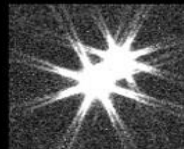




# M DWARF MULTIPLICITY in the SOLAR NEIGHBORHOOD

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**RECONS**  
Research Consortium on Nearby Stars

# MOTIVATION

- **What fraction of M dwarf systems are multiples?**
- **Where are the companions to M dwarfs found?**
- **What is the distribution of mass in M dwarf systems?**
- **How does the mass function for all M dwarfs behave?**
- **Are star systems primarily singles or multiples?**

# M DWARF PROPERTIES

- **MASSES:  $0.08 - 0.6 M_{\odot}$**
- **RADII:  $0.08 - 0.6 R_{\odot}$**
- **LUMINOSITIES:  $0.02 \% - 6 \% L_{\odot}$**
- **TEMPERATURES:  $2400 - 3900 \text{ K}$**
  
- **COLORS:  $3.7 \leq (V-K) \leq 9.5$**
- **$8.8 < M_V < 20.0$**
- **$\pi > 40 \text{ mas}, \sigma_{\pi} < 10 \text{ mas}$**



Tarter et al. 2007  
RECONS

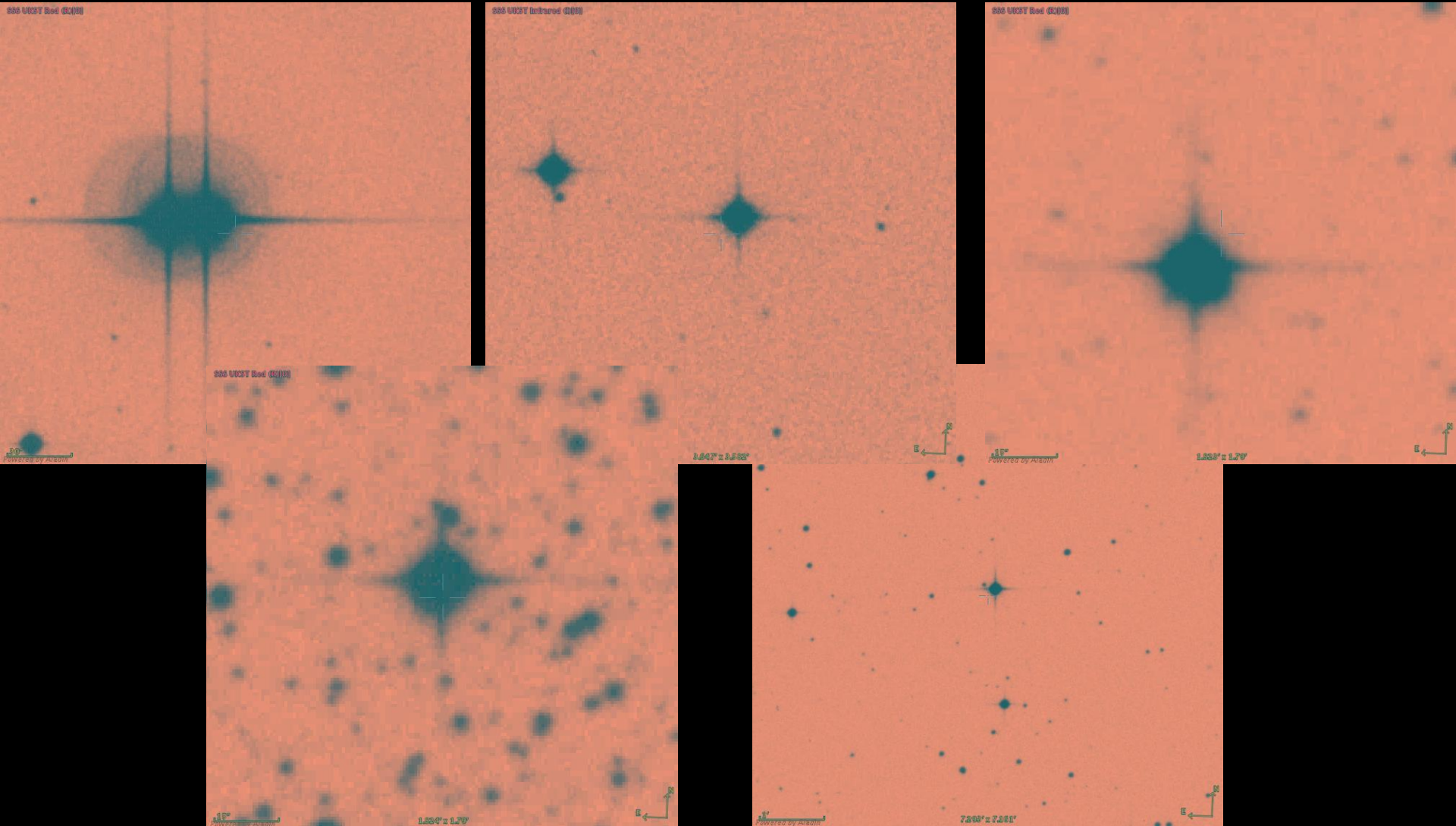
# PARALLAXES

SAMPLE ORIGIN	NORTH	SOUTH	notes
YPC + HIP	525	316	Within 25.0 pc from Compendia
From Literature (1995-2012)	66	30	Additions from others
RECONS Published	12	122	Already in Literature
RECONS Unpublished	21	162	More additions soon
<b>TOTAL</b>	<b>624</b>	<b>630</b>	<b>1254</b>

# SEARCH REGIMES

- **Wide Companions: 5 – 600''**  
(50 – 15,000 AU)
- **Close Companions: 1 – 5''**  
(10 – 50 AU)
- **Even Closer Companions: < 1''**  
(< 10 AU)
- ***Literature Search***

