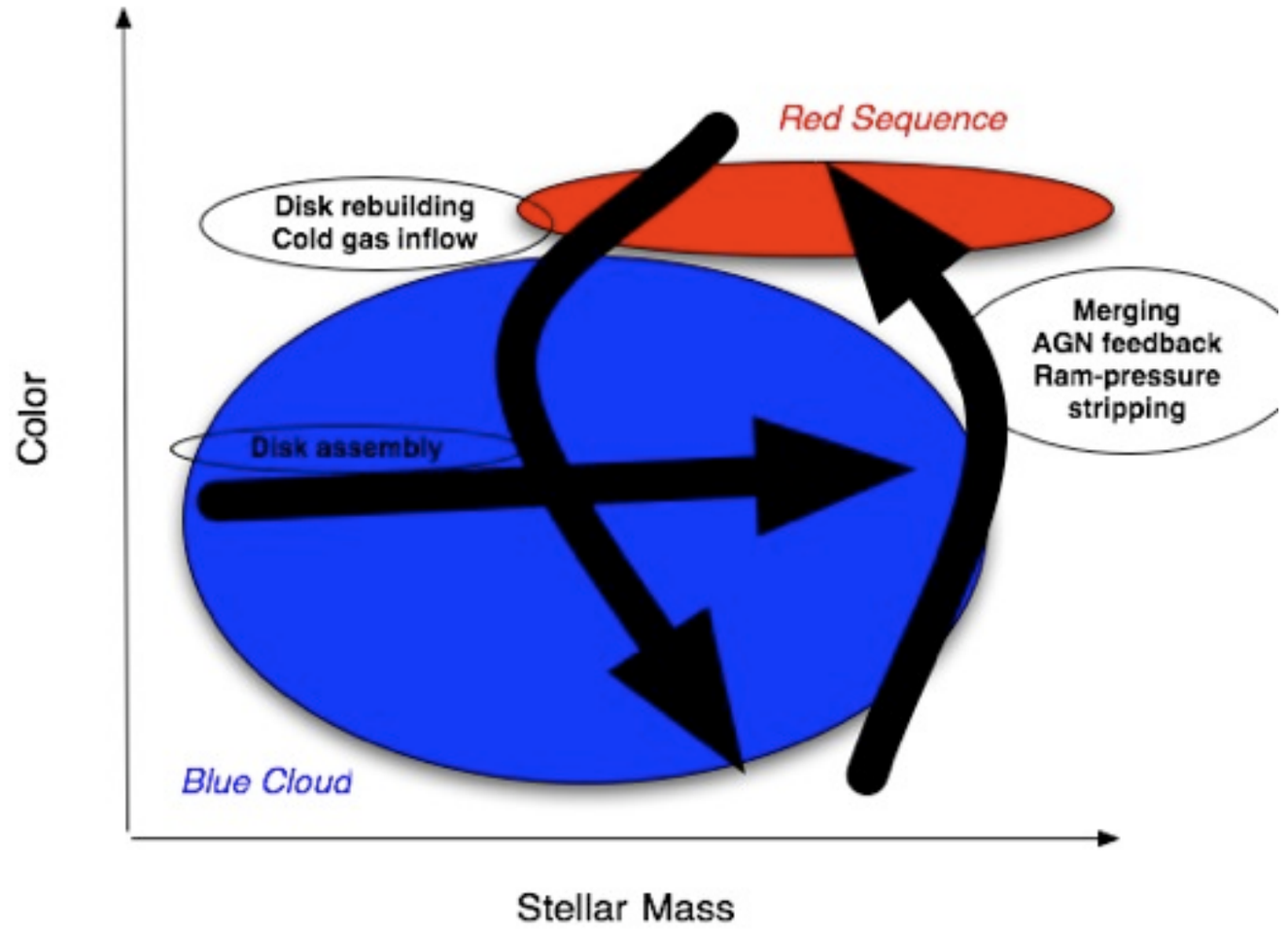
Evolution of blue E/S0s from z~1

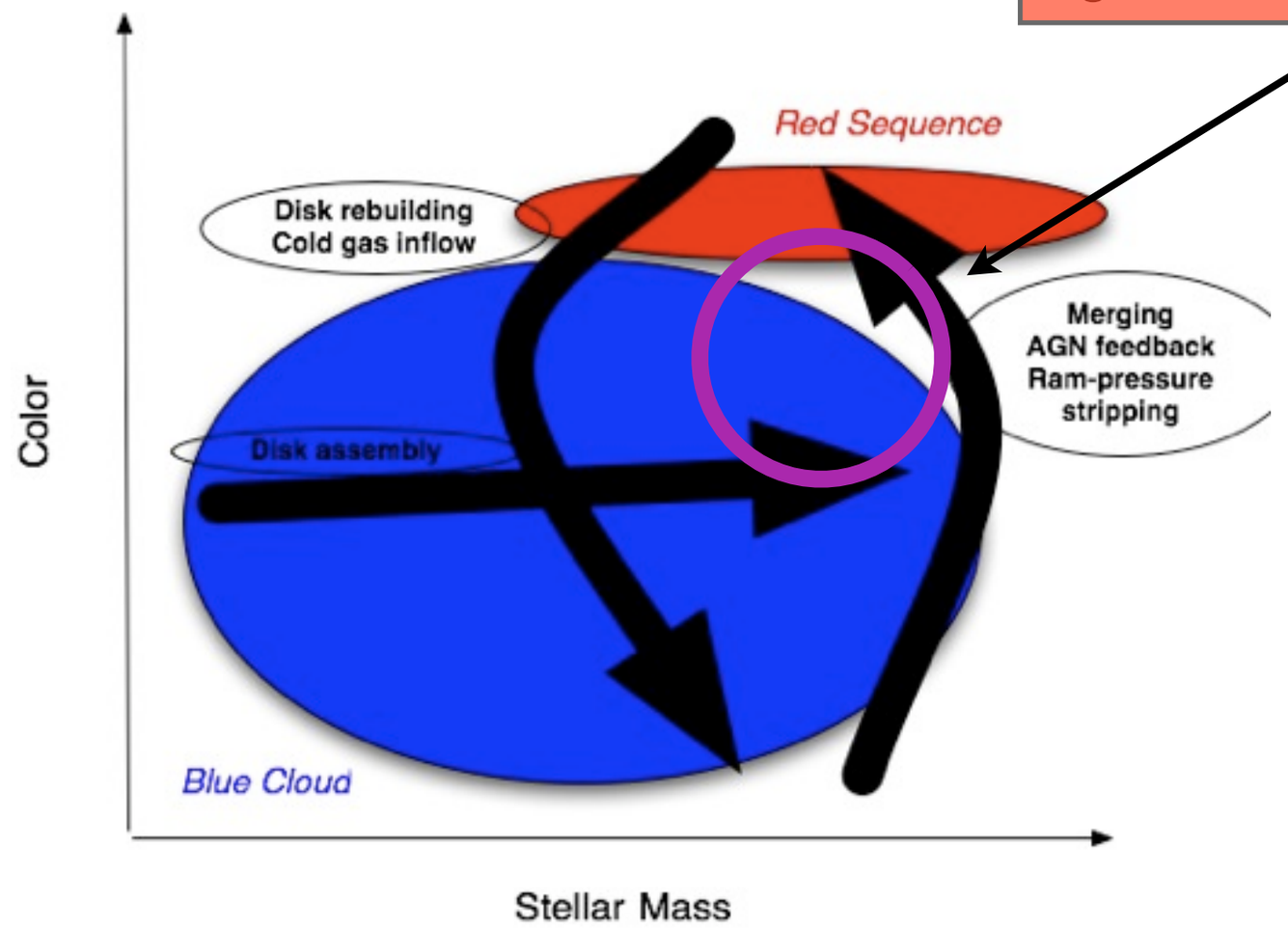
M. Huertas-Company[1], J.A.L. Aguerri[2], L. Tresse[3] + COSMOS

(Huertas-Company et al., 2009, A&A, in press)

1. GEPI (Paris)
2. IAC
3. LAM (Marseille)

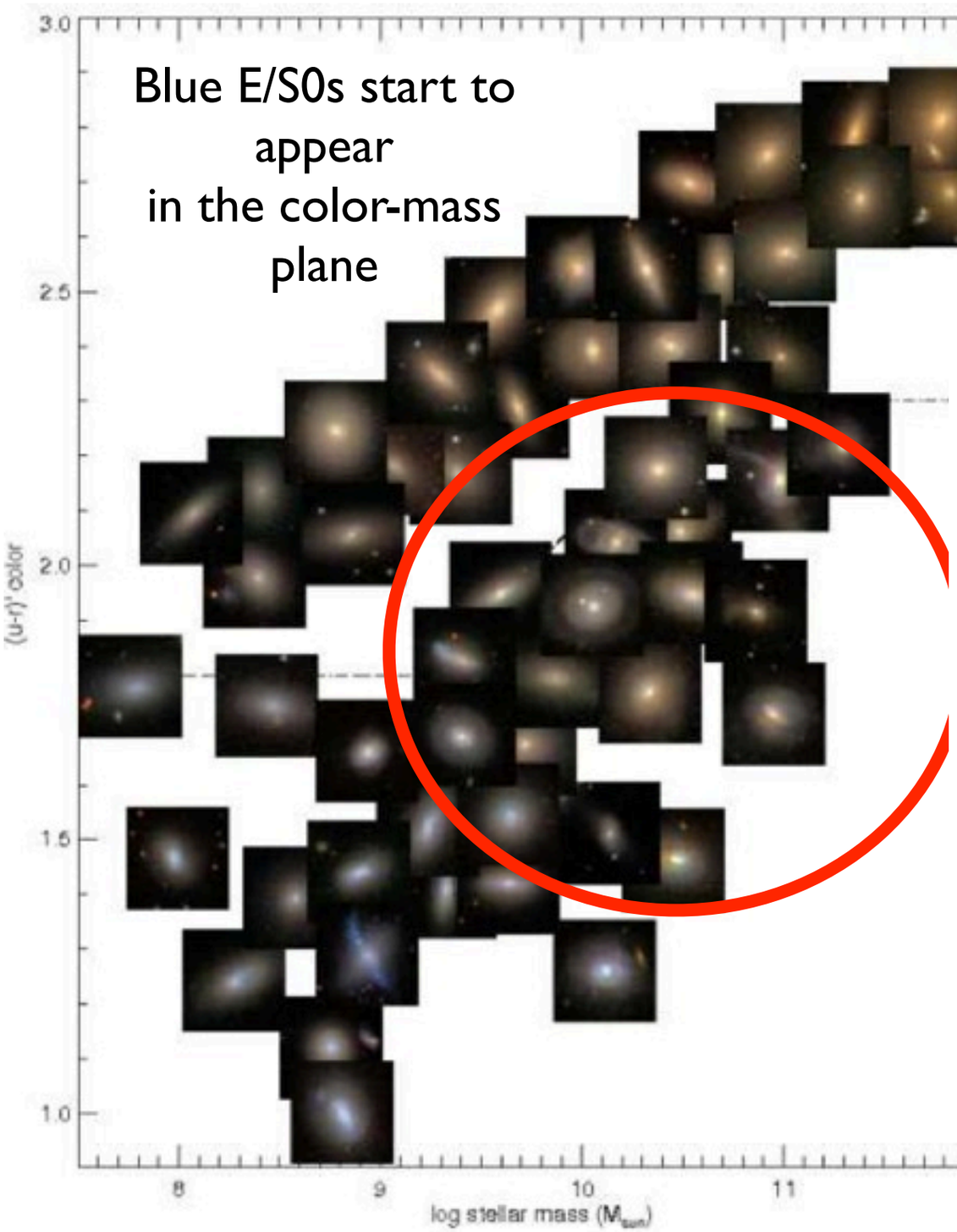

Red Sequence
Disk rebuilding
Cold gas inflow
Merging
AGN feedback
Ram-pressure
stripping
Disk assembly
Blue Cloud
Color
Stellar Mass

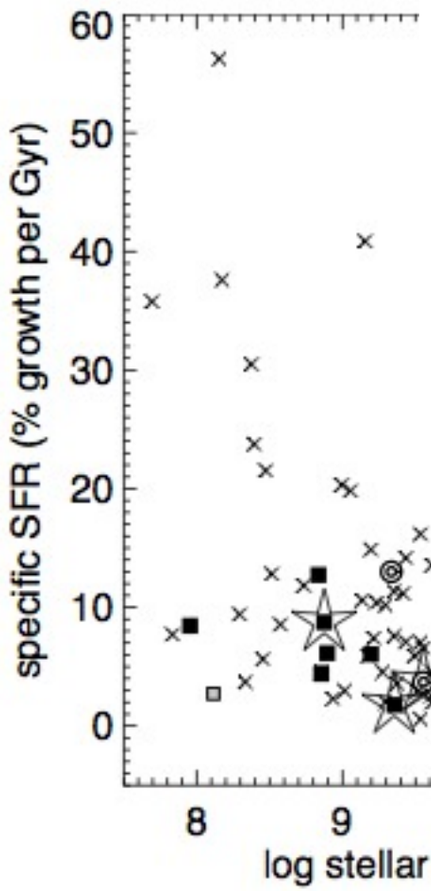
blue E/S0 galaxies: objects in migration? disk rebuilding activity?

