White Dwarfs in the Galactic Plane

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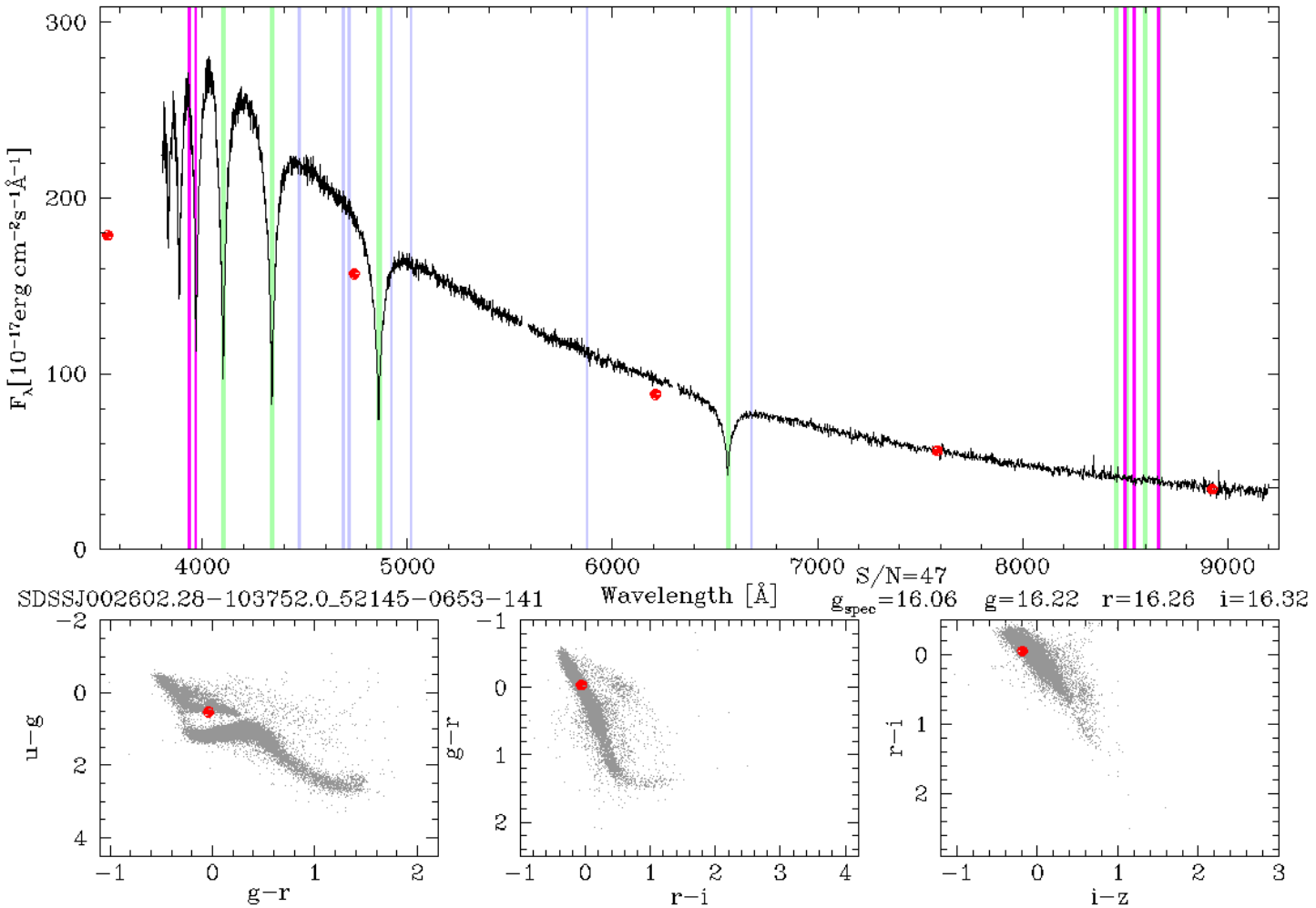
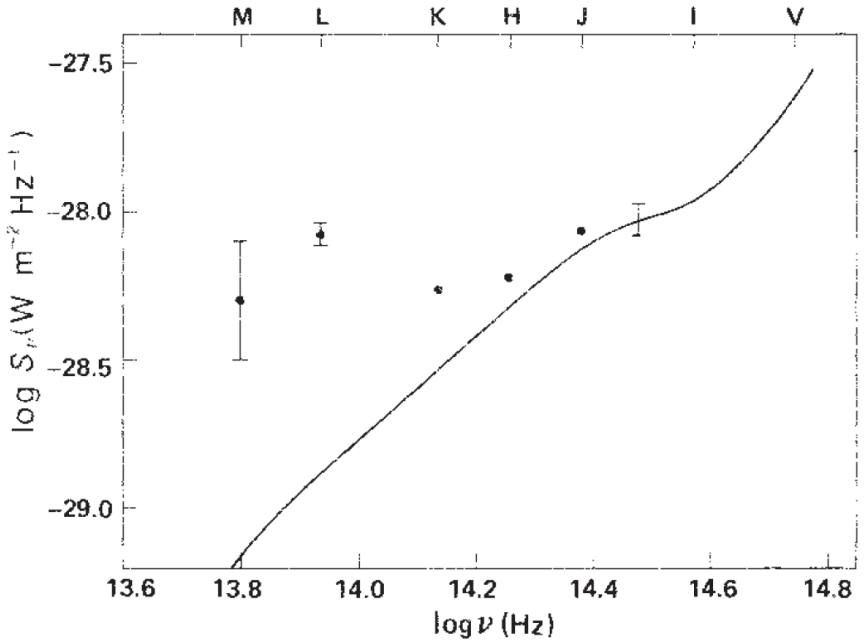
- White dwarfs and planetary remnants
- Selecting DA white dwarfs from SDSS
- IR excess white dwarfs from UKIDSS
- Potential to apply this to the Galactic plane

The Most Common Stellar Remnant in the Galaxy



An Infrared Excess to G29-38

- A brown dwarf companion
  - Zuckerman et al. (1987)



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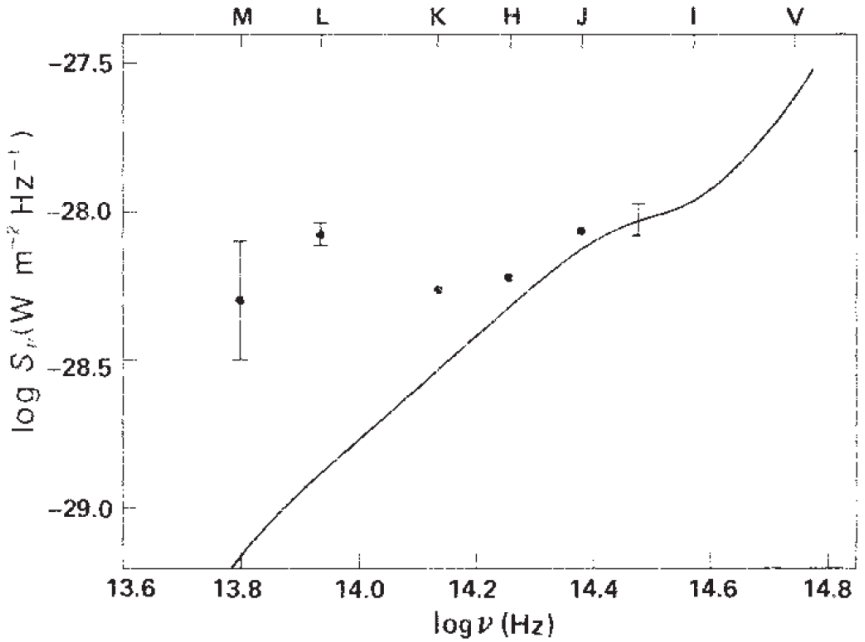

