

# The Solar Neighborhood Before, During, and After Gaia

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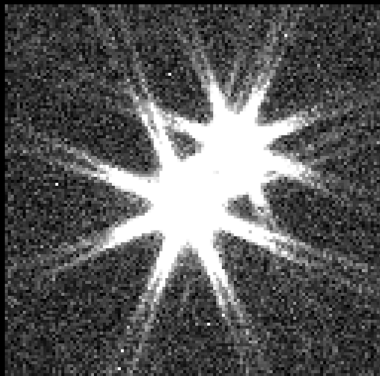
*Dan Nusdeo*



*Leonardo Paredes*



*Jennifer Winters*



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# RECONS

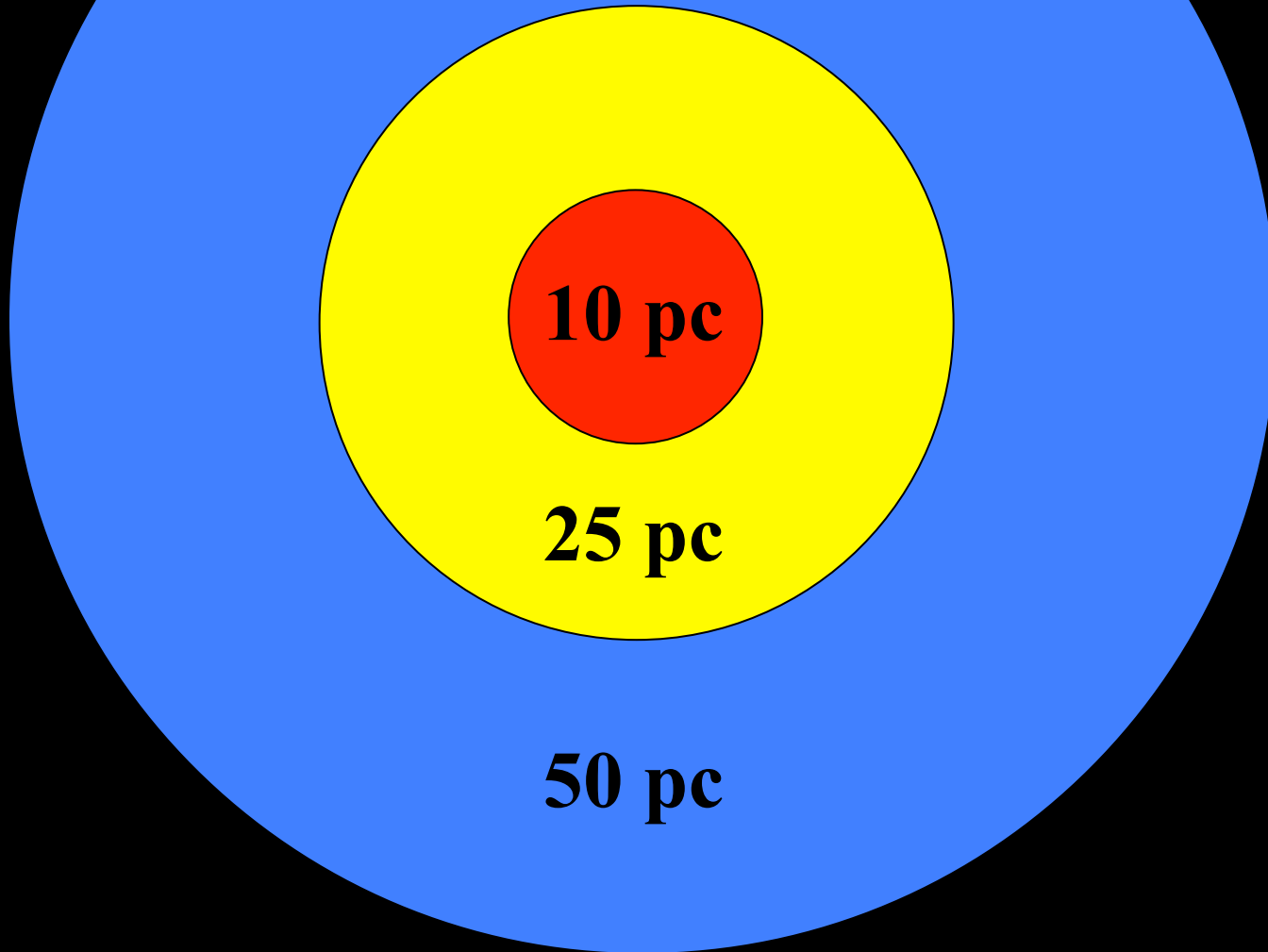
Research Consortium on Nearby Stars

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*recons.org*

*est. 1994*

# Neighborhood Horizons



# Cerro Tololo Inter-American Observatory



**RV  
program  
\$200/hr**

**parallax  
program  
\$600/nt**

**1.0m**

**Schmidt**

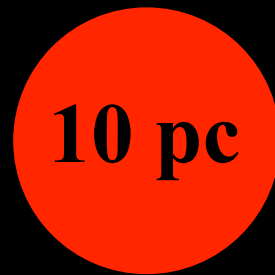
**4.0m**

**1.5m**

**0.9m**

**SMARTS telescopes at CTIO**

# RECONS 10 Parsec Sample

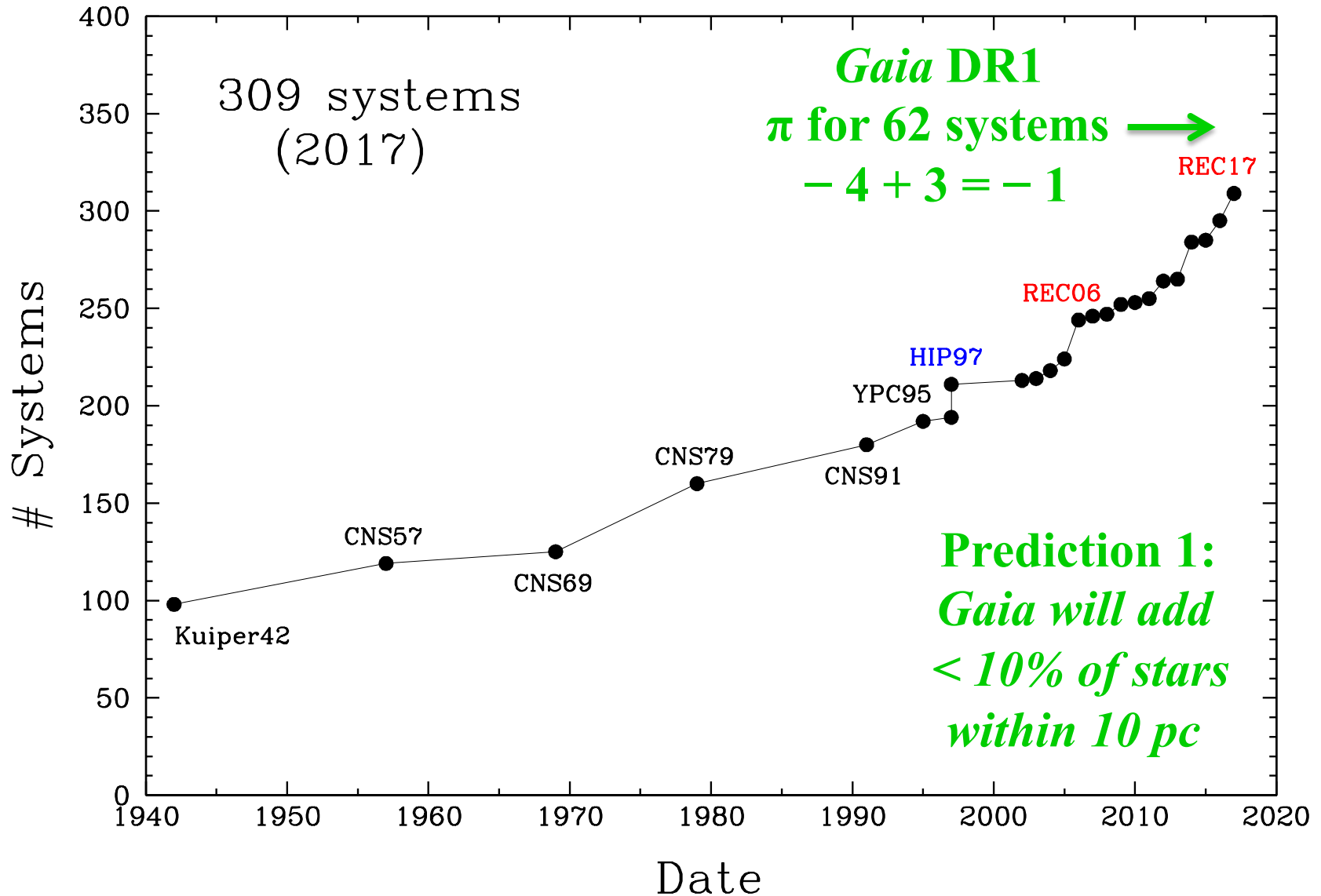


**309 systems**

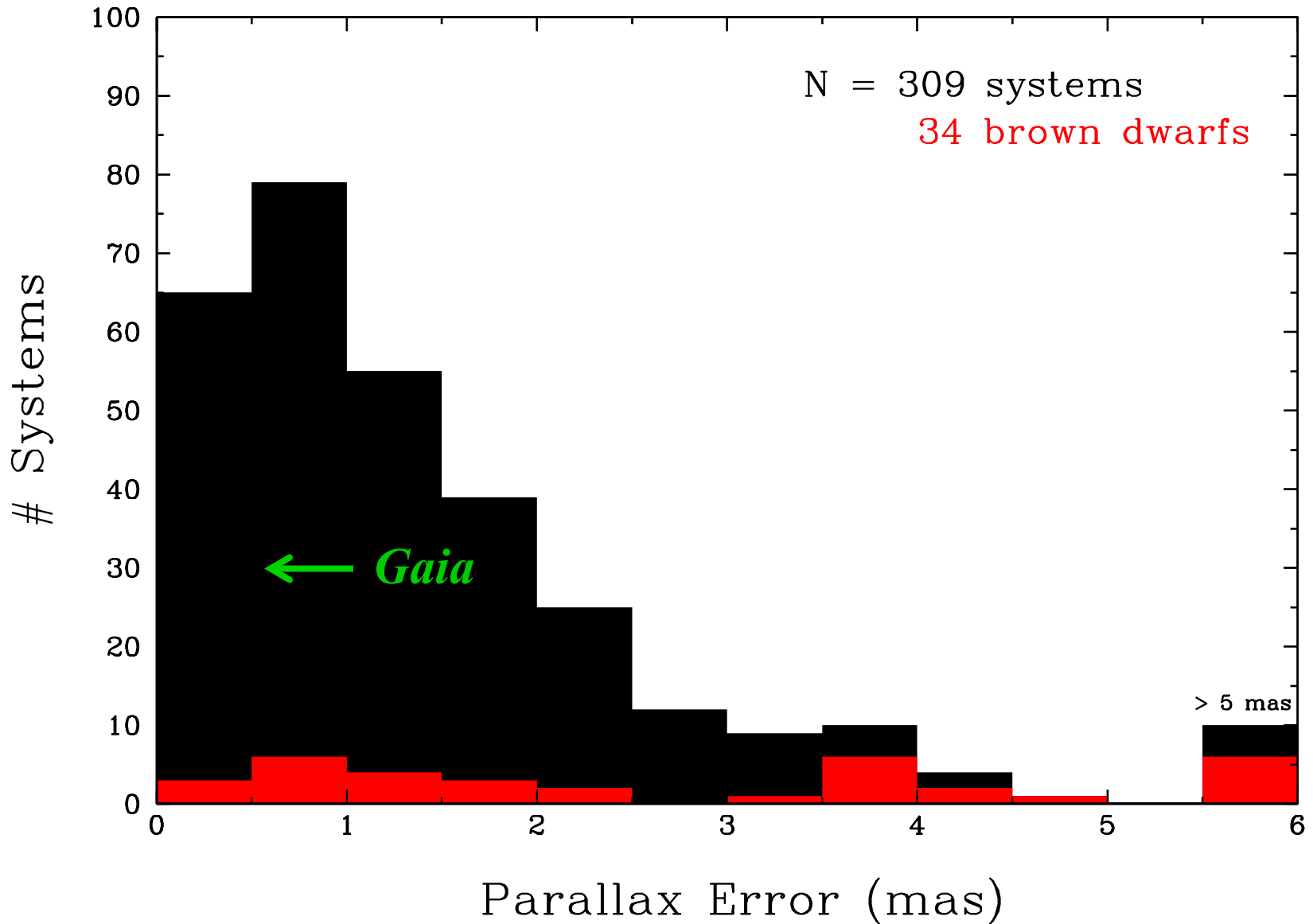
**as of October 2017**



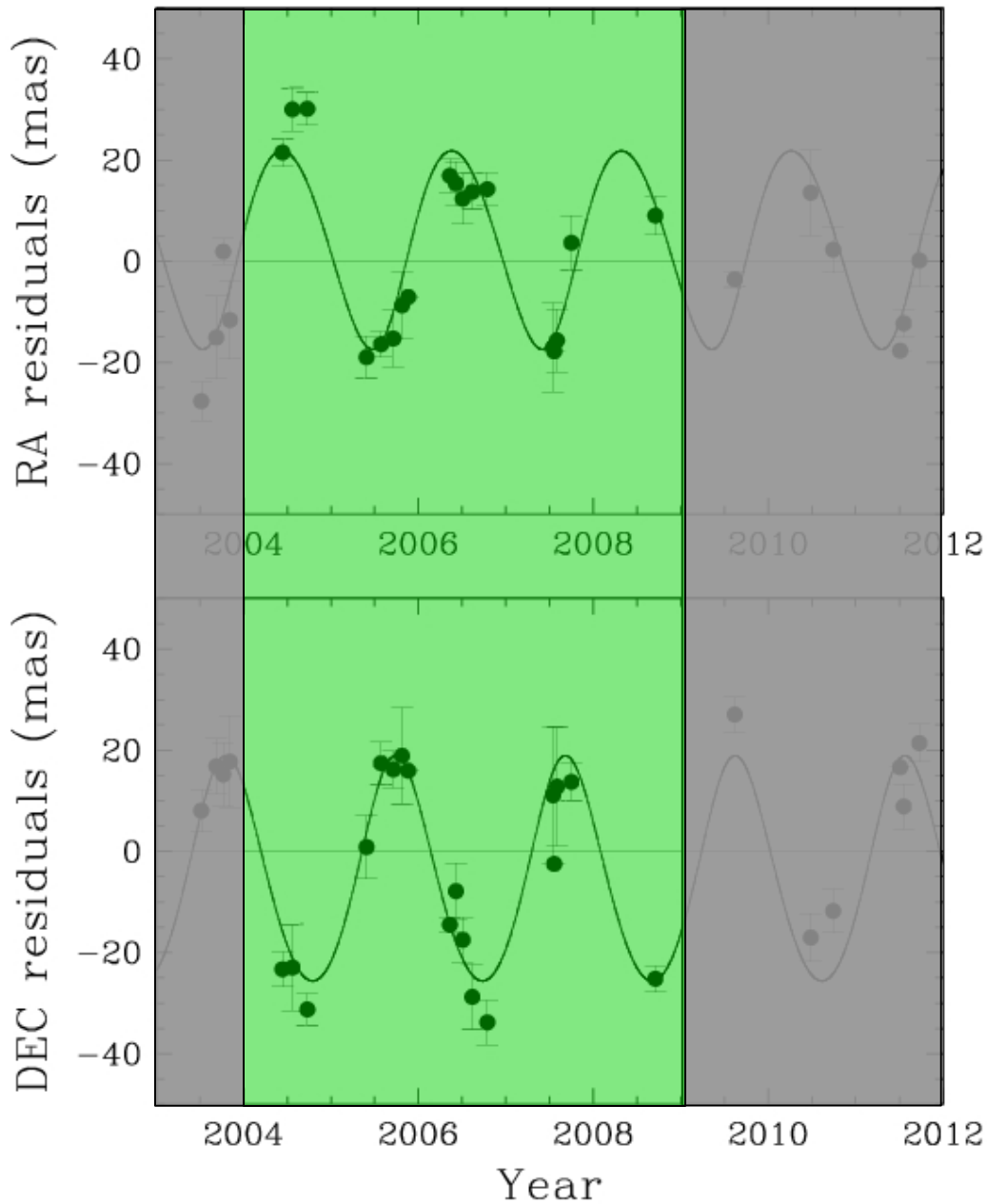
# 10 Parsec Census



# Parallax Errors



GJ 831 AB



