The low-mass initial mass function and dynamical state of Westerlund 1

Westerlund 1 (WFC3 J,H, 4'*5')

Morten Andersen (LAM, Marseille)

Outline

- Local and massive cluster IMF
- Wd1: HST obs. and mass functions
- Wd1: velocity dispersion
- Wd1: age spread

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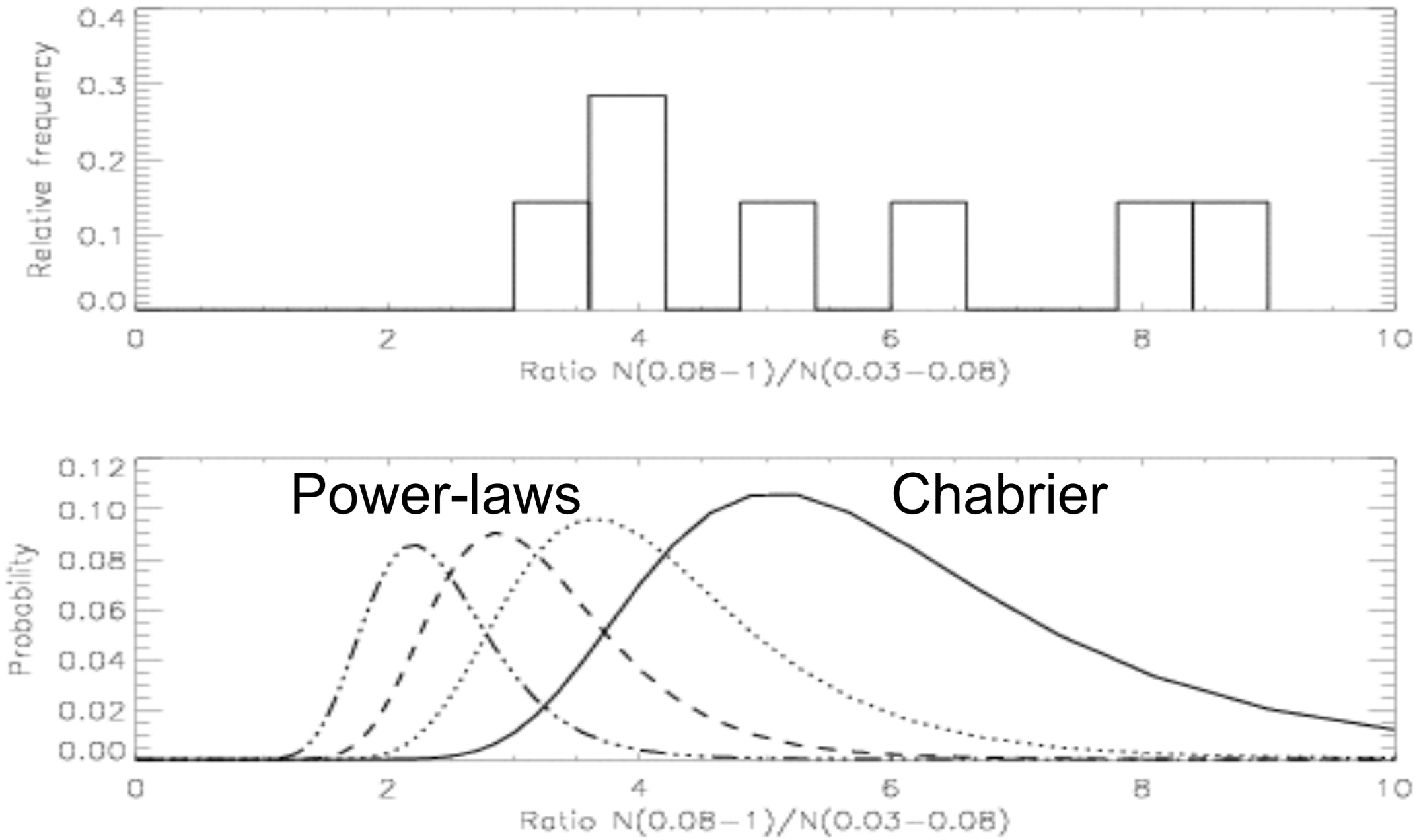
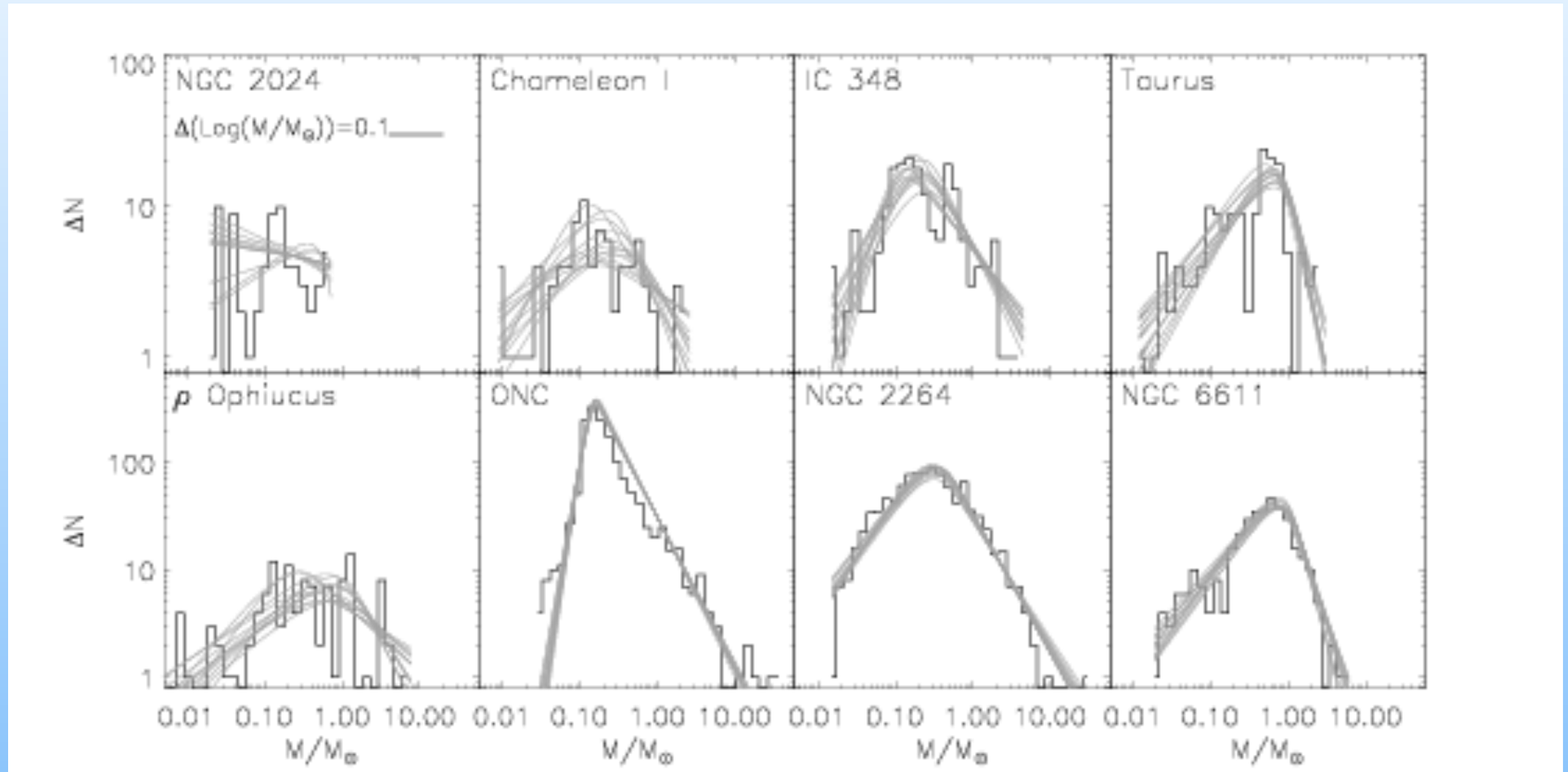
IMF in nearby emb. clusters

Ratio of stars to brown dwarfs similar.