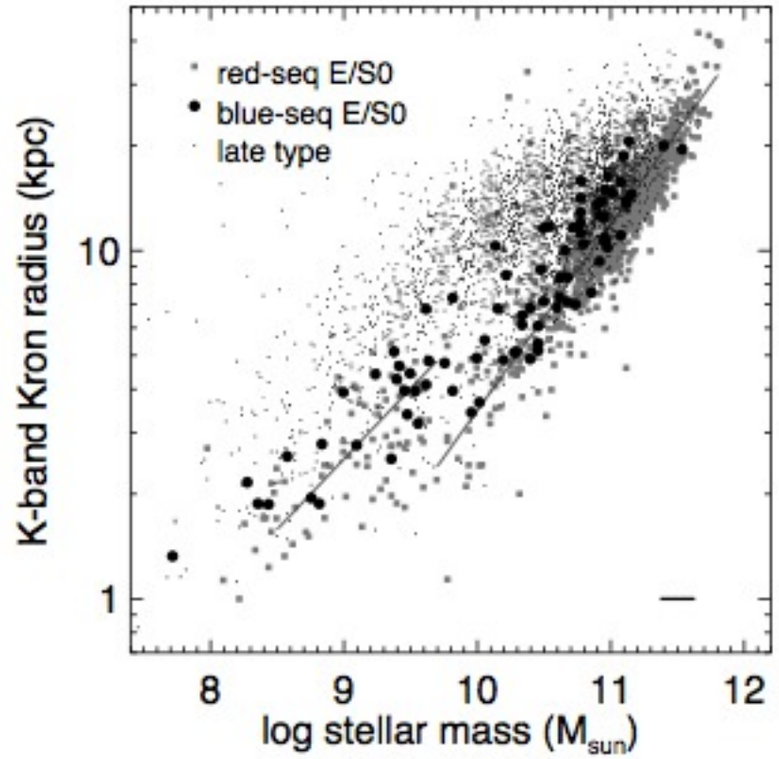


failures in the bimodal scheme can give clues on migration processes ...

At low redshift...







Kannappan et al. 09, AJ, 138, 579

The sample

redshifts

morphology

M* + ABSmag.

The sample

- zCOSMOS 10k sample, 10643 spectra of IAB<22.5 galaxies

redshifts

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redshifts

- ACS I band imaging of the COSMOS field
- 1.64 deg2, IAB < 22

morphology

M* + ABSmag.

The sample

- zCOSMOS 10k sample, 10643 spectra of IAB<22.5 galaxies

redshifts

- ACS I band imaging of the COSMOS field
  - 1.64 deg2, IAB < 22

morphology

- Multi-wavelength COSMOS imaging
  - NUV (GALEX), u (CFHT), B,V,g,r,i,z (SUBARU), Ks (CFHT), 3.6um and 4.5um (SPITZER)

M* + ABSmag.

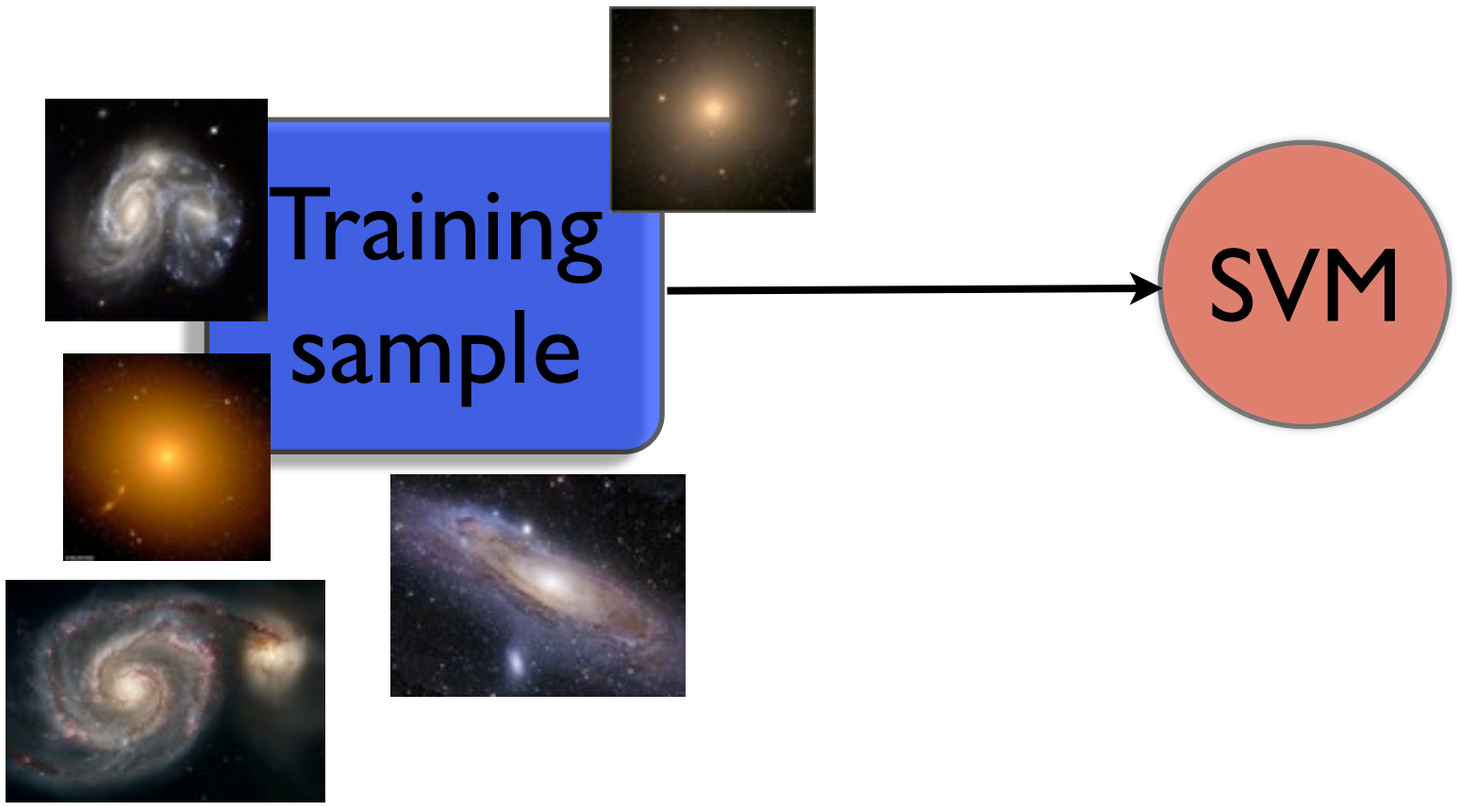
Redshifts - zCOSMOS

- Spectra (VIMOS) of 20.000 I-band selected galaxies
- 15<IAB<22.5
- DR2 - freely available, 10643 spectra + redshifts
- In this work: **z < 0.55 / 0.55<z<0.8 / 0.8<z<1.4**

ACS data - morphologies

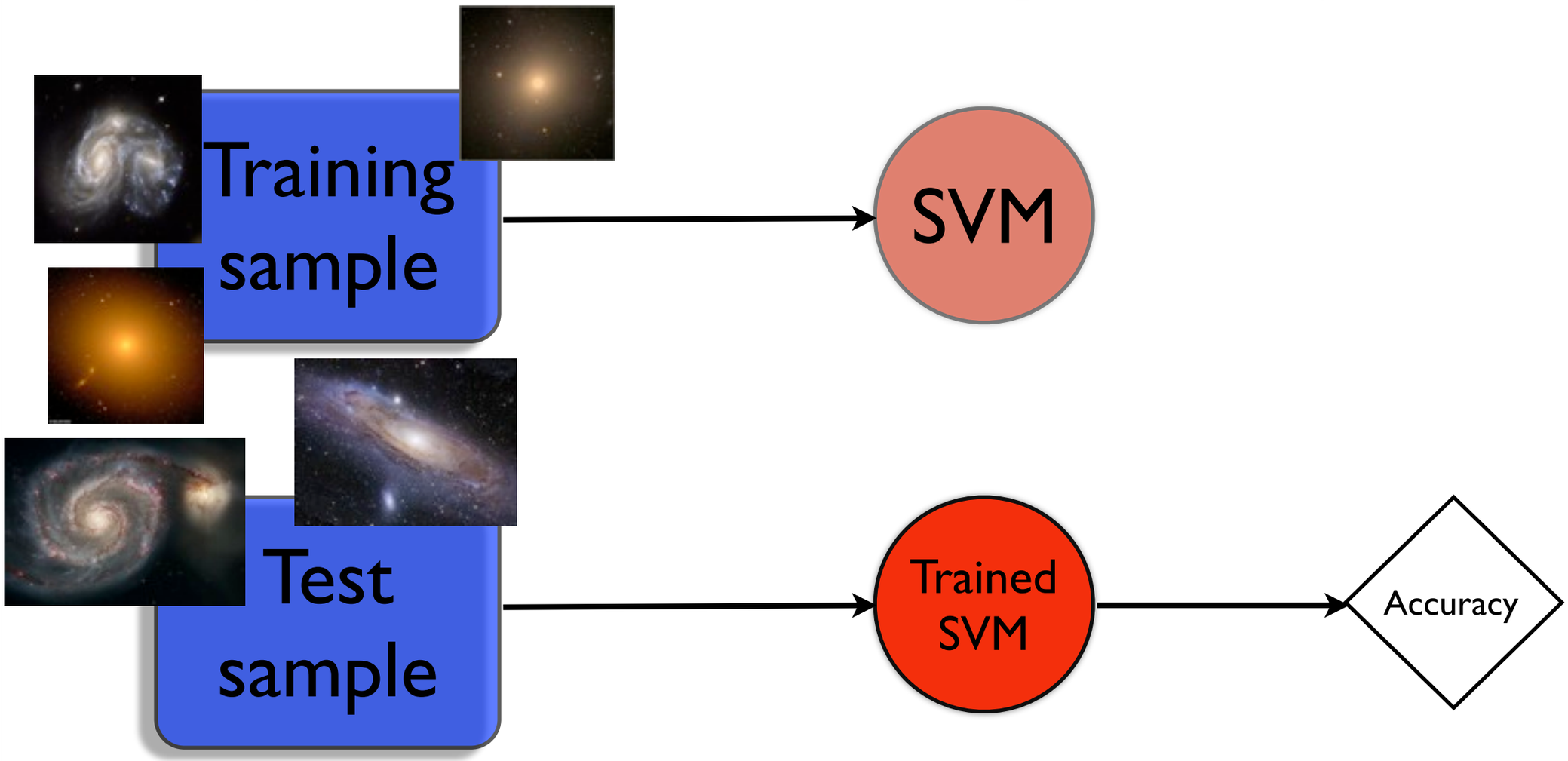
- Galaxies divided in 2 broad morphological classes with galSVM
  - Late-type / Early-type
- For every galaxy we give a probability of being early or late type

galSVM morpholgies (I)



(probability)

galSVM morpholgies (I)



(probability)

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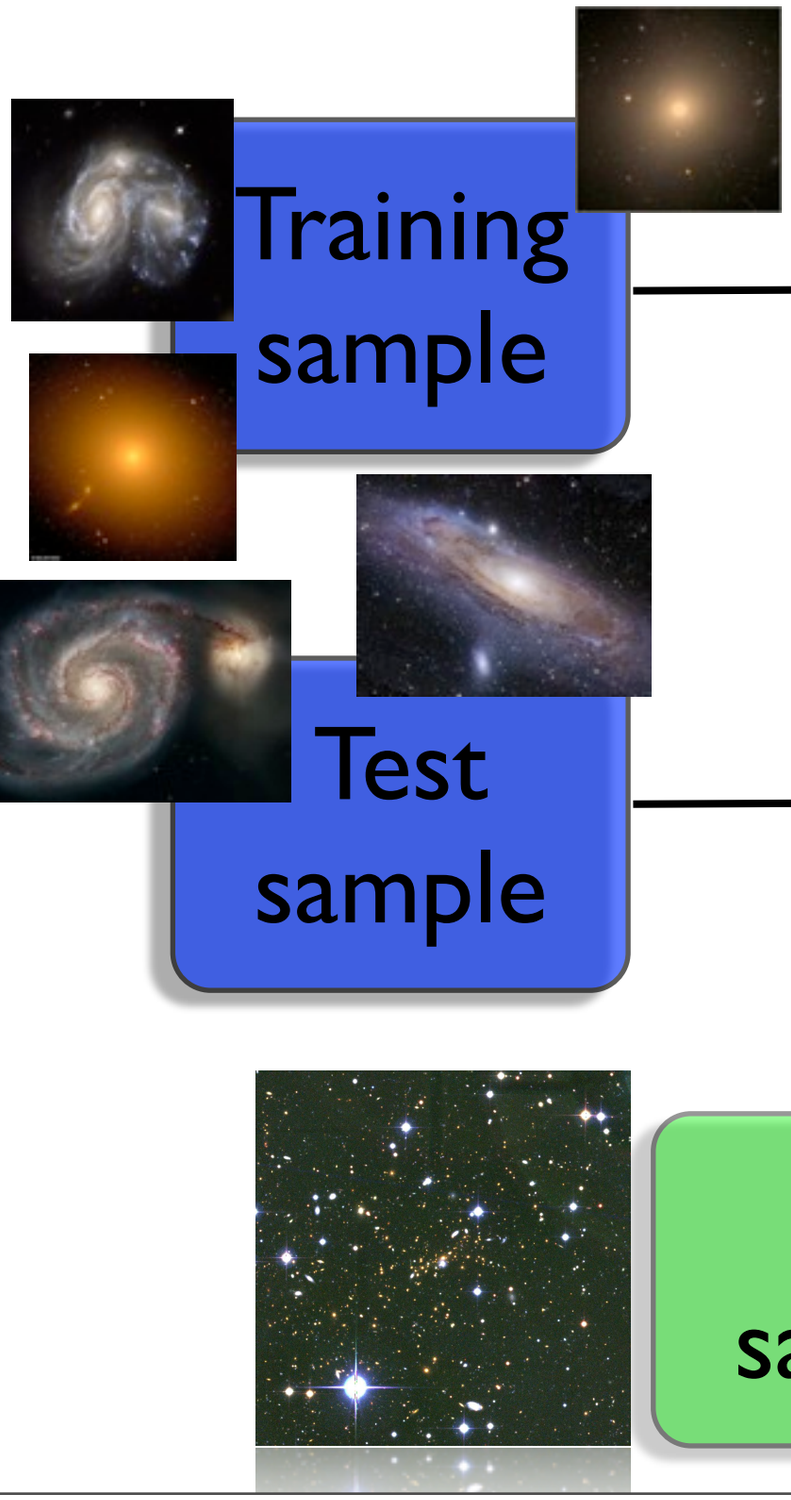


