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Argelander-Institut für Astronomie

The present-day mass function of the Quintuplet cluster

Constellation Conference - The Origin of Stellar Masses

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Outline

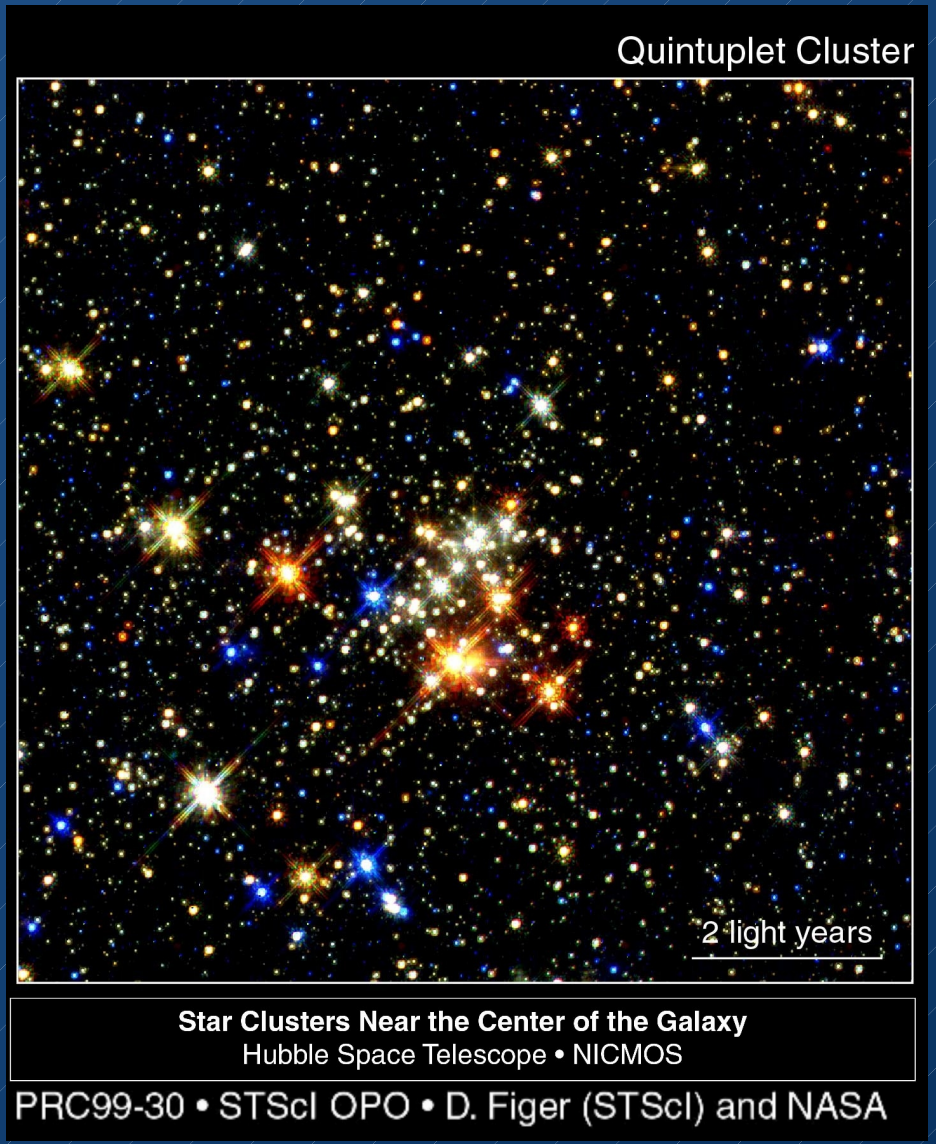
- Introduction
- Data sets
- Data analysis
- Proper motion membership
- Mass determination and PDMF
- Summary and Outlook
- References

Why young massive clusters?

- templates for extragalactic starburst clusters
- unique laboratories for stellar evolution
  - same age
  - homogeneous environment
  - extreme conditions
  - entire mass range

Quintuplet

- Quintuplet cluster
  - age: 4 Myr
  - density: $10^{3.2}$ $M_\odot pc^{-3}$ (Figer+ 1999)
  - Arches: 2.5 Myr, $10^{5.3}$ $M_\odot pc^{-3}$ (Espinoza+ 2009)
  - 85 OB stars, 13 WR stars, 2 LBV (Liermann+ 2009)



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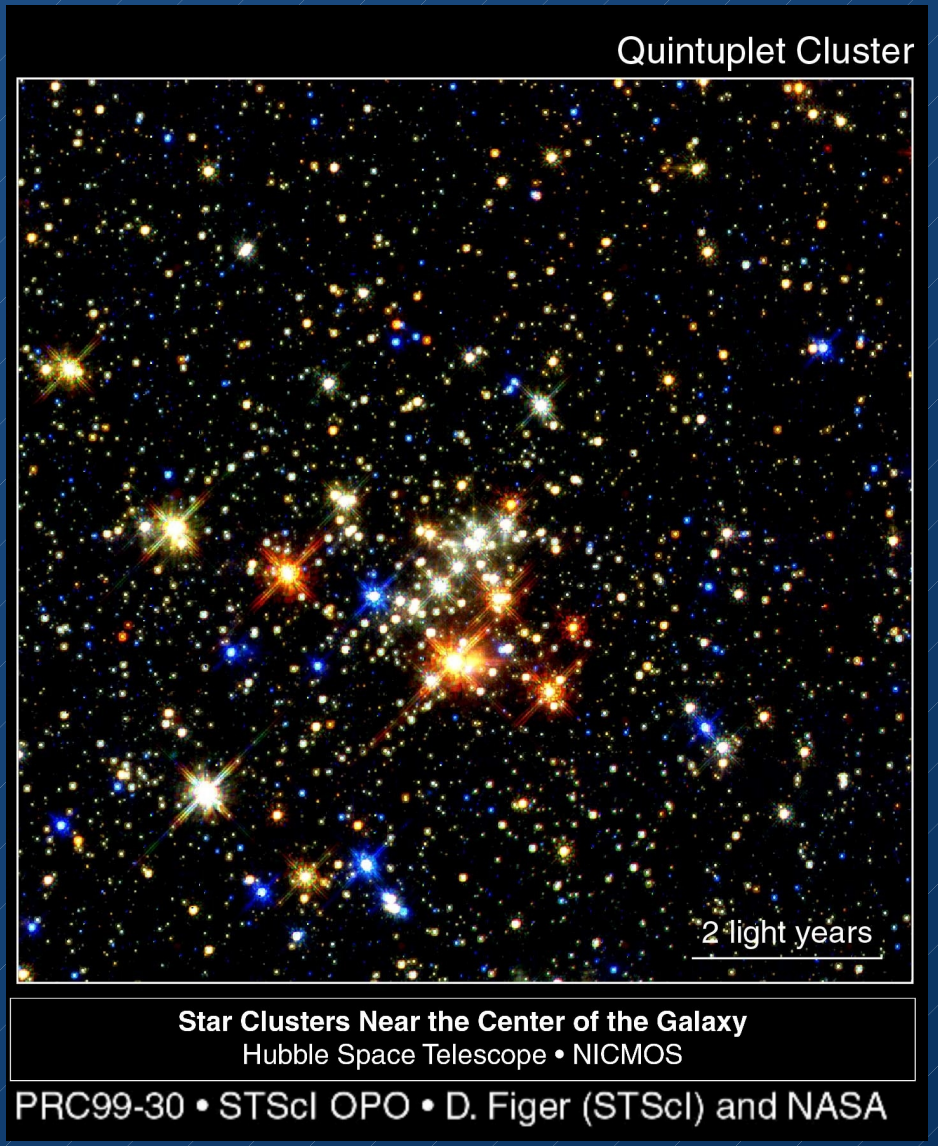
  - 85 OB stars, 13 WR stars, 2 LBV (Liermann+ 2009)
- Current aims
  - determine unbiased sample of cluster stars based on proper motion measurements
  - derive the present-day mass function (PDMF)