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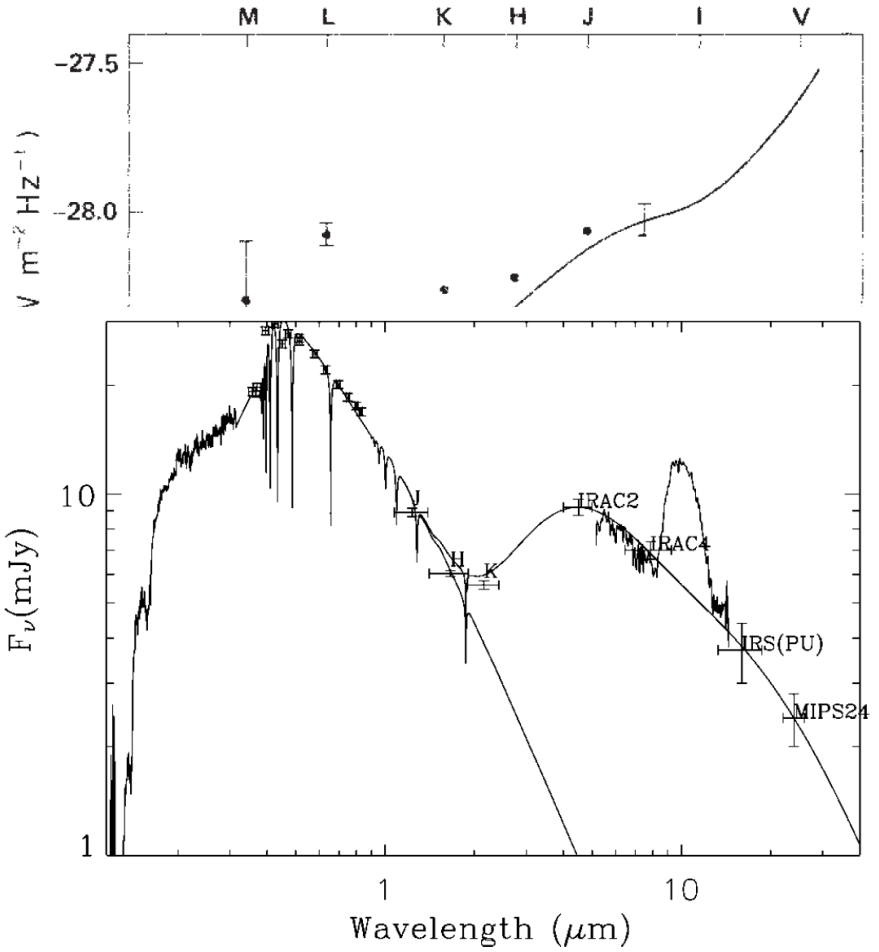

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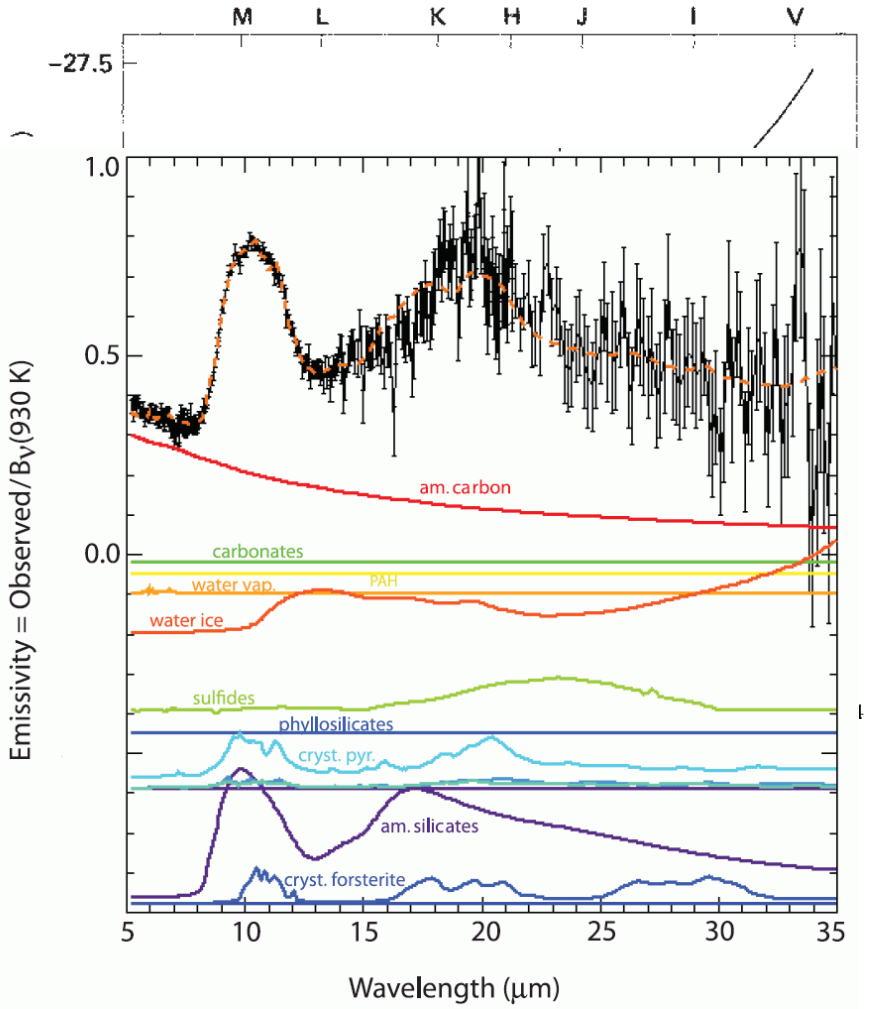
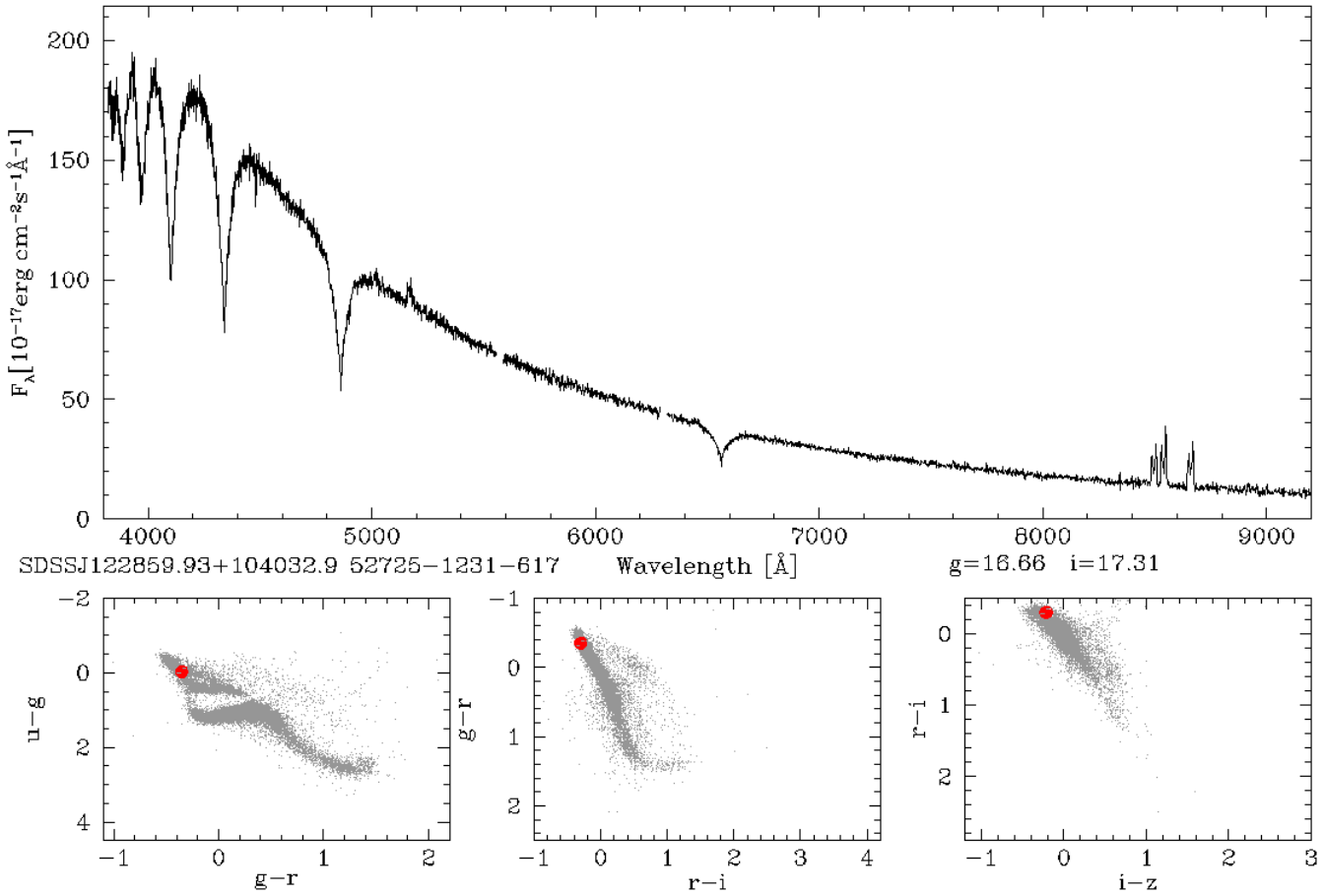