Absolute magnitudes and stellar mass

- SED fitting with COSMOS photometry from NUV to FIR
- 38 models from PEGASE.2
- Restrict the analysis to galaxies with photoz consistent with spectroz
- Divided the sample in:
  - BLUE:T21-T38
  - RED:T1-T21
- Stellar masses are also estimated from the best-fit template

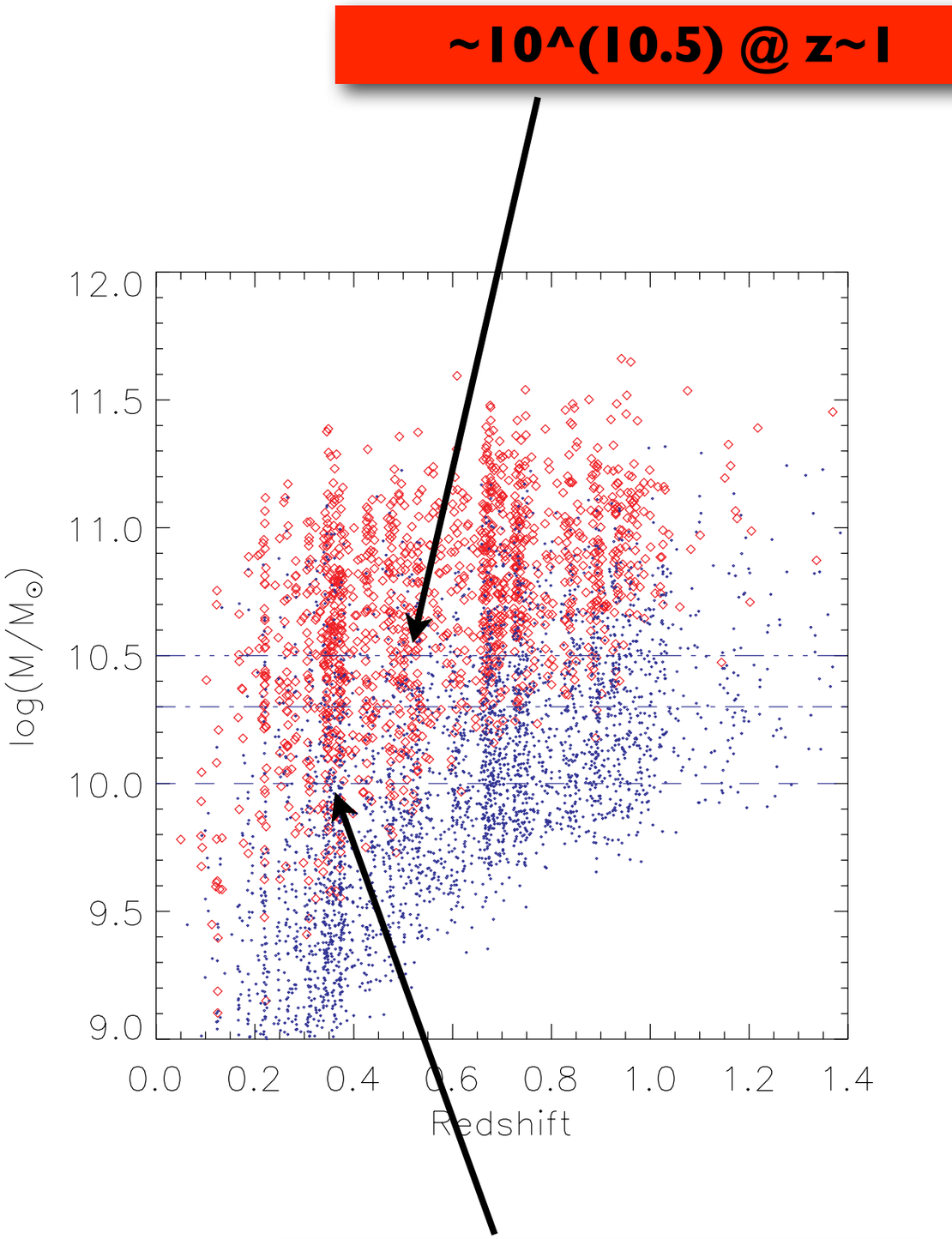
Completeness

Final sample:

6240 galaxies

18<IAB<22

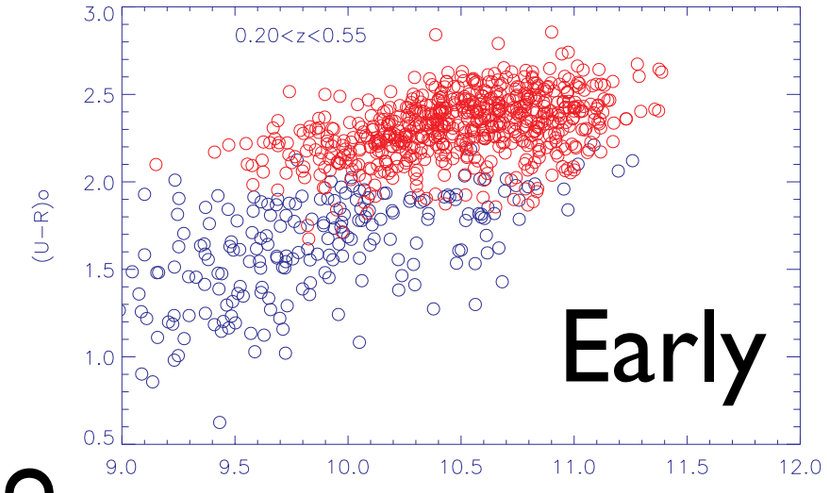
z~1

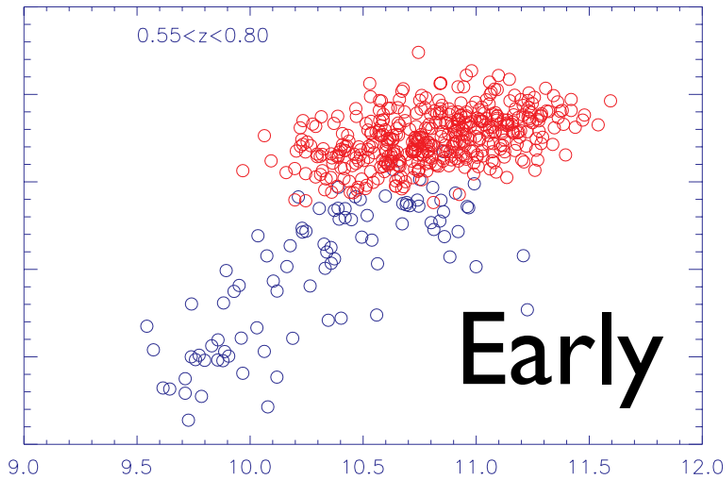


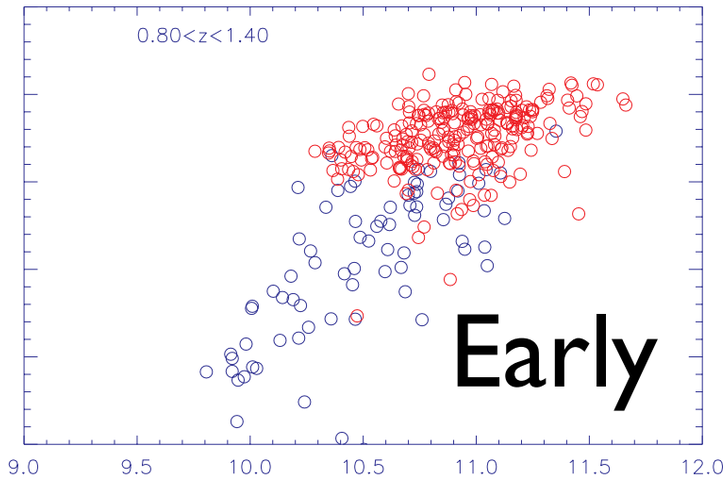
0.2<z<0.55

0.55<z<0.8

0.80<z<1.4

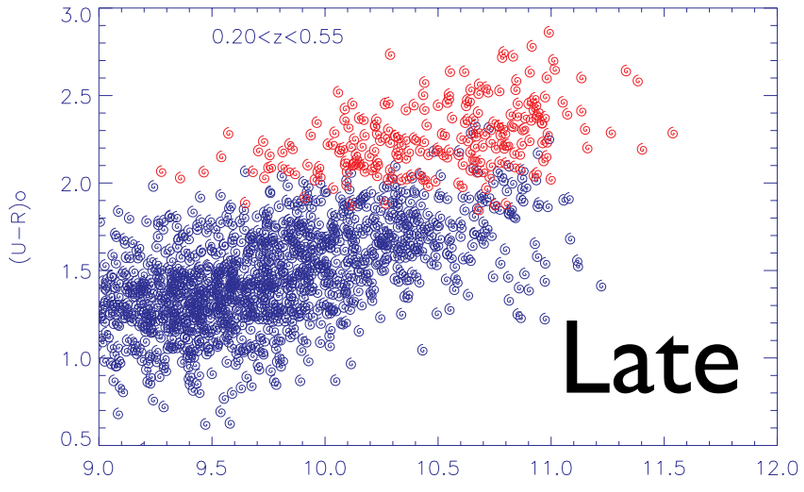


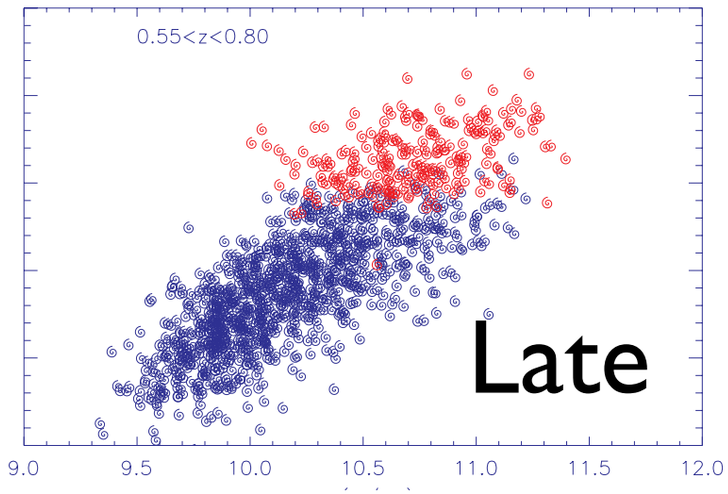


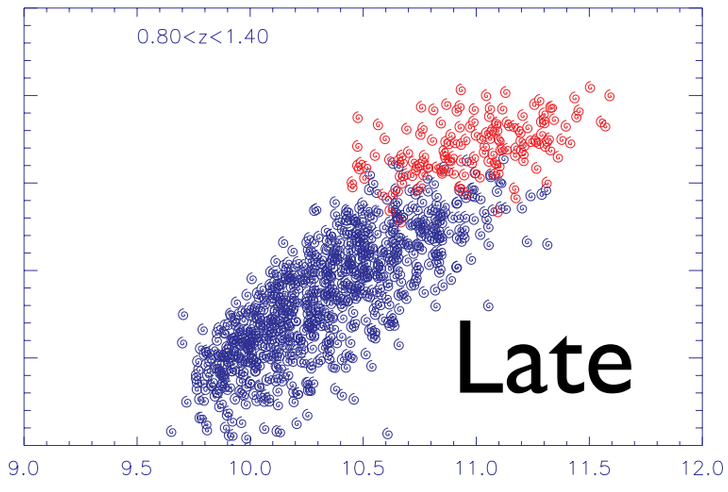


(U-R)o

Log (M/Msol)