Andersen et al. 2008. ApJL, 683, 1083

Recent sample

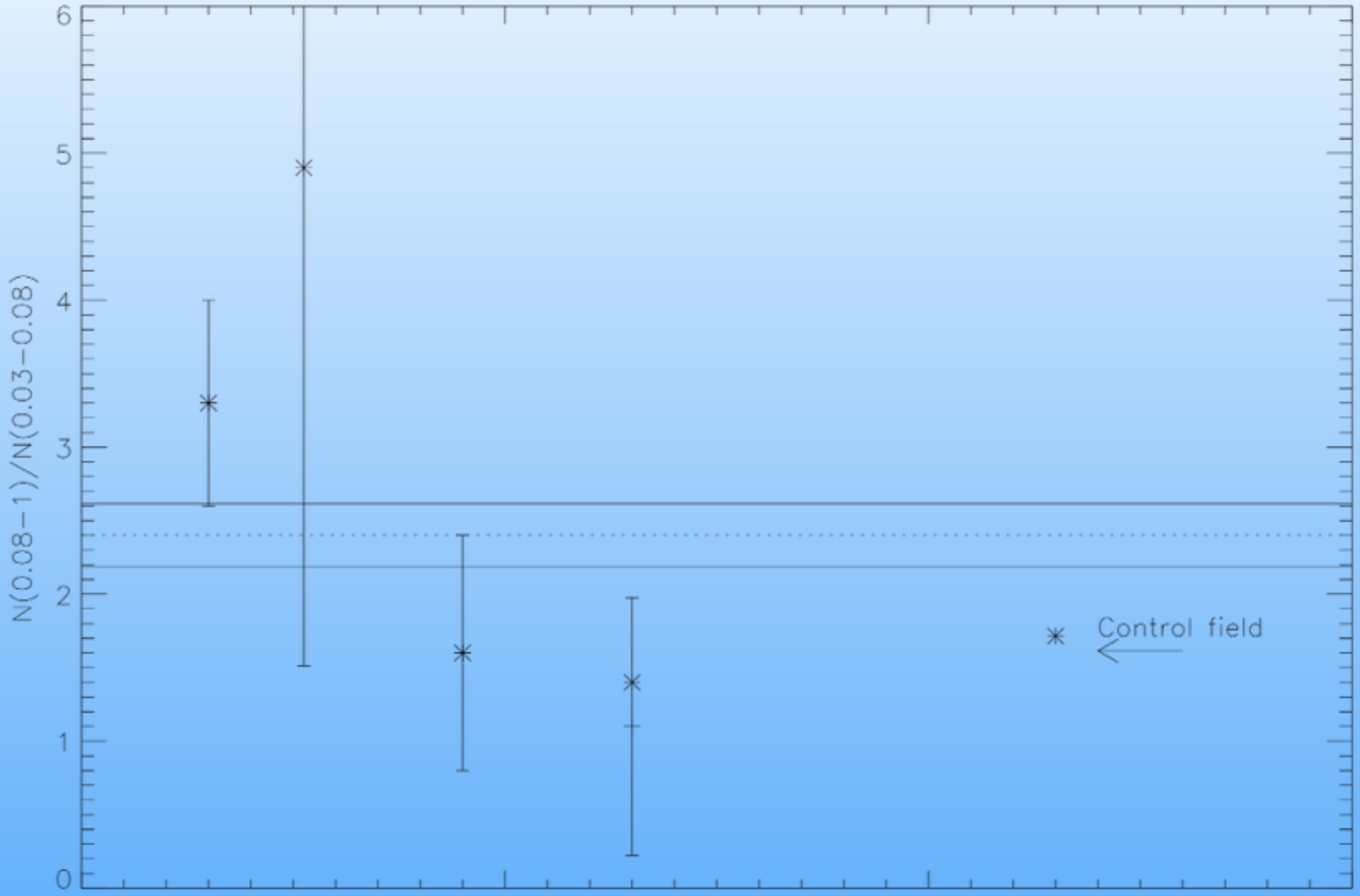


Dib 2014, MNRAS

Incompleteness, different methods to derive Teff

Extinction limited samples

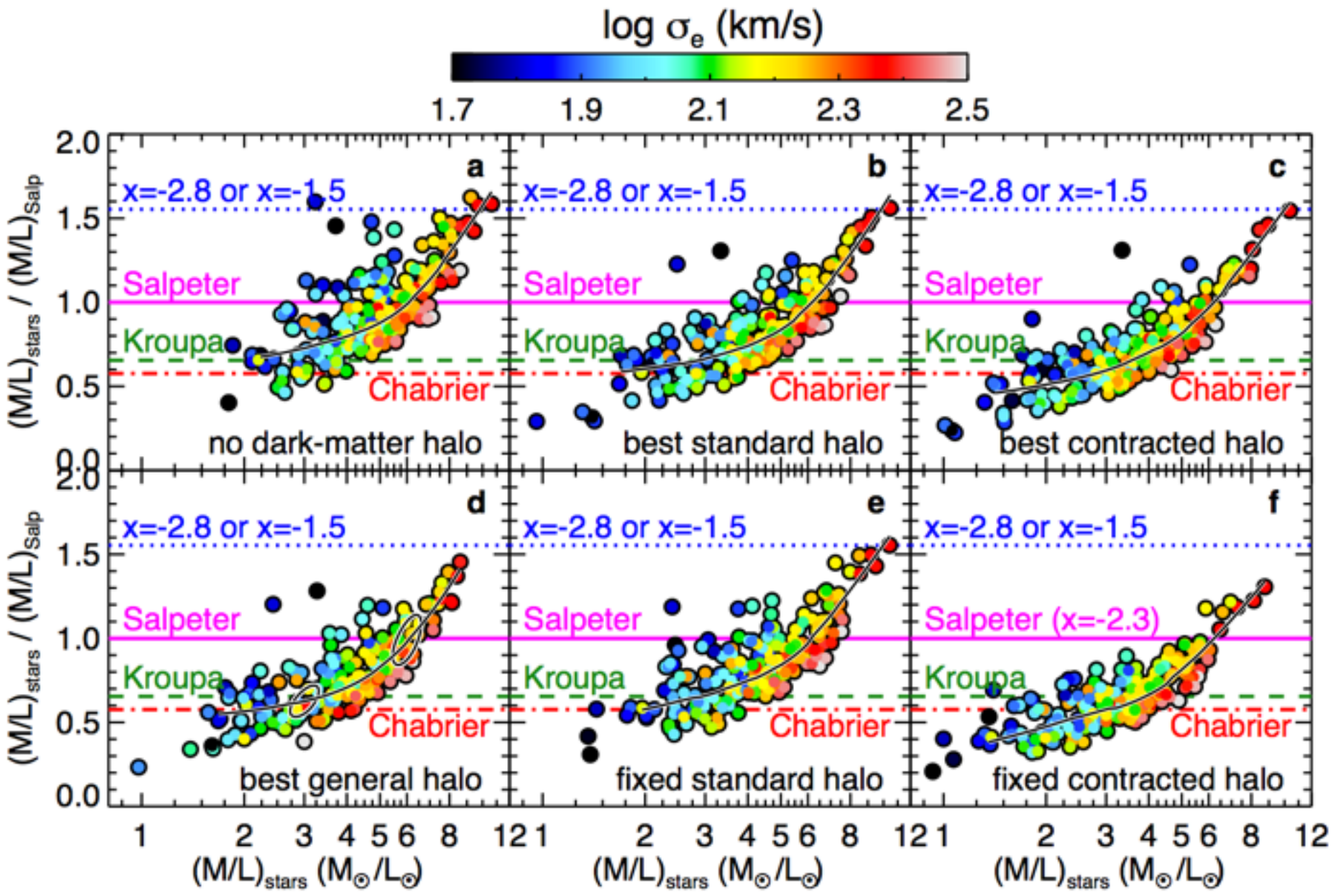
Radial variations? (ONC)