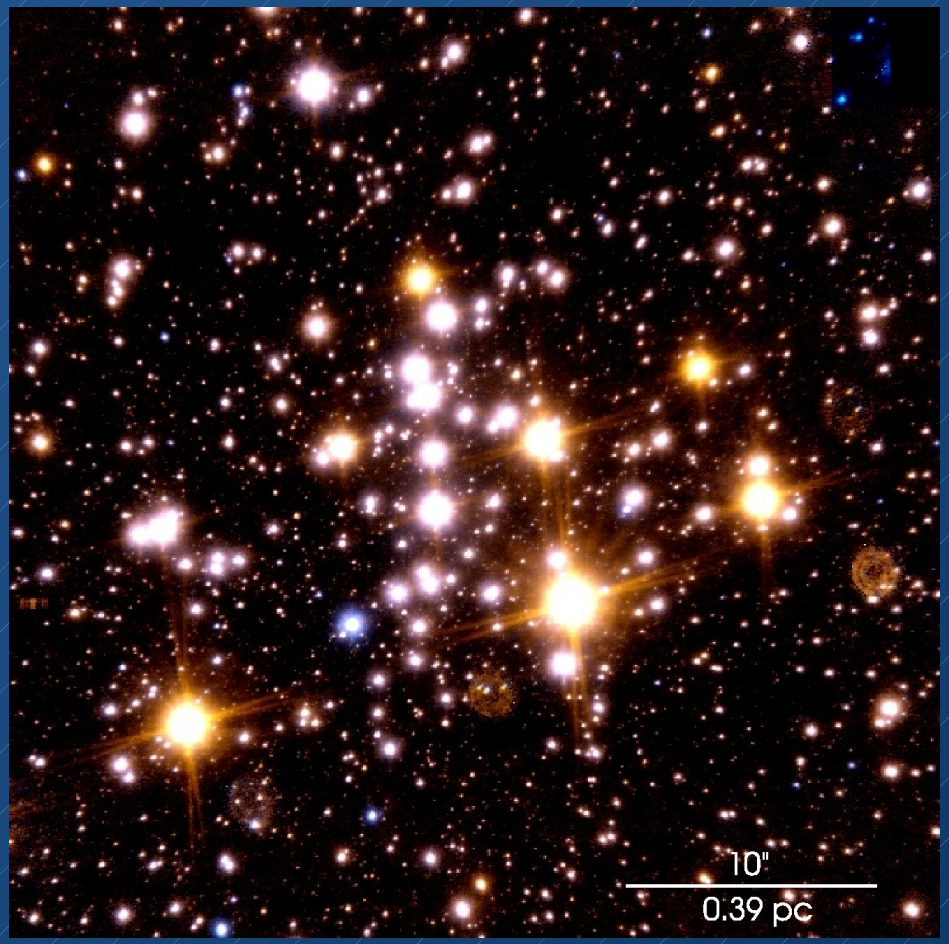
Data sets

- Two epochs of VLT NAOS-CONICA adaptive optics observations

2003	2008
Ks 2.0s Ks 20.0s H 2.0s	Ks 2.0s

  - time baseline of 5.0 years
  - FWHM: 78 mas - 82 mas
  - overall field of view: 36"

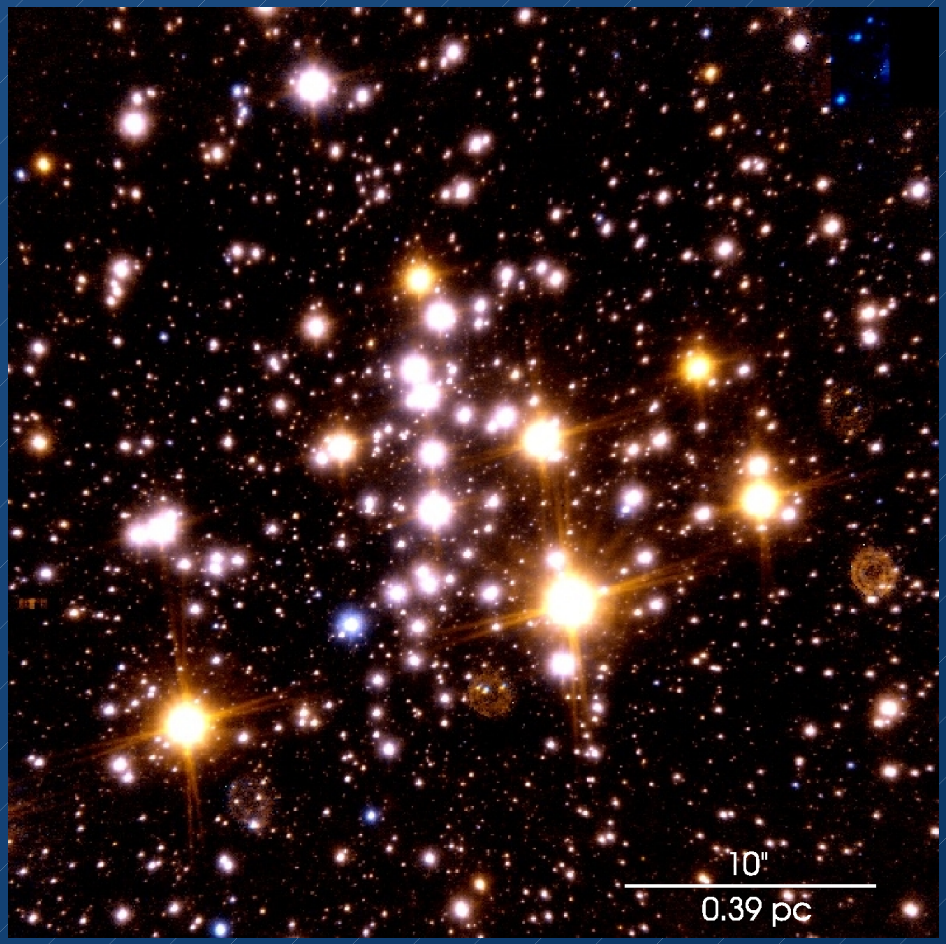
Data analysis



HK-composite image

Data analysis

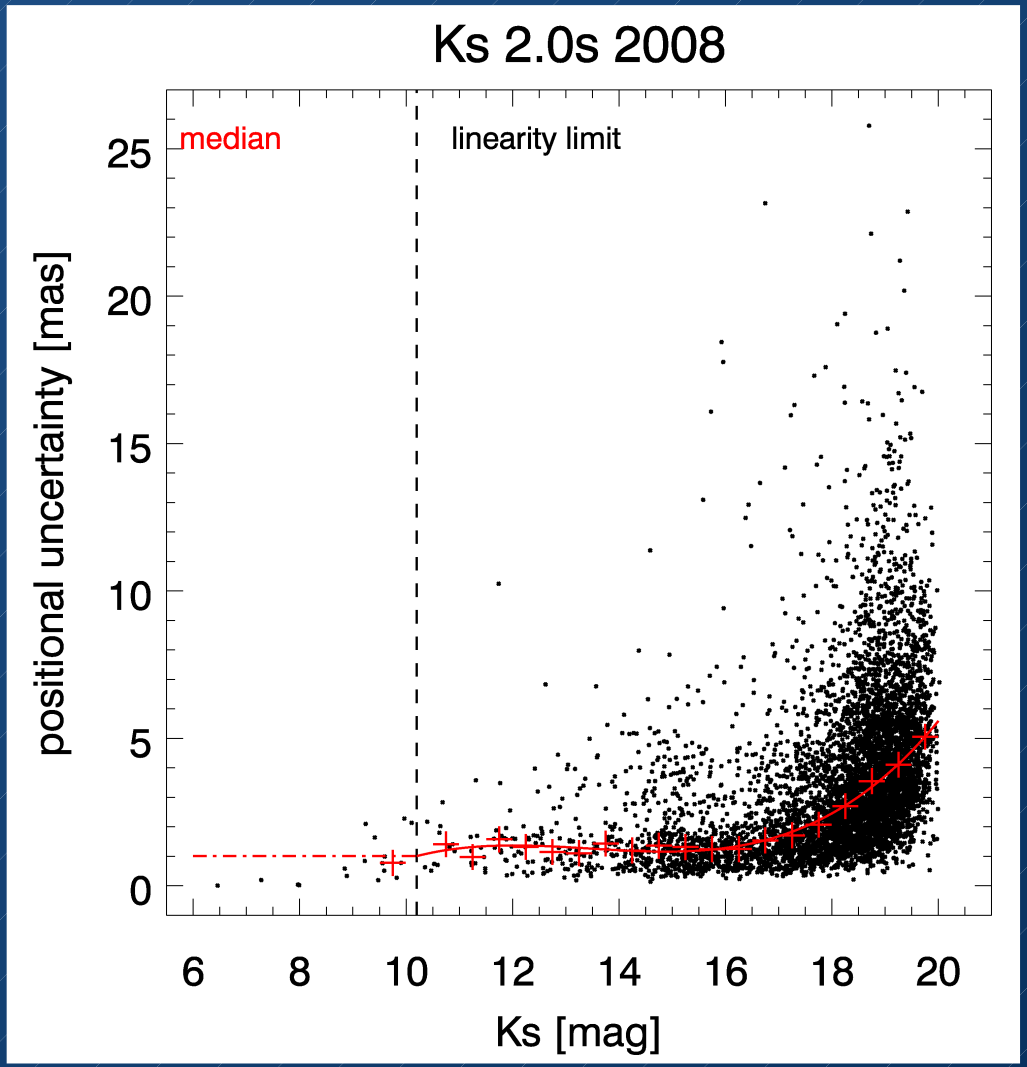
- combine frames with the *drizzle* algorithm
- stellar positions/fluxes determined with *starfinder*
- photometric calibration:
  - match stars with calibrated UKIDSS sources
  - determine zeropoints



HK-composite image

Data analysis

- error estimation
  - create three images from subsets of the data with equal coverage
  - determine stellar fluxes/and positions for each image
  - positional uncertainty:
    $\sigma_{pos} = (\sigma_x + \sigma_y)/2$