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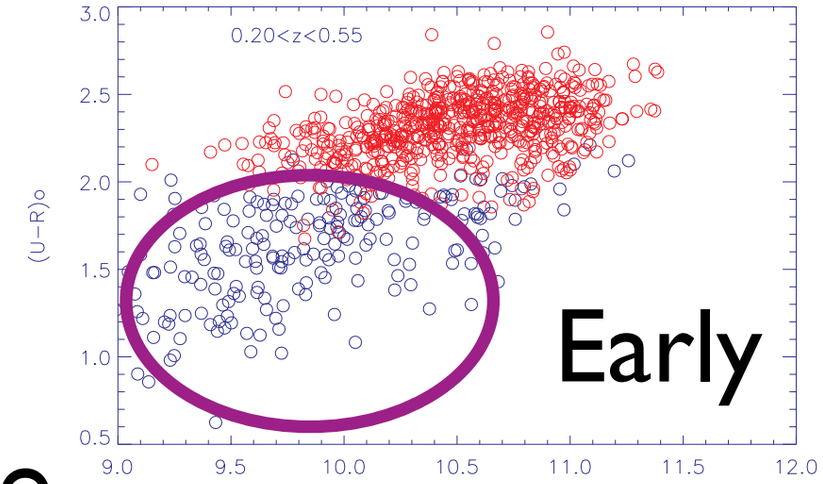

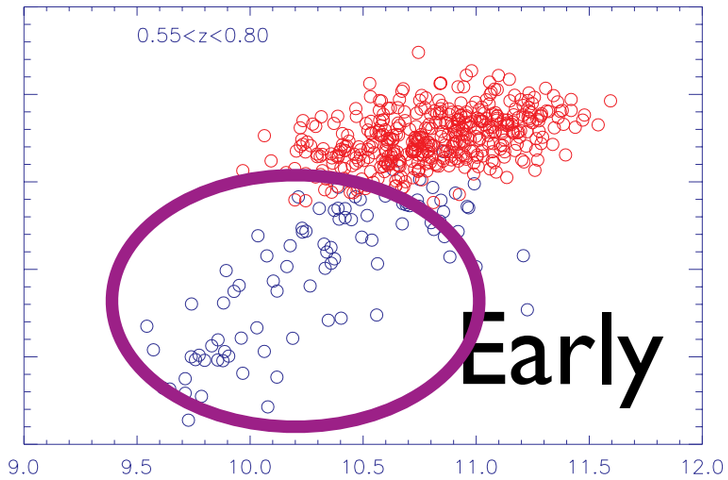

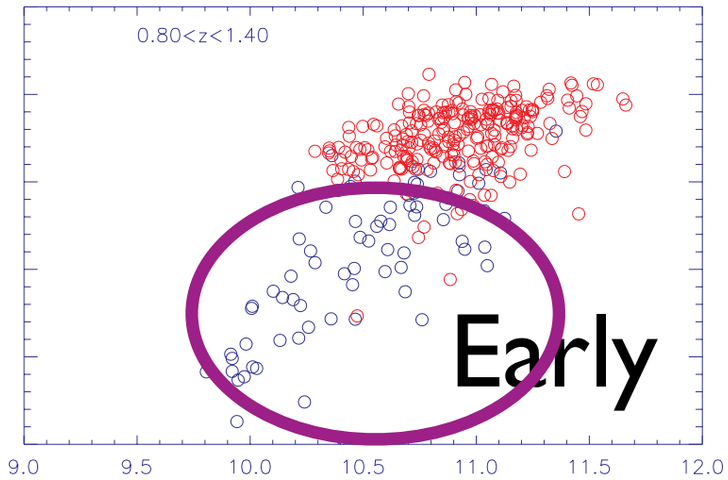

(U-R)o

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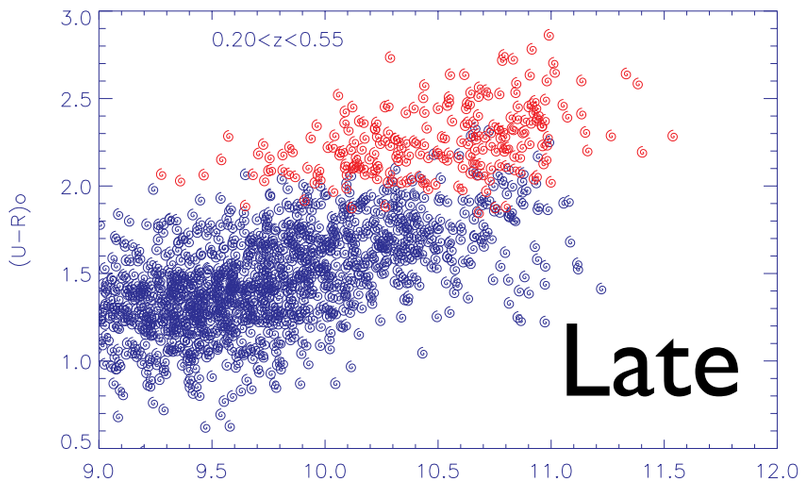
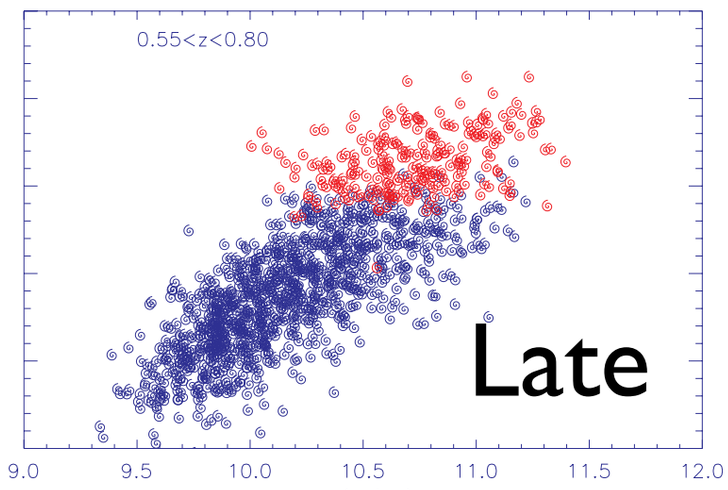
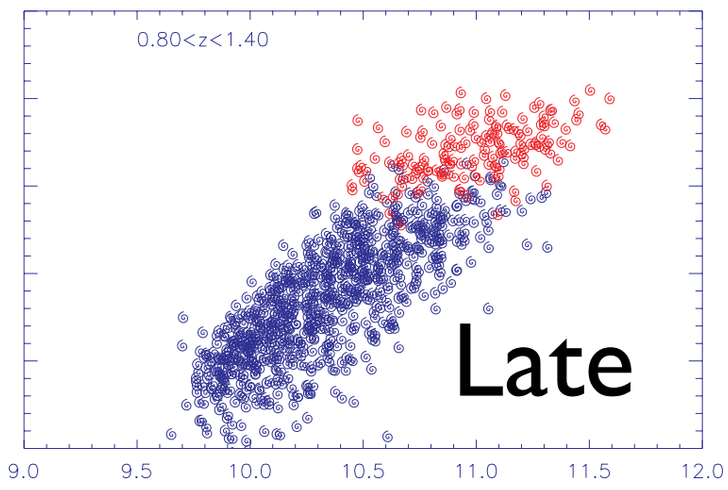
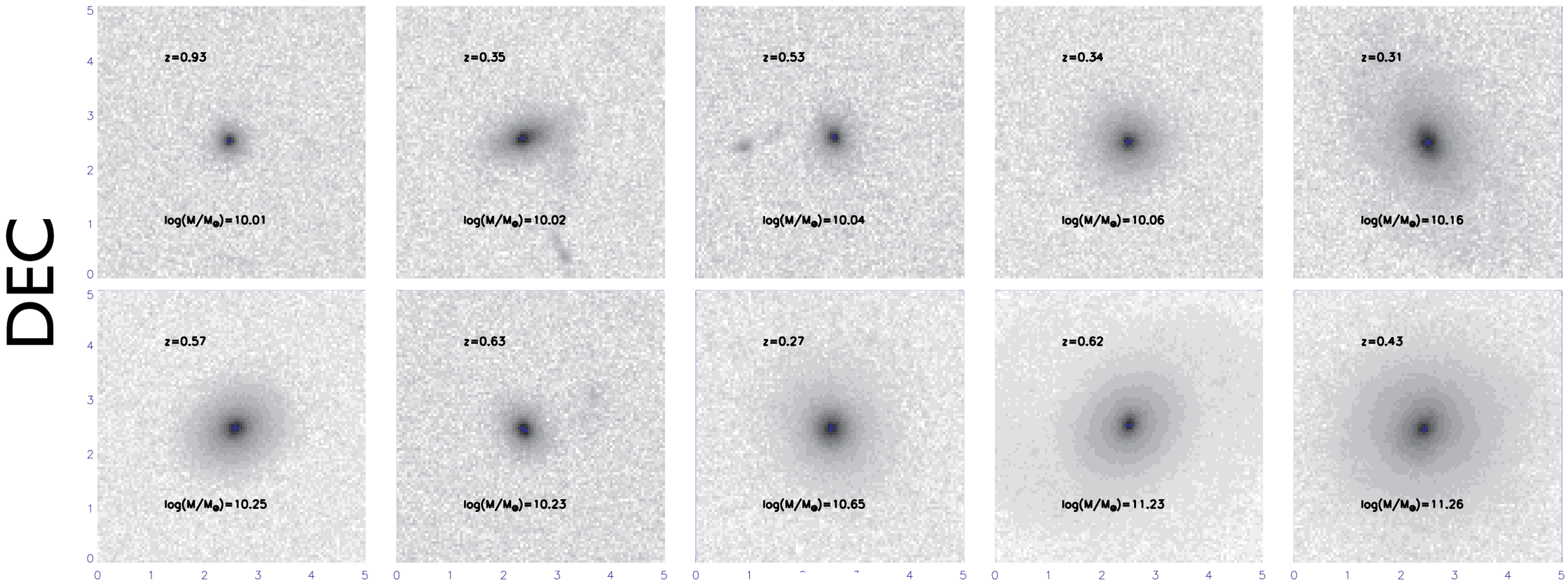




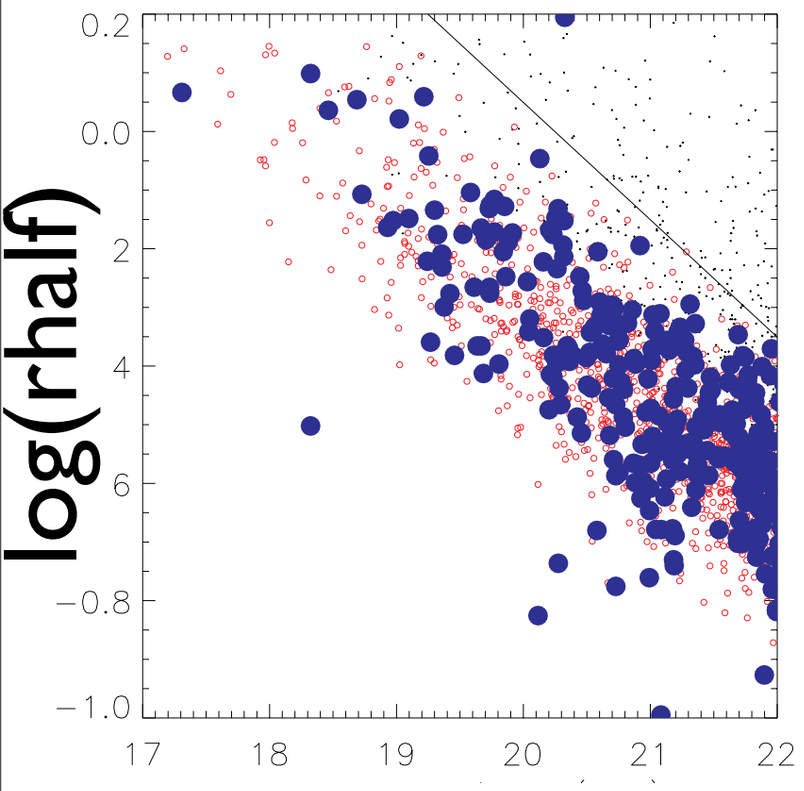


Log (M/Msol)

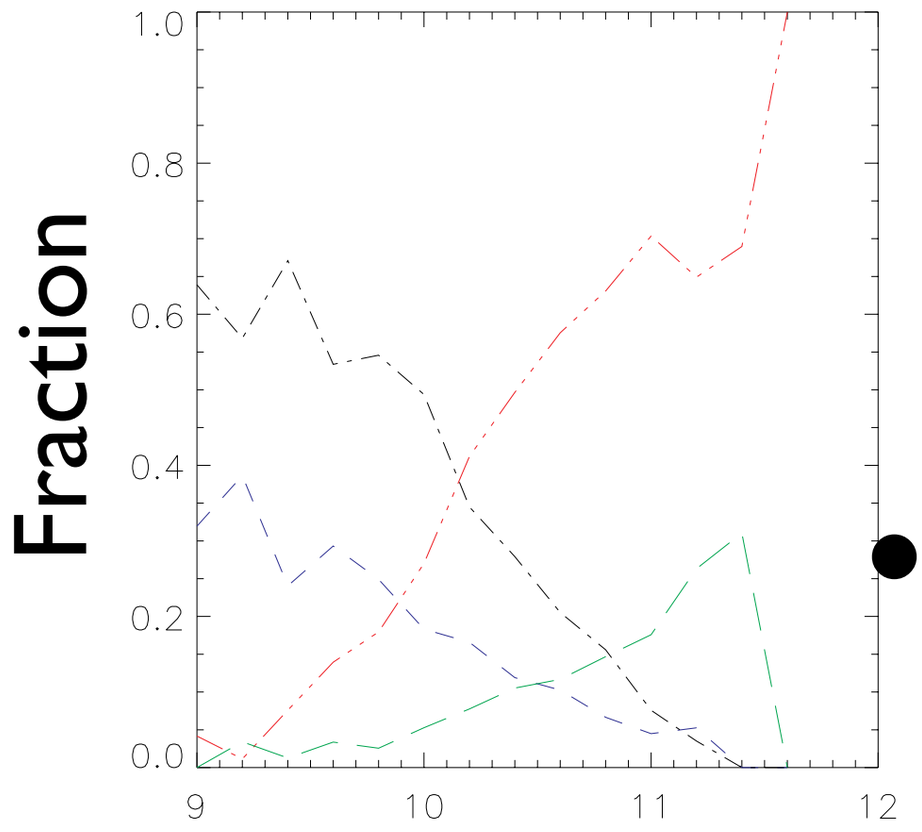
increasing stellar mass



Are blue E/S0s blue compact galaxies?