R(0.08-1)/(0.03-0.08)=2.4±0.2

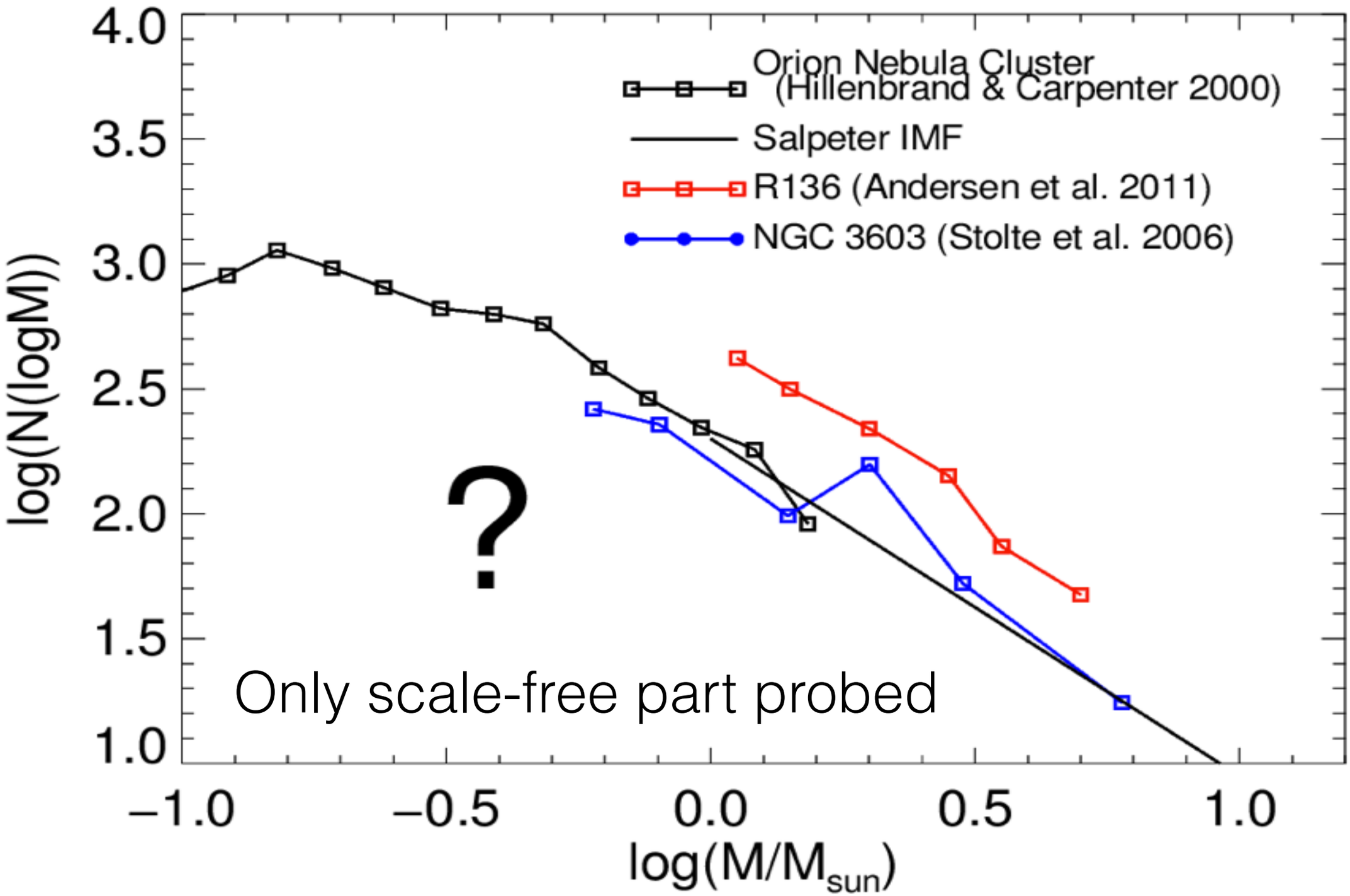
Andersen et al. 2011,A&A

Indirect evidence for variations

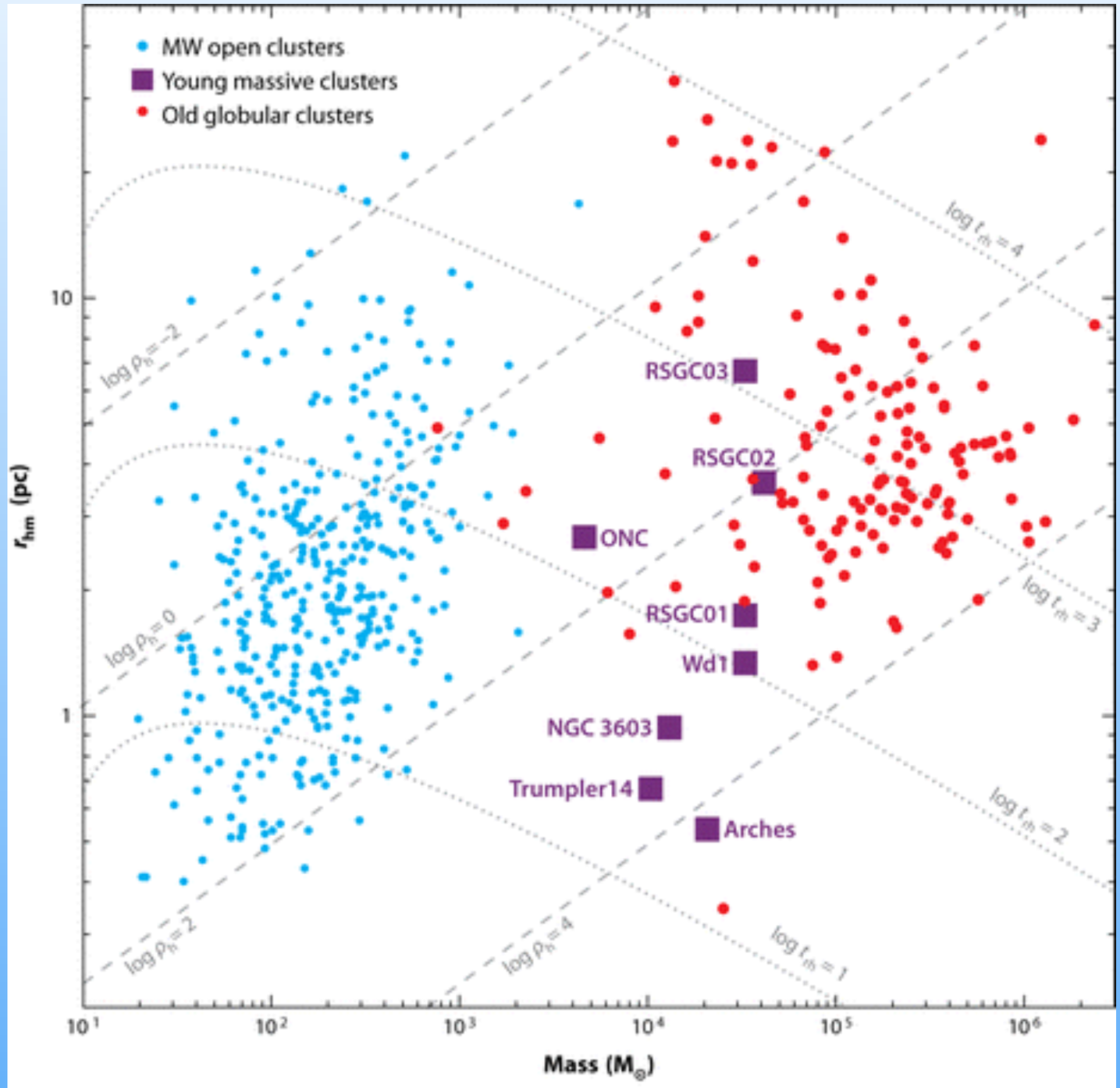


Cappelari et al. 2012

IMF in resolved massive clusters



Few local massive clusters



Zwart SFP, et al. 2010.
Annu. Rev. Astron. Astrophys. 48:431–93

Westerlund 1

Distance of ~4 Kpc, age 3-5 Myr

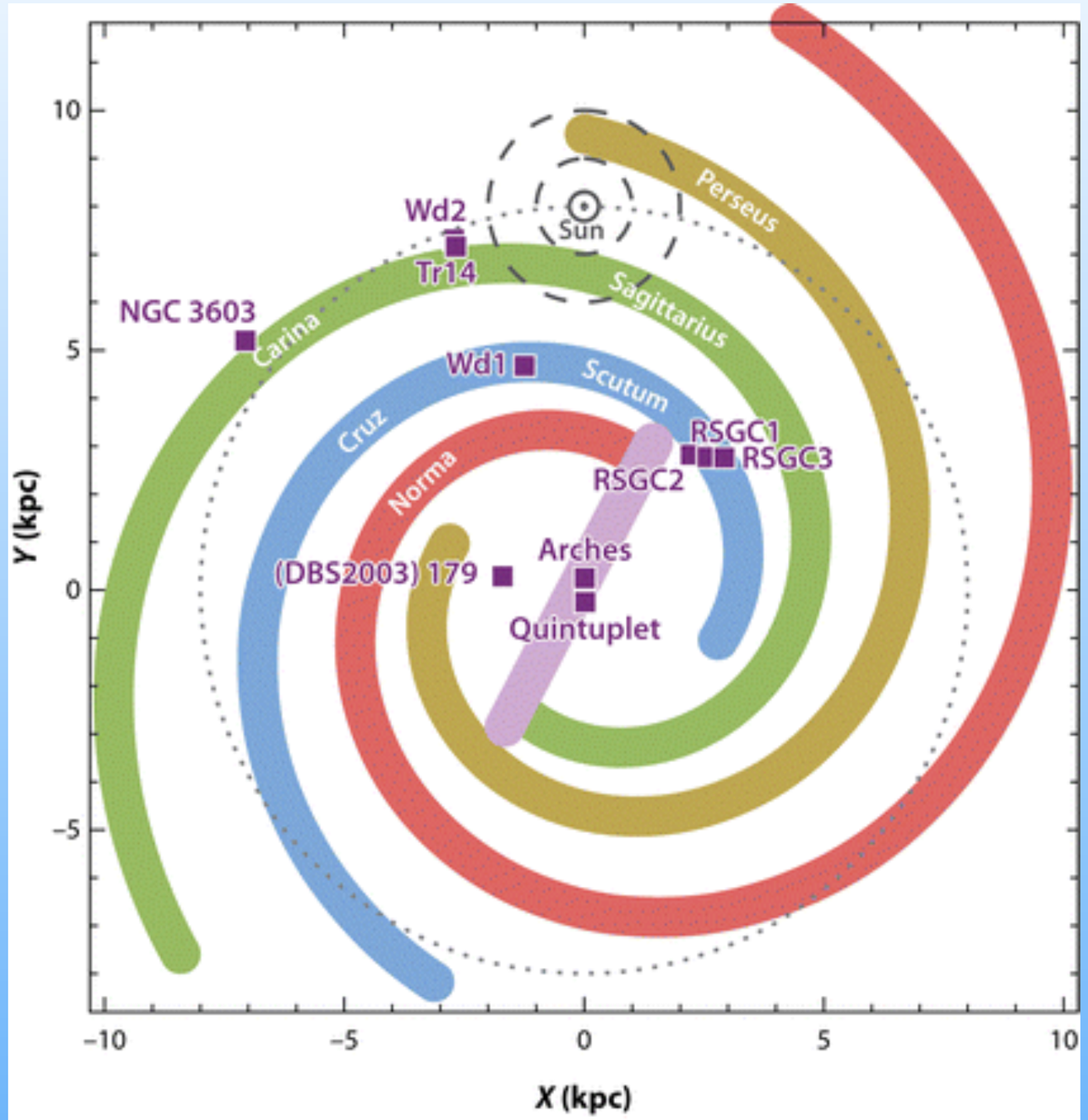
Total mass estimated to be 50000 Msun

High foreground extinction, favours near-infrared observations

Our best opportunity of resolving the low mass content in a young massive star cluster

