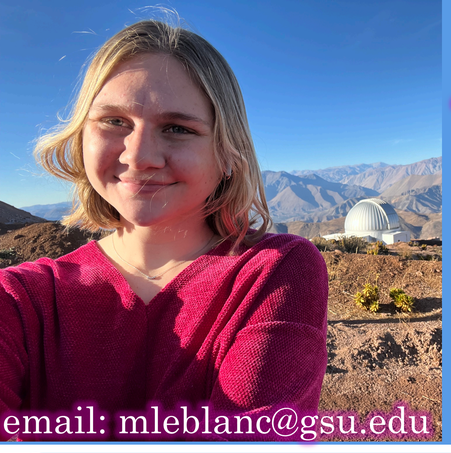

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A Comprehensive View of Companions to M Dwarfs: Exploring Gaia DR3 for Unseen Companions

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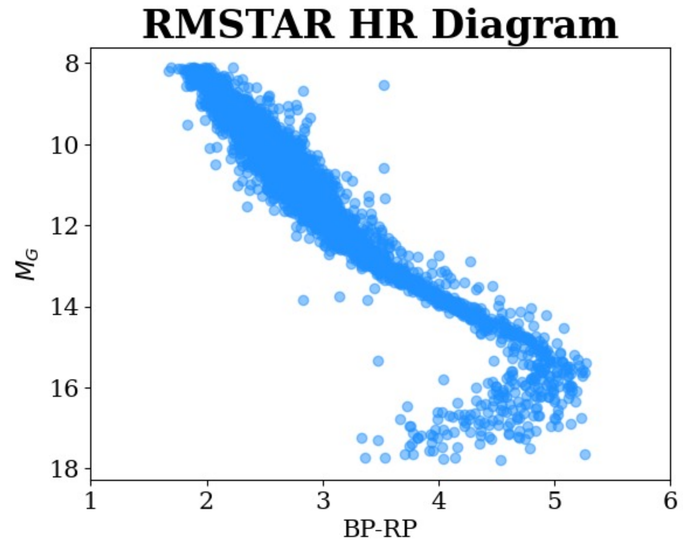
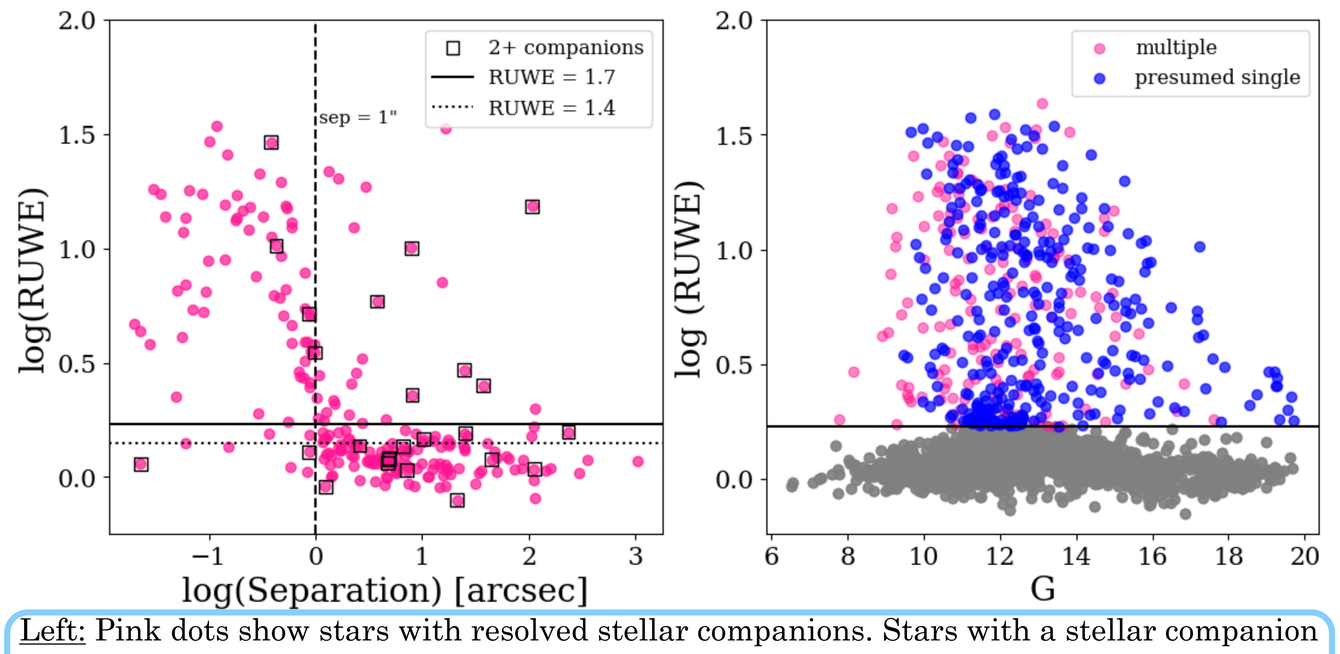
ABSTRACT