I mag (ACS)

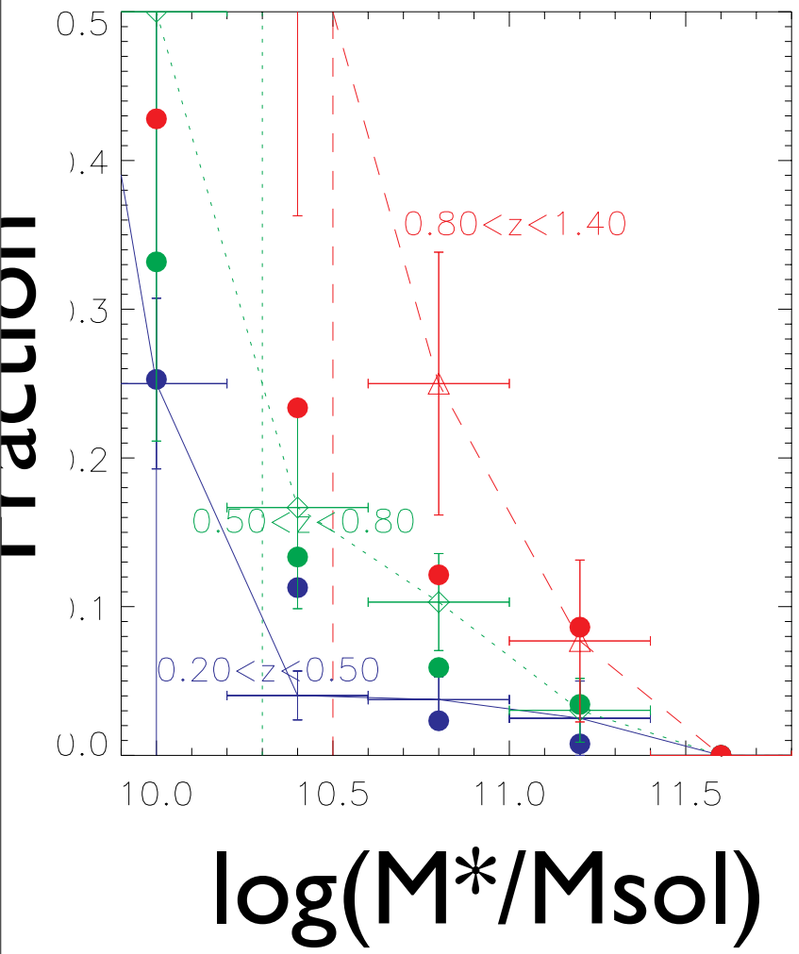


log(M*/Msol)

- Focused on the massive tail of the compact region

Phillips et al. 97

abundances



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$log(M_s/M_\odot)$	11.2	11.5 ± 0.38	11.5 ± 0.58	11.5 ± 1.20
$log(M_b/M_\odot)$	10.5	10.37 ± 0.1	10.72 ± 0.08	11.00 ± 0.2
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abundances

Threshold Mass increasing with redshit

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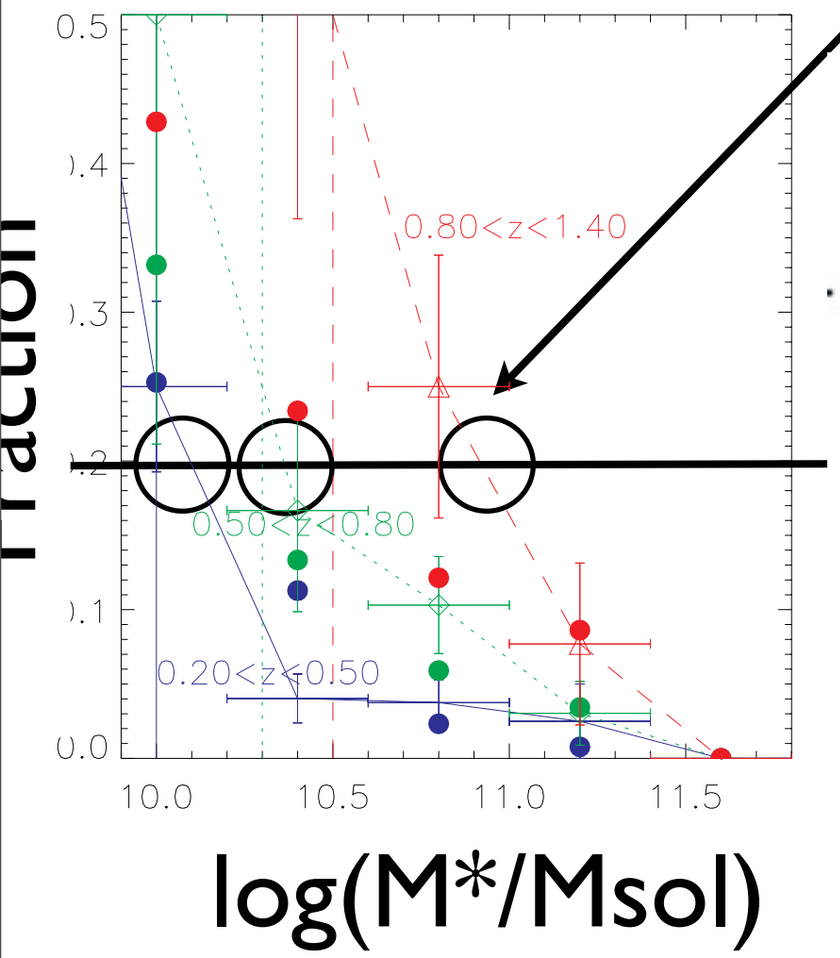

abundances

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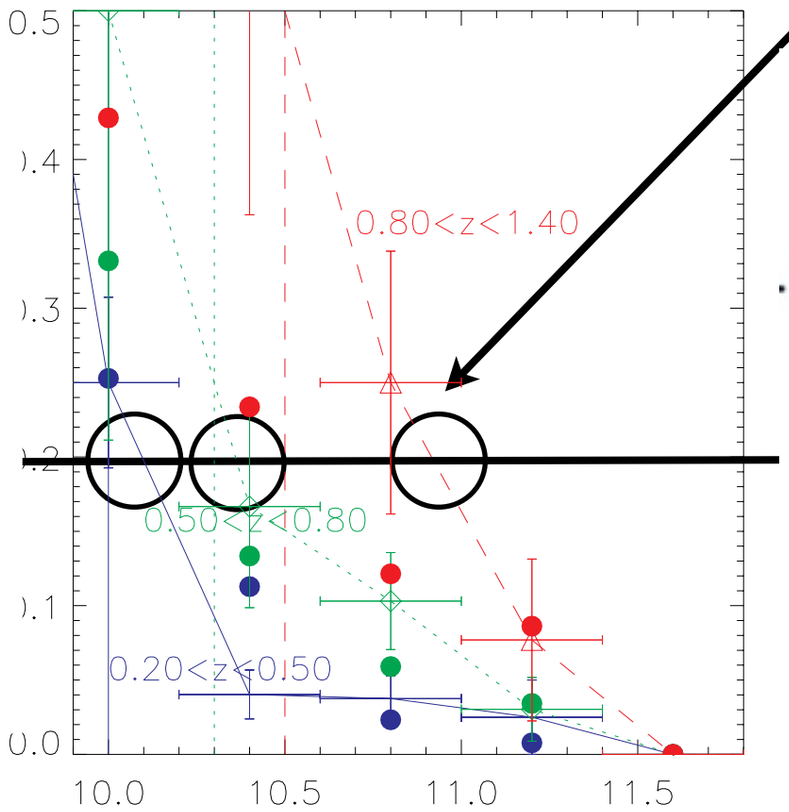

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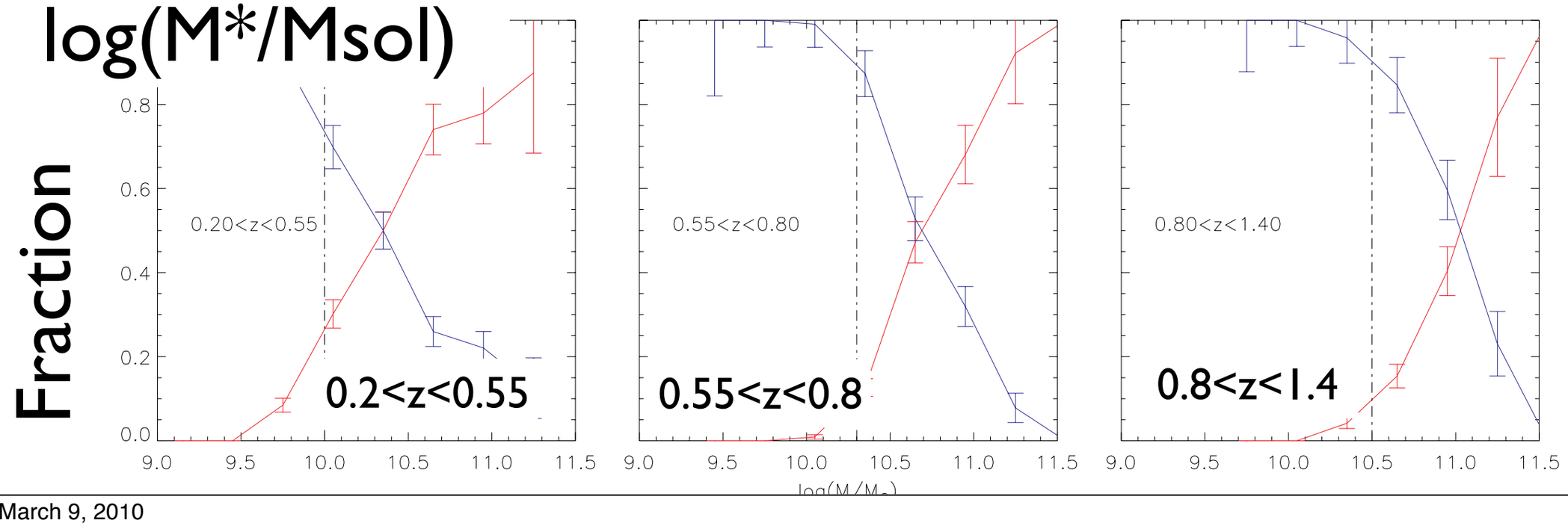
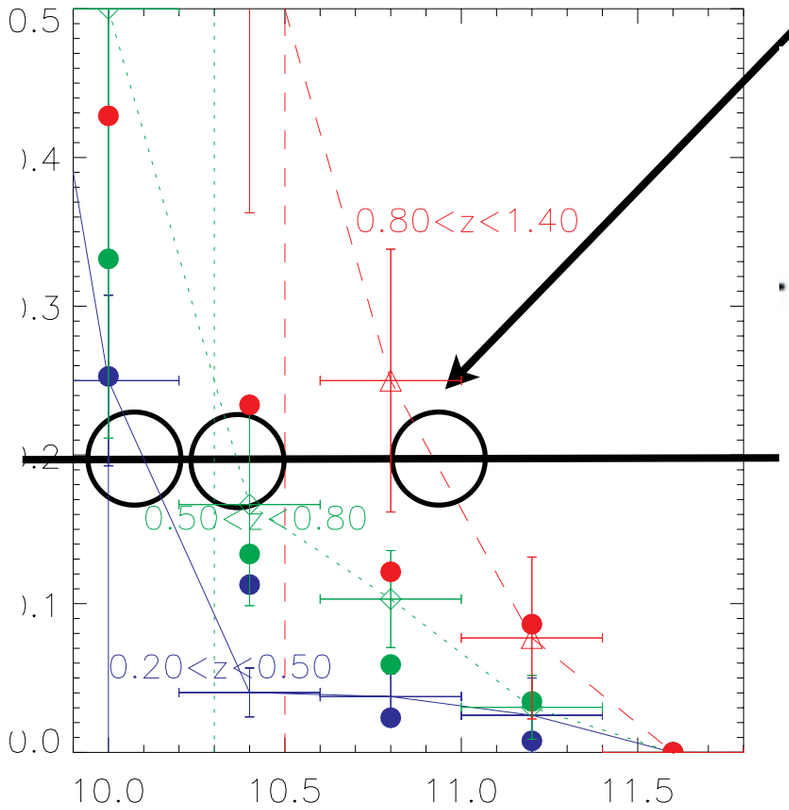