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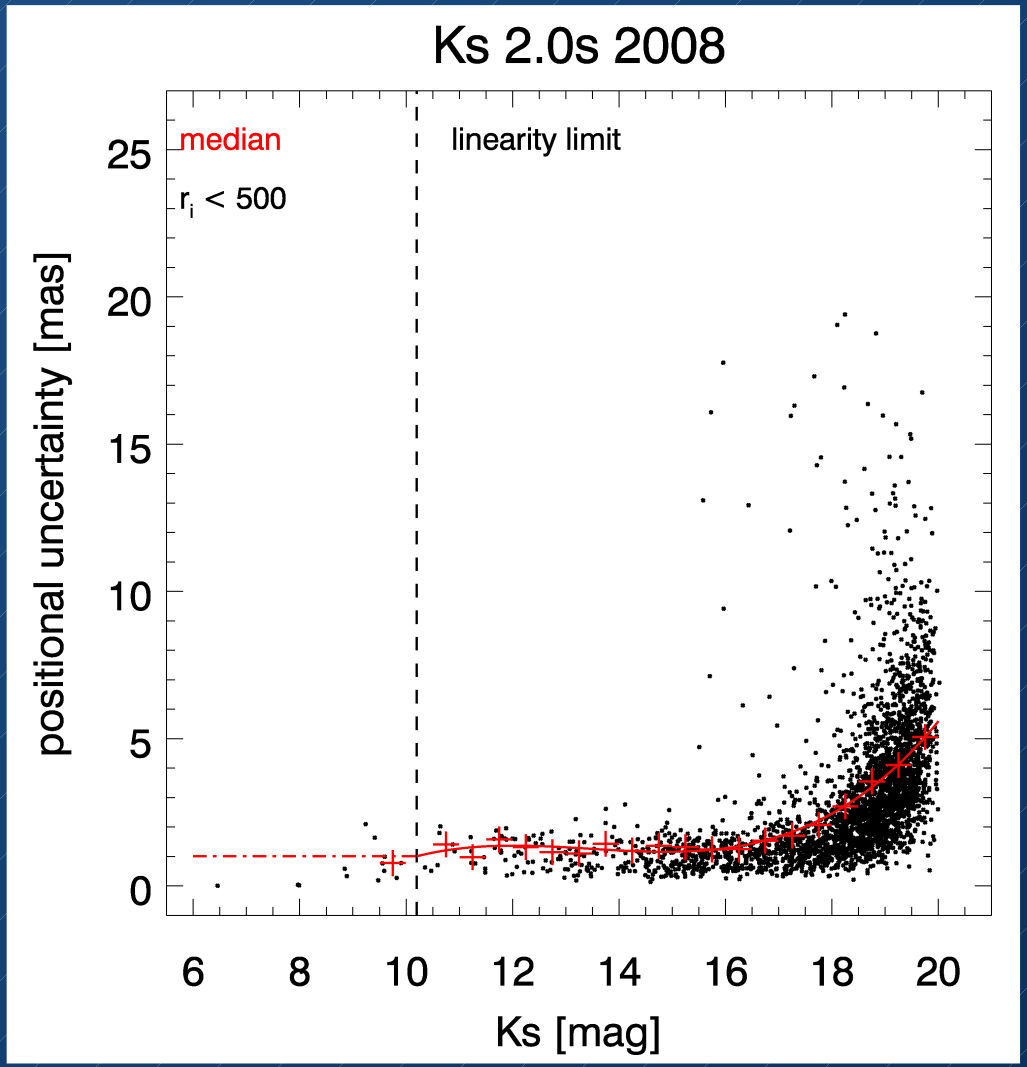

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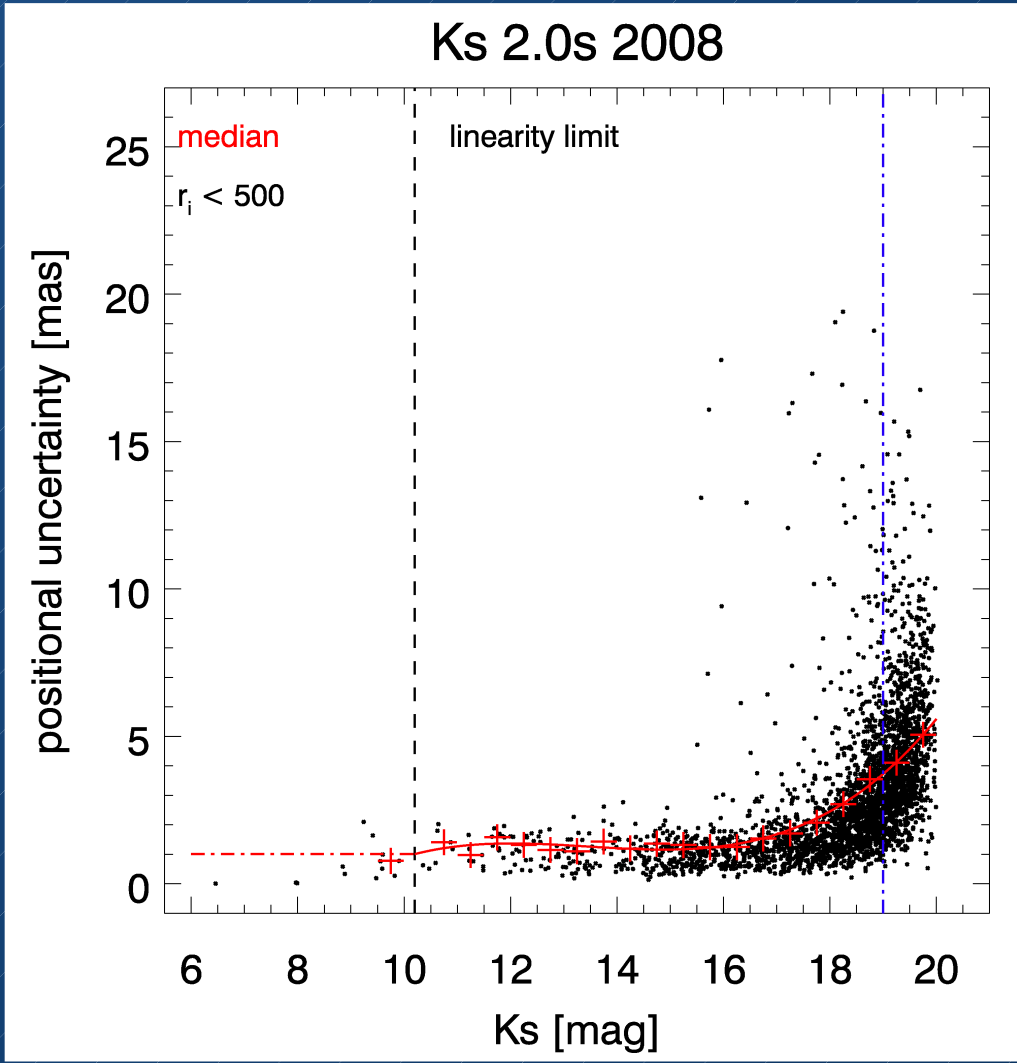
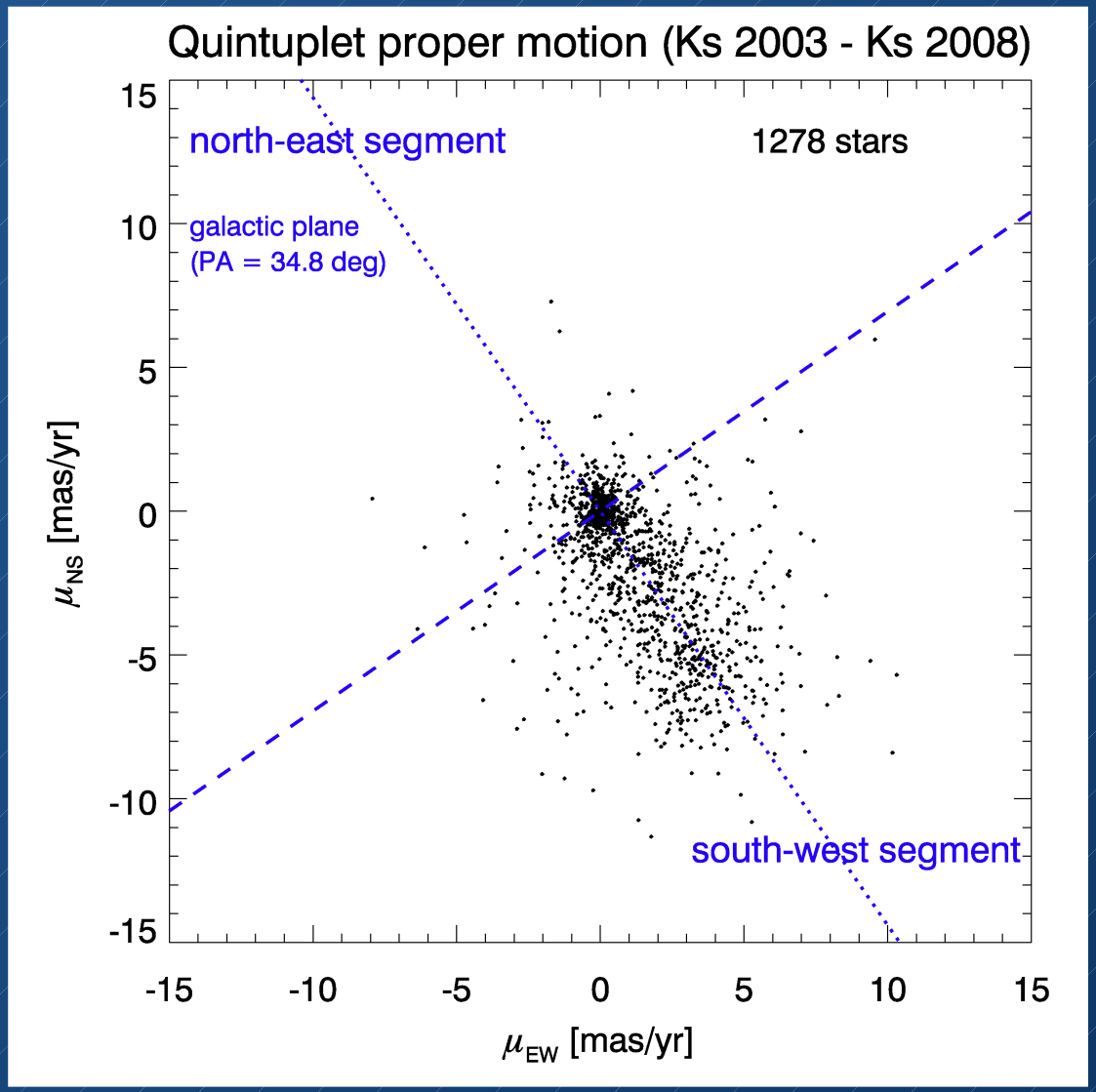
- magnitude cut at $m_{Ks} = 19$ mag



