Identifying M Dwarfs and their Stellar Companions

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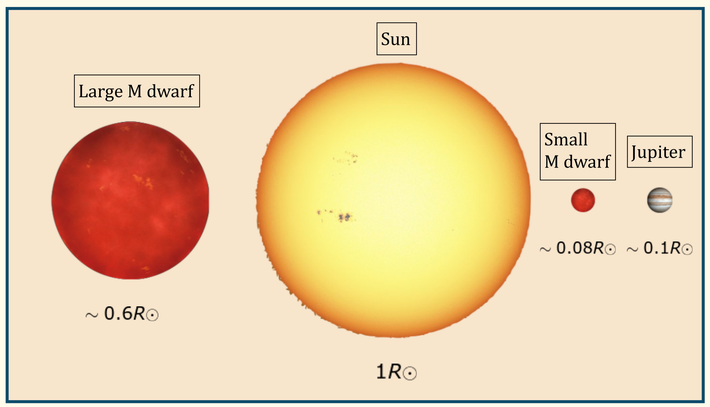
Abstract

We investigate the nearby environment of 1600 northern stars at distances < 25 pc away, and assess how frequently M dwarfs have stellar companions at small (< 2 arcsec) separations. Recent work indicates that planetary systems may not be able to form in the presence of a close stellar companion. Understanding the stellar multiplicity of these low mass stars will provide further insight into stellar and planetary formation processes. This work will help to characterize any exoplanets that may be found orbiting these stars.

Introduction

M dwarfs are low mass, relatively cool stars on the main sequence. As found in main sequence stars, mass roughly scales with radius. M dwarfs range from 8% to 60% the size and mass of our sun. They have effective temperatures of less than 3700 K. Because of their low temperatures and small radii, they emit a smaller amount of light. M dwarfs make up 75% of the stars found in our Milky Way, but we cannot see any of them with our naked eye.



M Dwarf Relative Sizes: M dwarfs range in sizes from 0.08 to 0.6 the size of our sun. The relation is similar for the mass of these stars

Adaptive Optics Mechanism

Robo-AO

The data we analyzed was collected by Robo-AO at the 1.5 meter telescope at Palomar. Robo-AO is an autonomous laser adaptive optics system and science instrument. Because of adaptive optics, Robo-AO is able to recover diffraction limited images at a resolution of 0.1 arc seconds.

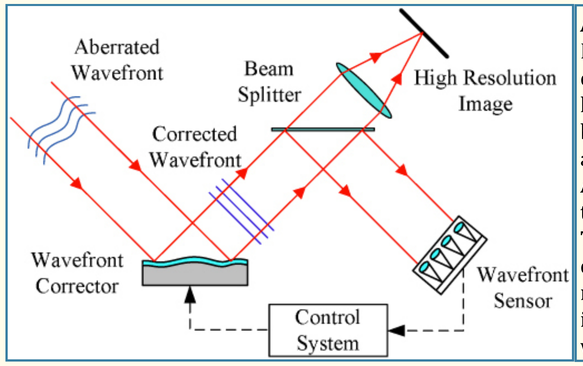
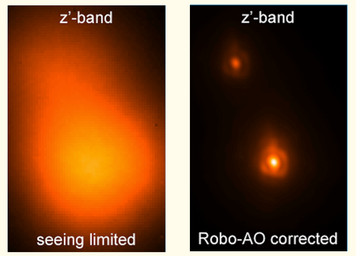


Diagram Credit: Iqbal et. al (2009)

Adaptive Optics: Images are distorted because light is refracted by particles in our atmosphere. With AO, we measure the distortion. This allows the deformable mirror to correct incoming light waves

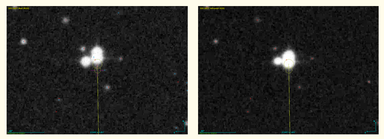
Robo-AO Corrected: Adaptive optics helps differentiate between one star or two stars with a small separation.



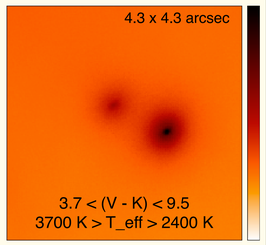
Procedure

Analyze Robo-AO Data

- Examine images and identify which are M dwarfs by checking (V-K) colors
- Compare to already confirmed binary star data
- Check for background star possibility using *Aladin* interface



Background Stars: There are three bright objects that appear to be stars. The image on the right shows that the two right stars moved together. credit: SuperCOSMOS

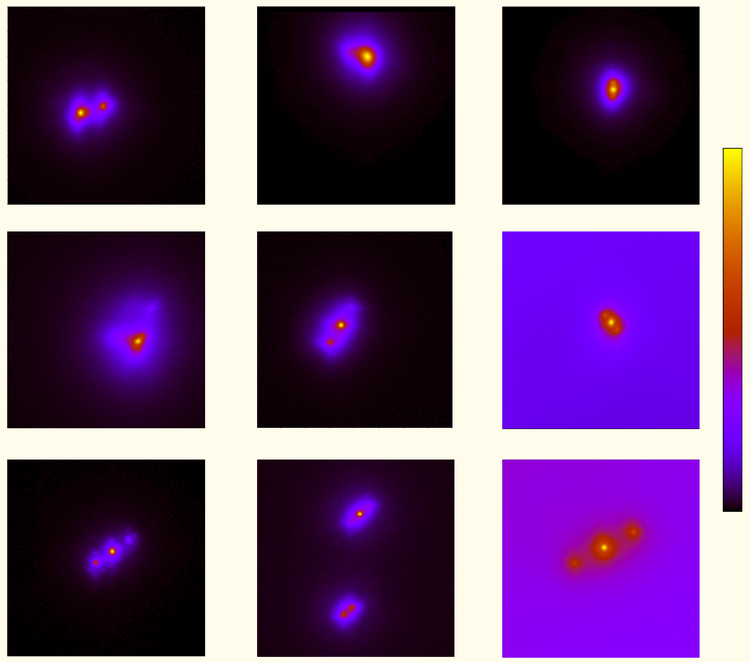


Robo-AO Image: Example of data taken by Robo-AO

Preliminary Results

- Examined 840 stars
- 480 M-Dwarfs
- 31 companions <2”
- 10 previously unknown binary candidates

Newly Discovered Binary Candidates



4.3 x 4.3 arcsec

Further Analysis

- Examine the remaining 840 images to get a value for the fraction of M dwarfs with close stellar companions
- Get precise separation measurements and confirm if the candidates are indeed binary stars
- Calculate separation and mass ratio distributions

References and Acknowledgements:

Ziegler et al. 2017 (AJ 153:66Z)
Robo AO Collaboration
Professor John Asher Johnson, *How do you Find an Exoplanet*
Banneker & Aztlán Institute Family
Advisor: Jennifer Winters