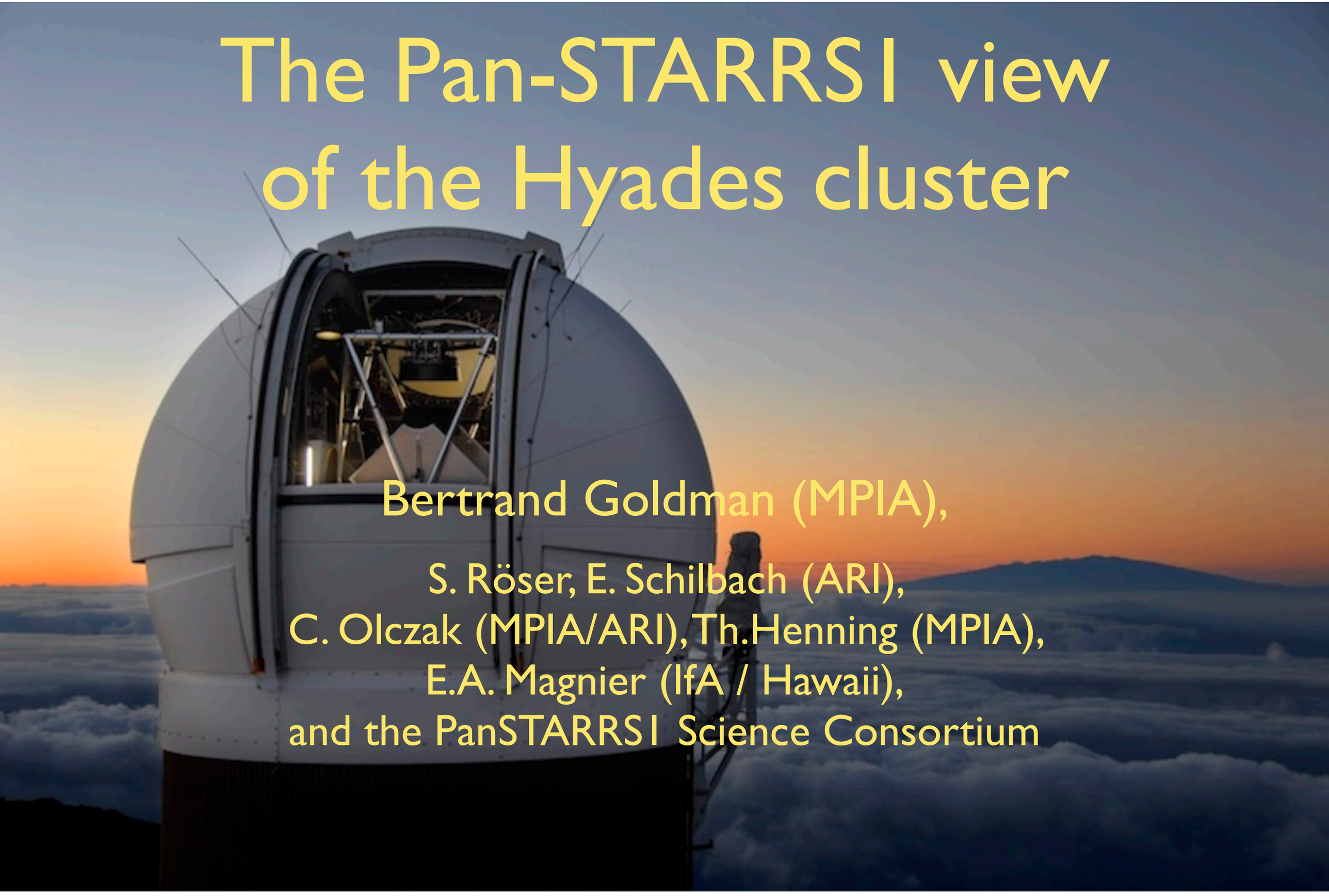
# The Pan-STARRS1 view of the Hyades cluster




Bertrand Goldman (MPIA),

S. Röser, E. Schilbach (ARI),
C. Olczak (MPIA/ARI), Th.Henning (MPIA),
E.A. Magnier (IfA / Hawaii),
and the PanSTARRS1 Science Consortium

# Motivation: Cluster MFs & evolution

- Mass function: slope(s), universality
- Evolution of clusters:
  how do they dissolve into the field
- Binarity
- Stellar evolution

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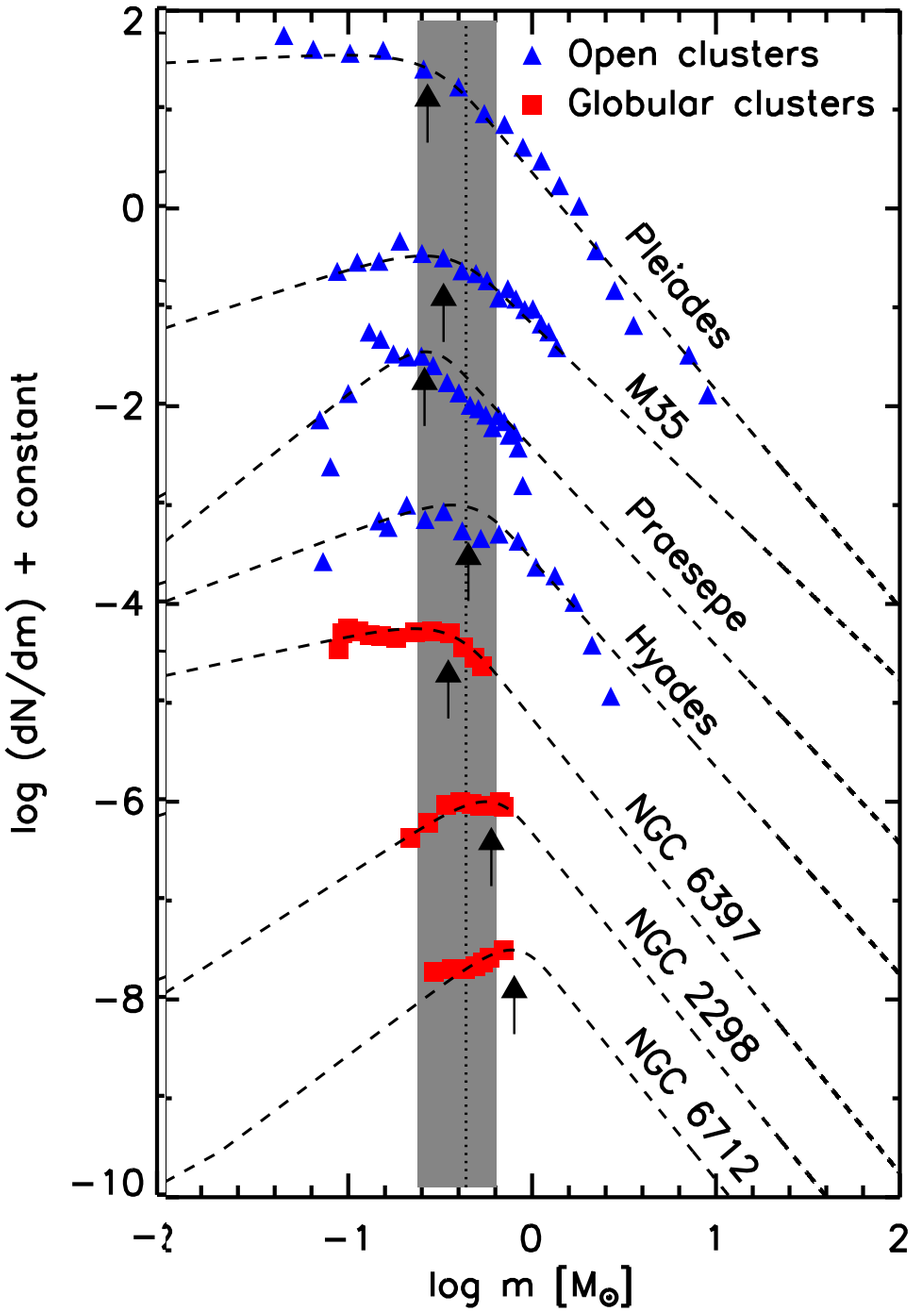


Bastian+, ARA&A, 2010

# Motivation: Cluster MFs & evolution

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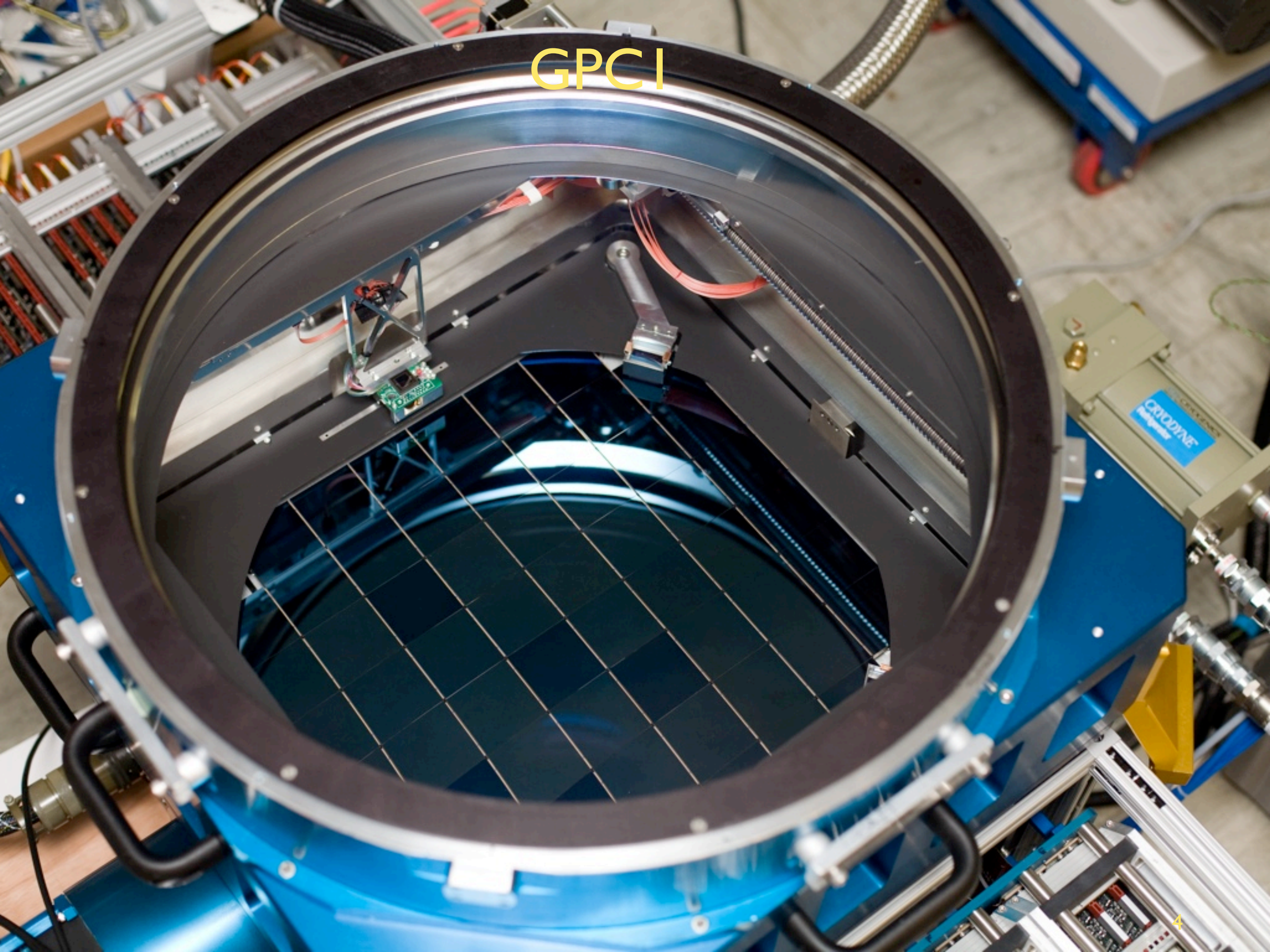
# Outline

- Pan-STARRS1, the most ambitious optical survey of the decade
  - Instrument
  - The 3π survey
- The Hyades cluster:
  - search for UCD members at large cluster radius
  - PS1 parallax search for nearby BD members

# GPCI



# GPCI

- 1.8-m dedicated telescope in Haleakala
- 7-sq.deg. FoV and 1.4 Gpix
- 13-sec overheads
- ~80% filling factor
- 3.5-year duration

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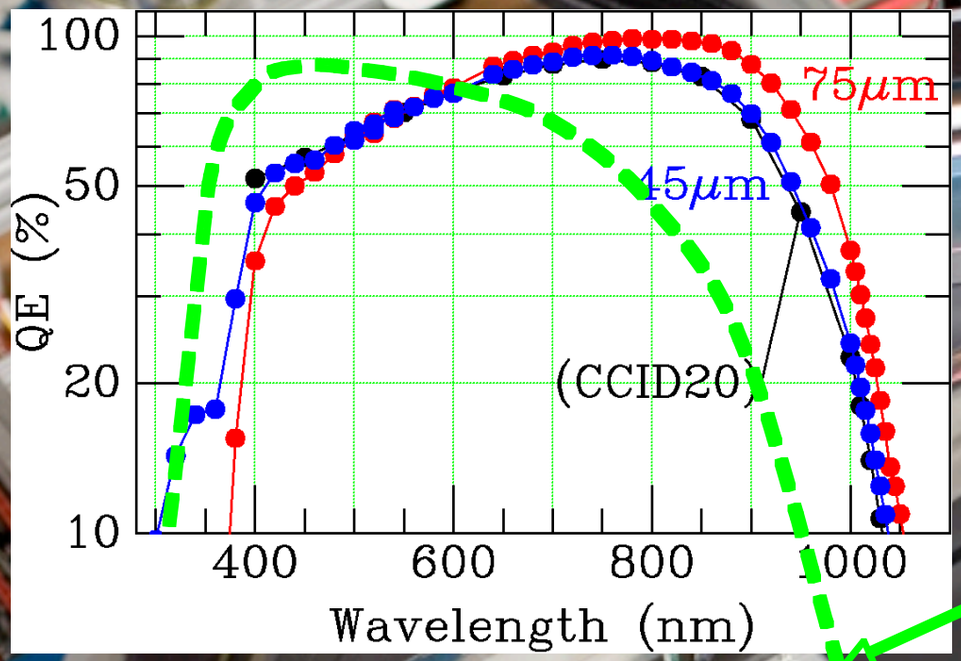


(Megacam)