Data analysis

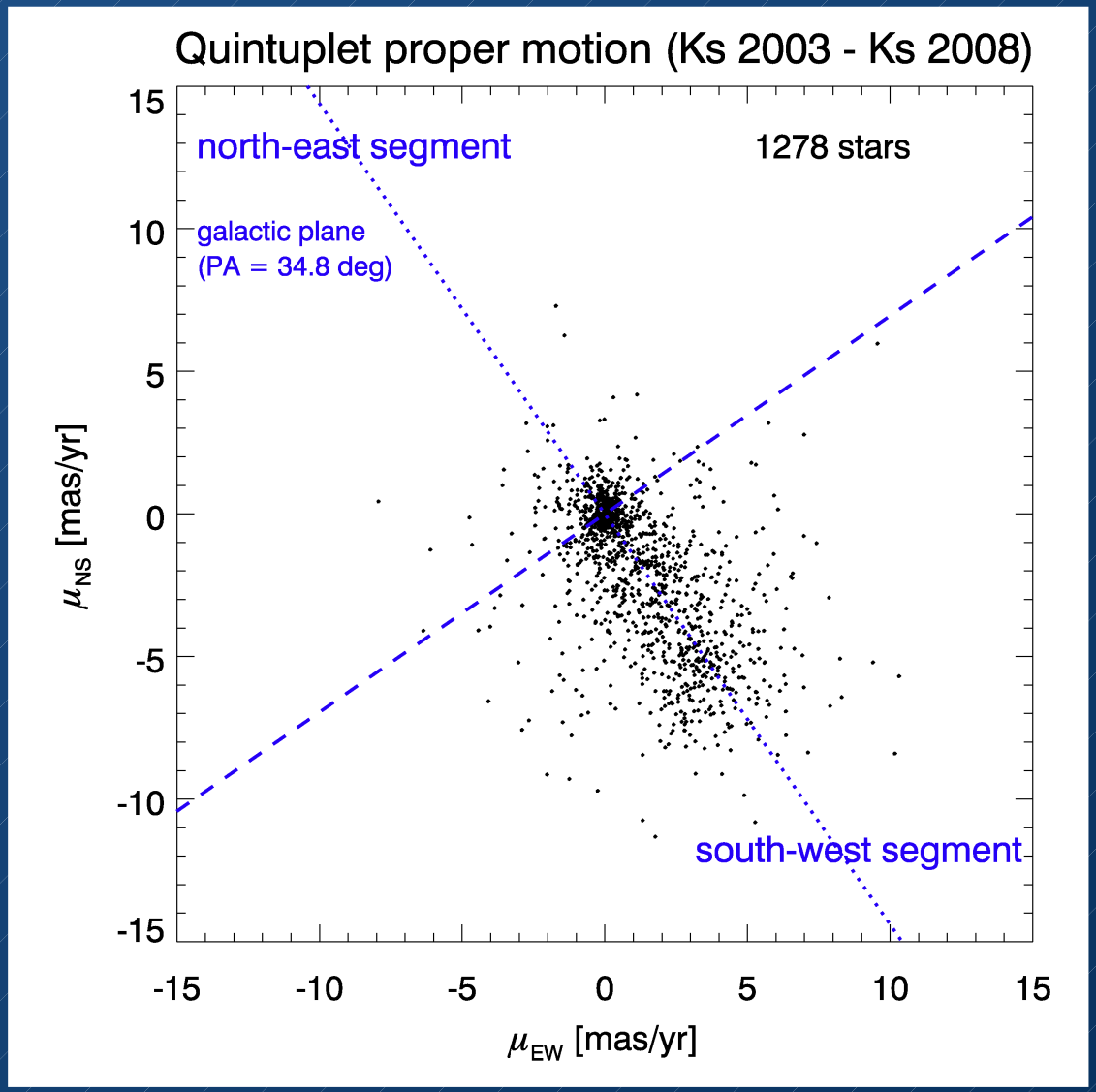
- derive spatial displacements between the two epochs
- use IRAF *geomap* to map Ks 2003 onto Ks 2008
  - assumption: internal motions are not resolved
    → cluster as reference frame
  - individual geometric transformations for
    - Ks 2003 2.0s → Ks 2008 2.0s
    - Ks 2003 20.0s → Ks 2008 2.0s
  - two proper motion catalogues
- combine the proper motion catalogues
  - Ks < 14 mag: Ks 2003 2.0s
  - Ks > 14 mag: Ks 2003 20.0s

Proper motion diagram



Proper motion membership

- NE-segment: least field contamination
- membership criterion:
  - fit distribution of proper motion with a gaussian
  - $2\,\sigma_{NE} = 2.3$ mas/yr