We present a study of a volume-limited sample of ~4000 M dwarfs within 25 parsecs, dubbed the RMSTAR (RECONS M STAR) sample. The sample has been created using Gaia DR3 results, augmented with ground-based discoveries of M dwarf systems that do not appear in DR3. M dwarfs account for three of every four stars in the solar neighborhood, so it is important that we have a full understanding of their multiplicity rates. We are synthesizing various research efforts revealing stellar, substellar, and planetary companions to paint a rich portrait of all types of M dwarf systems. Understanding all of these populations is essential to constraining formation processes across the continuum of mass.

We are surveying the RMSTAR sample using speckle imaging and radial velocity techniques to reveal companions. Here, we focus specifically on using RUWE (Renormalized Unit Weight Error), radial velocity errors, and Image Parameter Determination fraction of multiple peaks (IPDfmp) in DR3 as indicators of stellar companions to M dwarfs that are currently considered single stars. We identify additional presumed single stars that we deem likely to have stellar companions based upon examination of their RUWE, radial velocity errors, and IPDfmp. Identifying these unseen stars is the first step toward assembling the complete census of M dwarf companions from stellar masses all the way into the planetary regime.

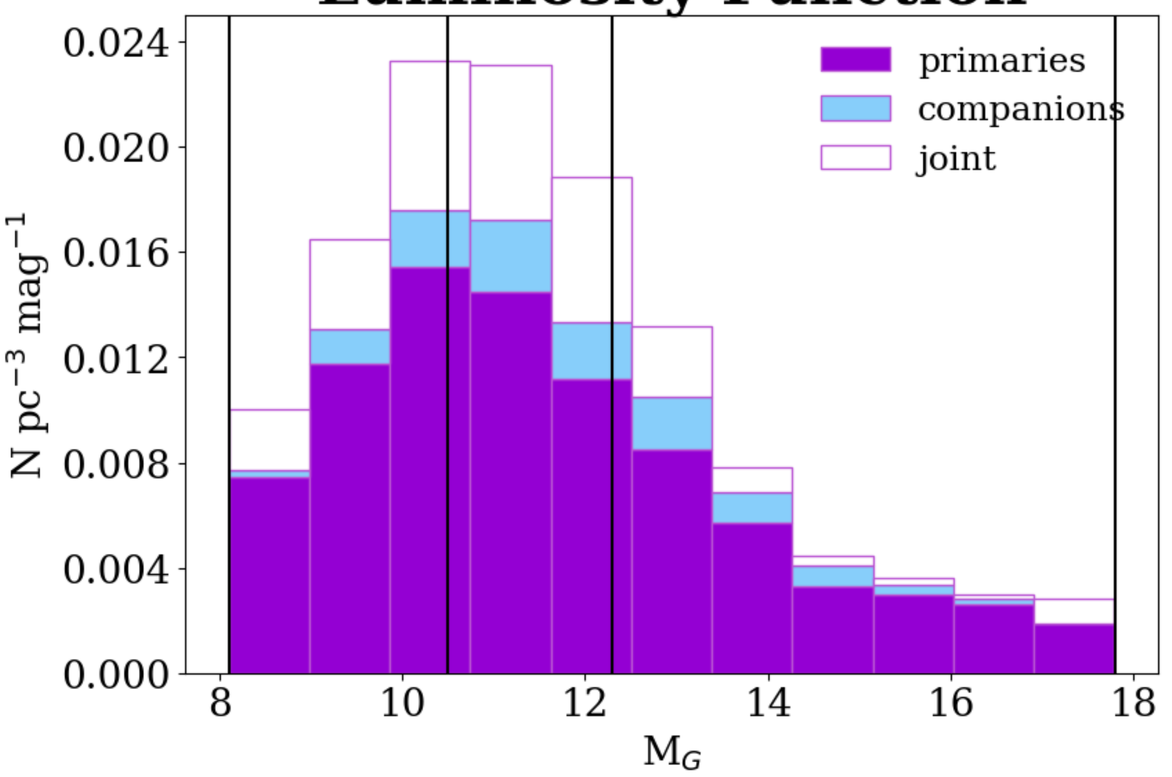


RUWE

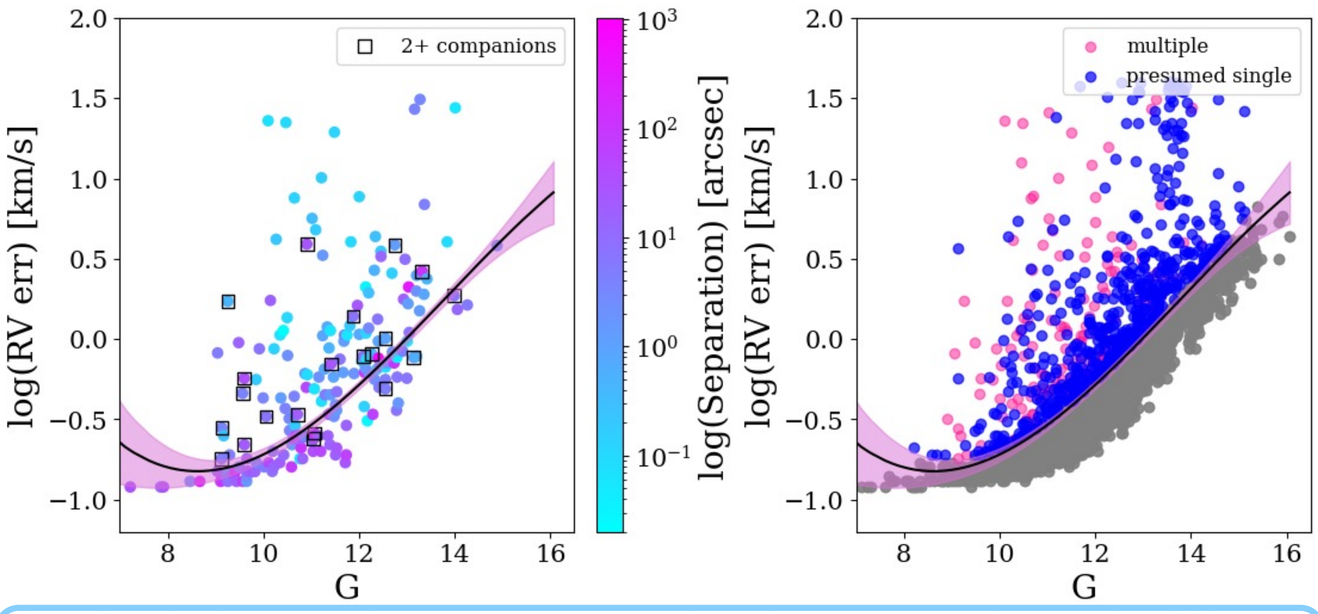


Left: Pink dots show stars with resolved stellar companions. Stars with a stellar companion with separation < 1" tend to have RUWE > 1.7. Right: Most stars with stellar companions (pink) lie above the black line drawn at RUWE = 1.7. Blue dots above the black line are high priority for our speckle survey.