# Short-Term Astrometry

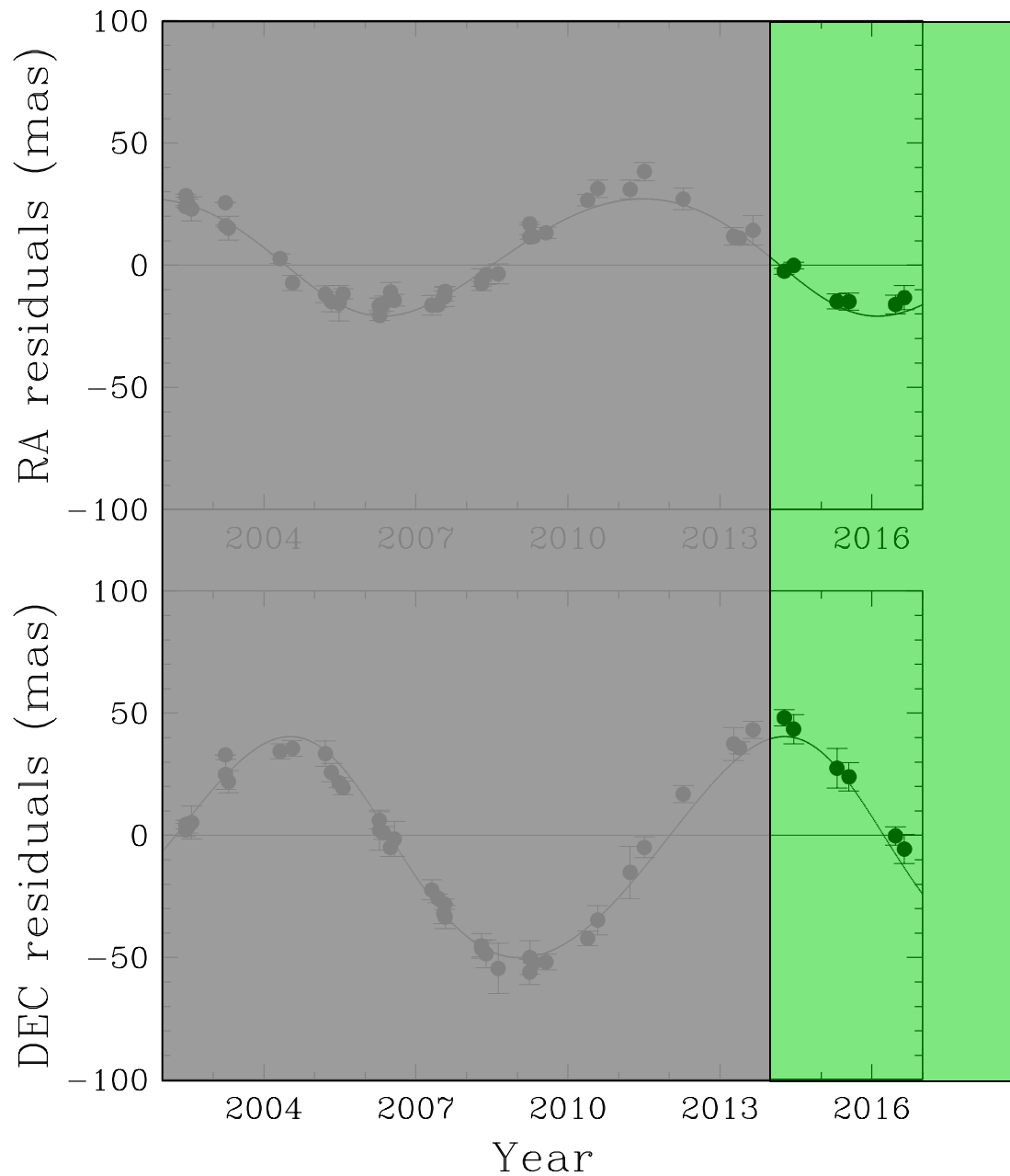
**P**      **1.94 yr**

**$\alpha_{\text{phot}}$**       **26 mas**

**A**      **M4.0 V**  
**0.25  $M_{\odot}$**

**B**      **M5.0 V**  
**0.16  $M_{\odot}$**

GJ 1215 ABC



# Long-Term Astrometry

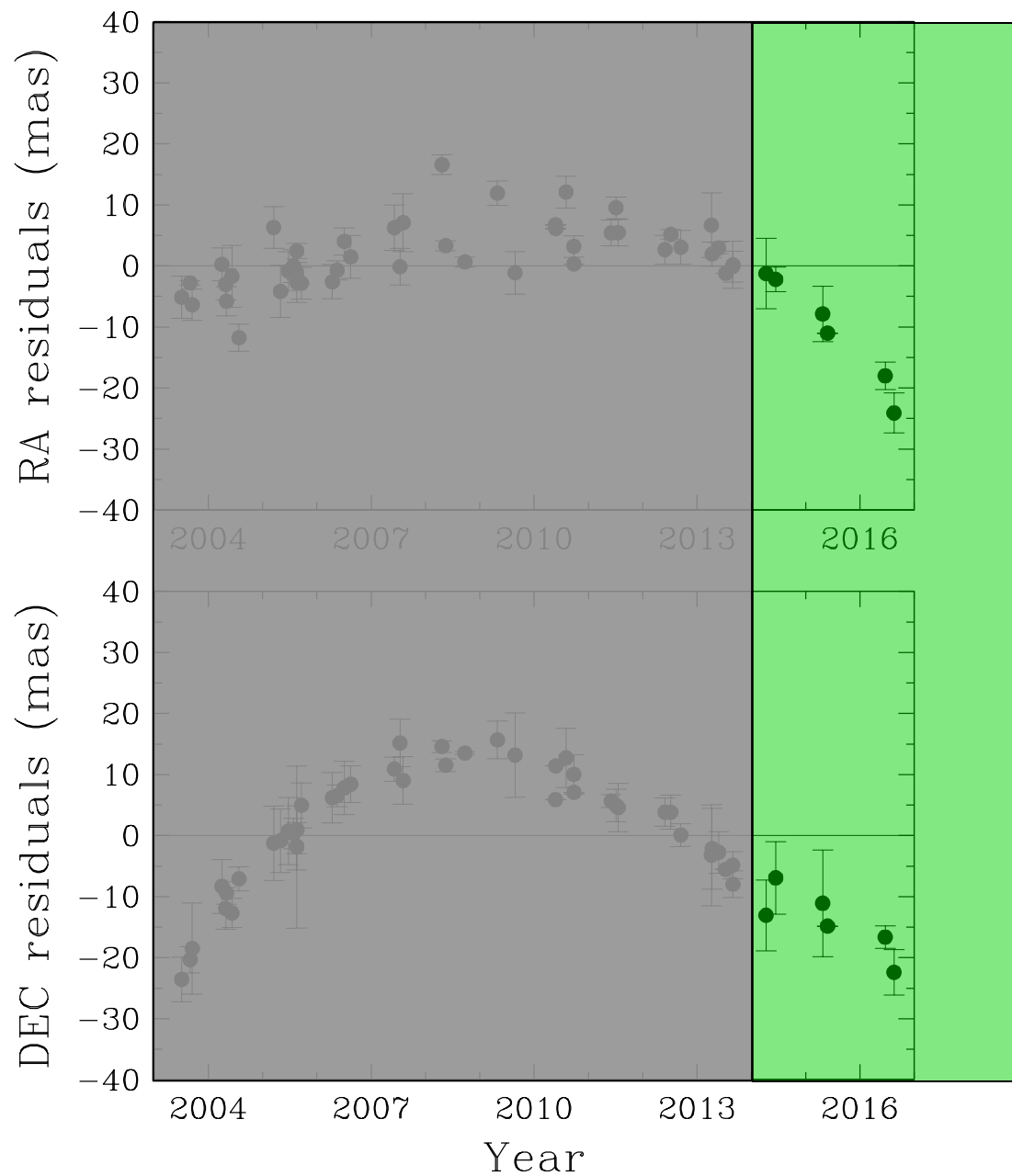
**P**      **9.8 yr**

**$\alpha_{\text{phot}}$**       **46 mas**

**A**      **M5.0 V**  
**0.2  $M_{\odot}$**

**B/C**      **BD/BD**  
 **$\sim 30 M_{\text{jup}}$**

SCR 1845–6357 AB



# Long-Term Astrometry

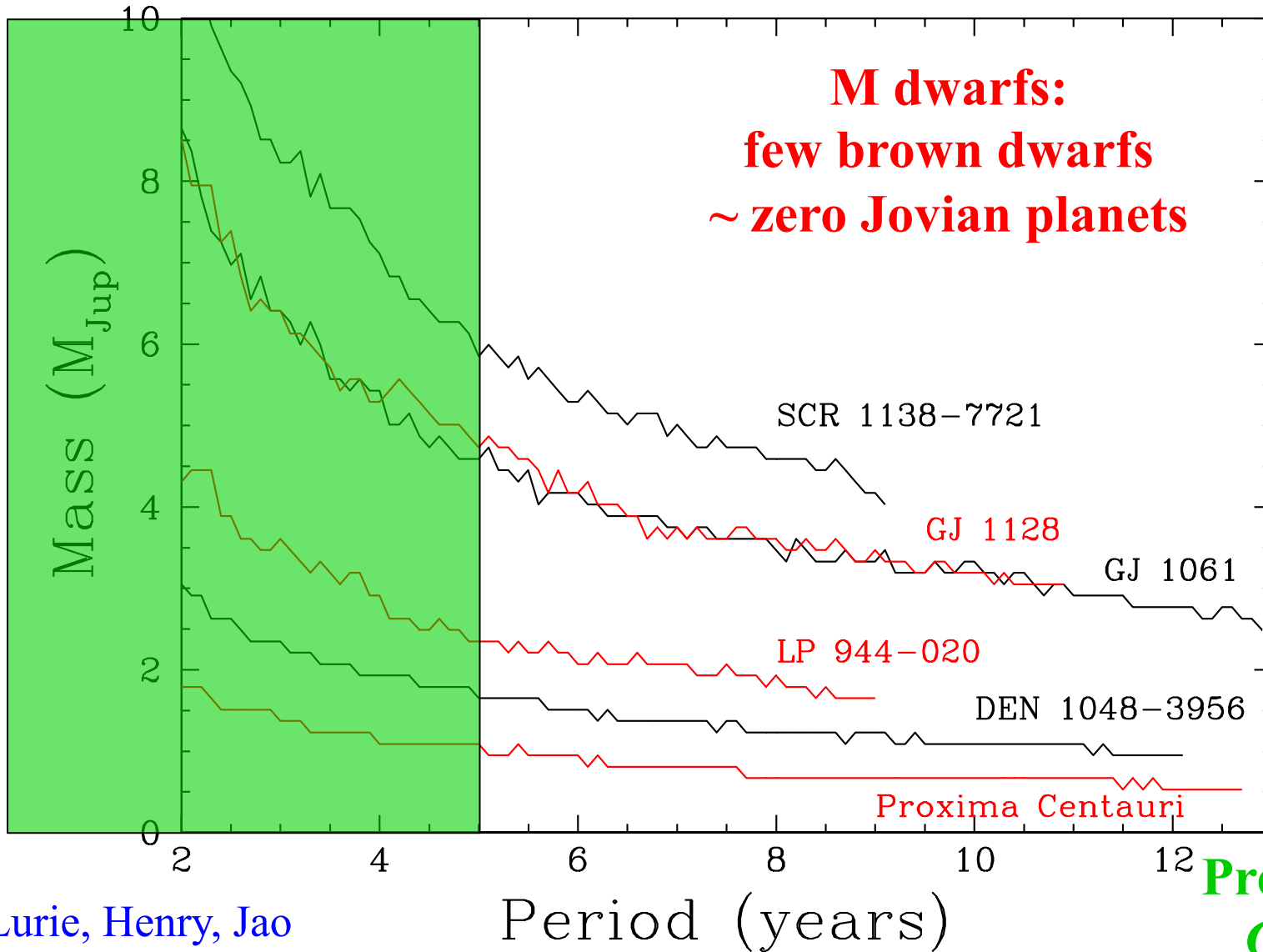
**P** > 13 yr

**$\alpha_{\text{phot}}$**  > 25 mas

**A** M8.5 V  
0.1  $M_{\odot}$

**B** BD  
 $\sim 30 M_{\text{jup}}$

# Planet Search



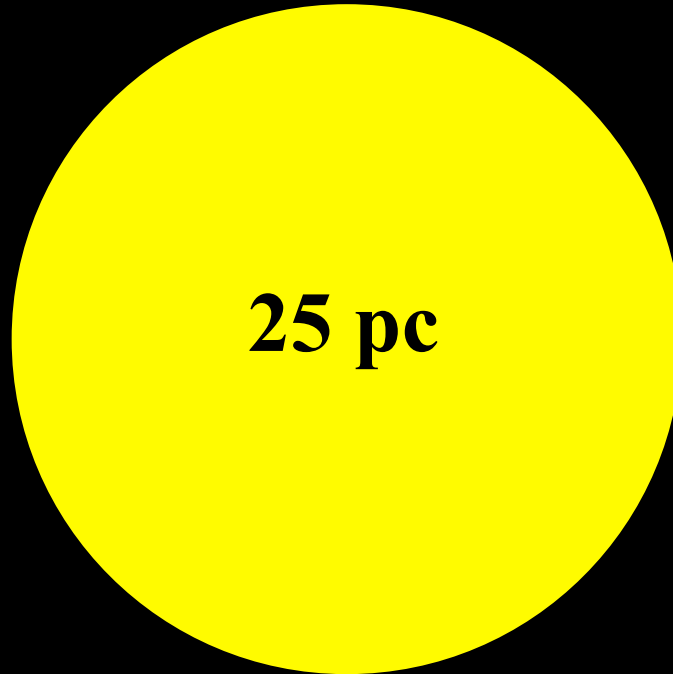
Lurie, Henry, Jao  
et al. (2014)

A lush jungle landscape with two Na'vi characters in the foreground, a large moon in the sky, and a small globe icon on a rock in the lower right.

**RECONS**

Gaia?