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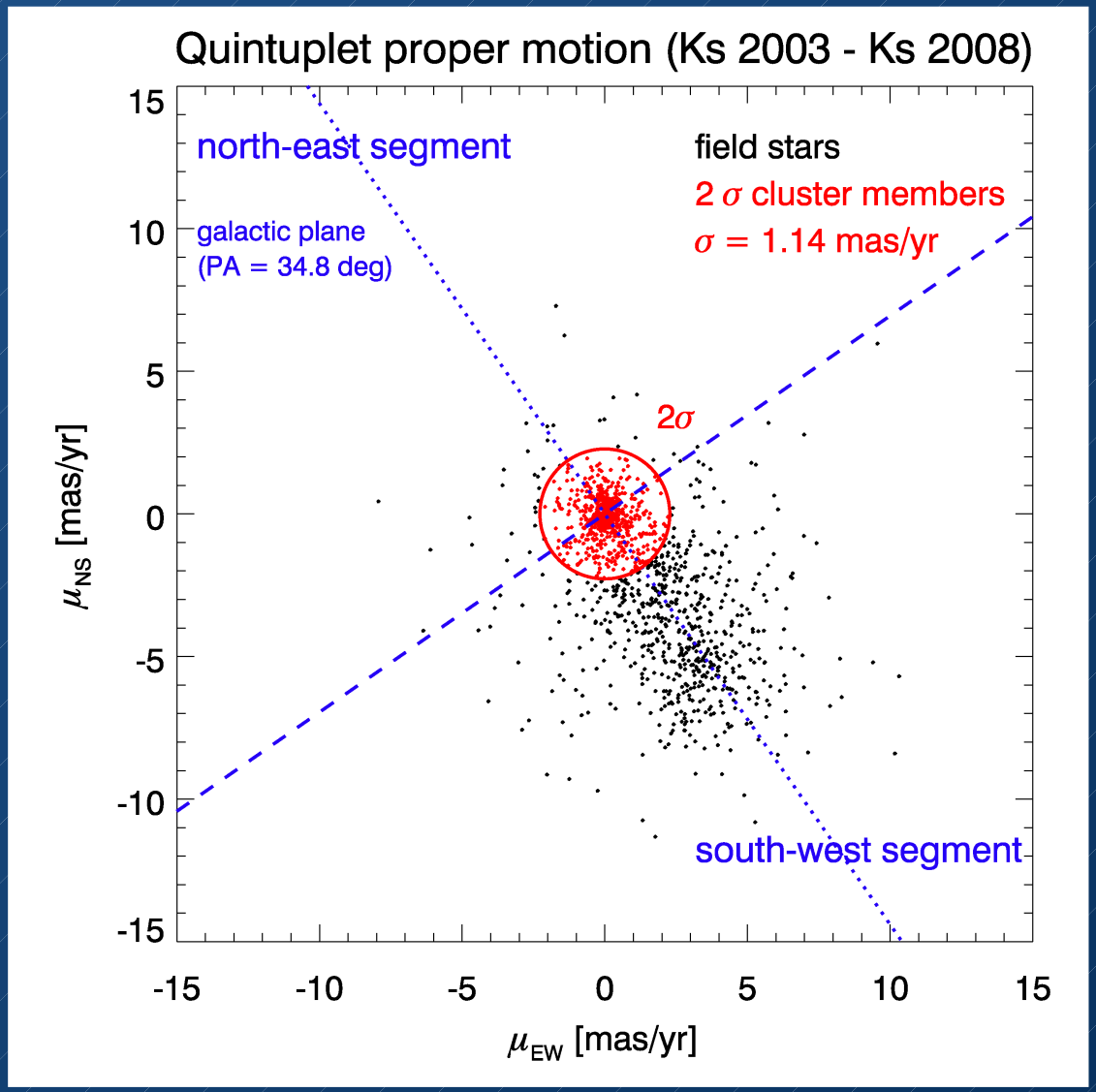
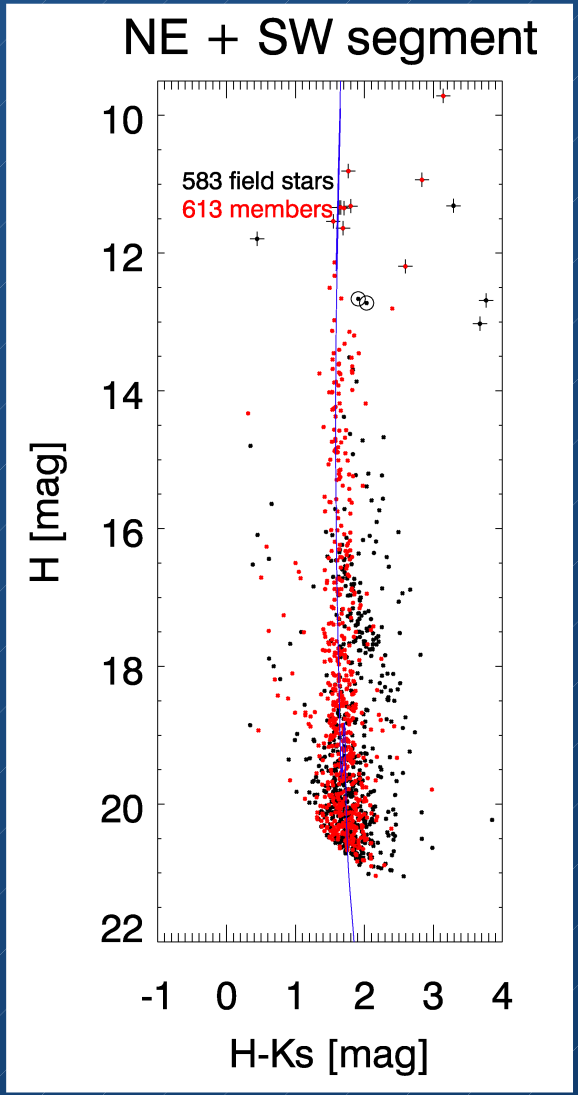
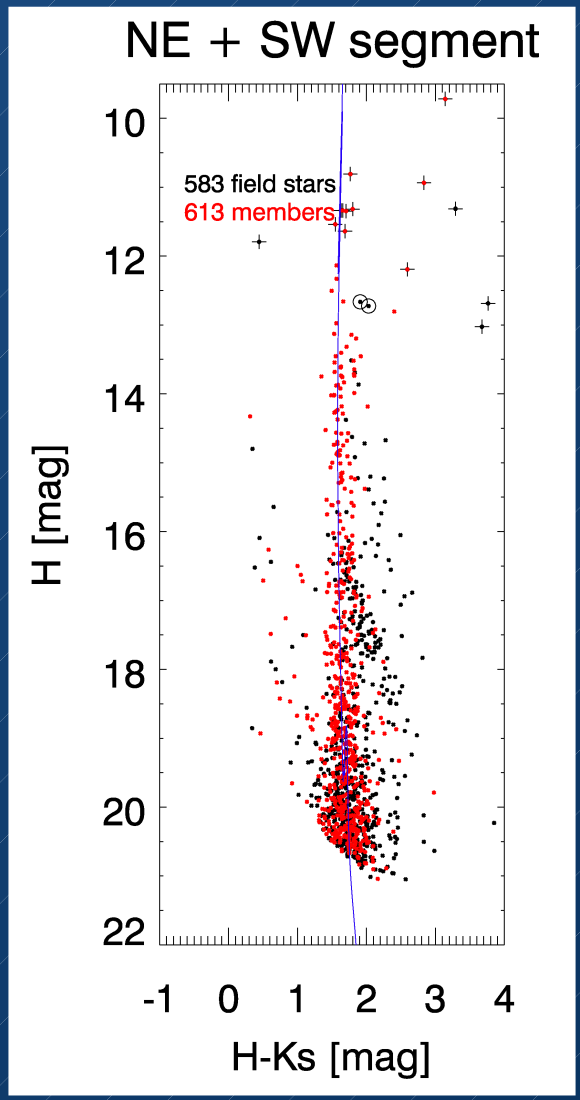


Colour-magnitude diagrams



Colour-magnitude diagrams

- assumed age: 4 Myr
- combined isochrone (Gennaro+ submitted to MNRAS)
  - Padova MS-isochrone (Marigo+ 2008)
  - Pisa-FRANEC PMS-isochrone (Degl'Innocenti+ 2008)
- distance: 8 kpc (Ghez+ 2008)
- average extinktion: $A_K = 2.3$ (extinktion law from Nishiyama+ 2009)



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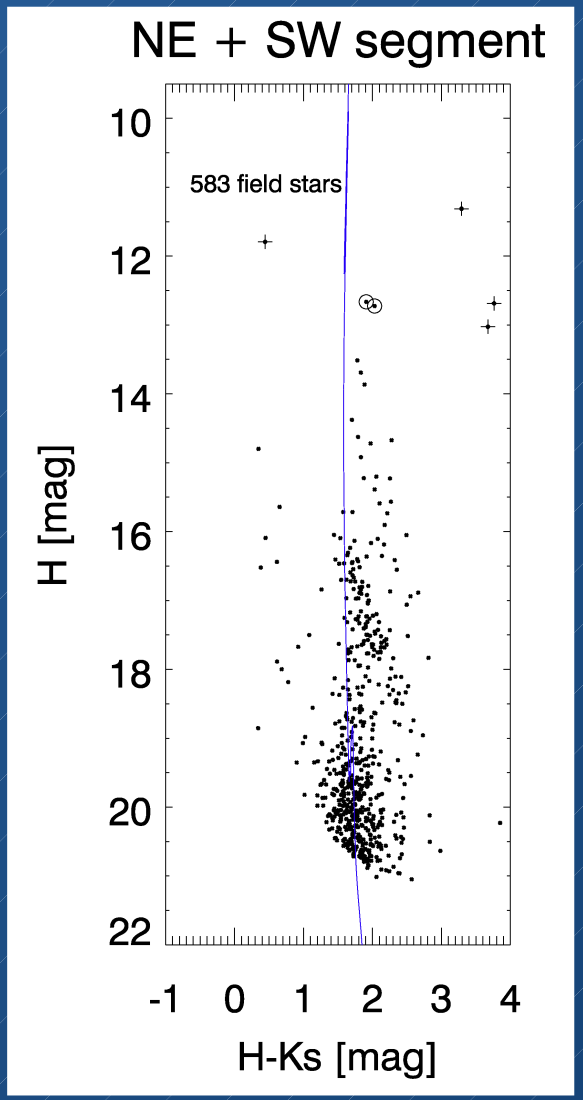