HST J (F125W) and H (F160W) band imaging

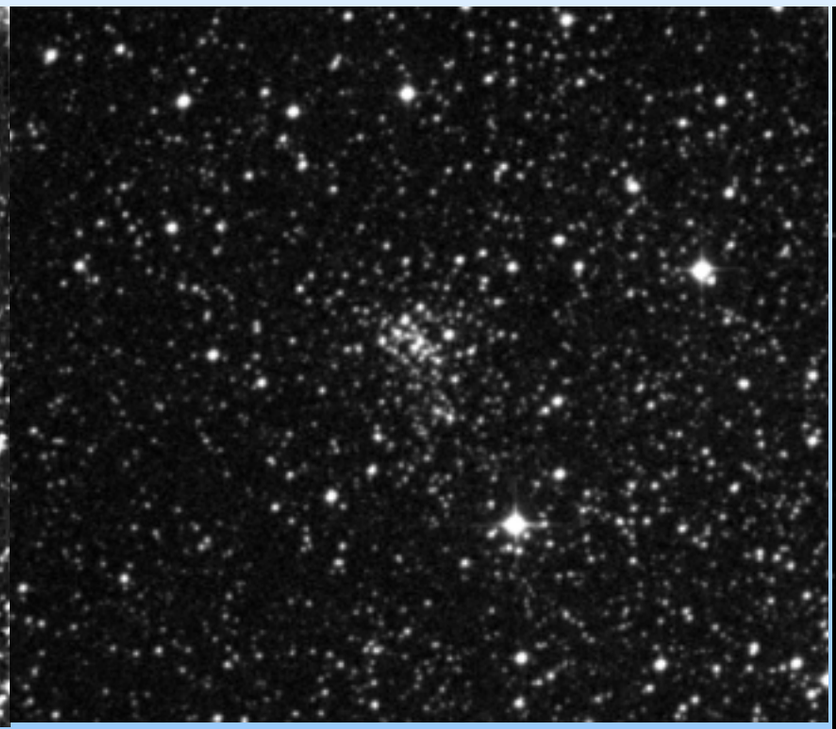
Location in the Galaxy



Zwart SFP, et al. 2010.
Annu. Rev. Astron. Astrophys. 48:431–93

The effect of extinction

Westerlund 1 (B)



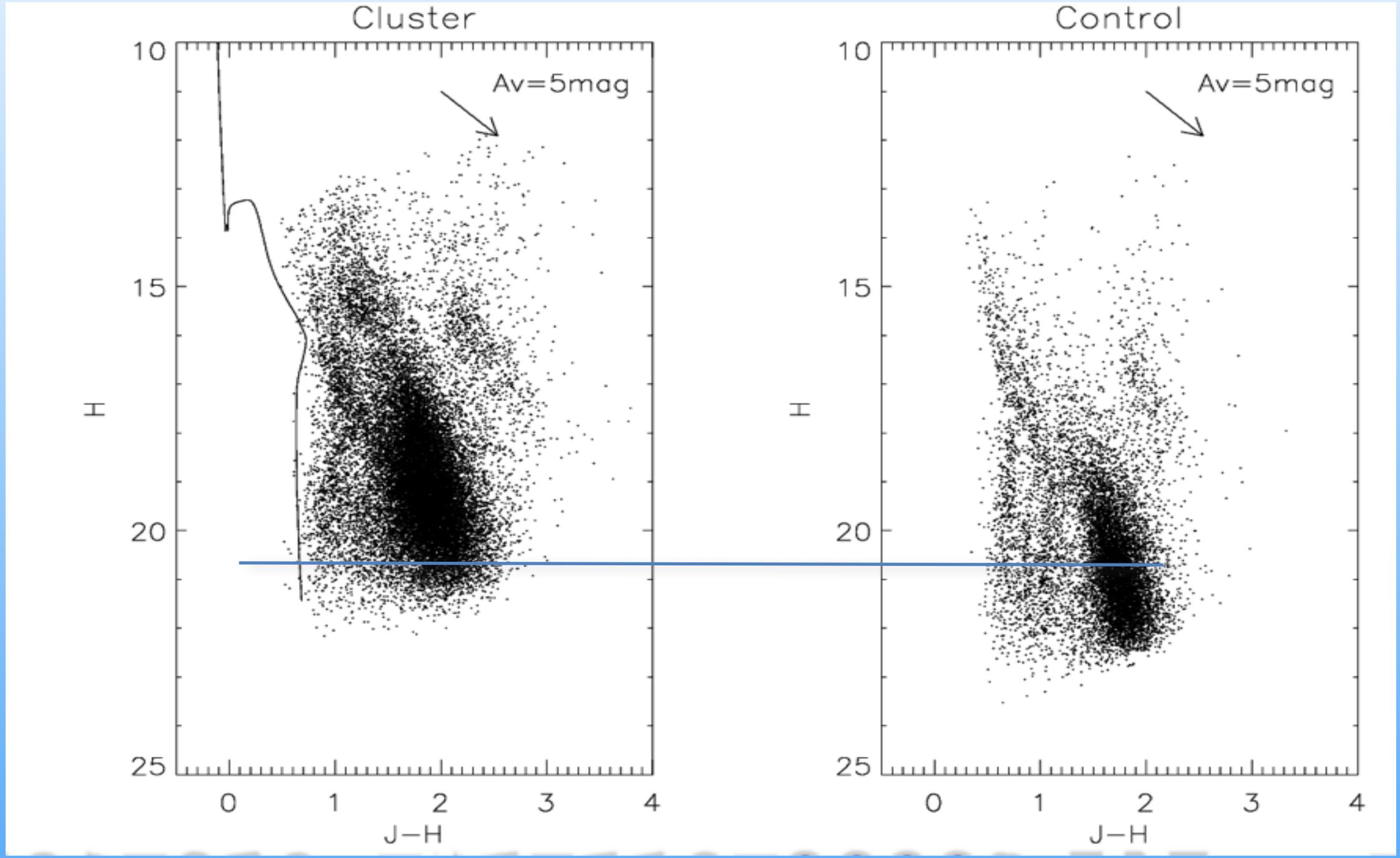
Westerlund 1 (R)

Westerlund 1 (J)

