Searching for IR Excesses Around White Dwarf Stars

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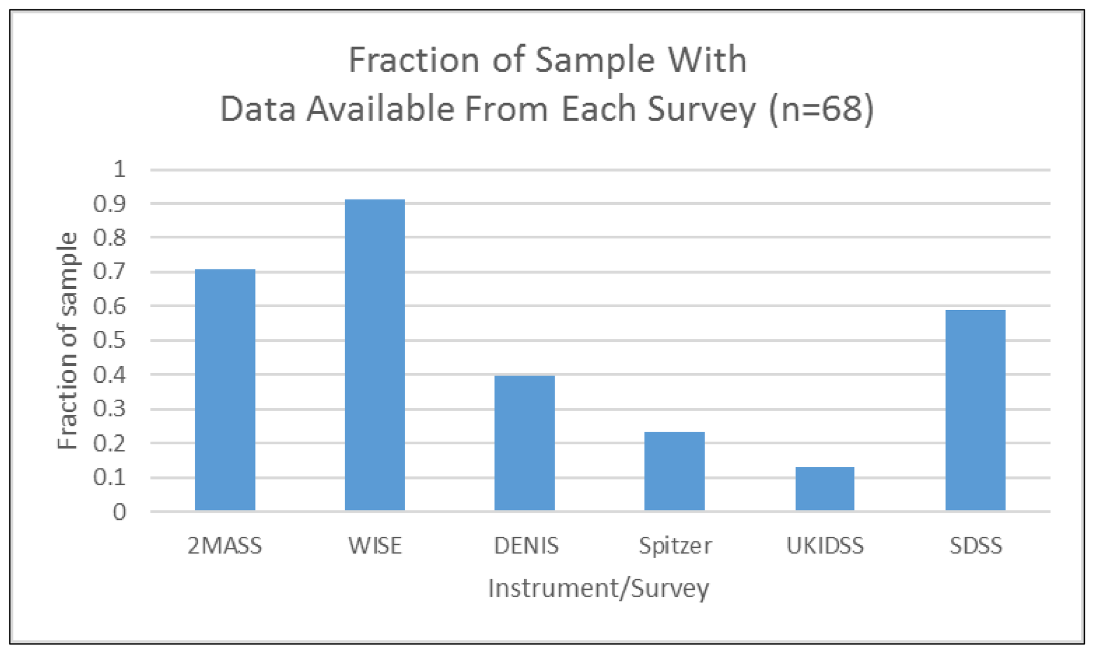
ABSTRACT & BACKGROUND

Many WDs have been found to be "polluted," meaning they contain heavier elements in their atmospheres. Either an active process that counters gravitational settling is taking place, or an external mechanism is the cause. One proposed external mechanism for atmospheric pollution of WDs is the disintegration and accretion of rocky bodies, which would result in a circumstellar (CS) disk. As CS disks are heated, they emit excess infrared (IR) emission. Statistical studies are still needed to determine how numerous dusty, polluted WDs are, along with trends and correlations regarding rate of planetary accretion, the lifetimes of CS disks, and the structure and evolution of CS disks. These findings will allow for a better understanding of the fates of planets along with potential habitability of surviving planets. In this work, we are trying to confirm IR excesses around a sample of 68 WD stars selected as part of the WISE InfraRed Excesses around Degenerates (WIRED) Survey (Debes et al. 2011). We have archival data from WISE, Spitzer, 2MASS, DENIS, UKIDSS and SDSS. We also have data from the Four Star Infrared Camera array, which is part of Carnegie Institution's Magellan 6.5 meter Baade Telescope located at Las Campanas Observatory in Chile. These Four Star data are much higher spatial resolution than the WISE data that were used to determine if each WD has an IR excess. There are often not many bands delineating the IR excess portion of the SED. Therefore we are using the Four Star data to check if there is another source in the WISE beam affecting the IR excess.

SOURCE SELECTION AND DATA

68 WD stars were selected as part of the WISE InfraRed Excesses around Degenerates (WIRED) Survey (Debes et al. 2011). These were originally selected from the Sloan Digital Sky Survey (SDSS) and identified as containing IR excesses based on WISE data. Data for the 68 targets were then pulled from archives.



