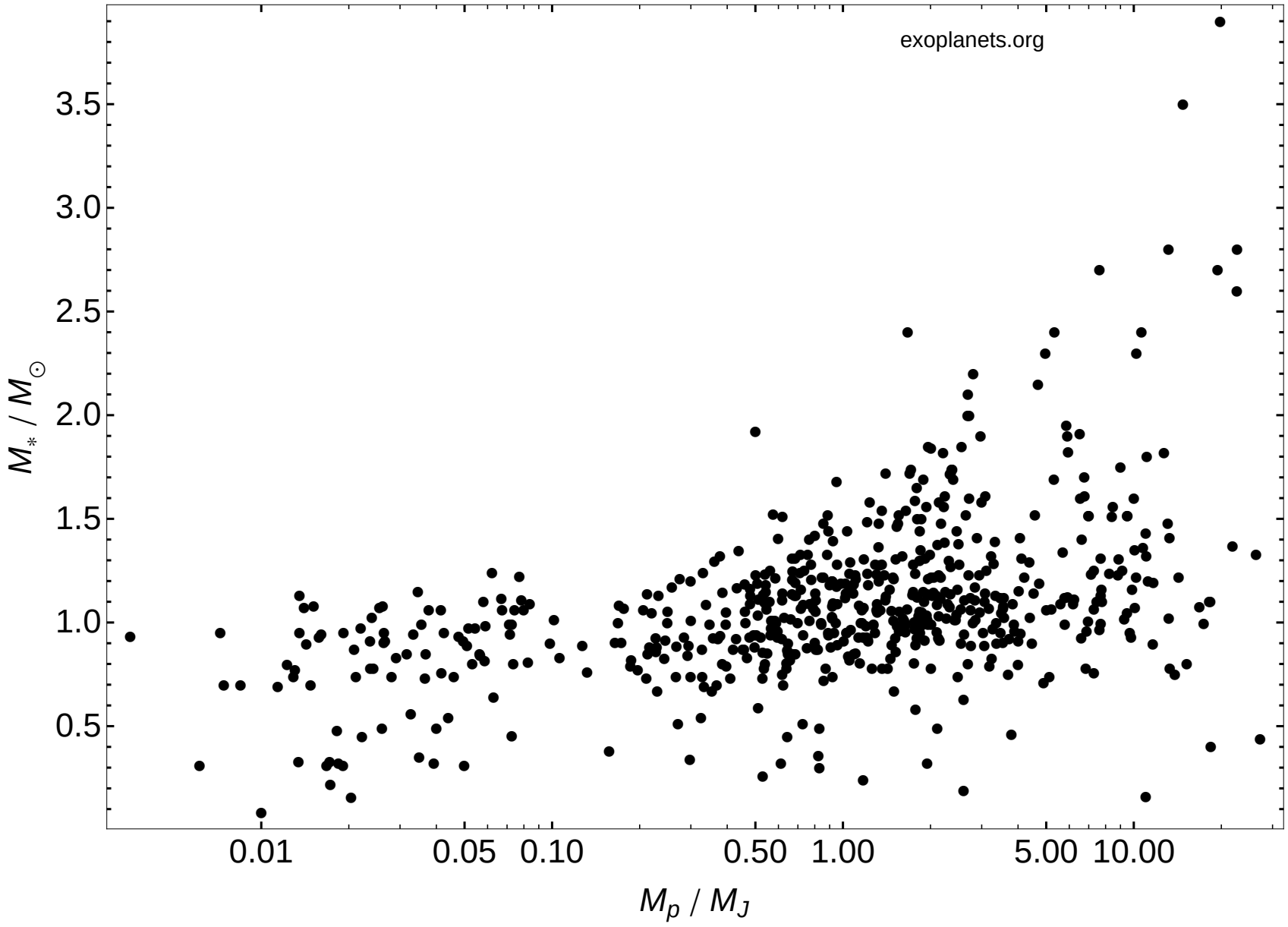
The Frequency of Dusty White Dwarfs

Sara D. Barber

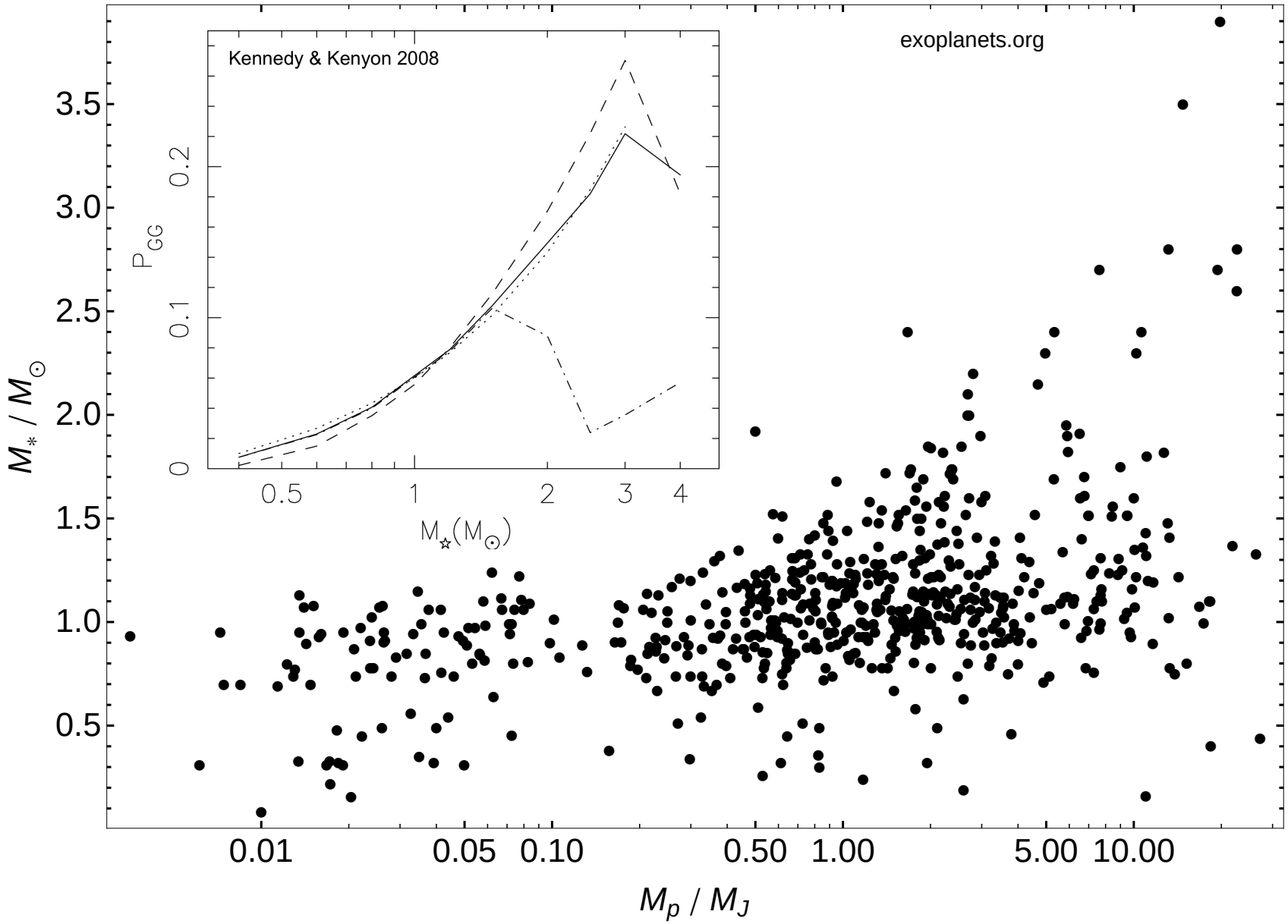
University of Oklahoma

Collaborators:
Mukremin Kilic
Warren Brown

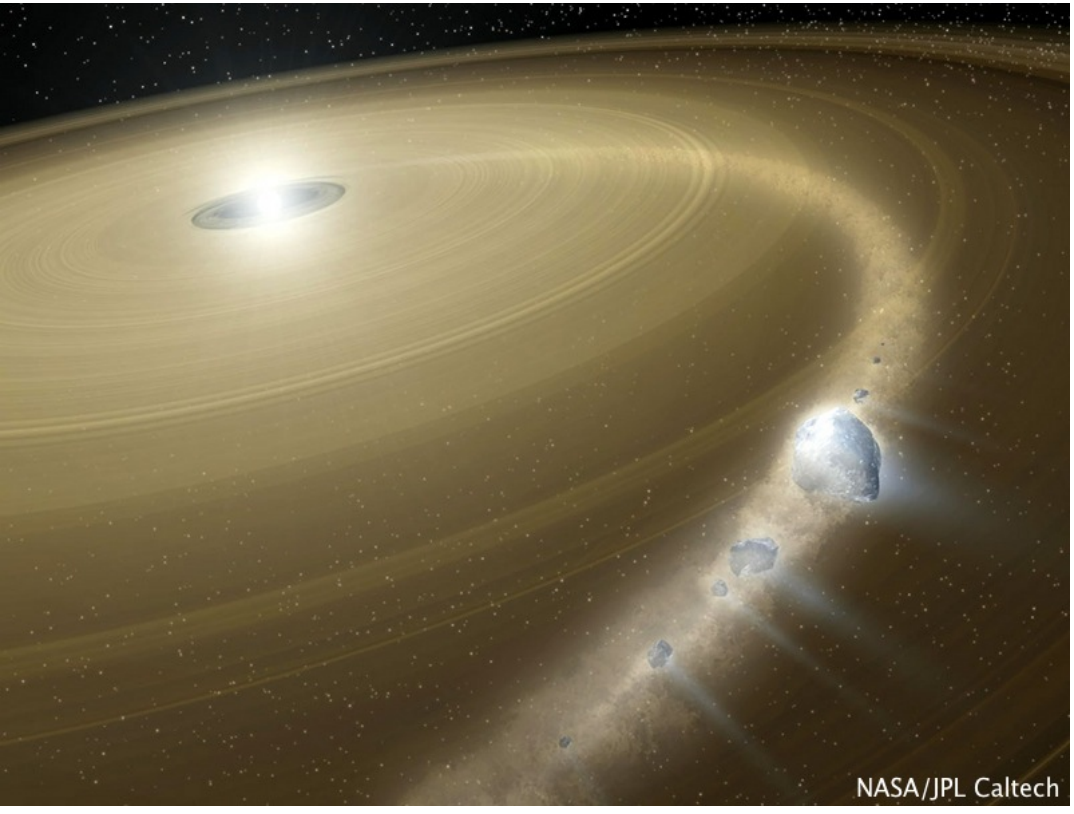
Planets Around Massive Stars

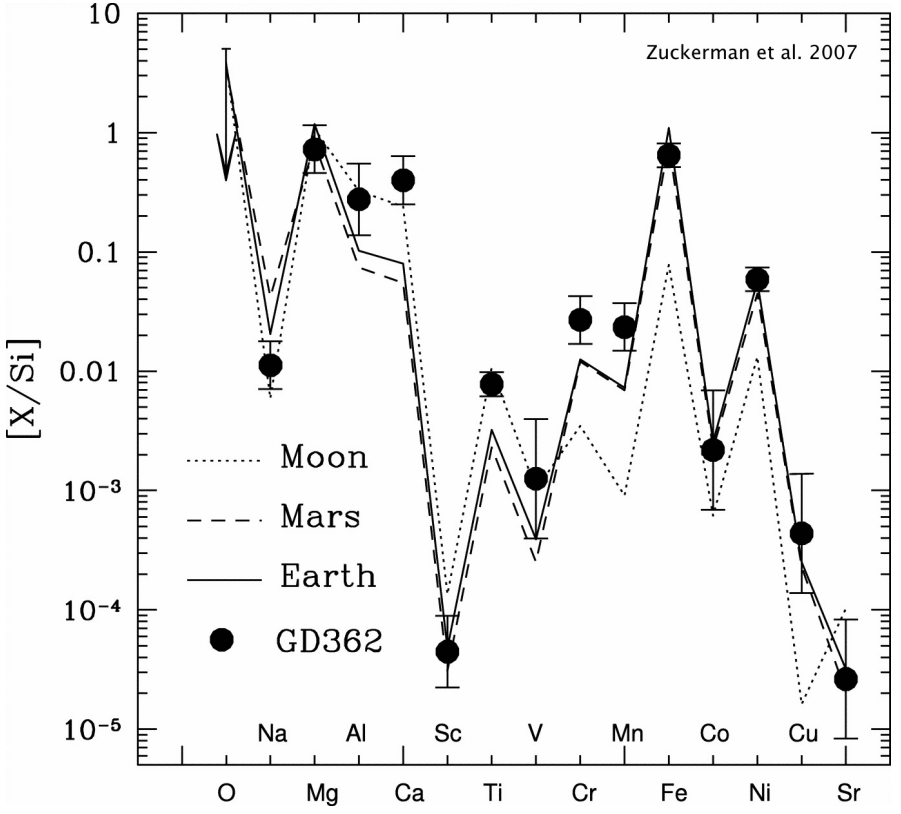