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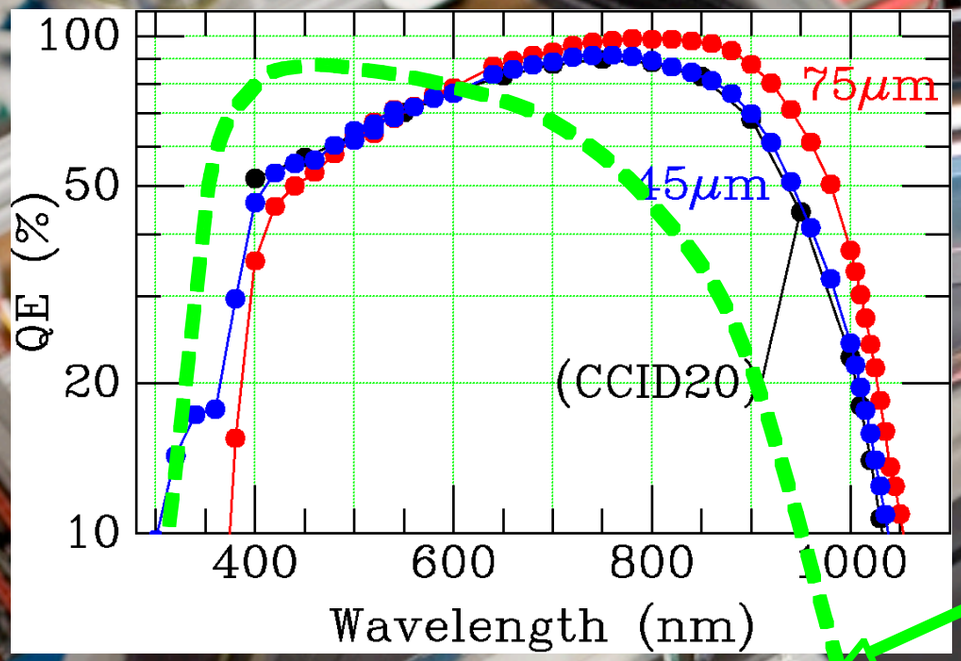


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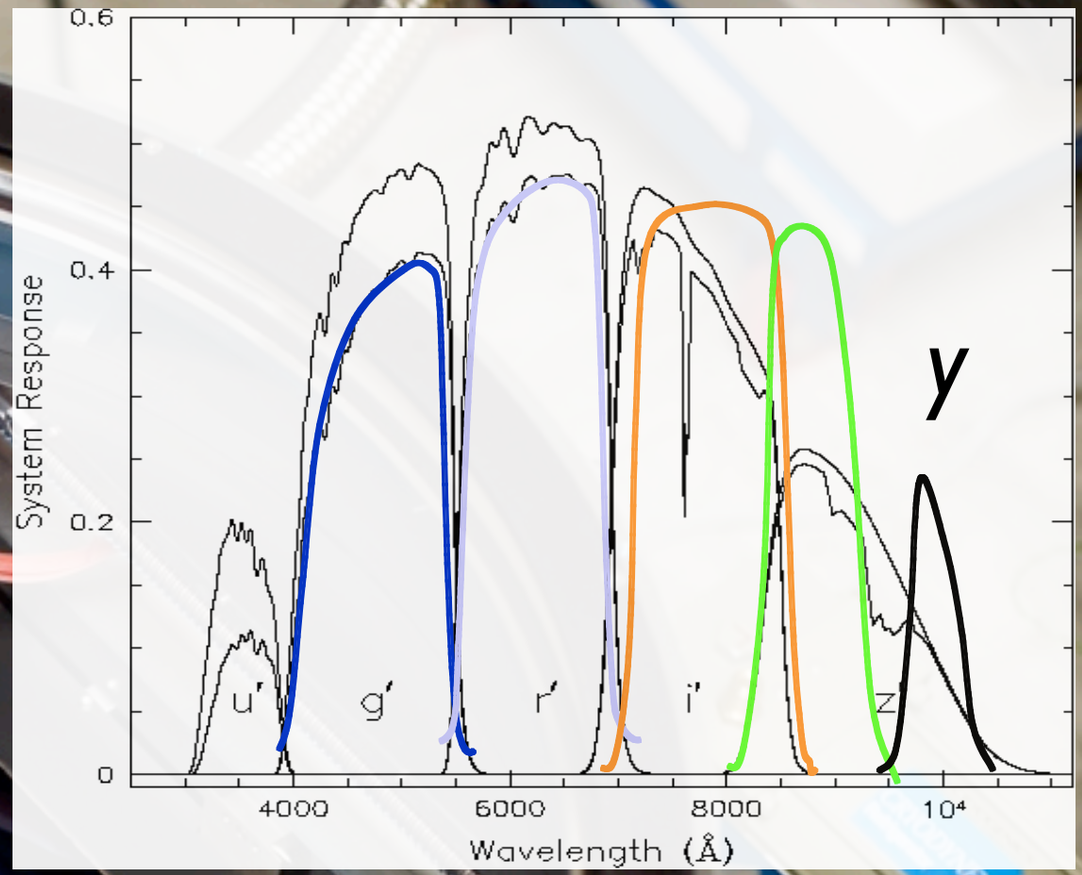


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# The 3π survey

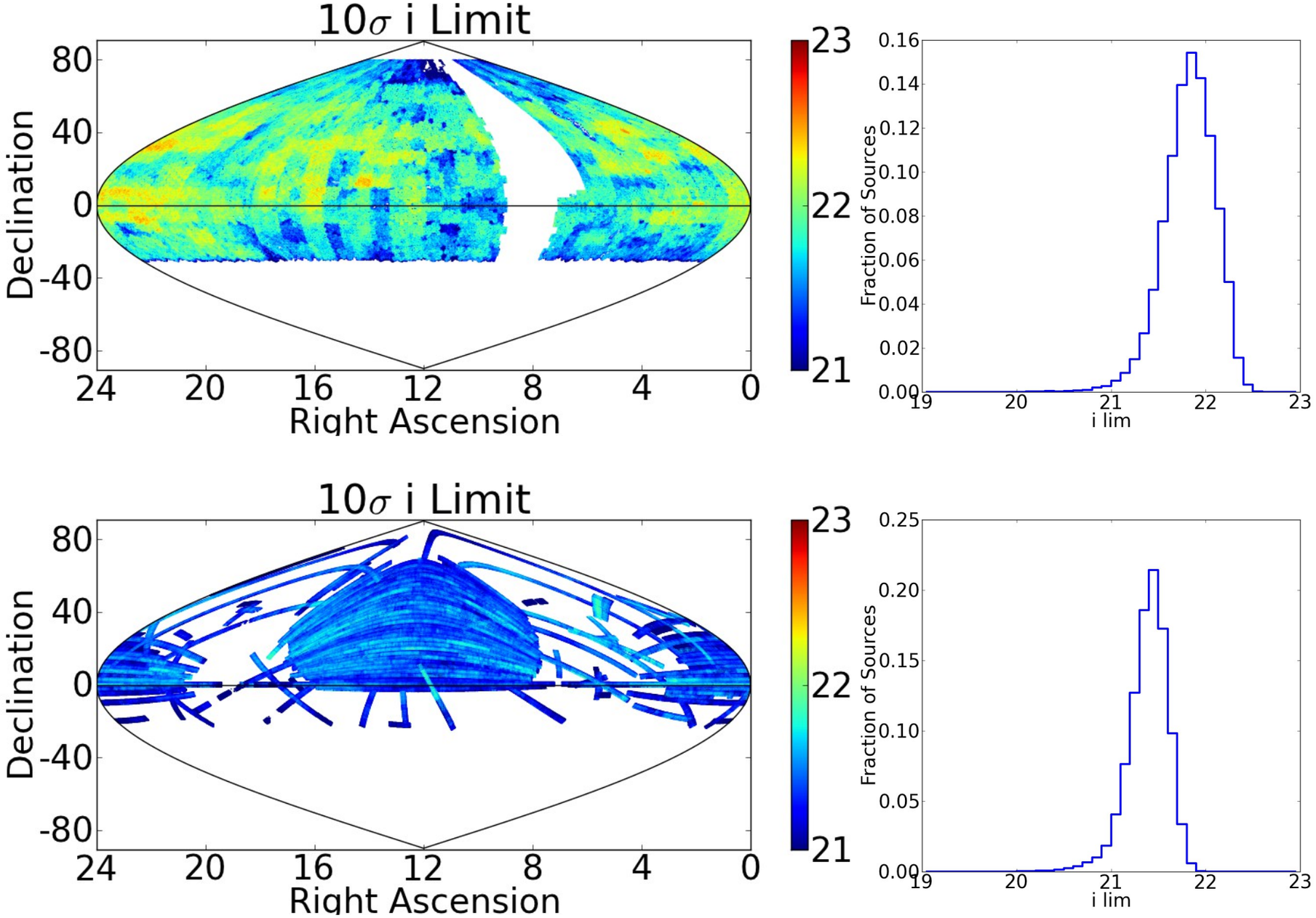
- makes 60% of the observing time
- 30,000 sq.deg., 5 filters x 12 exposures
- expect 10 measurements at a given location
- scheduling optimized for NEOs and nearby UCDs

# Stack depth

10σ

over 20x20arcmin$^2$

## i band PS1 vs. SDSS



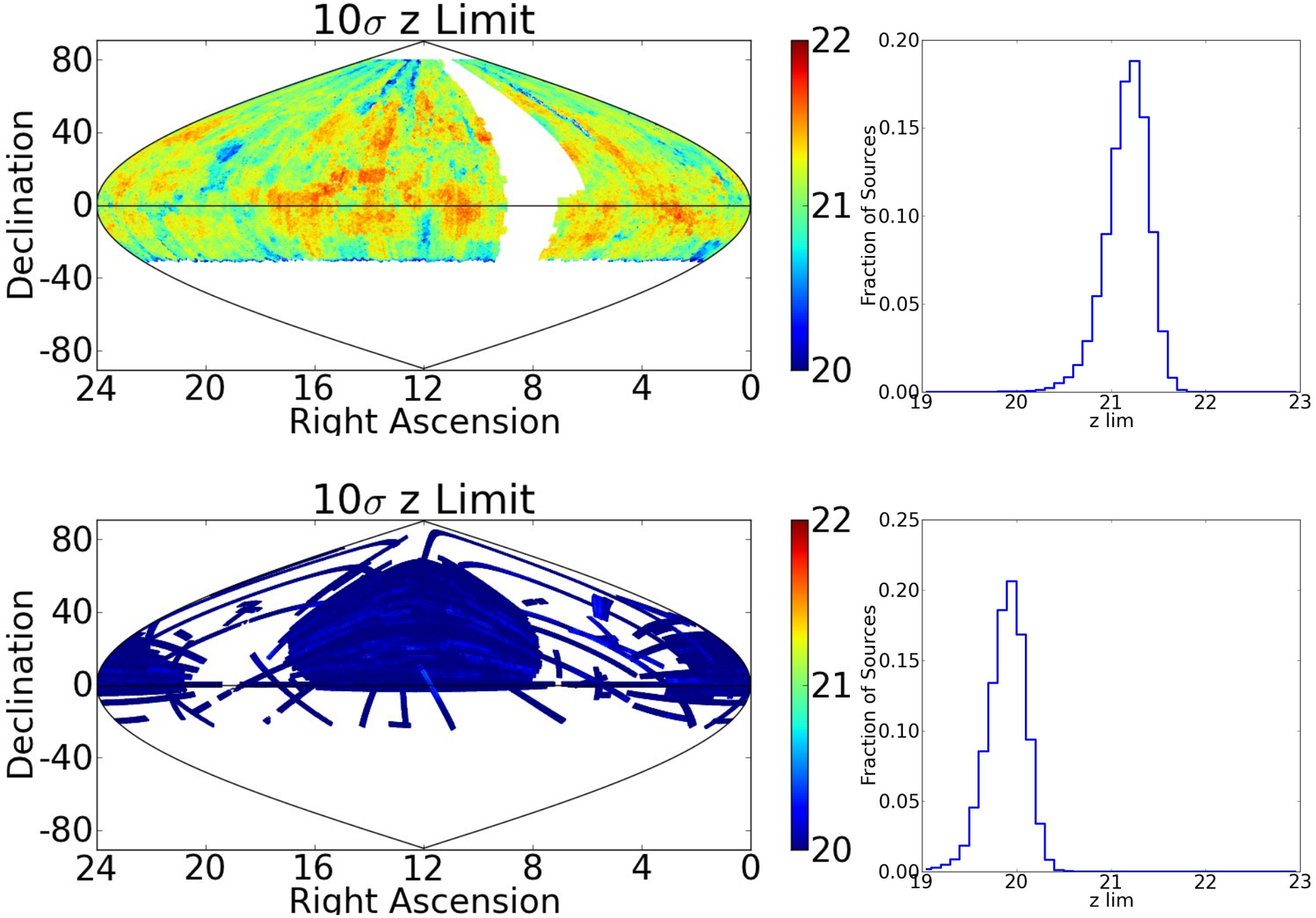

Plot by E. Morganson (MPIA)