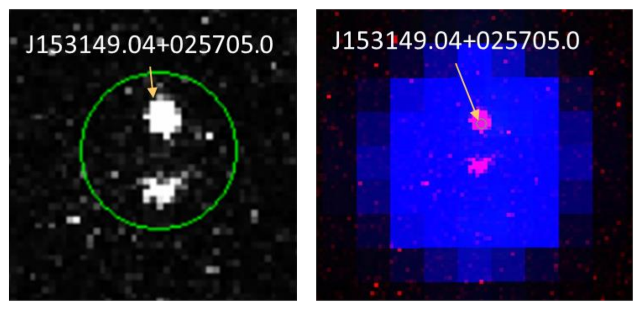
METHODS

- Assemble target list with good coordinates.
- Obtain archival data from SDSS, Spitzer, WISE, DENIS, UKIDSS and 2MASS.
- Plot archival SEDs and assign initial classifications for candidates that exhibit characteristics of source confusion. Compare with Finder Chart images to identify potential HPM candidates and check source matching.
- Attach WCS to reduced FourStar data.
- Create RB/RGB images of FourStar, 2MASS and WISE bands in DS9 to identify likely contamination of SEDs in WISE bands due to source confusion.
- Determine significance of small IR excesses by comparing near and far IR bands (Rebull et al. 2015; Mizusawa et al. 2012 and references therein):

$$\chi = \frac{([nearIR]-[FarIR])_{observed} - ([nearIR]-[farIR])_{predicted}}{\sigma([nearIR]-[farIR])}$$

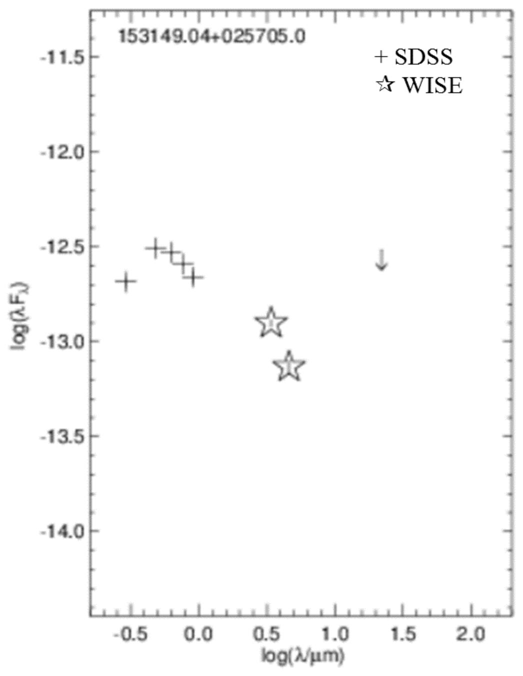
SOURCE CONFUSION

SDSS J153149.04+025705.0.

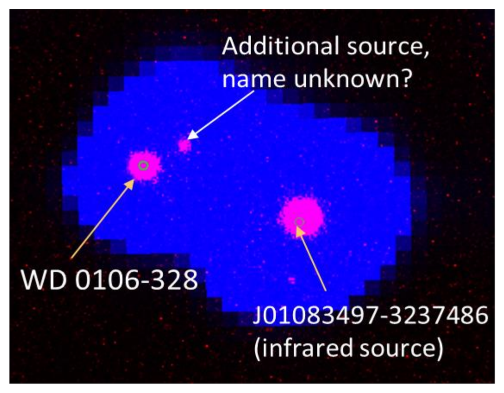


Left: FourStar J image

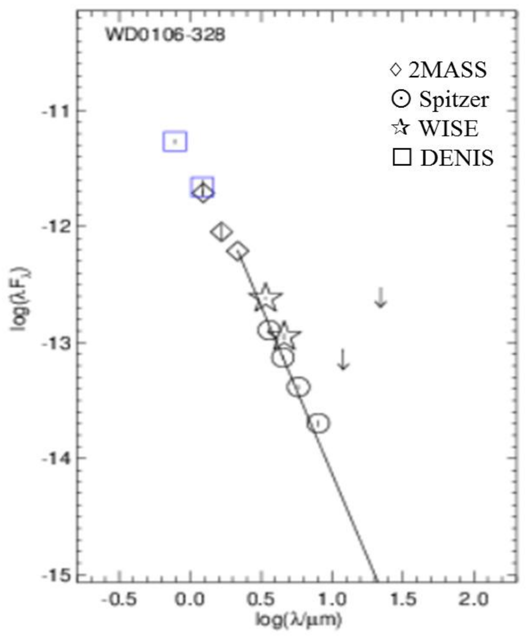
Right: RB image of FourStar J band (red) and W1 band (blue). There are two objects where WISE sees one.



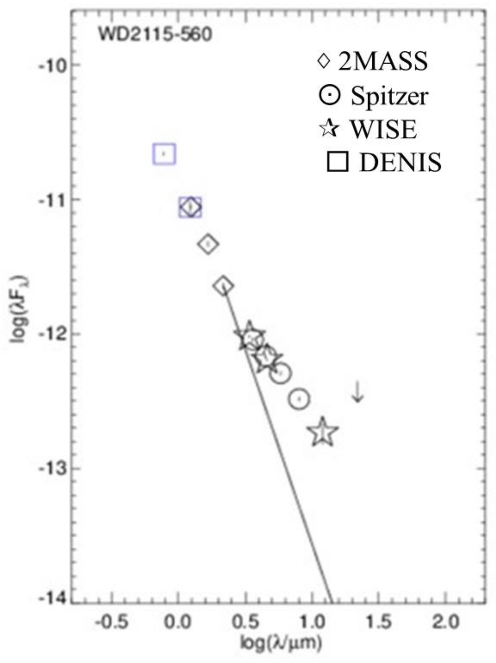
WD 0106-328



RB image of FourStar J band (red) and W1 band (blue); FourStar sees two sources where WISE sees one.