Planets Around Massive Stars

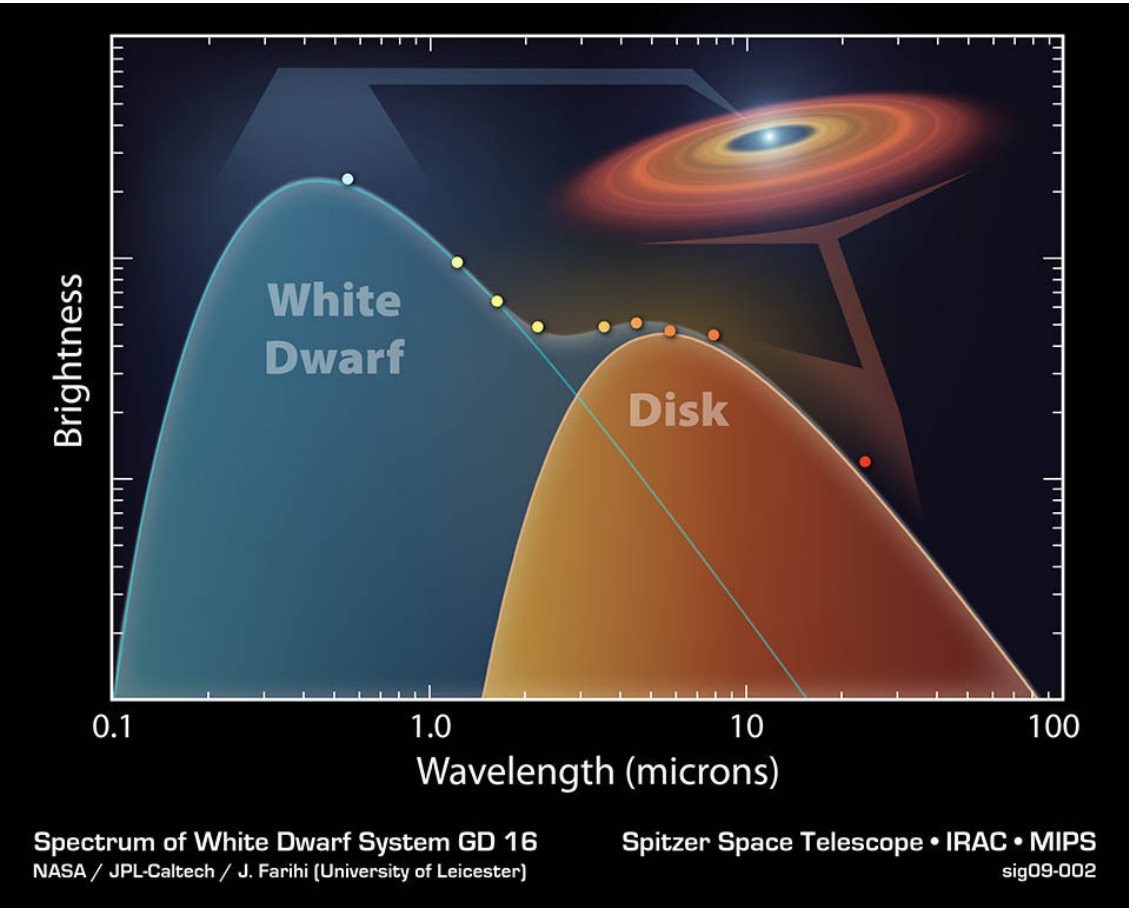


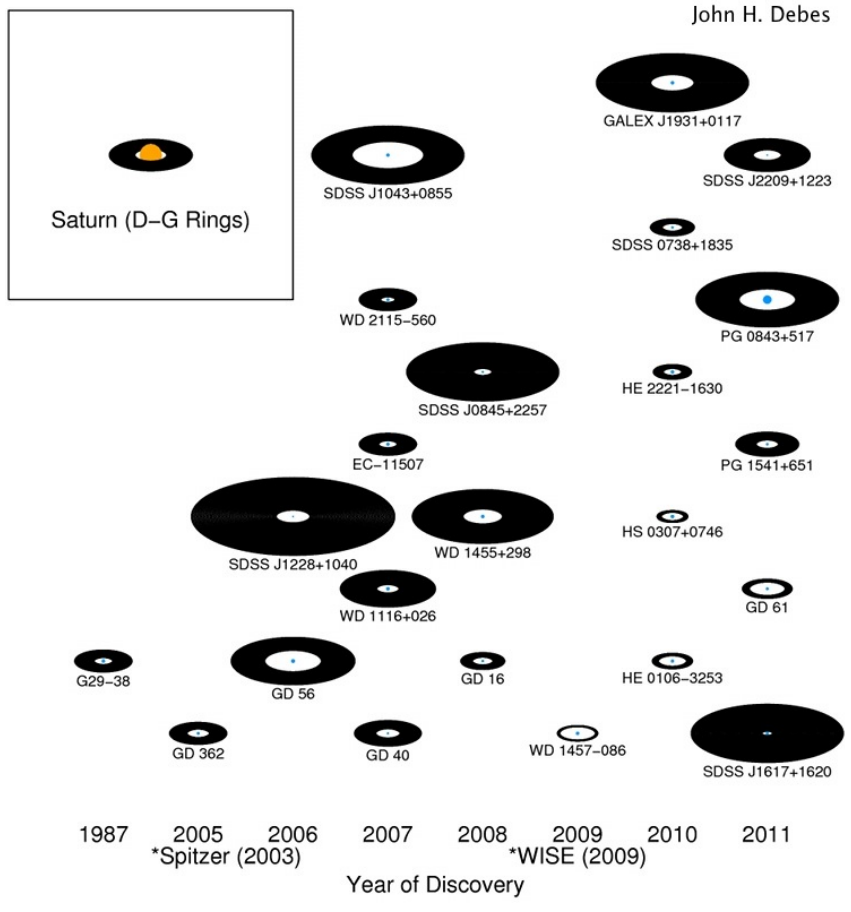
Dust Around White Dwarfs



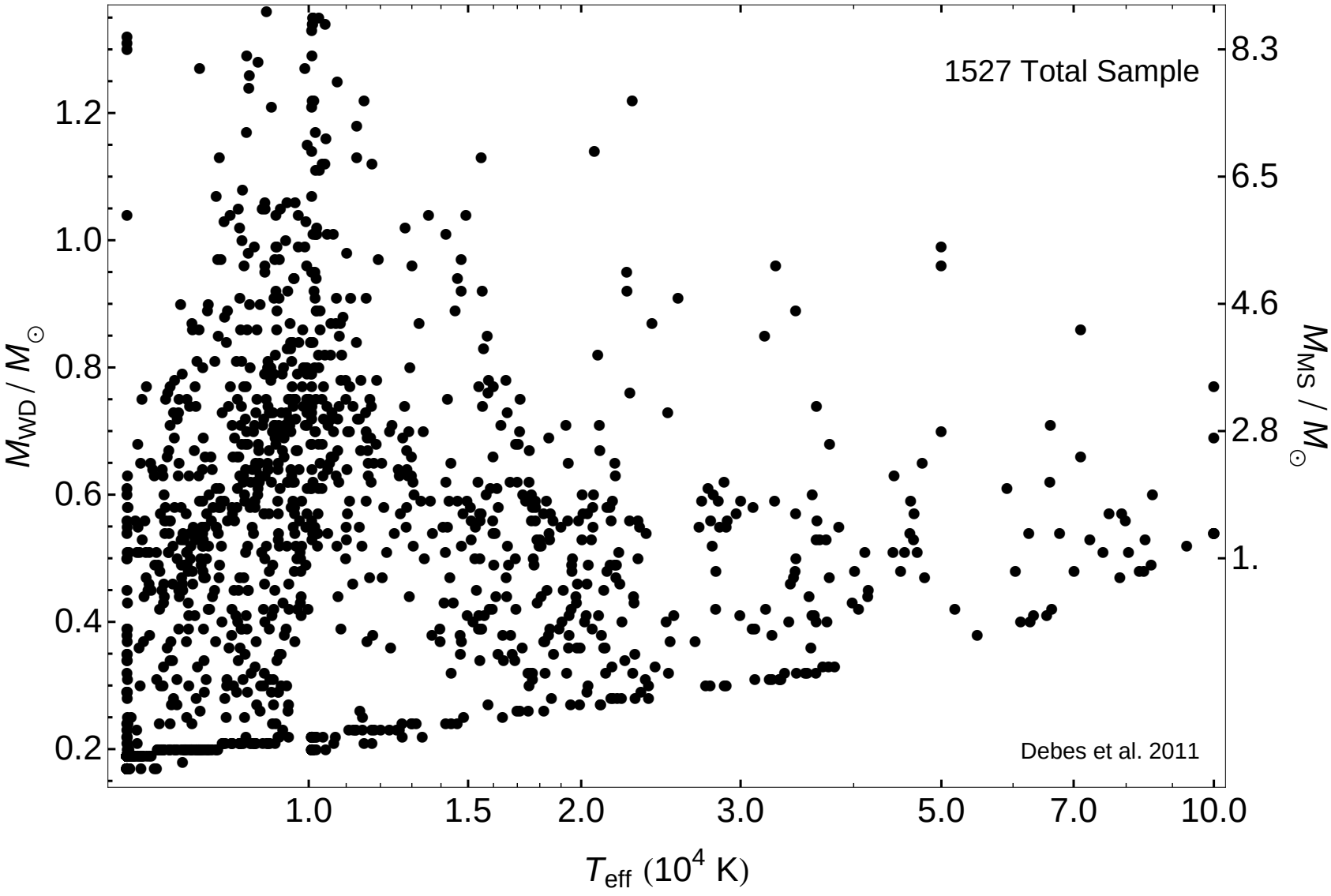


Dust Around White Dwarfs

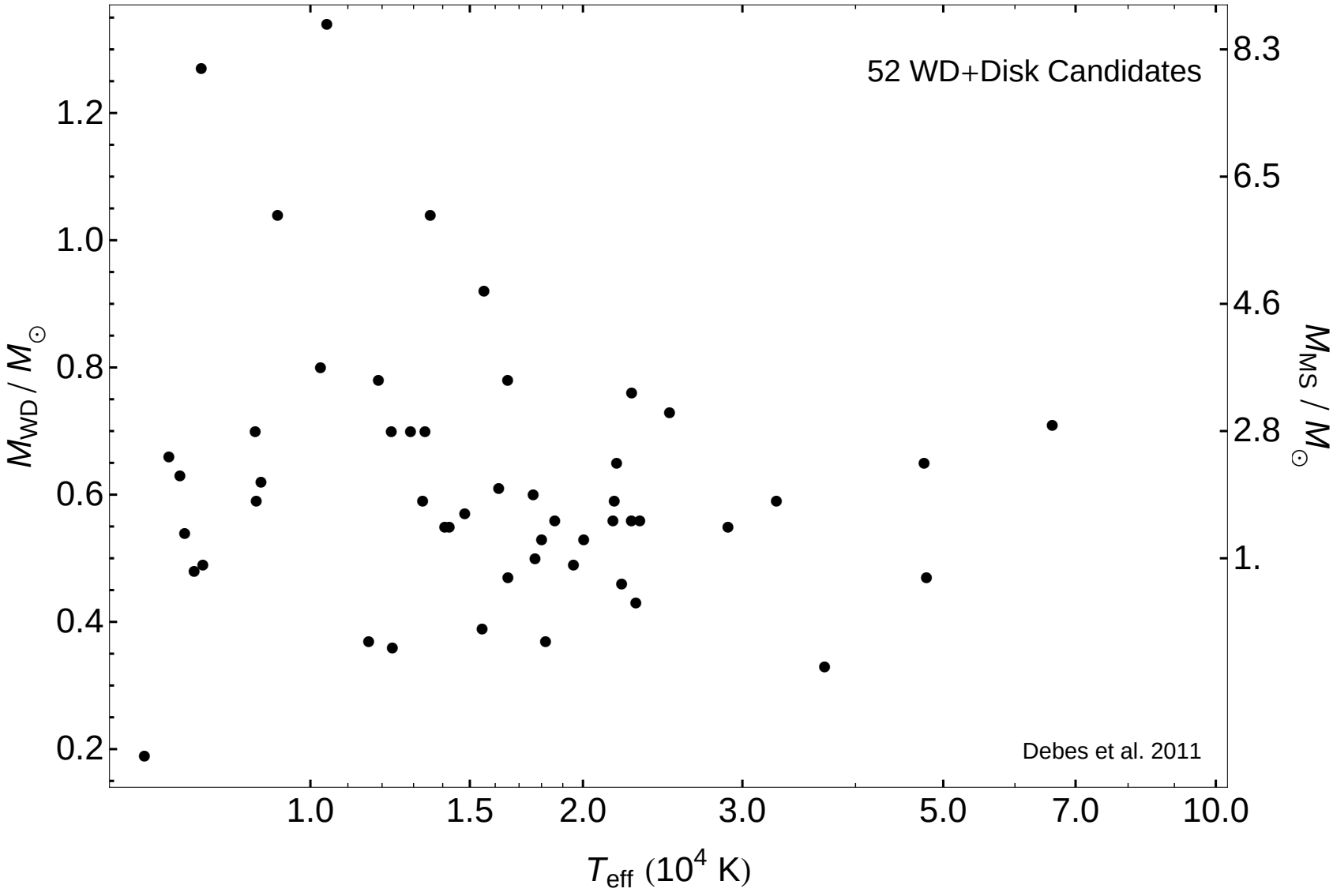




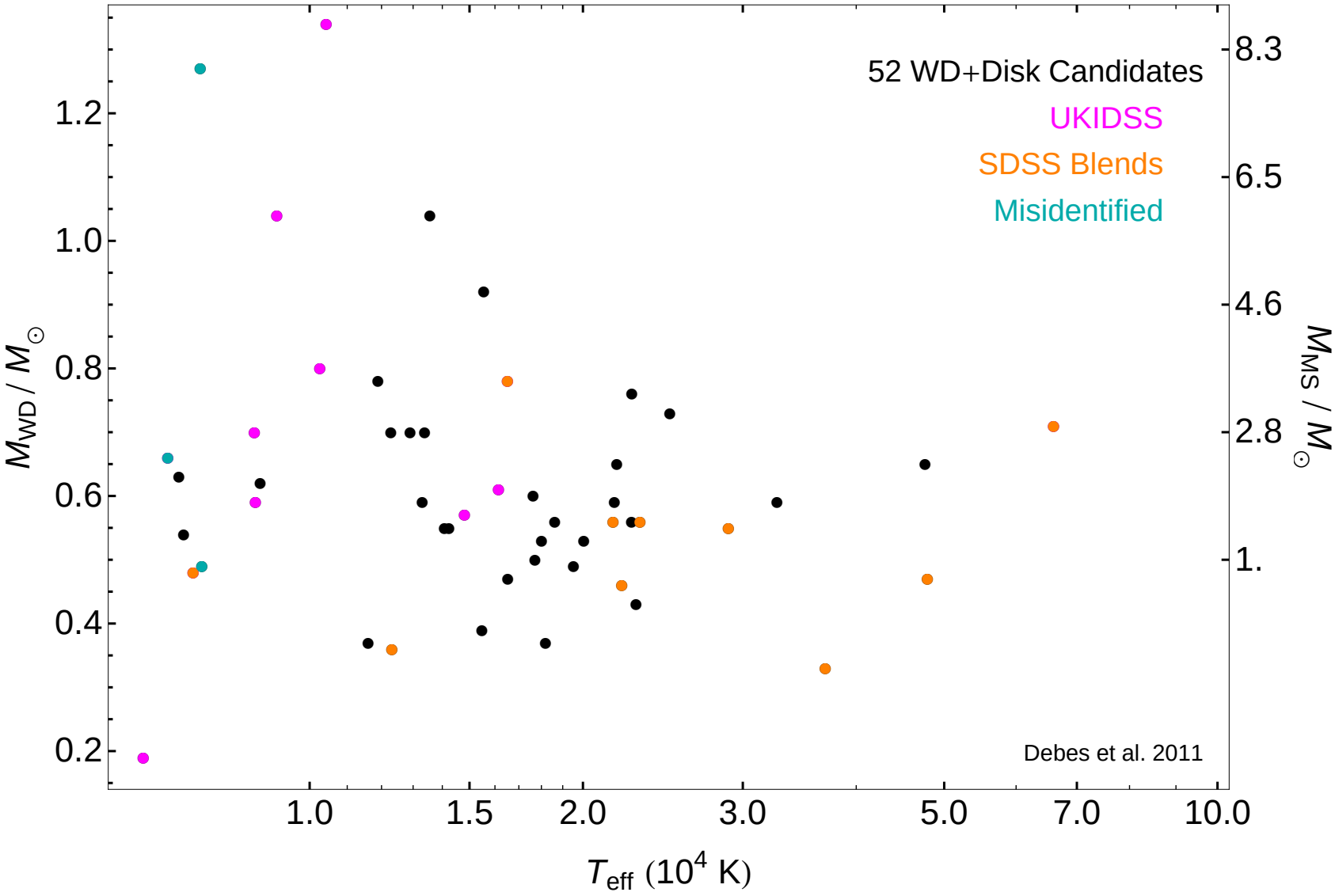