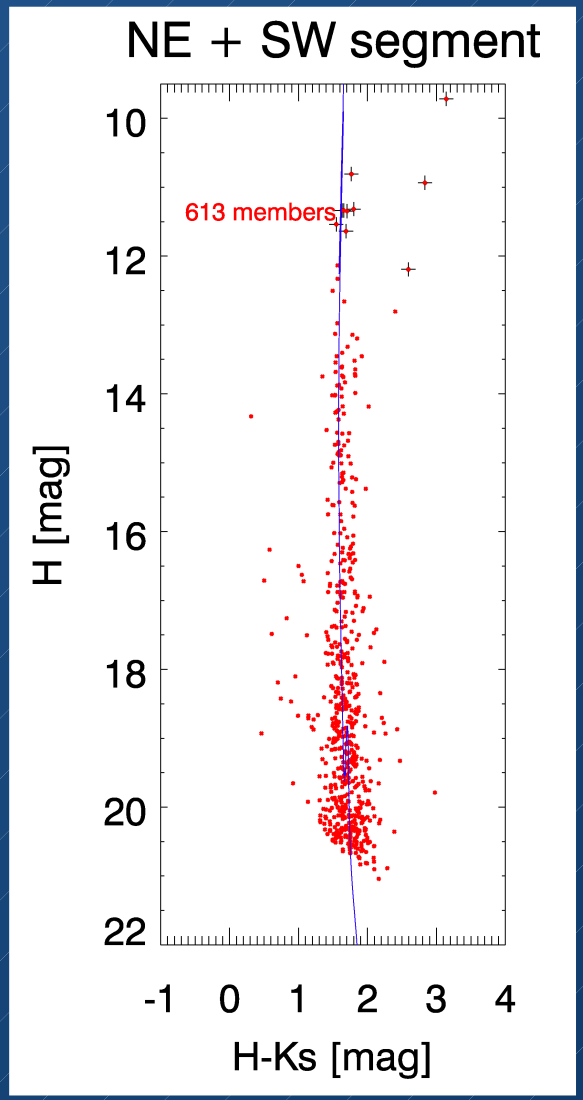

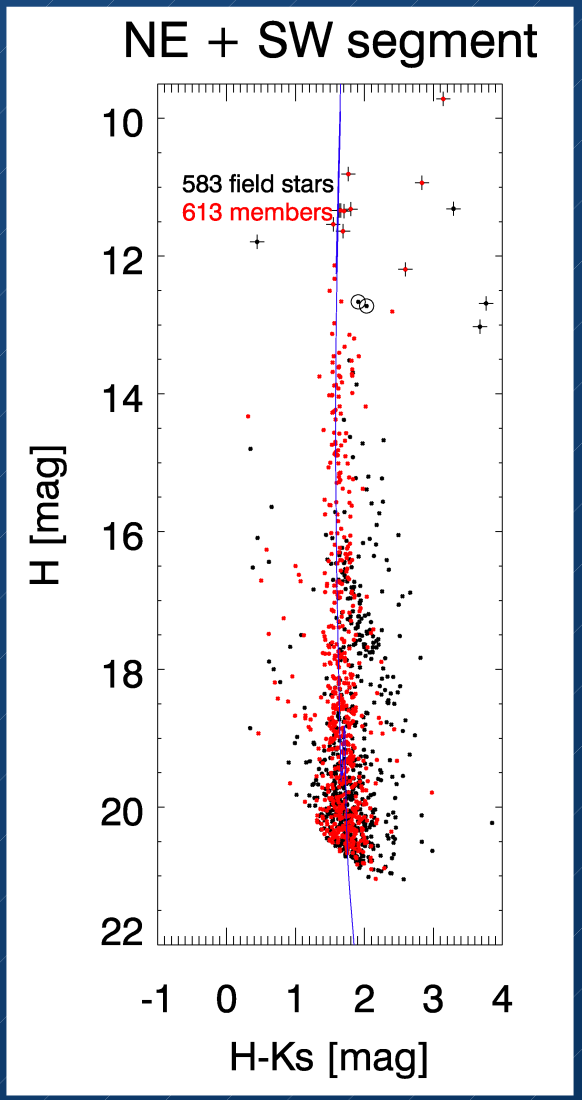

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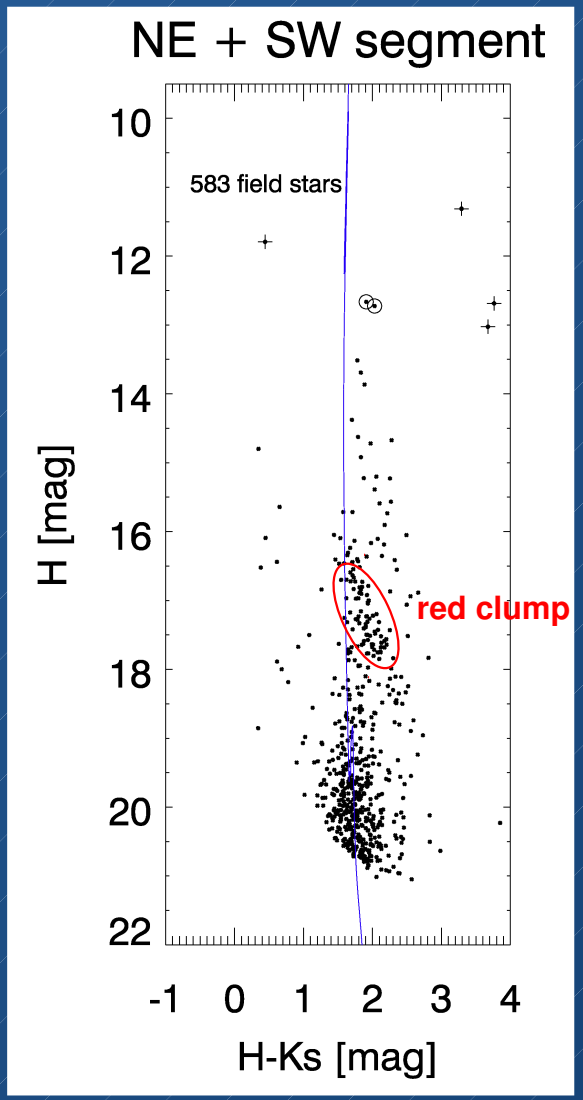

