White dwarfs with substellar companions: Gaia and the Virtual Observatory

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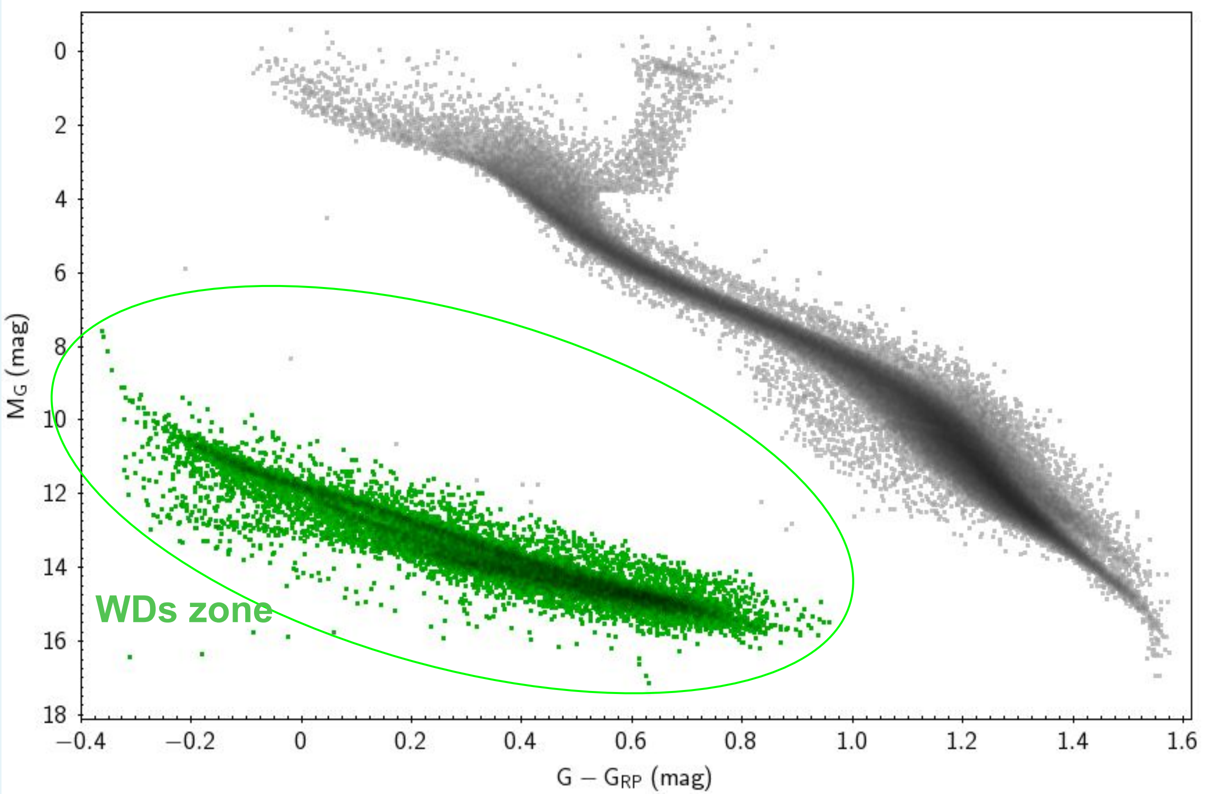
Introduction

White dwarfs (WDs) are one of the most common objects in the universe. 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.

Recently, and thanks to Gaia data, the number of WDs has gone from few thousands to several hundreds of thousands. Now we can study different types of WDs in the Galaxy, such as WDs with debris disks or substellar companions.

Introduction



Introduction

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

To do this:

1º.- Create an initial sample of white dwarfs.

2º.- Look for WDs with infrared flux excess (without contamination).

3º.- Determine the cause of the excess: circumstellar dust disk, substellar companion, ...

4º.- Characterise both white dwarfs and companions.

5º.- Create a white dwarf with substellar companion catalogue.

Initial sample: 100 pc catalogue

The work done so far has been the generation of **WD catalogues** using spectra from **Gaia DR3**.