Sample Selection



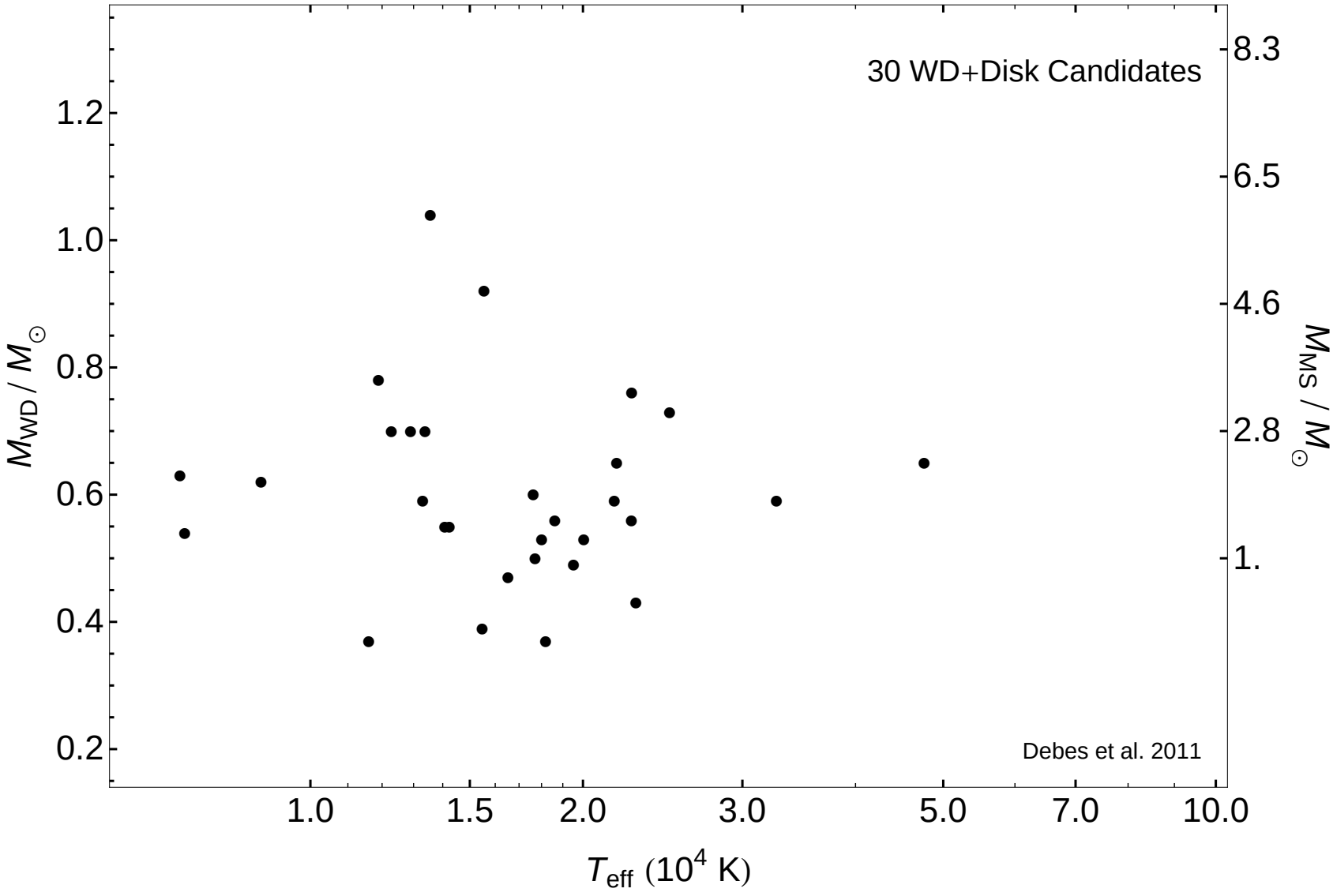
Sample Selection



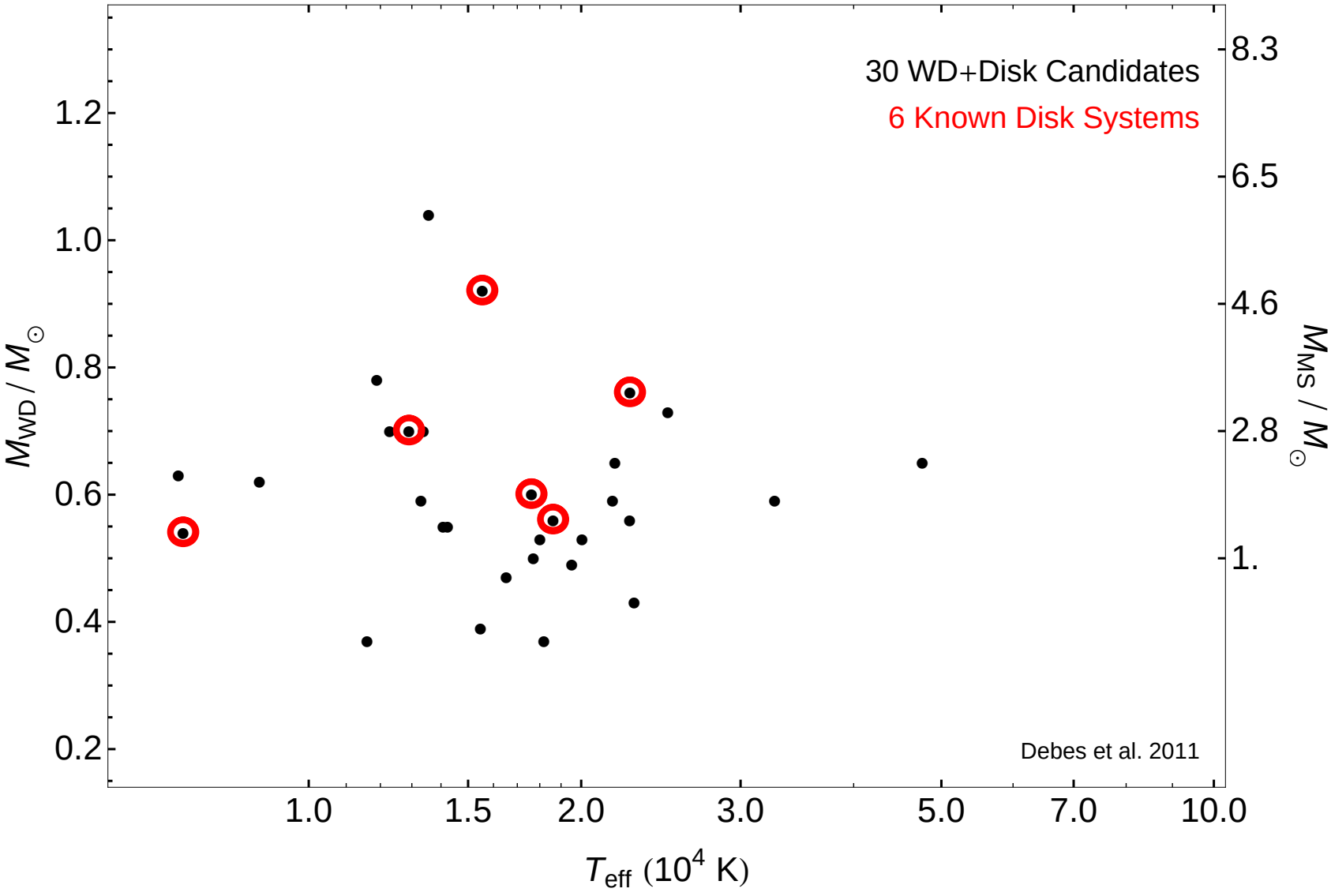
Sample Selection



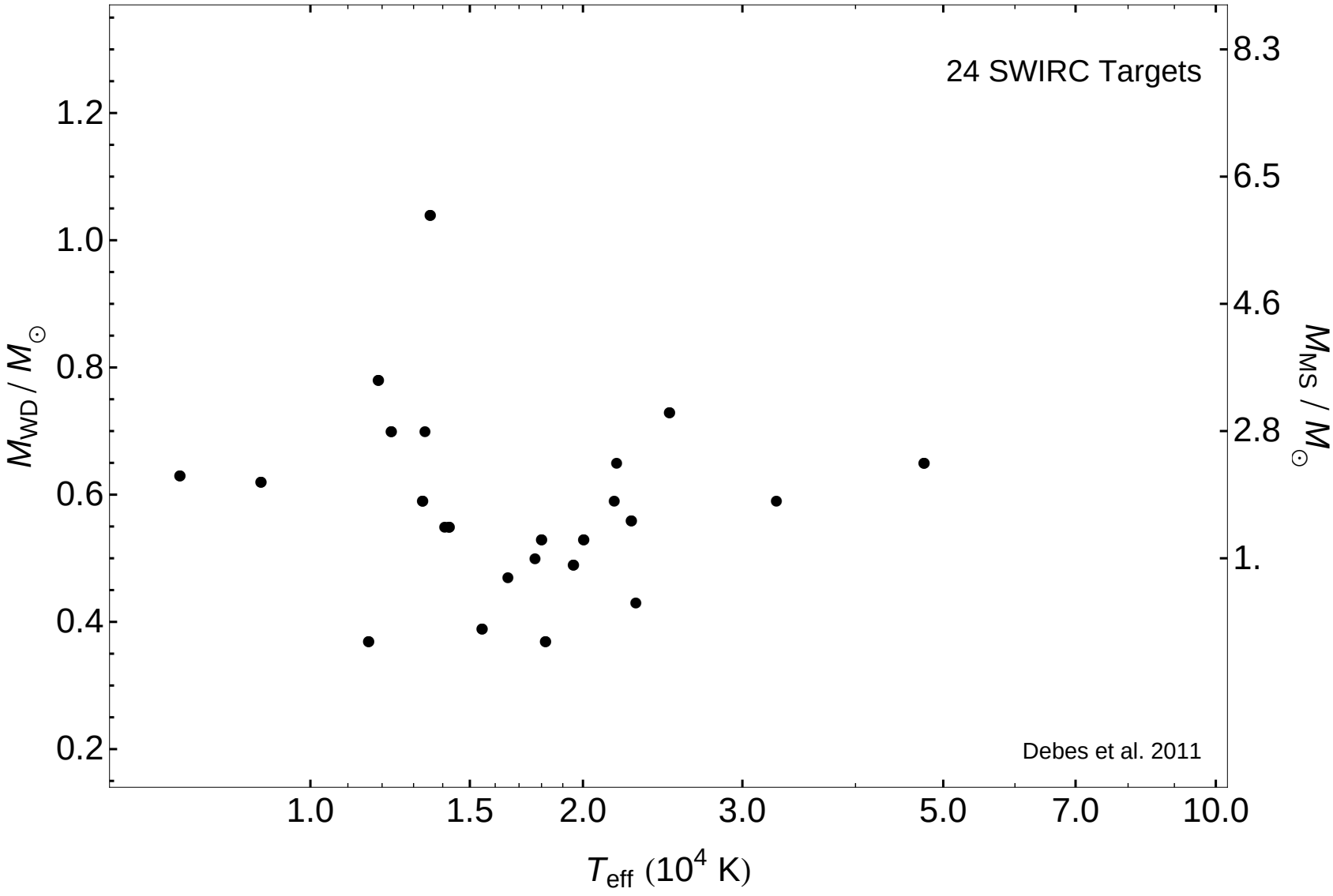
Sample Selection



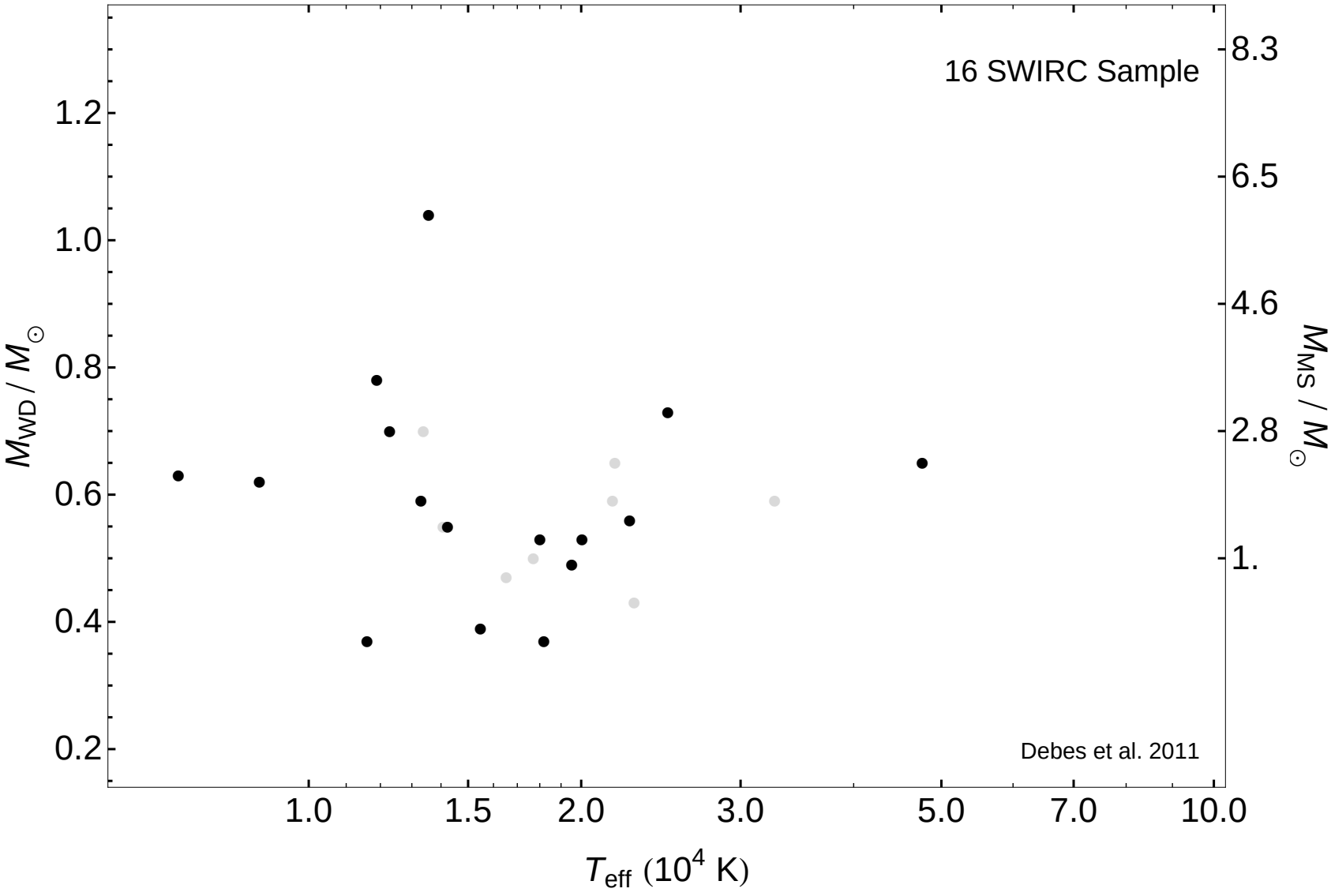
Sample Selection



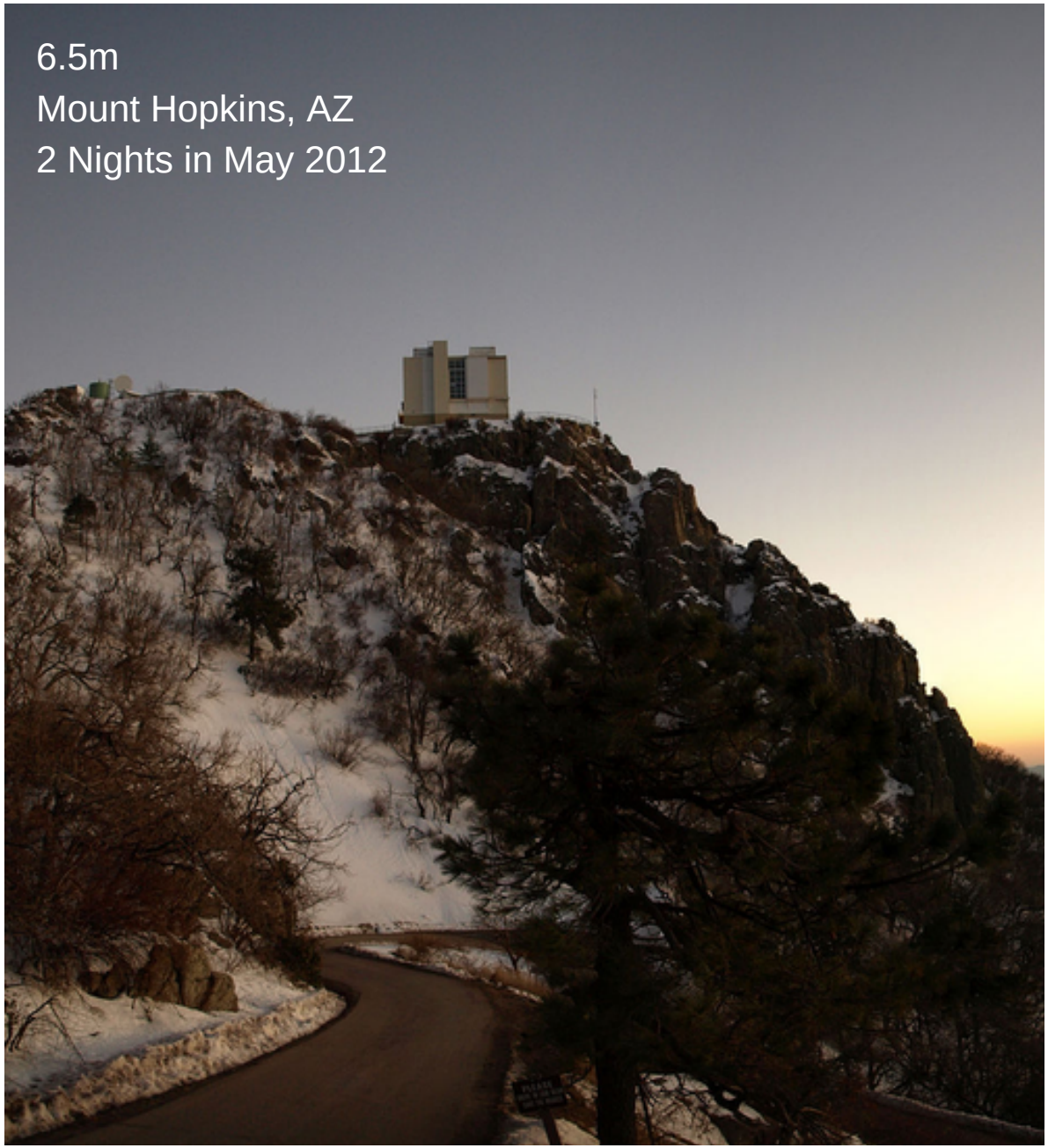
