

Circumstellar Environments of Southern M Dwarfs in the Solar Neighborhood

Michele L. Silverstein

Todd J. Henry

Wei-Chun Jao

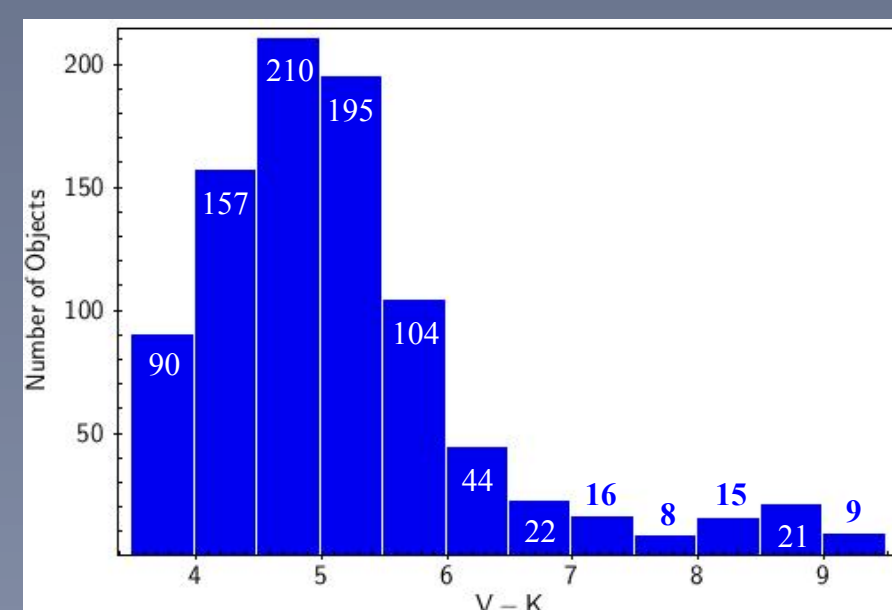
Jennifer G. Winters



Abstract

We present the first results from SIRENS, the Search for InfraRed Excesses around Nearby Stars. Our goal is to characterize the circumstellar environments of the most common and closest stars in the Universe, the ubiquitous red dwarfs. In this phase of the study, we search 1404 southern M dwarfs within 25 parsecs of the Sun, as reported in Winters et. al 2015, using (Johnson-Kron-Cousins) optical, (2MASS) near-infrared, and (WISE) mid-infrared photometry for low-mass companions and circumstellar disks. Several studies have recently used WISE photometry to detect circumstellar disks and companions --- searches around members of the nearby young moving groups, objects with parallaxes from Hipparcos, and many northern M stars in the SDSS. However, no work has yet been done that focuses on the nearest red dwarfs, which account for at least 75% of all stars. This study, a volume-limited search around M dwarfs in the southern sky, includes statistical conclusions applicable to a majority of the stars in the Universe, and opens potential gateways to a better understanding of star and planet formation.

Spectral Type Distribution of the 891 Objects with Trusted VRI Photometry within 25 Parsecs



- Acquisition of VRI for the remainder of the sample is in progress.

Missions and Telescopes



SMARTS 0.9-m at CTIO



0.5-m ARCSAT at APO



2MASS
Pairitell 1.3-m at Mt. Hopkins (left) & SMARTS 1.3-m at CTIO (right)