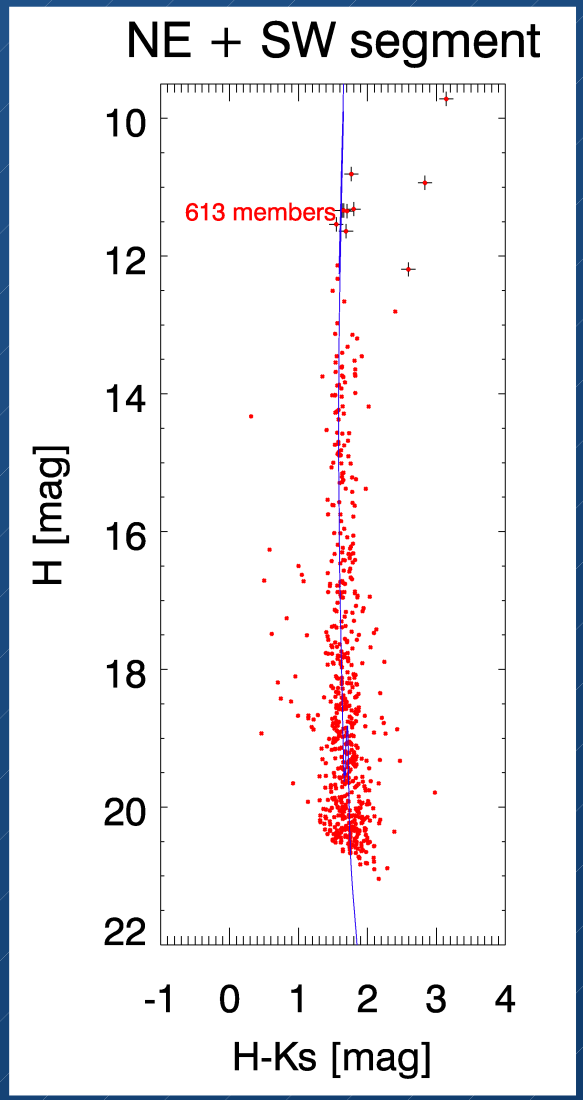

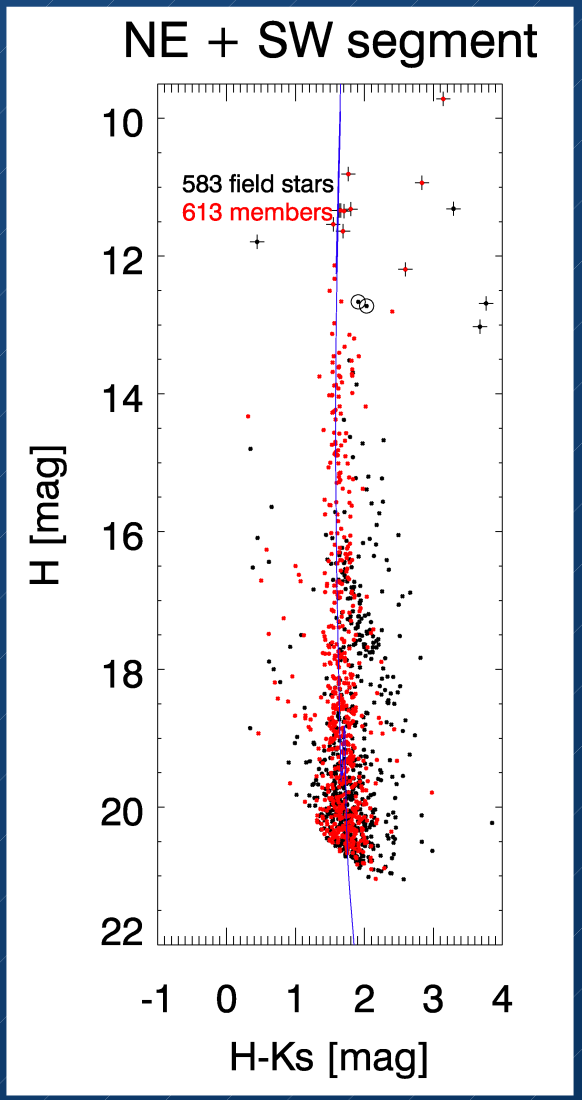

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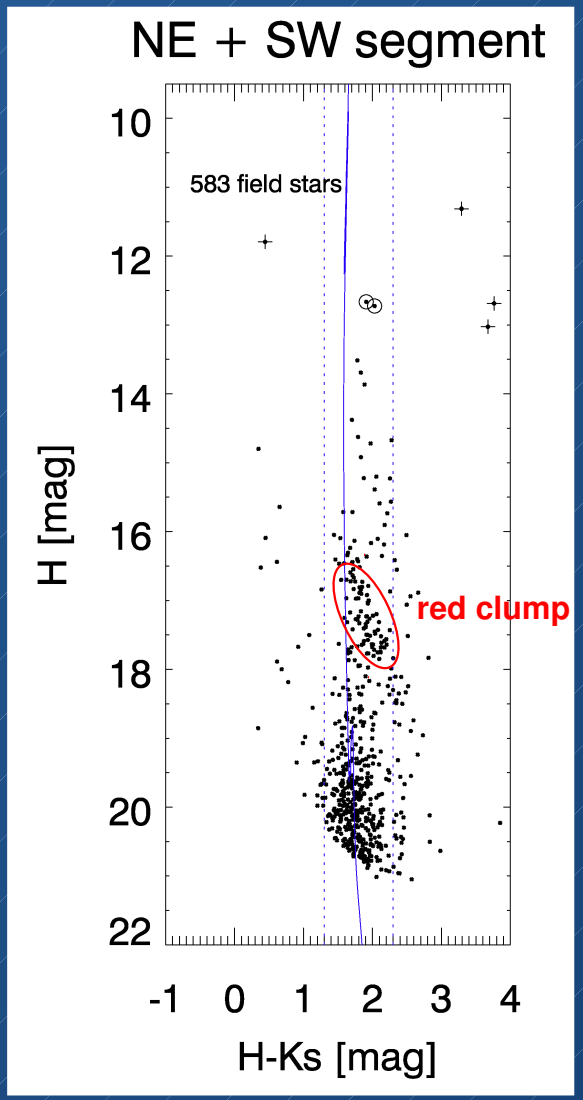
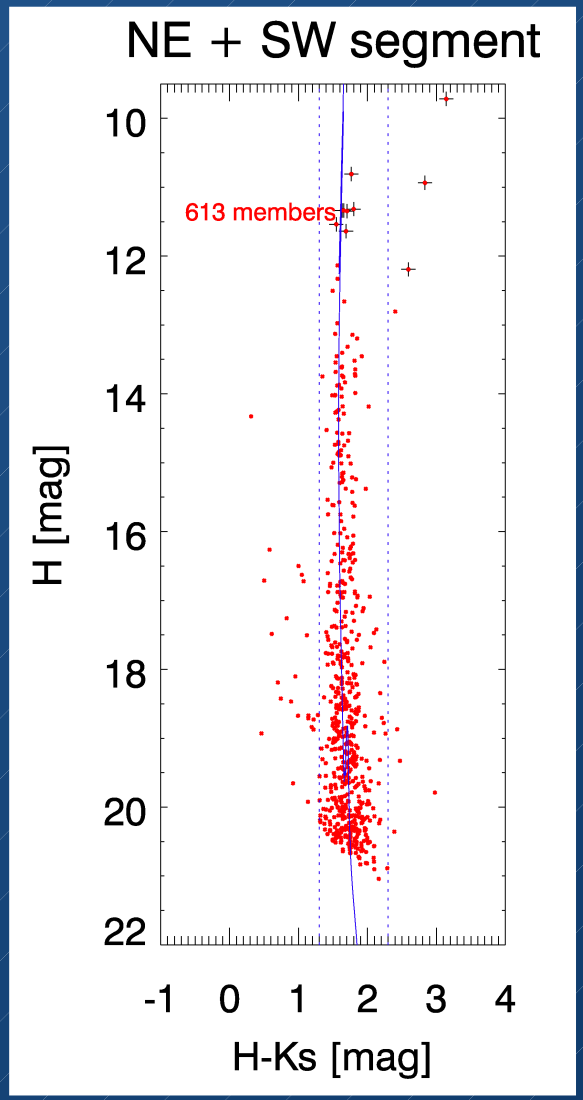
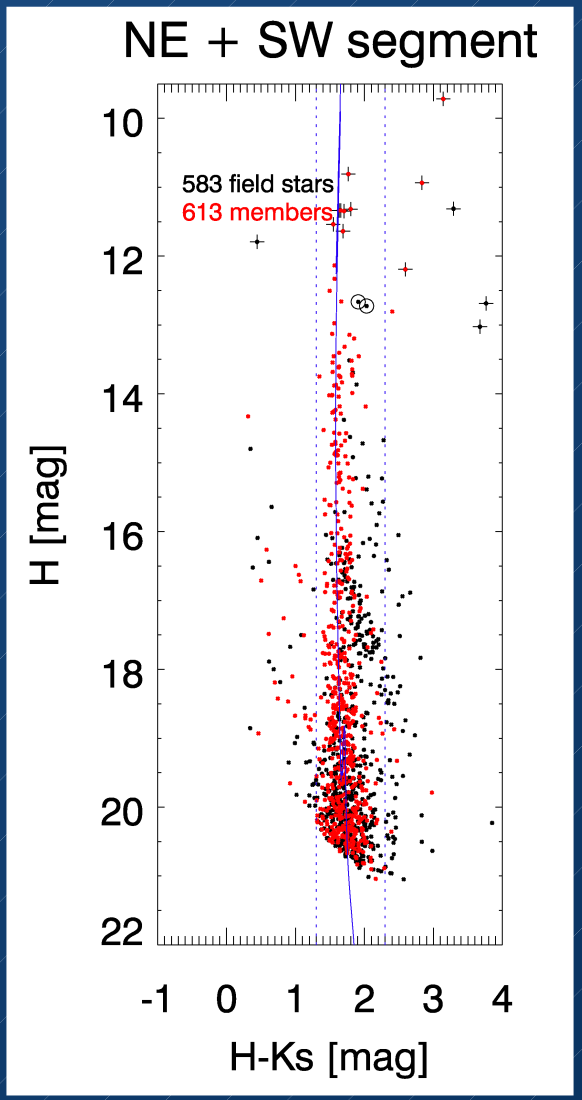
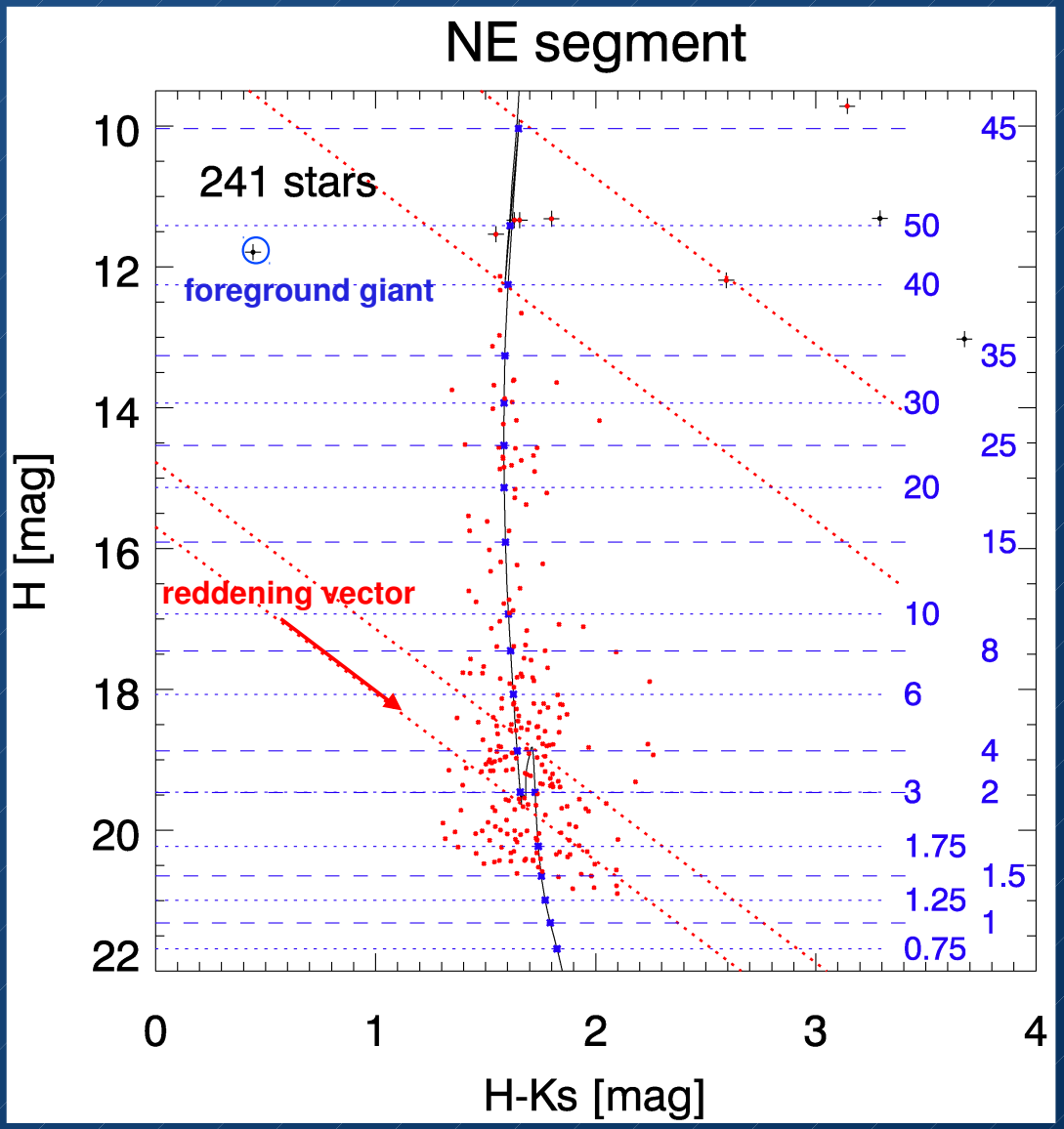