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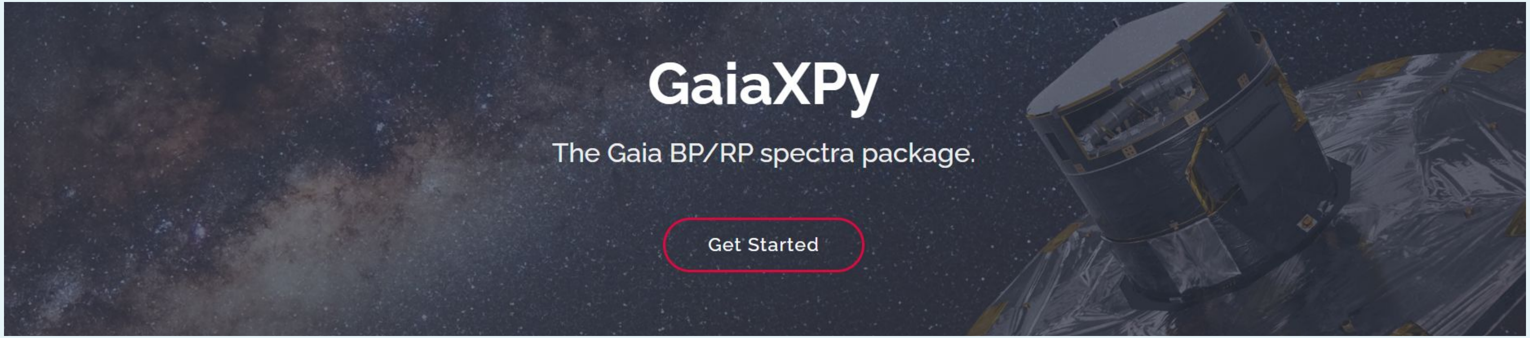
- We used the **GaiaXPy** tool to generate the J-PAS synthetic photometry of the WD candidates with spectroscopic information in Gaia DR3.



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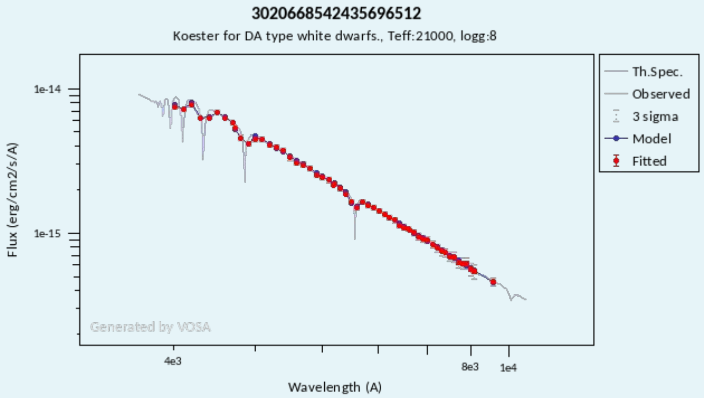

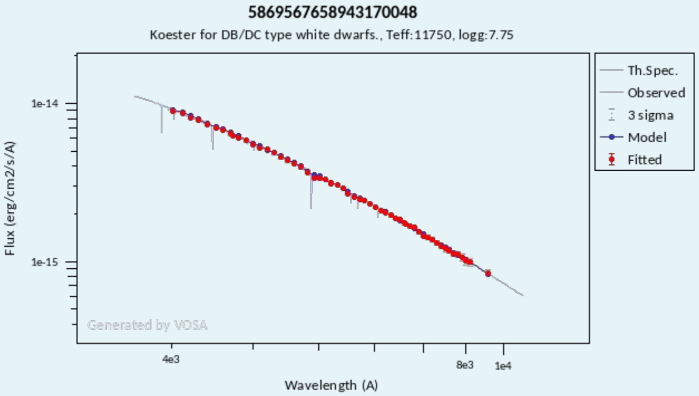

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- We obtained the **spectral classification** of the sample of WDs, giving the probability of being a DA.

$$P_{\mathrm{DA}} = \frac{1}{2}\left(\frac{\chi^2_{\mathrm{non-DA}} - \chi^2_{\mathrm{DA}}}{\chi^2_{\mathrm{non-DA}} + \chi^2_{\mathrm{DA}}} + 1\right)$$

Initial sample: 100 pc catalogue

This part of the work resulted in an already published paper:

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

F. M. Jiménez-Esteban[1★], S. Torres[2,3], A. Rebassa-Mansergas[2,3], P. Cruz[1], R. Murillo-Ojeda[1], E. Solano[1], C. Rodrigo[1], M. E. Camisassa[4]

https://ui.adsabs.harvard.edu/abs/2023MNRAS.518.5106J/abstract

Initial sample: 100 pc catalogue

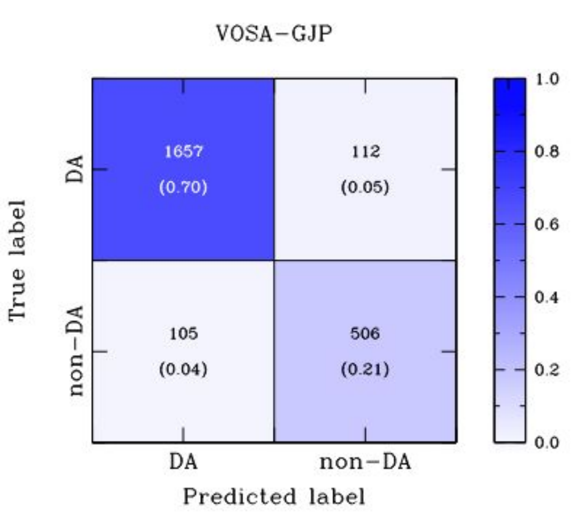
This part of the work resulted in an already published paper:

"Spectral classification of the 100 pc white dwarf population from Gaia-DR3 and the Virtual Observatory", F. Jiménez-Esteban et al. (2023).

We started from a total of 12 718 WD candidates, of which 12 342 had spectrum available in Gaia.

We obtained a good fit for 11 443 SEDs, and classified 8 150 between DAs and non-DAs (Teff > 5500 K)

We obtained with our estimator, VOSA-GJP (VOSA - Gaia J-PAS), an accuracy of 91% and a precision of 94%.



Expanding the initial sample: 500 pc catalogue

This part of the work will result in another catalogue:

Catalogue of WDs that are at a distance of less than 500 pc.

We are going to expand the catalogue from 100 pc to 500 pc.

We started from the same initial conditions as the previous catalogue, except for the distance limit.

Nearly 80 000 white dwarfs are expected to be classified in DA or non-DA types

Paper in progress (**Torres et al.**).

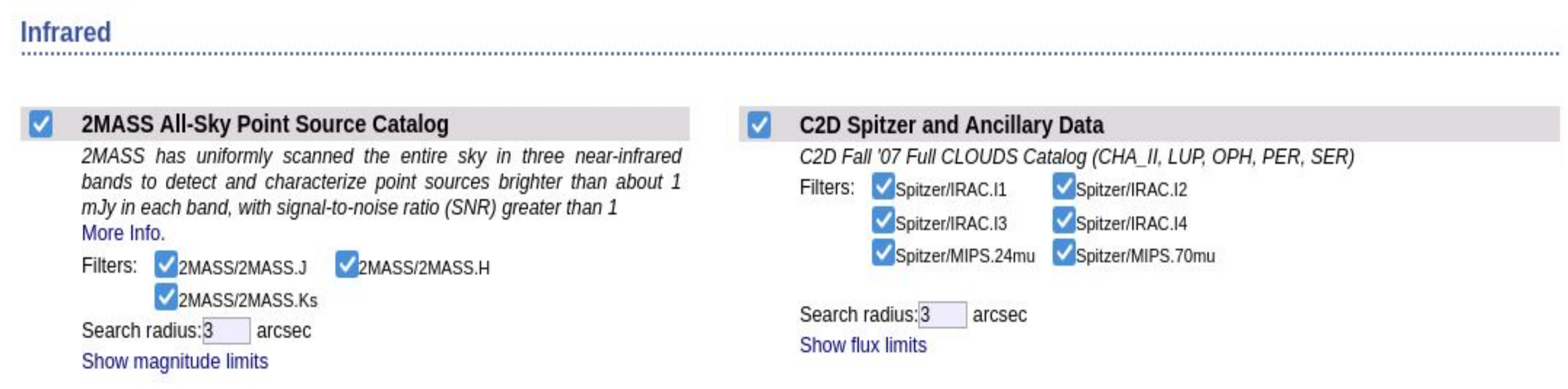
WDs with IR excess

1.- We searched for all **available VO photometry in the IR** (λ > 1.2 microns) and we selected the ones that had at least three reliable data points. We did this with VOSA.

We got photometric data from **2MASS, WISE, UKIDSS, VISTA and Spitzer**.