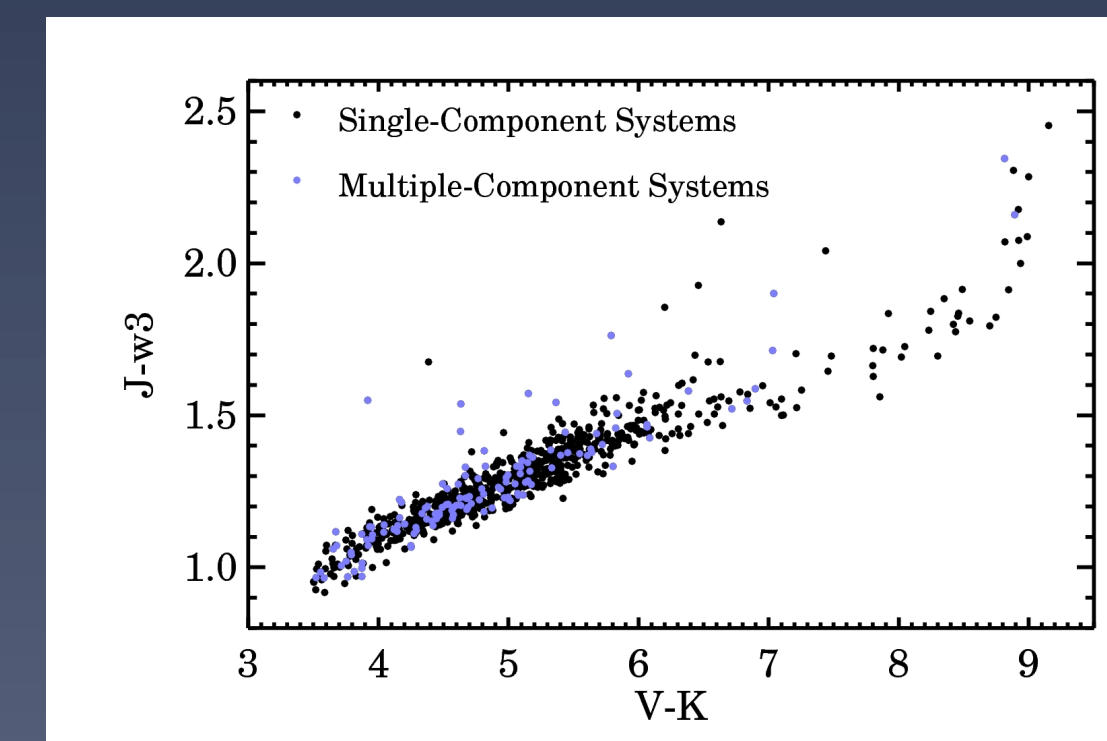


WISE

Color-Color & HR Diagrams

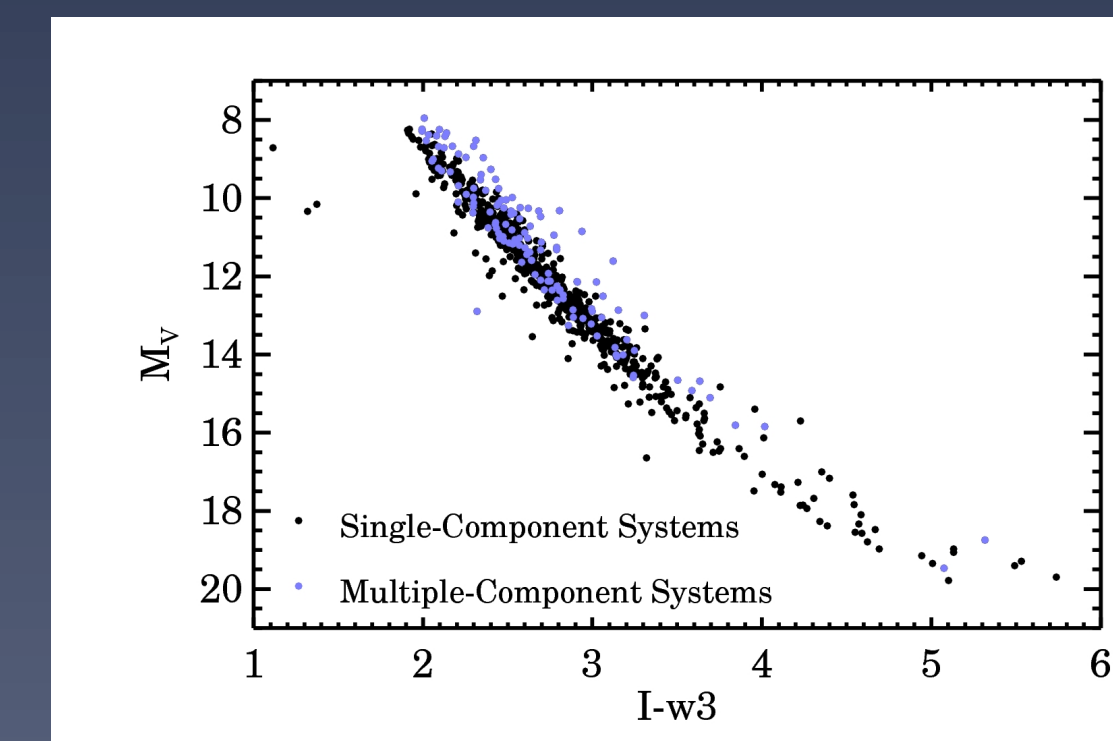
Companions

Color-Color Diagram



Companions are detectable above the curve.