Sample Selection



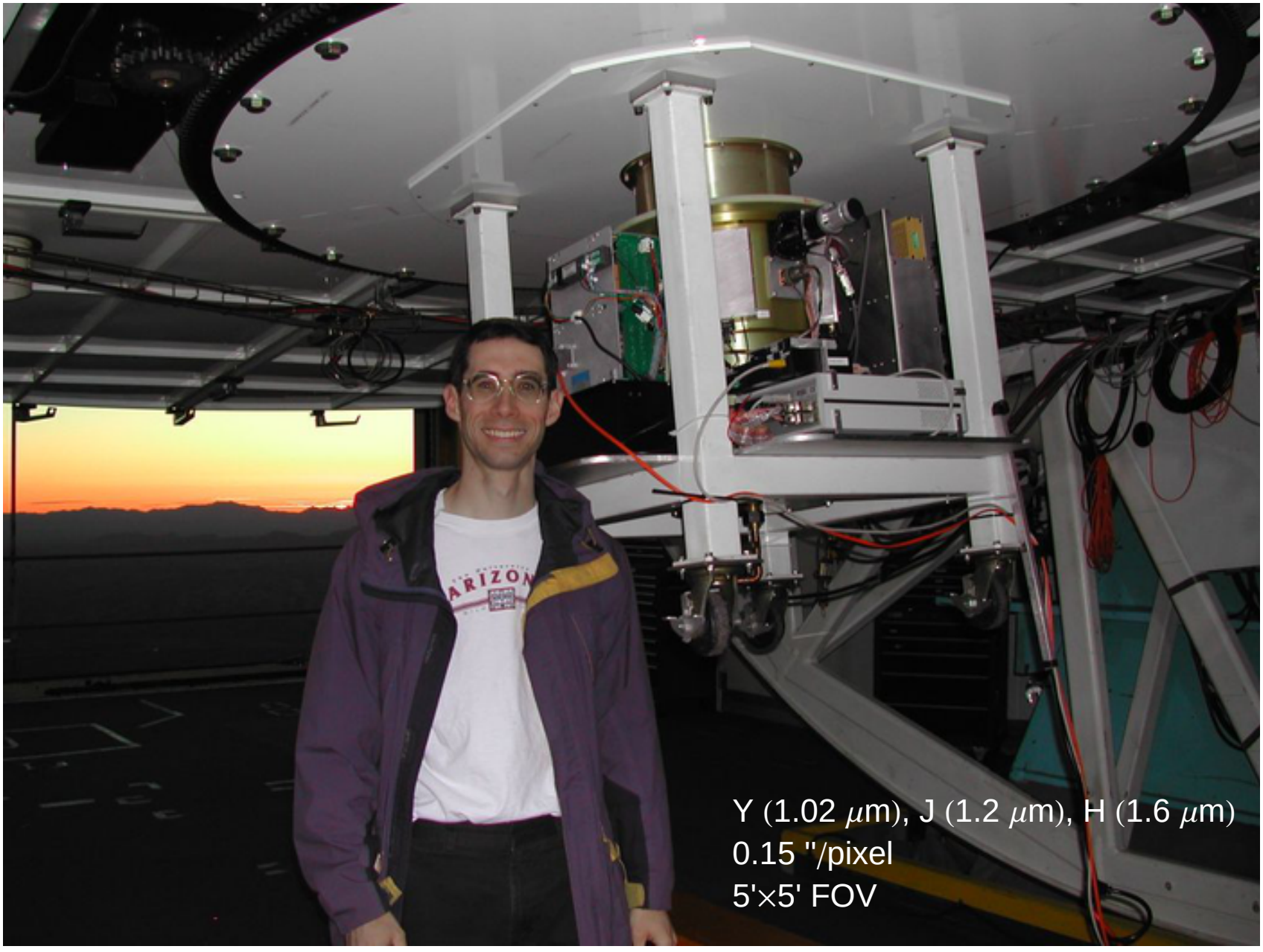
Sample Selection



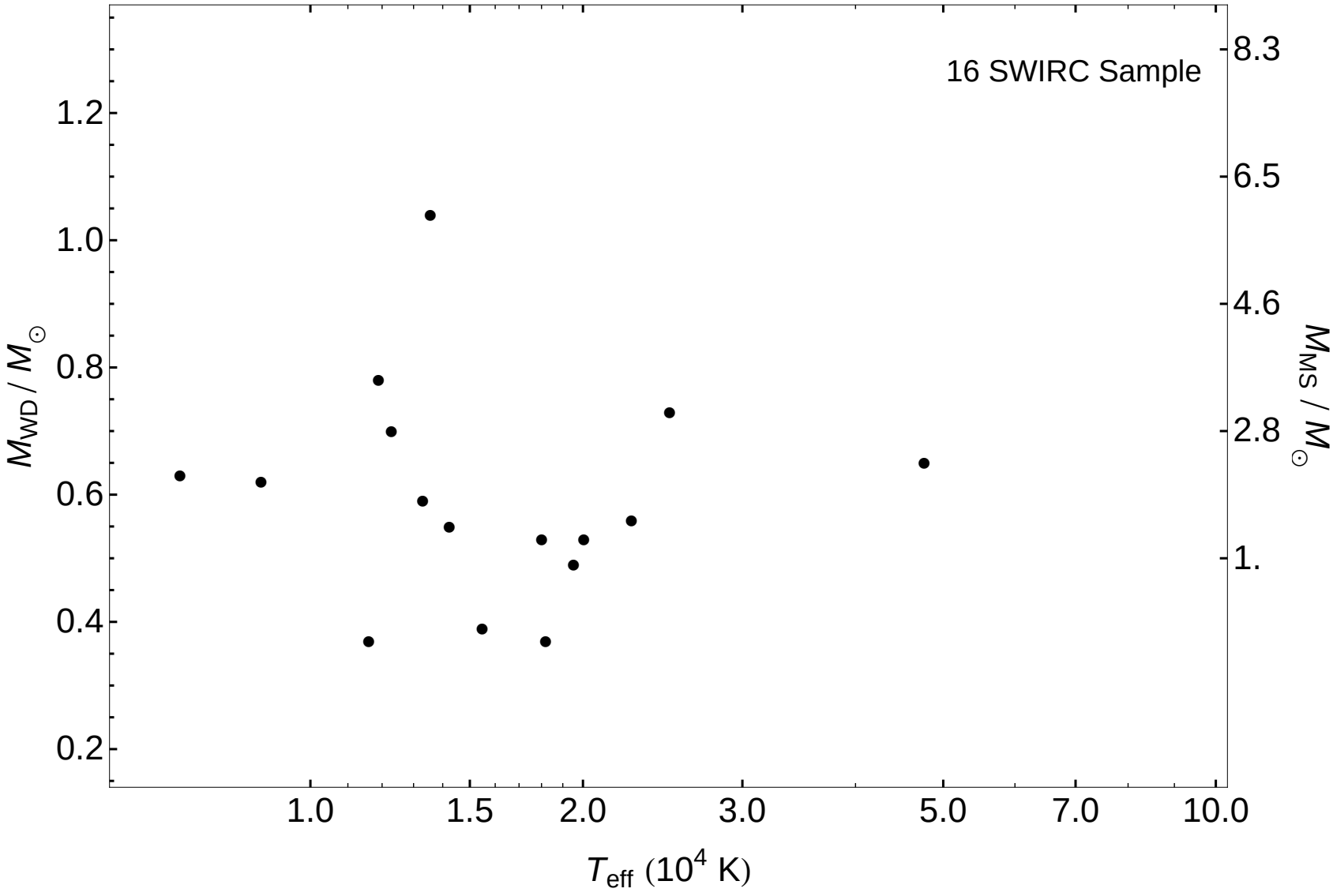
MMT



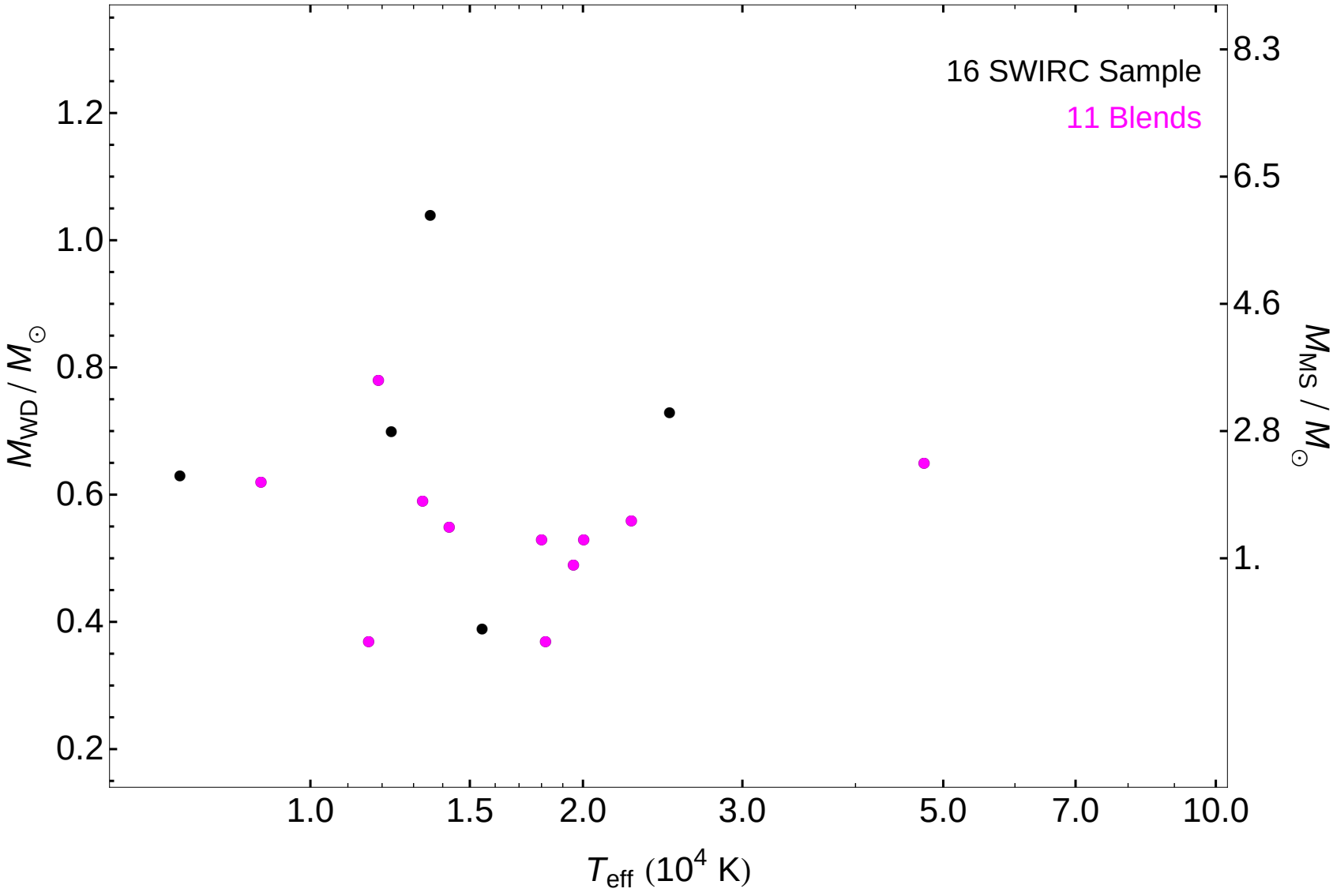
SWIRC



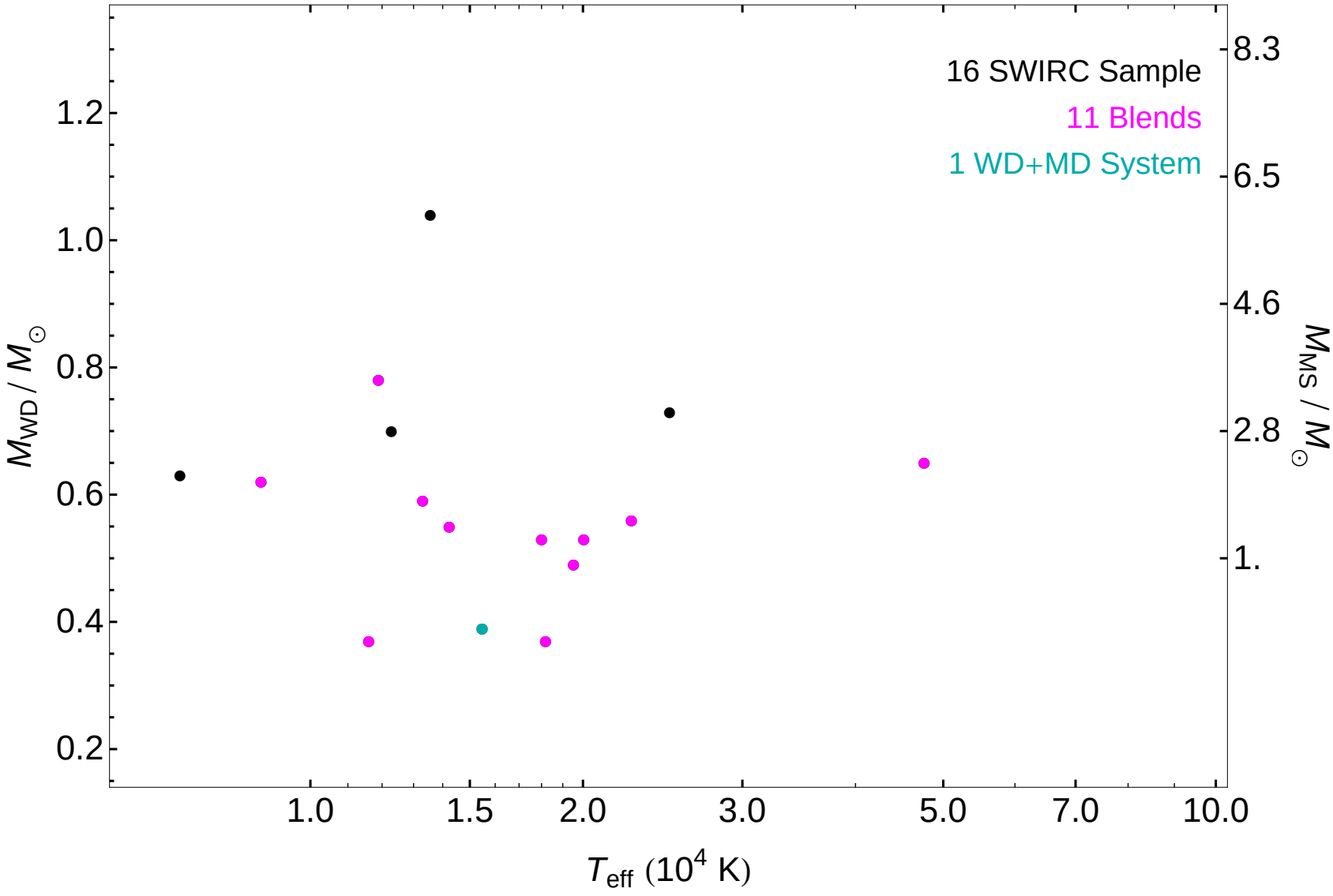
Results


16 SWIRC Sample
M_{WD} / $M_\odot$
M_{MS} / $M_\odot$