Luminosity Function



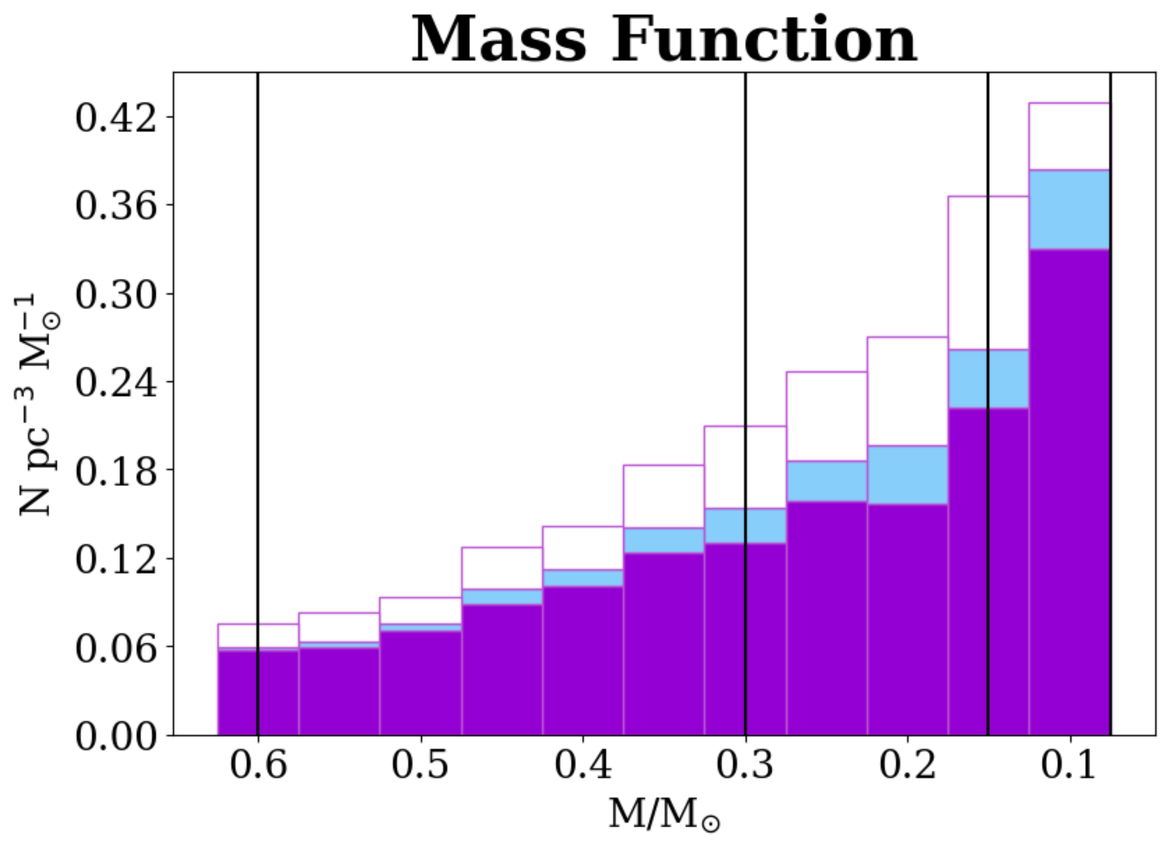
RV error



Left: Resolved stars (pink dots in top figure) colored by separation, showing that RV error increases as separation decreases. Right: Most stars with stellar companions lie above the black curve that fits the distribution of RV errors. Blue dots above the black line are high priority for our surveys.