# Stack depth

10σ

over 20x20arcmin$^2$

## z band PS1 vs. SDSS

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# Photometric calibration

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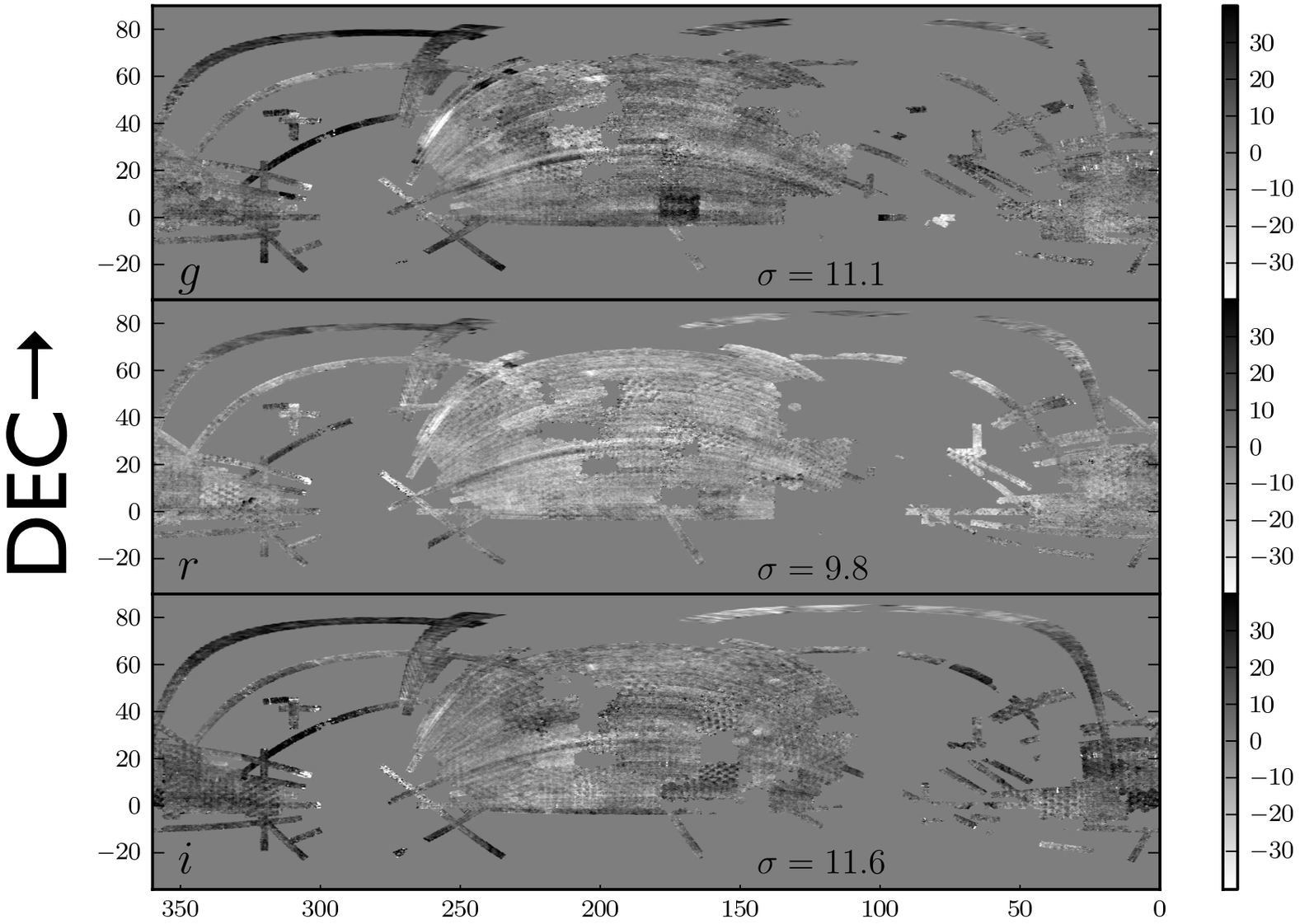
PS1–SDSS



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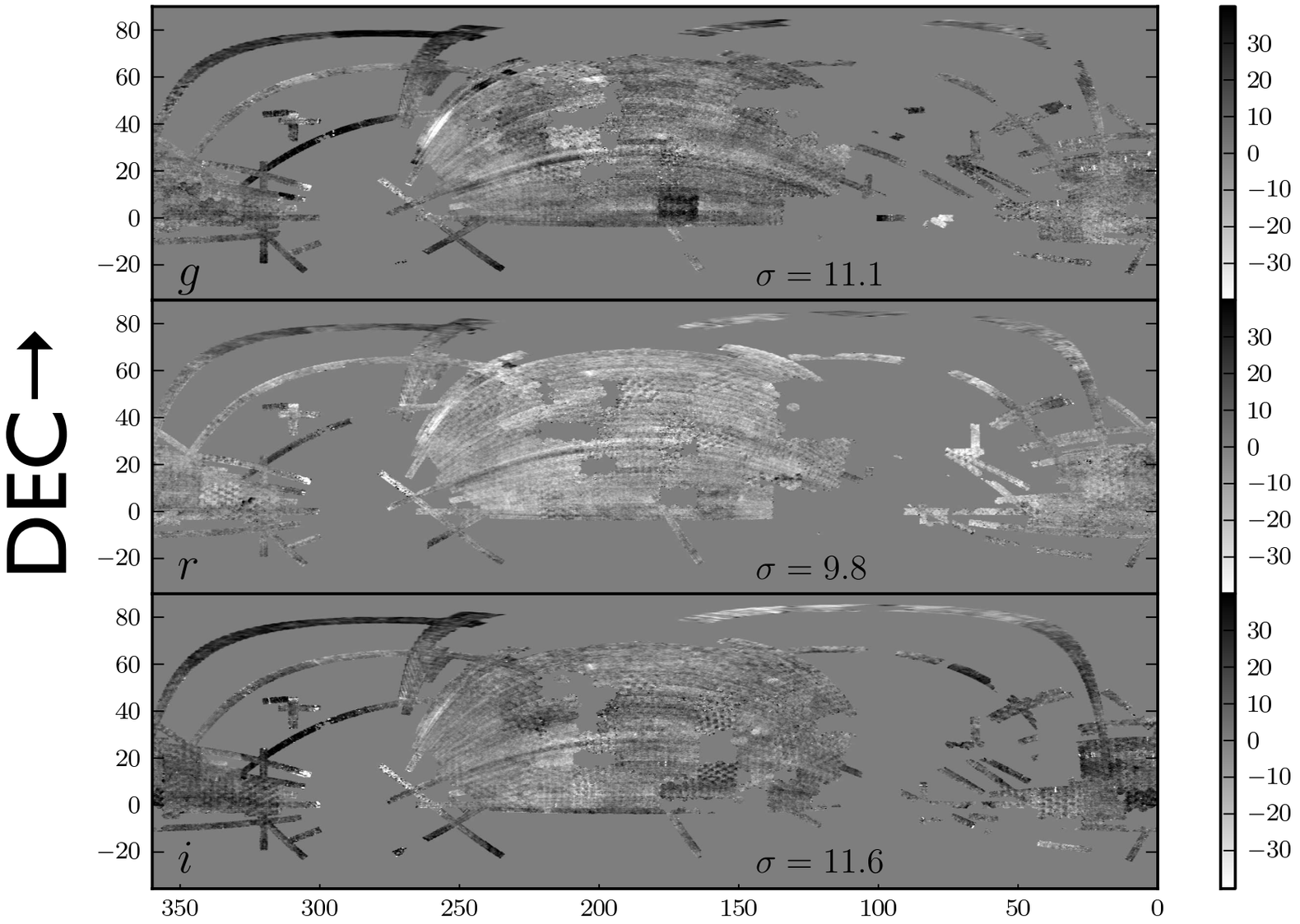


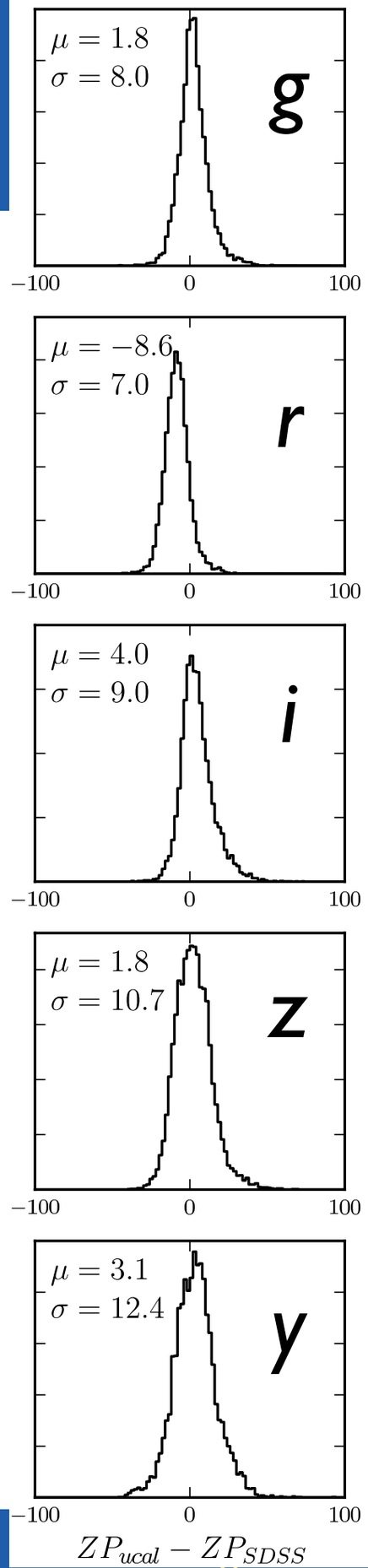

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Mean motion* of somewhat extended objects

*relative to nearby (2MASS) stars

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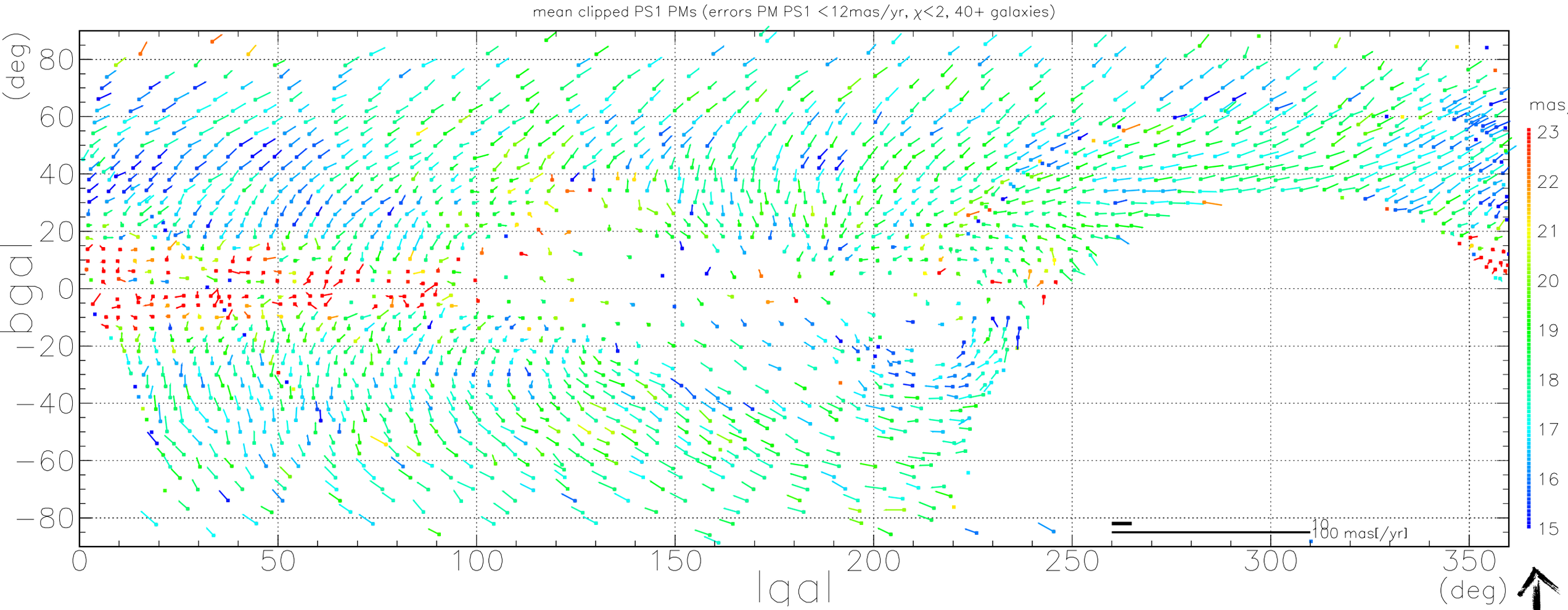



*relative to nearby (2MASS) stars

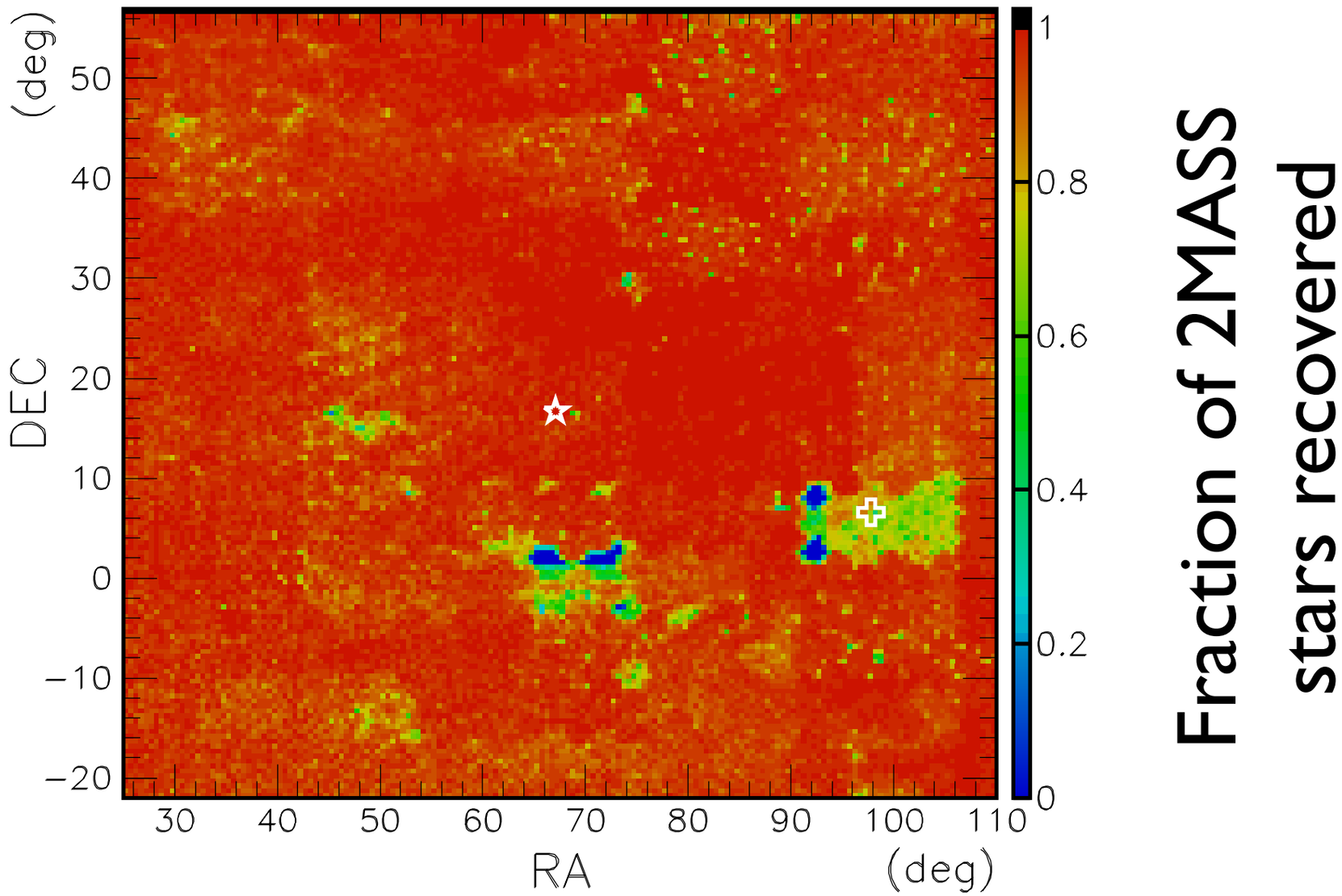
dispersion within each cell (red: larger)

