Near-infrared luminosity function of galaxies in distant clusters

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The near-infrared luminosity function as a tool to study galaxy evolution

- well established at redshift zero, providing a zero-point for evolutionary studies at higher redshift

- less affected by dust extinction (compared to bluer wavelengths)

- small dependence of k-correction on galaxy type

- provides a proxy to the stellar mass function, since observed K-band light reasonably traces stellar mass even at redshift ~ 1

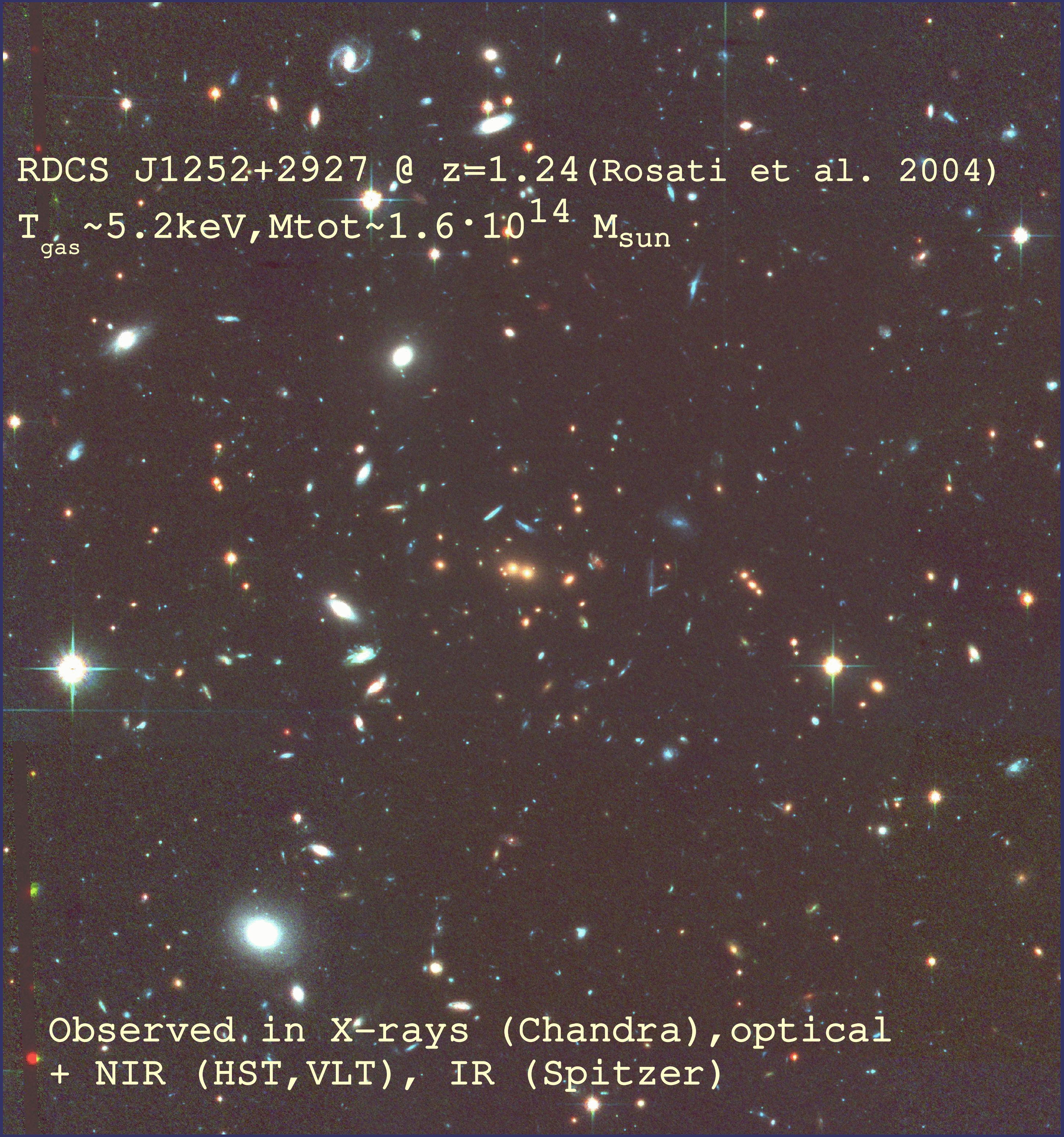
- observed over a wide look-back time range sets constraints on when the bulk of the stars formed and when the bulk of the galaxy mass was assembled