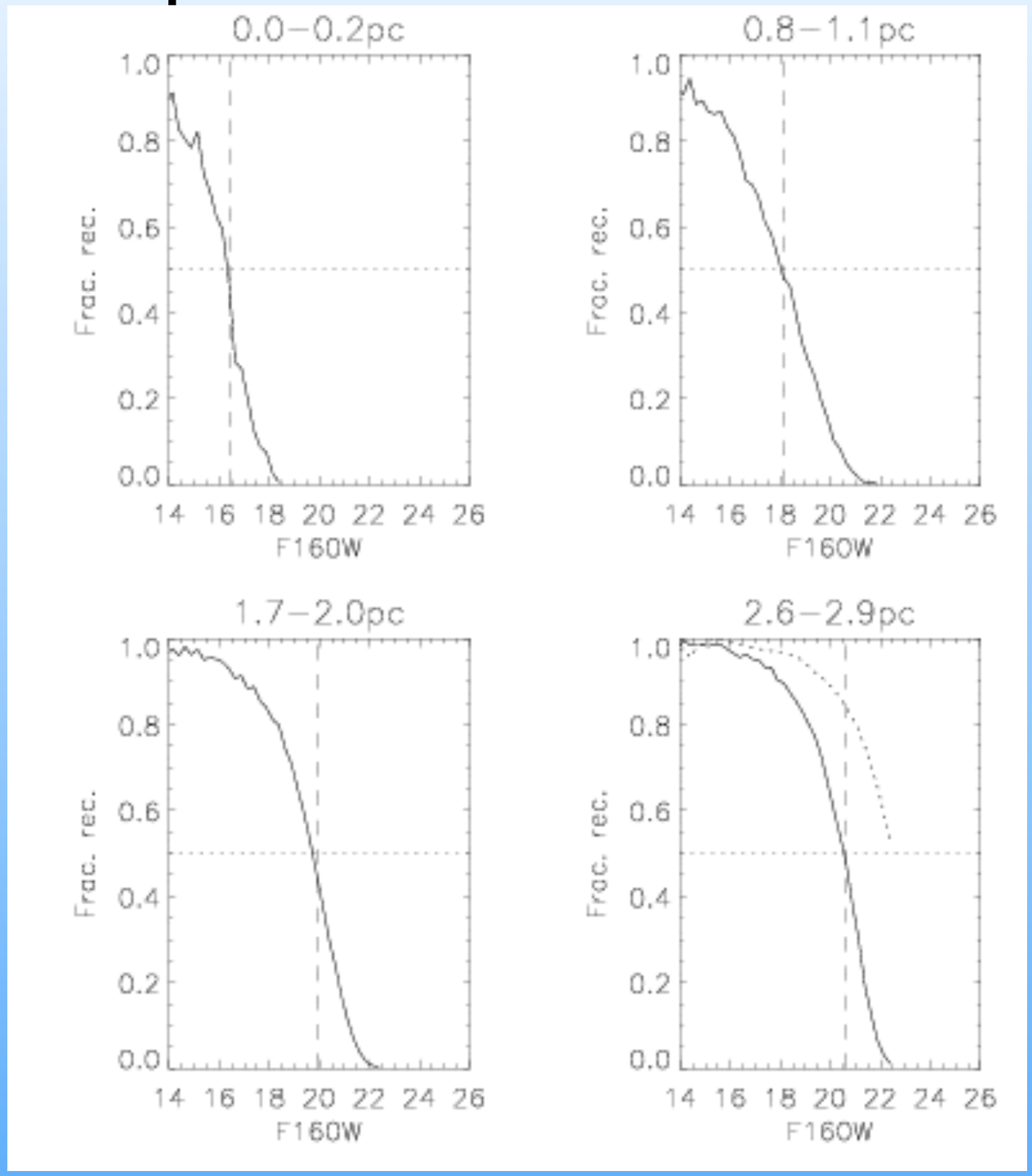
Westerlund 1 with HST

FOV=4*4.5 arcminute = 4.7*5.2pc^2

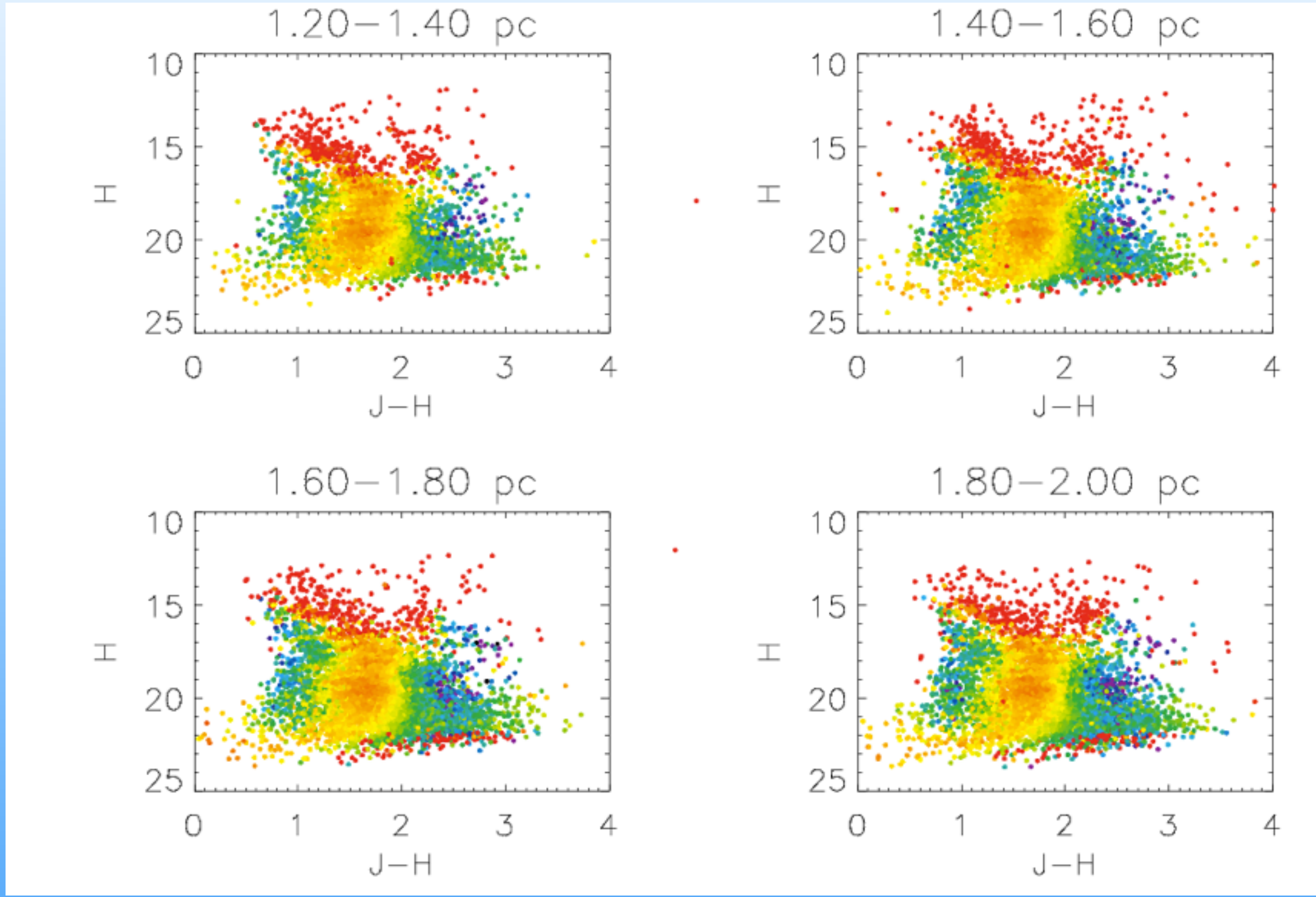
Colour-magnitude diagrams



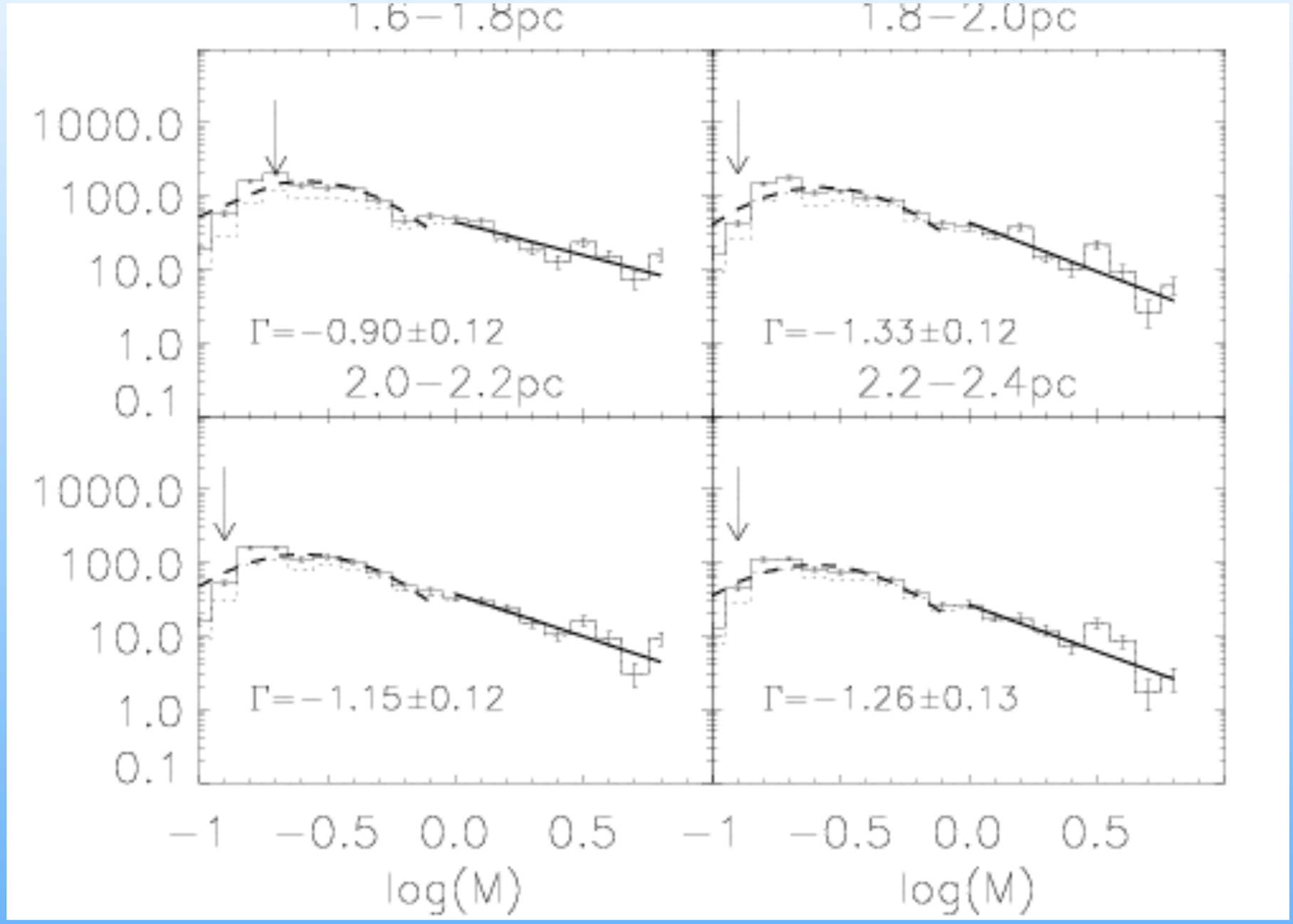
Completeness of data