# The Hyades survey

- Nearby cluster (47pc)
  - brown dwarfs (Ls at the centre, closest Ts) visible in PS1
  - study the spatial structure & dynamics
- Intermediate age of 625 Myr
- Large spatial velocity *U,V,W* = -41,-19,-1 km/s
  - PM selection to remove field contaminants

# The PanSTARRS1 data around the Hyades

*g*, *r* or *i* observations




This and most following plots from Goldman et al. (*A&A, in press, 1307.8124*)

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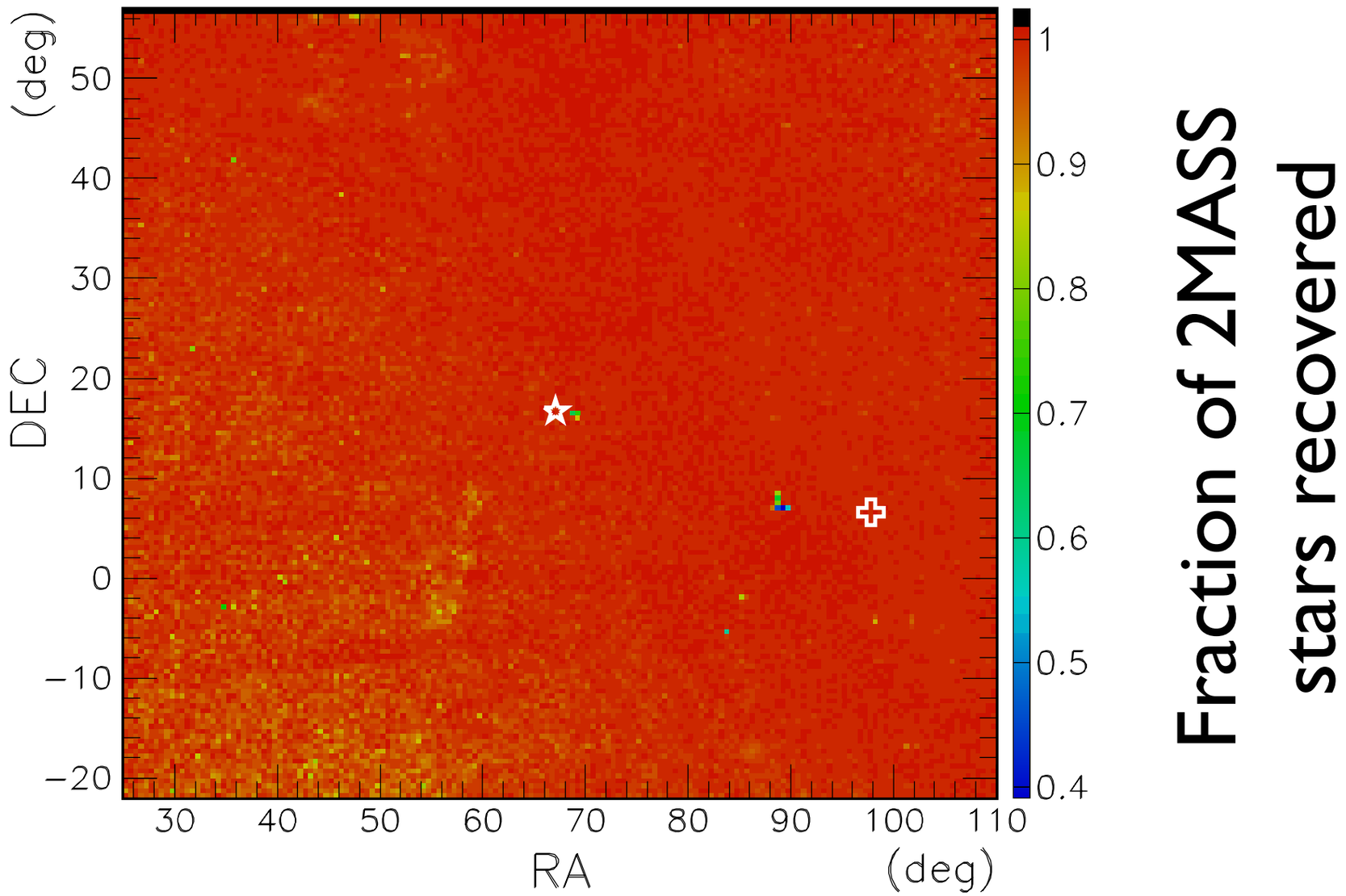


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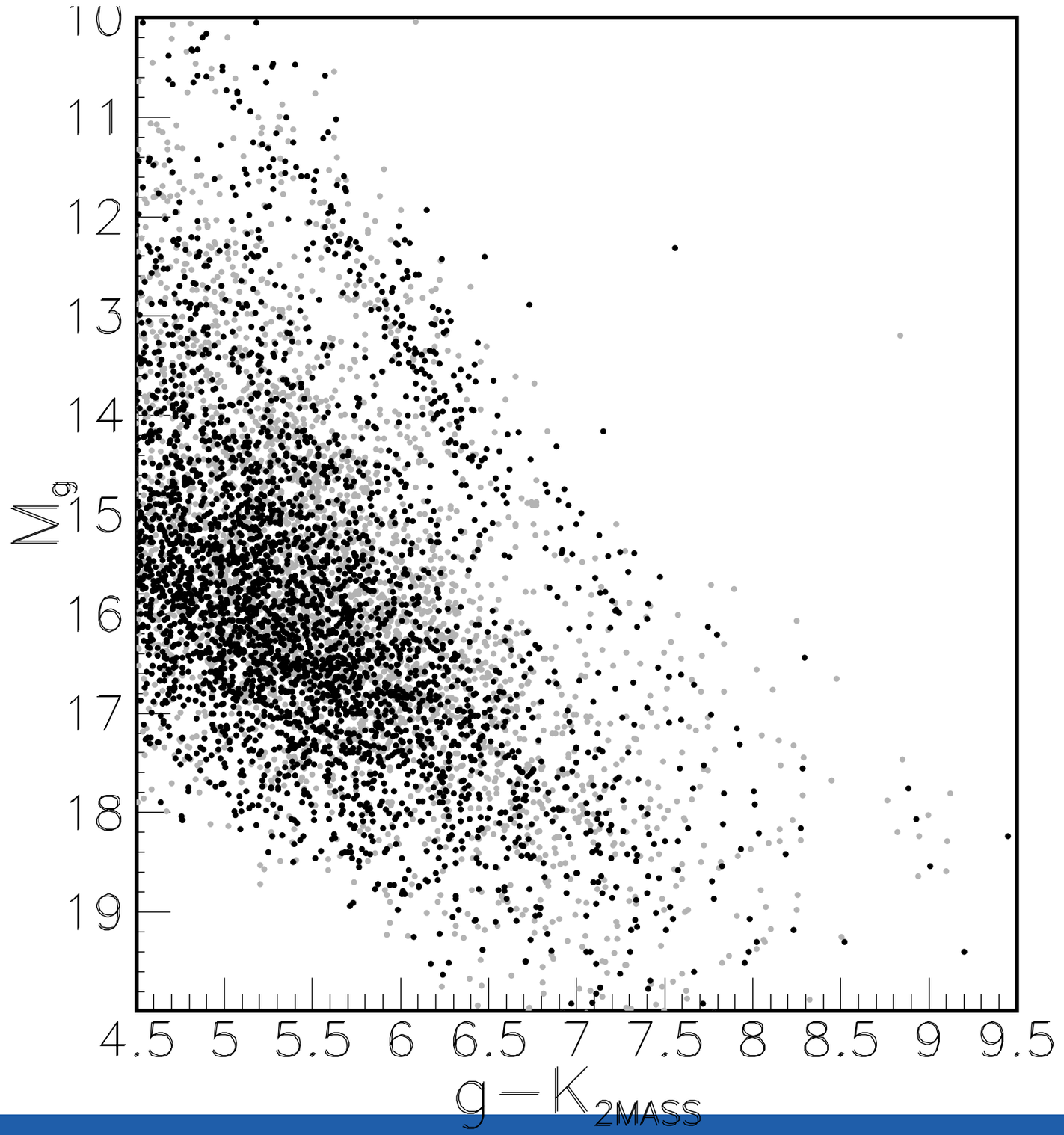
# Candidate selection

- Kinematic selection:
  - convergent point method: $|V_\perp| < 2$ km/s & 7 deg
  - proper motion from PPMXL
    - small PM errors < 20 mas/yr
    - 2MASS 'A' flag in *J* and *Ks*
- Photometry from PanSTARRS1
- Hunt for various problems:
  - erroneously large PMs

# Photometric selection




good: $|v_\perp|<1$ km/s

other kinematic candidates

Goldman et al. (submitted to *A&A*)

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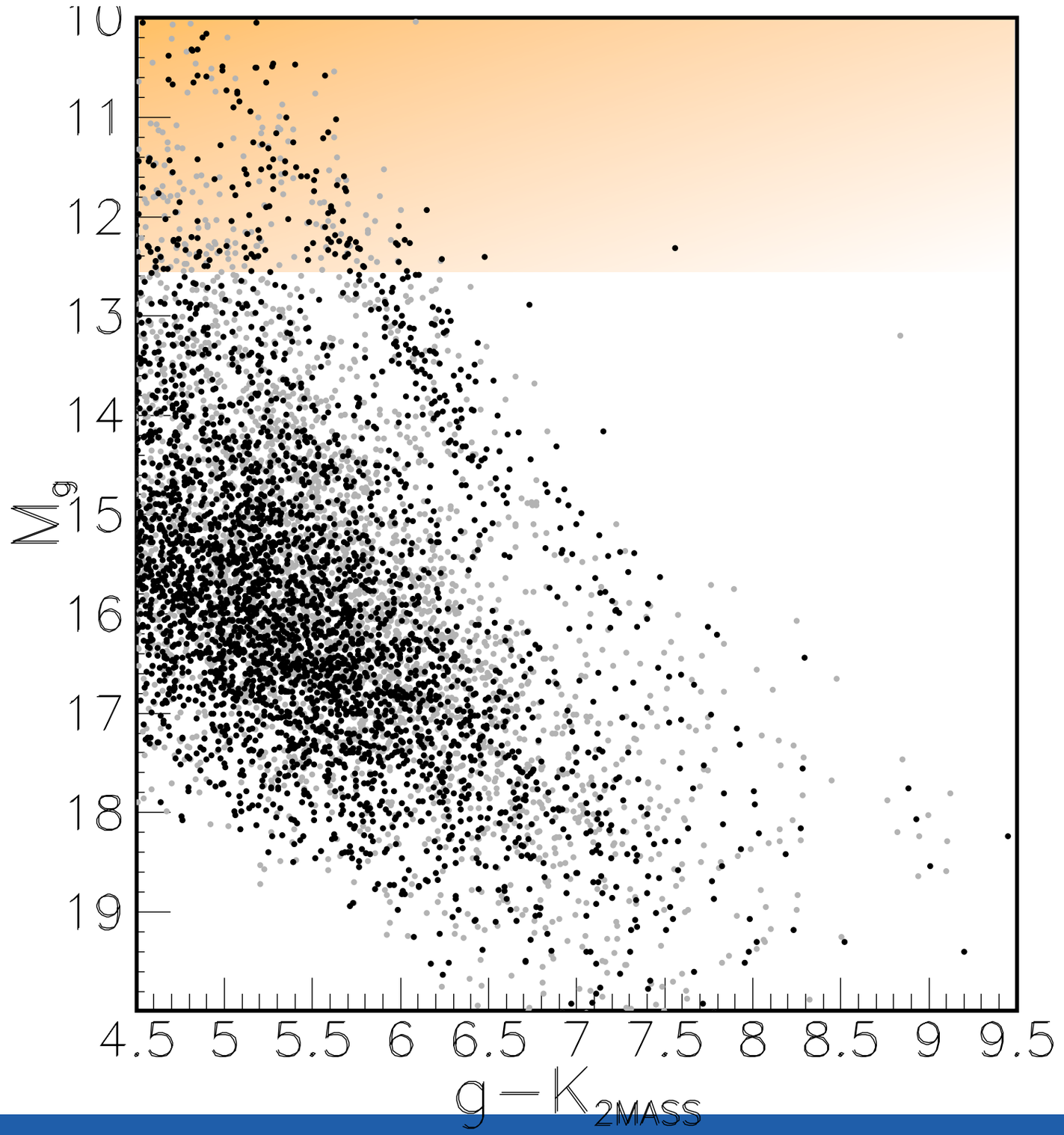


## Saturation

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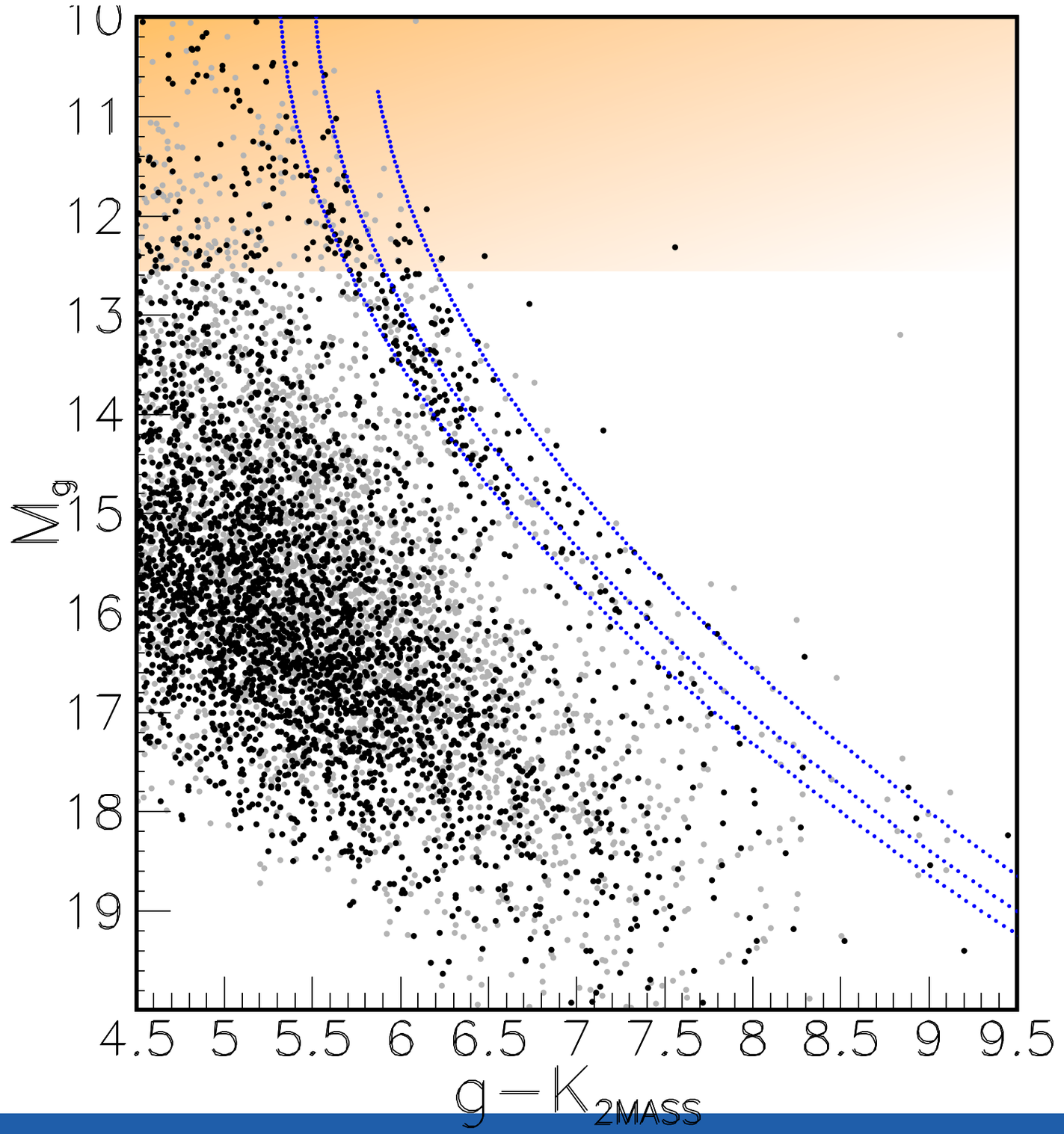