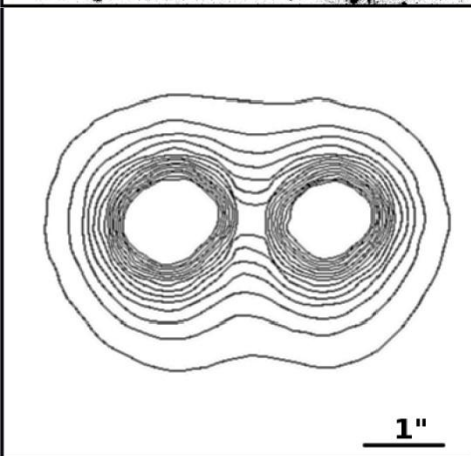
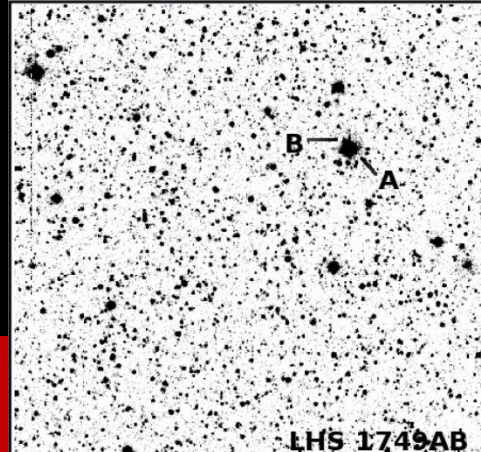
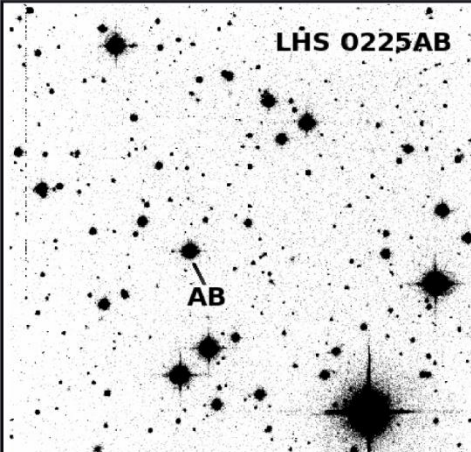
# WIDE COMPANIONS



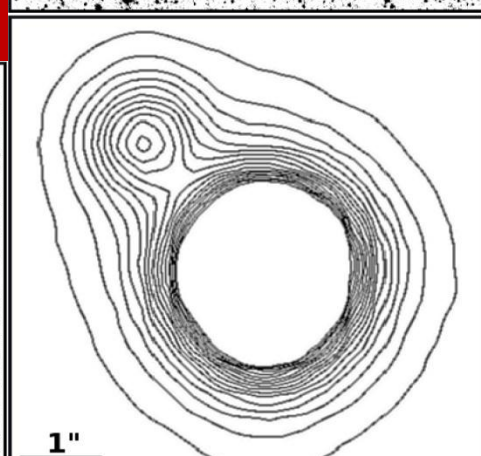
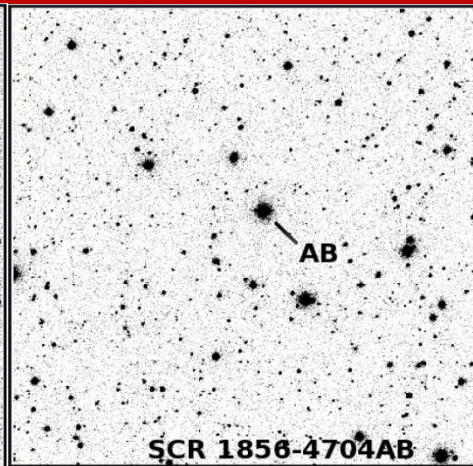
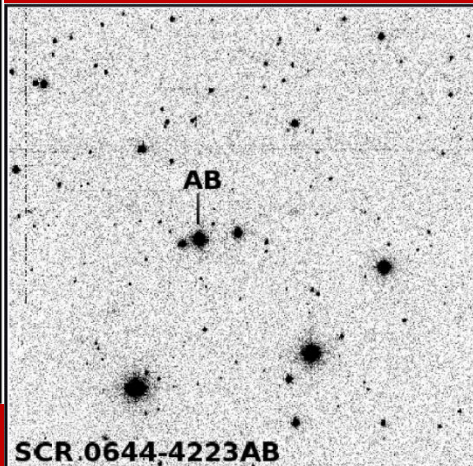


