White dwarfs with infrared excess: *Gaia* and the Virtual Observatory

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Context

White dwarfs (WDs) are one of the most common objects in the galaxy. They are stellar remnants of low and intermediate mass stars, such as the Sun. WDs are compact objects, with typical masses around half a solar mass and planetary sizes.

The superb astrometric data provided by Gaia has been a revolution in the field, like the discovery of several cooling branches in the Gaia Hertzsprung-Russell diagram which were unpredicted by the models and which still remain not fully explained. In addition, thanks to Gaia the number of known WDs in the Galaxy has increased tenfold, allowing us to perform more detailed studies of peculiar types of WDs, such as WDs with infrared excesses that may be due to debris disks or substellar companions. They are key sources in the understanding of the composition and evolution of exoplanetary material around intermediate mass stars in their late stages of evolution.

This work has focused on searching for infrared flux excess of the WDs at 100 pc sample of J*iménez-Esteban et al. (2023, MNRAS, 518, 5106; hereafter JE+23)*. *JE+23* is the most complete volume-limited WD sample so far. We applied the method of *Rebassa-Mansergas et al. (2019, MNRAS, 489, 3990; hereafter RM+19)*.

The final goal is to find white dwarfs with substellar companions.

VOSA fits

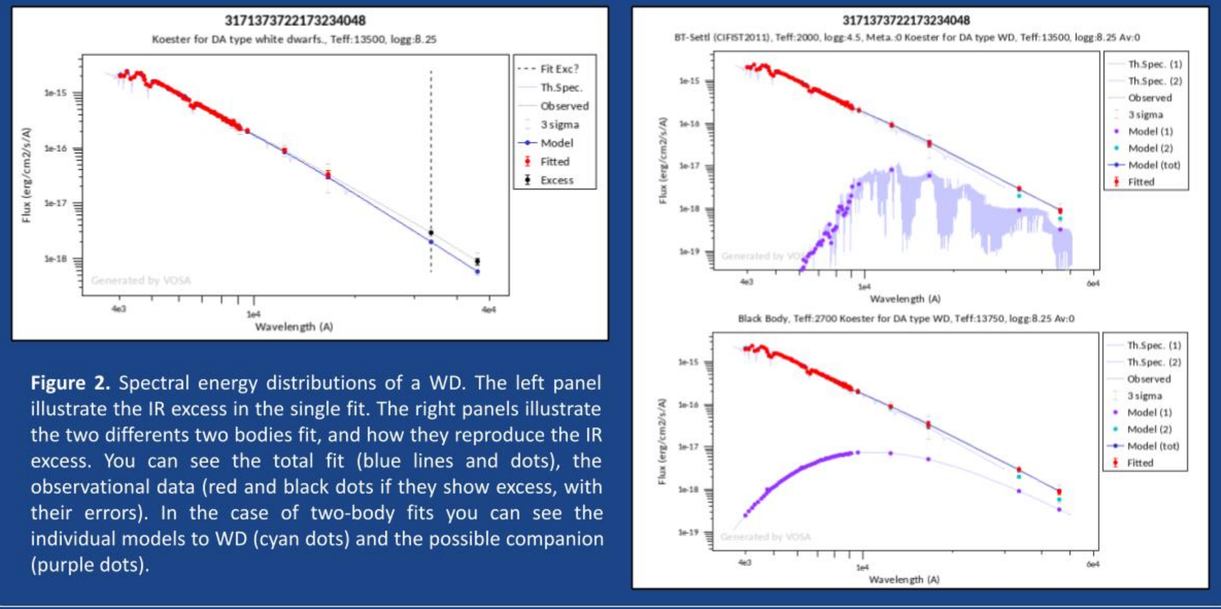

Figure 2. Spectral energy distributions of a WD. The left panel illustrate the IR excess in the single fit. The right panels illustrate the two differents two bodies fit, and how they reproduce the IR excess. You can see the total fit (blue lines and dots), the observational data (red and black dots if they show excess, with their errors). In the case of two-body fits you can see the individual models to WD (cyan dots) and the possible companion (purple dots).

