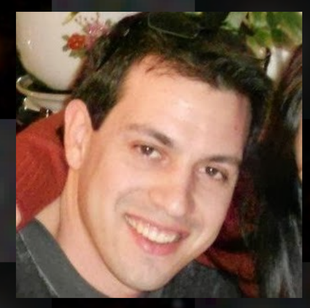
SDSS M dwarfs with *WISE* Infrared Excesses: Evidence of Warm Circumstellar Material in Low-Mass Field Populations



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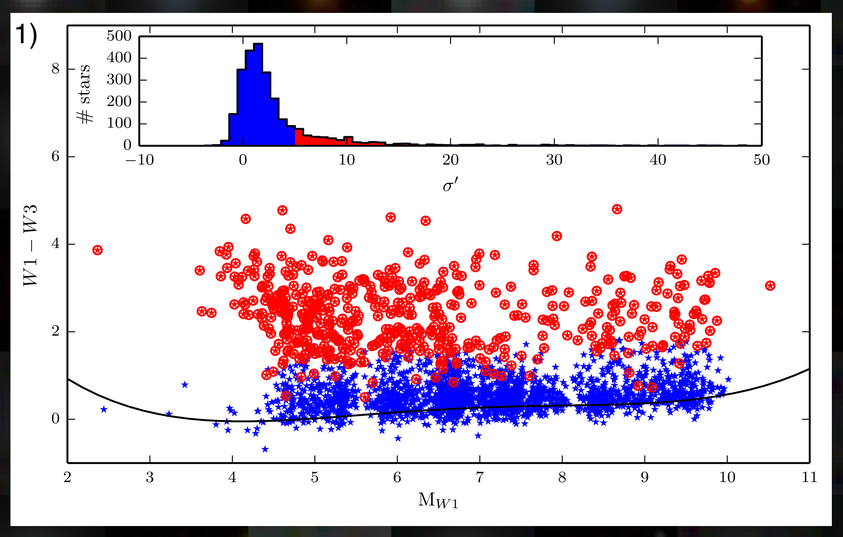
Infrared Excesses in M Dwarfs

How do we determine an infrared excess?

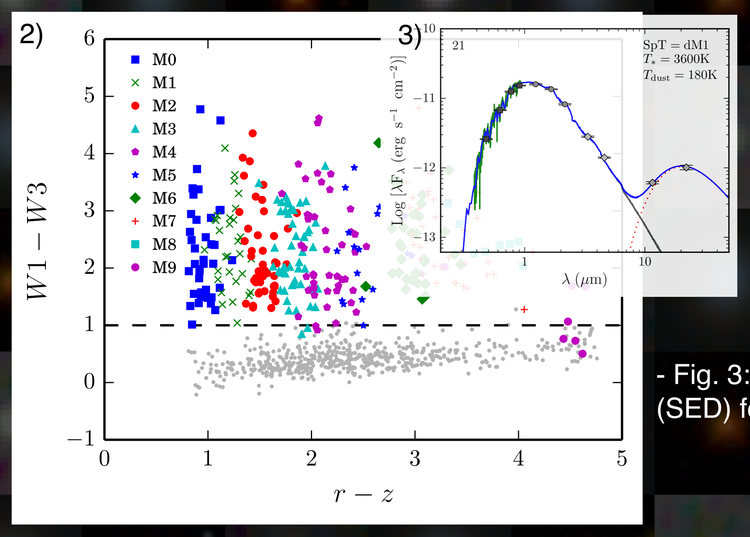


Using field stars we can calibrate expected flux levels by spectral type. We used the W11[11] SDSS DR7 spectroscopic M dwarf catalog for our sample.

- Fig. 1: Using results from A12[1], we are able to separate stars with infrared (IR) excesses (red) from non-excess stars (blue). A12 used low-mass stars from the RECONS[5] sample.

The RECONS data gave us initial criteria to separate excess from non-excess stars within the W11 DR7 spectroscopic catalog.