# CLOSE COMPANIONS

## 0.9m Discoveries

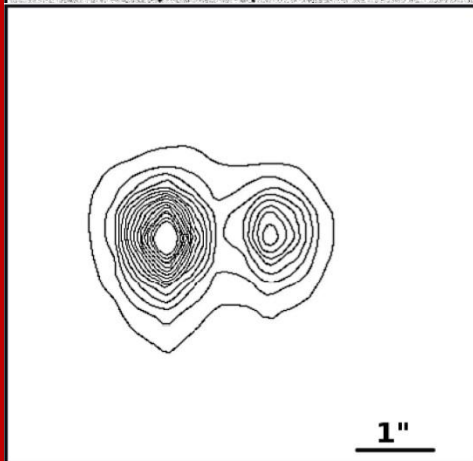


$\Delta I = 0.1$   
 $\rho = 2.5''$



$\Delta V = 3.0$   
 $\rho = 2.9''$

$\Delta I = 1.0$   
 $\rho = 1.6''$

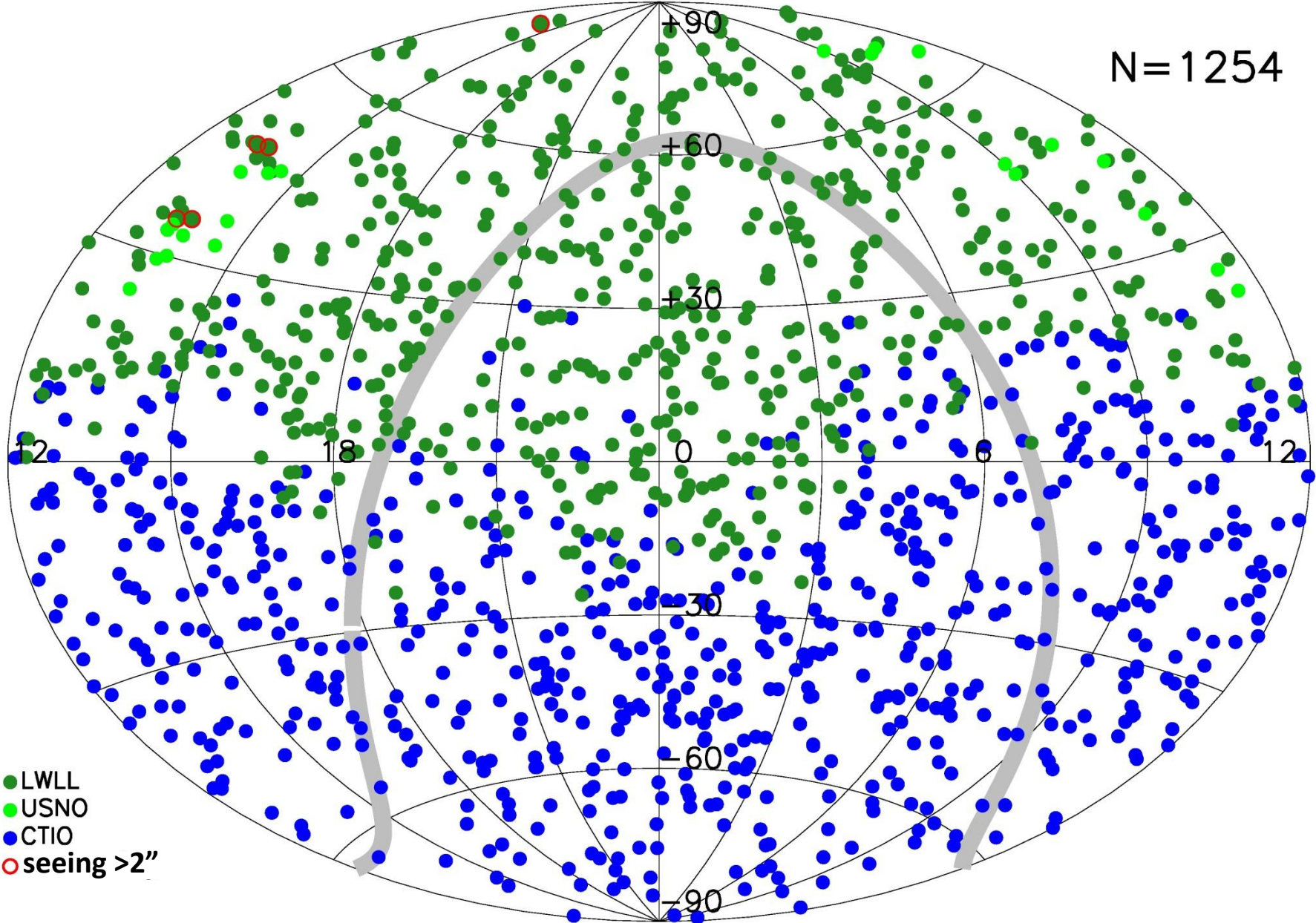


