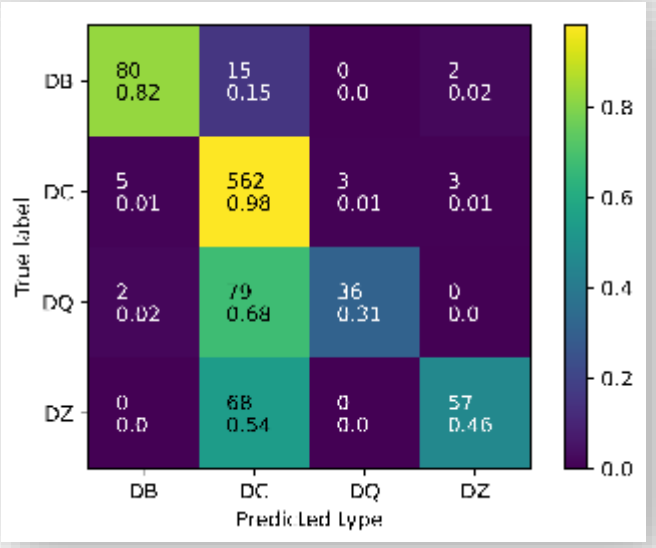
Classifying WD spectral types through *Gaia* coeffcients

White dwarf Random Forest classification through Gaia spectral coefficients
Enrique Miguel García-Zamora, Santiago Torres, Alberto Rebassa-Mansergas
Astronomy & Astrophysics, in press, August 2023

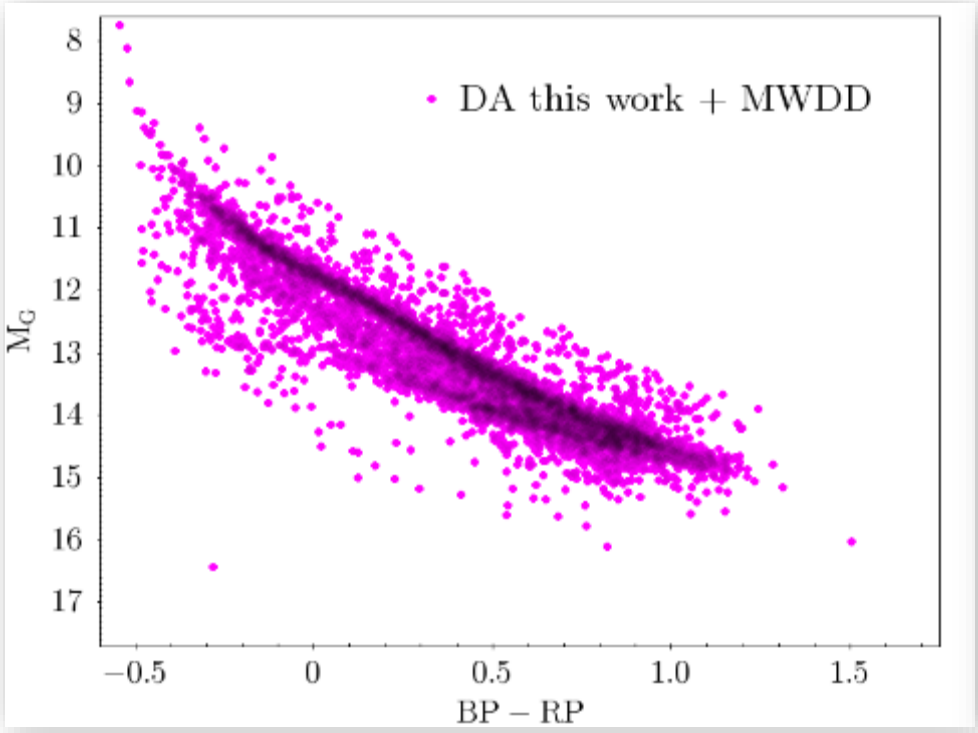
Methodology:

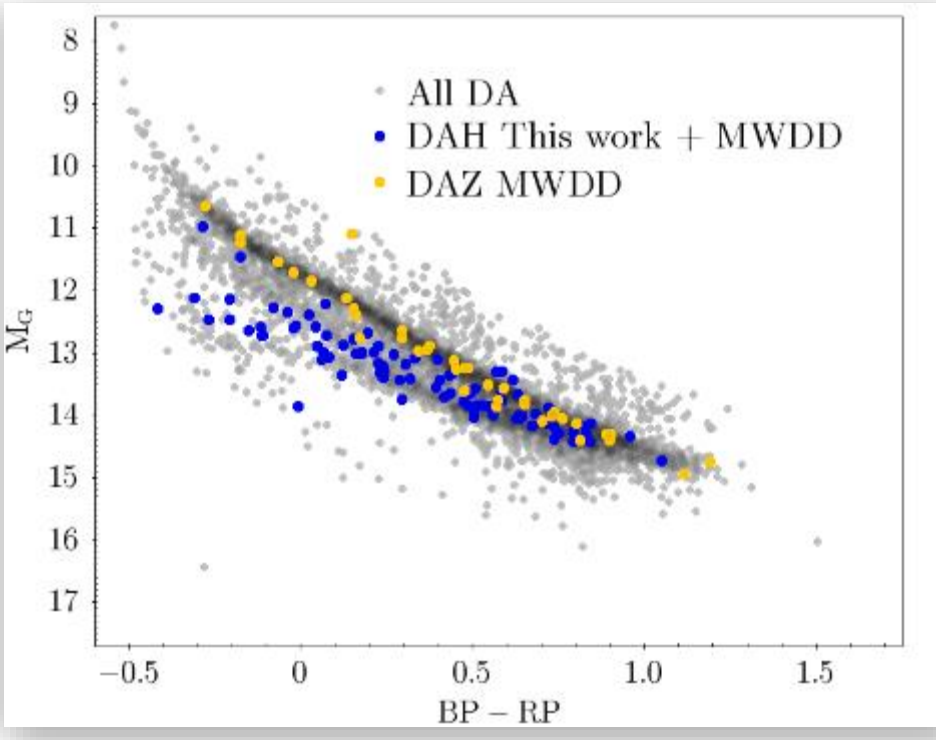
- Random Forest algorithm applied to the *Gaia* 55+55 spectral coefficients
- Trained with the Montreal White Dwarf Database
- We classified all WDs within 100 pc (9446 with RF +2905 already classified in the MWDD)





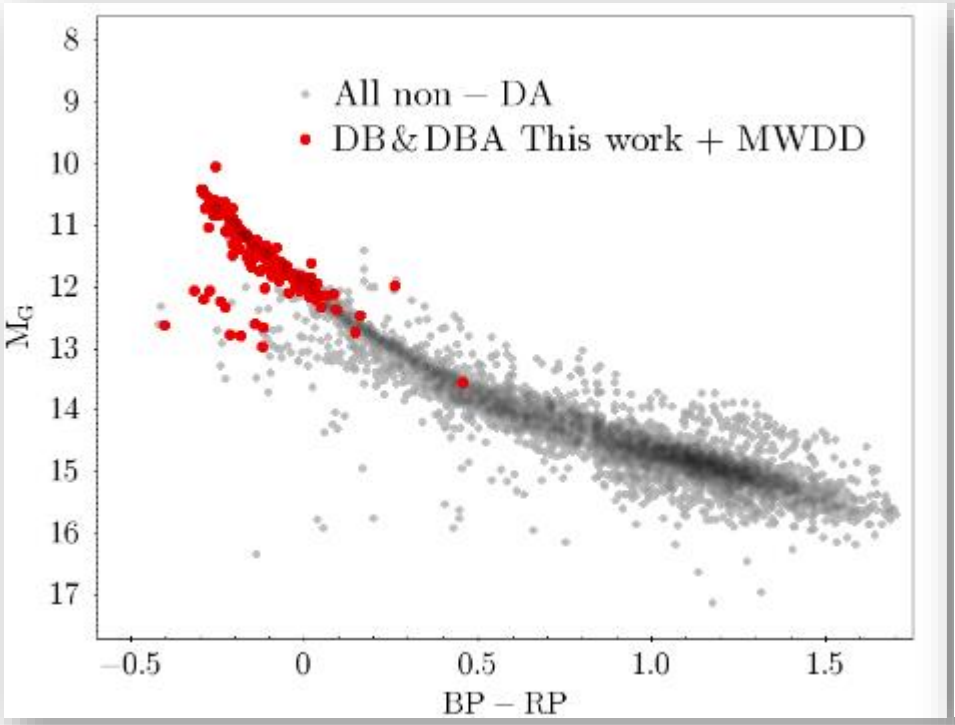
Classifying WD spectral types through *Gaia* coeffcients