Field star subtraction

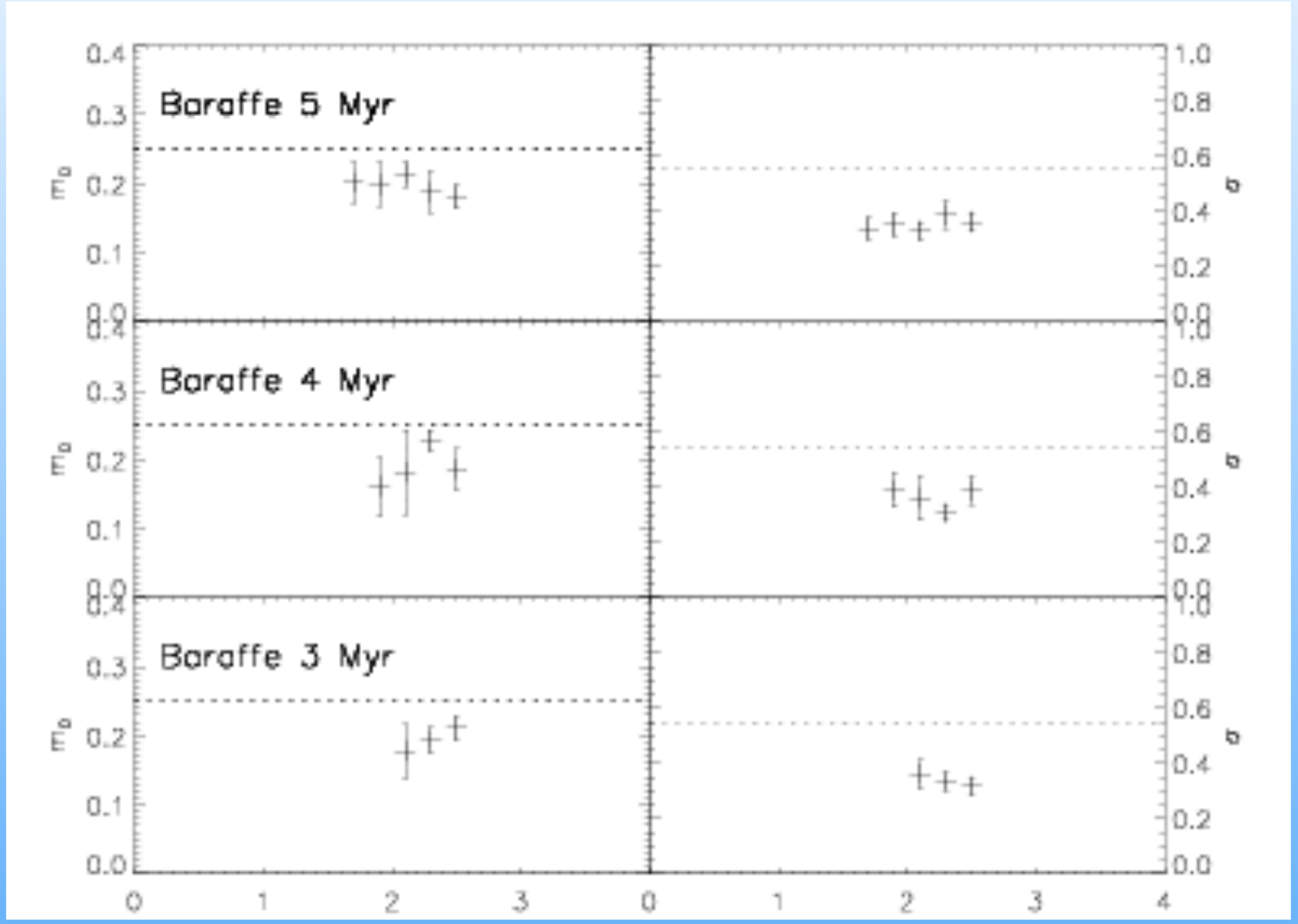


Mass Functions



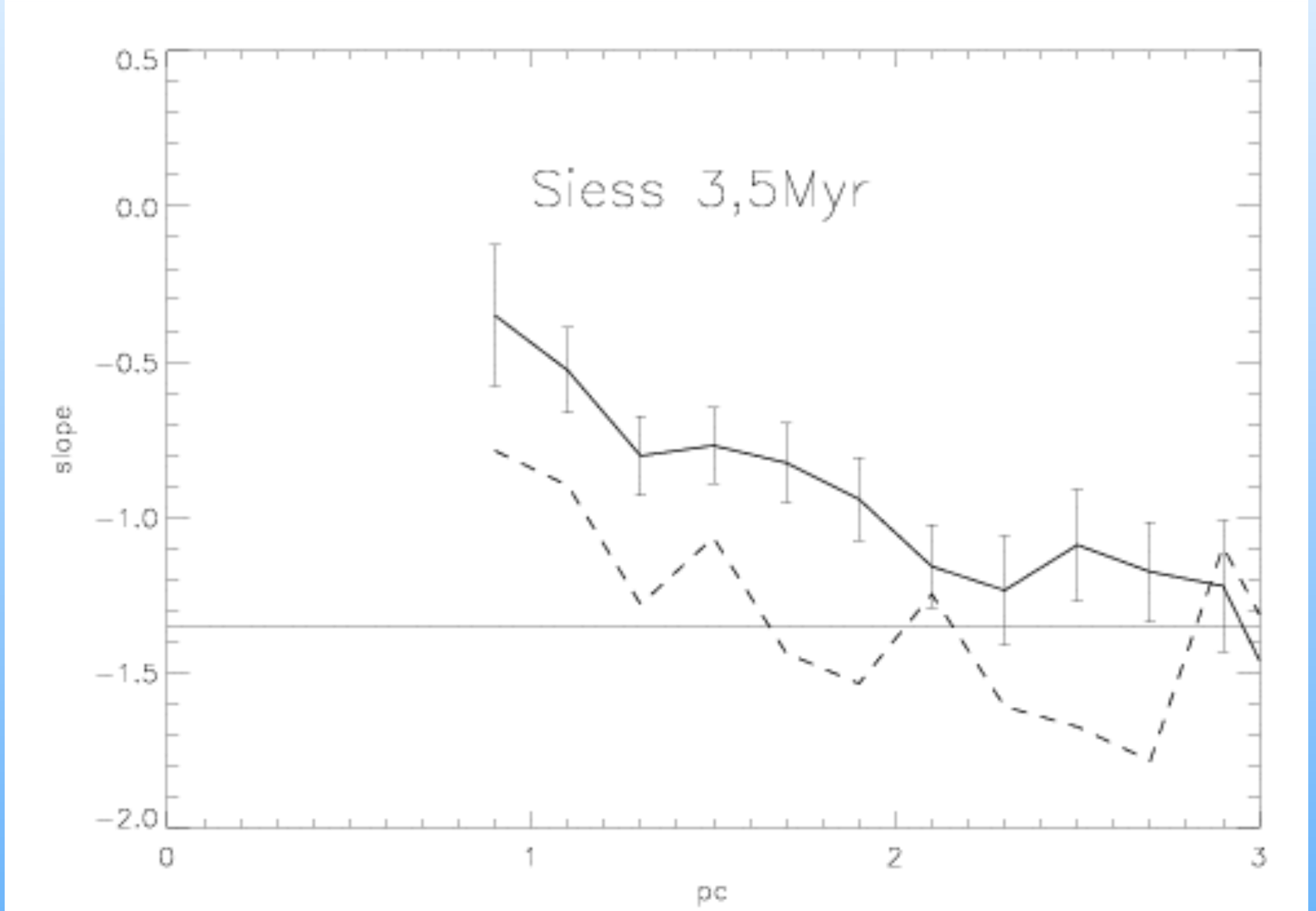
Log-normal fit below 1 Msun to the 50% completeness limit.
Power-law fit above 1 Msun (Siess 4 Myr isochrone)