$\Delta I = 0$   
 $\rho = 1.1''$

Winters et al. 2011

Jao et al. 2003

N=1254

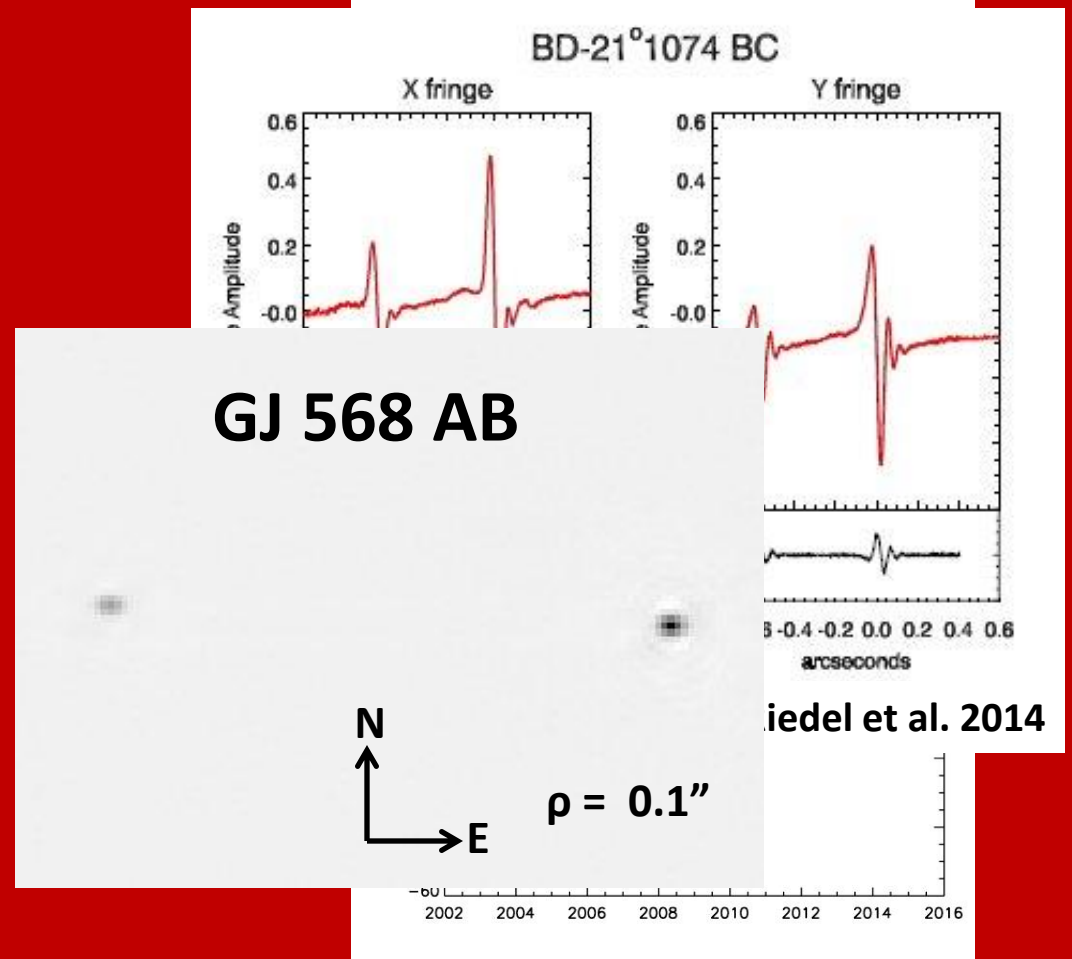


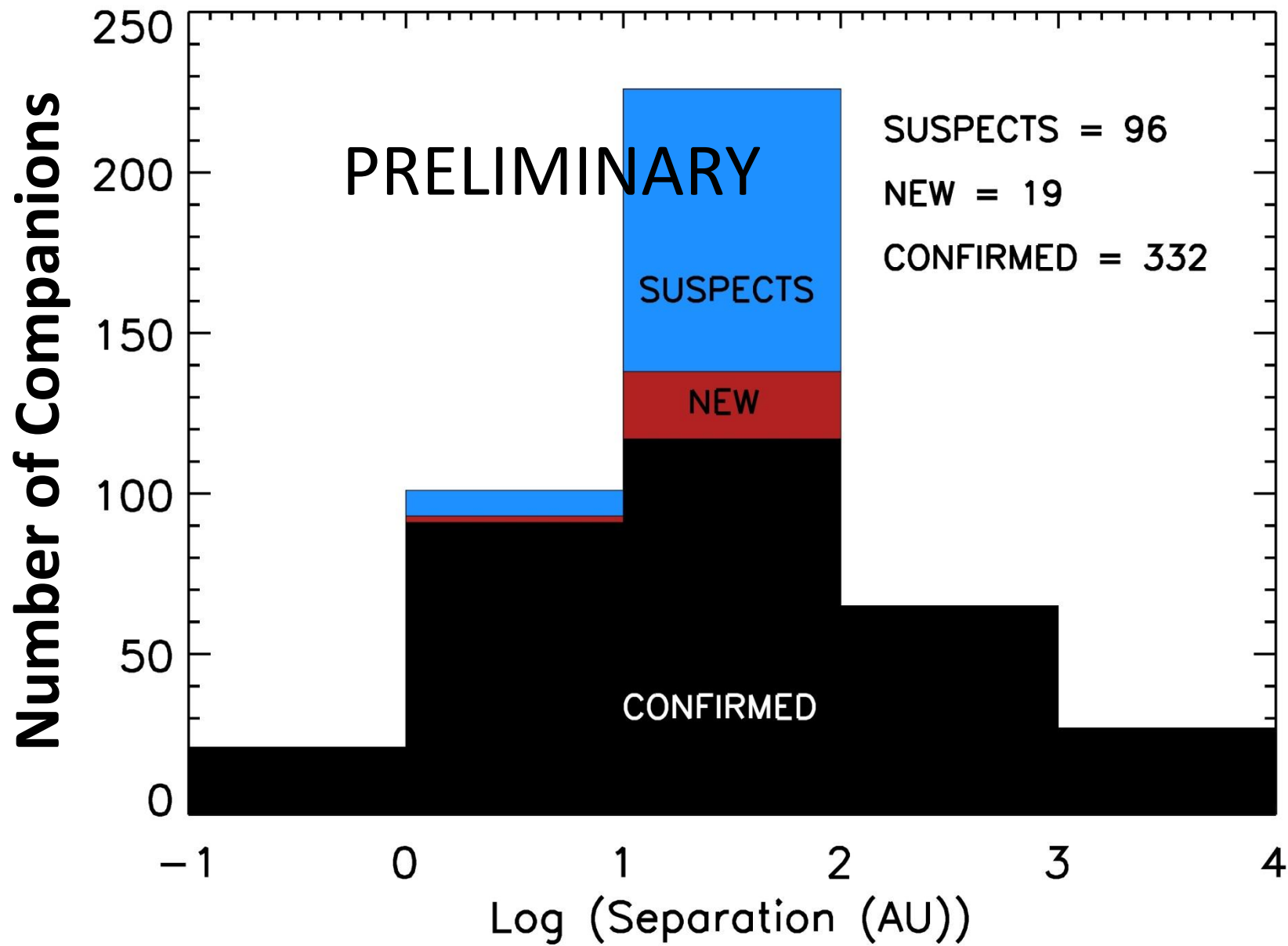
- LWLL
- USNO
- CTIO
- seeing >2''