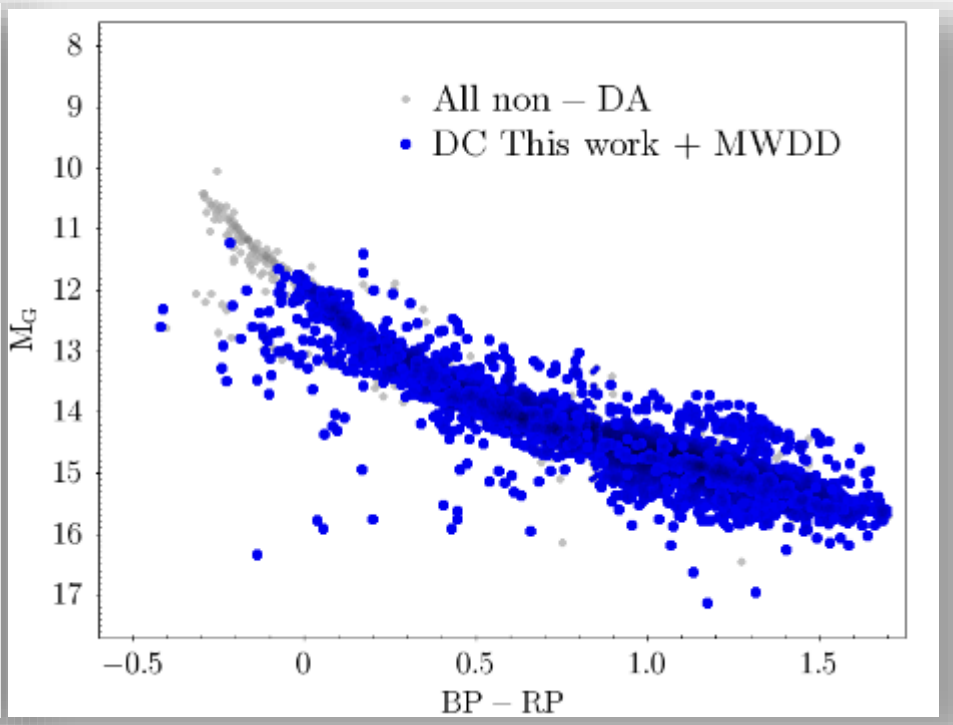




García-Zamora et al. (2023)
see also E. García-Zamora's poster

Classifying WD spectral types through *Gaia* coeffcients





García-Zamora et al. (2023)
see also M. Camisassa's poster

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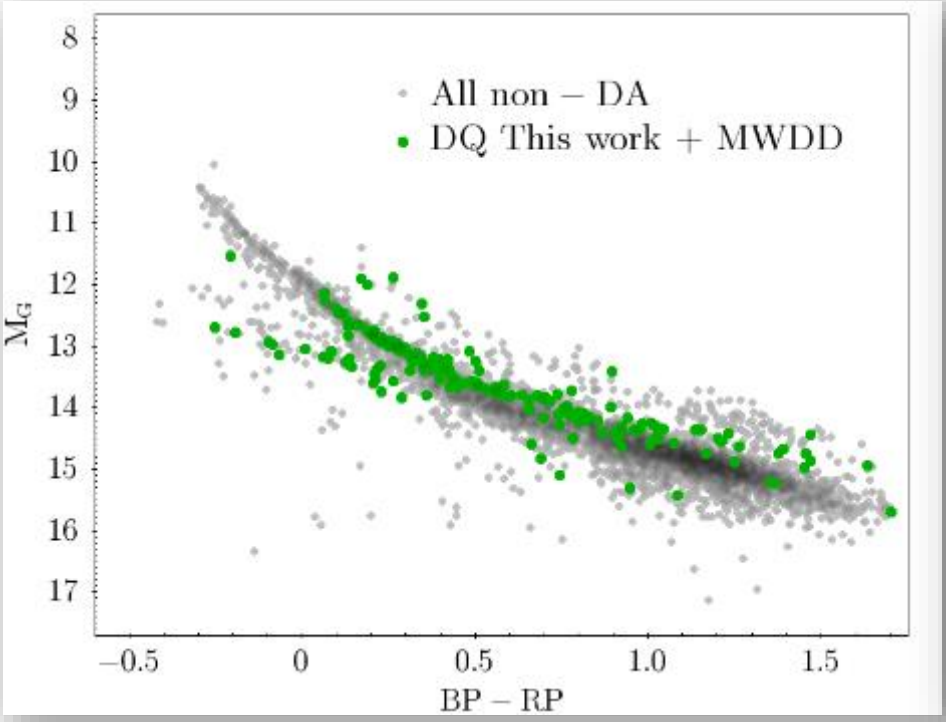

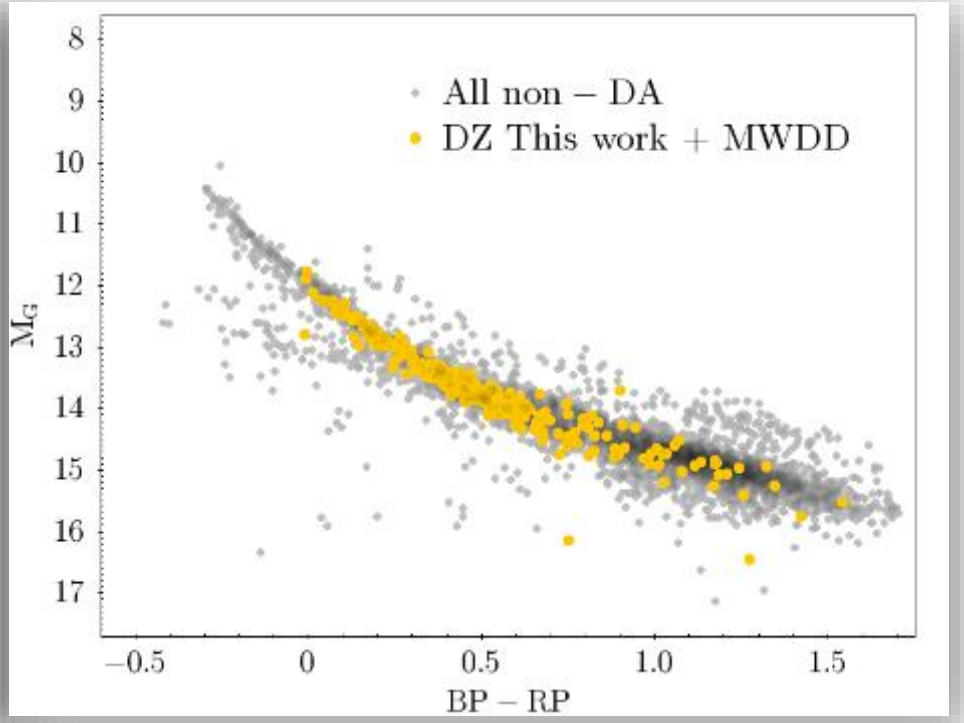

García-Zamora et al. (2023)
see also M. Camisassa's poster

Conclusions

- *Gaia* has bring a wealth of information about the white dwarf population
- White dwarf atmospheres play a key role in the identification of several structures in the HR-diagram
- *Gaia* spectra provides a first spectral classification of the white dwarf population up to 500 pc
- Accurate determinations of white dwarf masses, temperaturas, luminosities, and ages can now be provided
- Spectroscopic follow-up and extensions in the infrared (IR) and even ultraviolet (UV) observations are required

The white dwarf population revealed by *Gaia*

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