Change of fit parameters as a function of radius



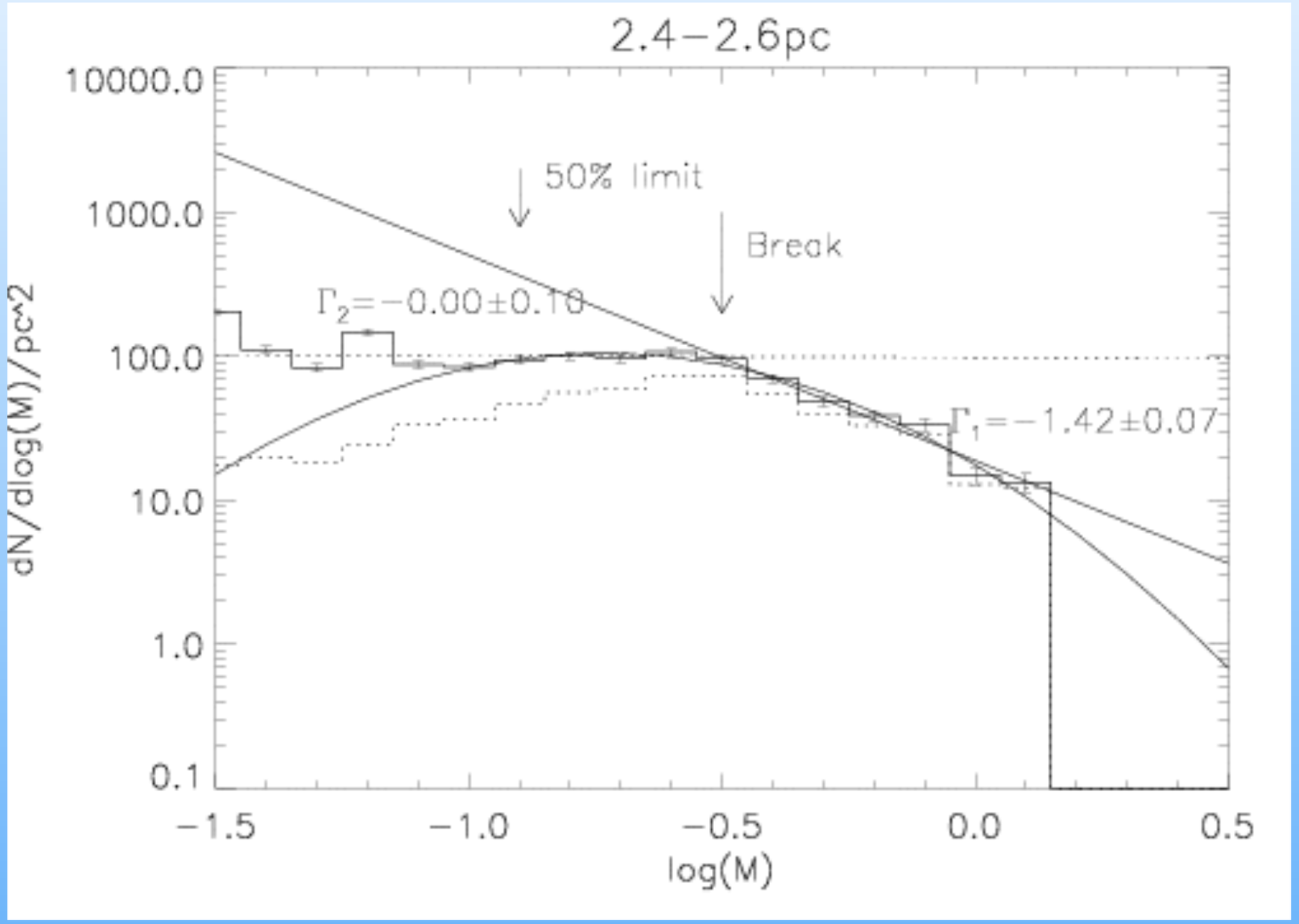
Comparable peak mass as the field. More narrow distribution

Change of fit parameters as a function of radius



Evidence for mass segregation to 1.5-2 pc

2 segment power-law



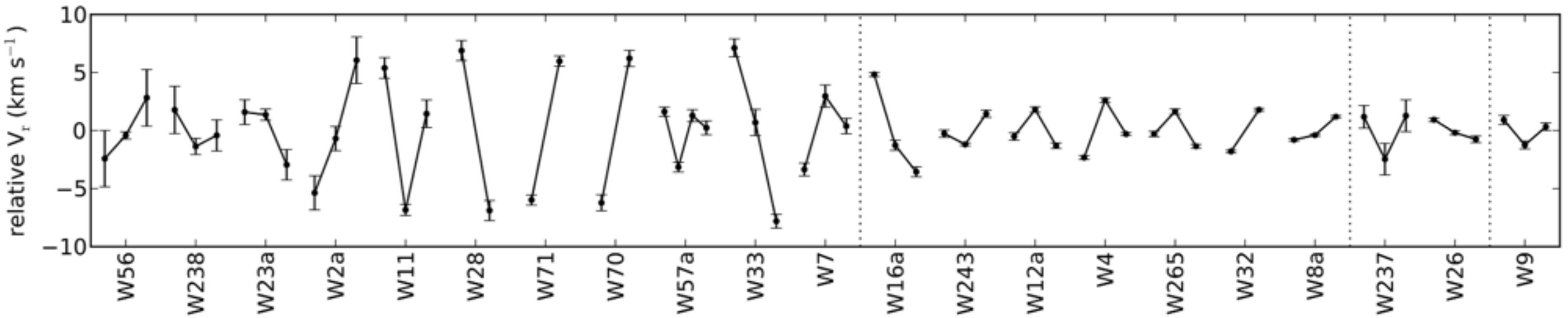
Break-point at log(M)=-0.5

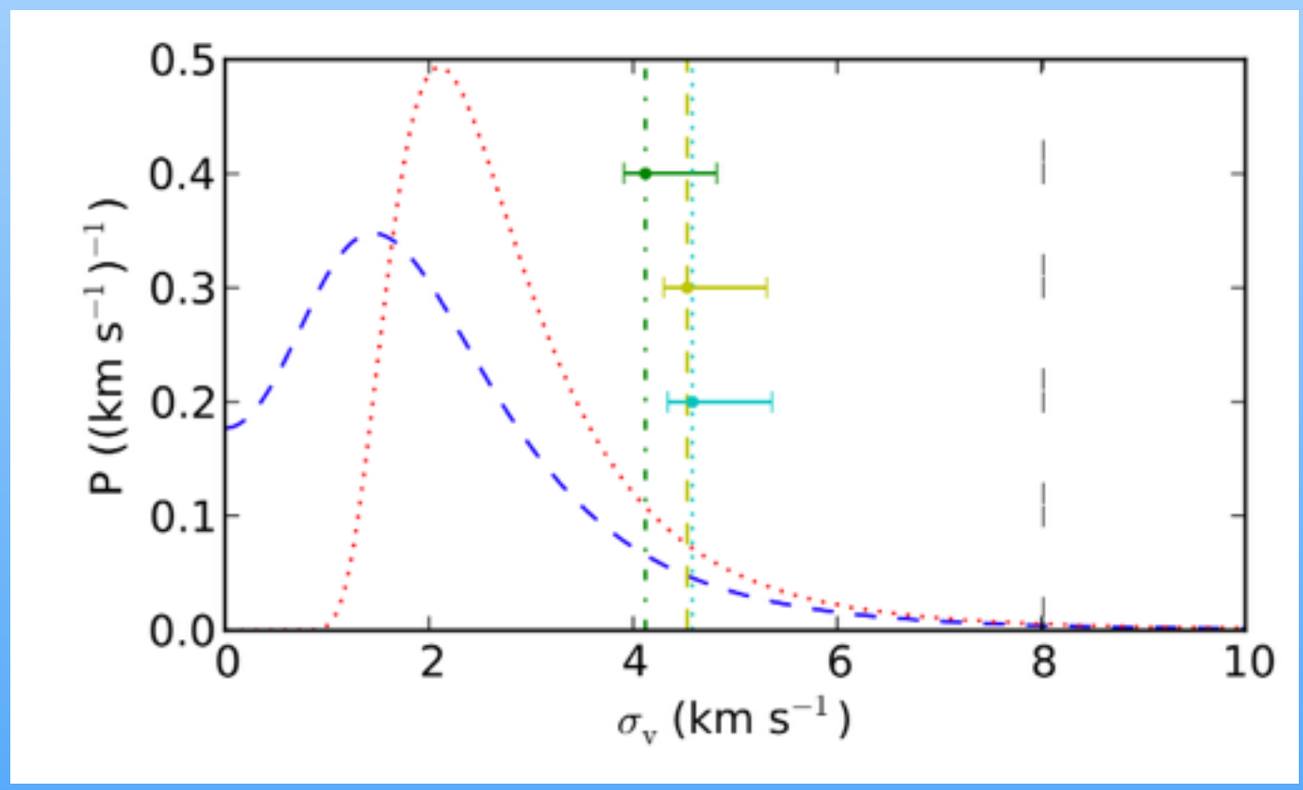
Is Westerlund 1 bound?