We added this data to the **J-PAS synthetic photometry obtained from Gaia-DR3 spectra**.

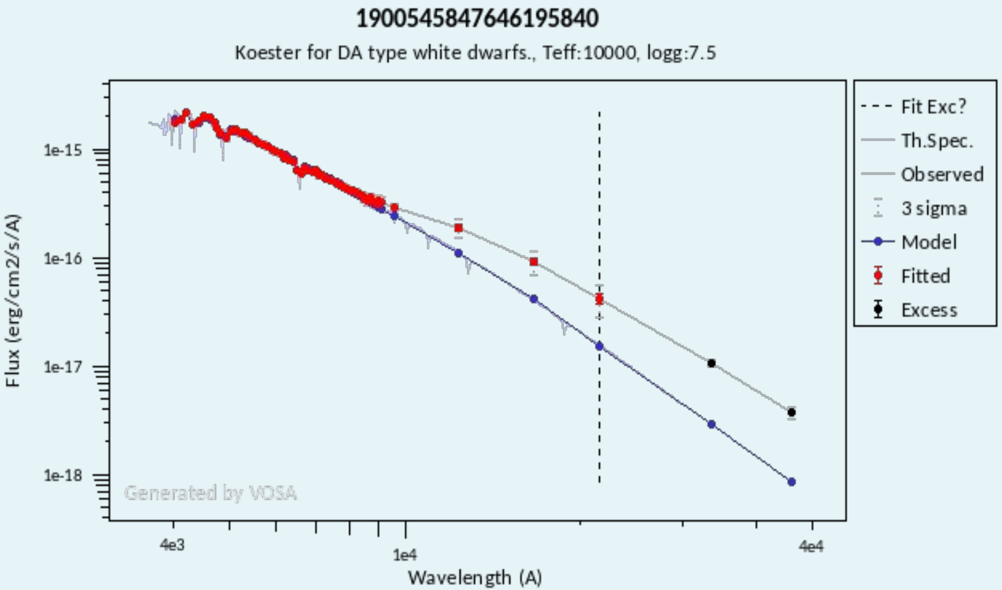
We used the method of A. Rebassa-Mansergas et al. (2019).



WDs with IR excess

2.- We **fit** the SEDs to Koester DAs and DBs models at **VOSA**.

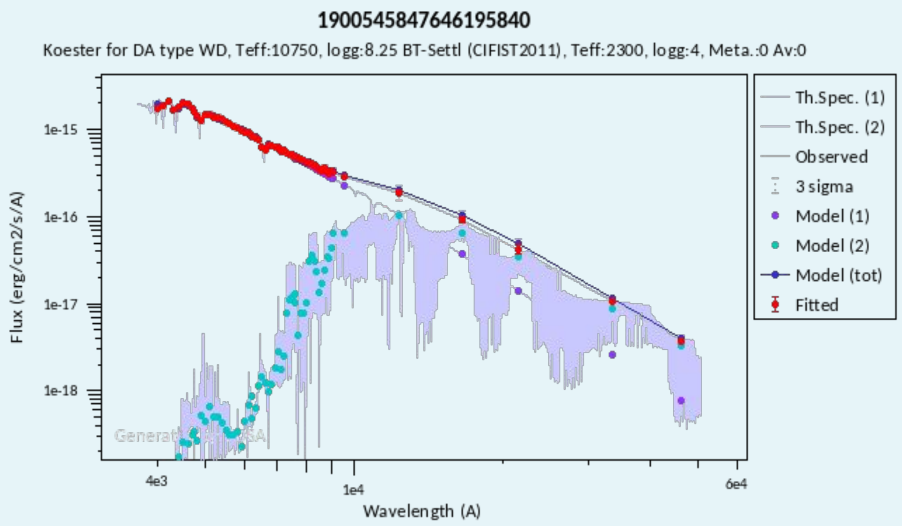
We looked for the SEDs with IR excesses taking advantage of the automatic detection of VOSA.