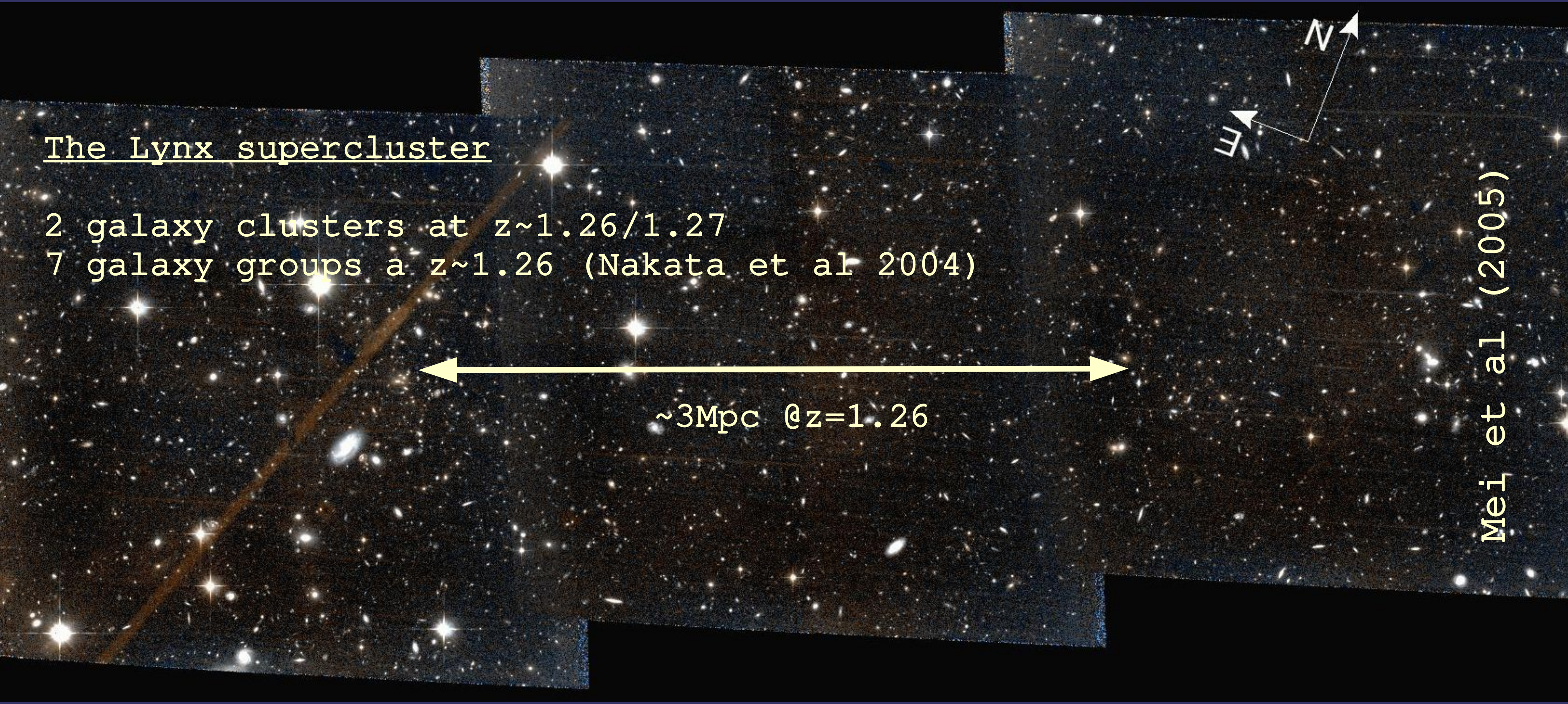
Distant Galaxy Clusters

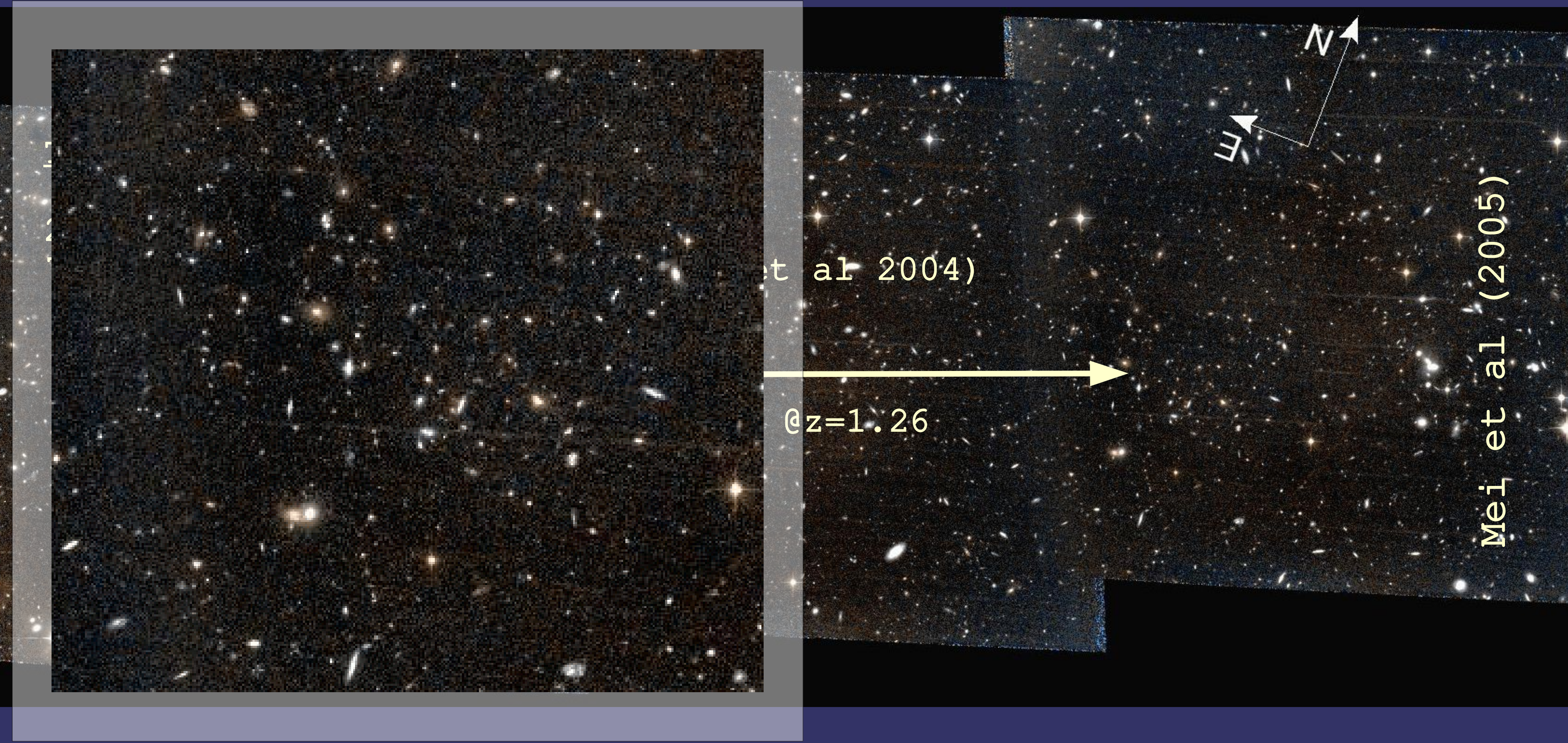
We studied 3 X-ray luminous clusters in the redshift range $1.1<z<1.3$

- already massive and dynamically evolved
- already host massive evolved galaxies
- already show a clear color-magnitude sequence
- provide a high-density counterpart to the study of field galaxies, thus probing the effects of environment on galaxy evolution


RDCS J0910+5422 @ z=1.11(Stanford et al. 2002)
T_{gas}~7keV,Mtot~$5\cdot10^{14}$ M_{sun}