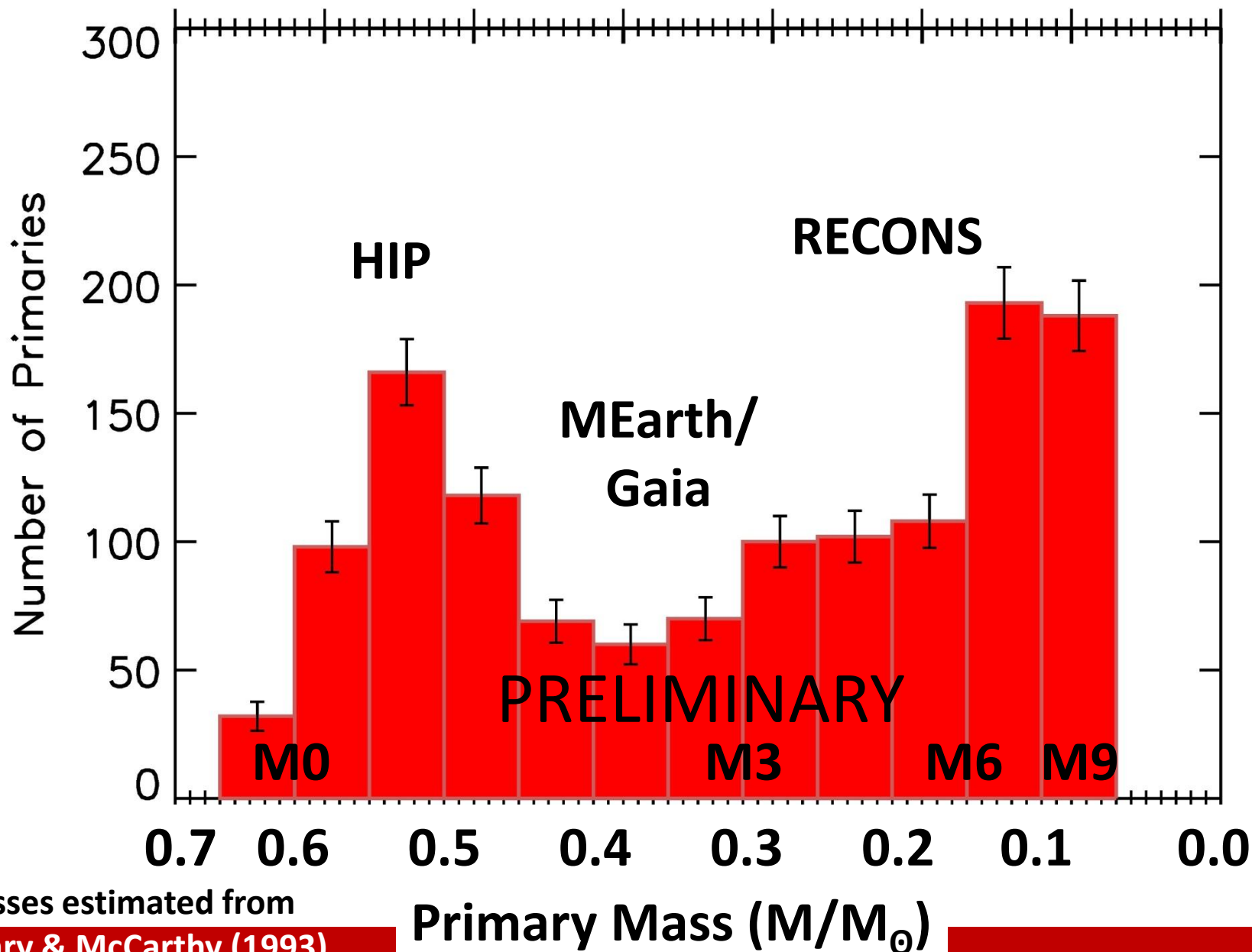
# UNSEEN COMPANIONS & FOLLOW-UP

- Astrometry
- HST FGS
- DSSI
- RoboAO

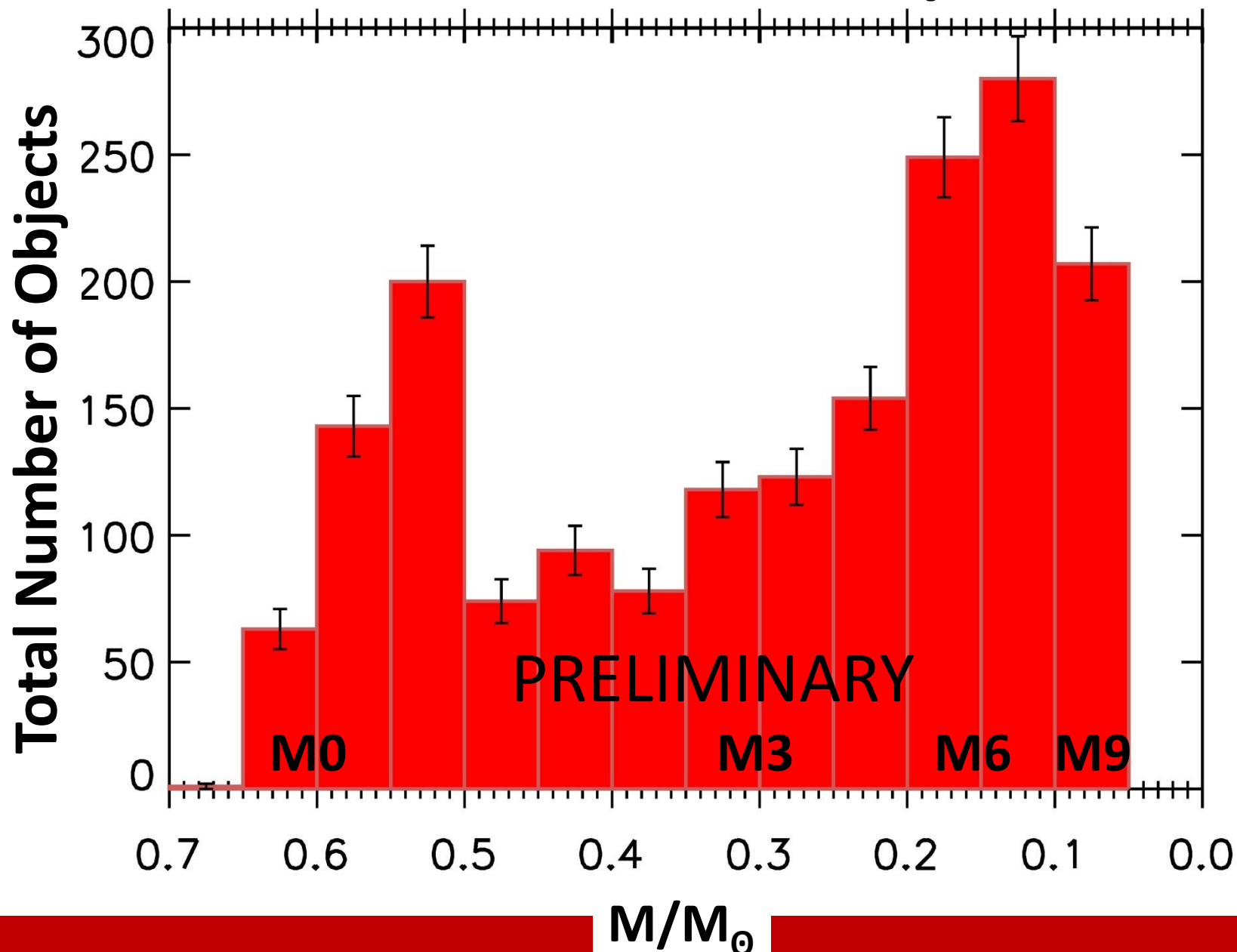