# Classic 25 Parsec Sample

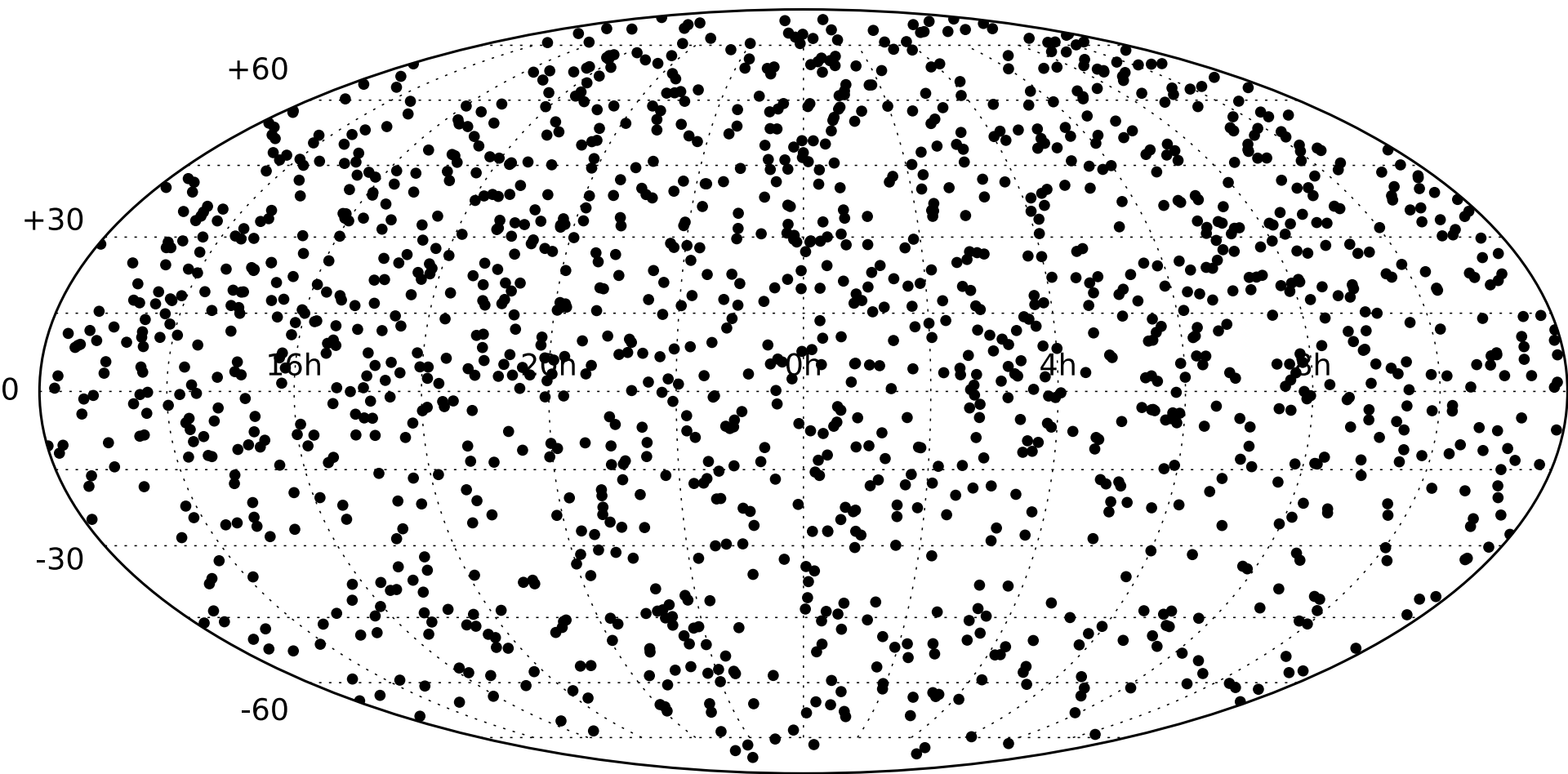


**3692 systems**

**as of October 2017**



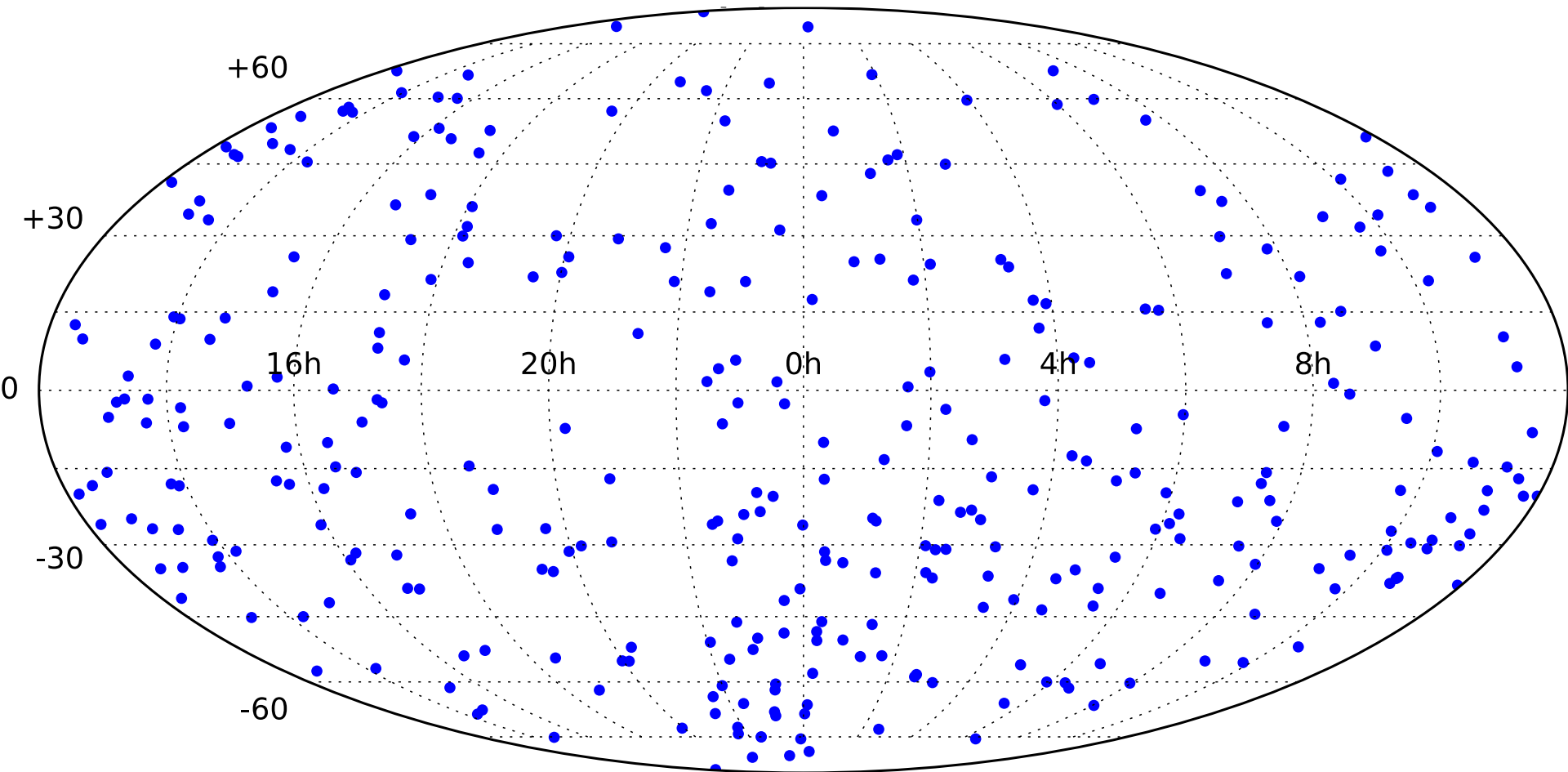
# Yale Parallax Catalog 1995



**1467 systems**

**39.7%**

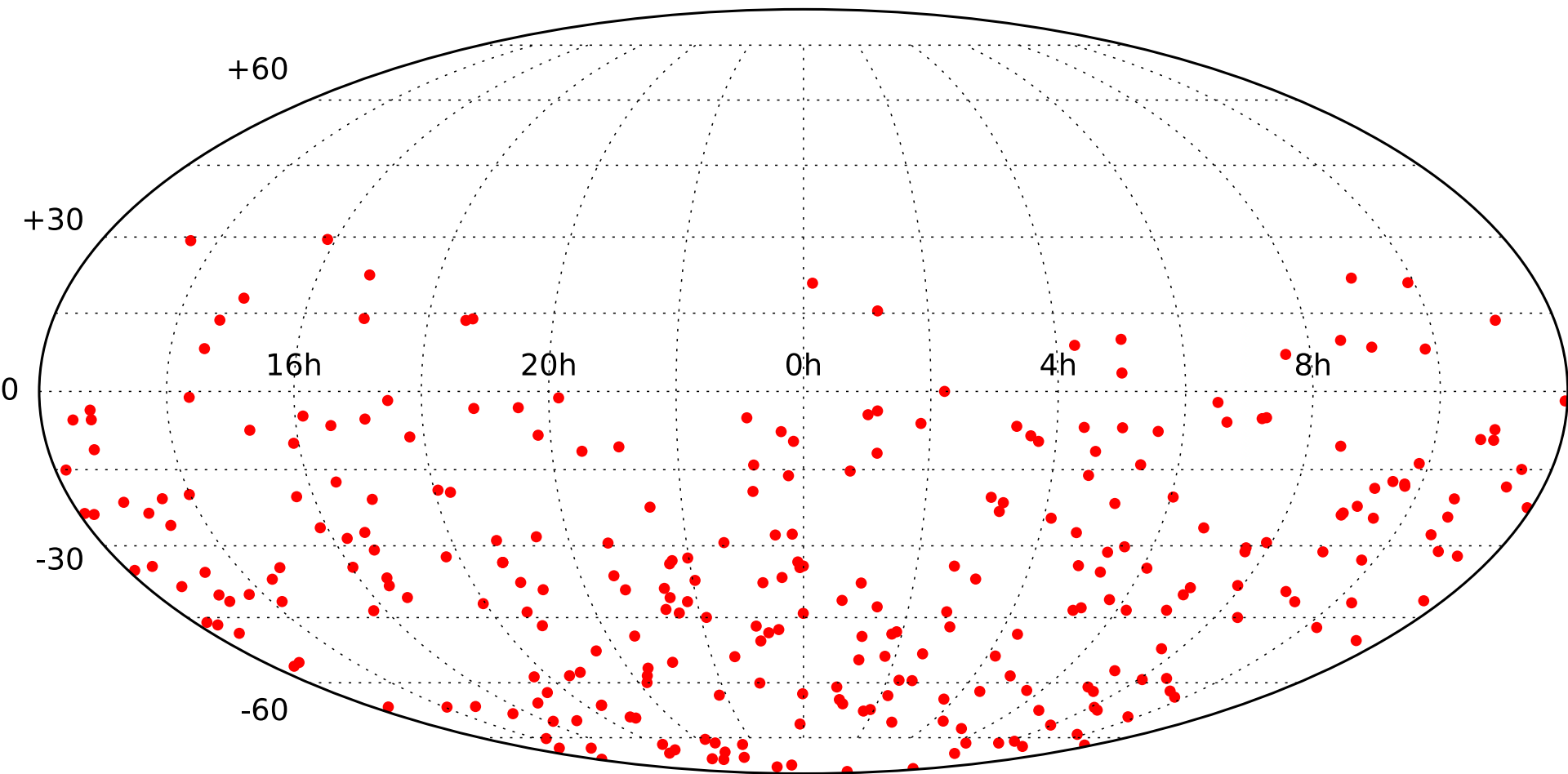
# Hipparcos 1997/2007



**346 systems**

**9.4%**

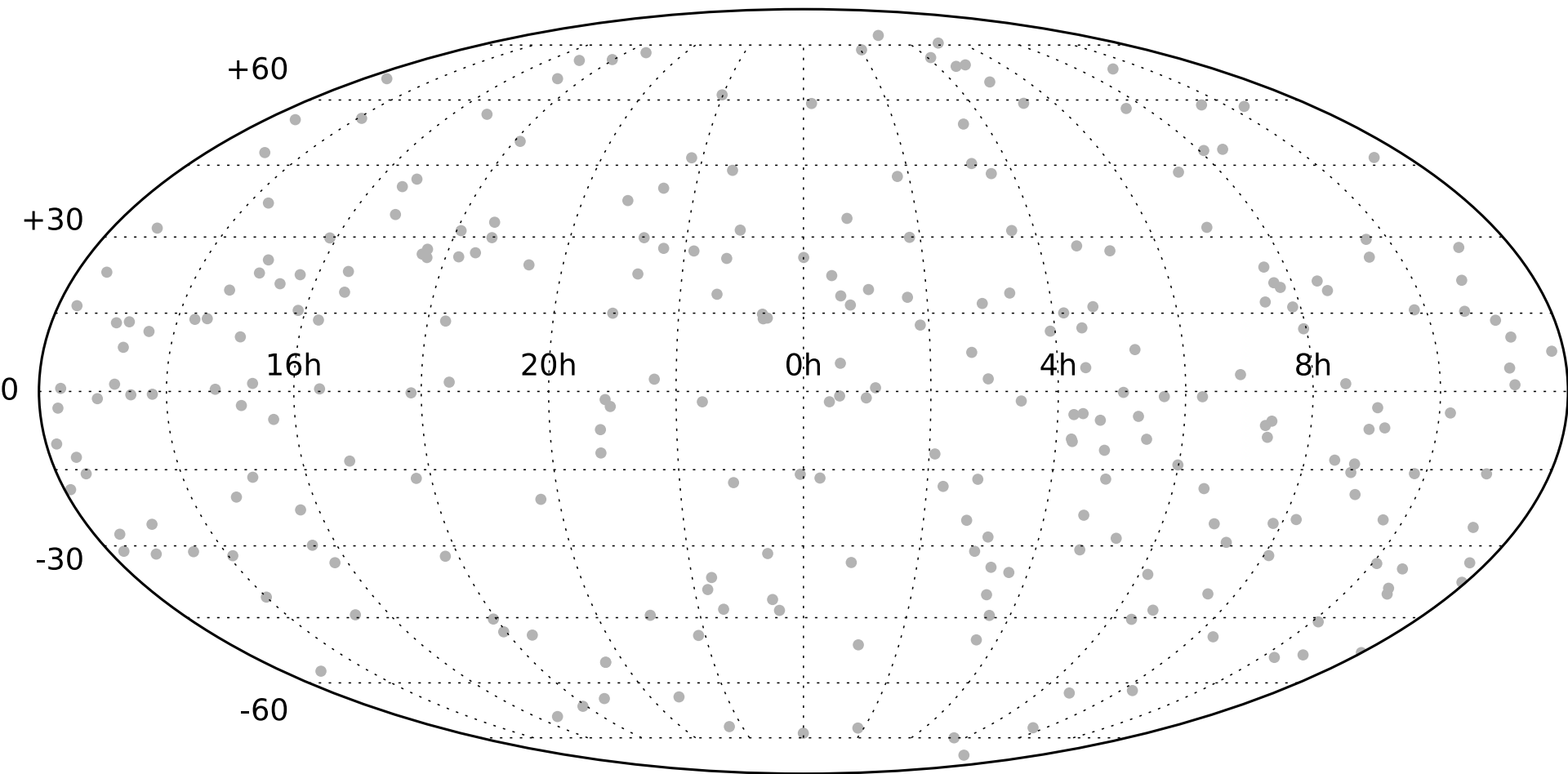
# RECONS 2005-present



**341 systems**

**9.2%**

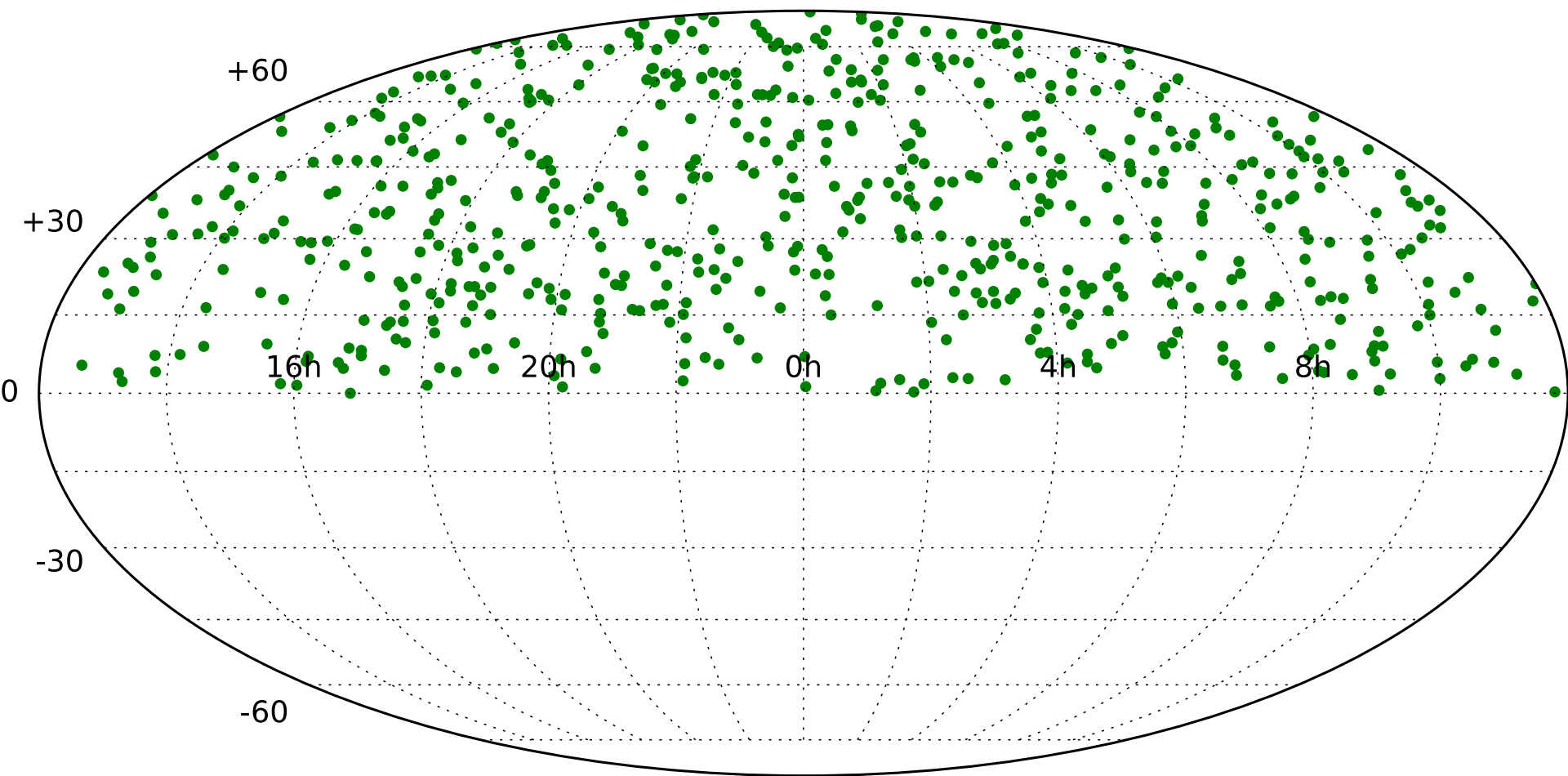
# Others 1995-present



**265 systems**

**7.2%**

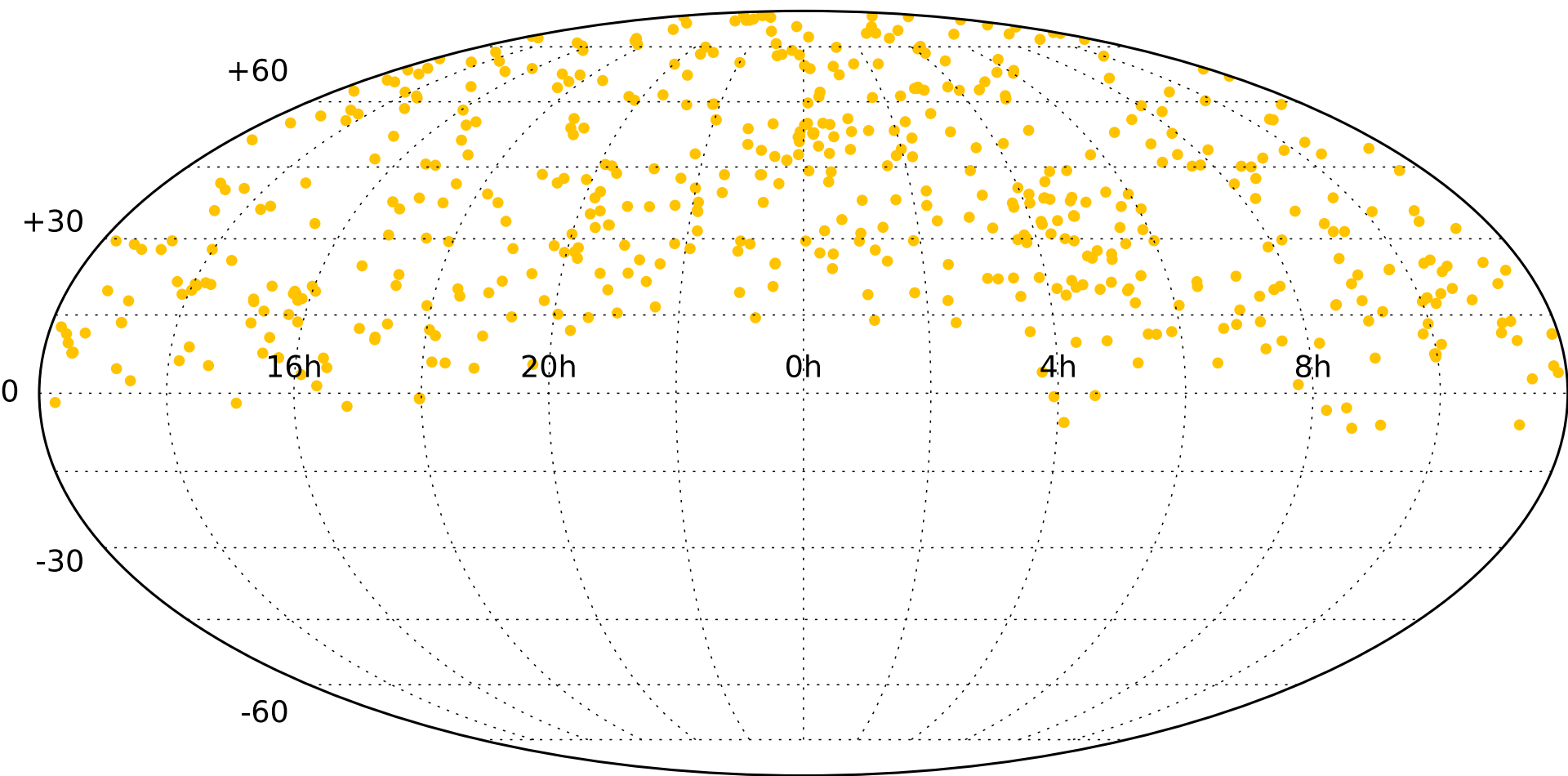
# MEarth 2014



**621 systems**

**16.8%**

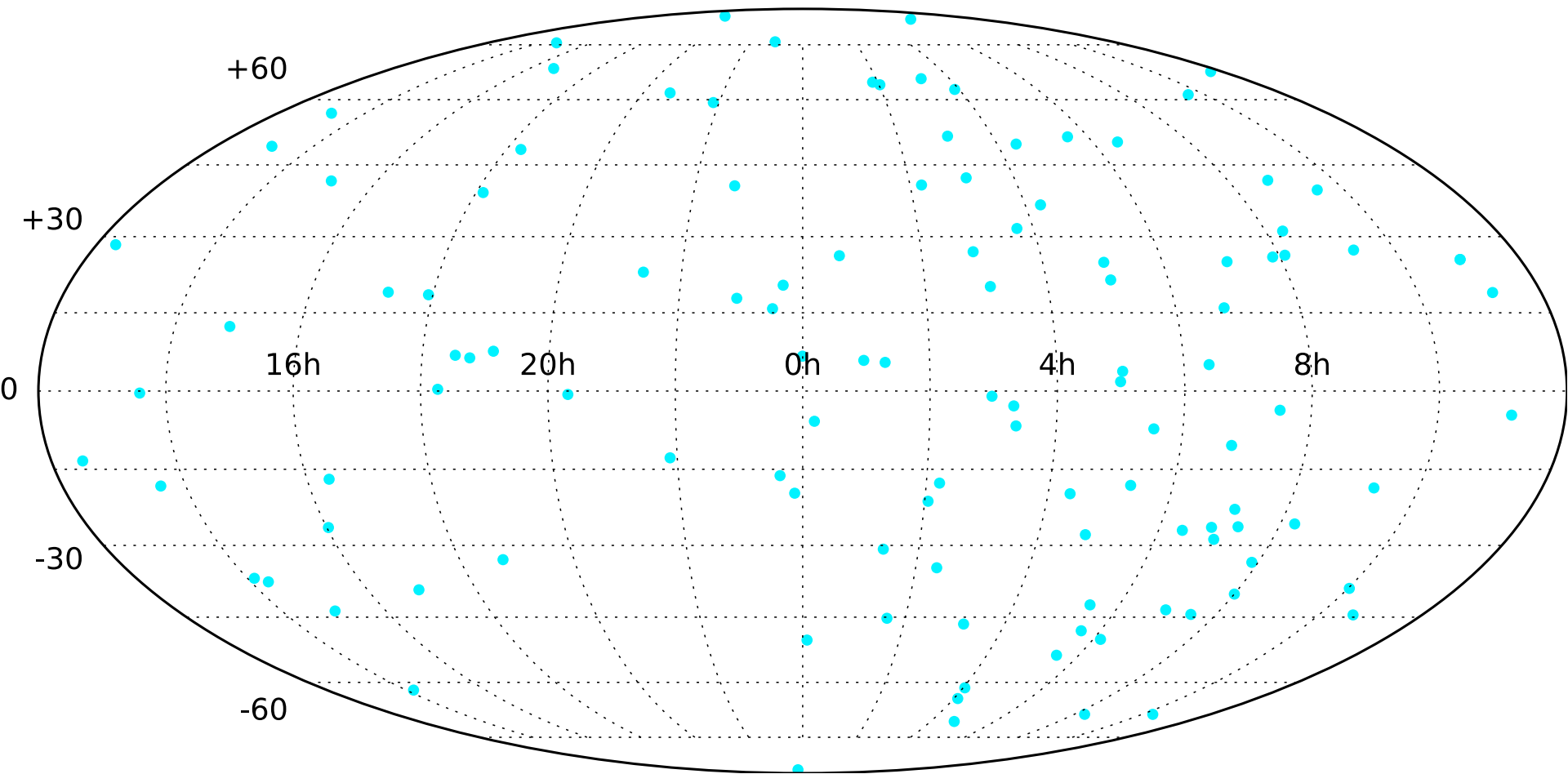