Mei et al (2005)
Observed in X-rays (Chandra), optical + NIR
(HST,Palomar 200”),IR (Spitzer)


RDCS J1252+2927 @ z=1.24(Rosati et al. 2004)
T_{gas}~5.2keV,Mtot~$1.6\cdot10^{14}$ M_{sun}
Observed in X-rays (Chandra),optical
+ NIR (HST,VLT), IR (Spitzer)


The Lynx supercluster
2 galaxy clusters at z~1.26/1.27
7 galaxy groups a z~1.26 (Nakata et al 2004)
~3Mpc @z=1.26
N
E
Mei et al (2005)



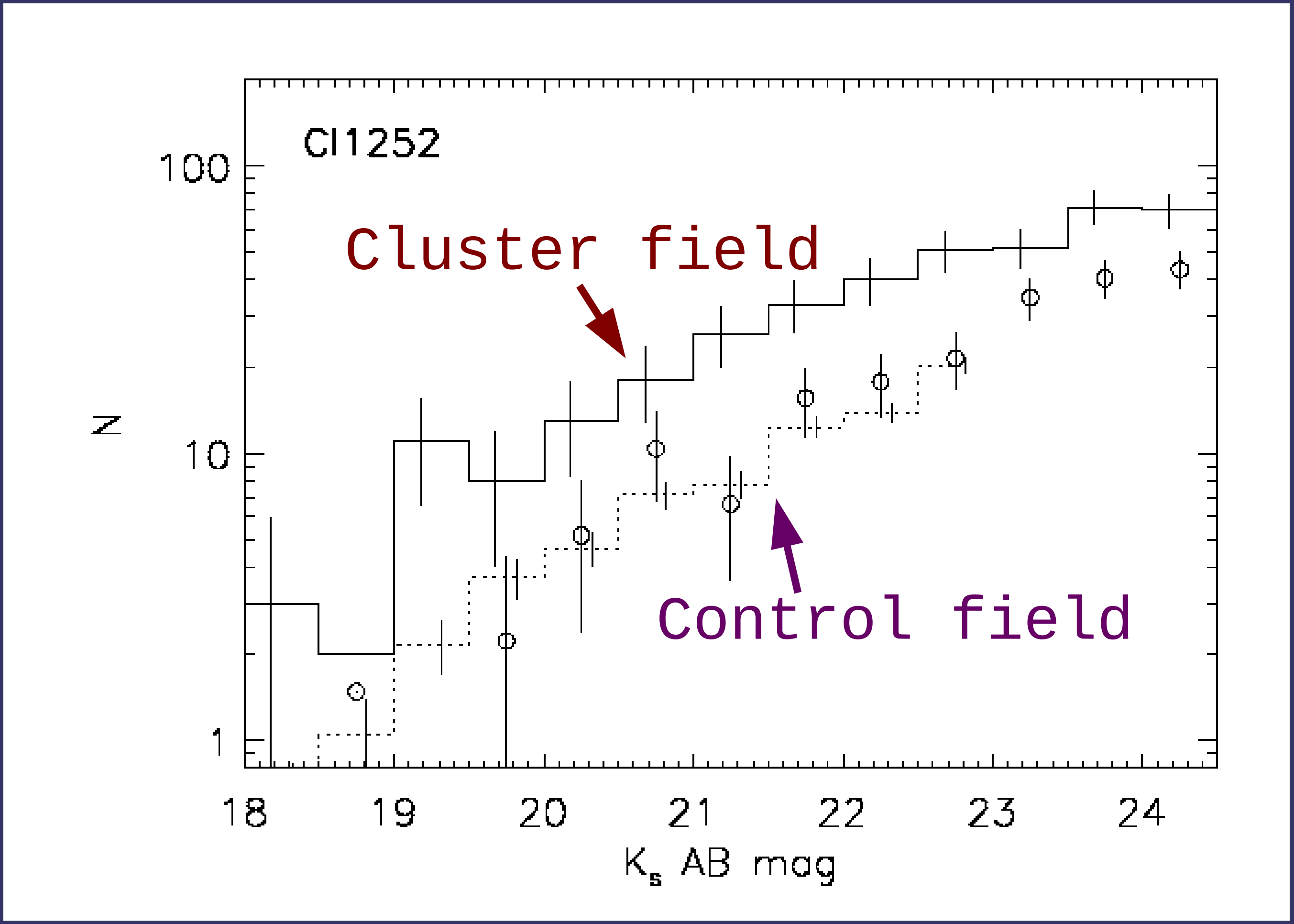
RX J0848+4453 @ z=1.27(Stanford et al. 1997,Rosati et al. 1999)