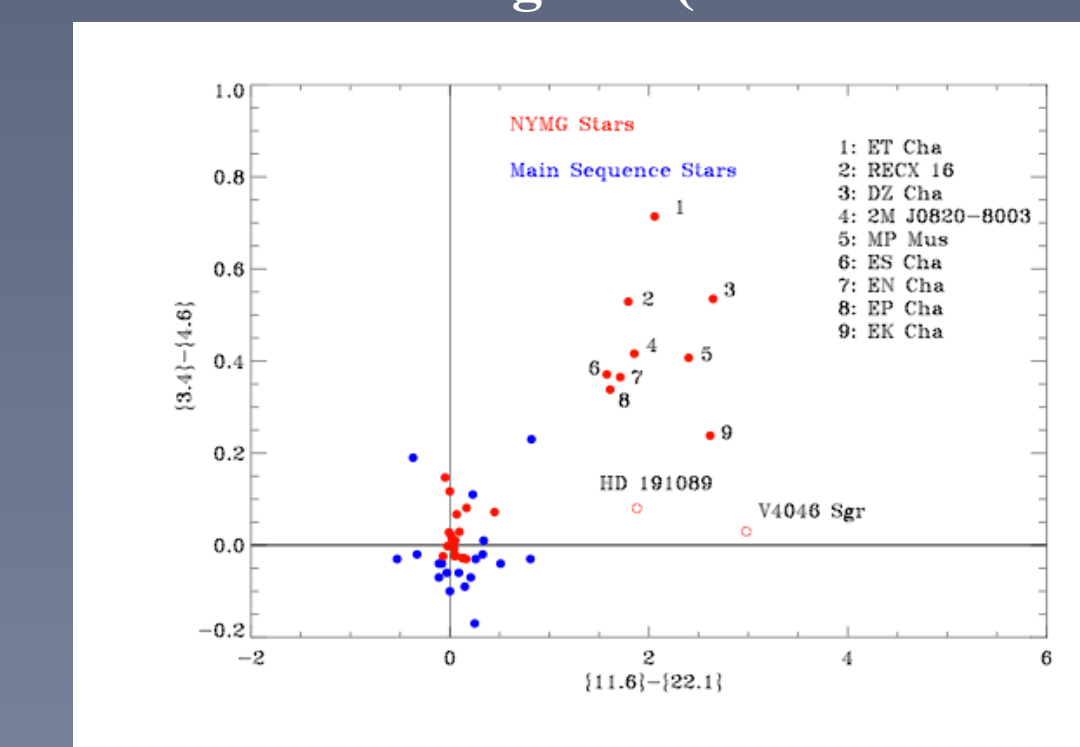
Observational HR Diagram



Companions are detectable above the main sequence.

Circumstellar Disks

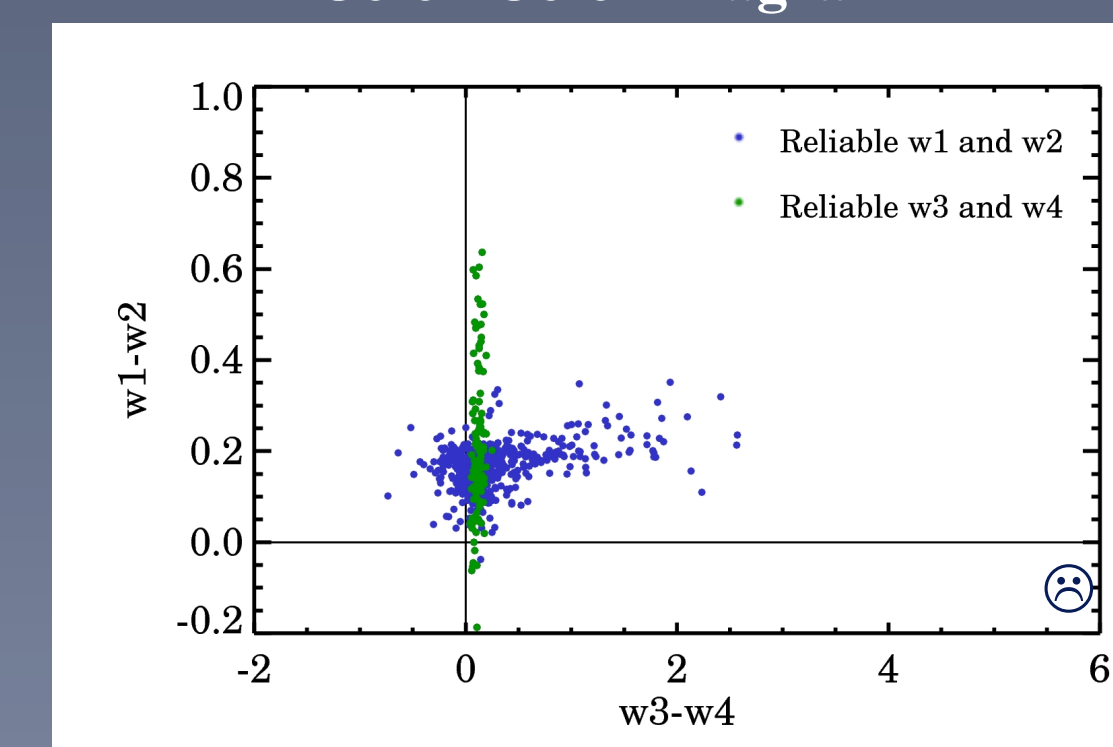
Color-Color Diagram (Simon et al. 2012)



No Disks around Nearby Southern M Dwarfs? The numbered points in the left plot indicate disks (mostly around M dwarfs) detected in the Eta Cha Moving Group using WISE. The blue points near the origin are main sequence stars of spectral type O through M without disks. In the right plot, there are only M dwarfs, known to have a higher w1-w2 color, and so the non-disk stars cluster at w1-w2 of -0.2 rather than 0.

One should note that there are two data sets in the right plot --- objects with reliable w1 & w2 photometry (blue) and objects with reliable w3 & w4 photometry (green). Note that there are no excesses in w1-w2 for the objects with reliable w1 & w2 photometry, nor excesses in w3-w4 for objects with reliable w3 & w4 photometry. Therefore, we must conclude that there are no detectable disks around at least 2/3 of southern M dwarfs within 25 parsecs.