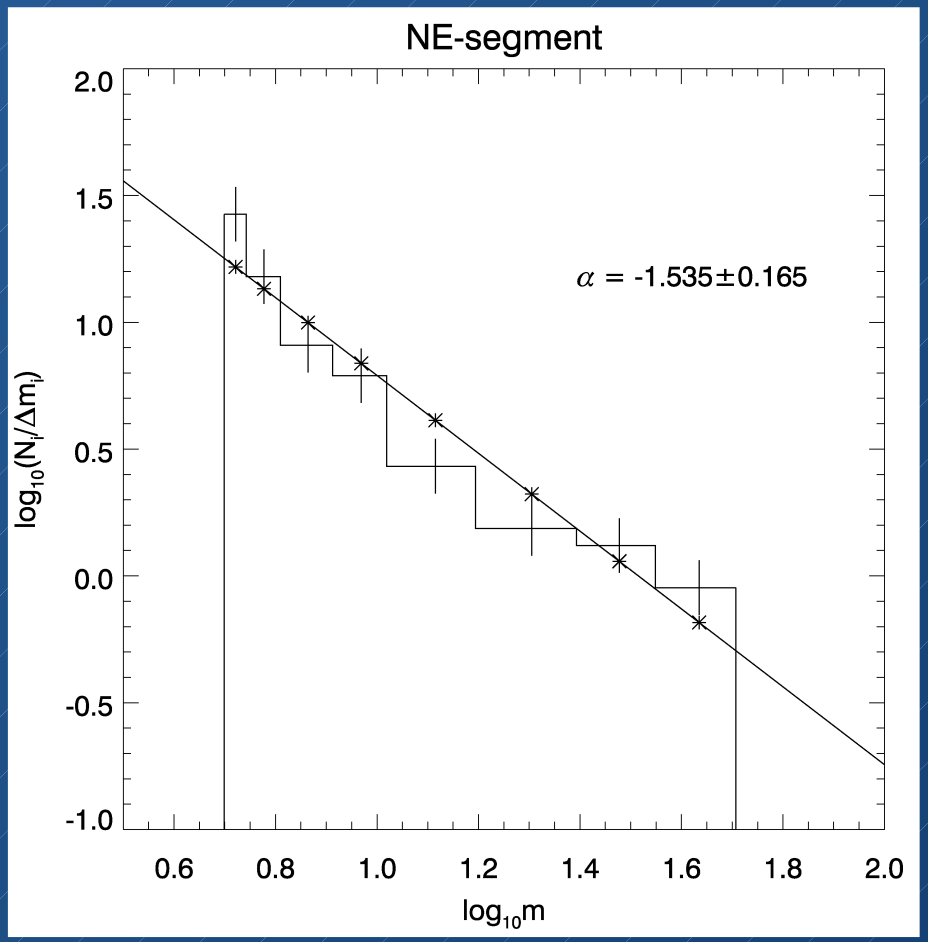


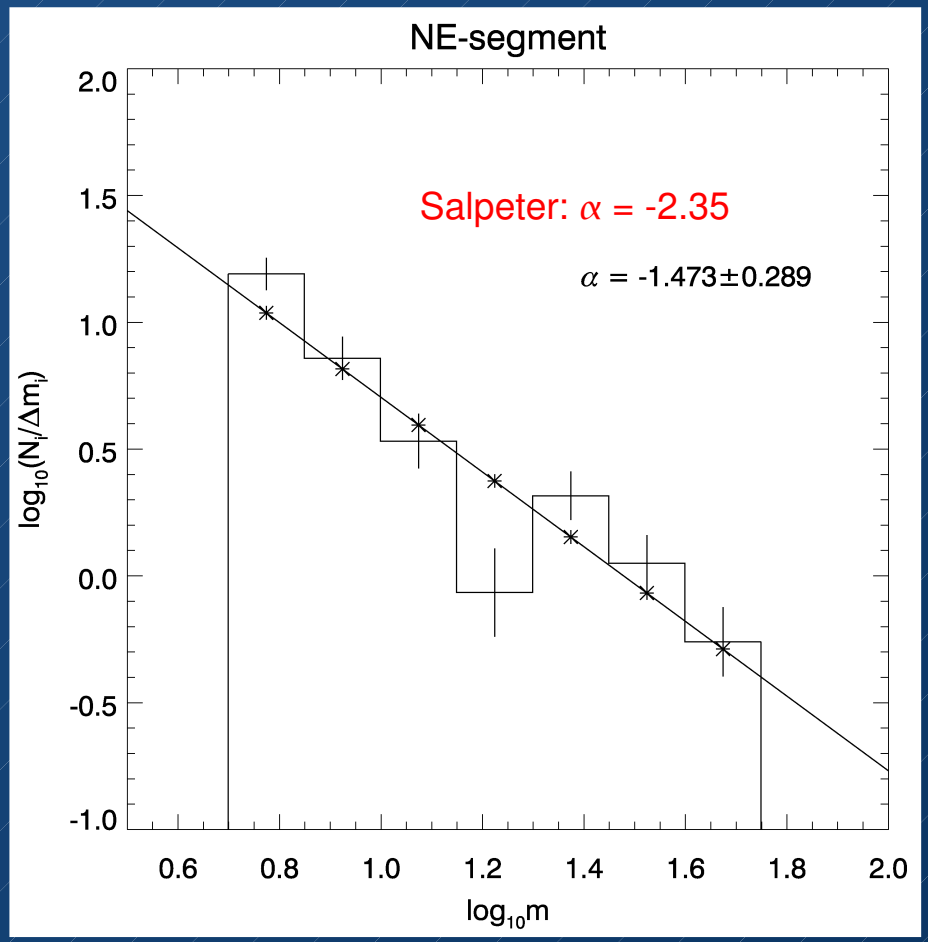
Mass derivation (NE)

- mass derivation for the cleanest sample
  - NE-segment
  - color-cut for $m_H > 13$ mag: $1.3 \leq H\text{-}Ks \leq 2.3$
  - keep saturated cluster members
- minimum mass
  - 90% complete in H-band at $m_H > 19.5$ mag
  - $M_{min} = 5\ M_\odot$ (avoid ambiguities)



Quintuplet PDMF





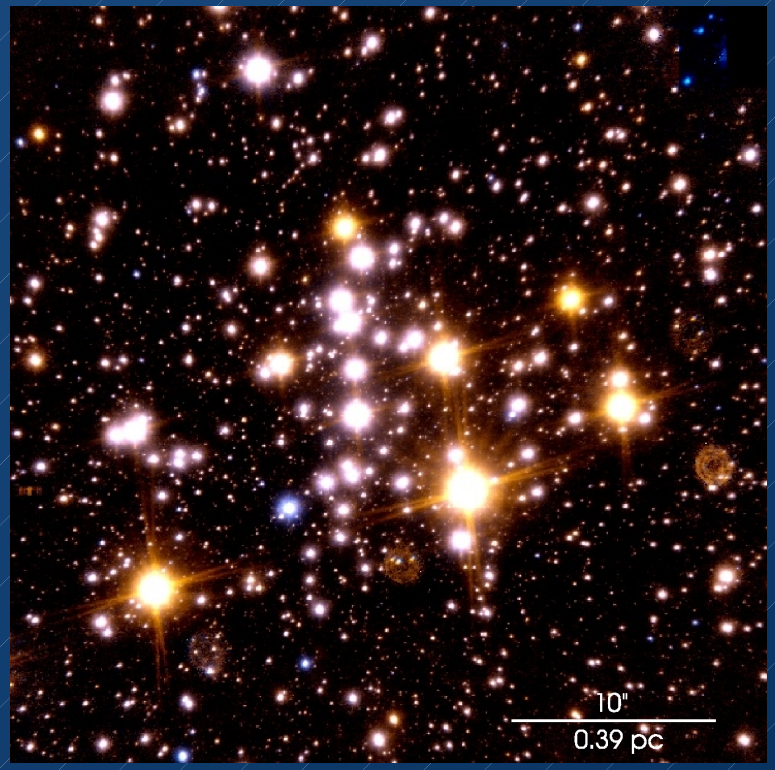
uniform number per bin: 14 stars
(as suggested by Maíz Apellániz+ 2005)

uniform logarithmic bin size: 0.15
(unweighted fit)

Summary and Outlook

Summary

- derivation of a clean sample of cluster members using proper motion for the Quintuplet cluster
- top-heavy PDMF in the cluster core (r = 0.5 pc)
- likely scenario: mass segregation



Outlook

- measure PDMF in outer fields
- quantify the dynamical evolution

References

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