# USNO 2016



**535 systems**

**14.5%**

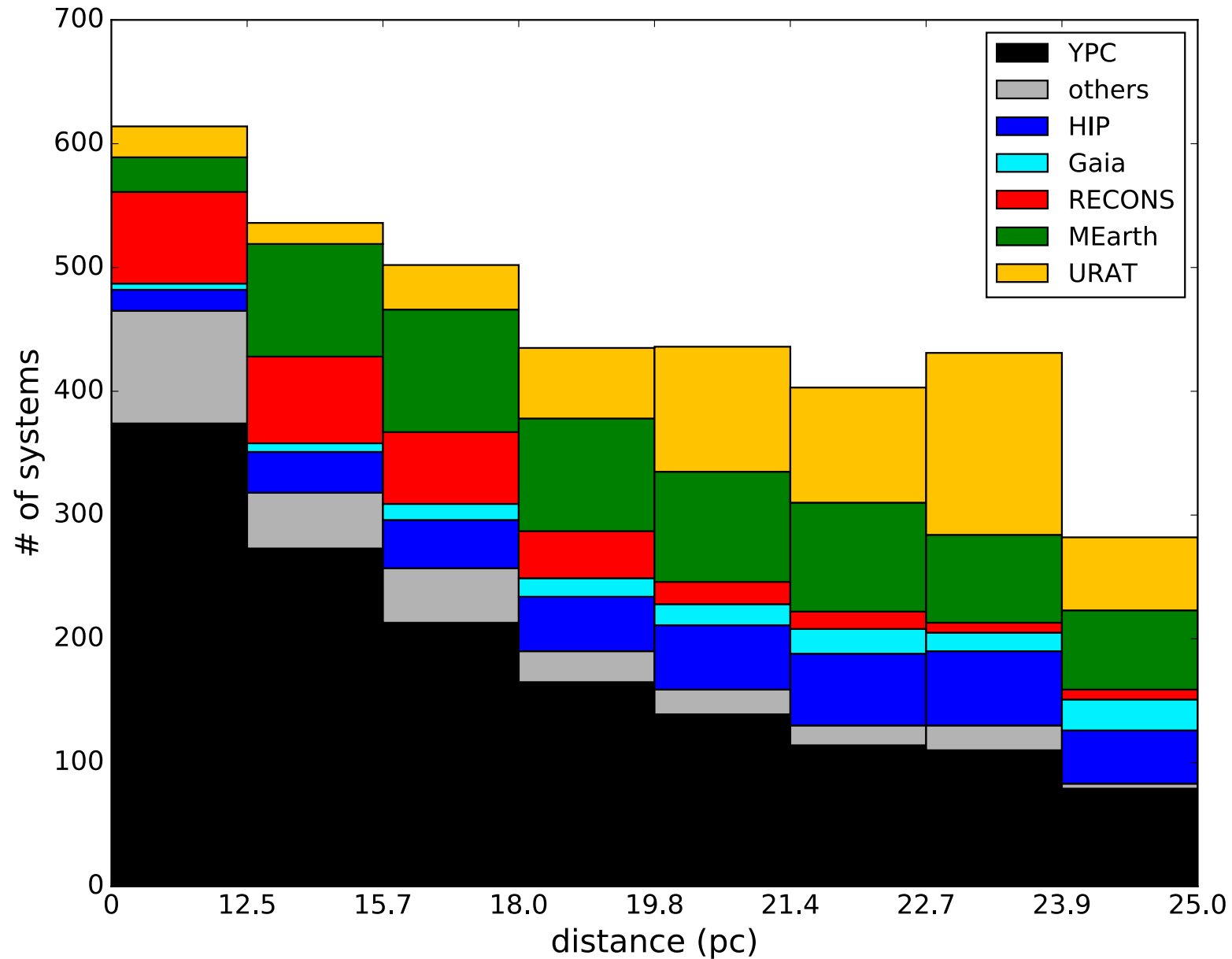
# *Gaia* 2016



**117 systems**

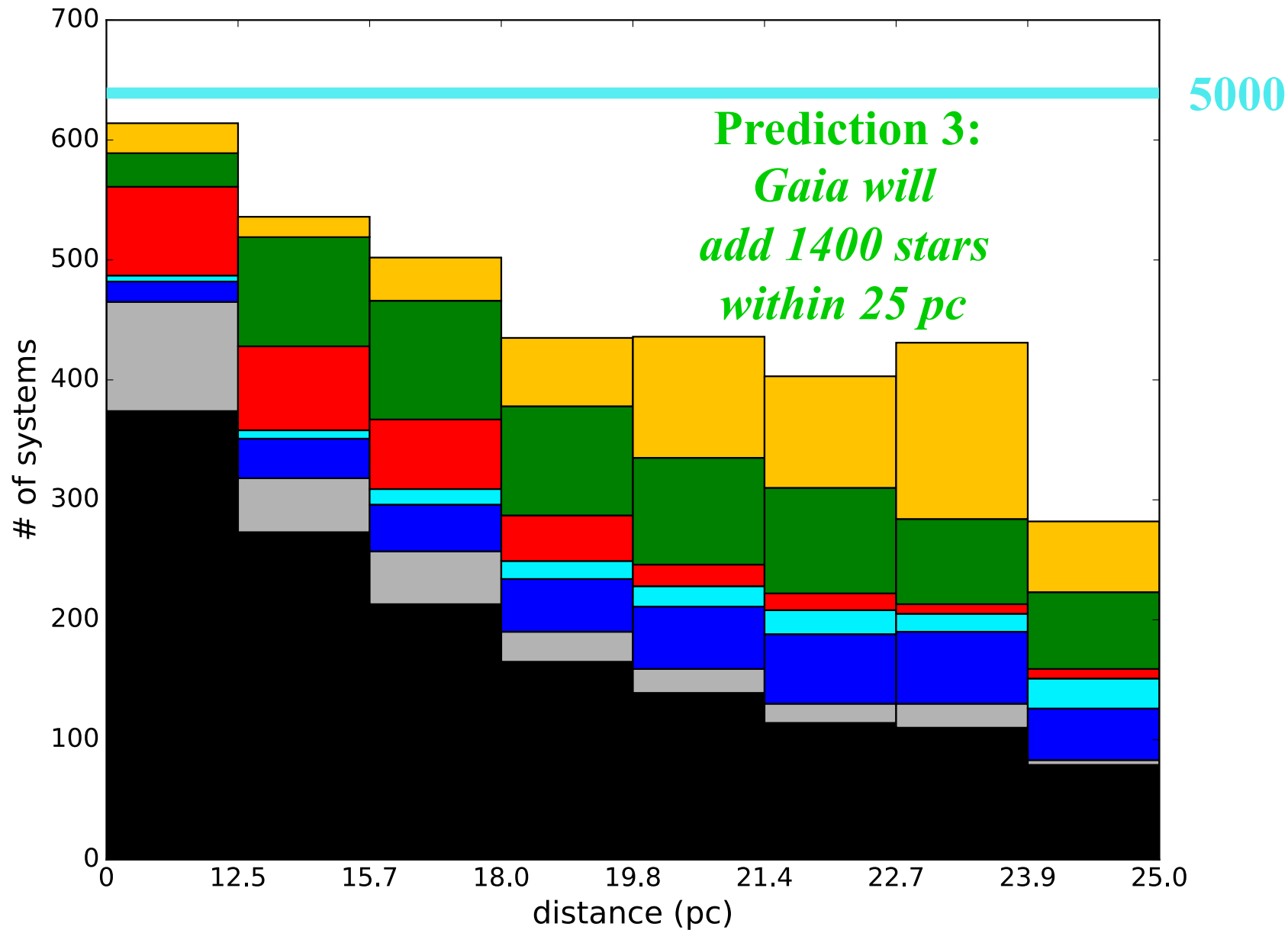
**3.2%**

# 25 Parsec Contributions





# 25 Parsec Contributions

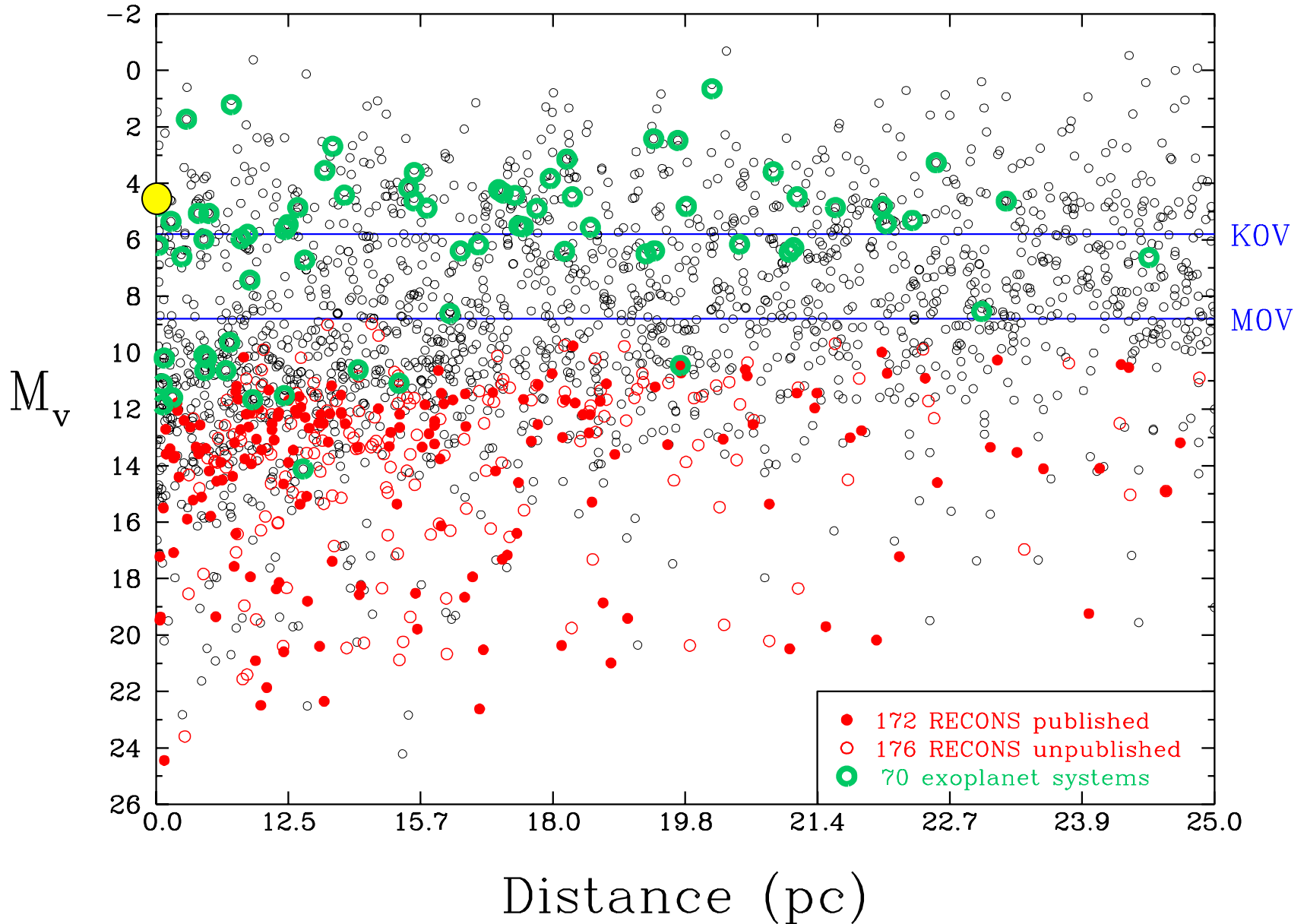


# Extended 50 Parsec Sample

50 pc

A large, solid blue circle is centered on a black background. The circle represents a 50 parsec sample. The text "50 pc" is written in a bold, black, serif font in the center of the circle. Above the circle, the title "Extended 50 Parsec Sample" is written in a bold, white, serif font.