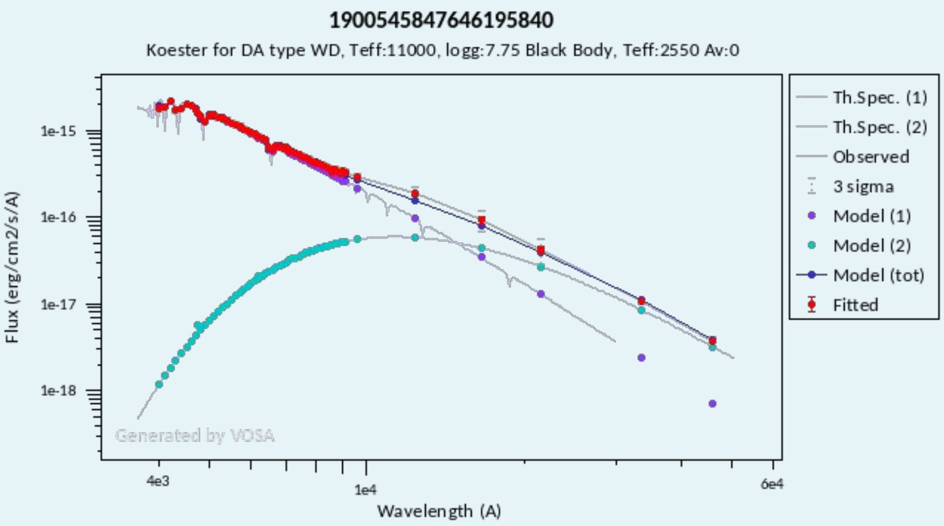


WDs with IR excess

2.- We **fit** the SEDs to Koester DAs and DBs models at **VOSA**.

We looked for the SEDs with IR excesses taking advantage of the automatic detection of VOSA. We repeated the fit, but this time we did a two bodies fit (fitbin).