Color-Color Diagram



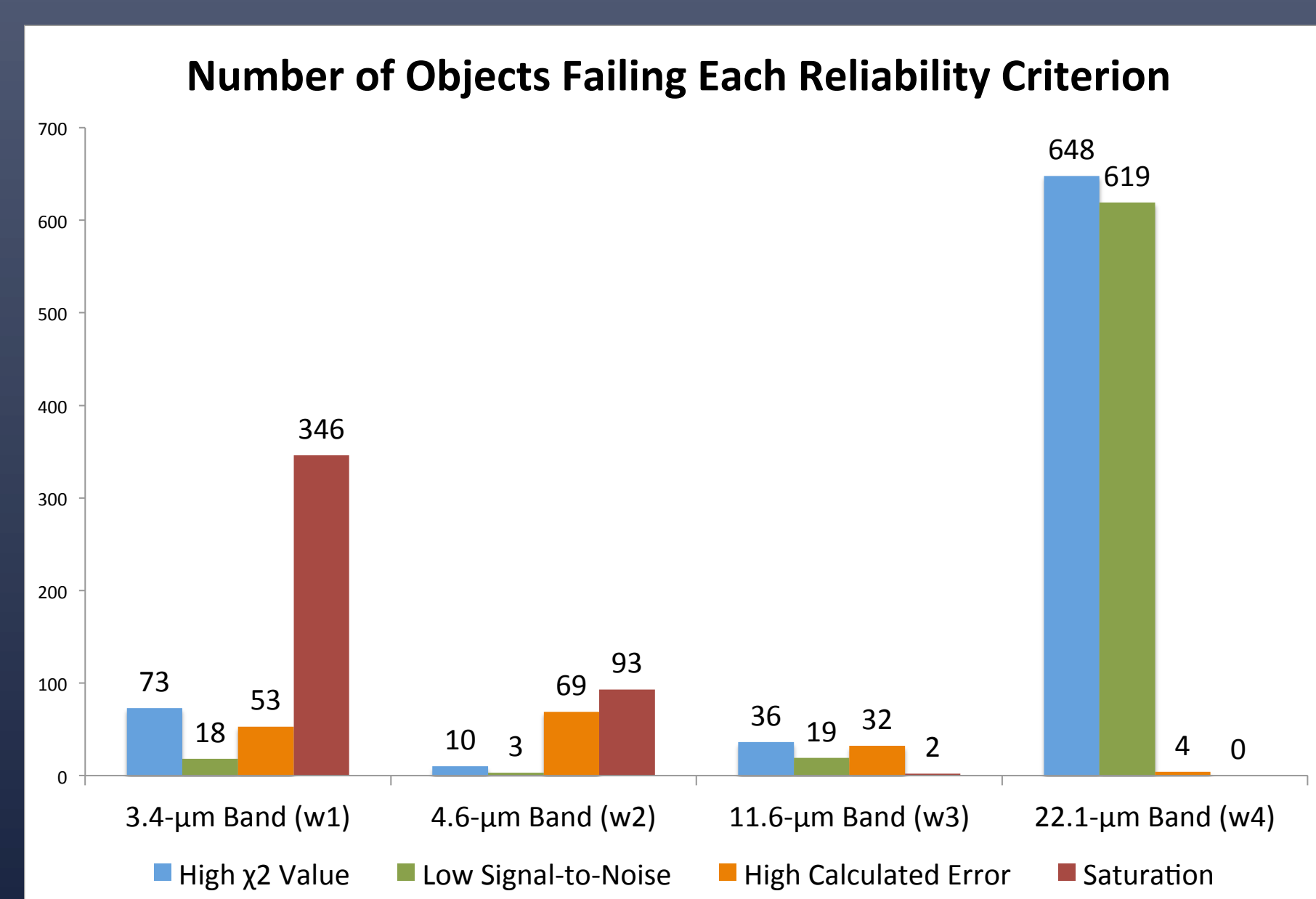
WISE Photometry

- WISE All-Sky PSF photometry data were considered reliable if they satisfied the following criteria:

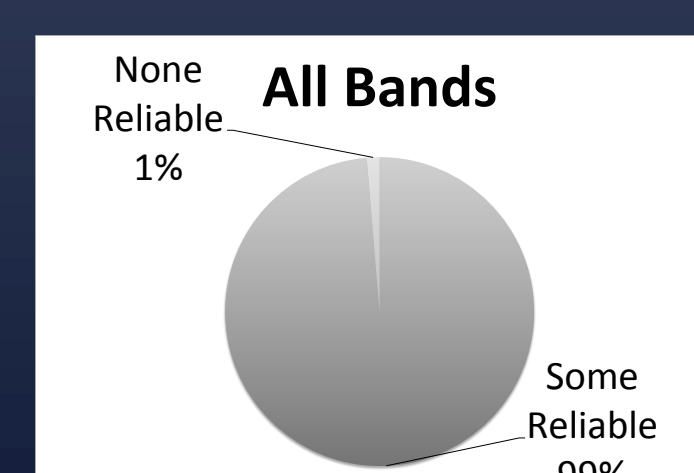
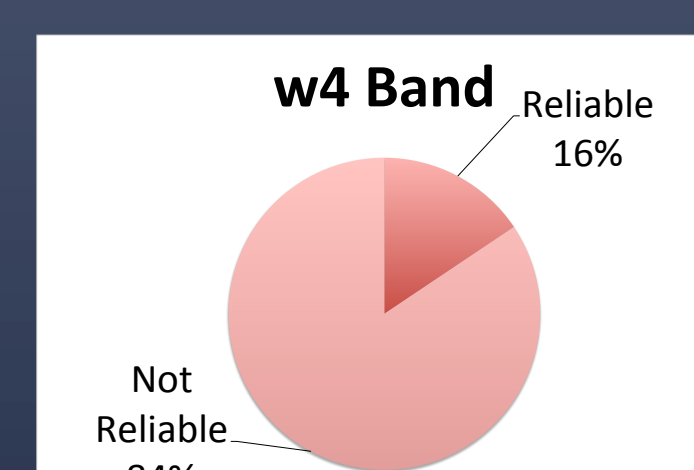
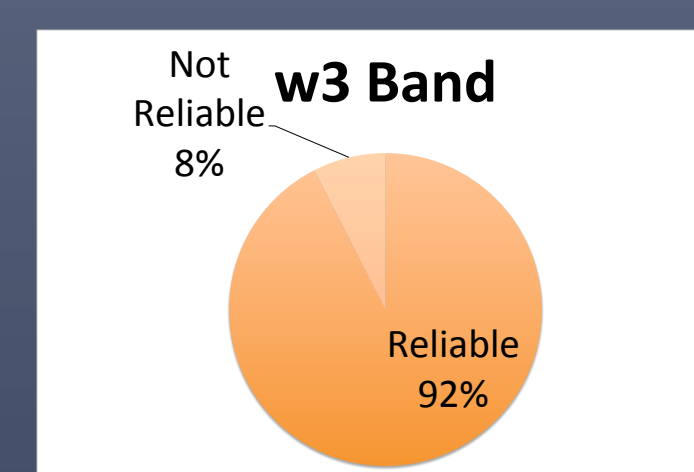
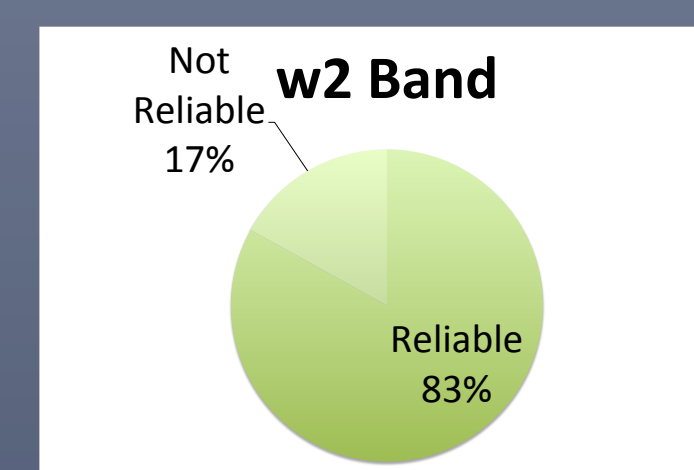
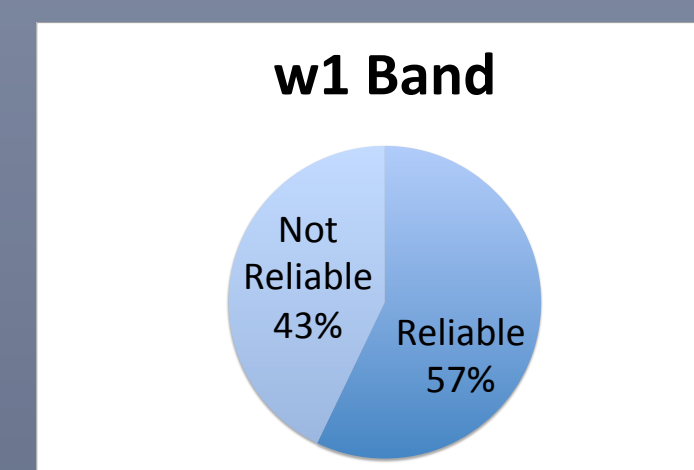
- $\chi^2 < 3$
- $SNR \geq 15$
- Error < 0.05 mags
- Saturation $< 5\%$ of pixels

- The WISE All-Sky Catalog was used instead of the newer AllWISE catalog because there are lower errors and saturation values for bright objects as found in this study and in Patel et al. 2014.