# K Dwarfs: Missing Planets



**K-KIDs**

**50 pc  
Survey**

**Wide Field Blinking**

**Direct Imaging**

**DSSI**

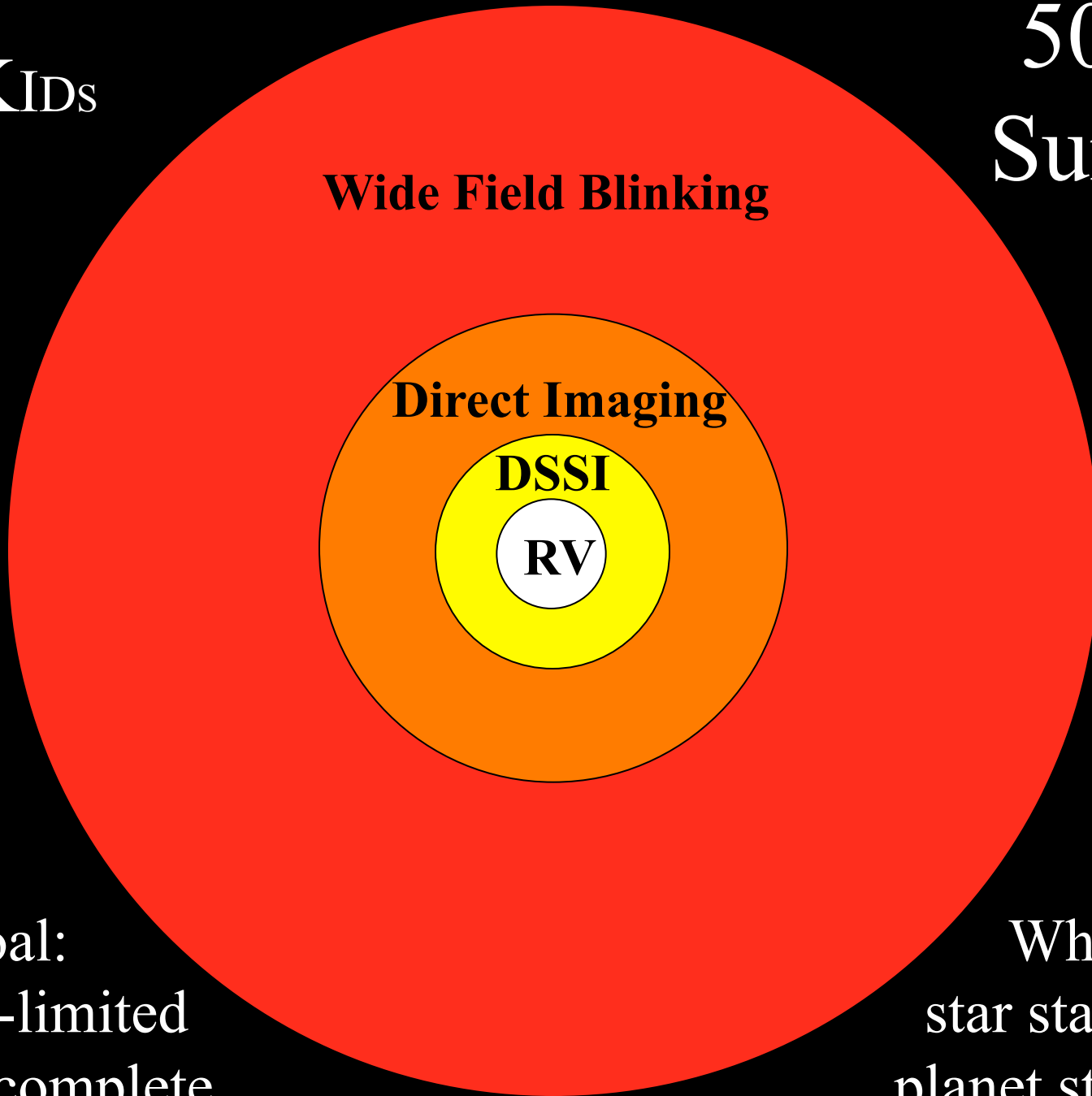
**RV**

**Goal:**

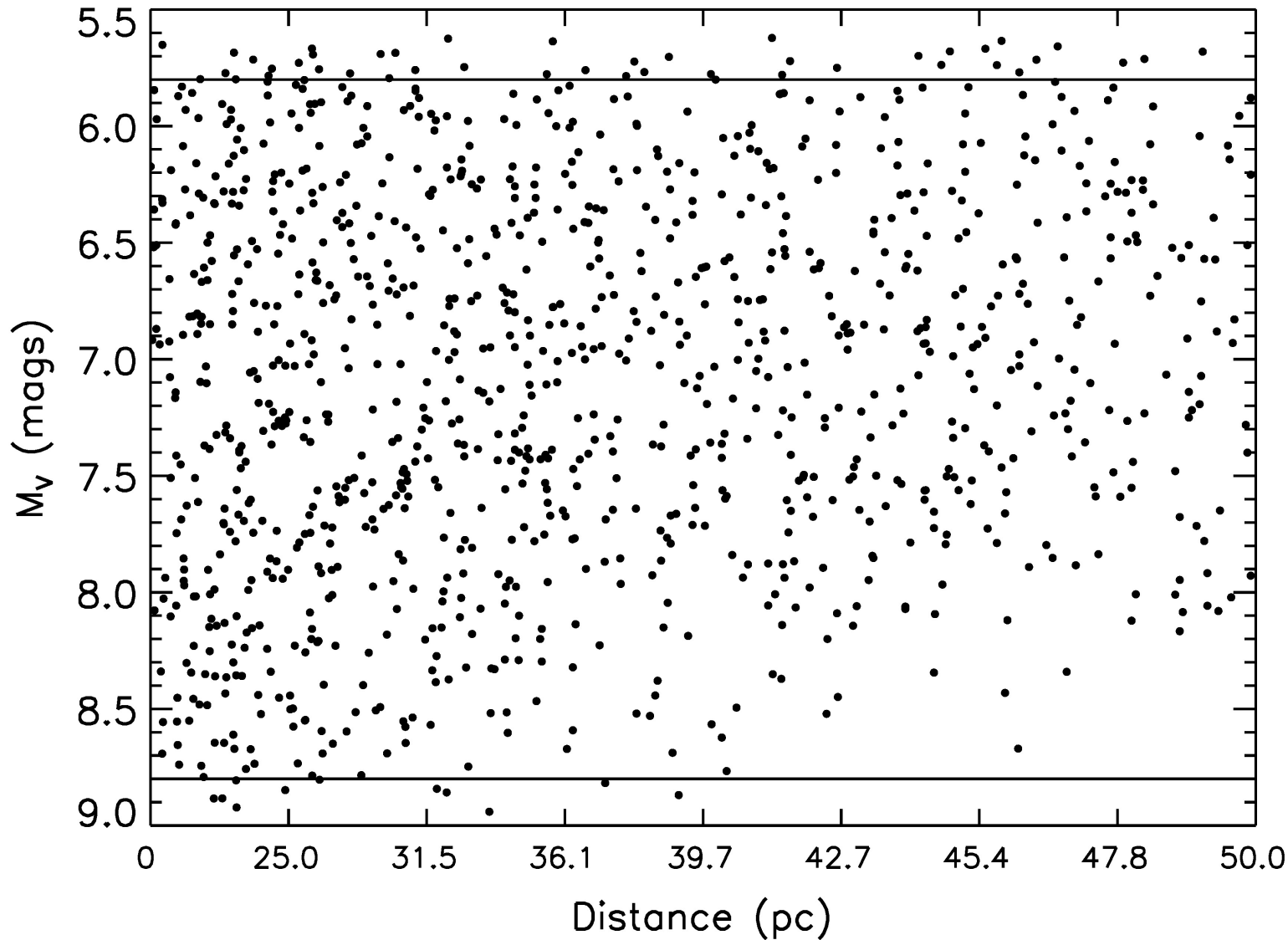
**volume-limited  
volume-complete**

**Why?**

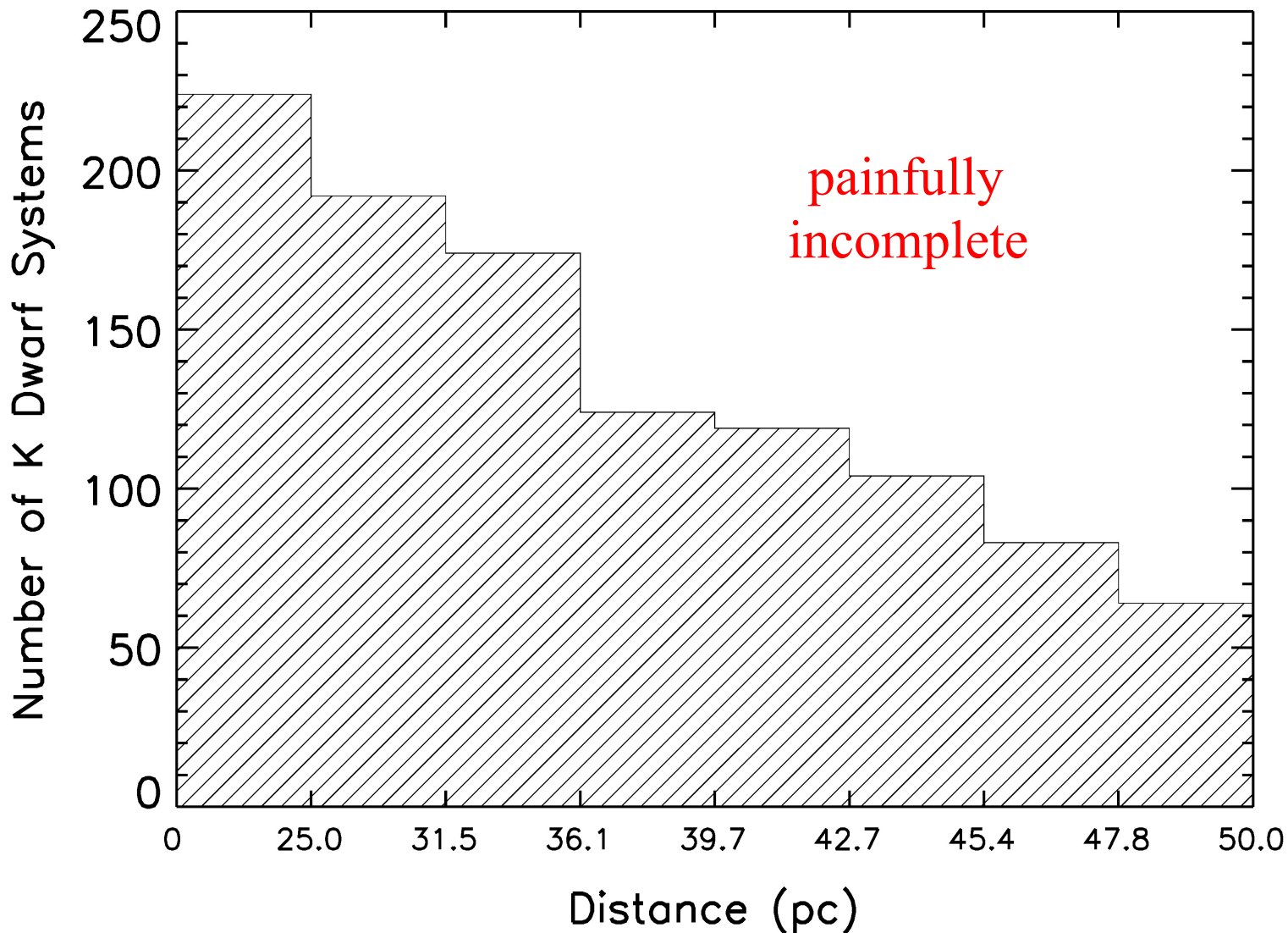
**star statistics  
planet statistics**