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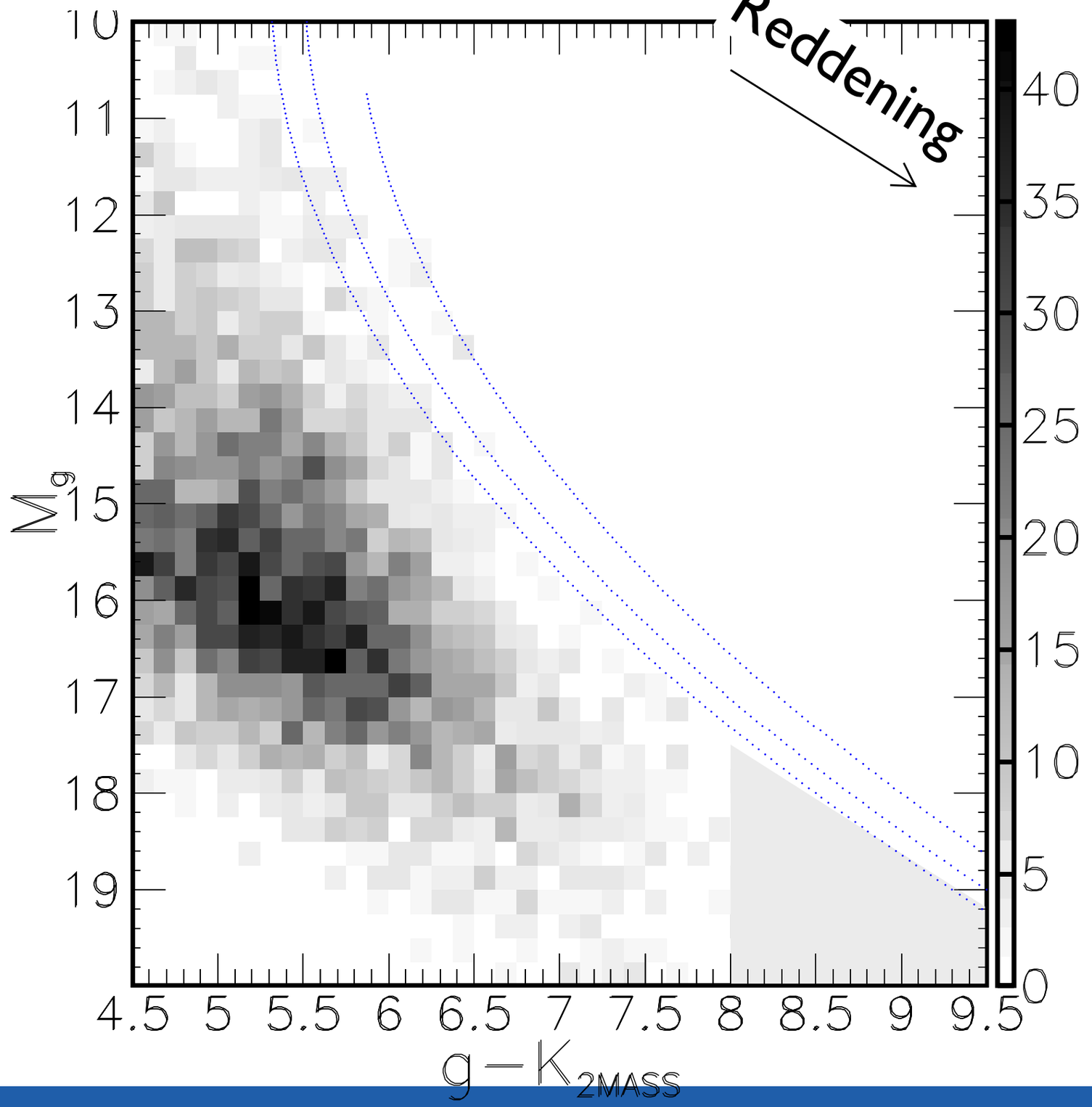


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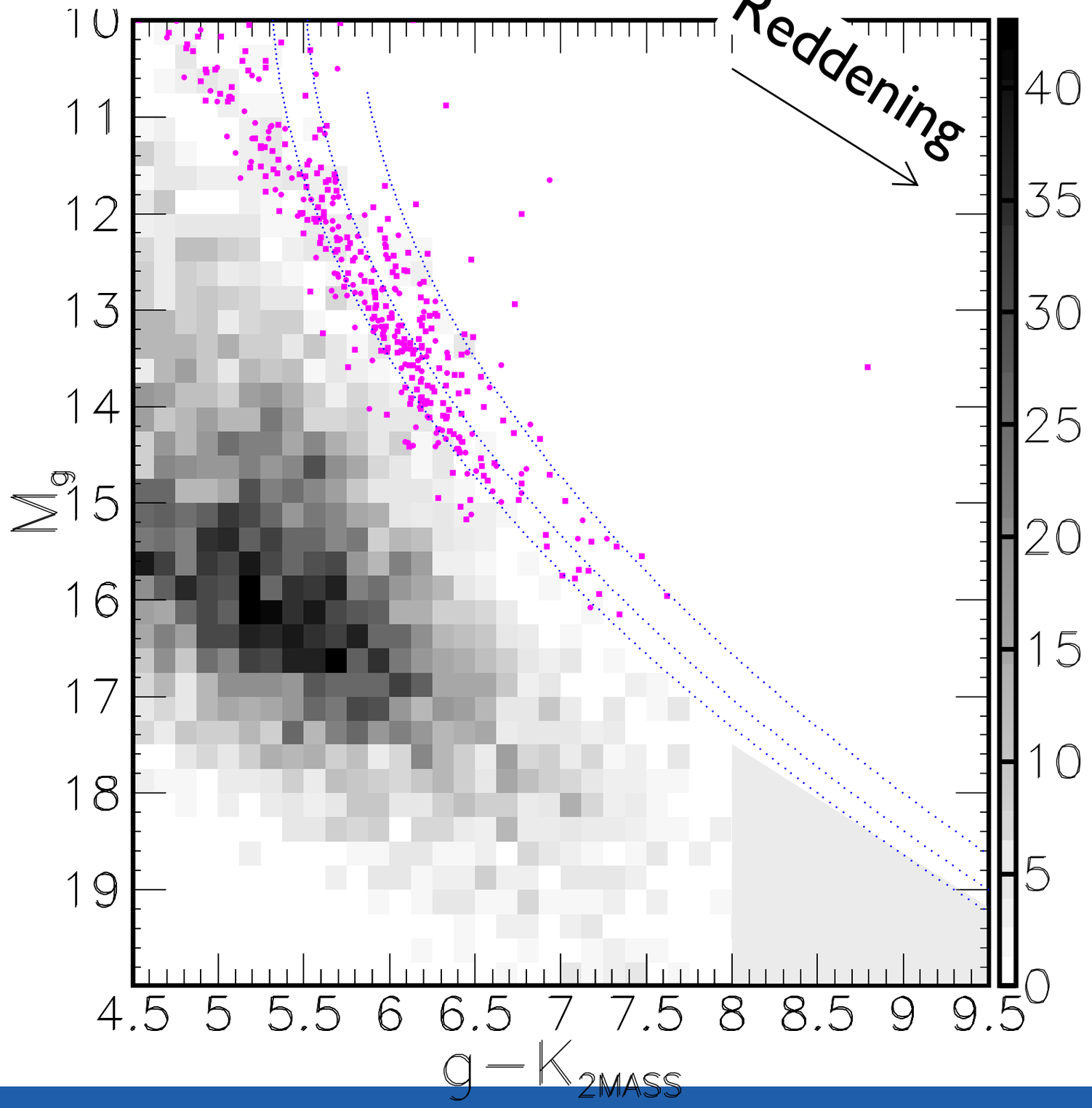
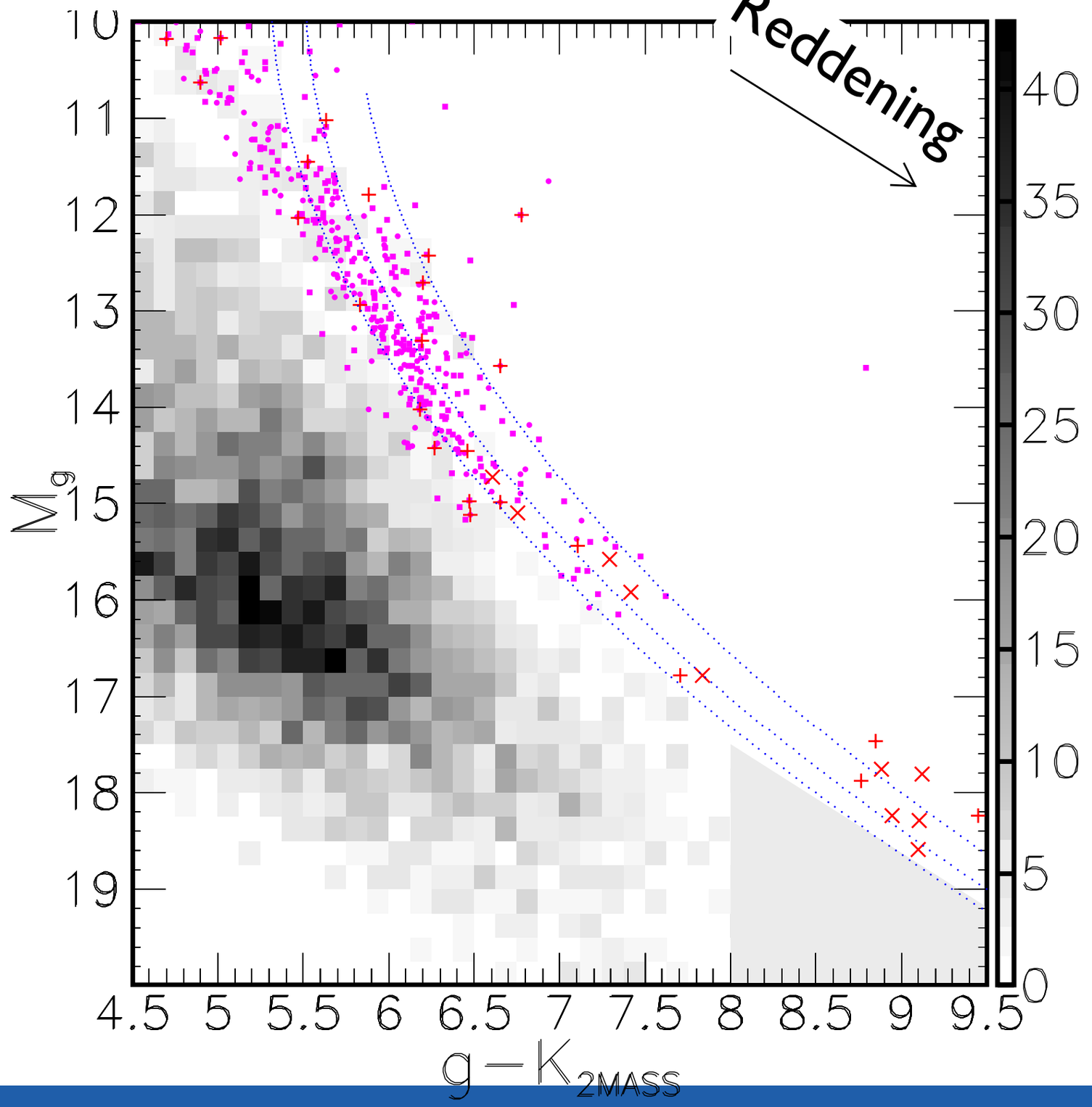



R11 candidates

Goldman et al. (submitted to A&A)