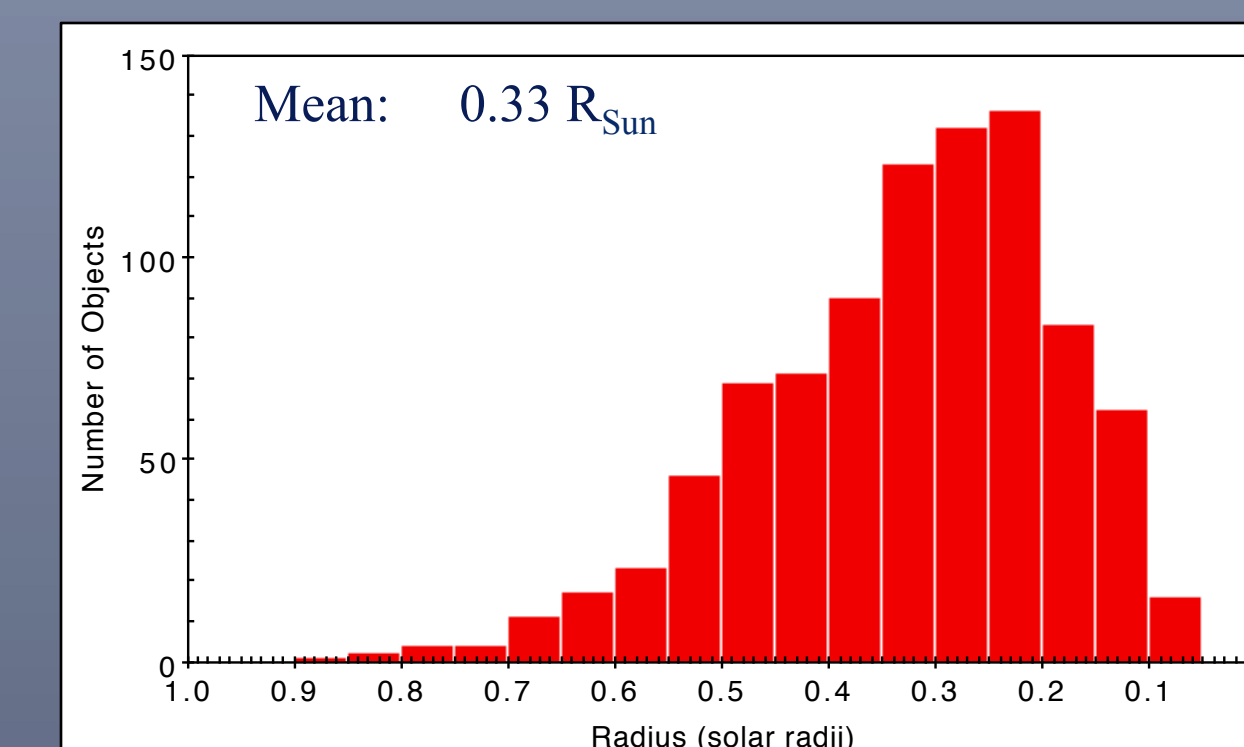
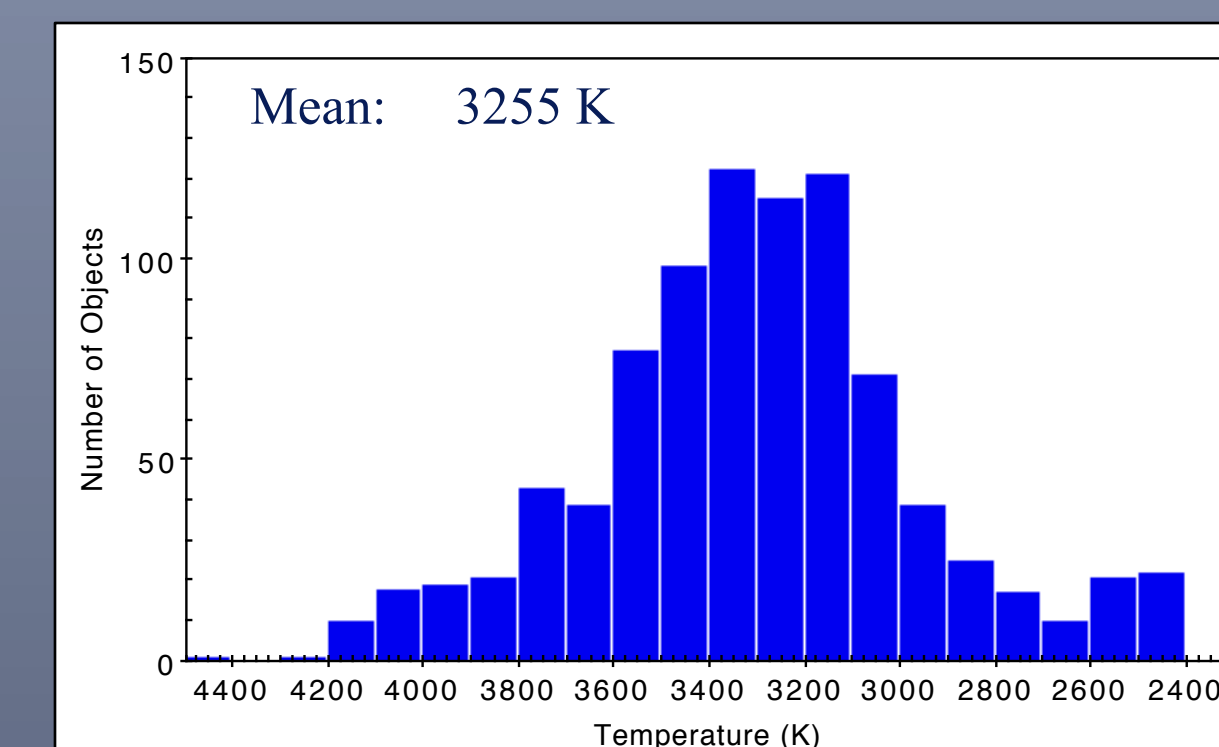
- There are no M dwarfs with reliable photometry in both the w1 and w4 bands or, therefore, in all four WISE bands.