abundances

Threshold Mass increasing with redshit



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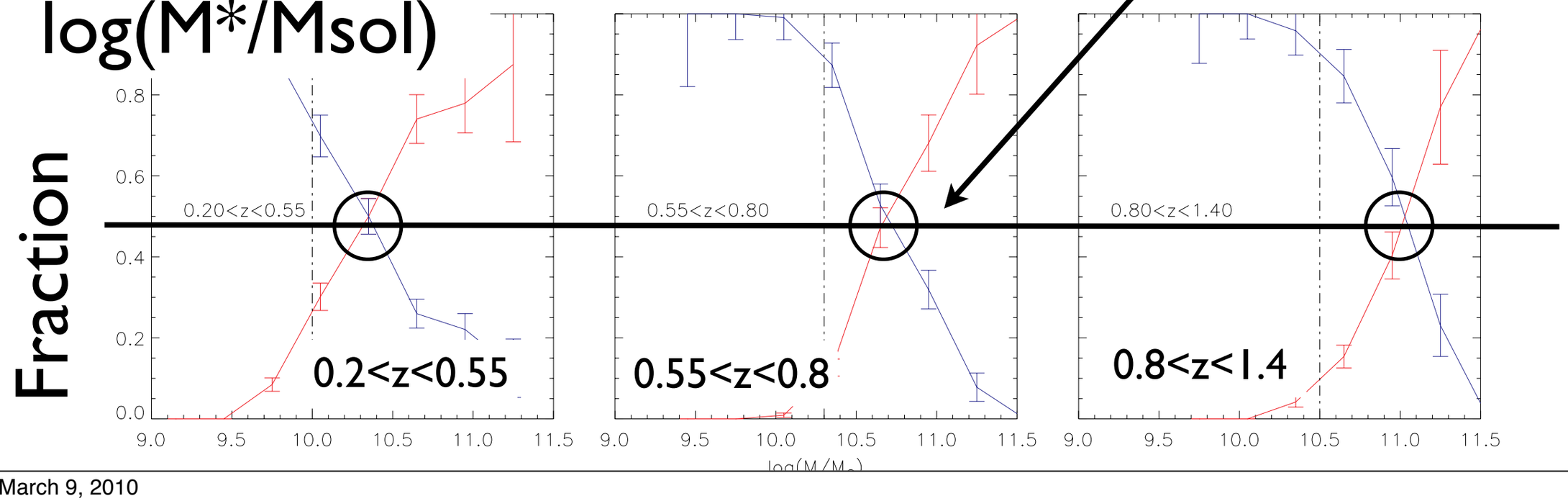
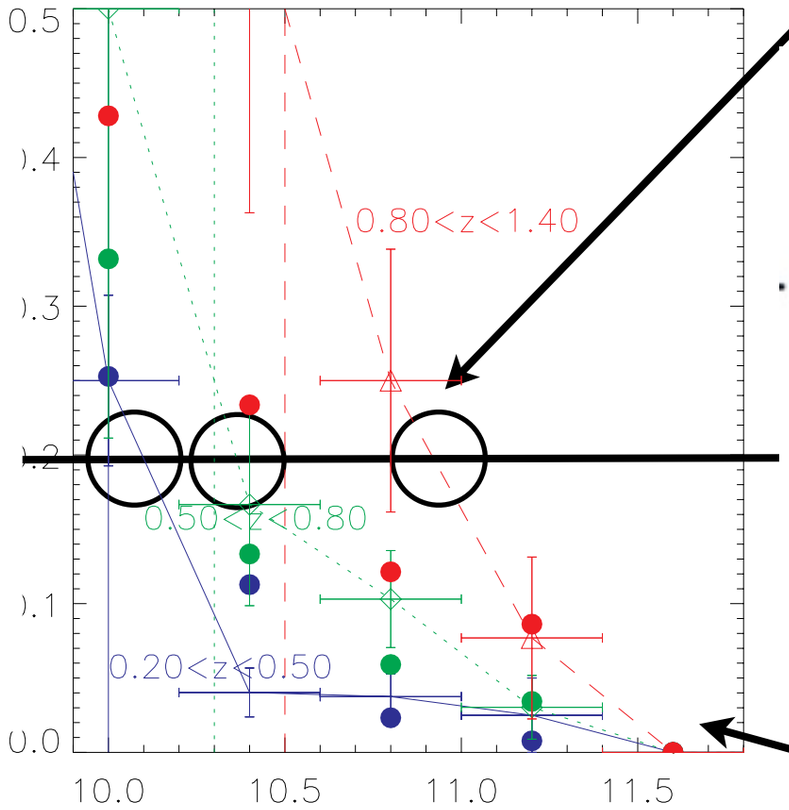
Bimodality Mass increasing with redshit



abundances

Threshold Mass increasing with redshit



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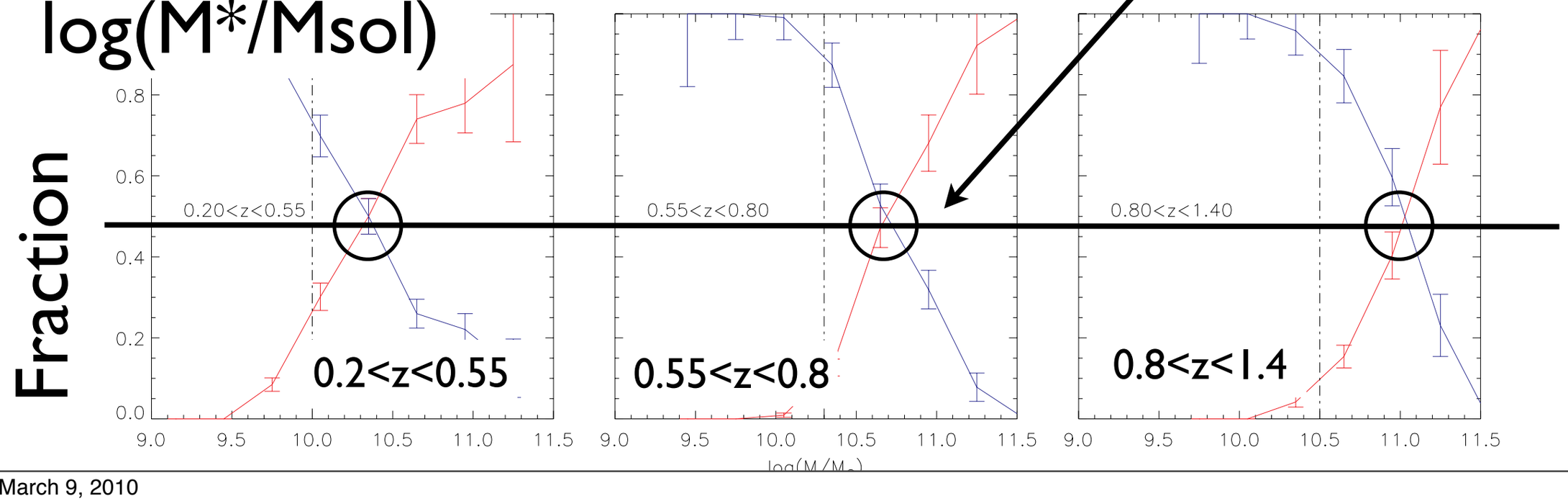
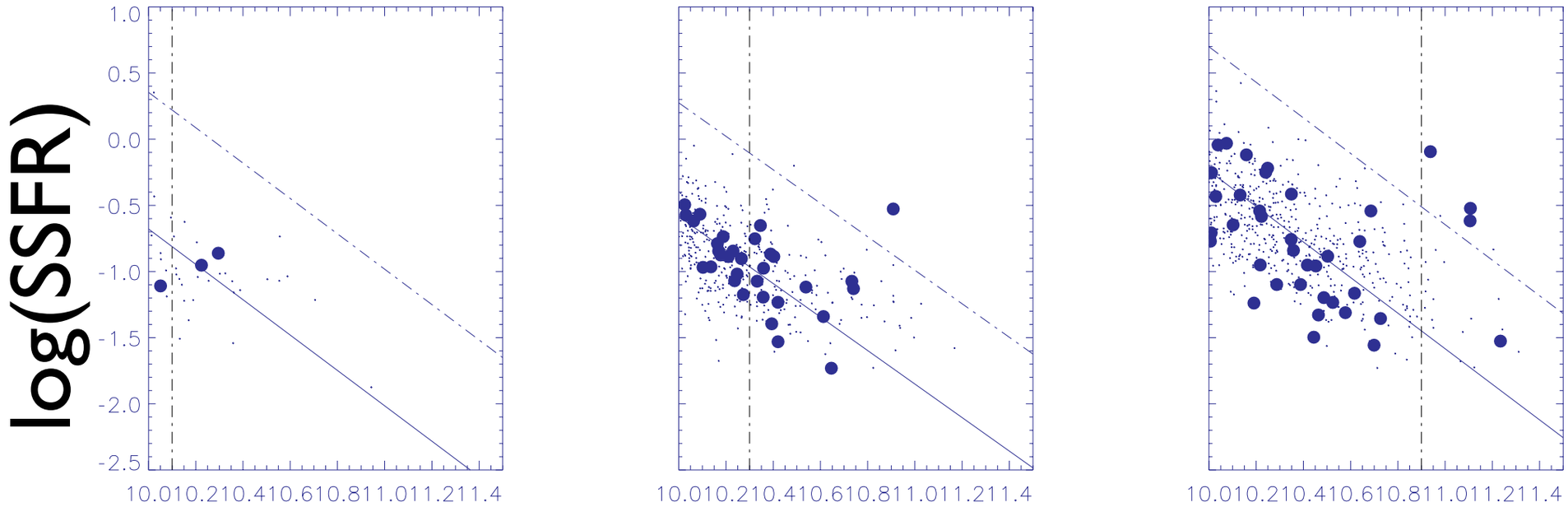
Bimodality Mass increasing with redshit

Shutdown mass ~ constant



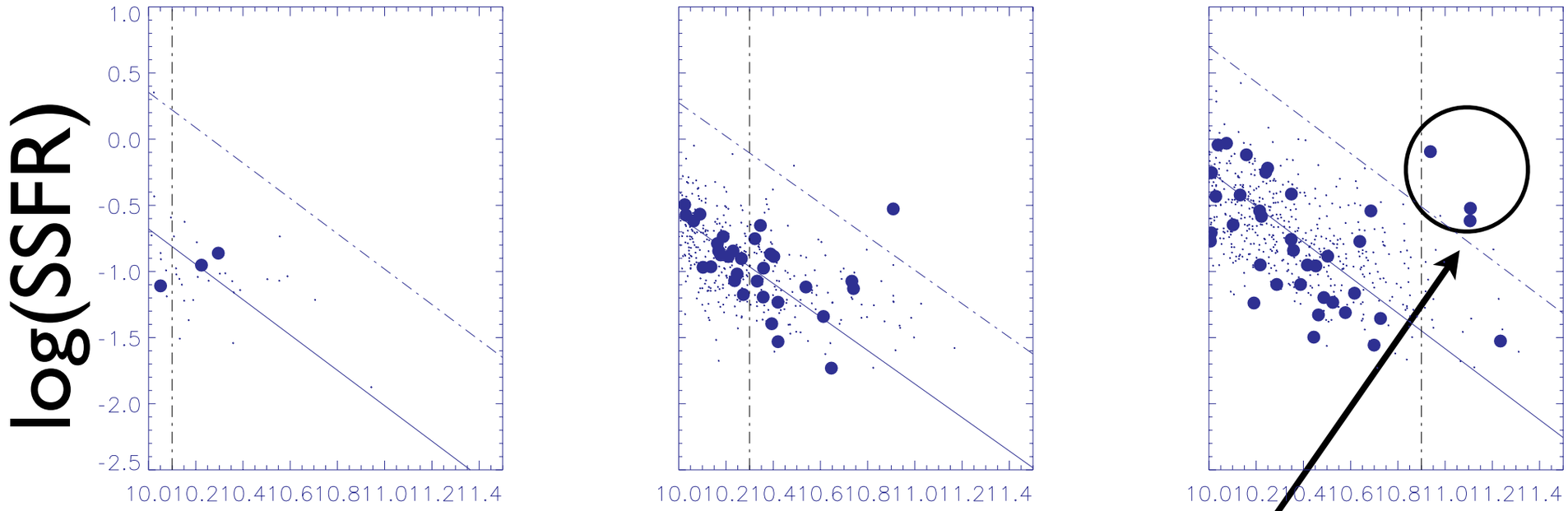
star formation



$$SFR(M_{\odot}yr^{-1}) \sim 2.5 \times 10^{-12} \times 10^{-0.4(M_B - M_{B\odot})} EW_{[OII]}$$