Double Peaked Emission Lines SDSS J1228+1040



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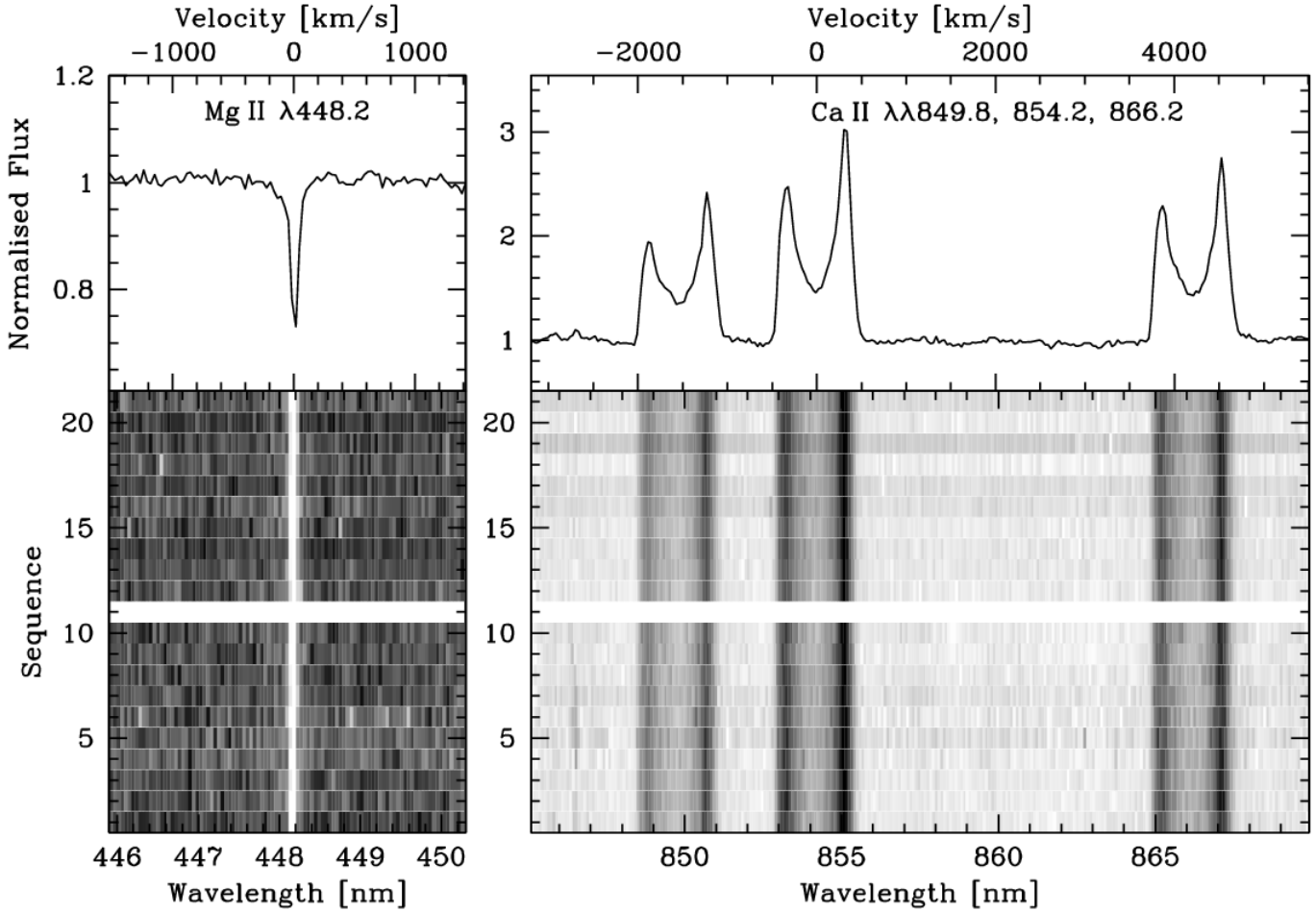
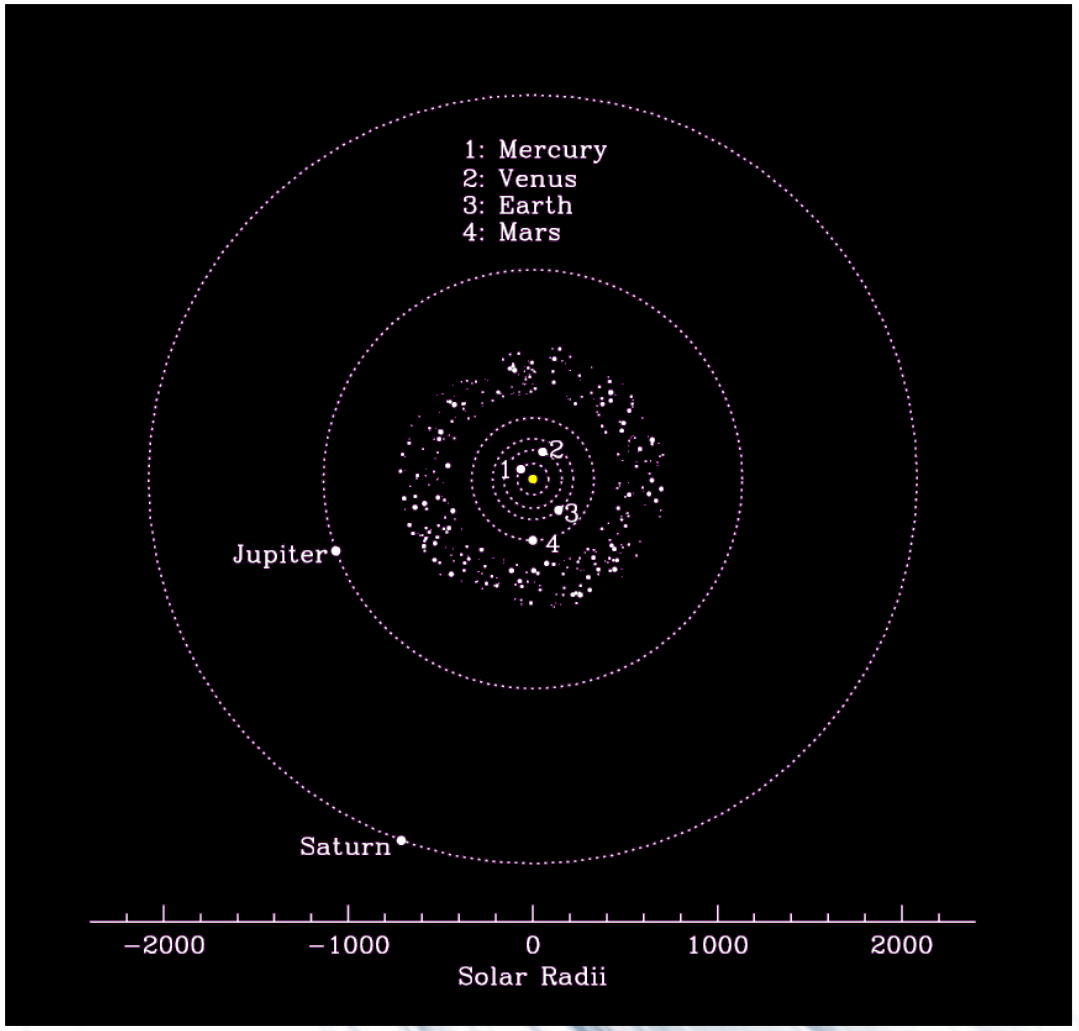
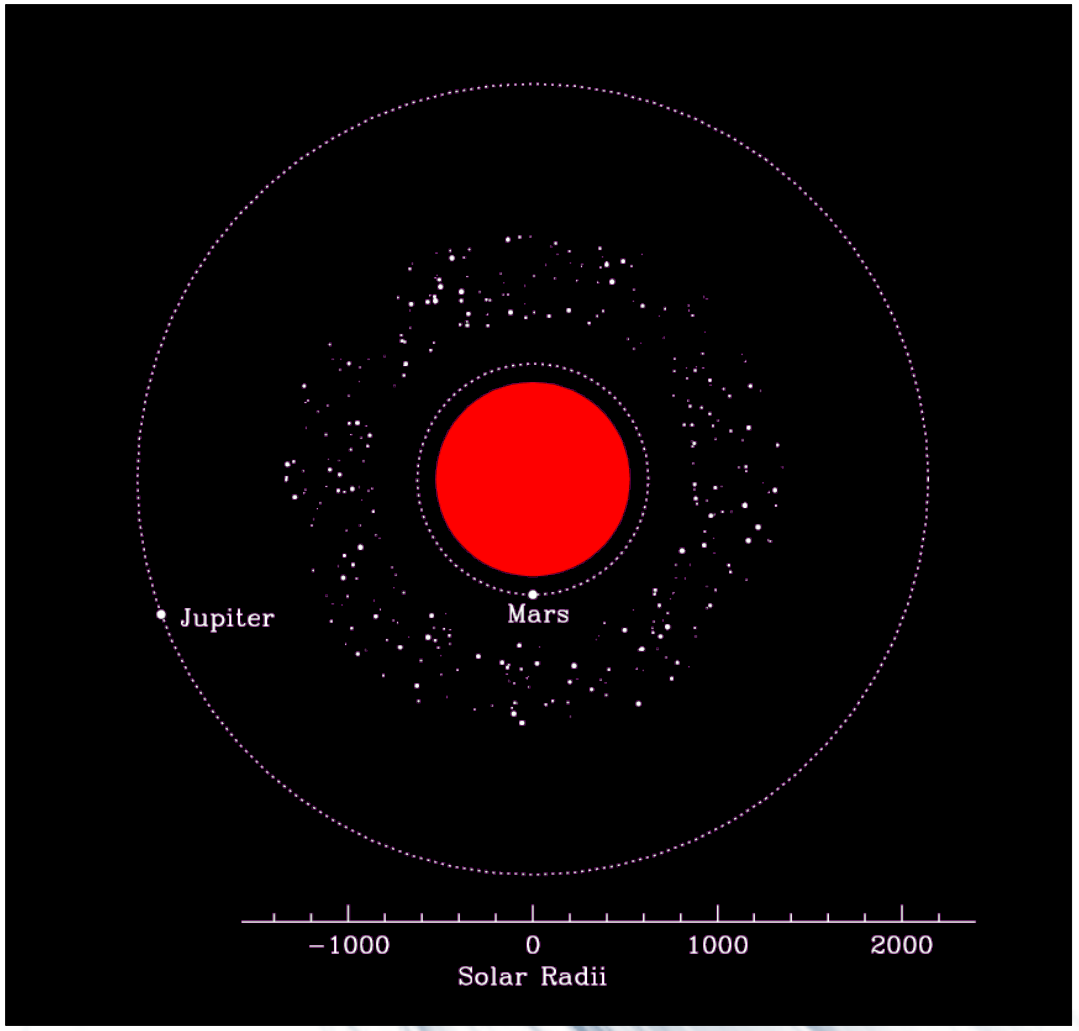