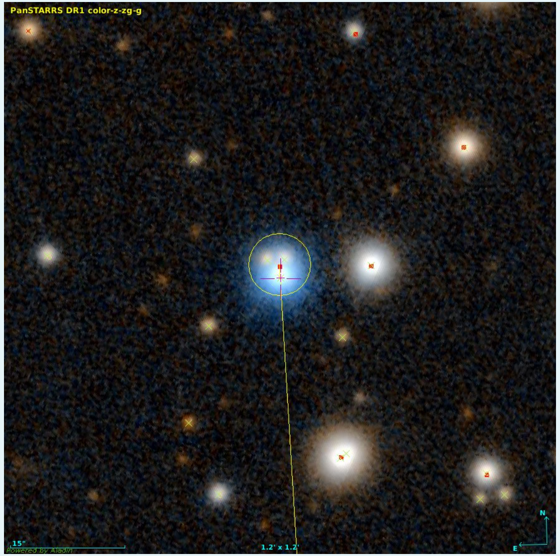




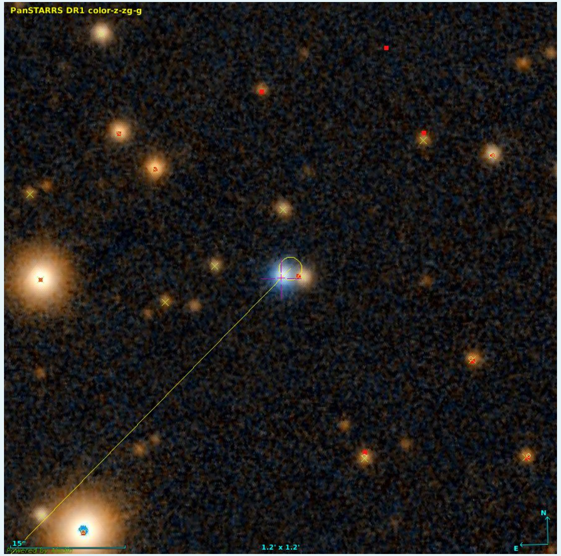
WDs with IR excess

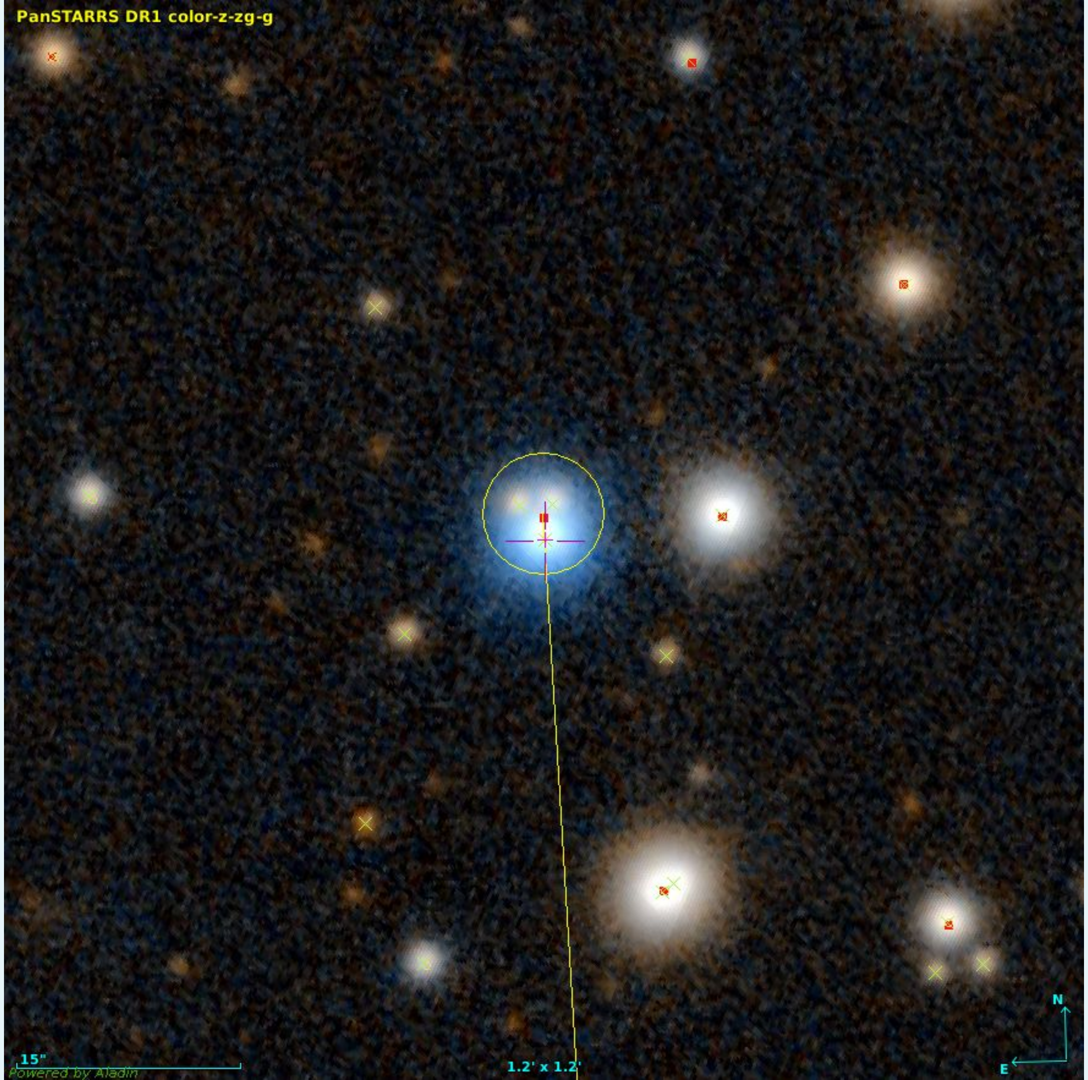
3.- Then, we had to verify the IR excesses were not due to contamination from nearly objects. For this checkup we used Aladin.

Once we have discarded all the candidates with contamination, we kept those that have a reliable IR excess.