Guzman et al. 1997

star formation



outliers seem to have higher stellar masses

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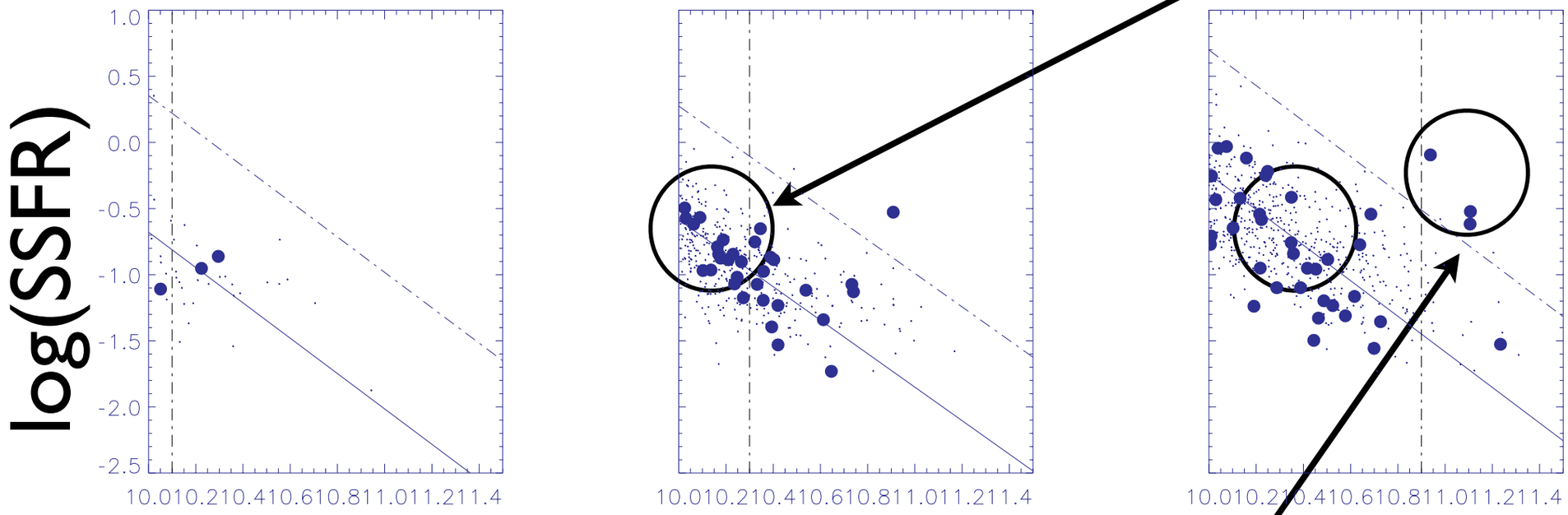
Guzman et al. 1997

star formation

low mass blue E/S0 have similar SF rates than normal spirals



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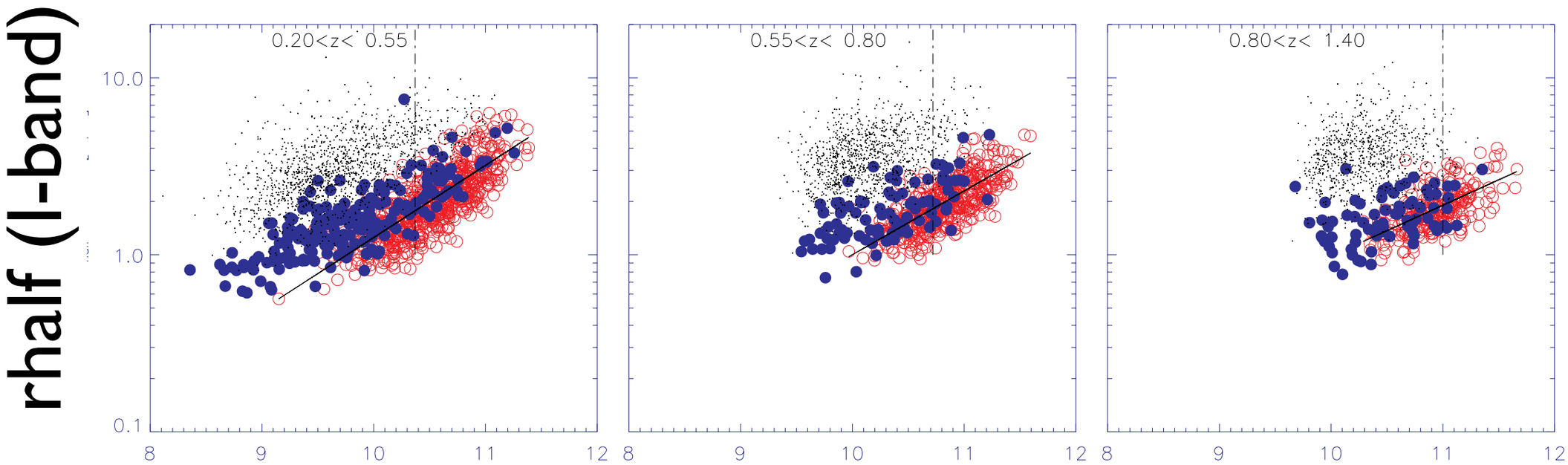
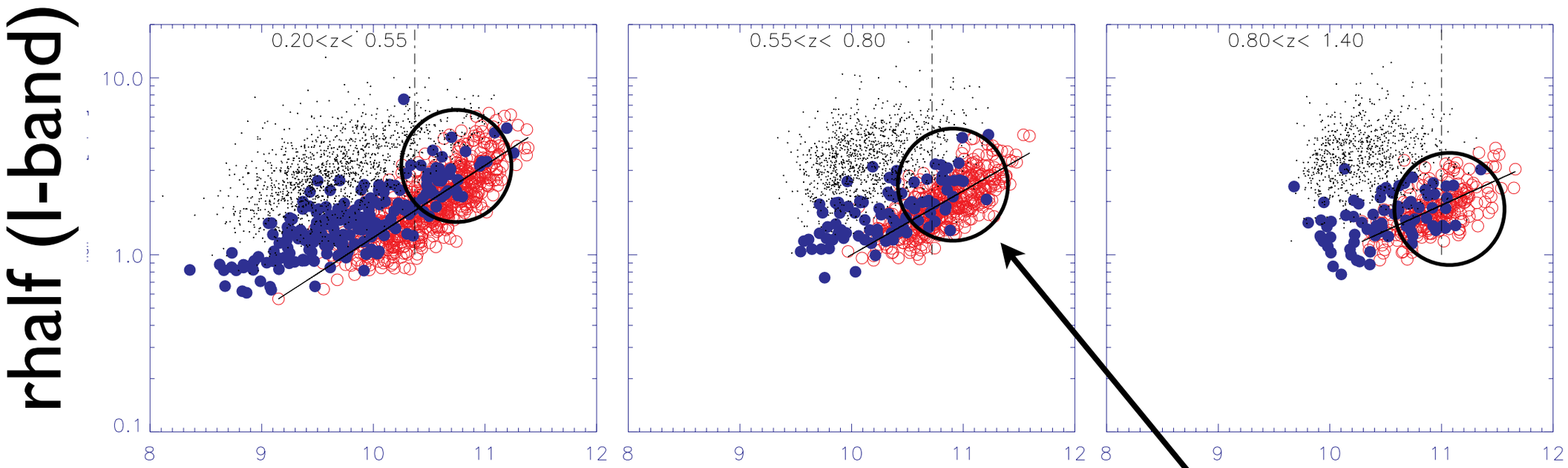
size

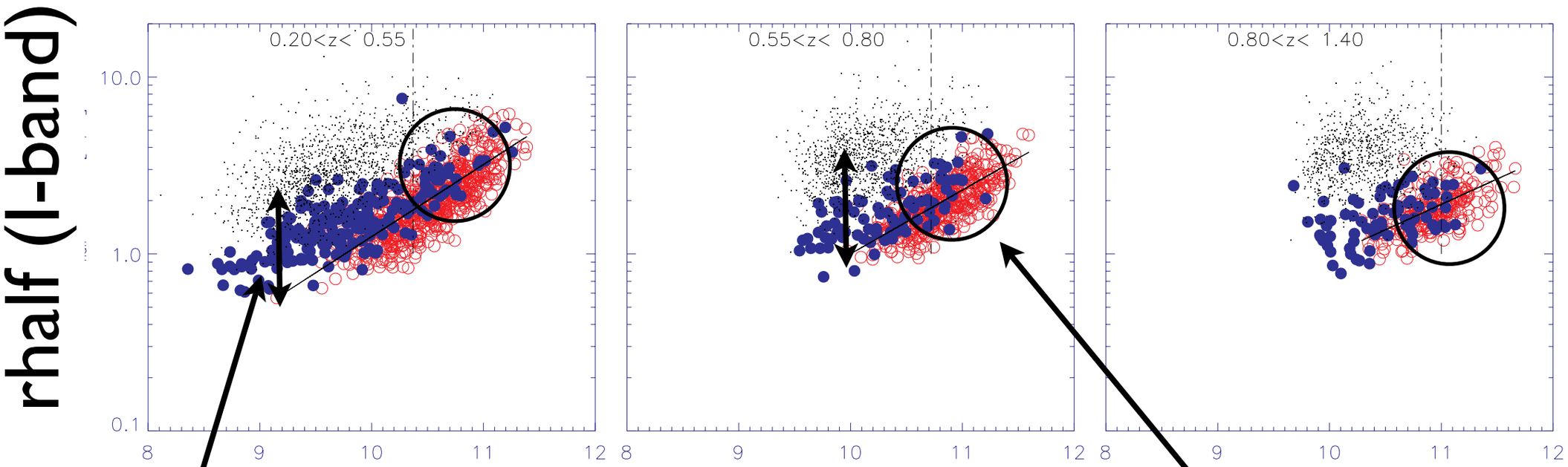

rhalf (I-band)
0.20<z< 0.55
0.55<z< 0.80
0.80<z< 1.40
10.0
1.0
0.1
8
9
10
11
12
log(M*/Msol)

size



at high masses blue E/S0s have similar sizes than red E/S0s

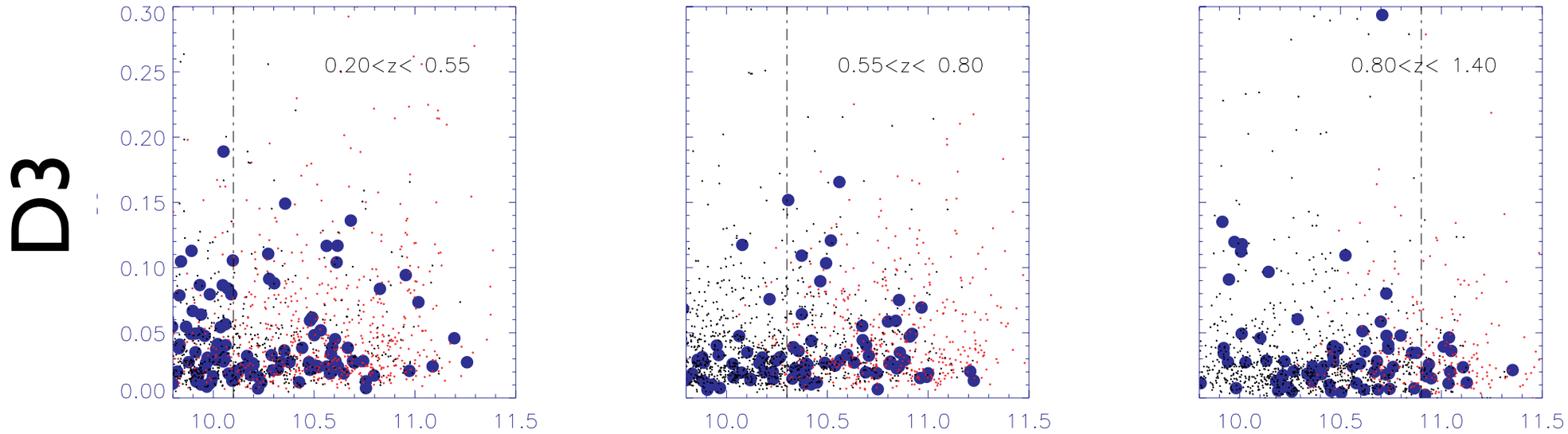
size



at low masses blue E/S0s tend to be closer to normal spirals

at high masses blue E/S0s have similar sizes than red E/S0s

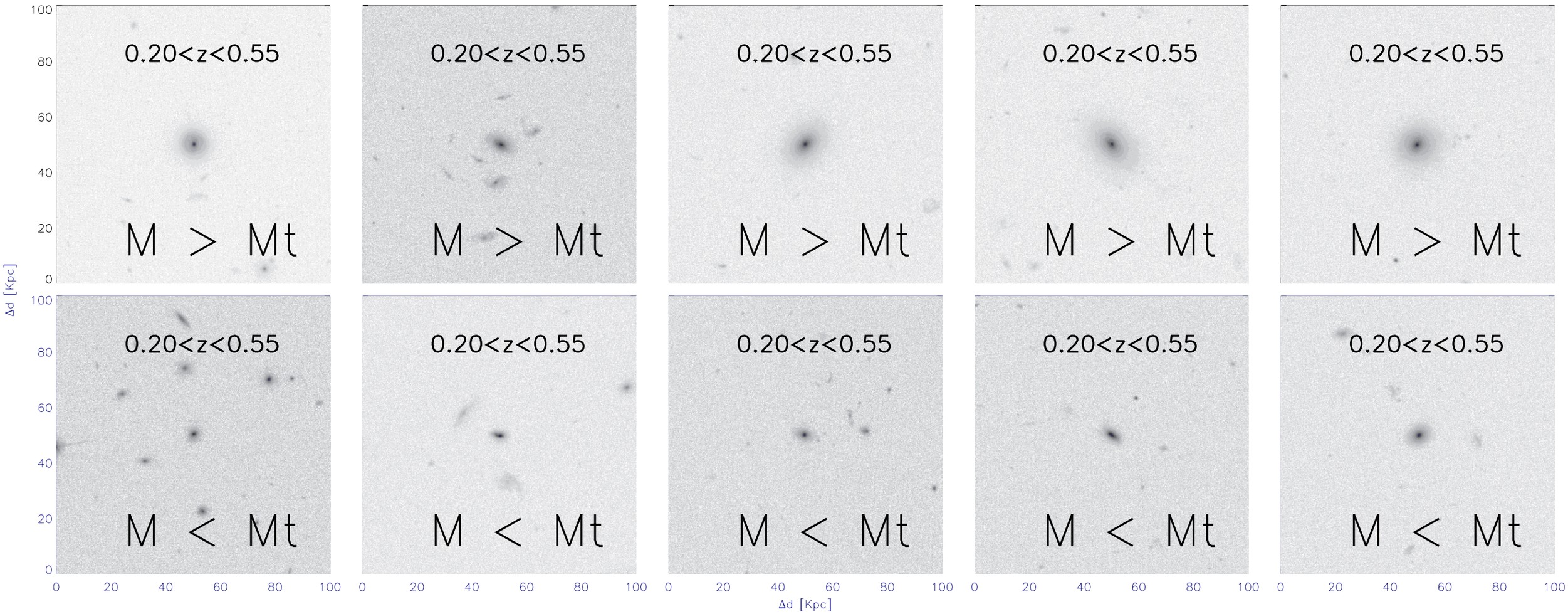
environment



log(M*/Msol)

do not reside in specially high density environments...