Methodology

For the 12,718 WDs in *JE+23*, we complemented the optical SED built in the J-PAS (Benitez et al. 2014) filter system (Marín-Franch et al. 2012) photometry from the *Gaia* spectra with all **available VO photometry in the IR** ($\lambda > 1.2$ microns).

We used VOSA Virtual Observatory tool, and taking into account the *Gaia* proper motion of each WD, to search for photometric data from **2MASS, WISE, UKIDSS, VISTA and Spitzer**. We continued our study with the WDs with at least three photometric points at the IR wavelengths.

We added this data to the **J-PAS synthetic photometry, which we obtained from the *Gaia*-DR3 spectroscopic coefficients**.

First, we fit the SEDs to the models from Koester et al. (2010); that is, hydrogen-dominated (DA) and helium-dominated (non-DA) atmosphere models, according to their classification in *JE+23*. We looked for the SEDs with IR excesses taking advantage of the automatic detection of VOSA.

Secondly, we verified the IR excesses were not due to contamination from nearly objects through Aladin (see Fig. 1).

Finally, we made a second fit. This time a two bodies fit, using in combination with Koester models, the Black Body and BT Settl (CIFIST) models (see Fig 2).

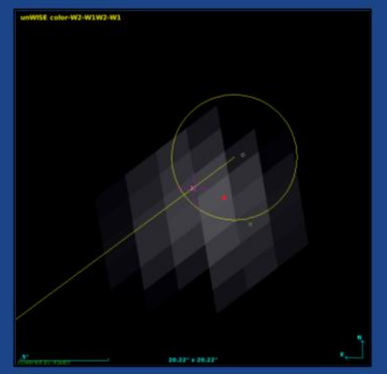

Figure 1. Example of contamination from nearly objects. We see there are two *Gaia* objects (green crosses), one is our WD (in the centre of the grid) and the other is a nearby object. We see photometry of 2MASS (orange sphere) and WISE (red square). WISE is a combination of both objects, and is hence contaminated.

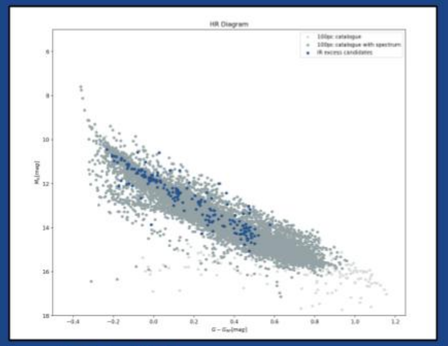

Figure 3. *Gaia* HR diagram.

Preliminary results

We found 5,468 WDs with three or more reliable photometric points at infrared wavelengths.

After doing the single fit of the SEDs with VOSA, we reduced the number to 505 SEDs with IR excess.

Finally, when we removed the WDs with contaminated photometry, we got **185 WDs with IR excess** in at least two photometric points. Of them, **61 WDs** were already in ***RM+19***, and **124 WDs** were identified for the first time in this work.

We have started a follow-up program to spectroscopically observe these source to disentangle the origin of the IR excess.

ACKNOWLEDGEMENTS: R.M.O. is funded by INTA through grant PRE-OBSERVATORIO. F.J.E. acknowledges support from ESA through the Faculty of the European Space Astronomy Centre (ESAC) - Funding reference 4000139151/22/ES/CM.
This research has made use of the Spanish Virtual Observatory (https://svo.cab.inta-csic.es) project funded by MCIN/AEI/10.13039/501100011033/ through grant PID2020-112949GB-I00. This work was partially supported by the AGAUR/Generalitat de Catalunya grant SGR-386/2021 and by the Spanish MINECO grant PID2020-117252GB-I00.

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