# Mass Function – All Primaries

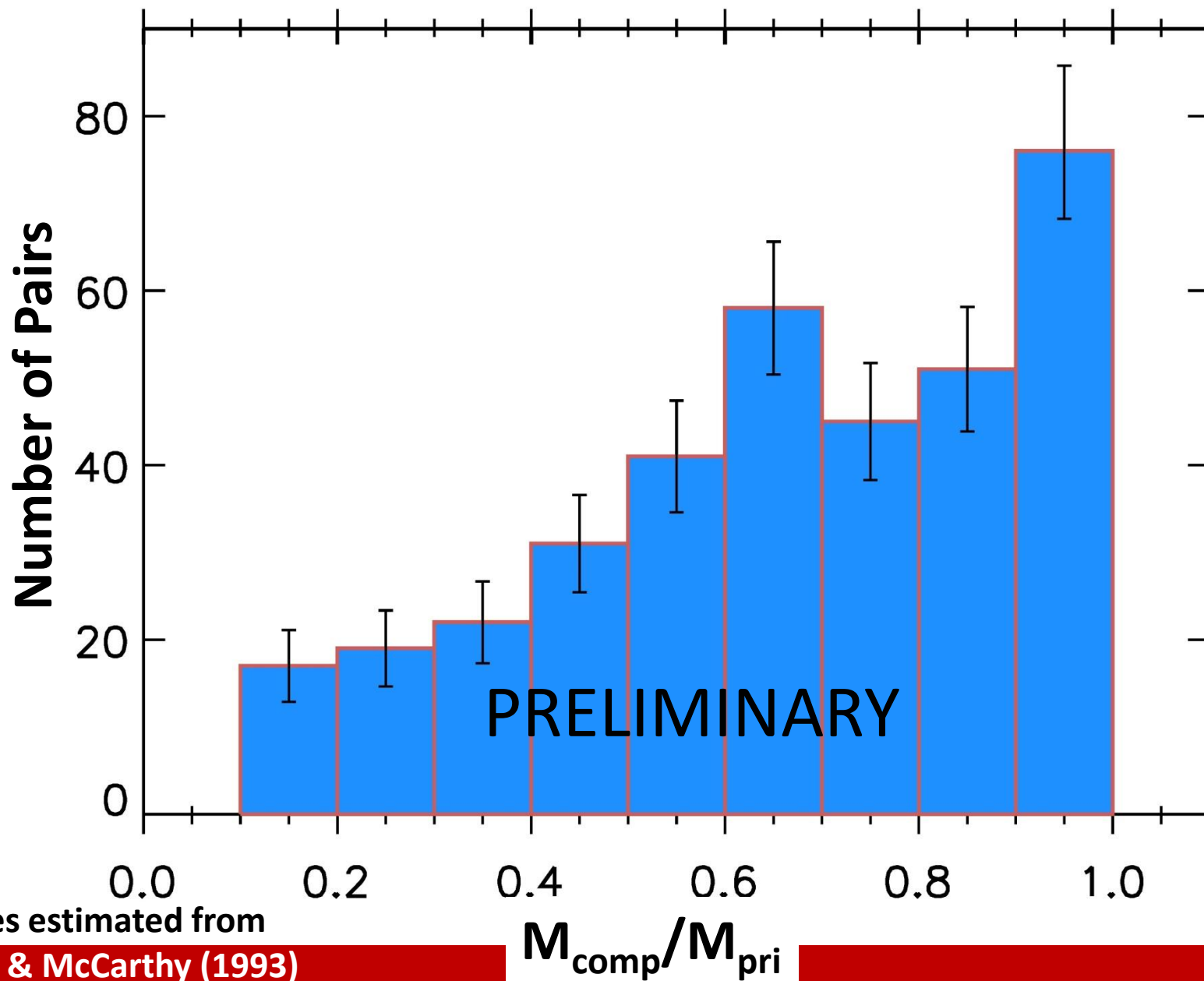


# Mass Function – All Components