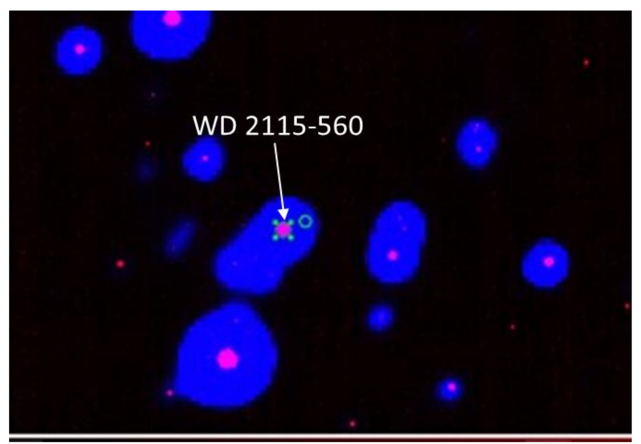


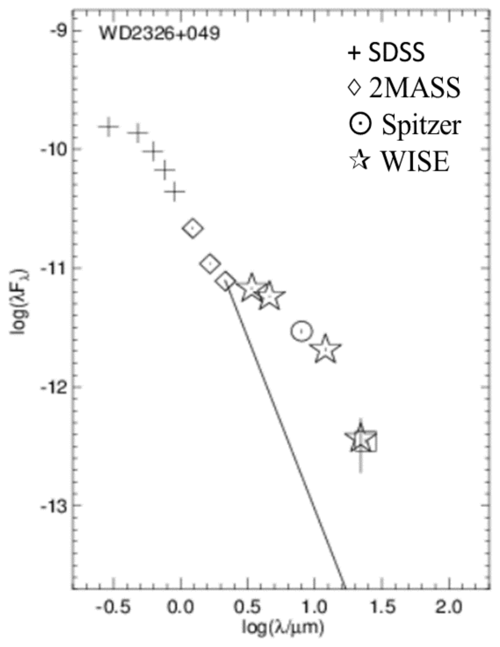
DISK CANDIDATES



WD 2115-560

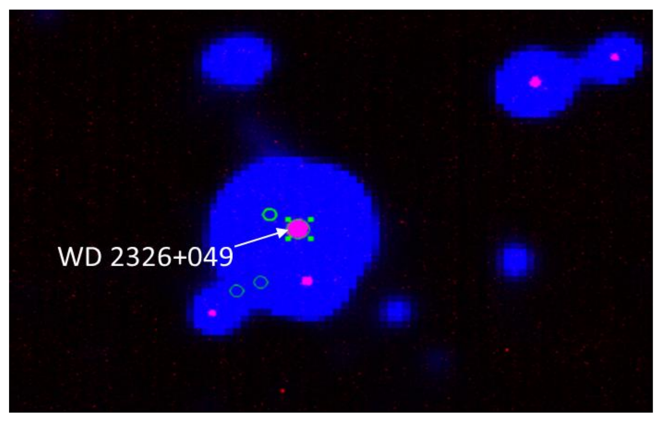
RB image of FourStar J band (red) and W1 band (blue). This object is known to have an excess.