T_{gas}~2.9keV,Mtot~$1.4\cdot10^{14}$ M_{sun}

Observed in X-rays (Chandra), optical and NIR (KPNO/4m, HST)

The K-band luminosity function at z~1.2

The individual luminosity functions have been determined via statistical subtraction



The K-band luminosity function at z~1.2

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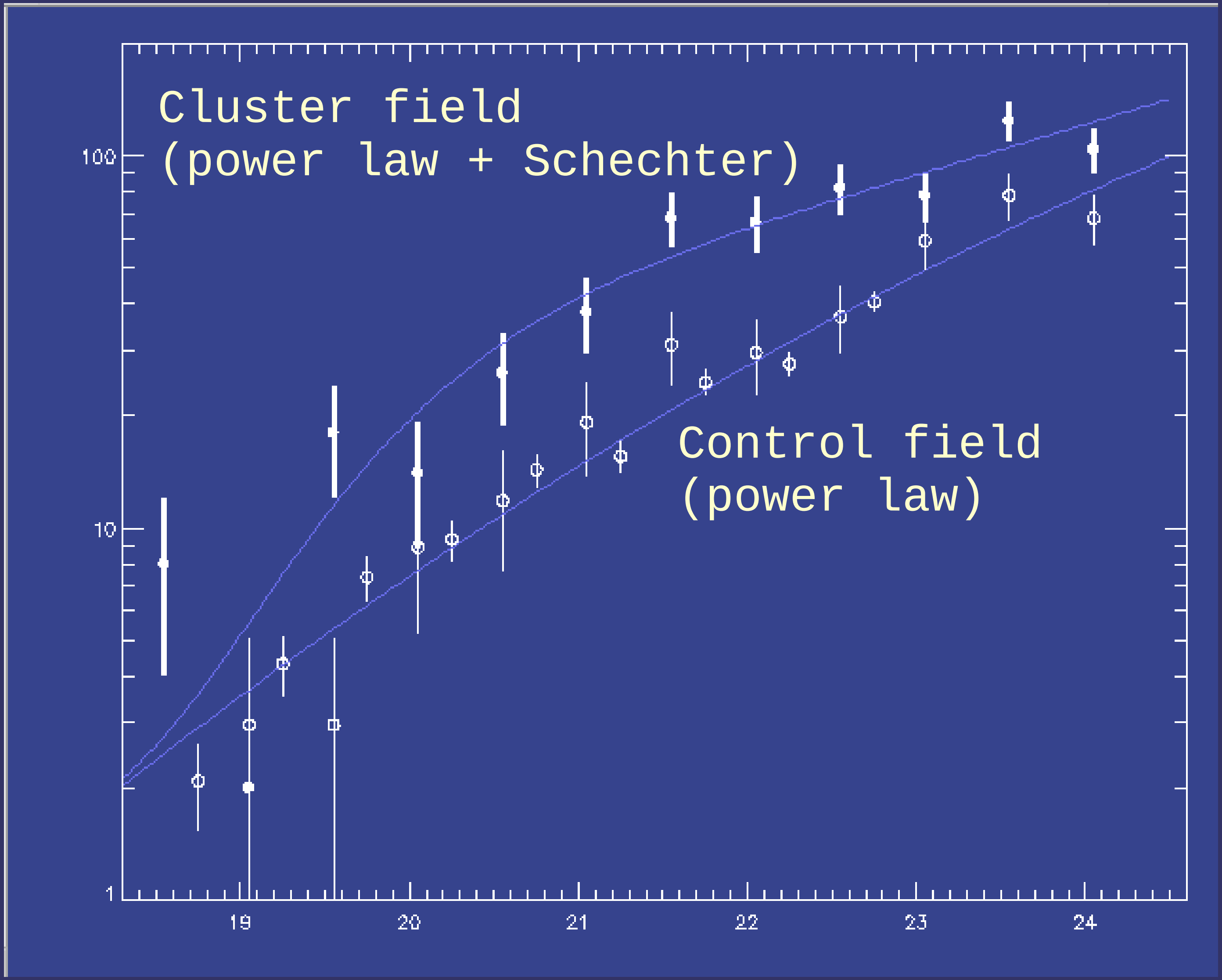
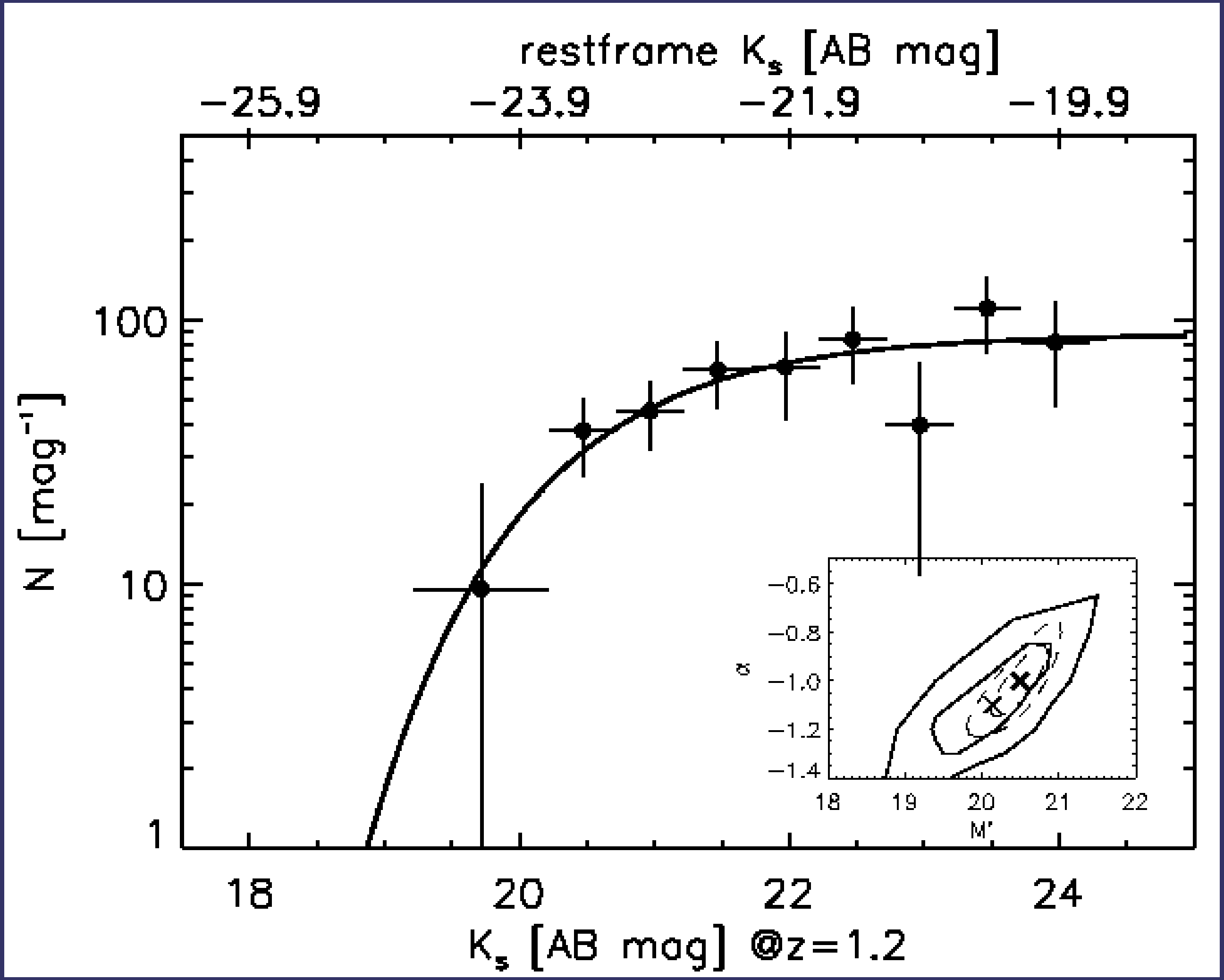