T_{eff} (10^4 K)
1.2
1.0
0.8
0.6
0.4
0.2
8.3
6.5
4.6
2.8
1.
1.0
1.5
2.0
3.0
5.0
7.0
10.0

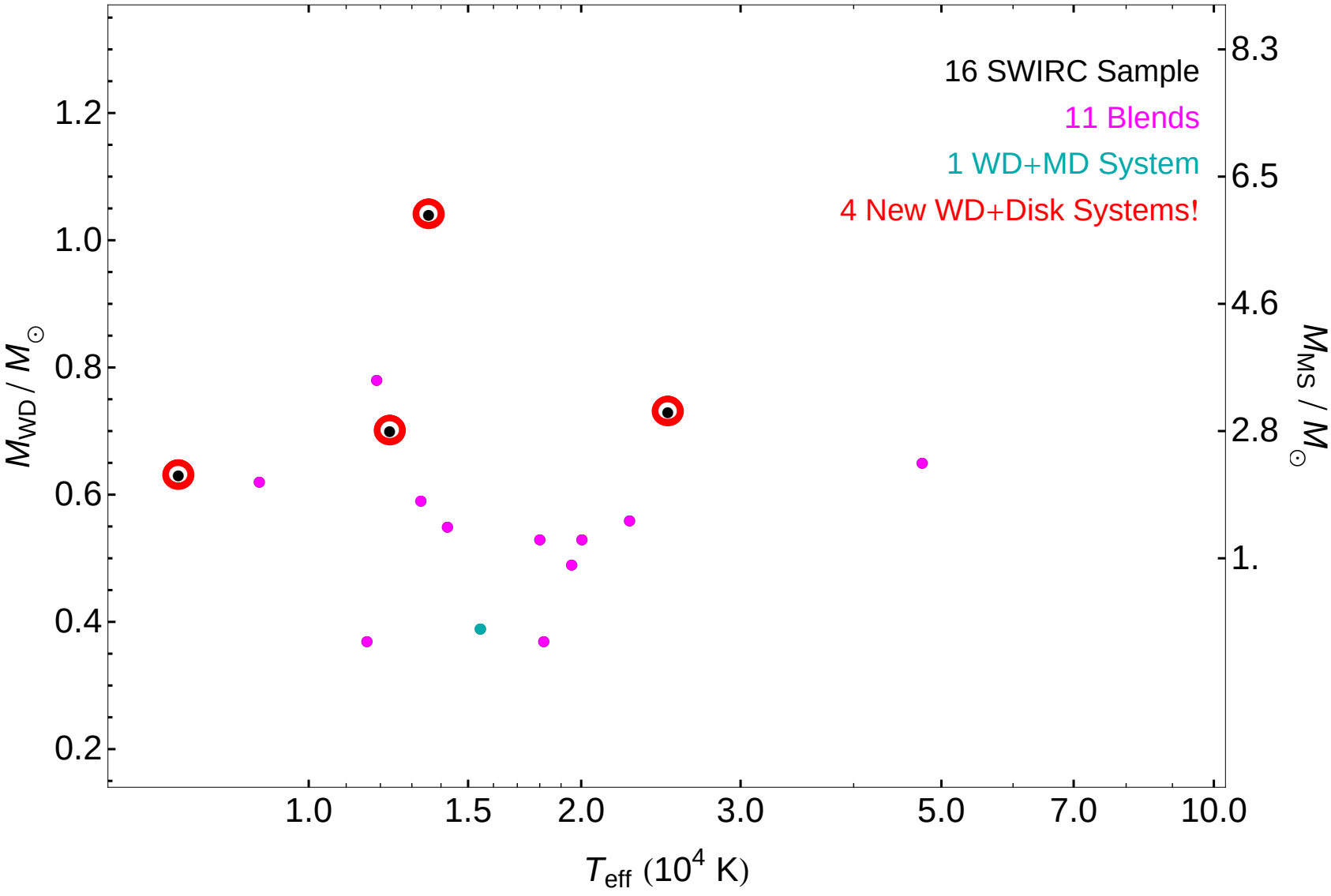
Results


16 SWIRC Sample
11 Blends
M_{WD} / $M_\odot$
M_{MS} / $M_\odot$
T_{eff} (10^4 K)
0.2
0.4
0.6
0.8
1.0
1.2
1.
2.8
4.6
6.5
8.3
1.0
1.5
2.0
3.0
5.0
7.0
10.0