Other methods for



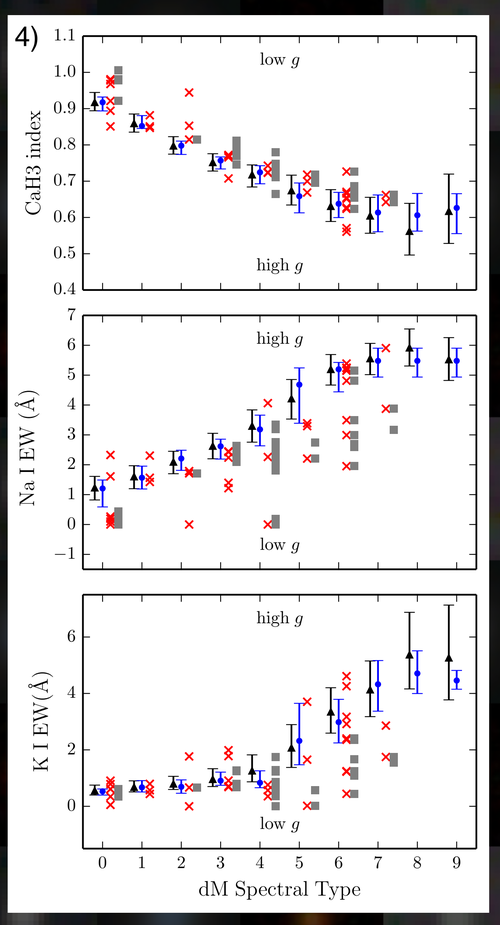
-Fig. 2: Using *r-z* color as a temperature proxy, we are able to separate excess stars without the need for distance measurements.

- Fig. 3: Spectral Energy Distribution (SED) for one of our excess candidates.

We were able to identify 308 candidate stars from the DR7 spectroscopic catalog.

Is this an age effect (are these stars young)?

Do these stars show low surface gravity?

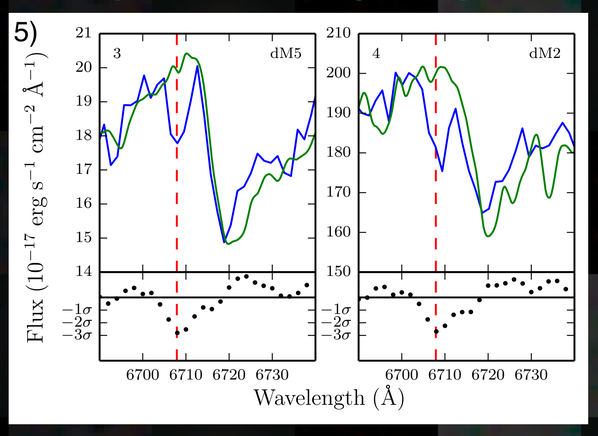


A star that is still contracting onto the main sequence will be larger and exhibit lower surface gravity than a zero-age main sequence star.

- Fig. 4: The values for the W11 (black), 12 µm sample (blue), and Orion candidates (gray).

The majority of stars do not exhibit surface gravities characteristic of pre-main sequence stars. However, our Orion candidates do appear to have low surface gravities.

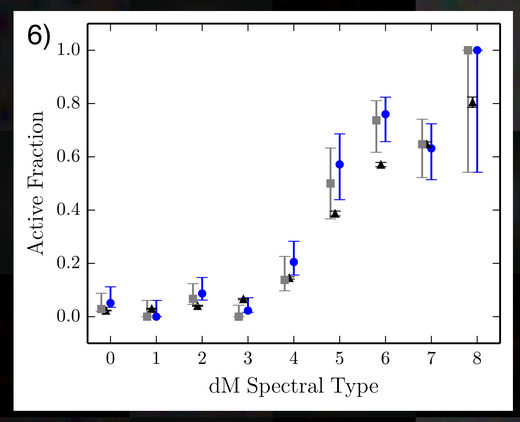
Do they show other signs of youth?



Low-mass stars may show lithium absorption for up to ~100 Myr before it is depleted[3].