WISE % Reliability

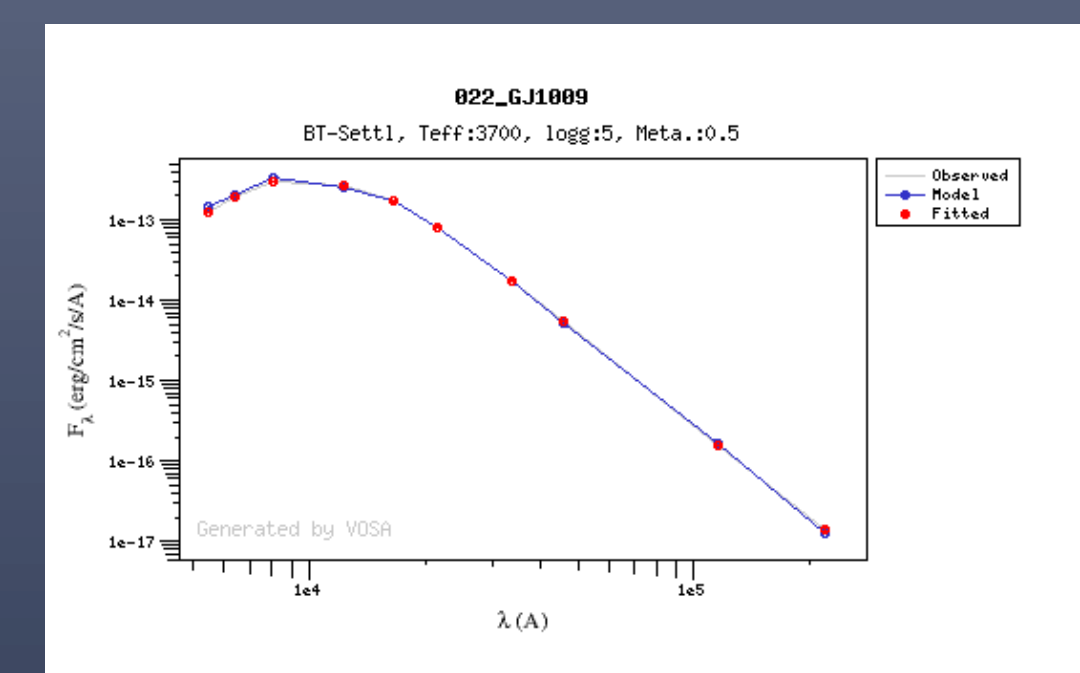


Temperatures & Radii using VOSA

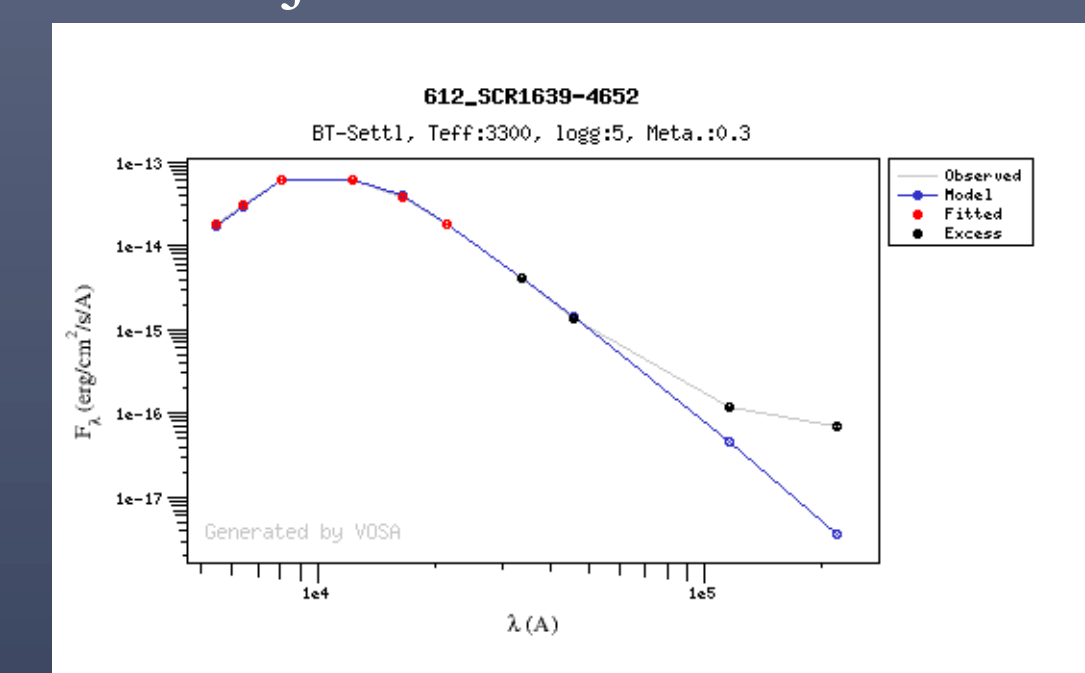


Spectral Energy Distributions using VOSA

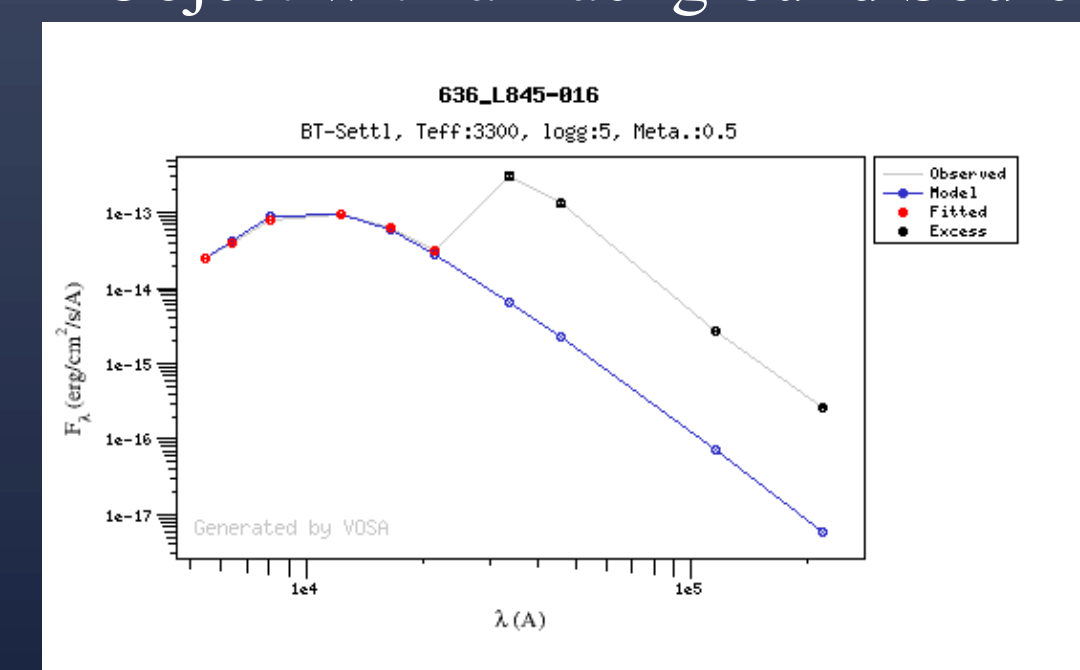