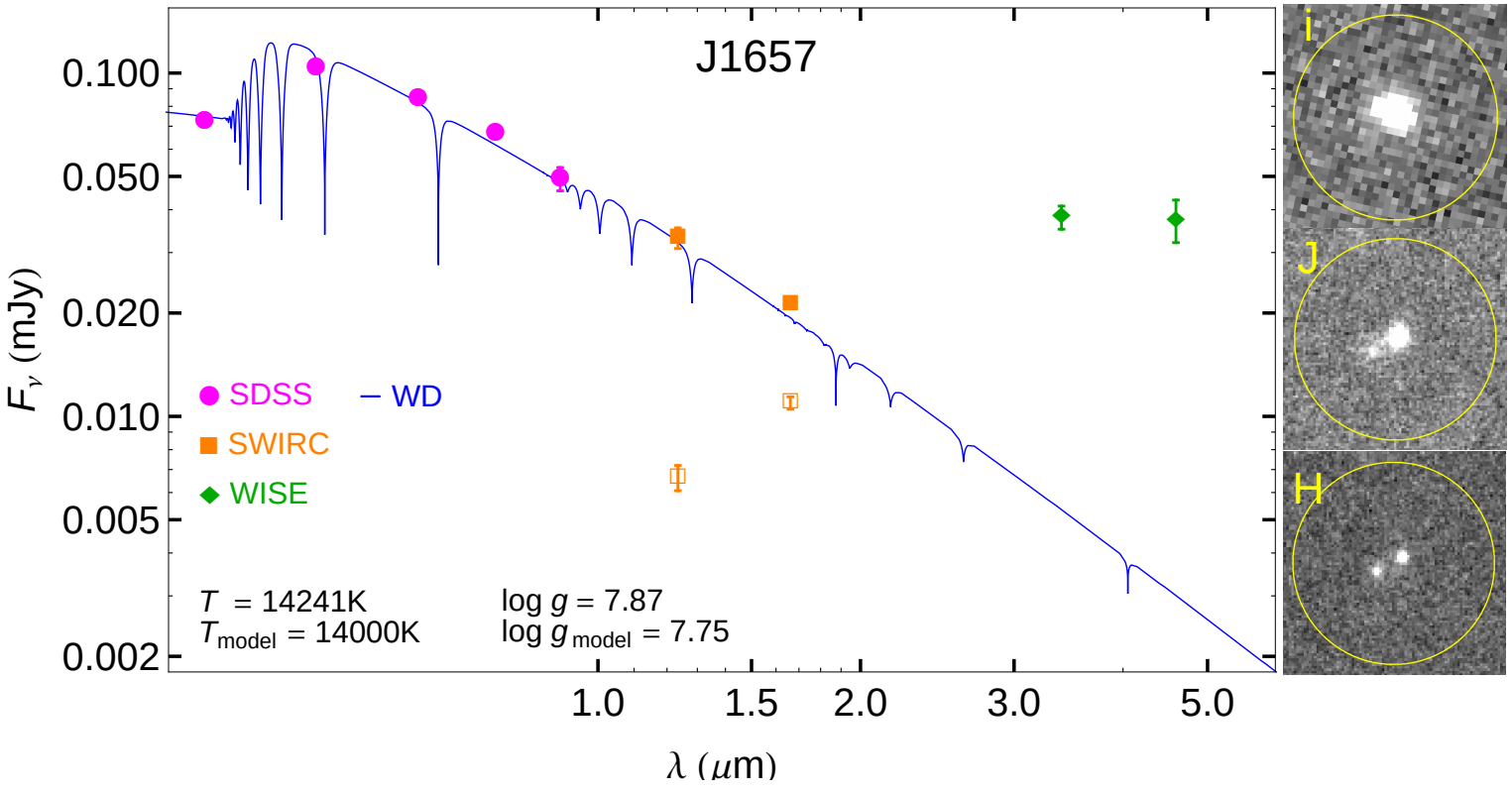
Results


16 SWIRC Sample
11 Blends
1 WD+MD System
M_{WD} / $M_\odot$
M_{MS} / $M_\odot$
T_{eff} (10^4 K)
0.2
0.4
0.6
0.8
1.0
1.2
8.3
6.5
4.6
2.8
1.
1.0
1.5
2.0
3.0
5.0
7.0
10.0

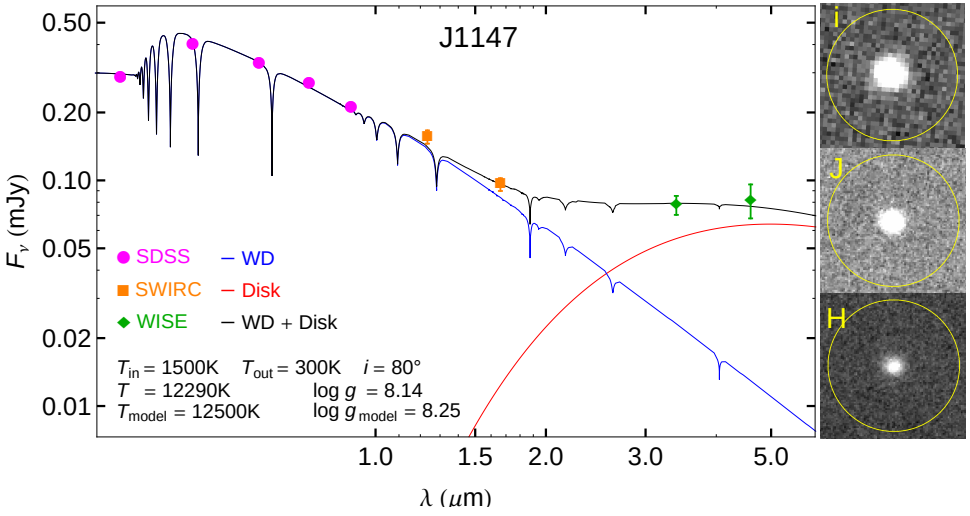
Results

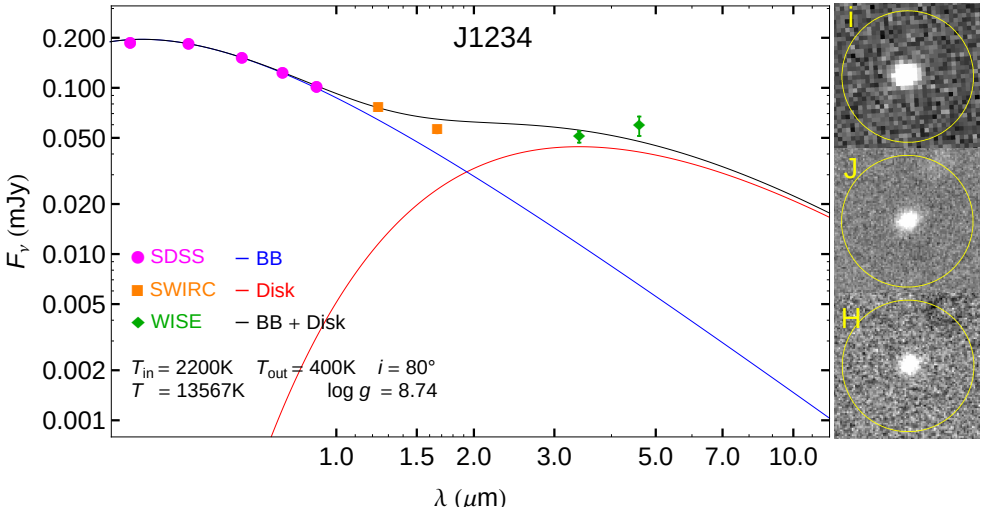

16 SWIRC Sample
11 Blends
1 WD+MD System
4 New WD+Disk Systems!
M_{WD} / $M_\odot$
M_{MS} / $M_\odot$
T_{eff} (10^4 K)
0.2
0.4
0.6
0.8
1.0
1.2
1.0
1.5
2.0
3.0
5.0
7.0
10.0
1.
2.8
4.6
6.5
8.3

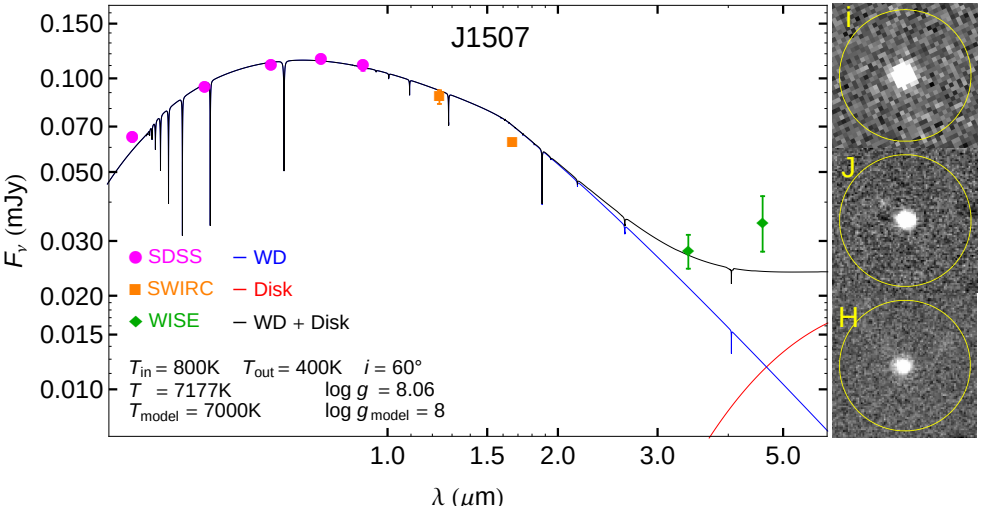
Results – Blends

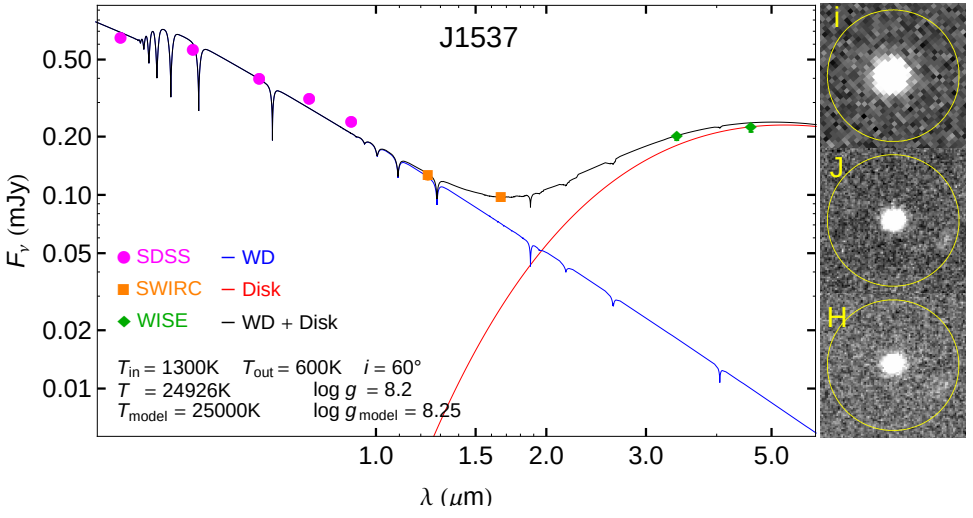


Results – Disks!