Gaensicke et al., 2006, Science, 314, 1908

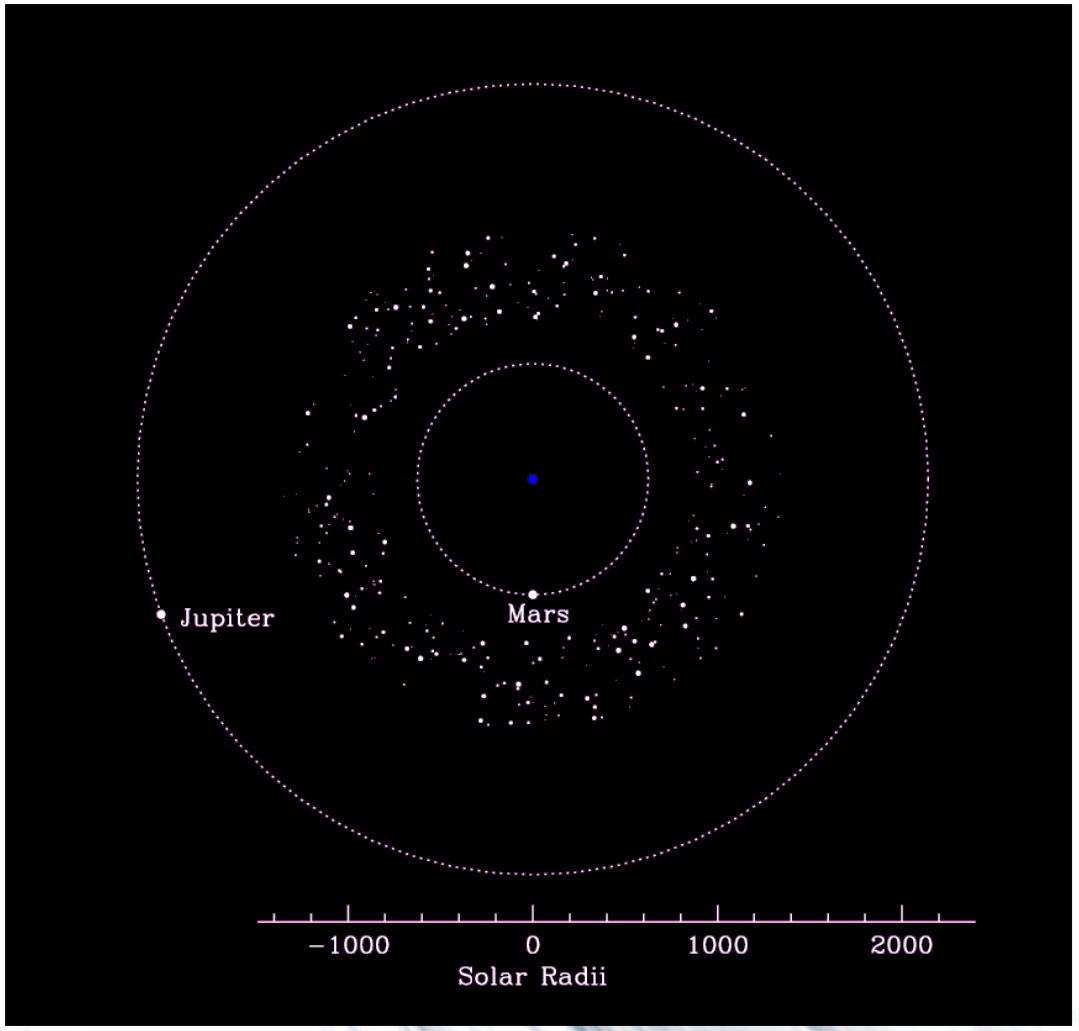
The Solar System - Today



The Solar System – 5 Billion Years



The Solar System > 5 Billion Years



Tidal Disruption of Asteroids

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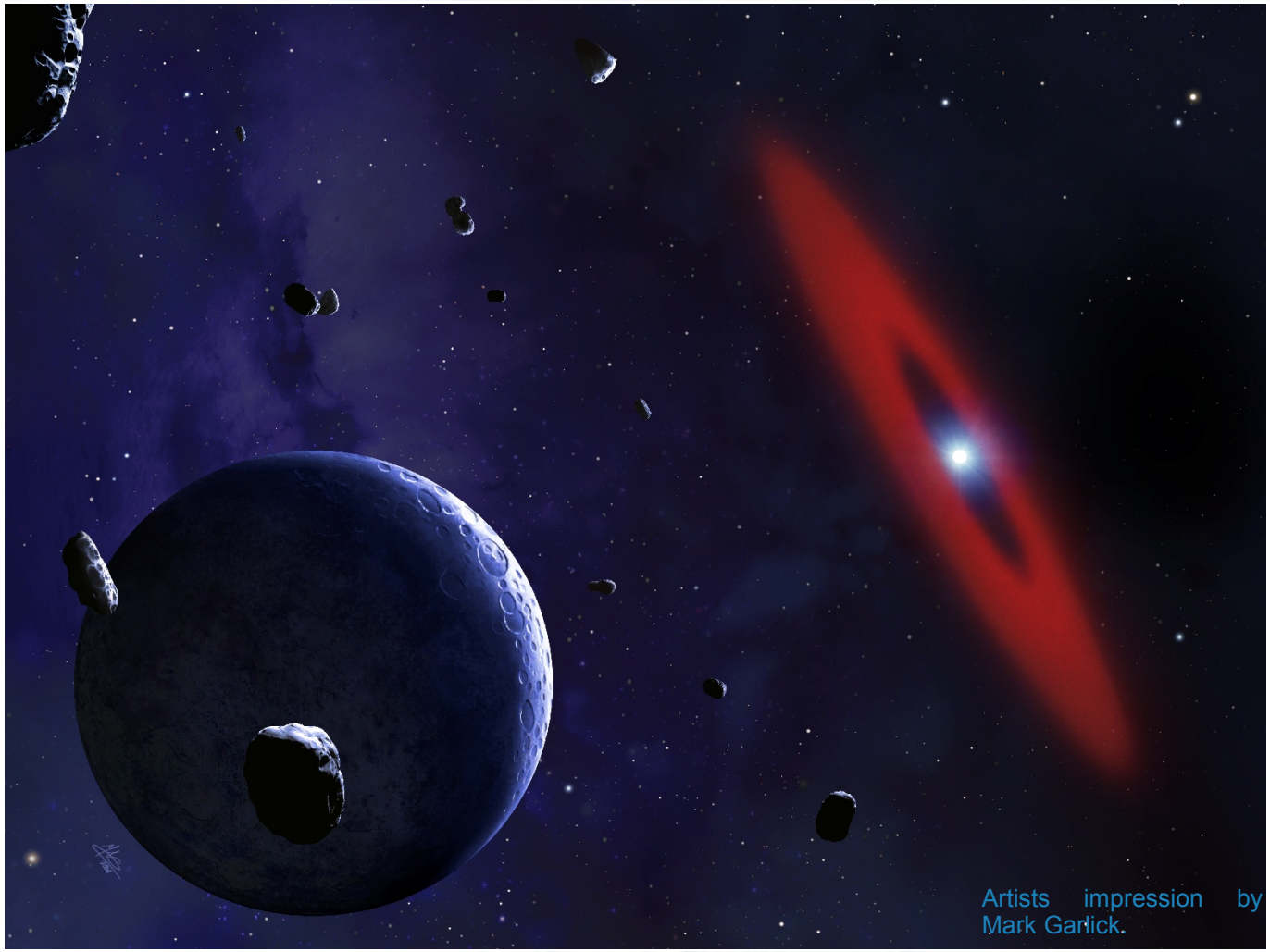
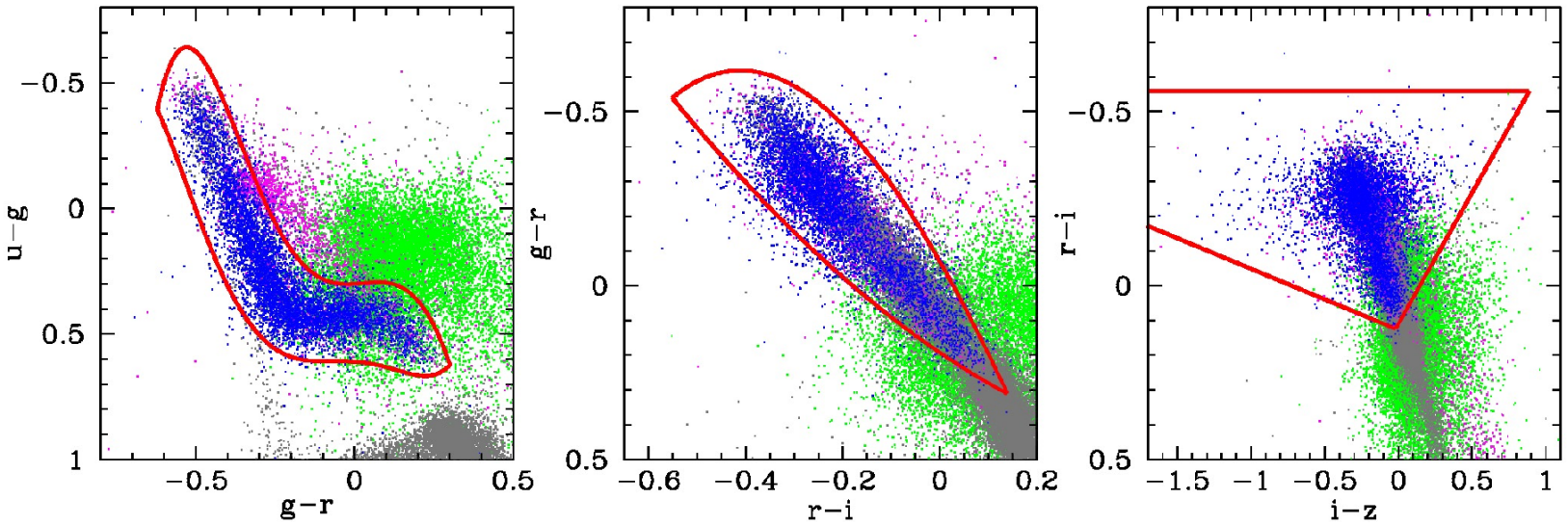


White Dwarfs in the SDSS

- SDSS Data Release 7
  - 11500 deg^2 of spectra and photometry in *ugriz* filters
- White dwarfs in the SDSS Data Release 4
  - Eisenstein et al. (2006)

Eisenstein, D. J., et al., 2006, ApJS, 167, 40

Colour-Colour Diagrams



DA white dwarfs (Eisenstein et al. 2006), non-DA white dwarfs, quasars and main-sequence stars are shown as blue, magenta, green and grey dots respectively. The polynomial colour cuts are overlaid as red lines.