Perfect Fit



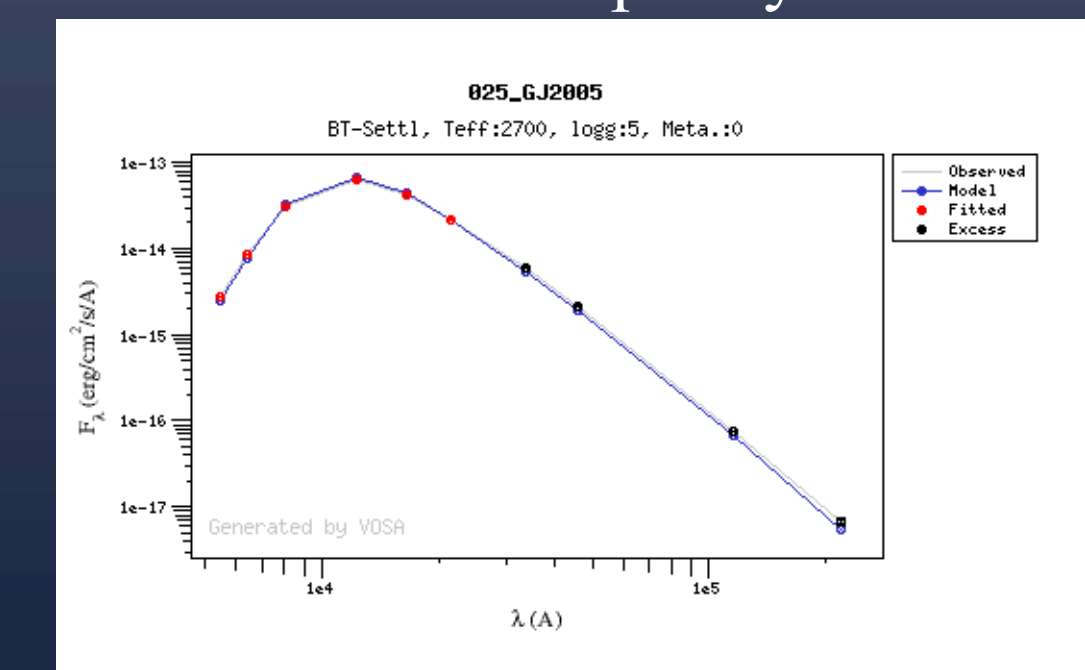
Object in the Galactic Plane



Object with a Background Source



Known Triple System



As shown above, one cannot visually detect companions around an M dwarf with an SED.