# Photometric selection

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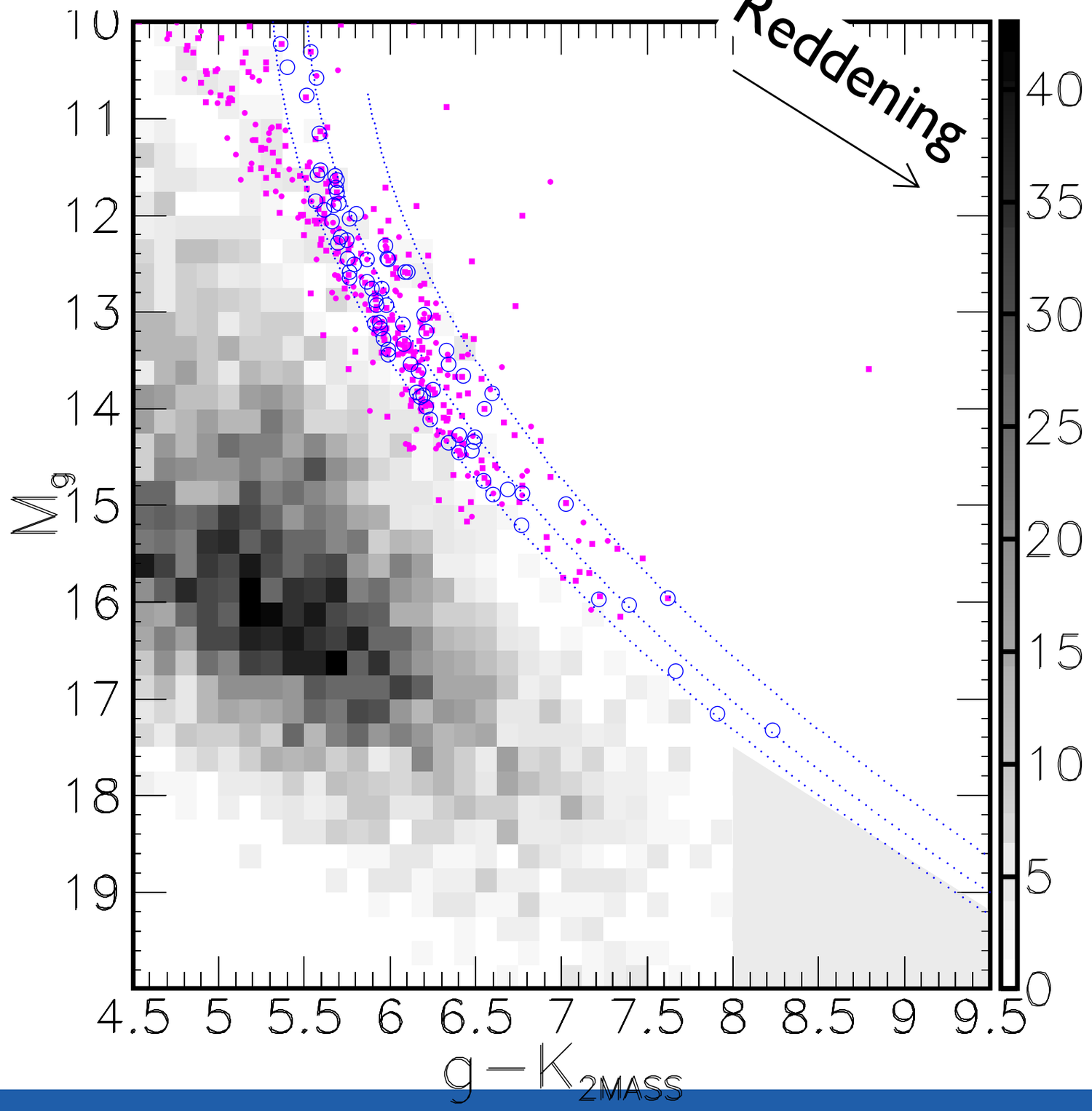


R11 candidates

g|r|i candidates

Goldman et al. (submitted to *A&A*)

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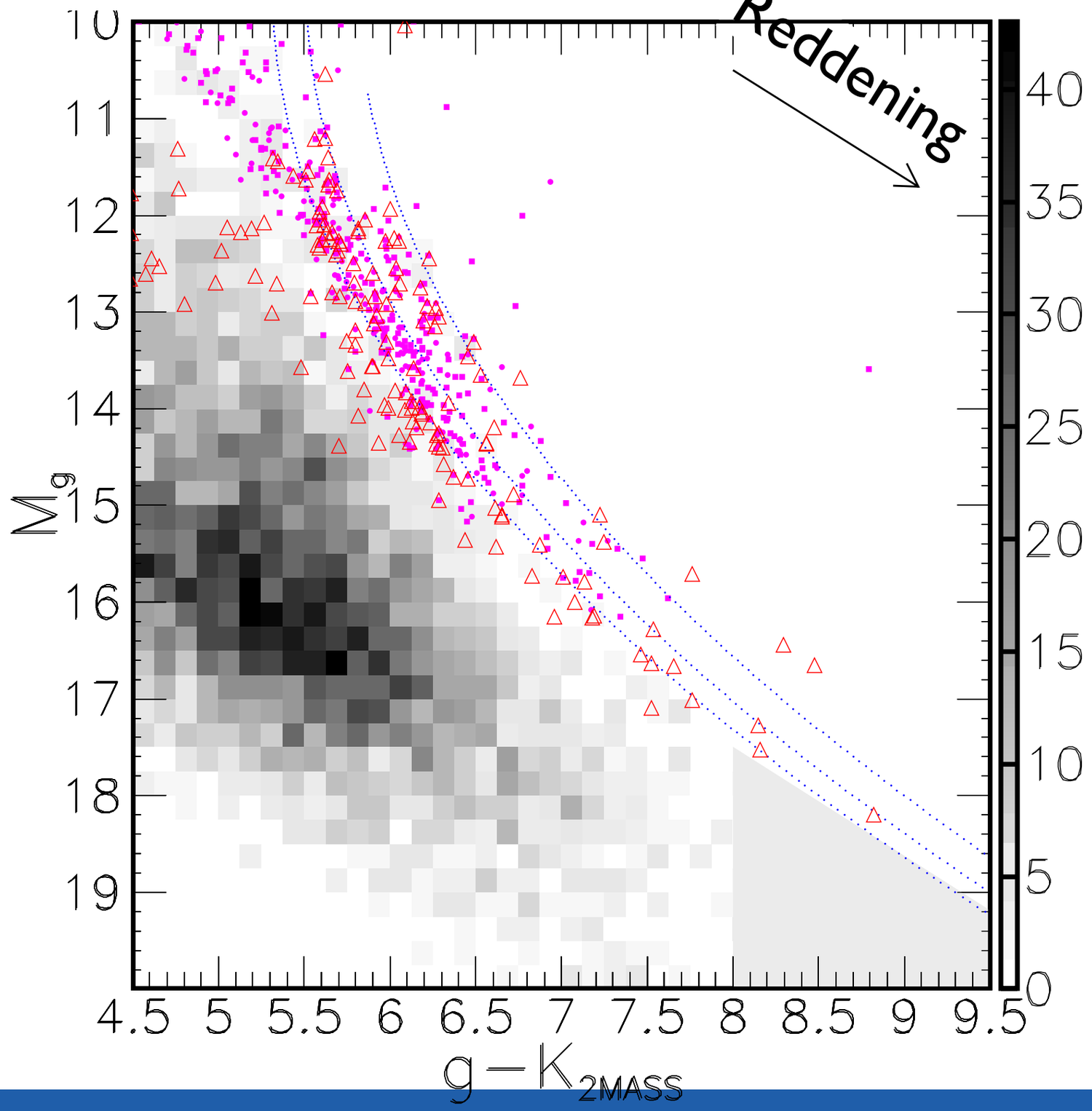
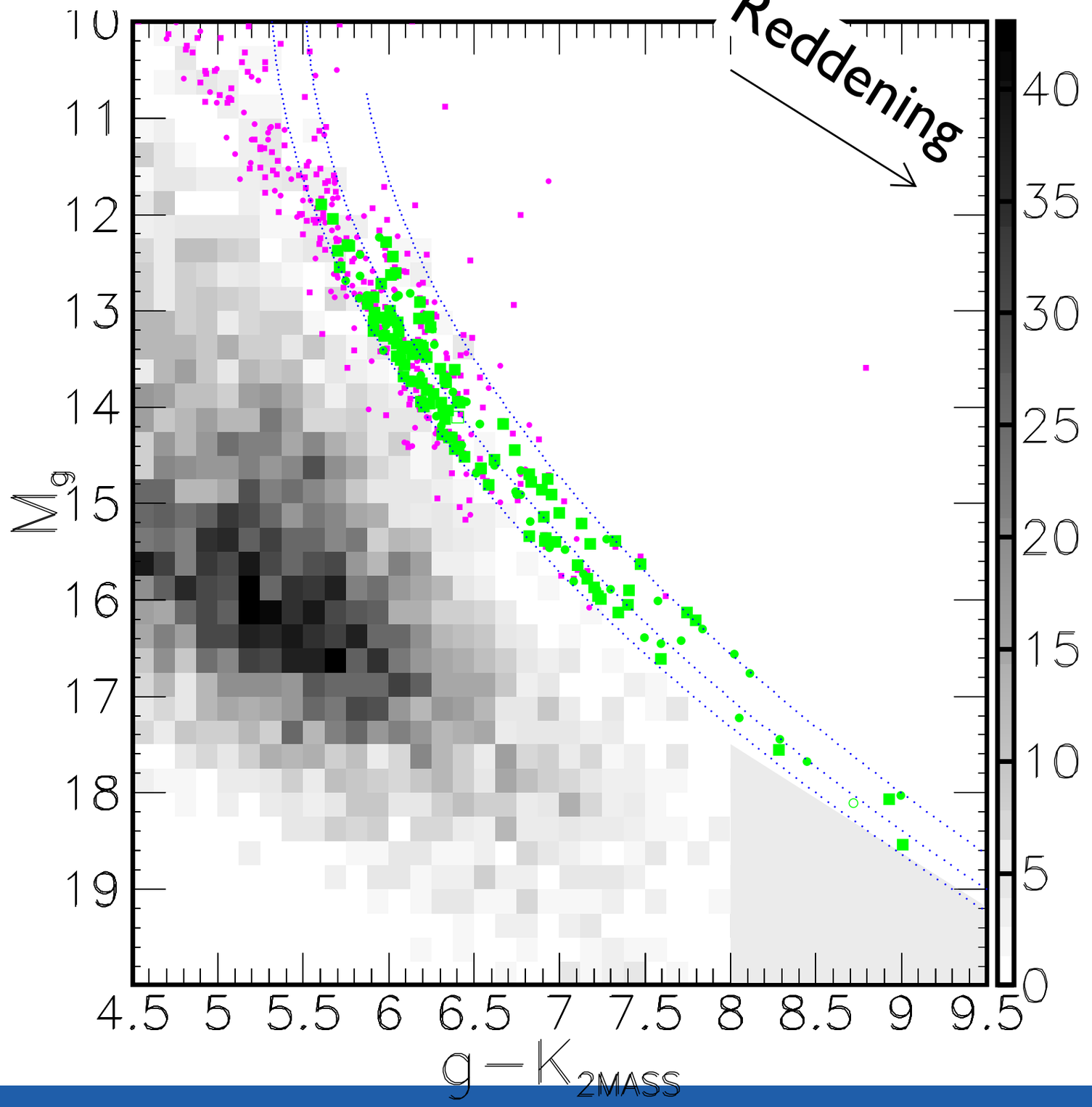



R11 candidates

rejected in other band

Goldman et al. (submitted to *A&A*)

# Photometric selection




R11 candidates

gri candidates

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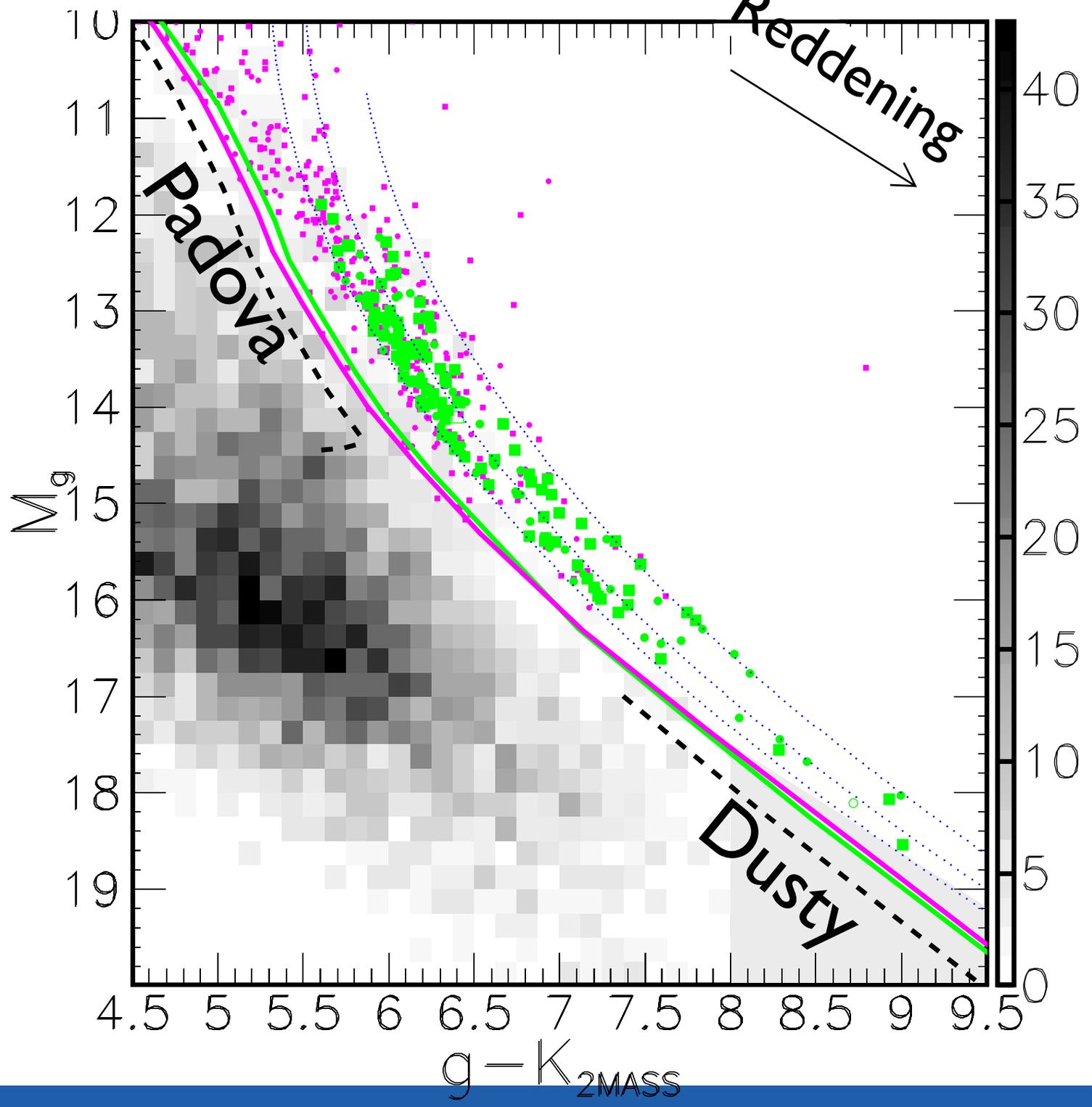