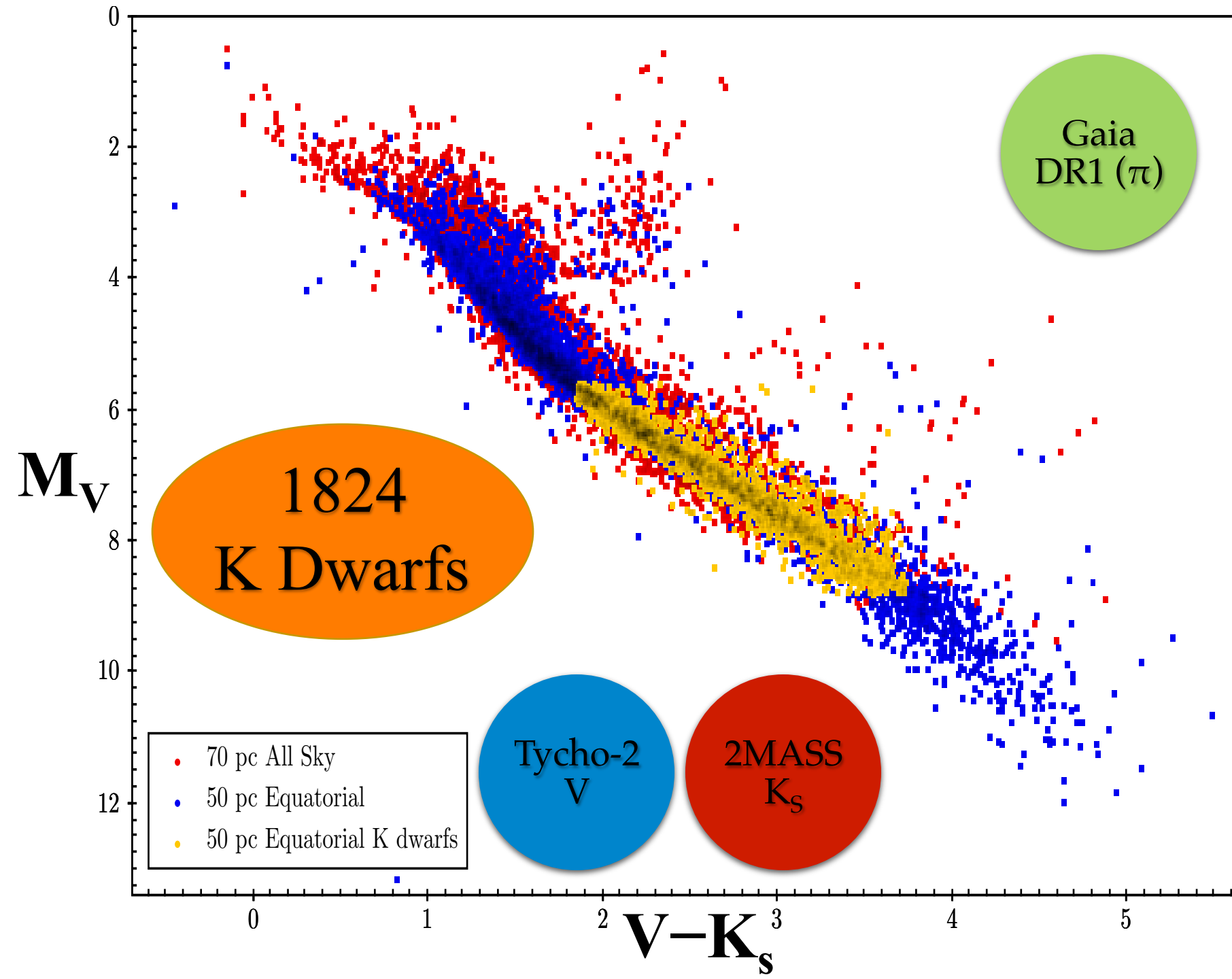


# K-KIDs 50 pc: Original 1048



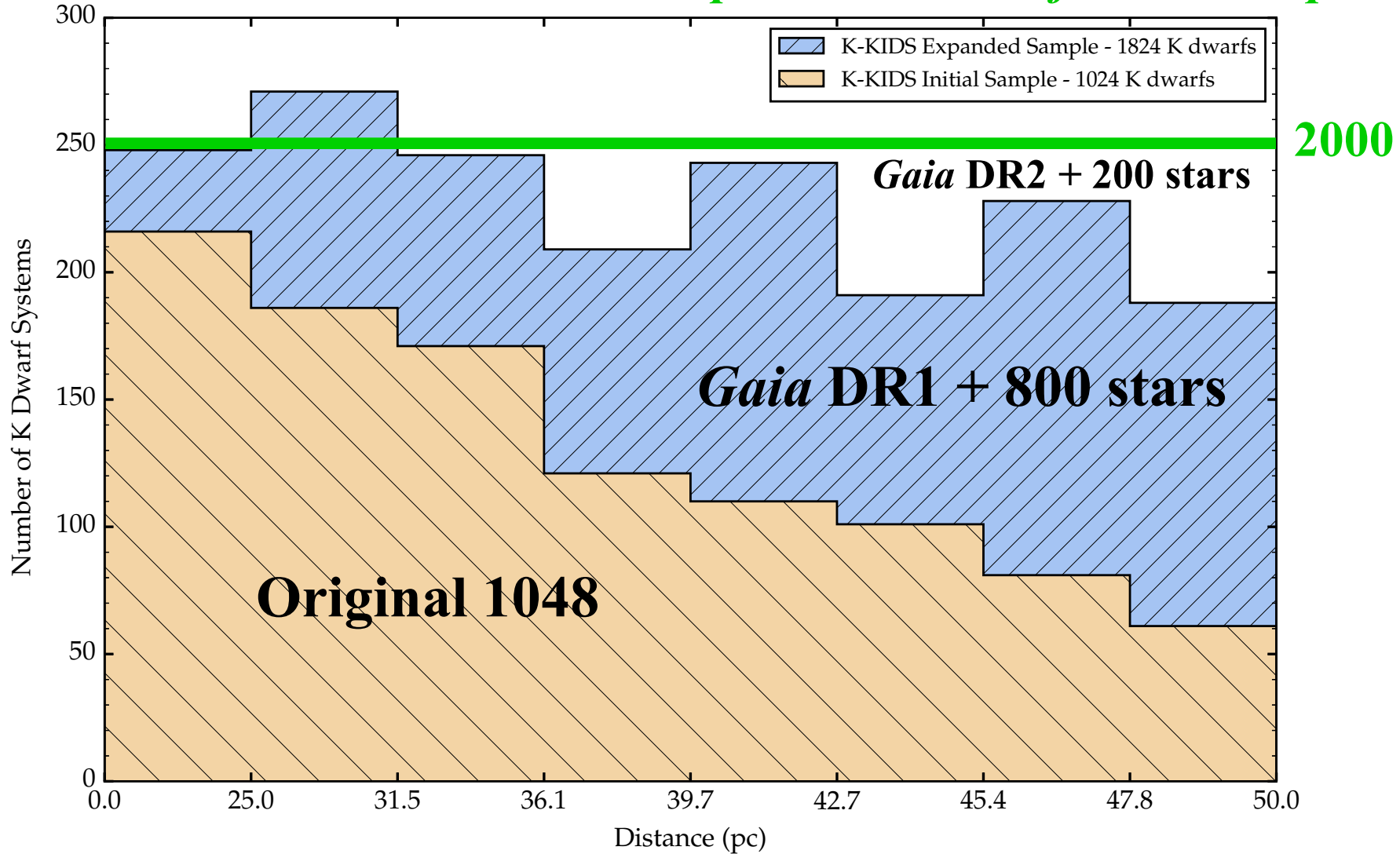
# K-KIDs 50 pc: Original 1048





# K-KIDs 50 pc: Revised 1824

**Prediction 4: *Gaia* will add 1000 equatorial K dwarfs within 50 pc**

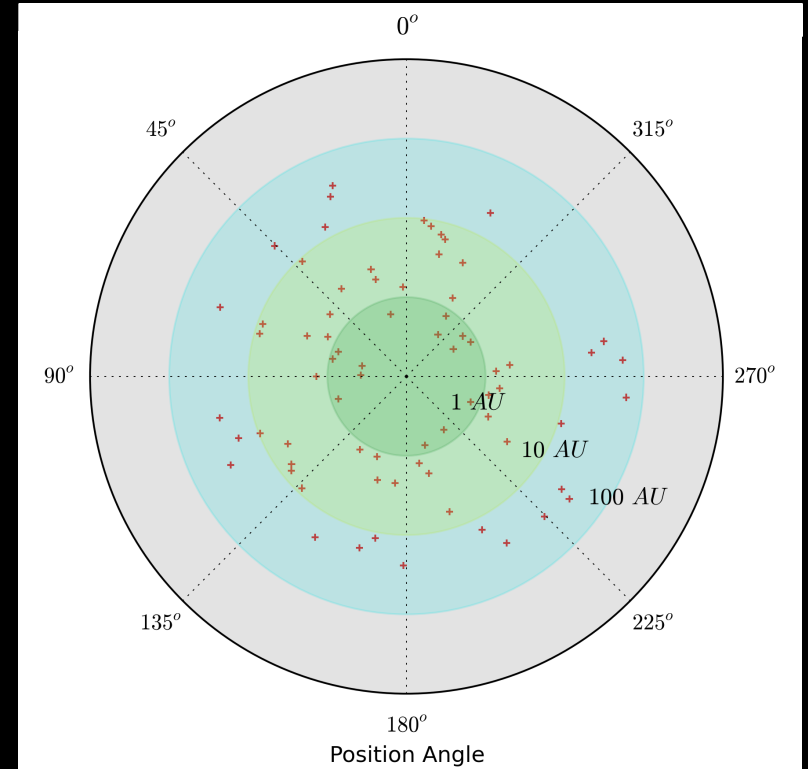
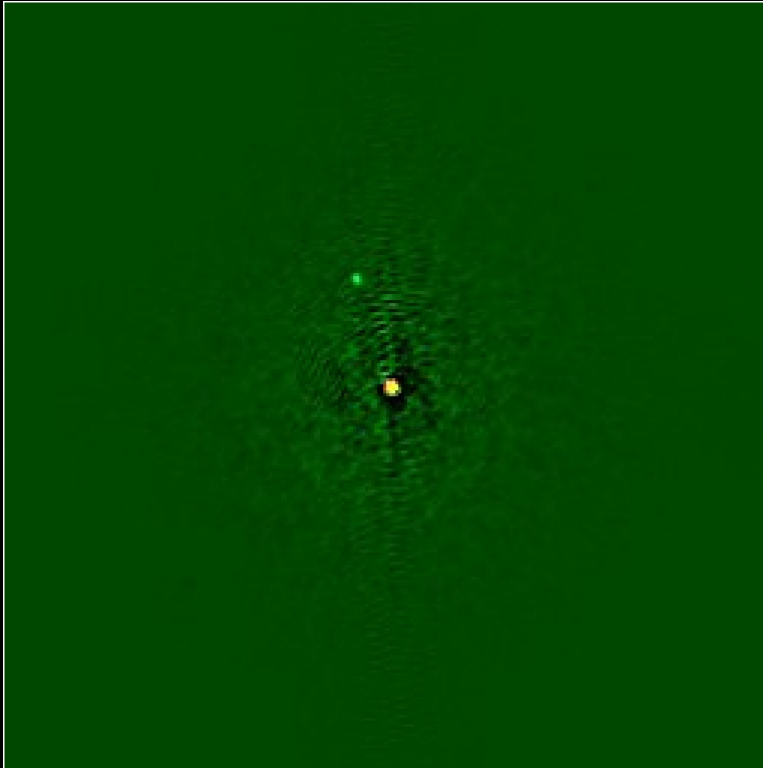