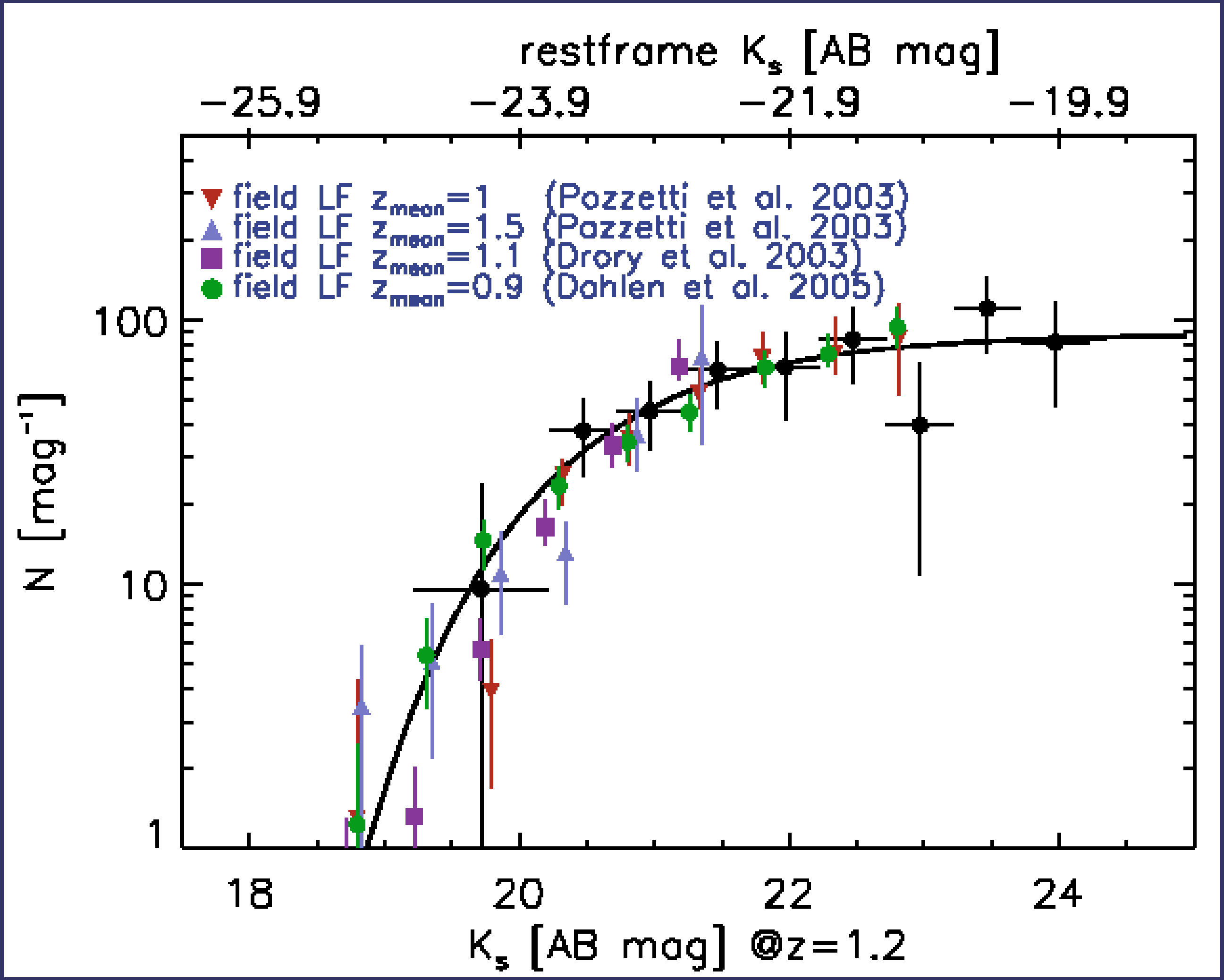
The K-band luminosity function at z~1.2

Composite LF of cluster galaxies at 1.11<z<1.27



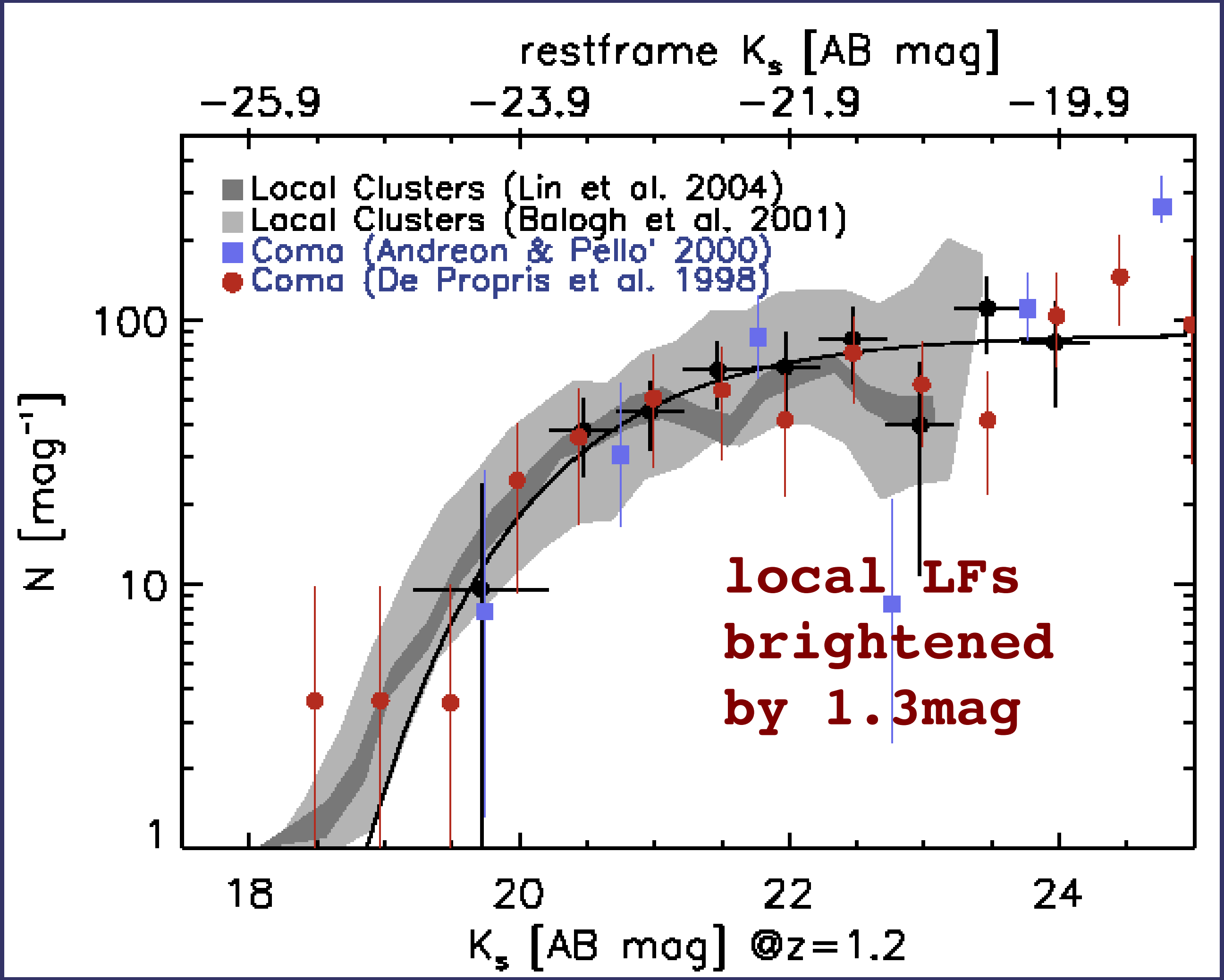
The K-band luminosity function at z~1.2

...compared to the field galaxy LF at z~1-1.5