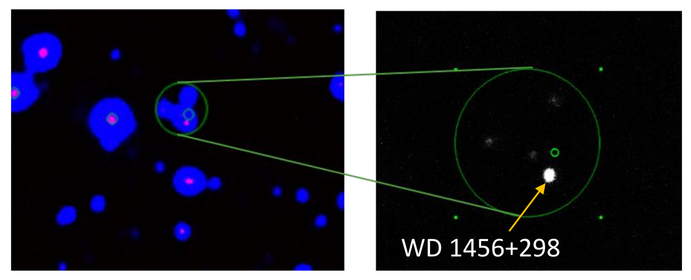
WD 2326+049

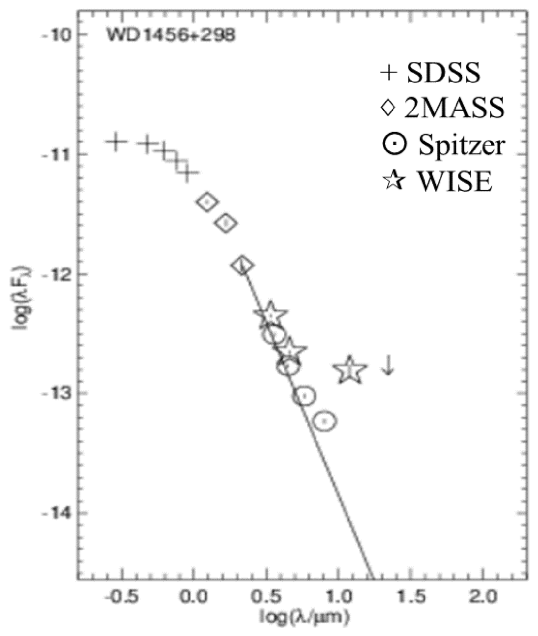
(blue). RB image of FourStar J band (red) and W1 band The SED shows a clear excess; Spitzer and WISE follow the same trend.



INCONSISTENCIES BETWEEN SPITZER AND WISE

WD 1456+298





Left: RB image of FourStar J band (red) and W1 band (blue).

Right: Zoomed in image of target in FourStar.

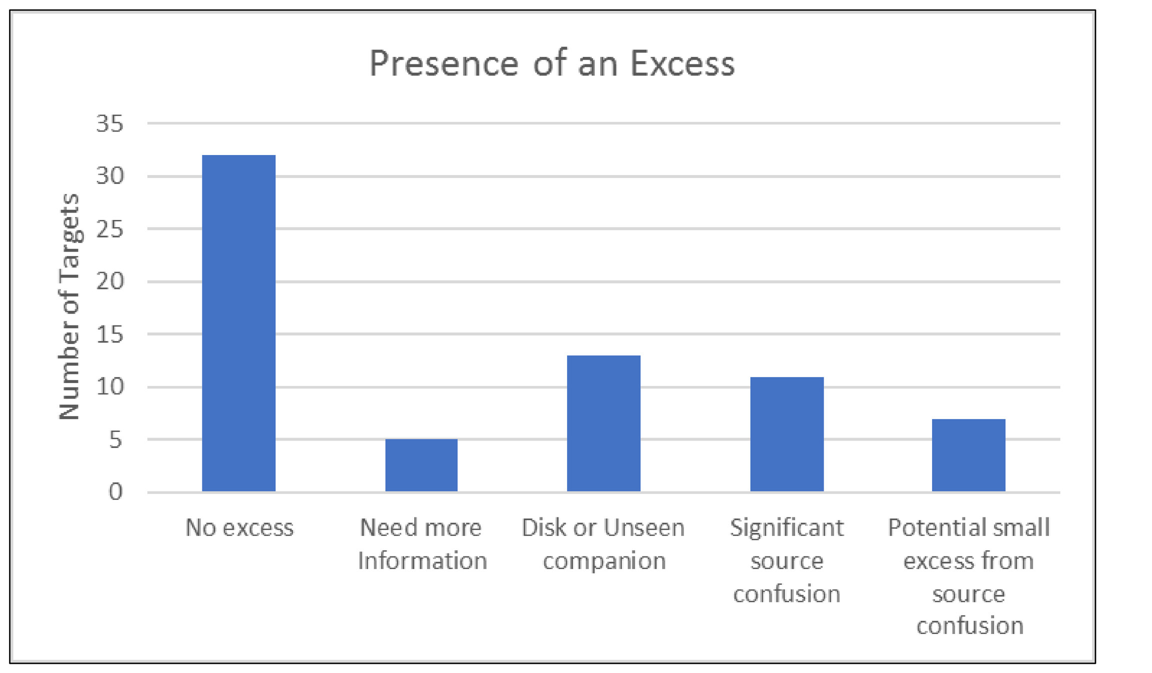
Spitzer and WISE data points both indicate varying, inconsistent levels of excess. Both values cannot physically be accurate. The WISE values seem to be influenced by source confusion.

χ calculations

K_s-[12] (WISE)	K_s-[8] (Spitzer)
16.09	5.275

RESULTS AND DISCUSSION

- Of the 68 targets, 26 targets identified as having significant proper motions (IRSA) (SIMBAD) (Girven et al. 2011).
- 18 appear to have mild to moderate excesses that can be attributed at least partially to source confusion.
- 13 targets identified as likely disk candidates—an excess is present, there are no additional visible sources near the target.



Next steps:

- Incorporate FourStar data into SEDs; this requires resolving some calibration challenges.
- Model curves for targets that seem to have an excess, even in the presence of a visible companion, as a disk can still exist and be detected (Debes et al. 2012).
- We have time-series photometric data on WD 2115-560, consisting of 35 observations over the span of an hour. This data will allow us to determine potential characteristics of the disk and/or fragments orbiting the object.

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