- 5th order polynomial colour-colour cuts to select DA white dwarfs from SDSS
- Applicable to KIDS, ATLAS, IPHAS and VPHAS+

Efficiency and Completeness

- Efficiency
  - Contaminants
    - Narrow line hot stars (NLHS)
    - Quasars
    - Other white dwarfs
  - The ratio of spectroscopically confirmed DA white dwarfs to all objects in our colour-magnitude selection: 62.3%
- Completeness
  - The fraction of Eisenstein et al.'s DA white dwarfs recovered by our constraints: 95.4%
- 4600 spectroscopic DA white dwarfs (~70% increase)

Eisenstein, D. J., et al., 2006, ApJS, 167, 40

Completeness of SDSS DR7 Spectroscopy for White Dwarfs

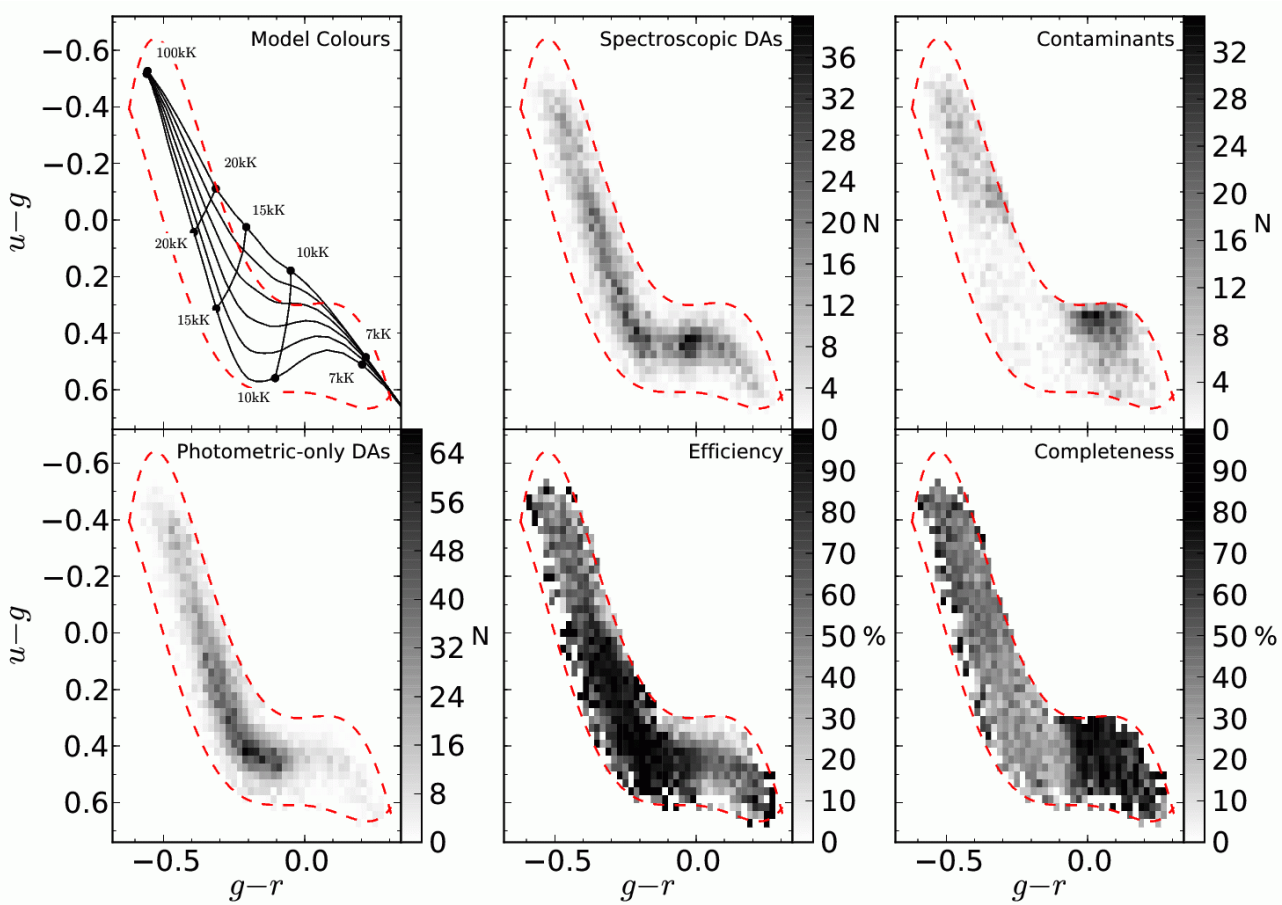
- Completeness:

  44.3%

Number of spectroscopic and photometric objects over the u-g vs g-r colour-colour space.