- Gas expulsion has occurred
- The most massive stars exploded.
- Has this disrupted the cluster or will it survive?
- Radial vel. measurements provide vel. dispersion

Multi-epoch Magellan R~20000 spectra

Radial velocity dispersion



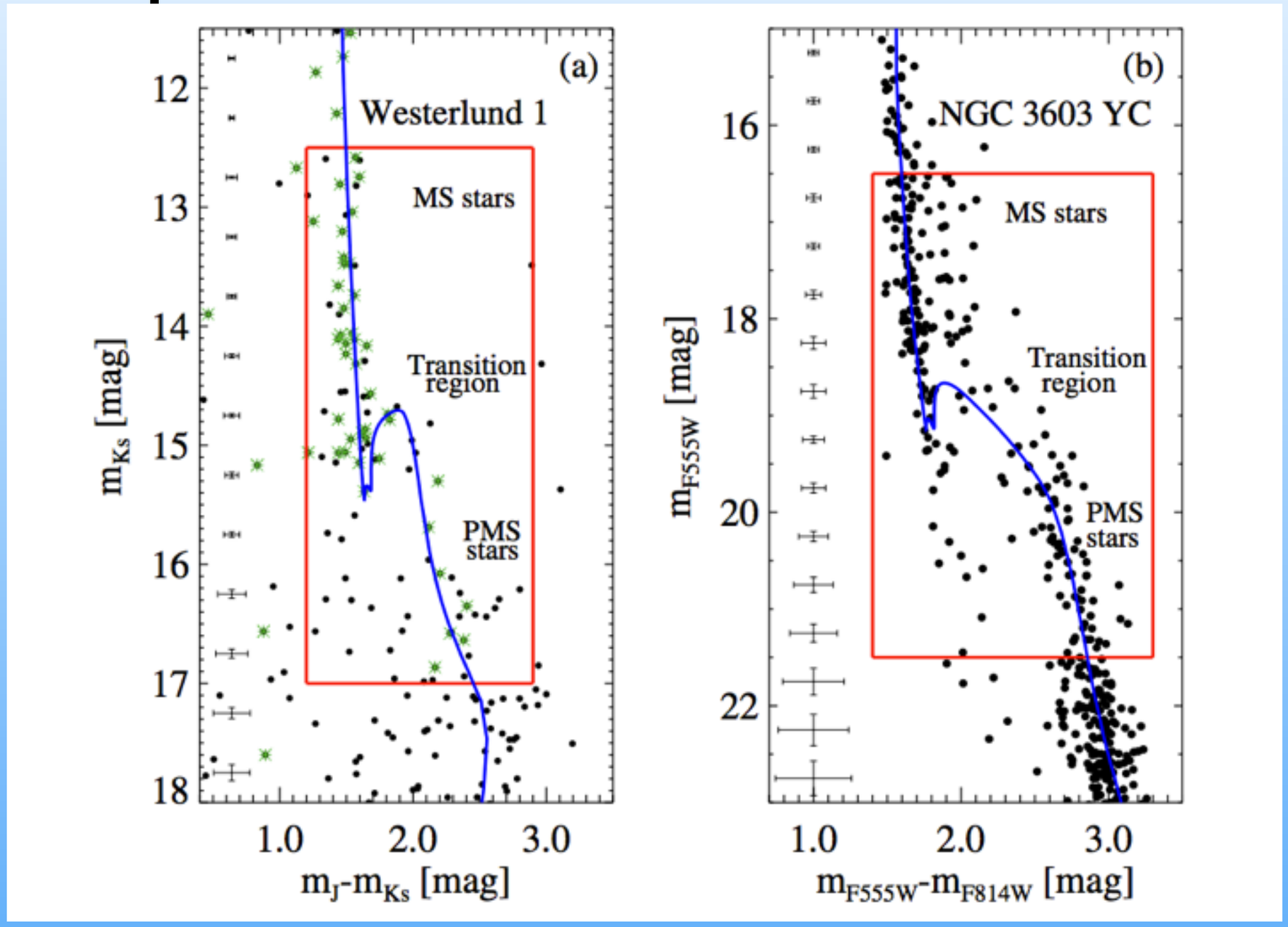


Cottaar, Meyer, Andersen & Espinoza, A&A 2012

Coevality?

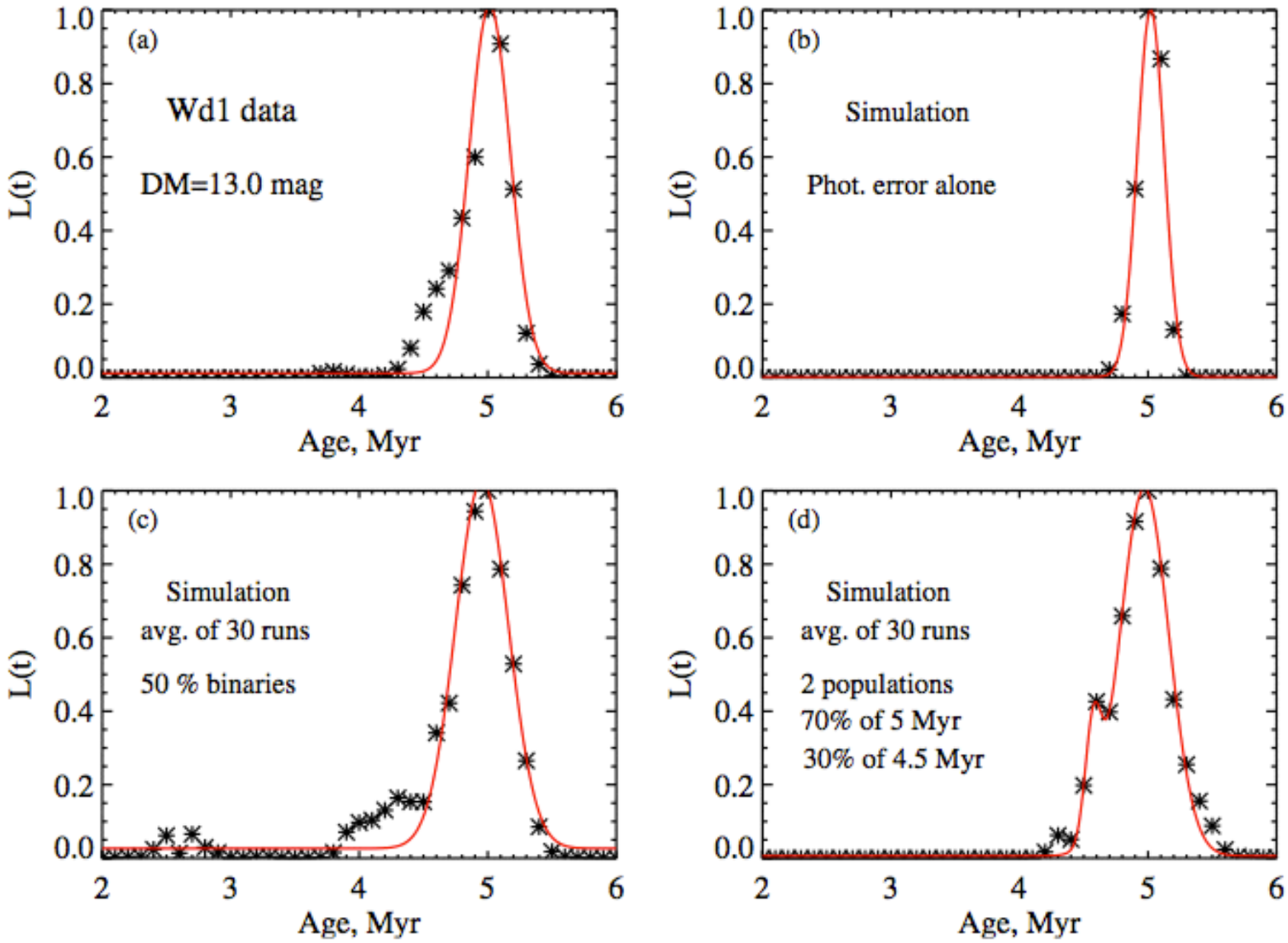
- Difficult from the color-magnitude diagrams
  - field stars, binarity, intrinsic luminosity scatter
  - All contribute to a spread on the CMD
  - First steps: clean proper motion sample to only have cluster members. VLT/AO+WFC3

proper motion selection



Proper motion selection (VLT+HST) Kudryavtseva et al. 2012

proper motion selection



Proper motion selection (VLT+HST) Kudryavtseva et al. 2012

Conclusions

- Deep HST/WFC3 imaging of Wd1
- The Mass function is derived to 0.2 Msun
- Similar peak to the field IMF, but more narrow
- Evidence for mass segregation above ~1 Msun
- Cluster is found to be in virial equilibrium
- Currently little evidence for an age spread (<1Myr)