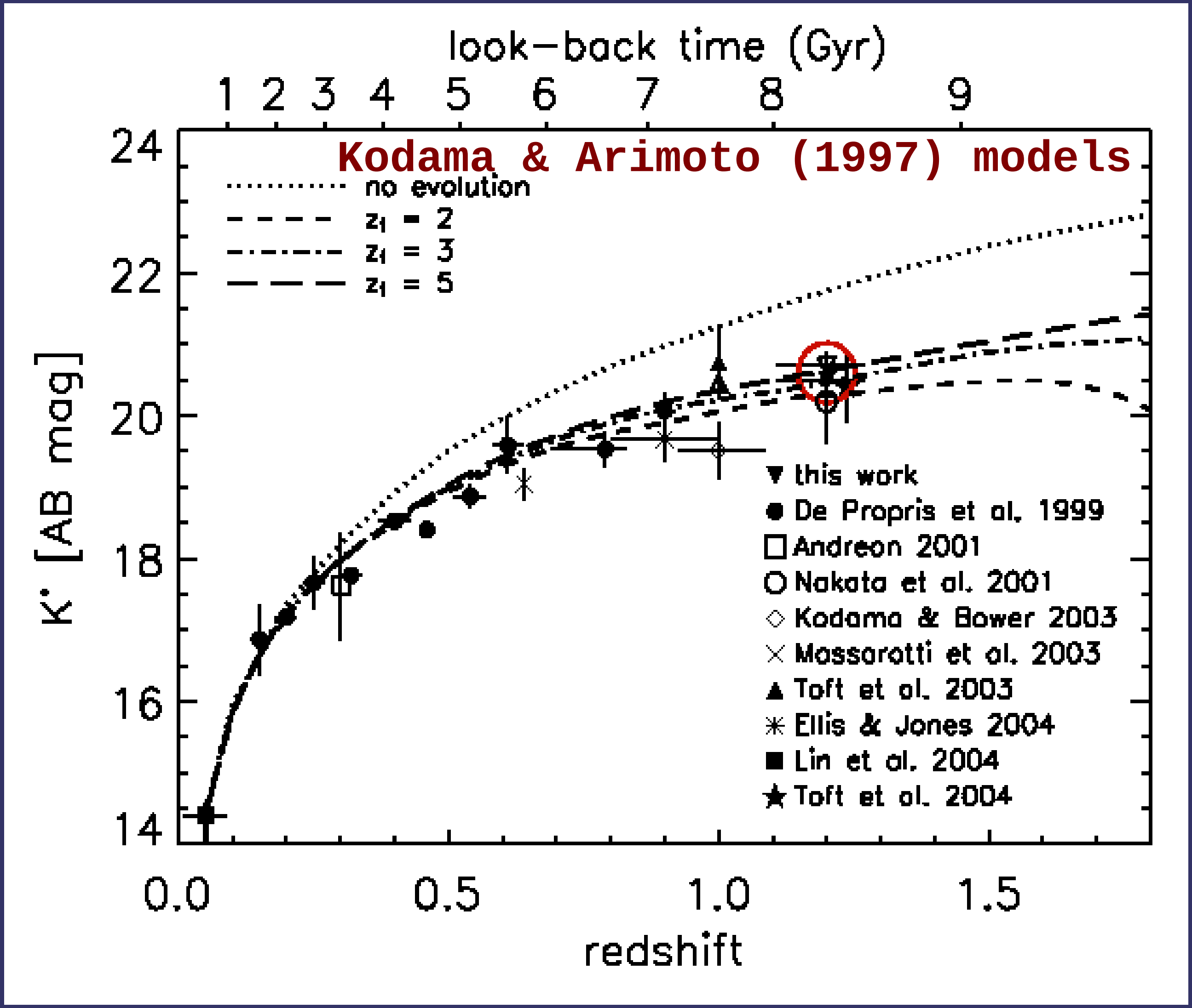
The K-band luminosity function at z~1.2

...compared to the local cluster galaxies LF

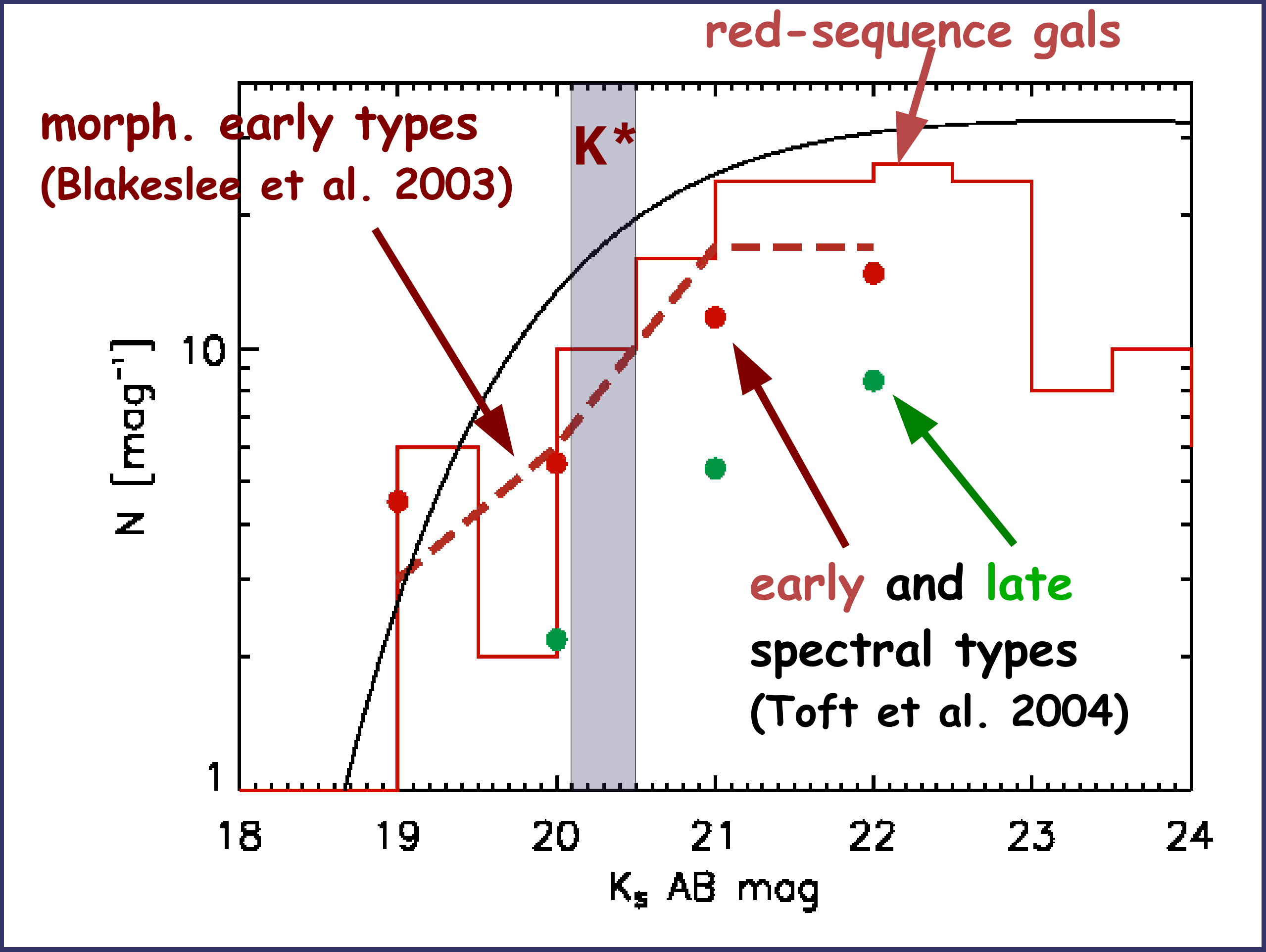


The K* redshift evolution

up to redshift ~1.2 is compatible with passive evolution of a stellar population formed at z≥2