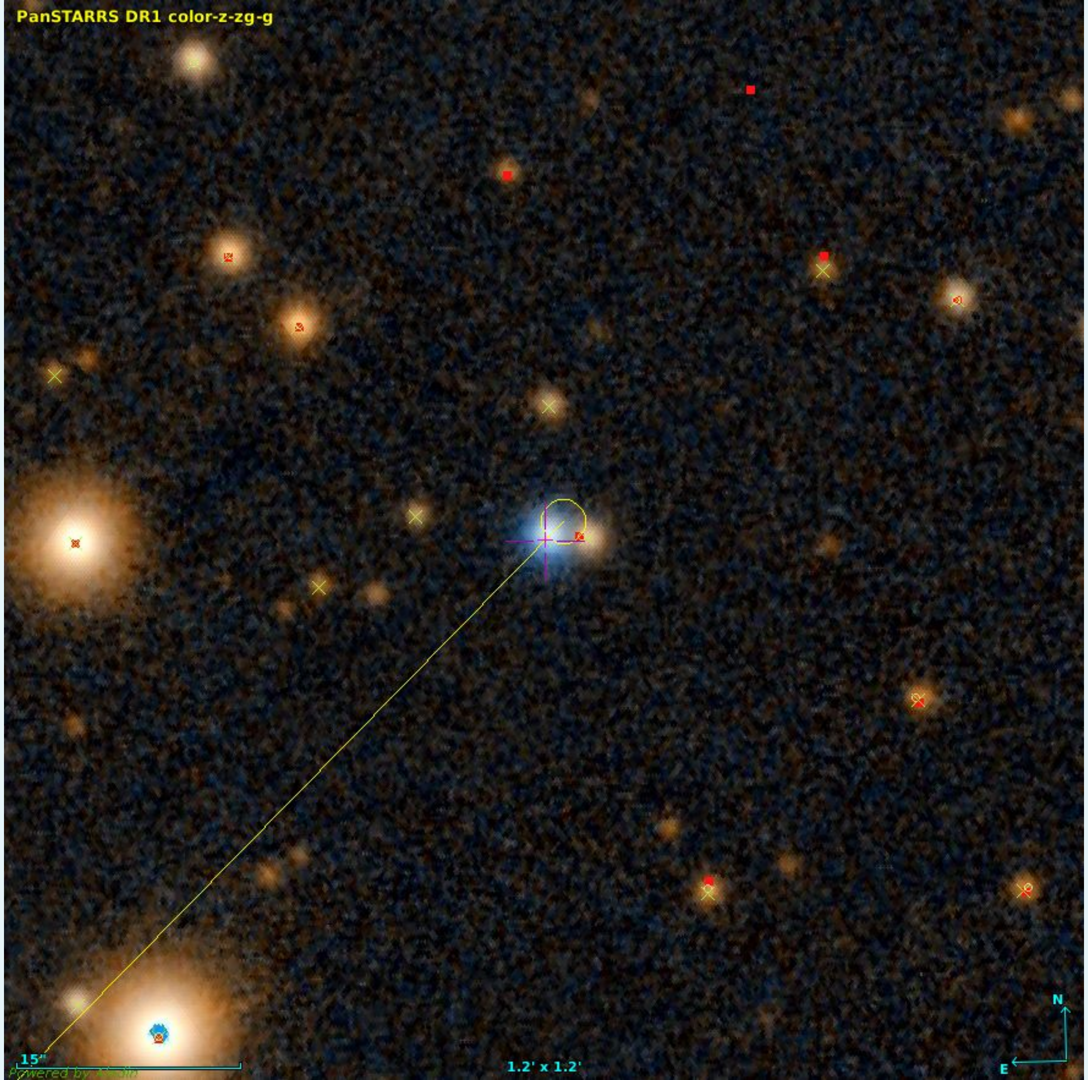


Examples of Aladin charts with contaminated photometry





PanSTARRS DR1 color-z-zg-g
15"
1.2' x 1.2'
N
E
Powered by Aladin



PanSTARRS DR1 color-z-zg-g
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WDs with IR excess

4.- Preliminary results:

We found **4 683** WDs with three or more reliable photometric points at infrared wavelengths.

After we had done the single fit of the SEDs with VOSA, we reduced the number to **516** SEDs with IR excess candidates.

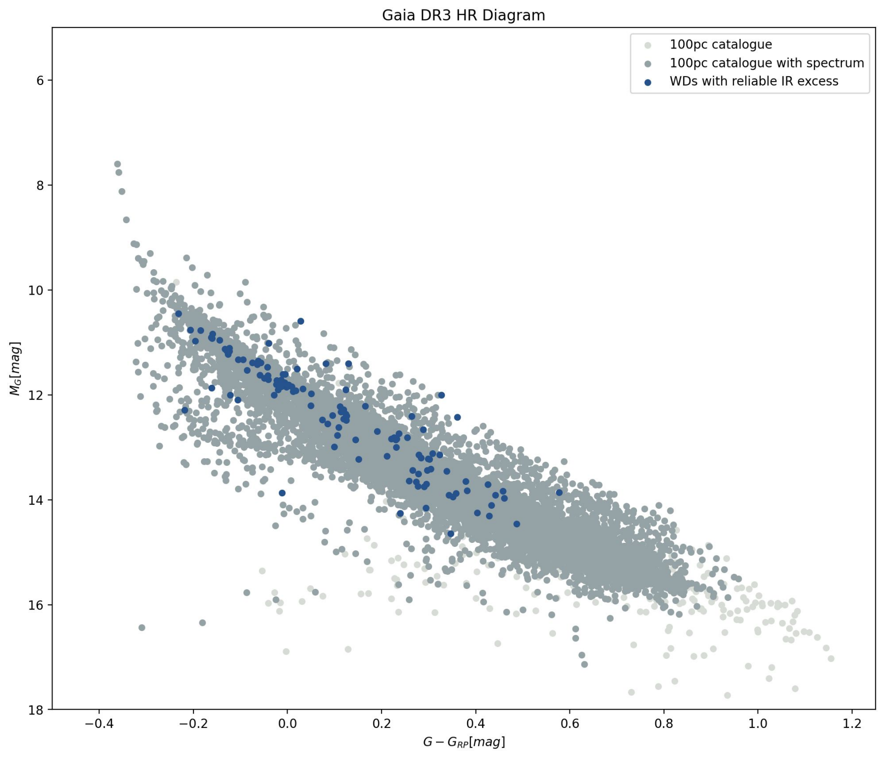
Finally, when we removed the WDs with contaminated photometry, we got **117 WDs with reliable IR excess**.