R11 candidates

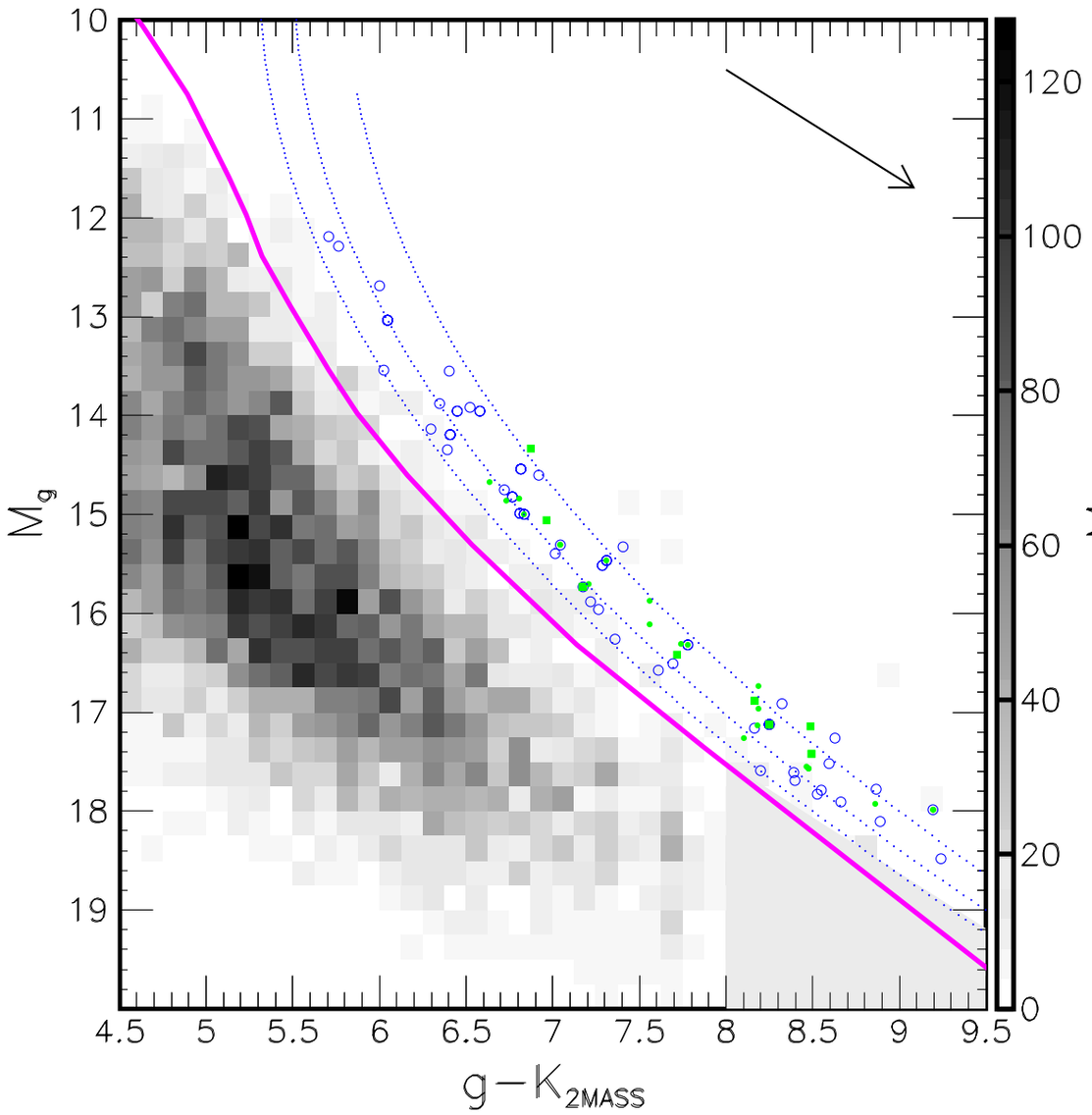
gri candidates

AGSS2009 CIFIST2011

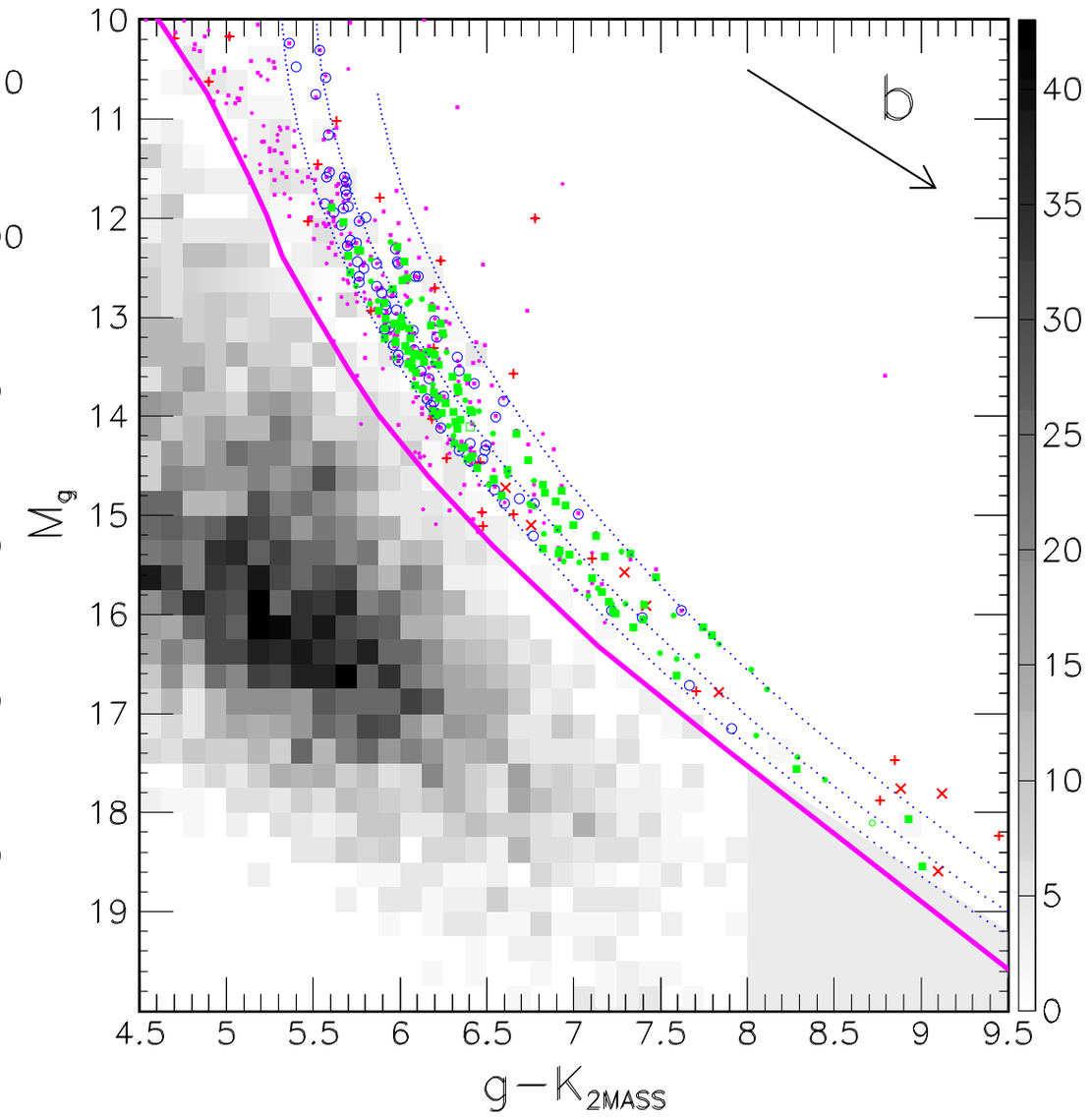
Goldman et al. (submitted to A&A)

# Contamination

## Simulation




## Data



# Previous studies

- Double the numbers of candidates with $m$<0.15$M_{\odot}$
- Refine Röser et al (2011) sample:
  refine poor CMC photometry or PPMXL PMs
- Confirms 13 candidates of Bouvier et al. (2008), rejects five (kinematic)
- Not sensitive to Hogan et al. L dwarfs (depth)
- 2MASS J0230155+270406 L0: Cruz et al (2007)

# Mass functions

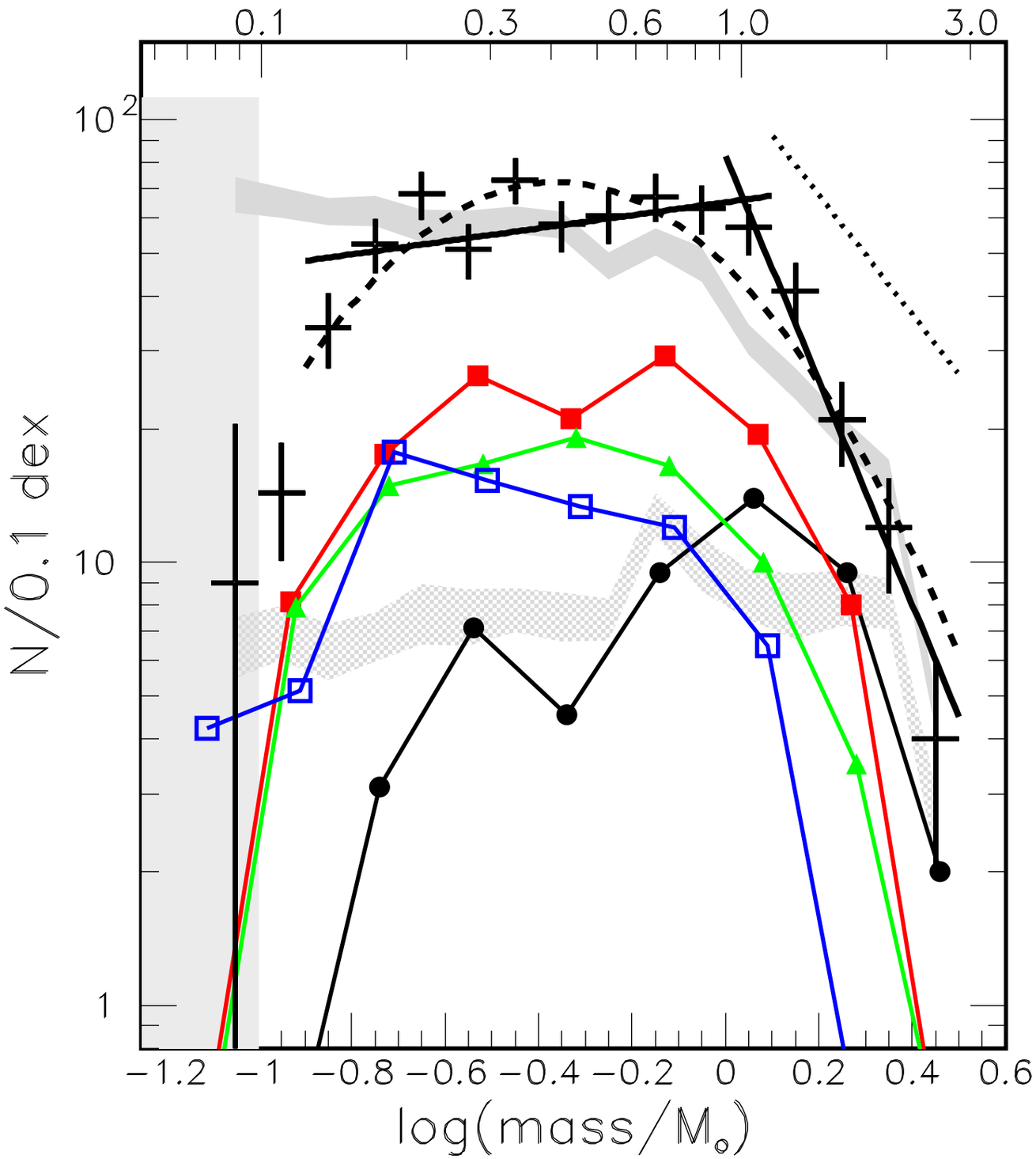
all

3.1<<9pc

18<<30pc

9<<18pc

0<<3.1pc

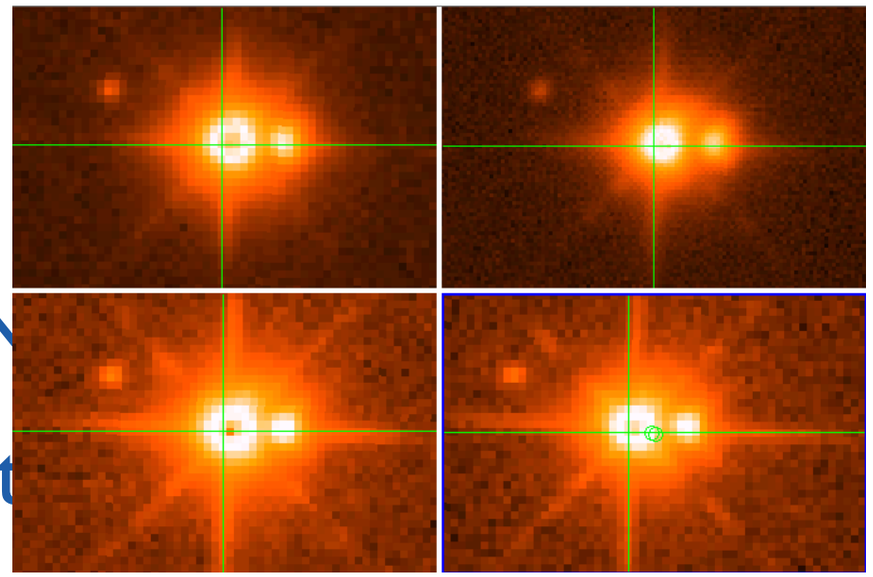



Simulation by Ernst et al (ARI)

# Binarity

- Crucial to get to the object MF
- Taisiya Kopytova+ (MPIA) AstraLux imaging
- Survey data
  - ‘higher’ resolution imaging
  - wide CPM binaries (outside of cluster centre)
- Joshua Schlieder+ high-res spectroscopy