The number of DA white dwarfs without spectra is calculated as the number of photometric-only objects
weighted by the colour-dependent efficiency of our selection algorithm (lower-middle panel).

The spectroscopic completeness of SDSS for DA white dwarfs, i.e. the ratio of spectroscopic DAs to the total number of DAs, is shown in the bottom right panel.

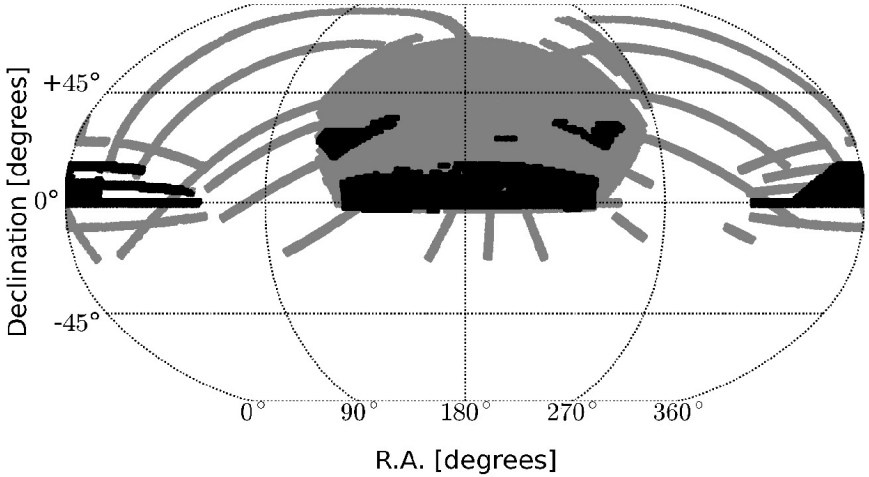


EGAPS

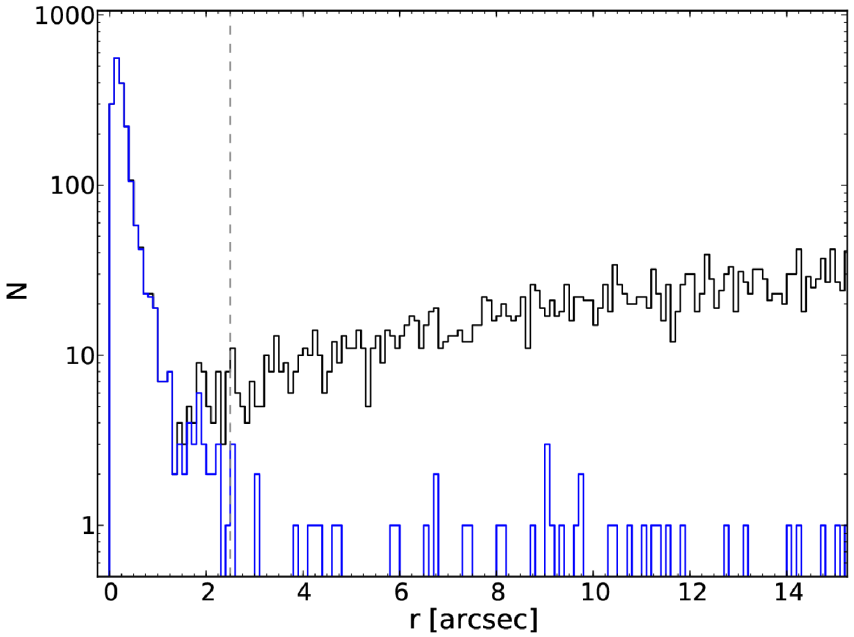
- Potential to apply the same method to …
  - KIDS
  - ATLAS
  - UVEX / IPHAS
  - VPHAS+
- Huge new area
- Applicable to the Galactic plane

DA White Dwarfs in UKIDSS DR8

- Cross-matching with UKIDSS LAS DR8



The sky coverage and overlap of SDSS (grey) and UKIDSS (black).

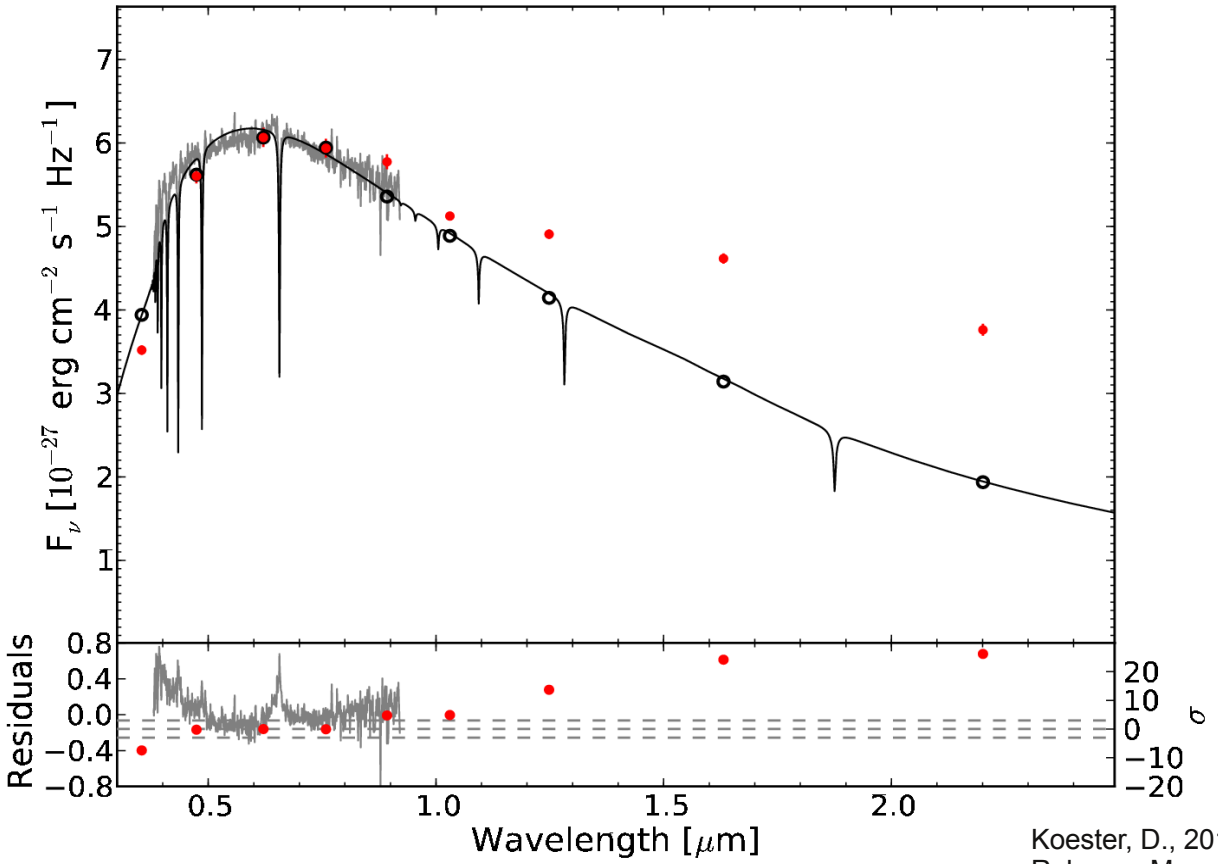


Spatial offsets of the SDSS and UKIDSS positions for a sample of 5000 spectroscopically confirmed DA white dwarfs randomly selected from our constraint set. The blue histogram shows the distance to the closest neighbour in UKIDSS, the black histogram plots the distances to all possible matches.

- ~260 sq. deg. of overlap
- Matches within 2.5”

White Dwarf Fitting

- Spectroscopic and photometric fitting



Line profiles of DA white dwarfs were compared to the models of Koester (2010) to calculate a spectroscopic fit as performed in Rebassa-Mansergas et al. (2007).