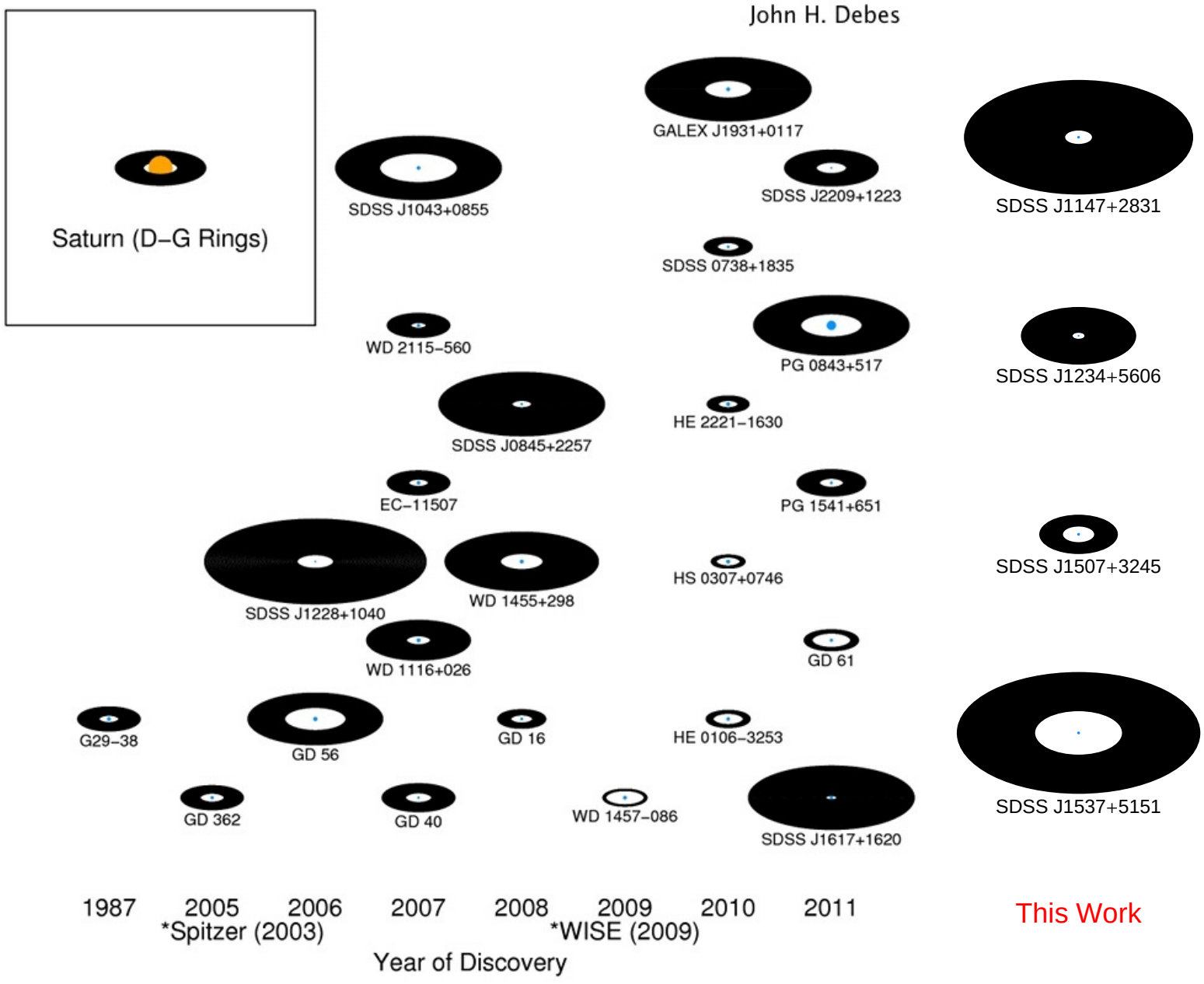






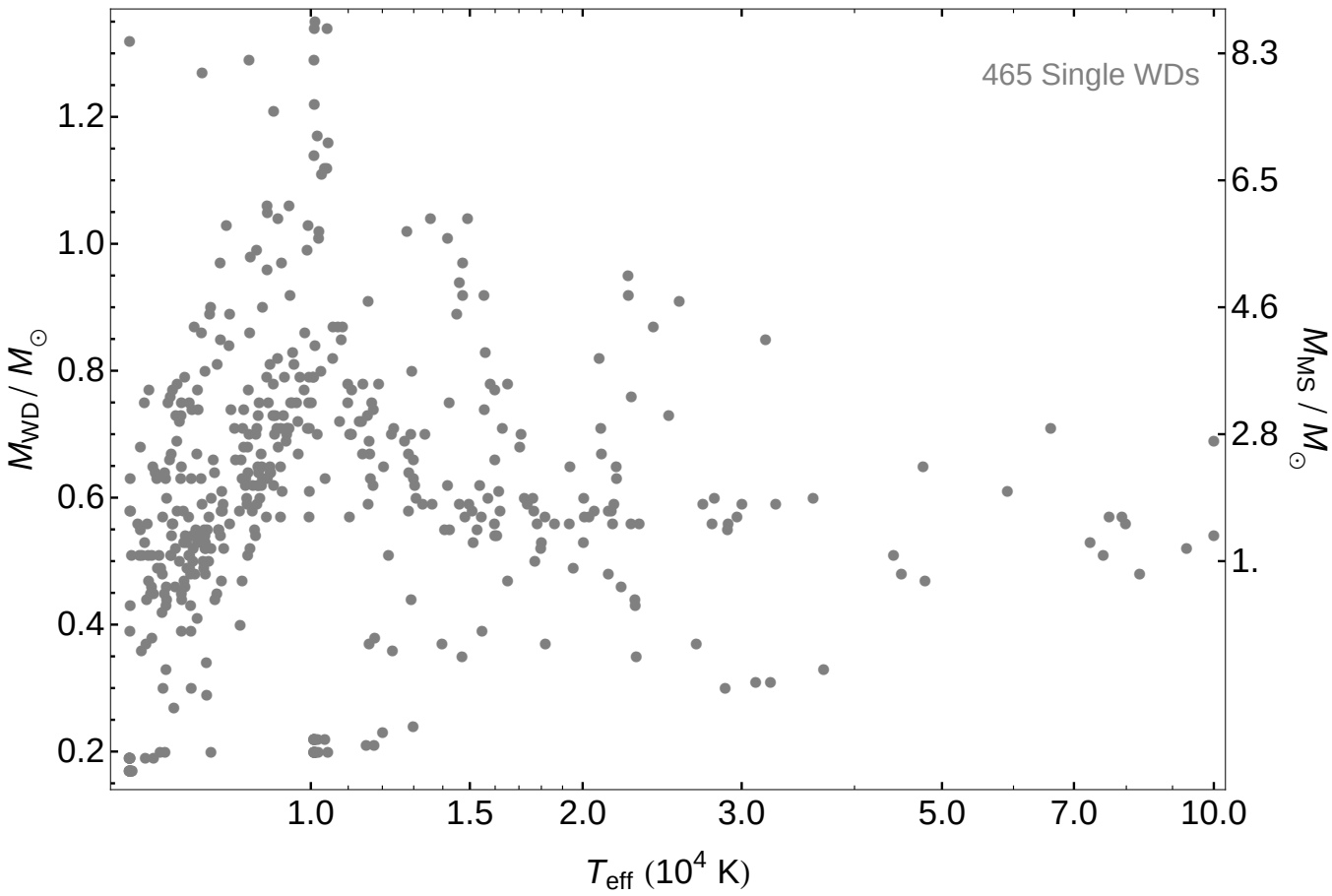


Results – Disks!



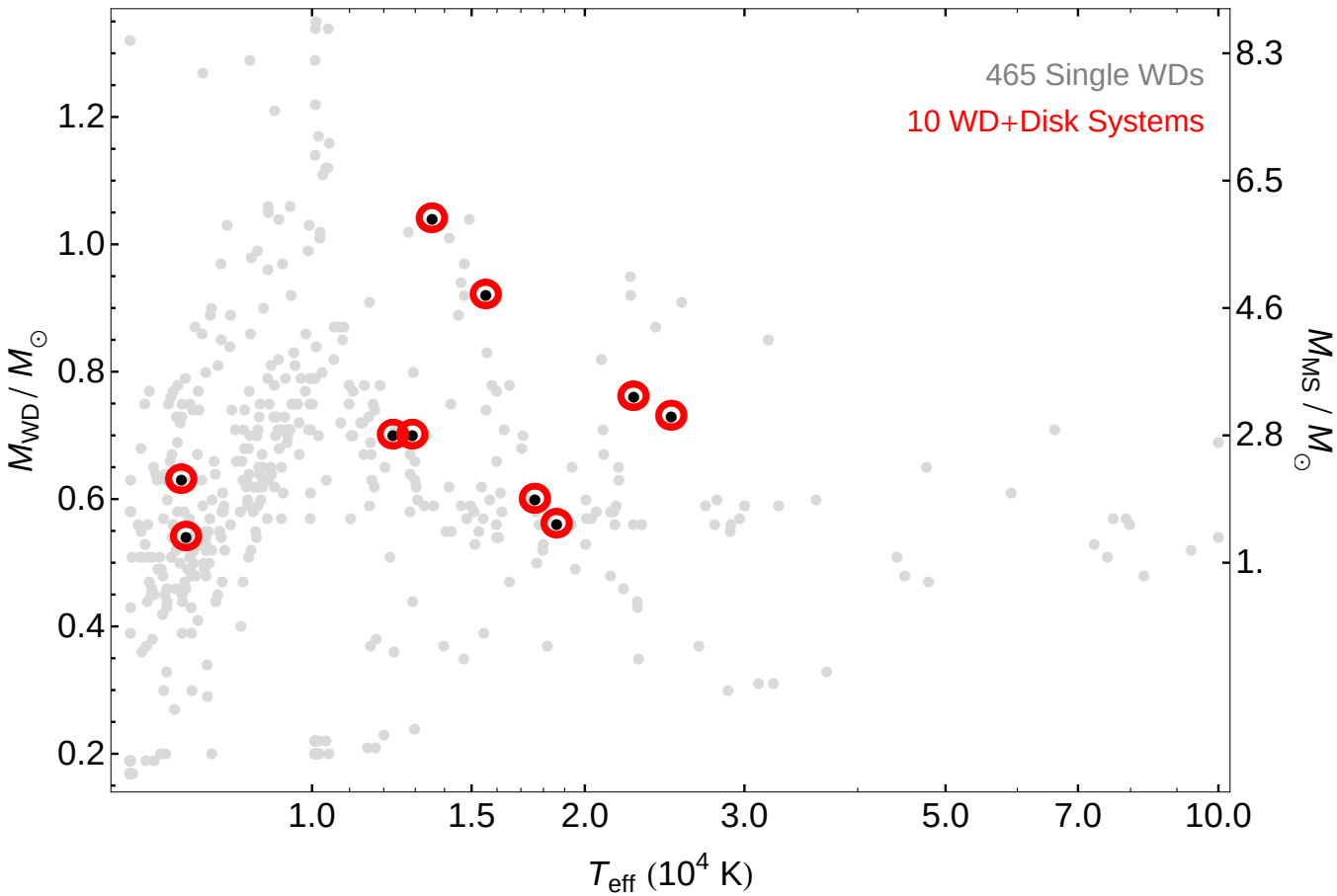
Disk Frequency

$$\frac{\quad}{465} \times 100\% = \_\_\_\_\%$$



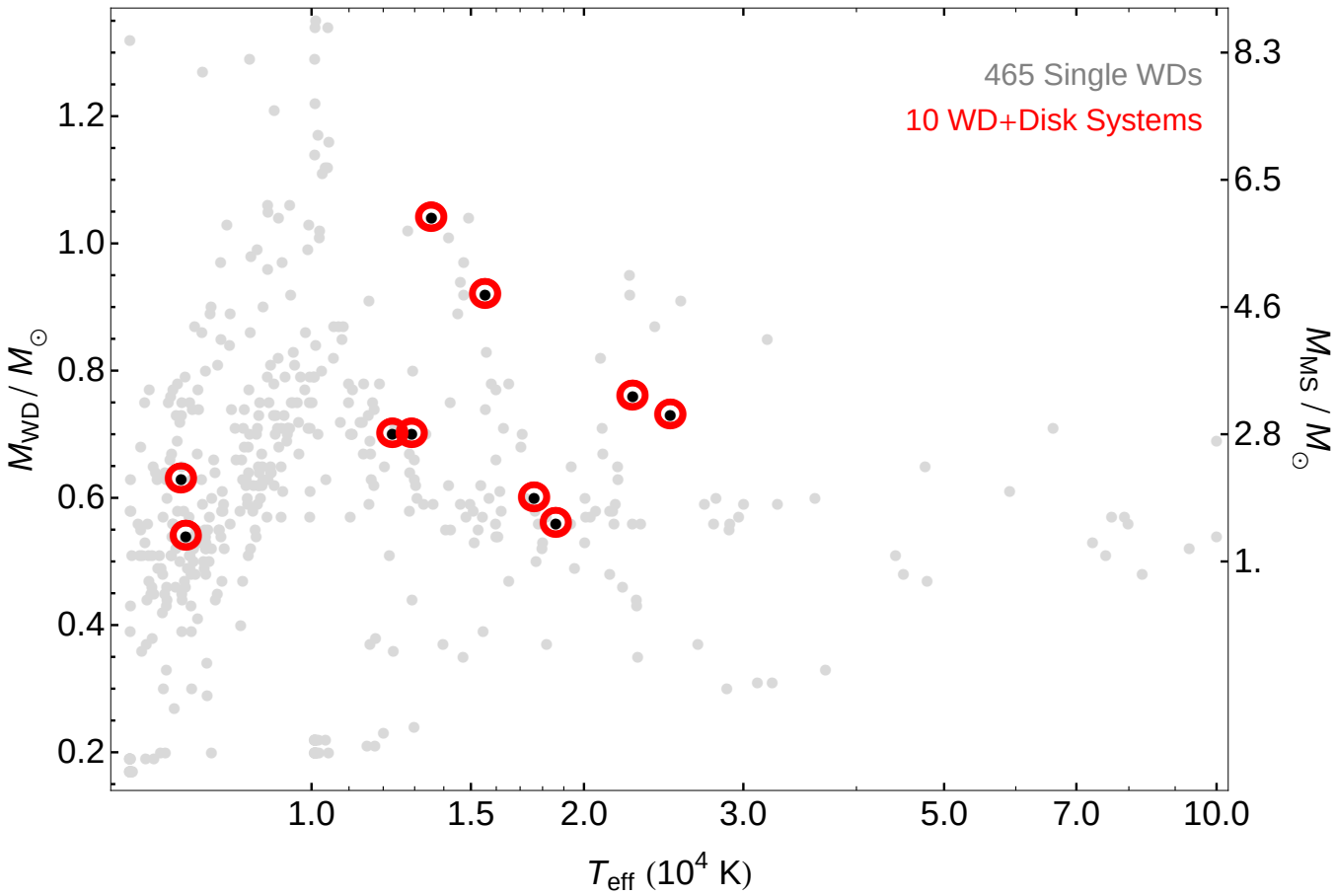
Disk Frequency

$$\frac{10}{465} \times 100\% = 2.2\%$$



Disk Frequency

At least 2.2% of WDs host dust.



Last Year at MARAC

The Astrophysical Journal, 760:26 (11pp), 2012 November 20 doi:10.1088/0004-637X/760/1/26

THE FREQUENCY OF DEBRIS DISKS AT WHITE DWARFS

Sara D. Barber[1], Adam J. Patterson[1], Mukremin Kilic[1], S. K. Leggett[2], P. Dufour[3], J. S. Bloom[4], and D. L. Starr[4]
[1] Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, 440 W. Brooks St., Norman, OK 73019, USA; barber@nhn.ou.edu
[2] Gemini Observatory, 670 N. A'ohoku Place, Hilo, HI 96720, USA
[3] Département de Physique, Université de Montréal, C.P. 6128, Succursale Centre-Ville, Montréal, Québec H3C 3J7, Canada
[4] Department of Astronomy, University of California, Berkeley, CA 94720, USA
Received 2012 July 4; accepted 2012 September 13; published 2012 October 31