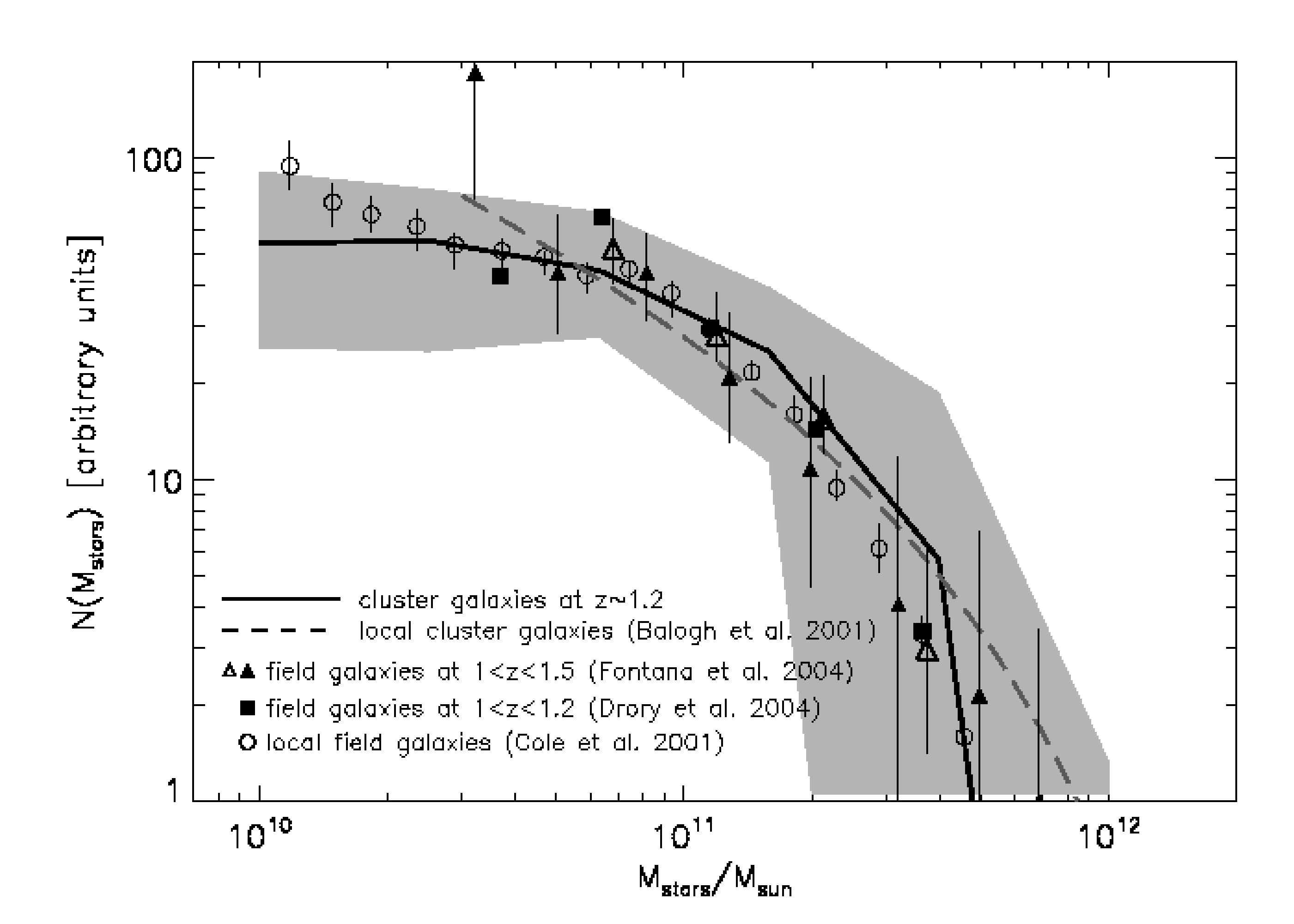


The LF bright end is already dominated by evolved galaxies



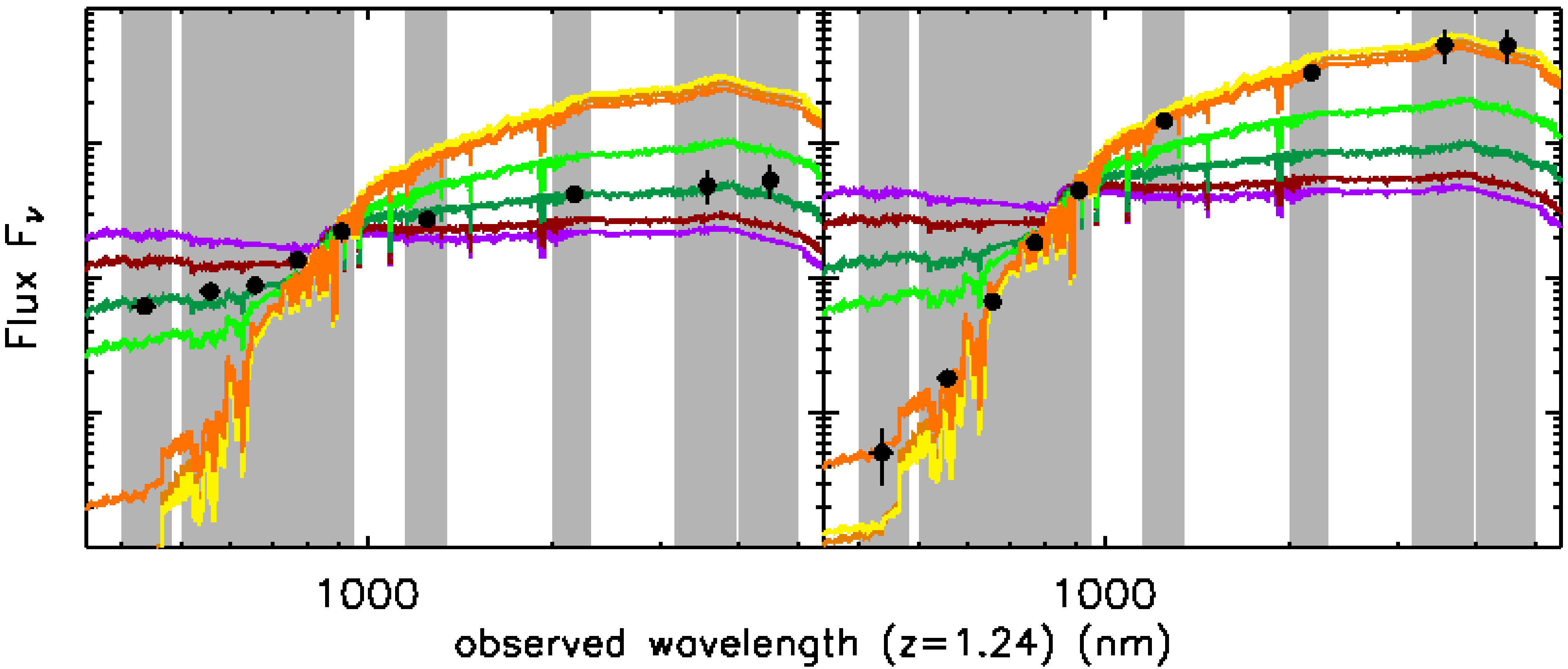
The stellar mass function of cluster galaxies at z~1.2

From the K-band LF it is possible to derive an estimate of the stellar mass function:



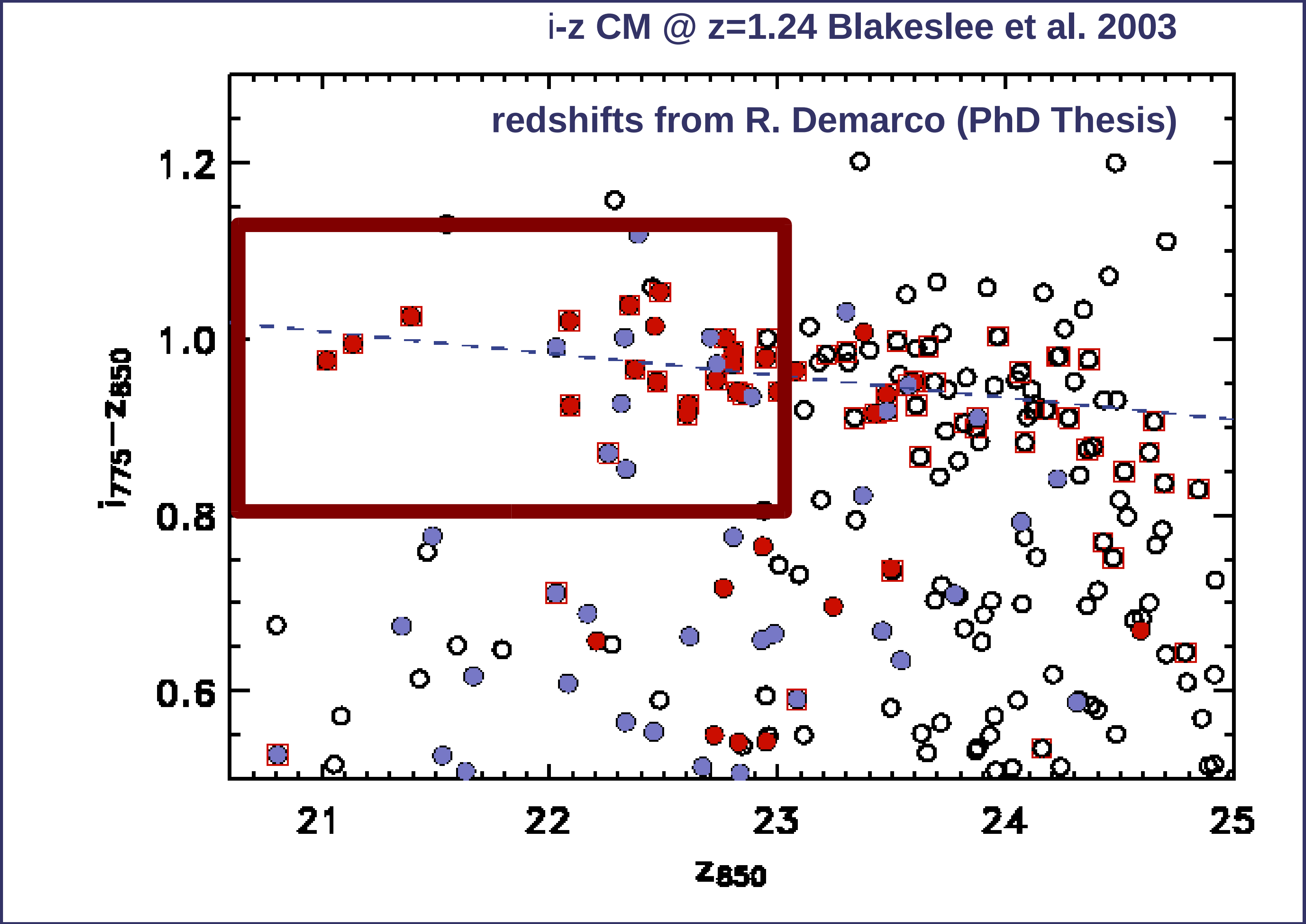
SED fitting with 9 passbands from B to 4.5μ