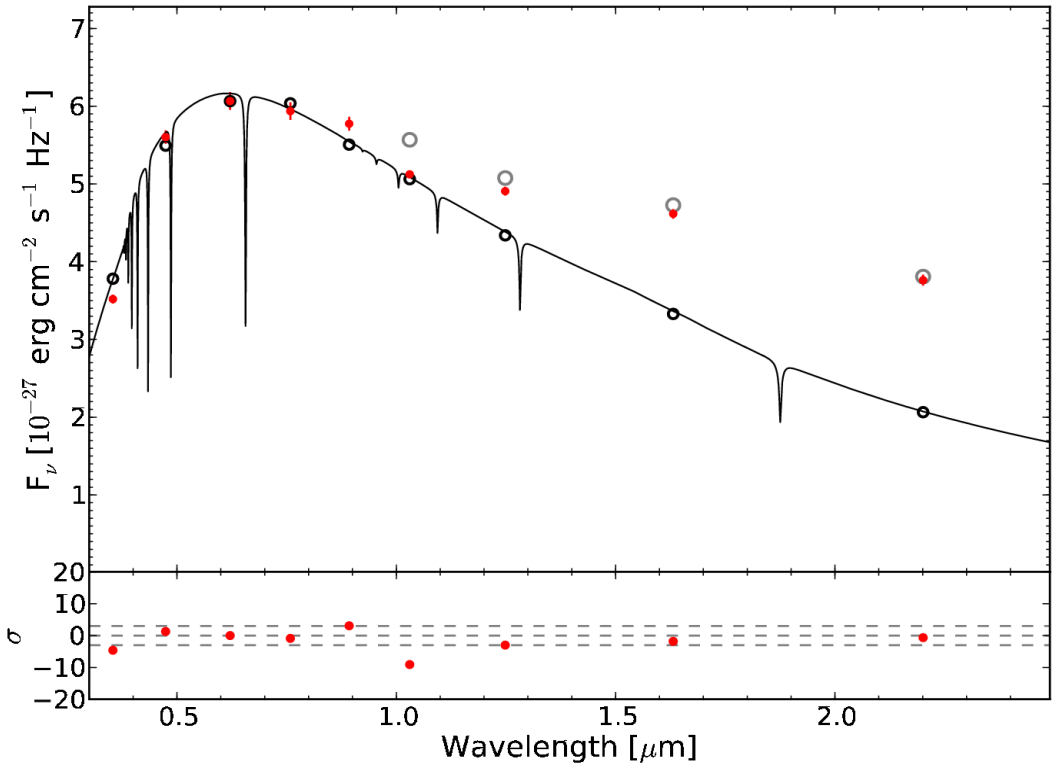
Photometric objects were fitted by comparing the SDSS ugri magnitudes to the white dwarf model grid, based upon a smallest χ^2.

Left Top: SDSS J0135+1445, plotted are: SDSS spectra (grey), SDSS and UKIDSS magnitudes with associated errors (red), best fit white dwarf model (black line) and its corresponding magnitudes (black open circles).

Left bottom: Residuals with respect to the best fitting white dwarf model.

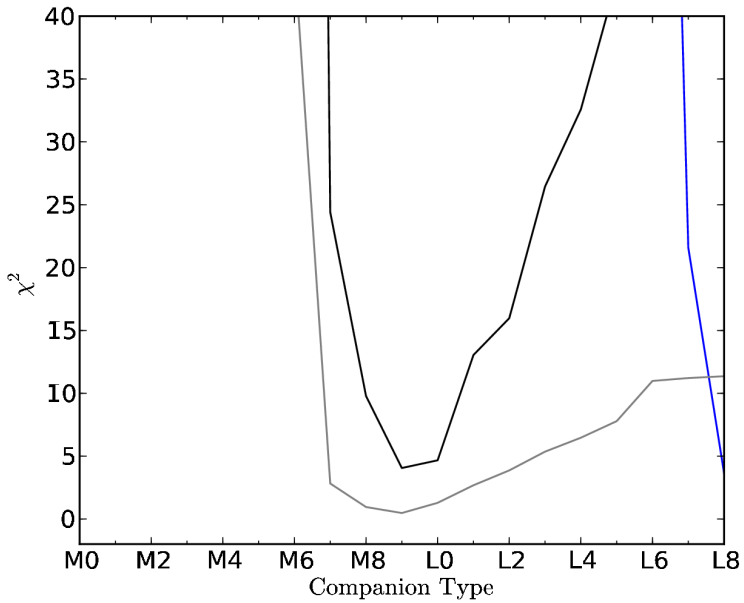
Koester, D., 2010, Memorie della Societa Astronomica Italiana, 81, 921
Rebassa-Mansergas, A., Gaensicke, B. T., Rodraıguez-Gil, P., Schreiber, M. R., Koester, D., 2007, MNRAS, 382, 1377

IR Excess Fitting



The YJHK$_s$ magnitudes of each system exhibiting signs of an IR excess were fitted with at set of low-mass companion models of Hoard et al. (2007) using a least χ^2.

Above: SDSS J1619+2533 fitted with an 18000K white dwarf plus L6-type companion.



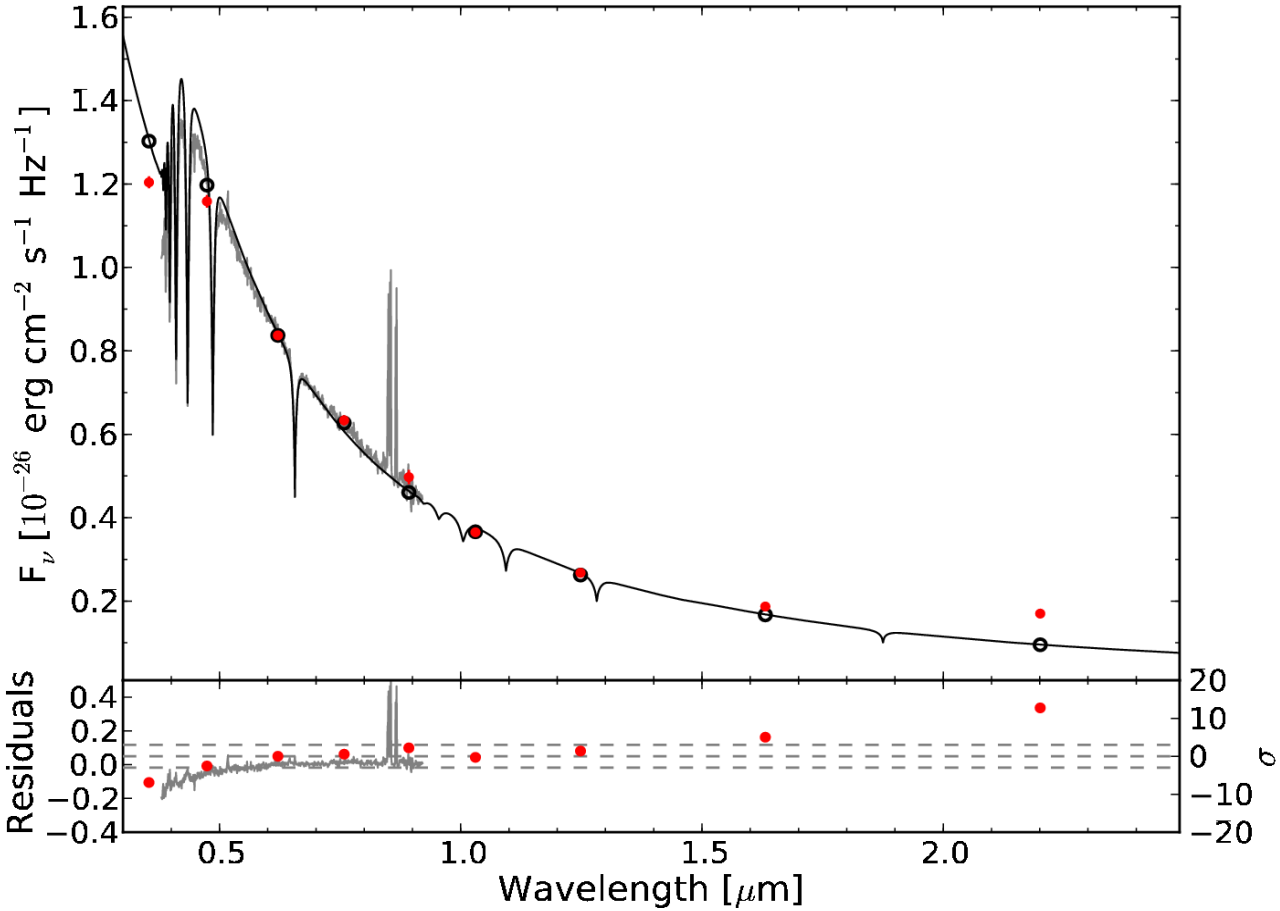
χ^2 as a function of companion type for three example IR excess systems.