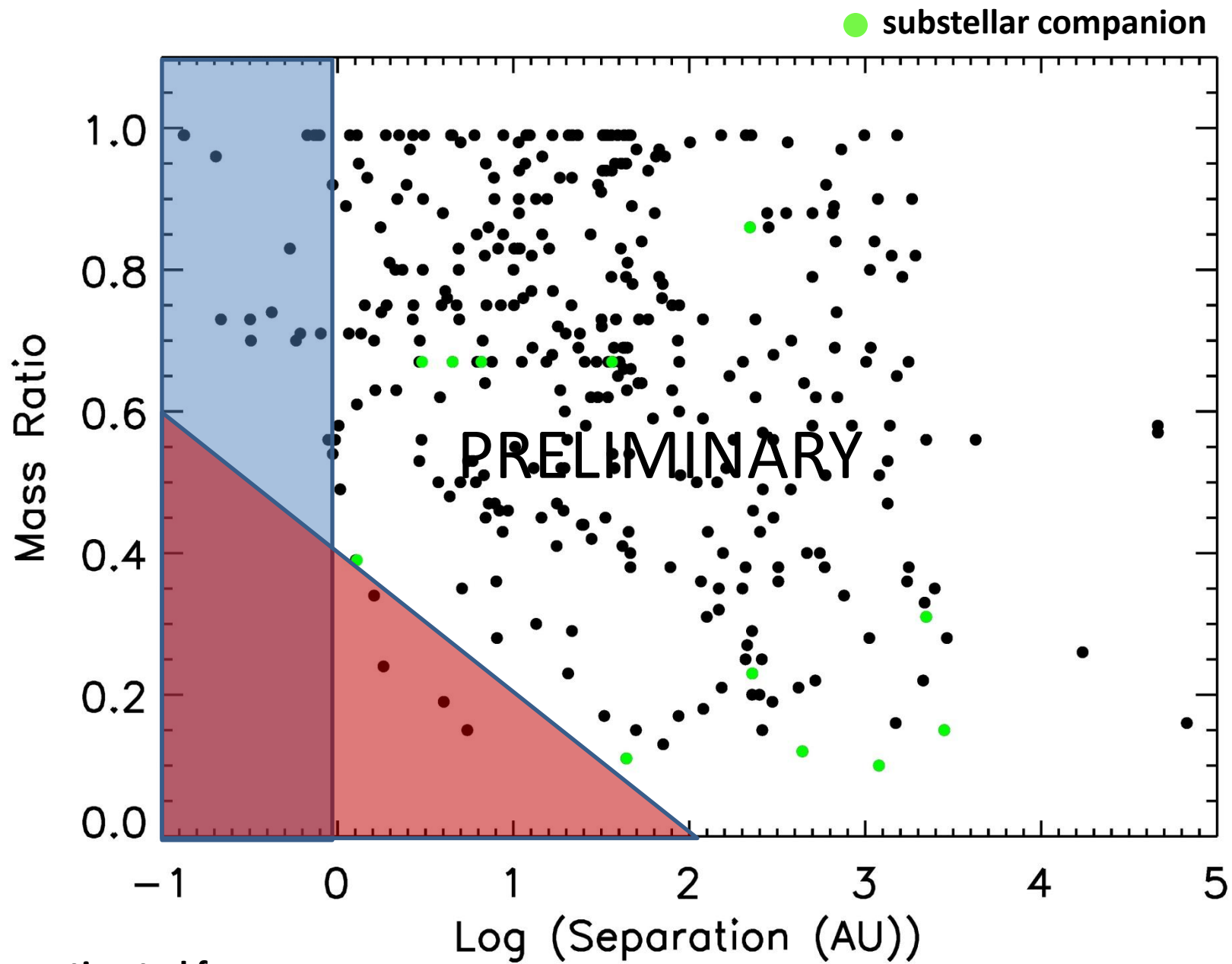


# Mass Ratio Distribution

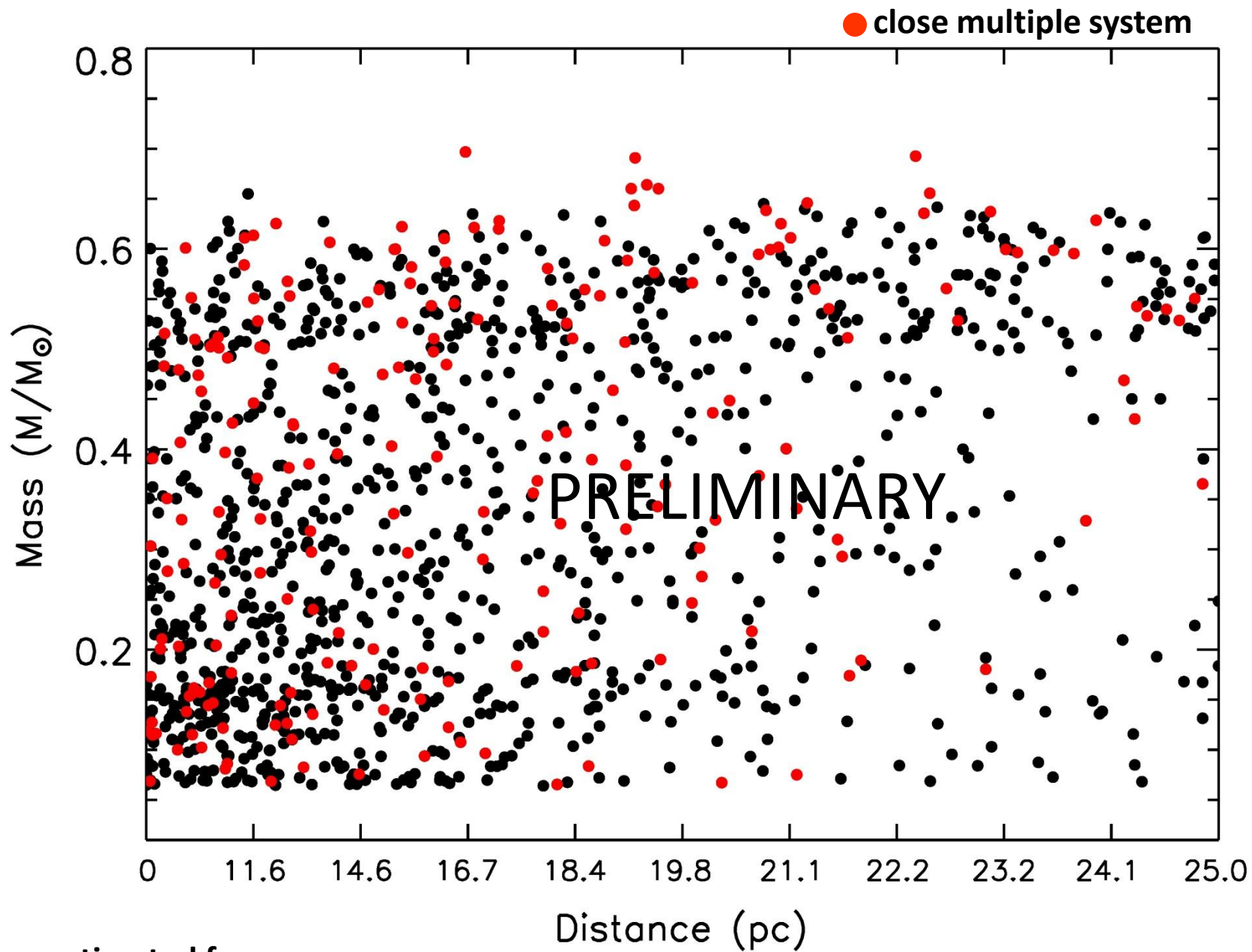


Masses estimated from  
Henry & McCarthy (1993)