- Fig 5: Spectral profiles (blue) for our stars and SDSS field dwarf template spectra[2] for plotted for comparison (green).

None of the stars outside Orion show lithium absorption in their spectrum, therefore, they are most likely older than 100 Myr. Older than the assumed timescale for disk dispersal (< 100 Myr).

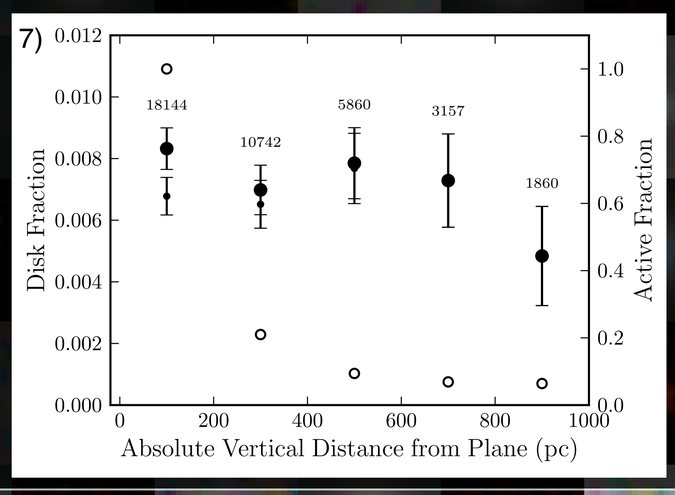


Hα has been shown to trace magnetic activity for low-mass stars, with activity declining with age[10].

- Fig. 6: Activity fractions for our sample (blue) (gray - w/o Orion candidates), and the W11 catalog (black)

The magnetic activity fractions for our stars is comparable to those of field dwarfs. We do not appear to be observing a young stellar population.

Is this a common occurrence?



Less than ~1% of field M dwarfs show signatures of warm dust.

What timescales are we exploring?

Galactic vertical height can be used as a proxy for age, a phenomena known as "Galactic Stratigraphy"[10].

- Fig. 7: Our sample (filled) and the W11 Galactic stratigraphy trend [10]. There is a slight declining trend at large Galactic heights, although not as pronounced as the activity trend.

There appears to be a trend with Galactic height in our sample, indicating an age dependence on which the mechanism creating this dust acts.

What is the interpretation?

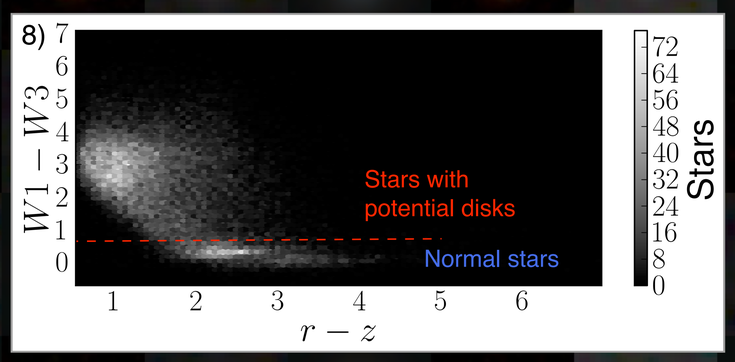
In recent years, a handful of stars with approximate ages > 1 Gyr have been discovered with warm dust[7,8,9]. One such star, BD +20 307, is thought to have created its dust content from giant impacts within the terrestrial zone[9]; a phenomenon analogous to our own Solar system's late heavy bombardment that happened ~1 Gyr after the system formed. This appears to be the most plausible explanation for our observed IR excesses due to the following:

1. Our field M dwarfs have inferred ages > 100 Myr.
2. M dwarfs are prone to terrestrial planet formation[6].
3. Planetary systems are inherently chaotic[4].

Other possibilities include:

- Failed planet formation.
- Tidal disruption of planetary bodies.

Future Work: Photometric M dwarfs



SDSS DR10 will help to increase our sample size using photometric M dwarfs

References

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Acknowledgements

- The Ford Foundation
- Research Corporation for Science Advancement