# Gemini DSSI Imaging 0.1-100 AU

**GJ 538 AB at 17 pc**

**1036 stars imaged**



**0.4" = 7 AU**

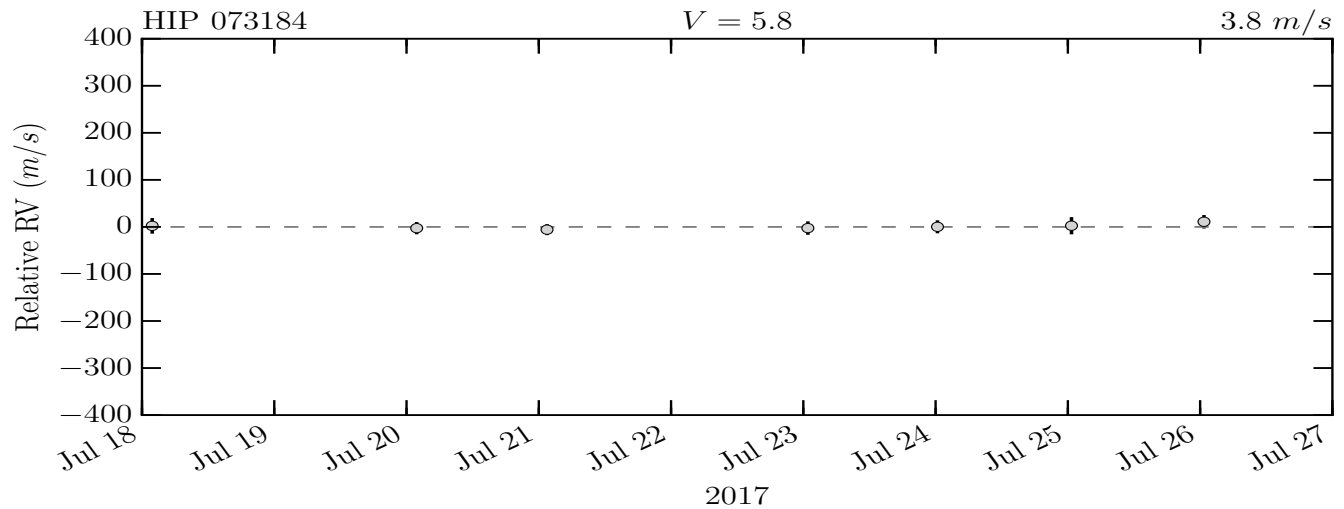
**97 companions (so far)**

**Nusdeo+**  
**2018**

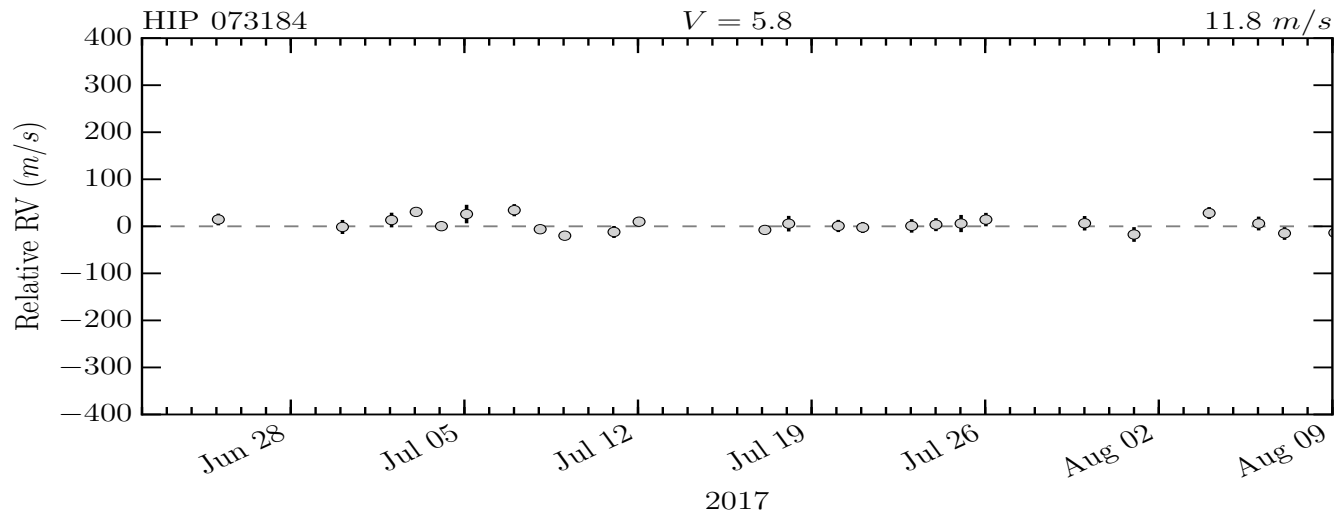
**Prediction 5: *YOU* want to use DSSI et al.**

# 1.5m Radial Velocities < few AU

**1  
week  
3.8 m/s**



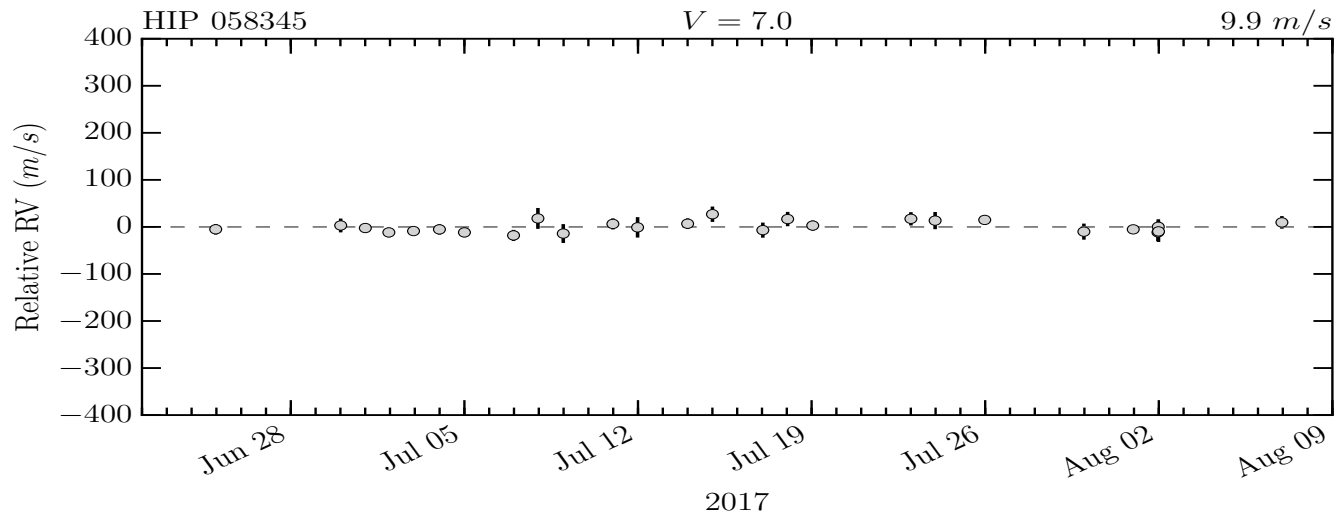
**6  
weeks  
11.8 m/s**



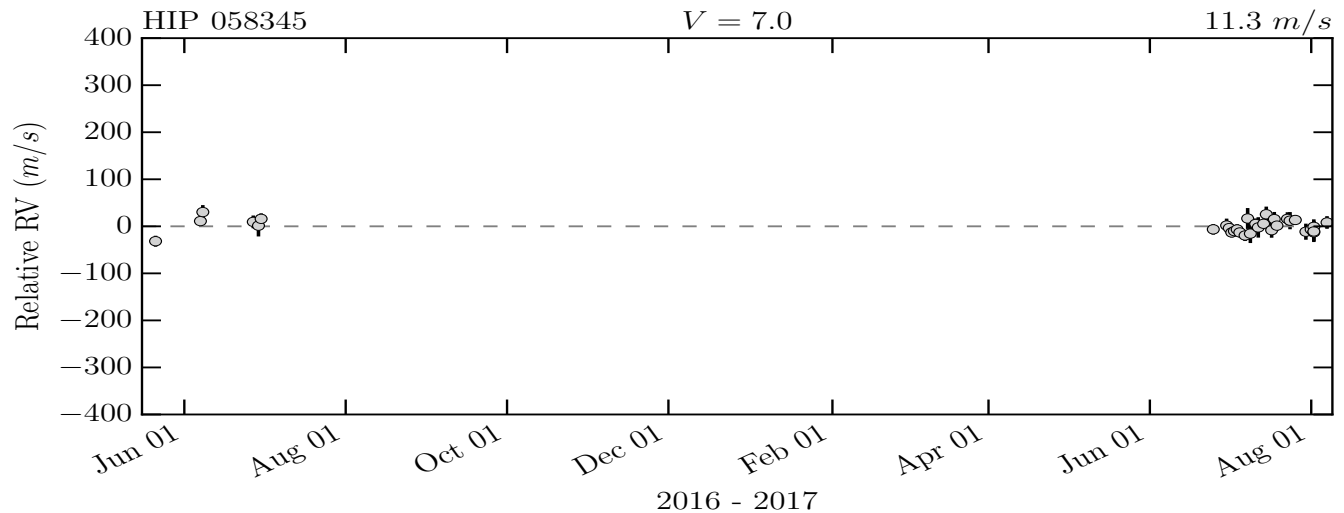
**Paredes+  
2018**

# 1.5m Radial Velocities < few AU

**6  
weeks  
9.9 m/s**



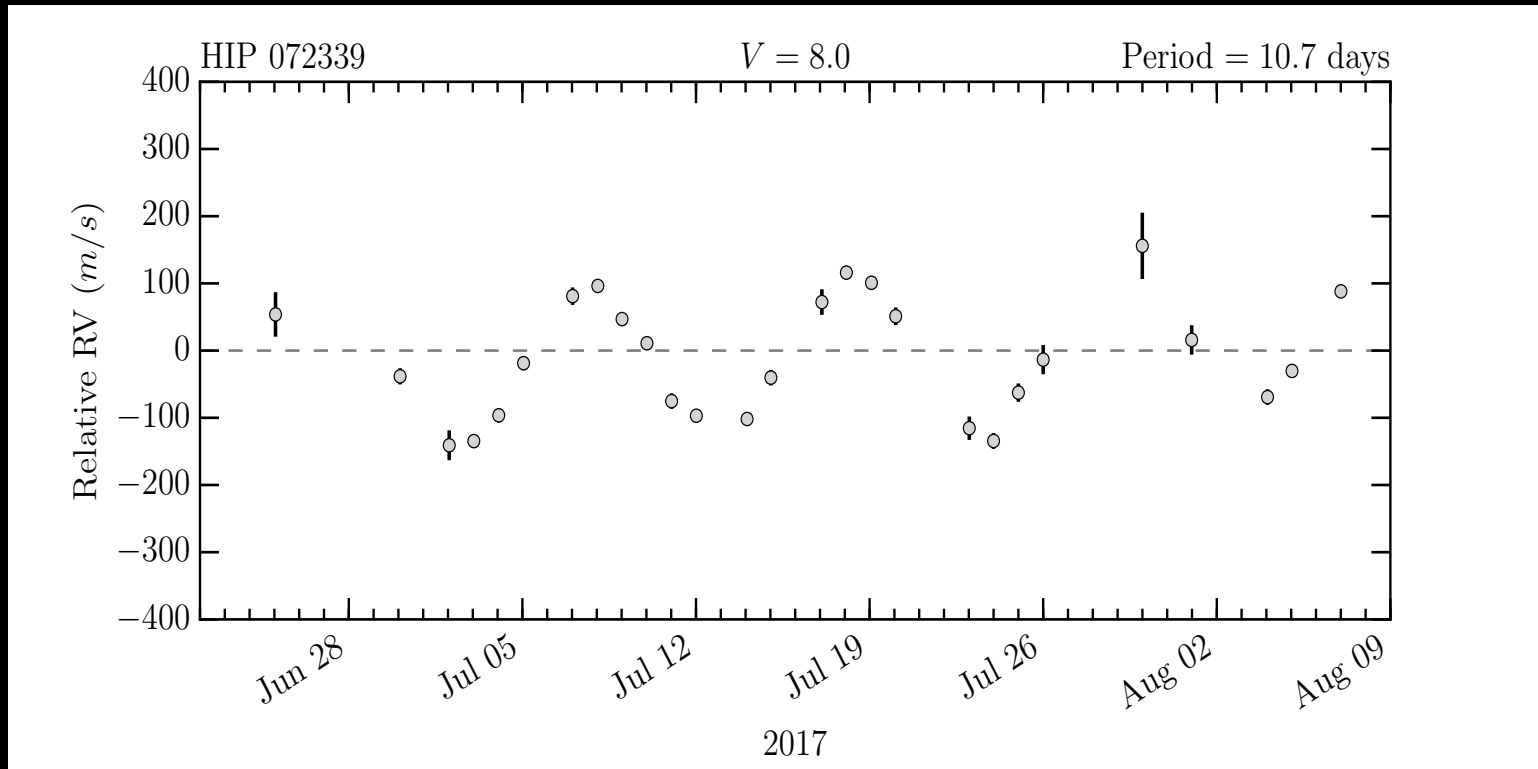
**14  
months  
11.3 m/s**



**Paredes+  
2018**

# 1.5m Radial Velocities < few AU

**1.1  $M_{\text{jup}}$**   
 **$P_{\text{orb}}$**   
**10.7 days**



**Hot Jupiters EASY**

**Prediction 6: *YOU* want to use *CHIRON*.**

**Paredes+**  
**2018**

Final Prediction:

**YOU**

*will use Gaia*

# The *Gaia* Predictions

**#1** *Gaia will add < 10% of stars within 10 pc.*

**#2** *Gaia will find planets.*

**#3** *Gaia will add 1400 stars within 25 pc.*

**#4** *Gaia will add 1000 equatorial K dwarfs within 50 pc.*

**Final ... YOU will use Gaia.**







# Stars vs. Brown Dwarfs in *Gaia*

1885 possible brown dwarfs

553 with  $G_{est} < 20.3$

321 recovered in DR1

231 L0V-L2V

90 > L2

*“ultimately, 1000 L dwarfs in DR2”*

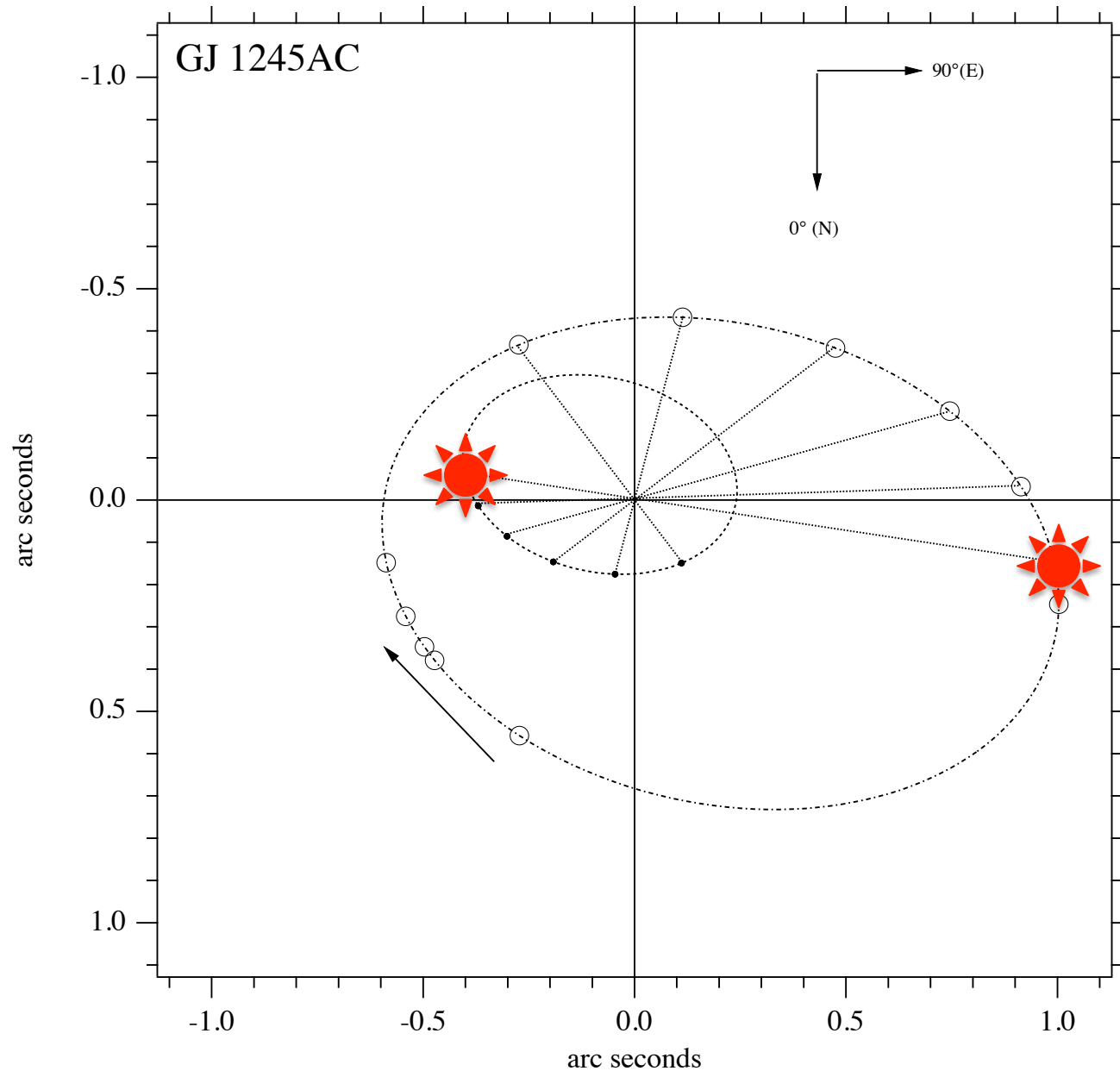
R. Smart June 2017

**Prediction 2:**  
*Ricky will be  
right*

complete to L5 to 25 parsecs

Smart, Marocco,  
Caballero et al. (2017)