# Binarity



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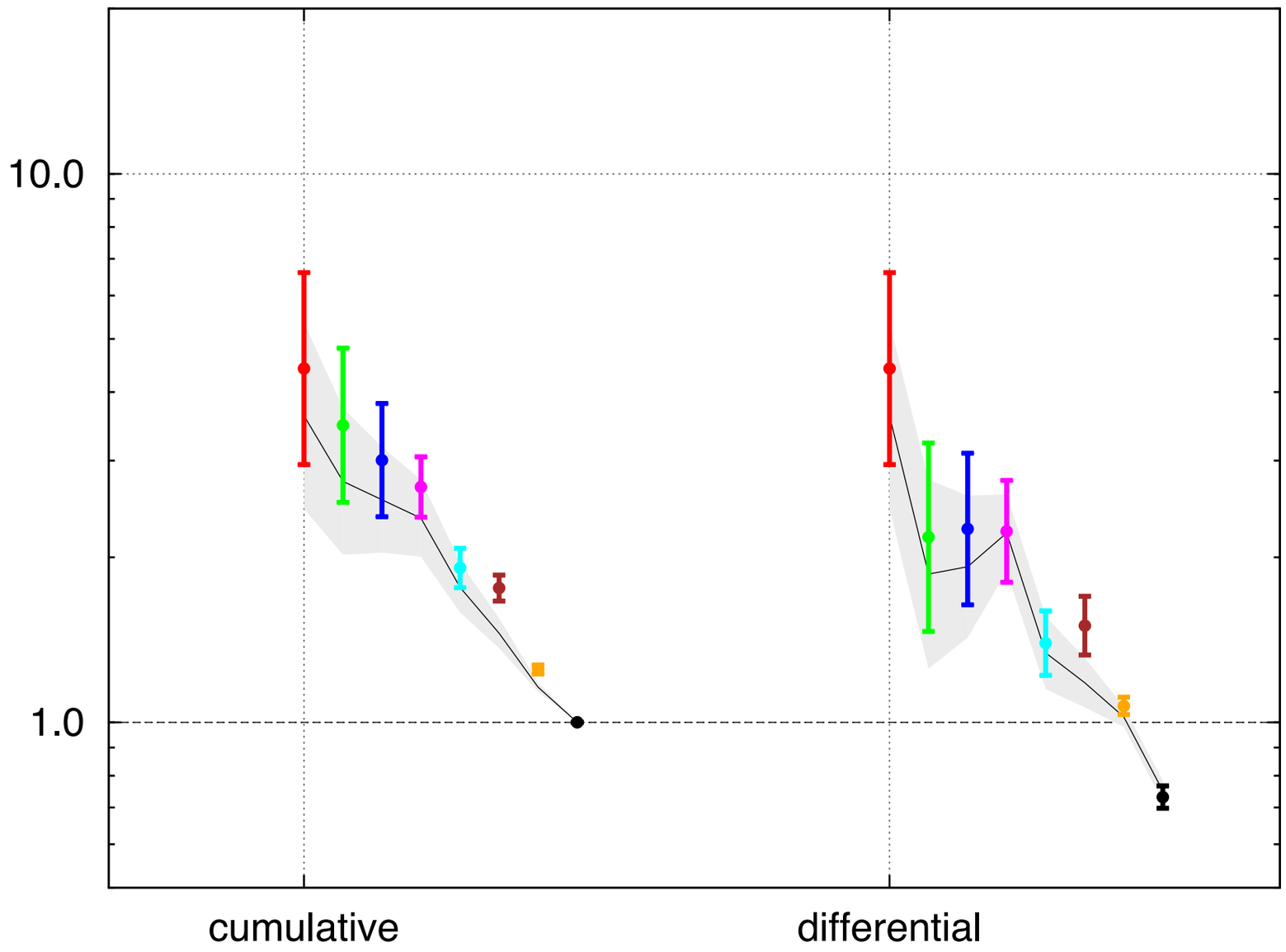
# Cluster evaporation

## Minimum spanning tree

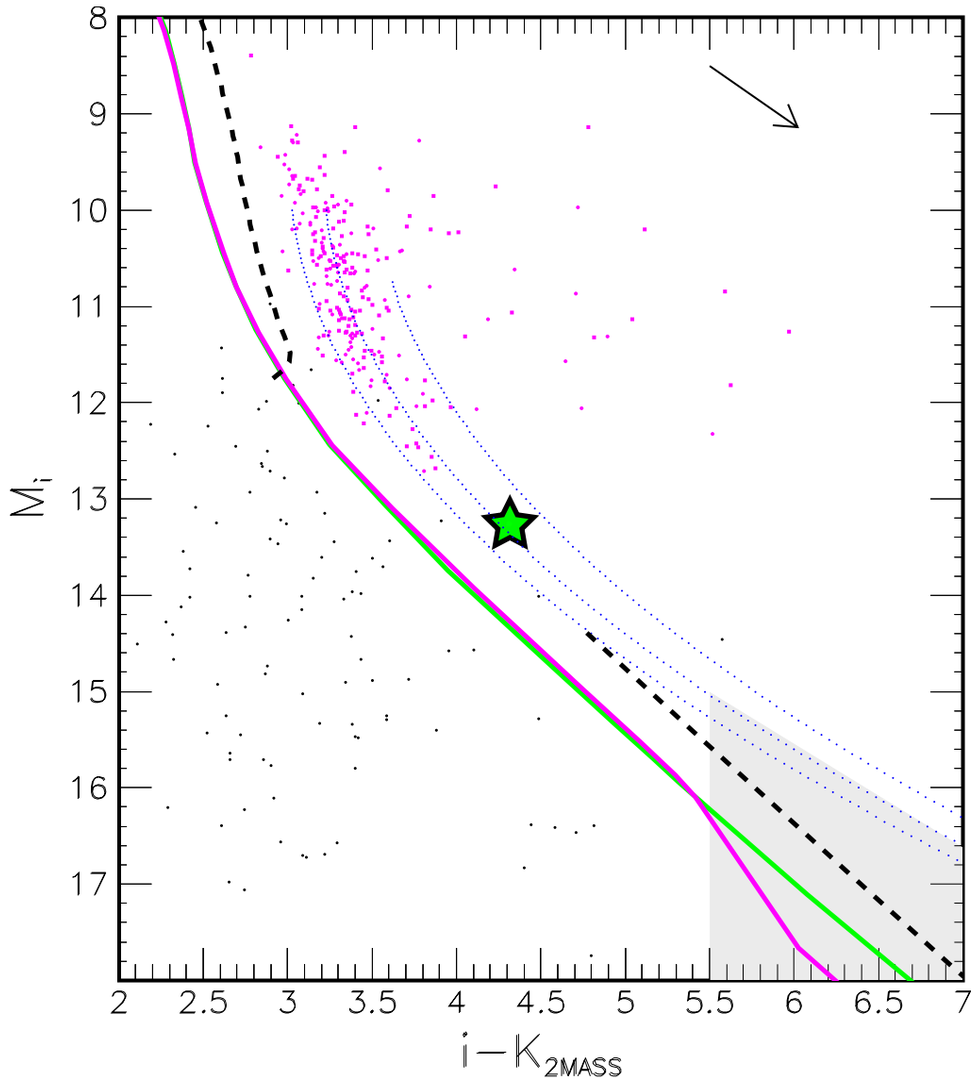



grey: previous analysis based on R11

Plot by Christoph Olczak

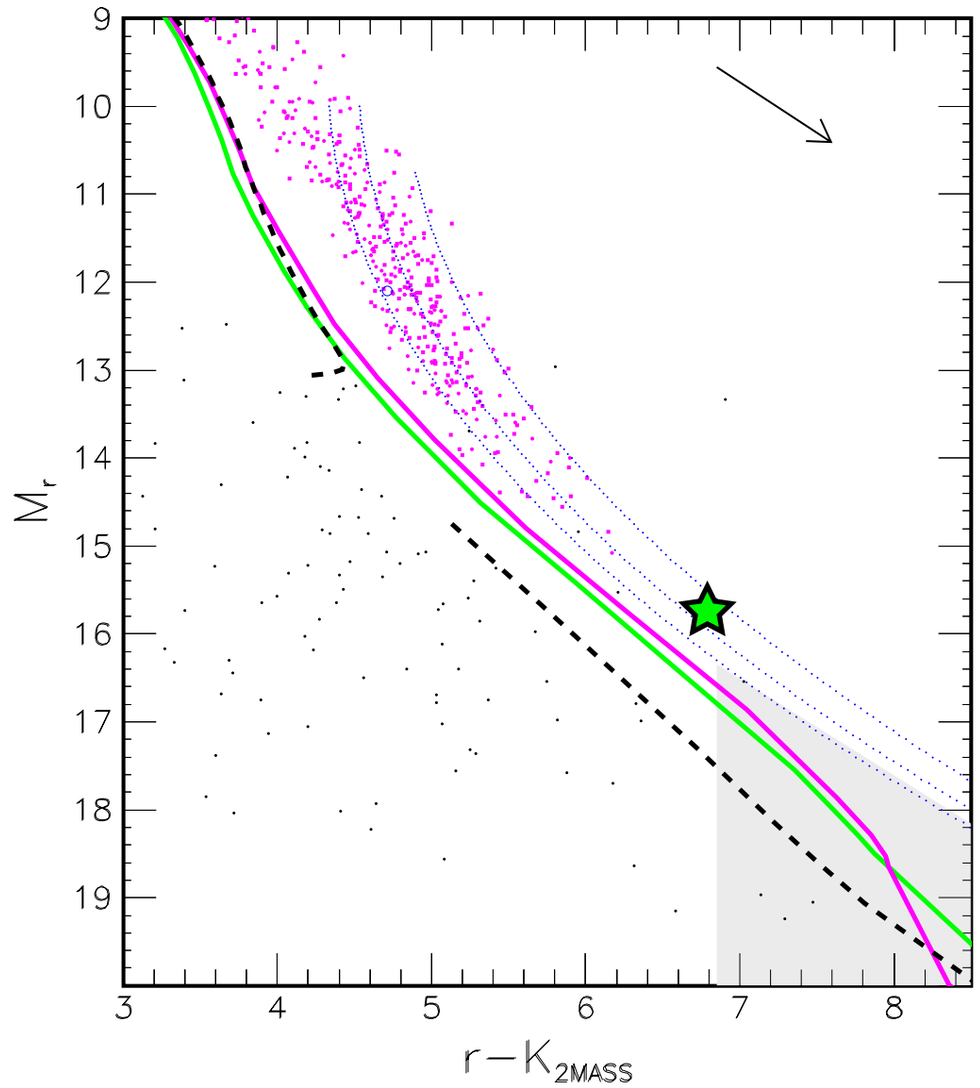
# PS1-only PMs: 1st optical candidate

- 2MASS J04482244+2051433 M6V
  Luhman (2006) as Taurus candidate??
- PS1 PMs: +92±6, -36±5 mas/yr
  [no good match in PPMXL, USNO-B1, NOMAD]
- PS1 parallax: 19±7 mas
  vs. kinematic: 22±1 mas



# PS1-only PMs: 2nd optical candidate

- LP 155-252
- PS1 PMs: +121± 7,–75±7 mas/yr
  vs. +113, –66 mas/yr*
- PS1 parallax: 21±5 mas
  vs. kinematic: 18±1 mas




* Lépine & Shara (2005)

# PS1 parallaxes of kinematic candidates

- Require baseline>1.5 years, 8+ detections, good PM, π
  - 50% of the area
    after two seasons
- 1.5 $10^5$ objects with large PMs
- 400 kin. candidates
- 160 candidates
  based on PS1 parallax
- Still requires photometric
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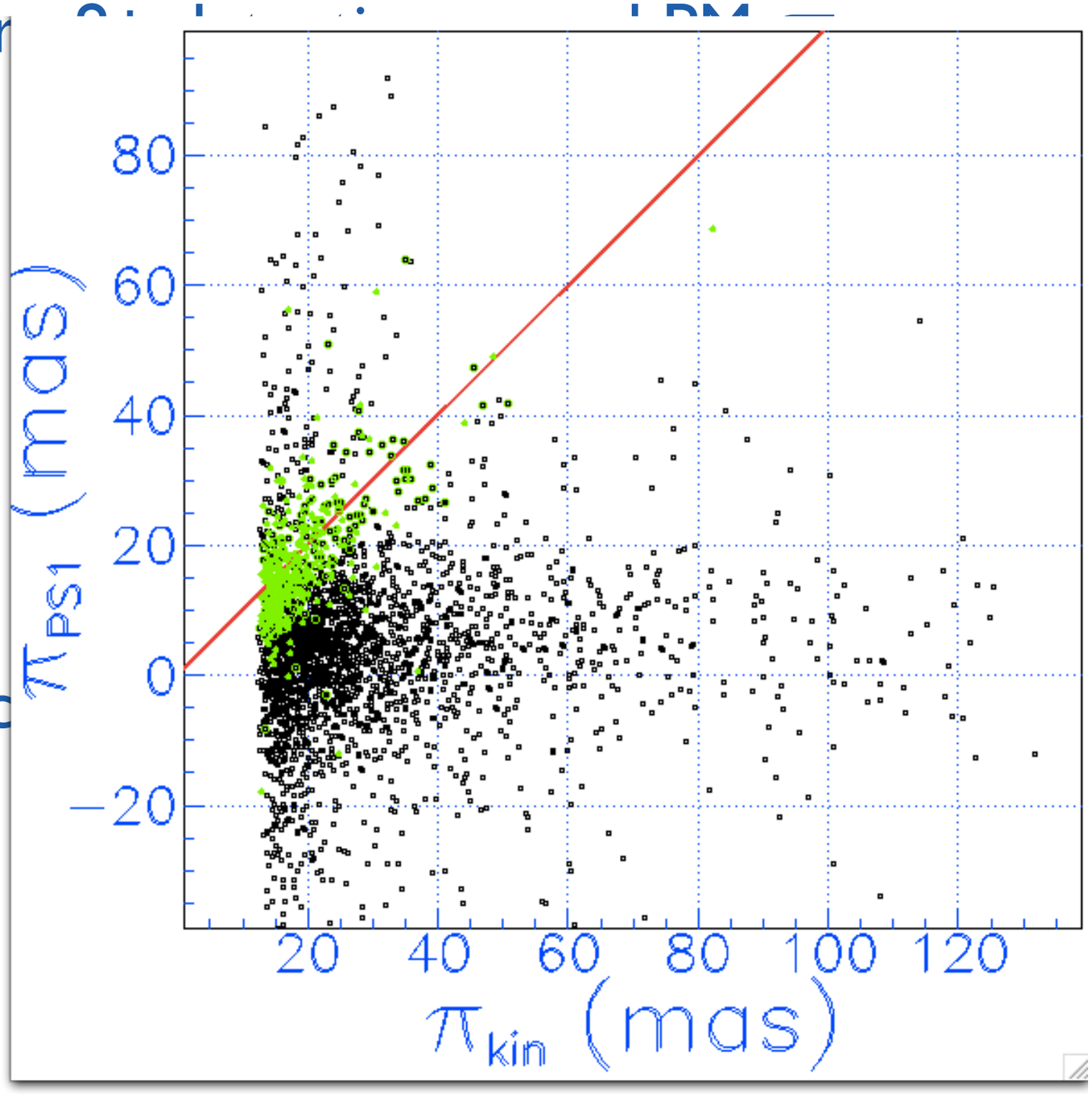

# Conclusions

- Derived the MF to 0.1$M_\odot$ to larger cluster radii
  - double the numbers of candidates with $m$<0.15$M_\odot$
  - depletion of UCDs in the centre
- Cluster simulations provide a roughly good picture
- Multi-band coverage and astrometry improve purity
  - soon parallaxes to allow search for nearby BD members
  - will provide nearby, known-age BDs & good targets for high-resolution imaging for fainter companions