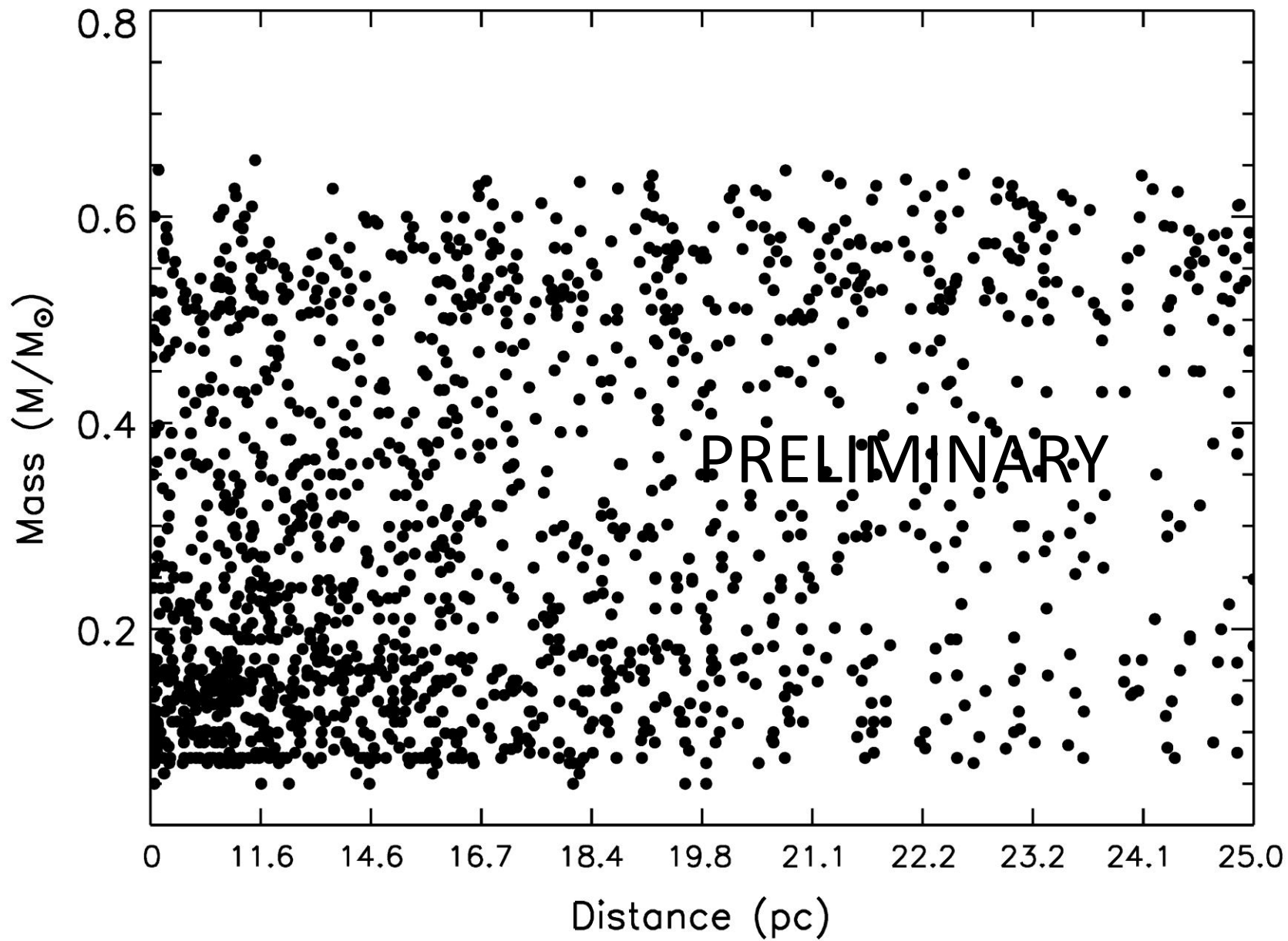
$M_{\text{comp}}/M_{\text{pri}}$



Masses estimated from  
Henry & McCarthy (1993)



Masses estimated from  
Henry & McCarthy (1993)





# M DWARF MULTIPLICITY

30%

$\pm 4\%$

S:B:T:Q:Q = 947:259:45:1:2

# ARE MOST SYSTEMS SINGLE OR MULTIPLE?

SPECTRAL TYPE	% OF ALL SYSTEMS	MULTIPLICITY FREQUENCY	REFERENCE
O	tiny	75-100	Mason+ 1998; Mason+ 2009
B	small	75-100	Mason+ 1998; Mason+ 2009
A			
F			
G			
K	10	~40	Raghavan+ 2010
M	74	30	This work

**MF = ~33%**  
**FOR ALL SYSTEMS**

# ANSWERS

- What fraction of M dwarf systems are multiples? **30%**
- Where are the companions to M dwarfs found?  
**Separations on outer Solar System scales: 1-100 AU**
- How does the mass function for all M dwarfs behave?  
**It increases to the end of the main sequence.**
- What is the distribution of mass in M dwarf systems?  
**It increases to equal mass ratios**
- Are star systems primarily singles or multiples?  
**Singles!**

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