Hoard, D. W., Wachter, S., Sturch, L. K., Widhalm, A. M., Weiler, K. P., Pretorius, M. L., Wellhouse, J. W., Gibiansky, M., 2007, AJ, 134, 26

IR Excess Candidates

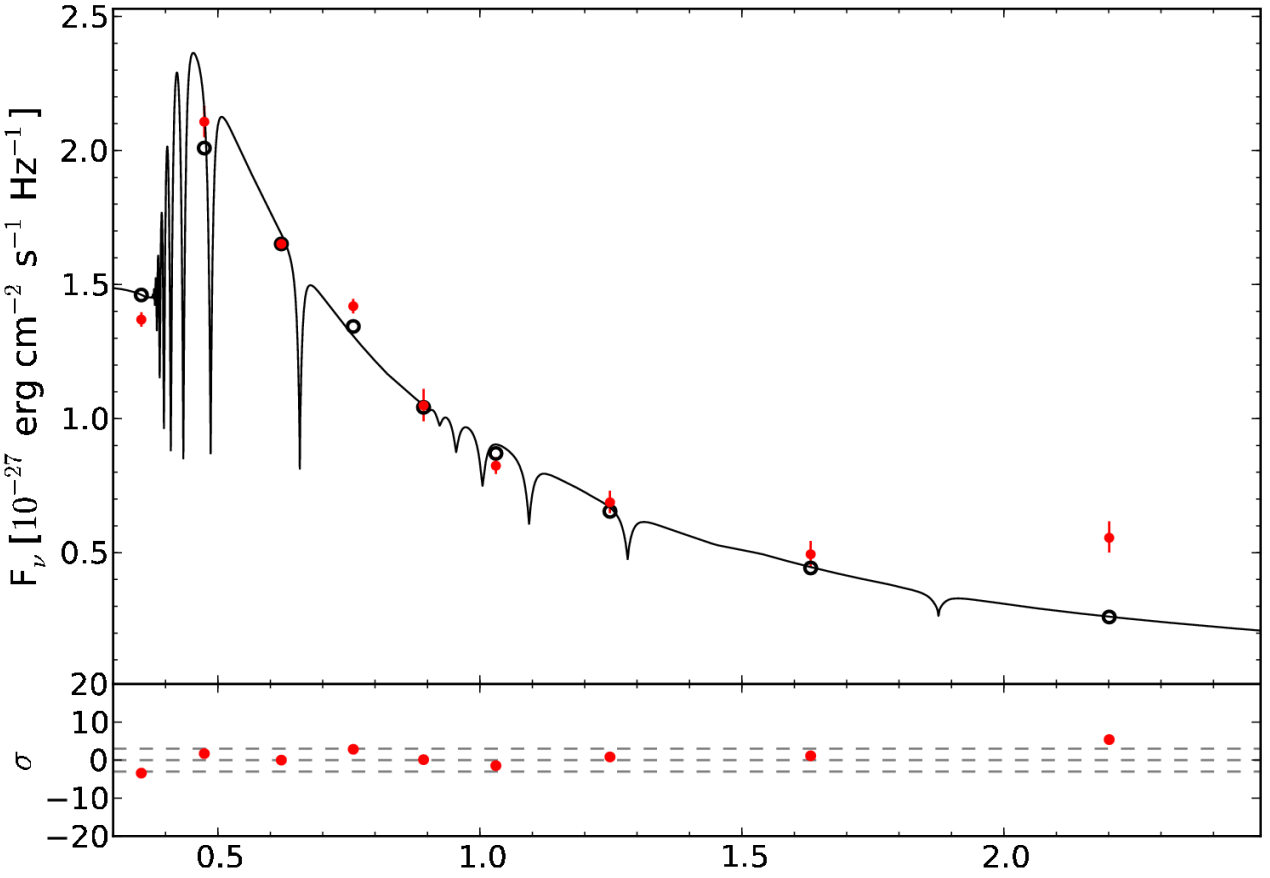
One of the prototype white dwarf plus dusty debris disk systems:
SDSS J1228+1040, found due to its strong, double peaked calcium-II emission (Gaensicke et al. 2006).

The object shows a 3σ excess in H and 12σ in K, independent of the method used for fitting the optical data.



IR Excess Candidates

SDSS J0959-0200, a photometric-only white dwarf candidate which is an excellent candidate of having a dusty debris disk. An optical spectra is needed to confirm its nature as a white dwarf and far-IR data is needed to confirm the presence of a dusty debris disk.

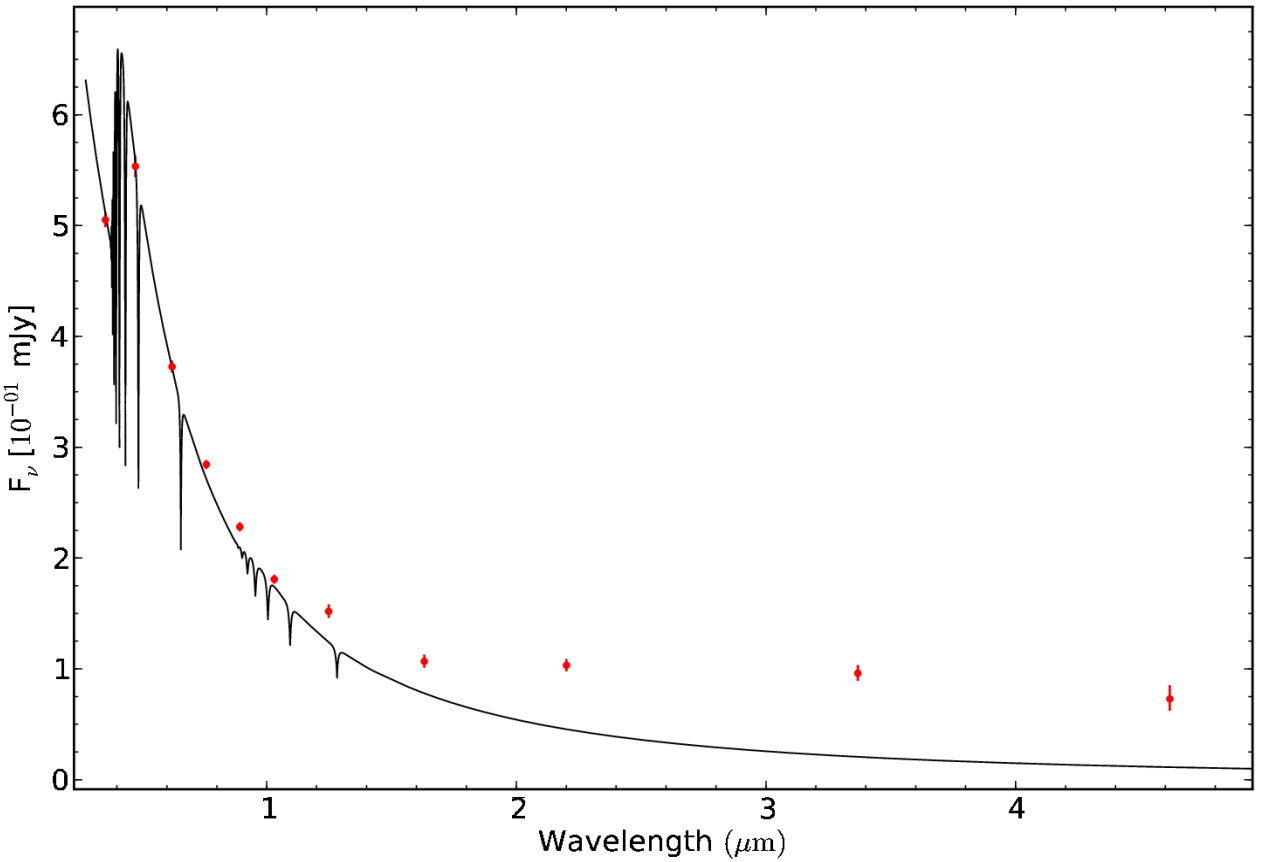


IR Excess Candidates

- 42 and 105 spectroscopic and photometric IR excess candidates respectively
- 2% of spectroscopically confirmed DA white dwarfs have an IR excess consistent with a brown dwarf companion
- 0.8% firm lower limit
- 1.8% from photometric sample
- Both samples show ~1% have an IR excess consistent with a dusty debris disk

Confirmation with WISE

SDSS J1538+2957:
A white dwarf candidate with an IR excess where WISE 3.4 and 4.6μm magnitudes are available to confirm the excess. SDSS J1538+2957 was found to have an M7:-type companion.



Conclusions

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  - Optical method for finding DA-type white dwarf stars
    - KIDS, ATLAS, IPHAS & VPHAS+
  - IR method to search for white dwarfs with IR excess
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Thank You