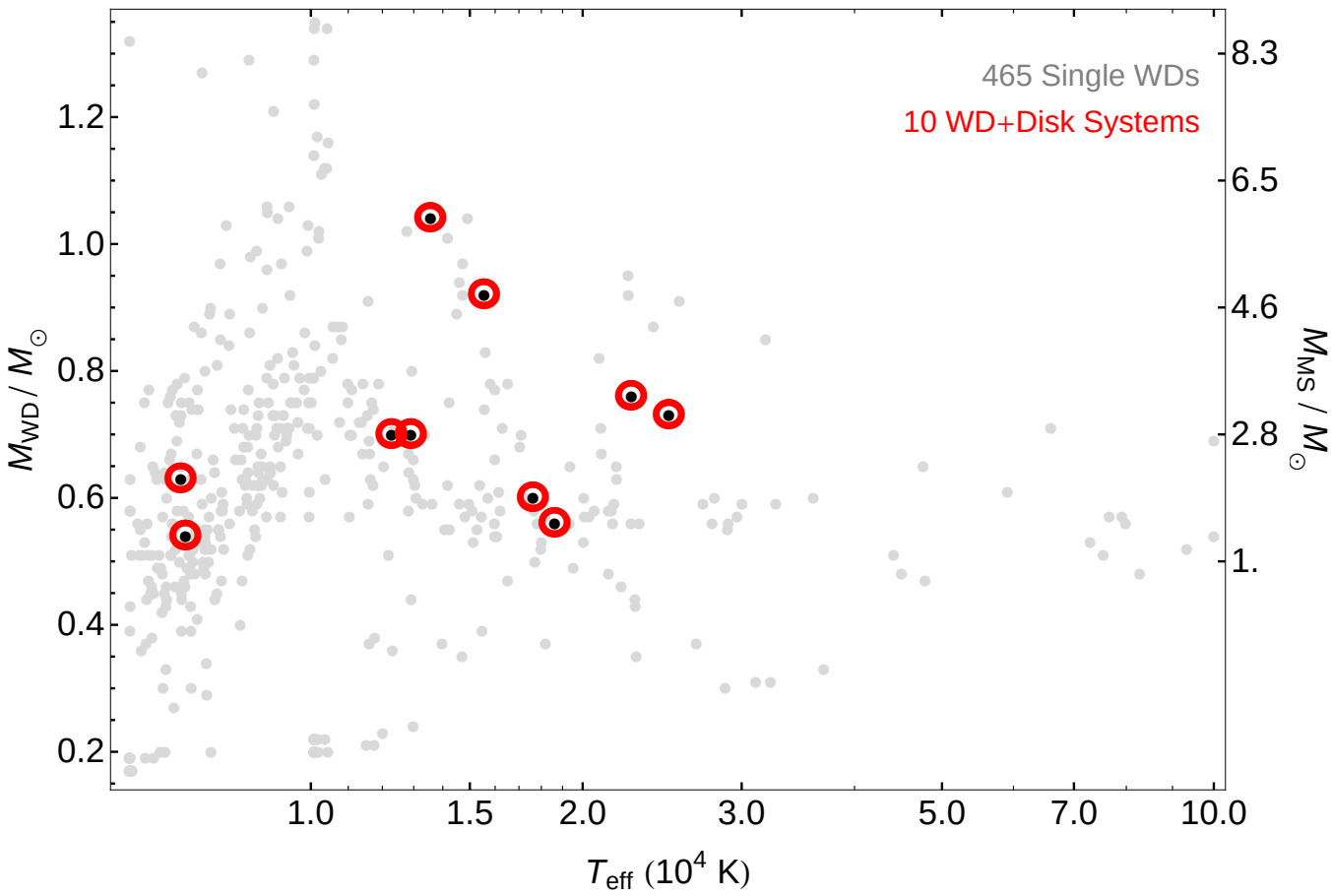
ABSTRACT

We present near- and mid-infrared photometry and spectroscopy from PAIRITEL, IRTF, and *Spitzer* of a metallicity-unbiased sample of 117 cool, hydrogen-atmosphere white dwarfs (WDs) from the Palomar-Green survey and find five with excess radiation in the infrared, translating to a $4.3^{+2.7}_{-1.2}$% frequency of debris disks. This is slightly higher than, but consistent with the results of previous surveys. Using an initial–final mass relation, we apply this result to the progenitor stars of our sample and conclude that 1–7 $M_{\odot}$ stars have at least a 4.3% chance of hosting planets; an indirect probe of the intermediate-mass regime eluding conventional exoplanetary detection methods. Alternatively, we interpret this result as a limit on accretion timescales as a fraction of WD cooling ages; WDs accrete debris from several generations of disks for ∼10 Myr. The average total mass accreted by these stars ranges from that of 200 km asteroids to Ceres-sized objects, indicating that WDs accrete moons and dwarf planets as well as solar system asteroid analogs.

Key words: infrared: planetary systems – infrared: stars – white dwarfs

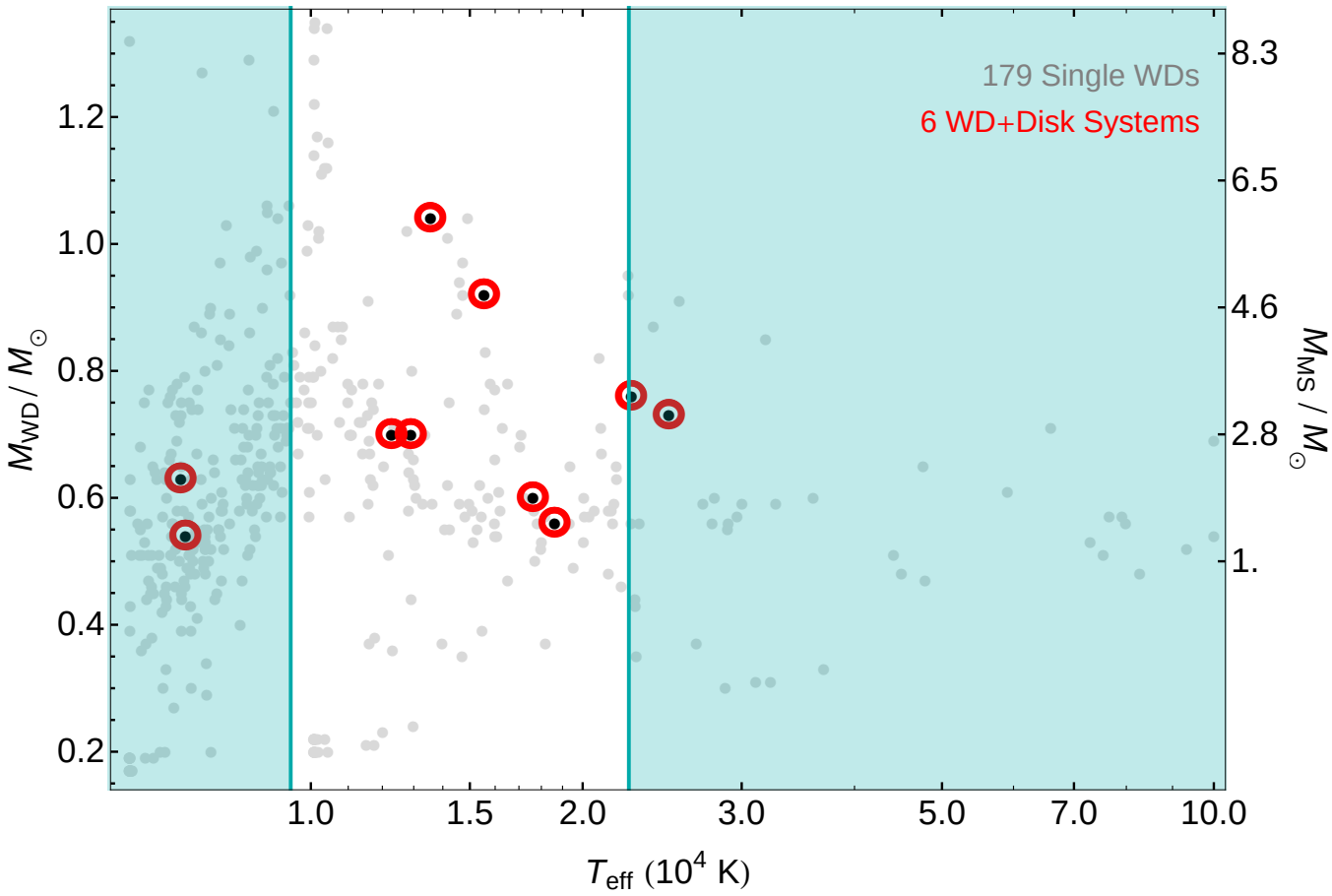
Online-only material: color figures

Disk Frequency



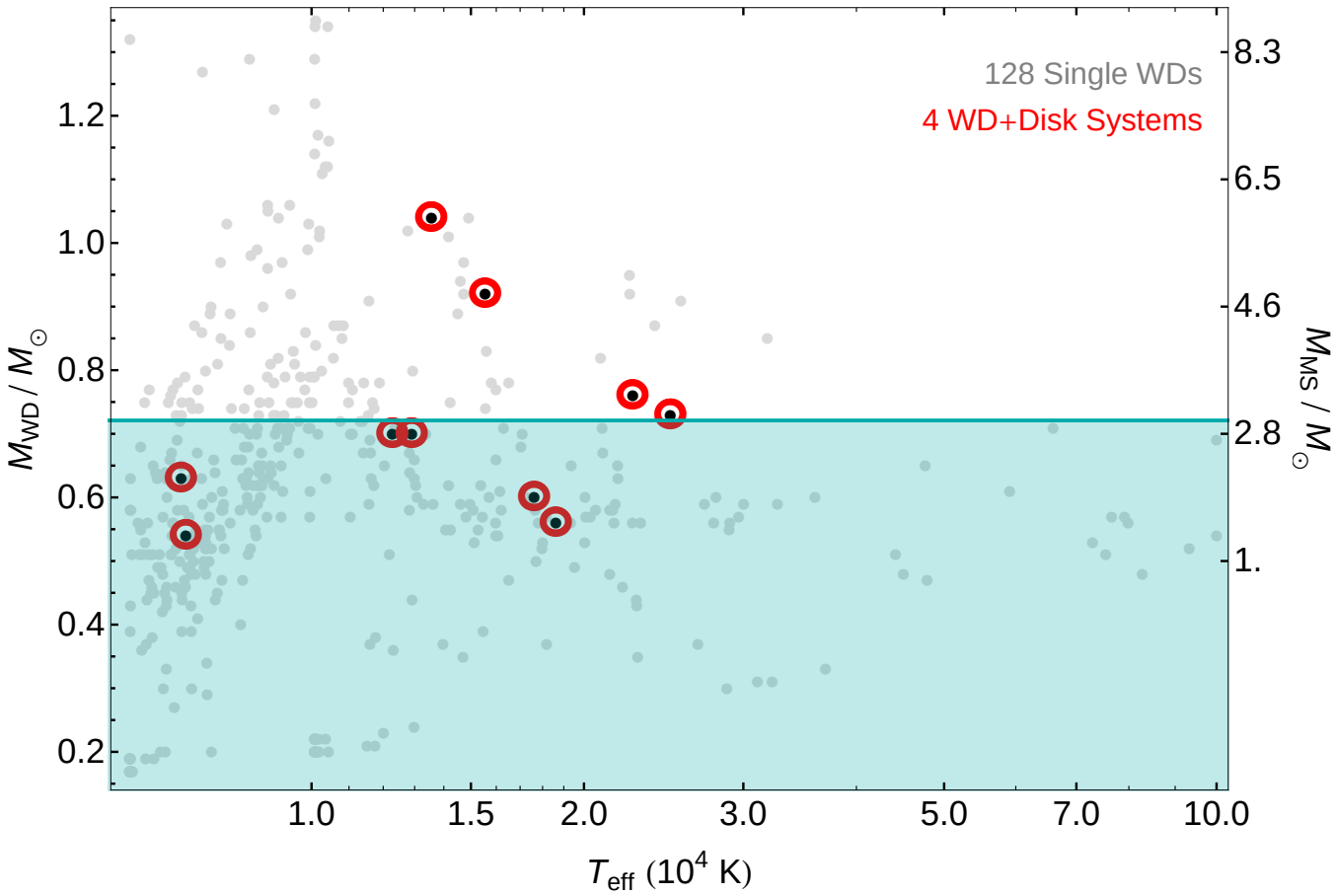
Disk Frequency – Temperature Cut

At least 3.4% of $9500 - 22,500K$ WDs host dust.



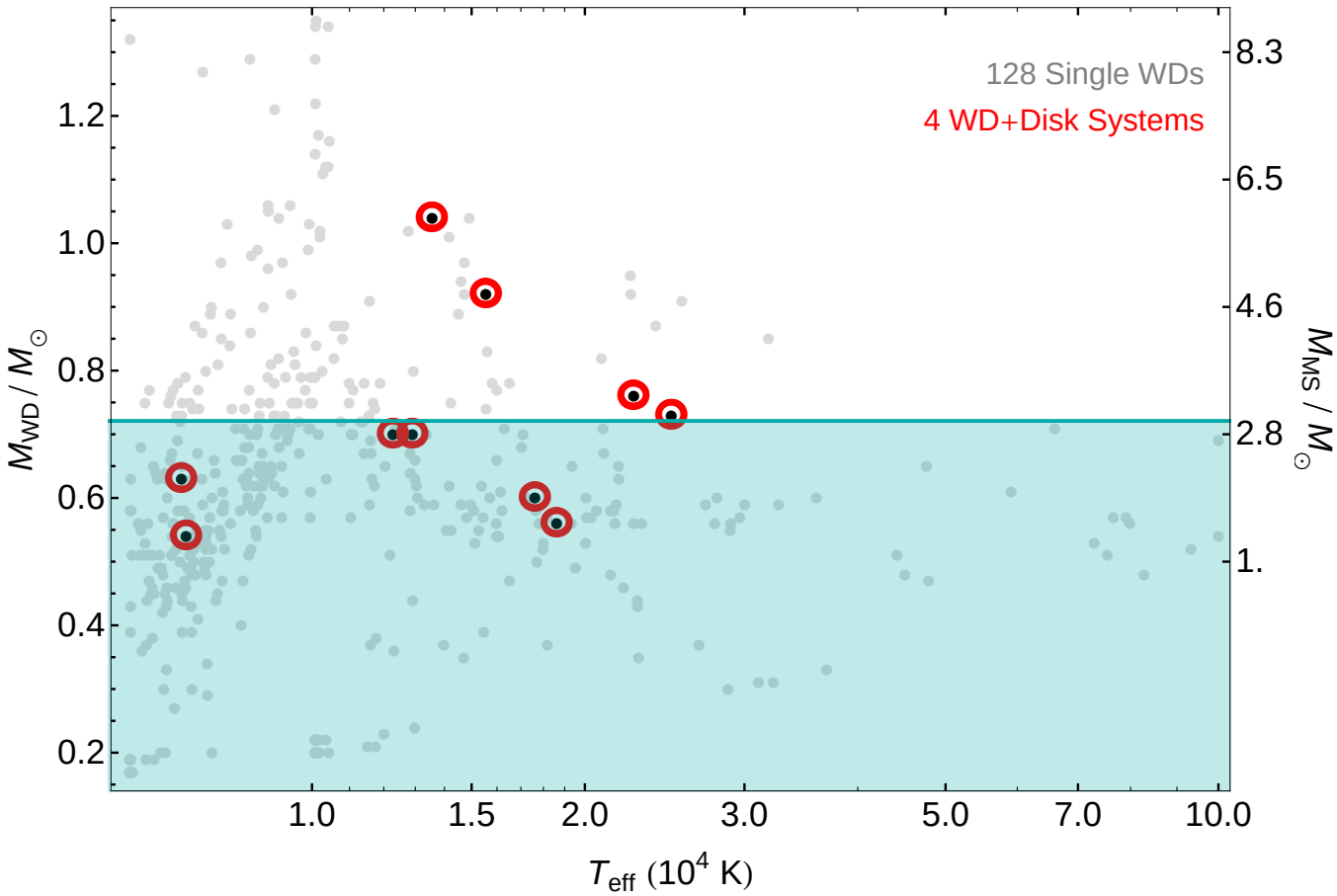
Disk Frequency – Massive White Dwarfs

At least 3.1% of $0.7 - 1.4 M_{\odot}$ WDs host dust.



Disk Frequency – Massive Main Sequence Stars

At least 3.1% of $3 - 8 M_{\odot}$ MS stars host planets.



Future Work

100 WD remnants of $3 - 8 M_{\odot}$ MS stars