# Orbits

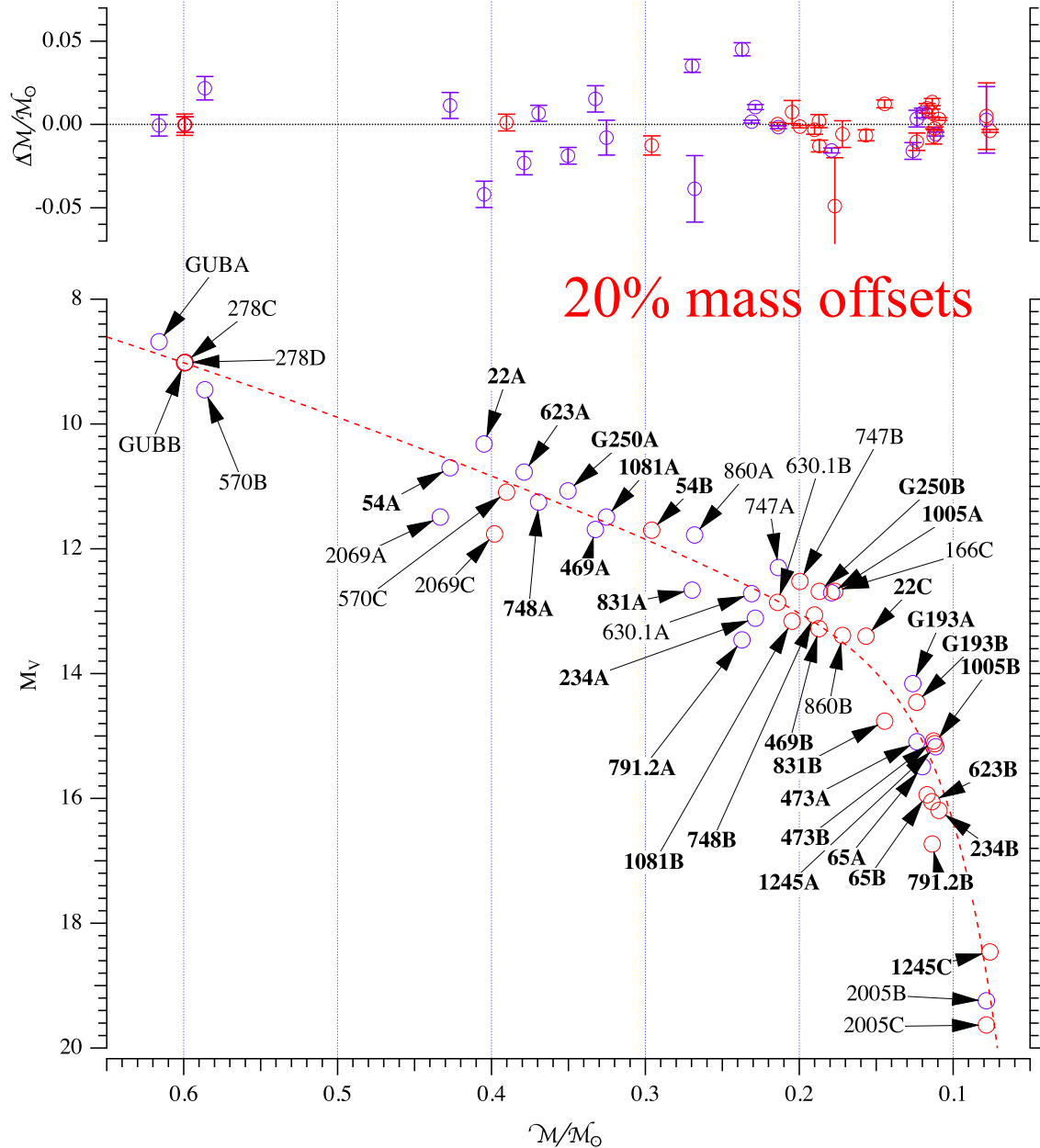


$0.111 \pm 0.001 M_{\odot}$   
 $0.076 \pm 0.001 M_{\odot}$

47 M dwarfs  
2% mass errors

Benedict, Henry, Franz  
et al. (2016)

# Mass-Luminosity Relation



*metallicity*



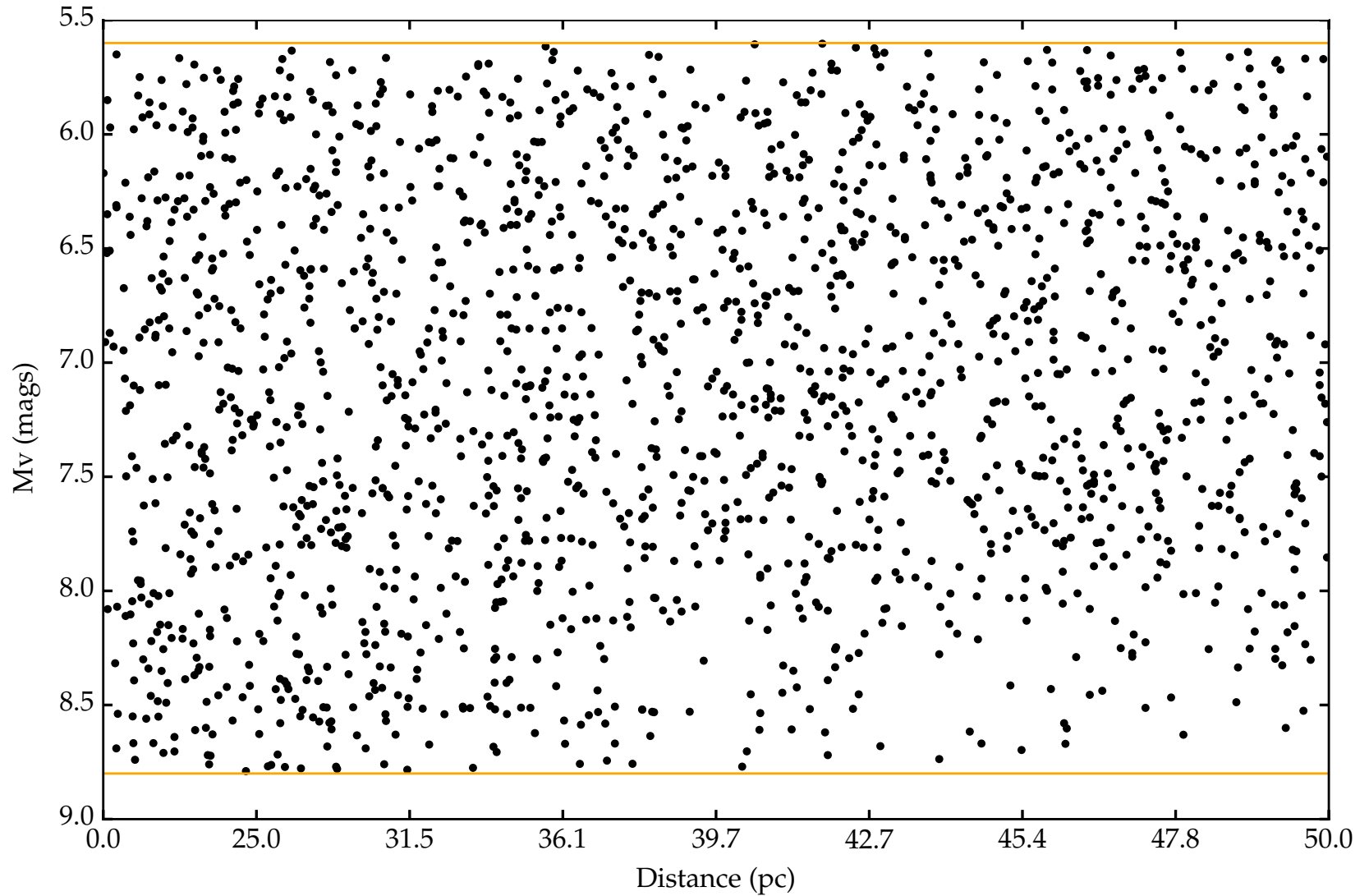
*age*



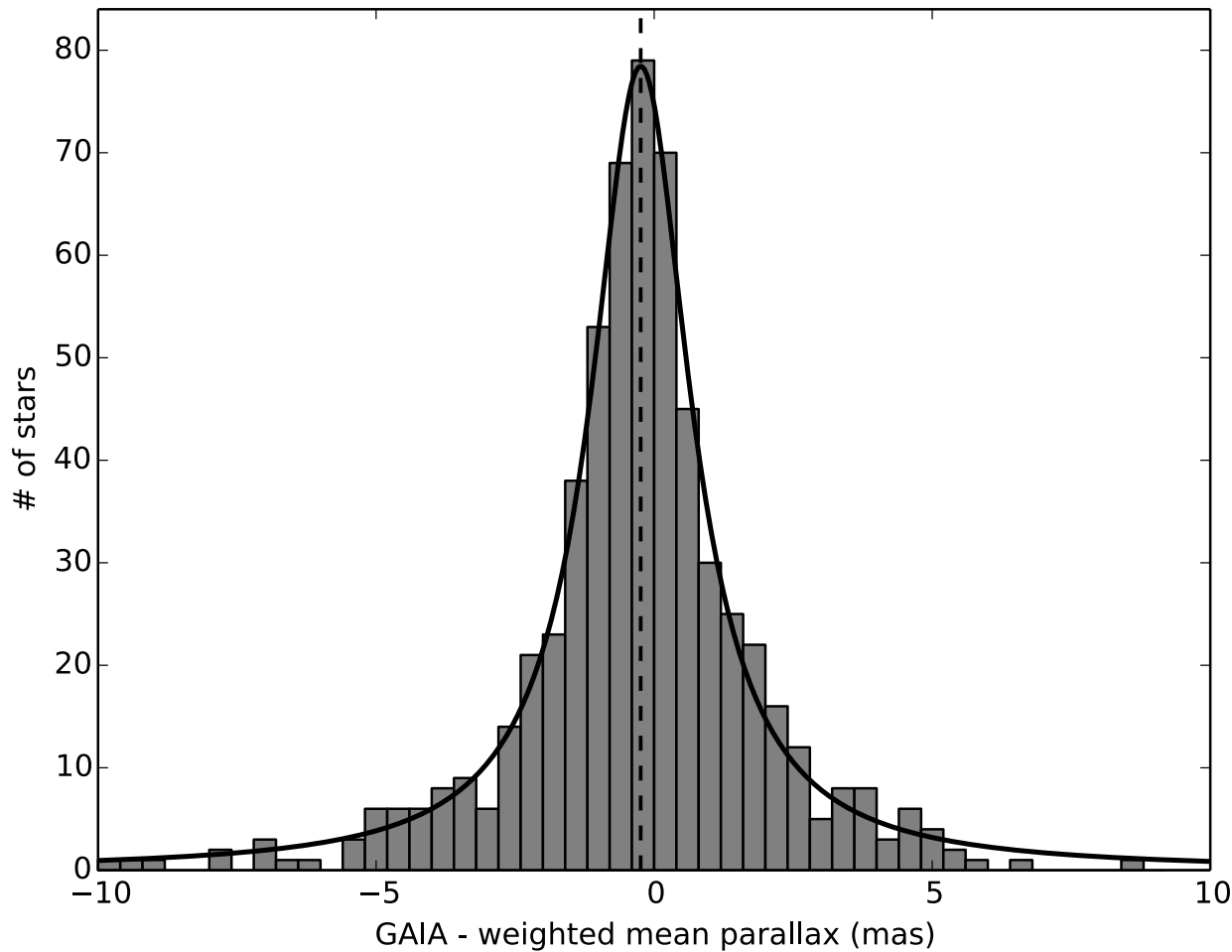
*magnetics*

Benedict, Henry, Franz  
et al. (2016)

# K-KIDS 50 pc: Revised 1824



# Gaia Parallax Offsets



Jao, Henry, Riedel  
et al. (2016)

612 systems  
within 25 pc

$-0.24 \pm 0.02$  mas

*distance dependent*

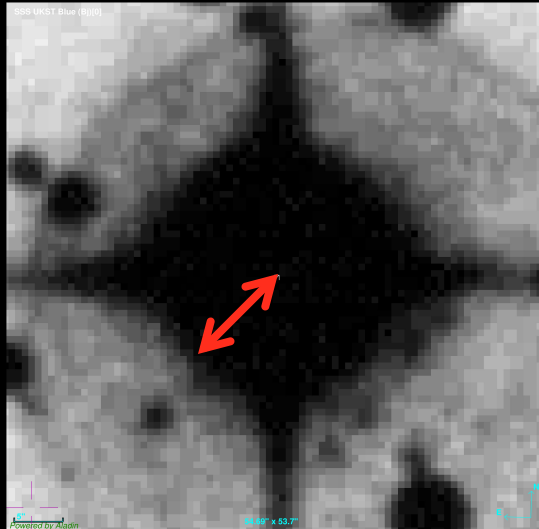
Stassun & Torres (2016)

108 eclipsing binaries ...  $-0.25 \pm 0.05$  mas ... *north/south asymmetry*

# K-KIDS Imaging

**Wide Field**  
**200-10000 AU**

**SuperCOSMOS**  
**+ new VRI**

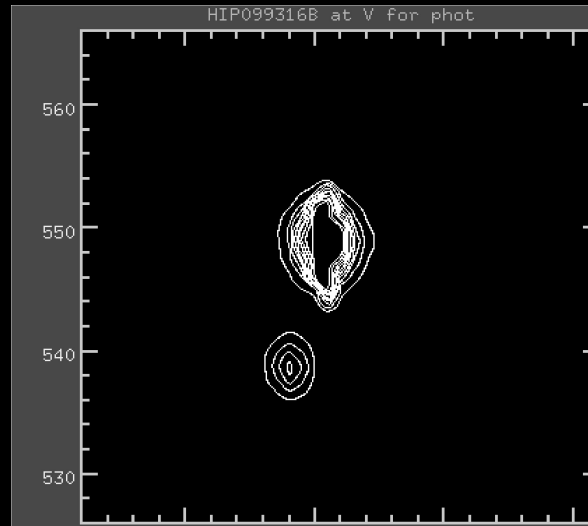


**saturated to 11"**

**HIP 99316 AB**  
**K0V 24 pc**

**Medium Field**  
**20-1000 AU**

**SMARTS 0.9m**  
**new images**

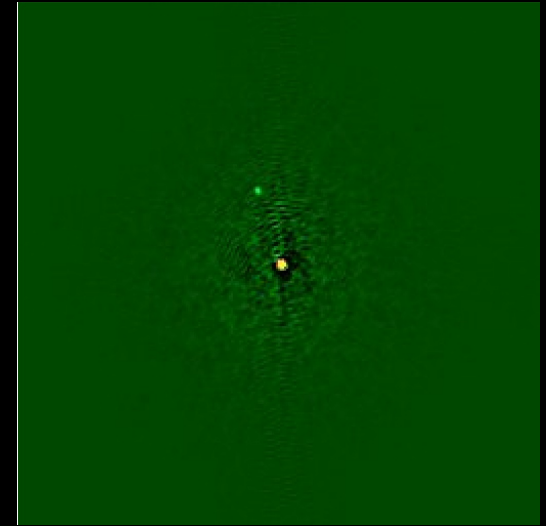


**B at 3.8"**

**HIP 99316 AB**  
**K0V 24 pc**

**High Res**  
**0.2-100 AU**

**DSSI on**  
**Gemini/DCT**



**B at 0.4"**

**GJ 538 AB**  
**17 pc**