We recovered **47** SEDs with reliable IR excess from *Rebassa-Mansergas et al. (2019)*.

We discover **70** new SEDs with reliable IR excess.

Paper in progress (**Murillo-Ojeda et al.**).

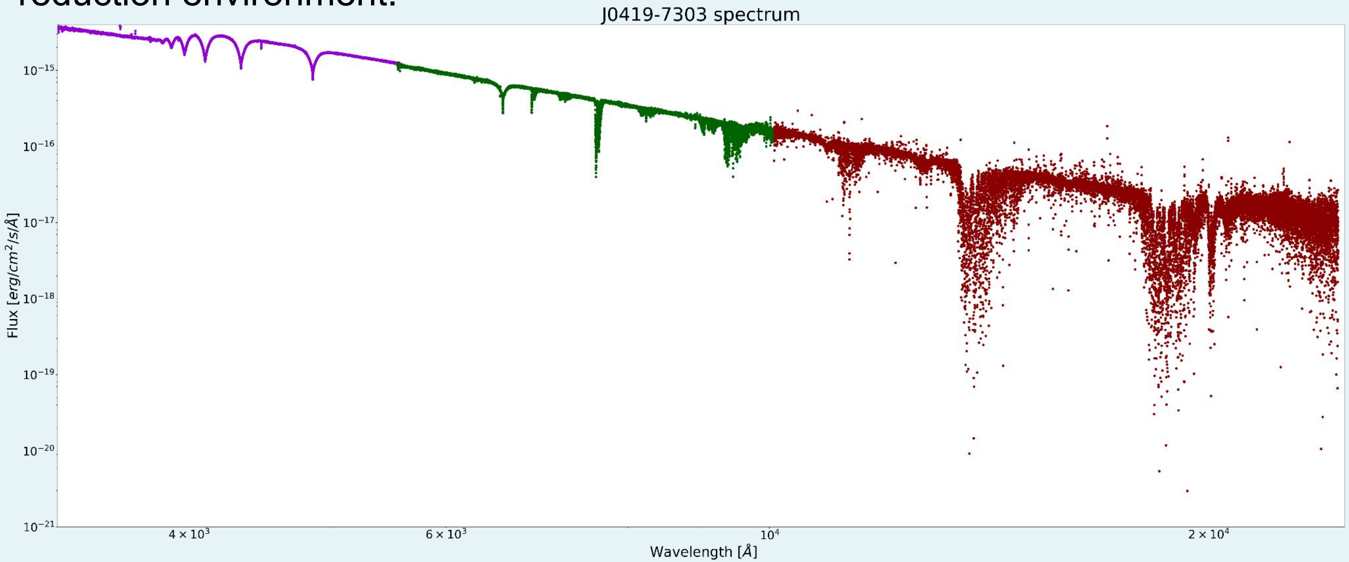
WDs with IR excess



Cause of the IR excess

Disentangle the real nature of the origin of the infrared emission in these objects:

- Using spectra from X-Shooter (VLT instrument). We are using ESO Reflex data reduction environment.



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REFLEX
The ESO Recipe Flexible Execution Workbench

- We will make new observation proposals for telescopes such as VLT and GCT.

Thanks for your attention