B VR i z J K 3.6 4.5 B VR i z J K 3.6 4.5



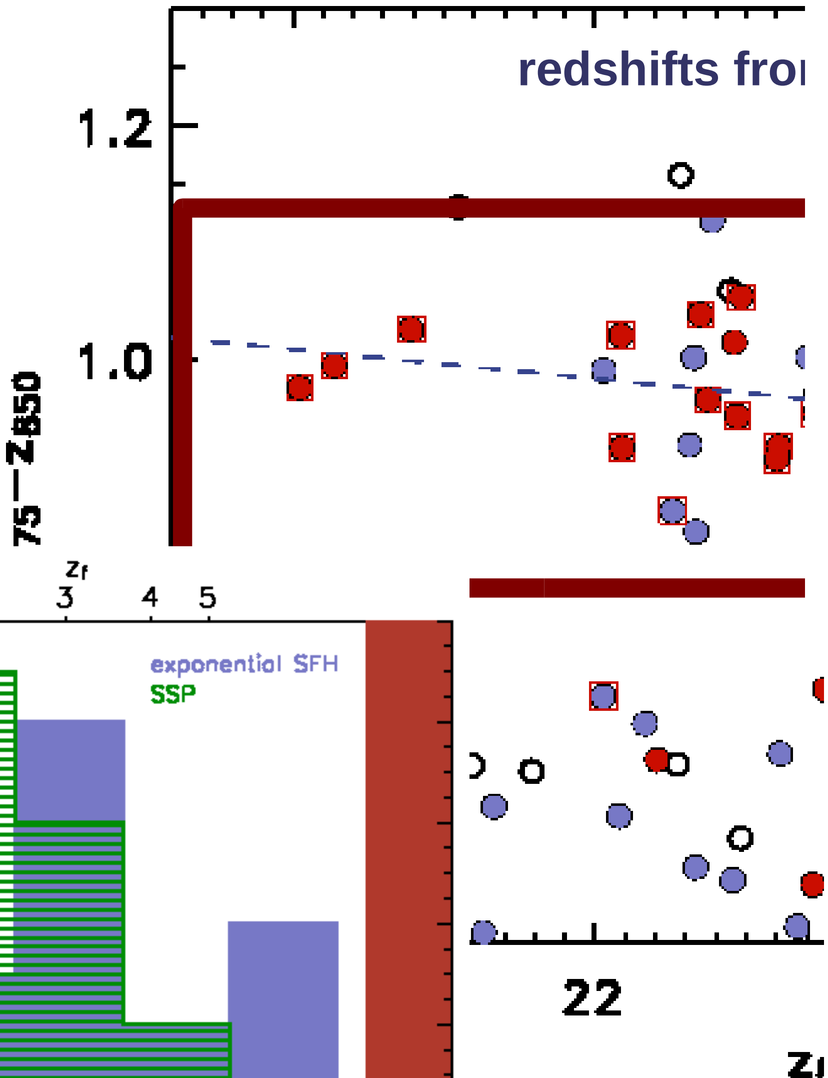
VLT/FORS HST/ACS VLT/ISAAC Spitzer/IRAC

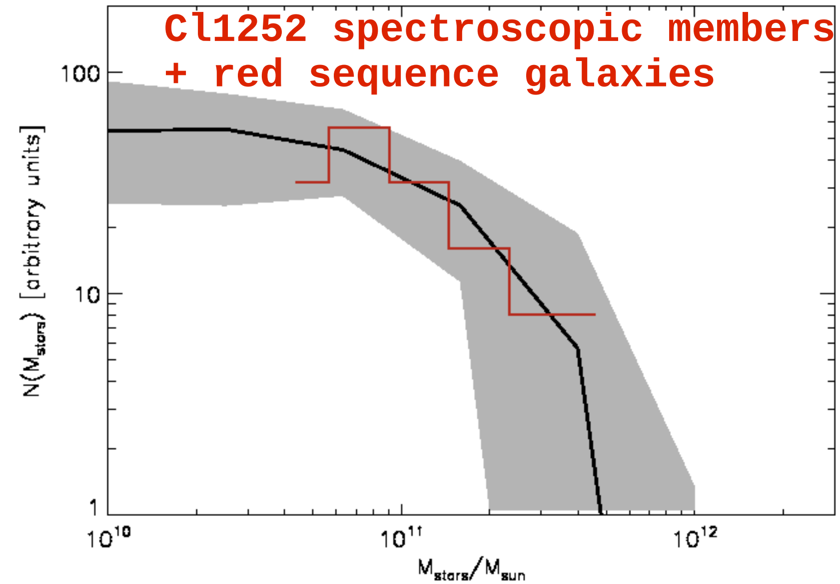
Massive galaxies with old stars

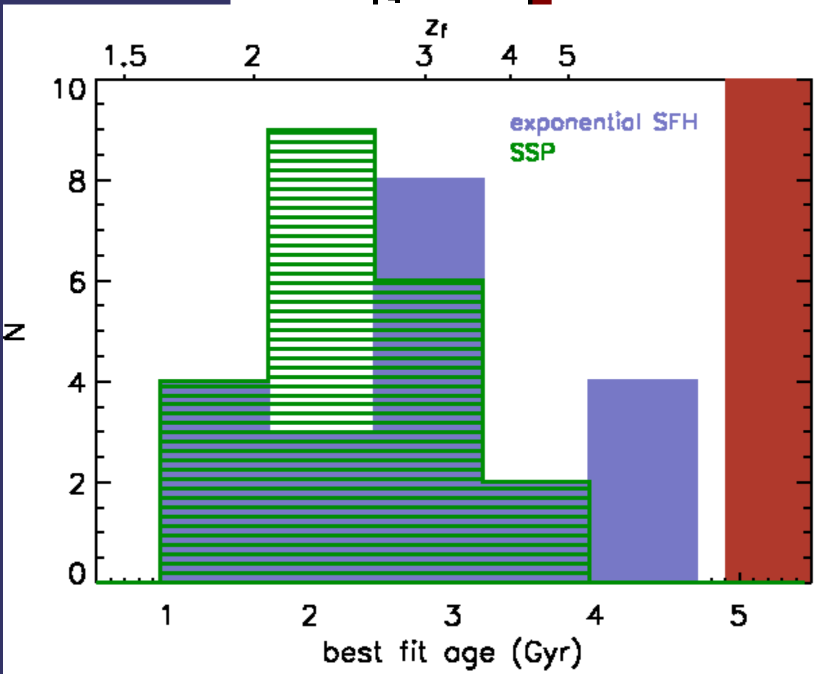


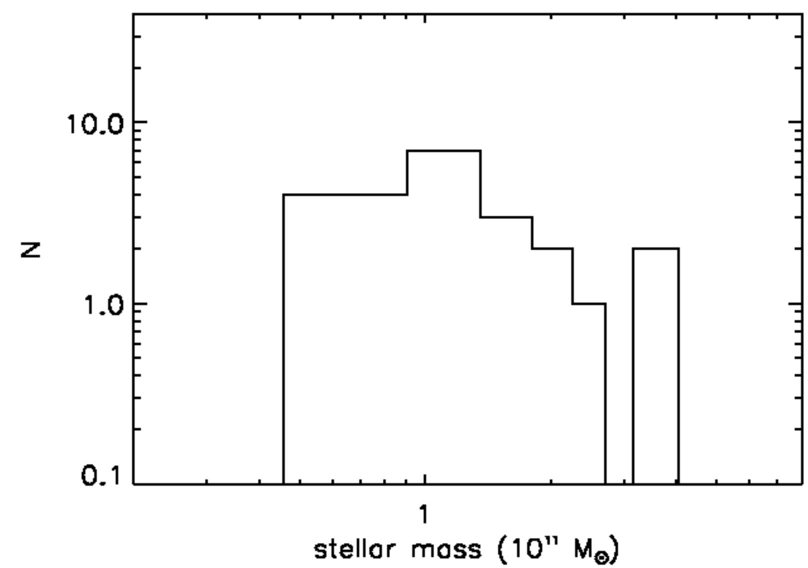
Massive galaxies with old stars

i-z CM @ z=1.24 Blakeslee et al. 2003









Conclusions

- The evolution of the NIR luminosity function of bright galaxies in X-ray luminous clusters is consistent with passive evolution up to redshift ~ 1.2

- The redshift evolution of K^* is consistent with the bulk of the stars in such bright galaxies being formed at redshift >2, as indicated by the CMR evolution, and by SED fitting of bright members in the restframe [0.2 – 2]μm wavelength range

- No significant difference can be seen between the shapes of the z~1.2 and the local LFs of cluster galaxies (once a brightening of ~1.3 mag is applied to the local LF to account for passive evolution of the stellar populations)

- No significant difference can be seen between the shapes of cluster and field (bright end) LFs at z~1

- The bright end of the cluster galaxies LF appears to be dominated by galaxies already evolved both morphologically and spectrophotometrically