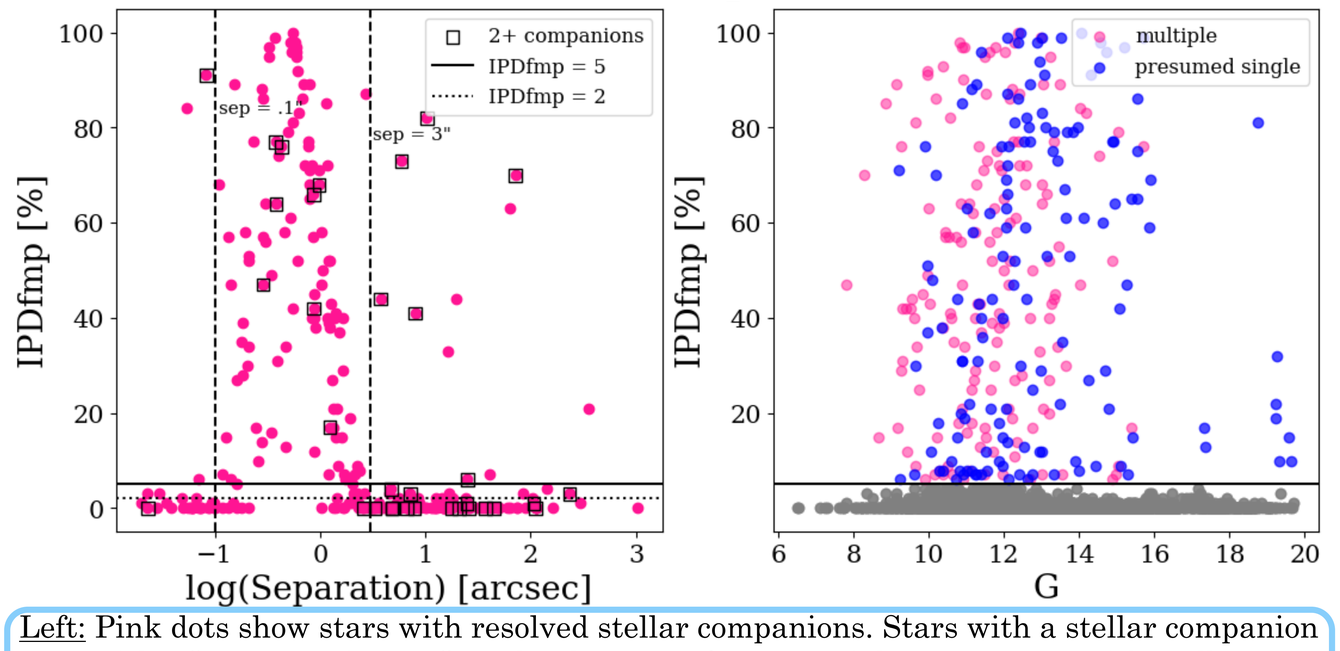
Luminosity function of the 25 pc volume complete sample of red dwarfs: primaries and companions are shown separately and "joint" (white) sources are either known or suspected unresolved multiple stars. Upon resolution the latter systems will split and shift to the right. Vertical black lines represent factors of two in mass mass M = 0.60, 0.30, 0.15, and 0.075 $M_\odot$.

Mass Function



Mass function of the 25 pc volume complete sample of red dwarfs: colored in the same way as the luminosity function. Unknown masses were estimated using V band mass-luminosity relationship. Vertical black lines represent factors of two in mass M = 0.60, 0.30, 0.15, and 0.075 $M_\odot$. The mass function clearly rises to the end of the main sequence.

IPDfmp



Left: Pink dots show stars with resolved stellar companions. Stars with a stellar companion with .1" < separation < 3" tend to have IPDfmp > 5. Right: Most stars with stellar companions (pink) lie above the black line drawn at IPDfmp = 5. Blue dots above the black line are high priority for our speckle survey.

Acknowledgements:
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References:

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