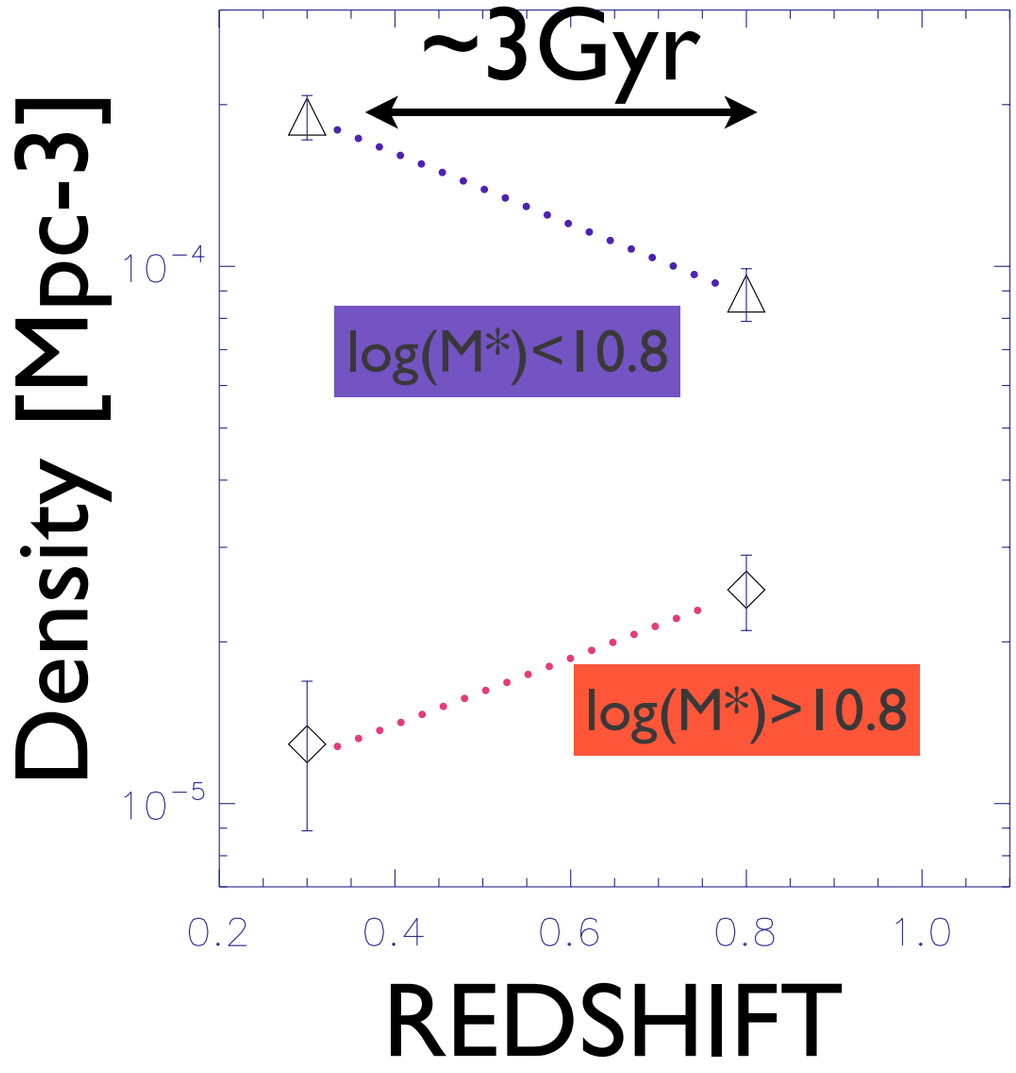
environment



How these blue E/S0s evolve?

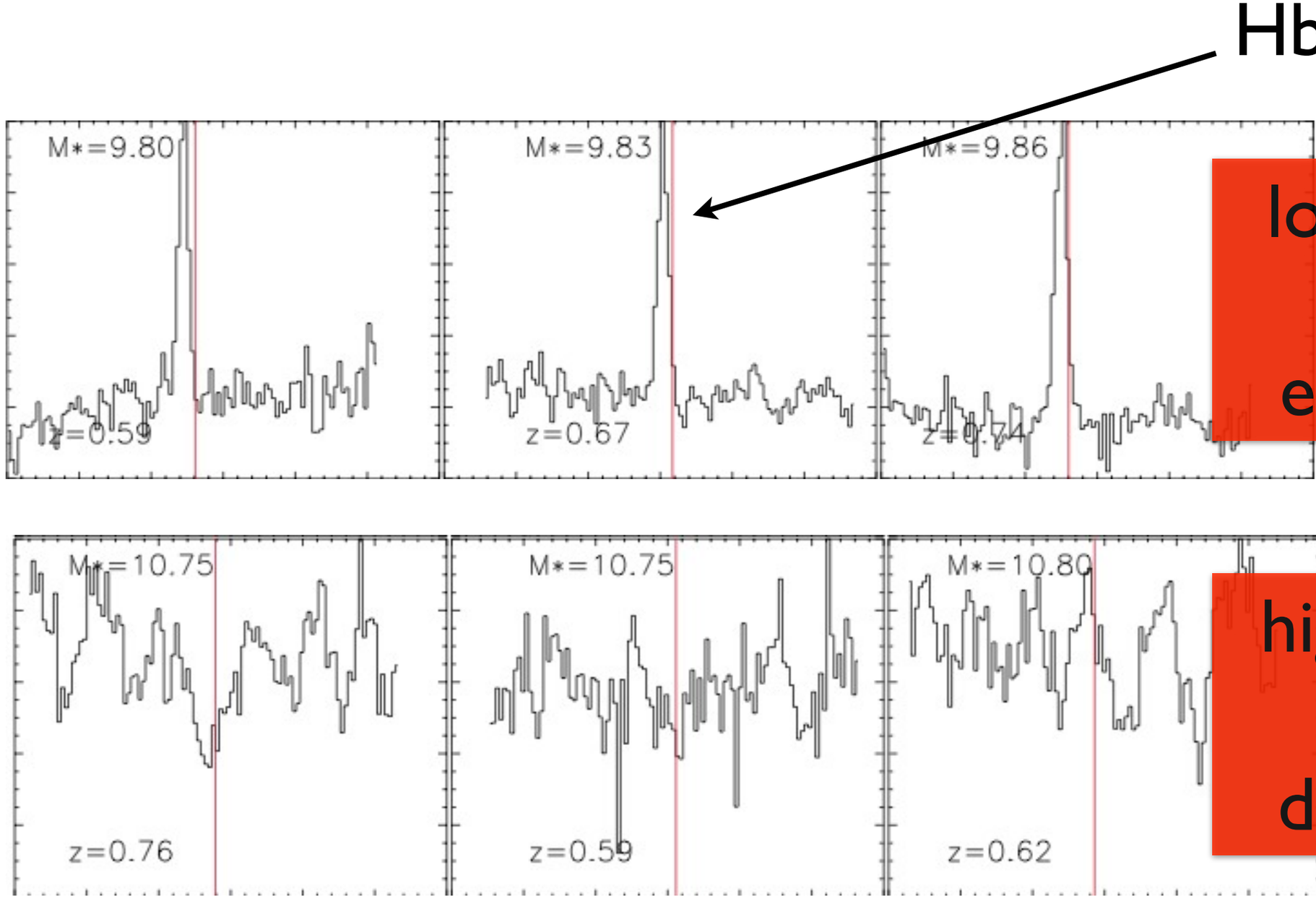
- It seems that there is a threshold mass which separates the properties of blue E/S0s...
- If the past and the future of these galaxies is indeed different, the timescales should be different as well...
- Simulations: typical time-scale for migration to the RS after major merger ~2-3Gyr (Springel et al. 05)

Time-scales



- The comoving density of massive blue E/S0s decreases: leaving the blue cloud?
- Less massive galaxies seem to stay in the blue-cloud...

E+A features

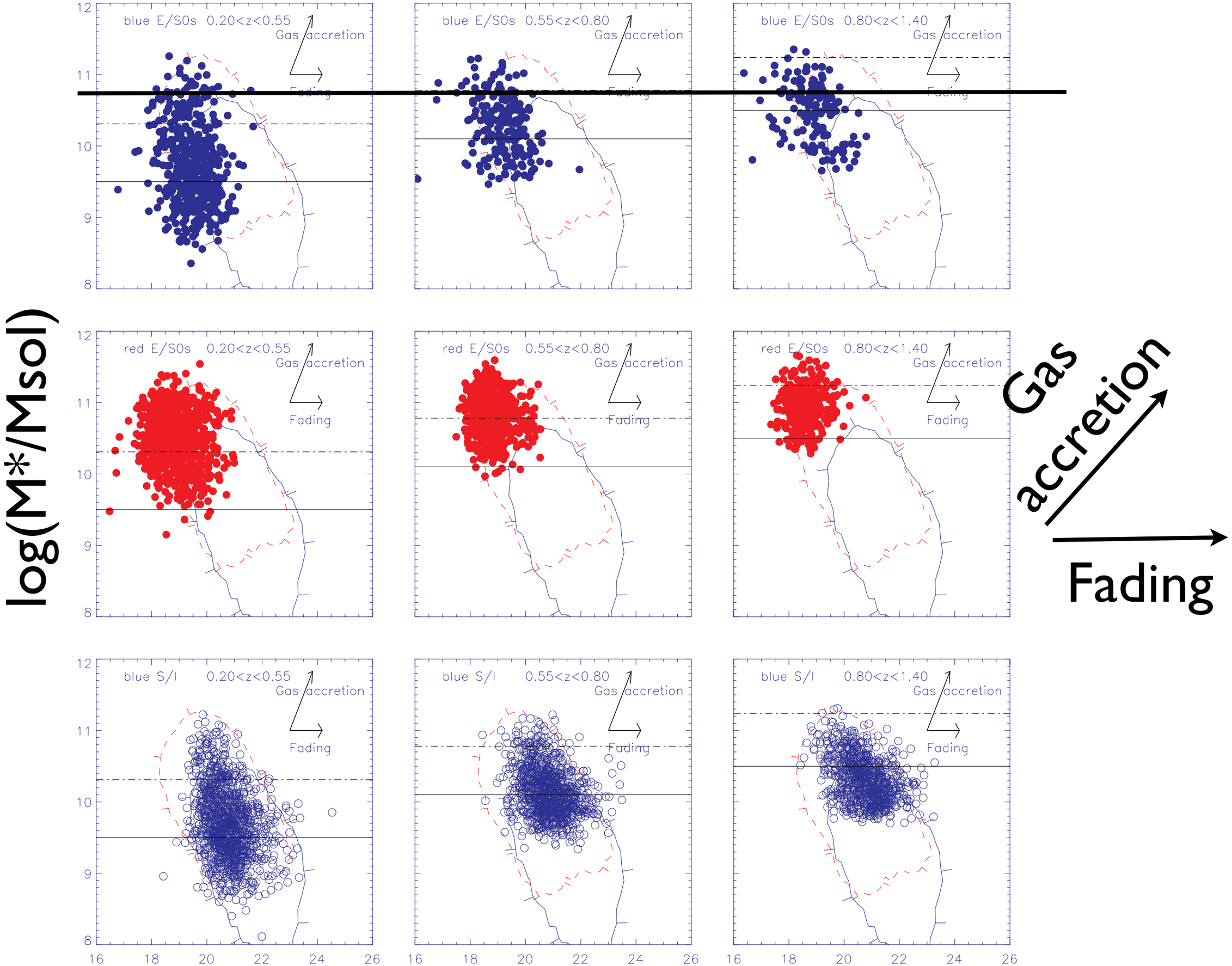


low mass, clear emission

high mass, not detected

What happens to low mass blue E/S0s?

- Evolve by fading into normal disks?
- Rebuilding disks from surrounding gas (e.g. Hammer et al. 01)?
- Minor mergers? (e.g. Eliche-Moral 06, Martig et al. 09)


blue E/S0s 0.20<z<0.55
blue E/S0s 0.55<z<0.80
blue E/S0s 0.80<z<1.40
red E/S0s 0.20<z<0.55
red E/S0s 0.55<z<0.80
red E/S0s 0.80<z<1.40
blue S/I 0.20<z<0.55
blue S/I 0.55<z<0.80
blue S/I 0.80<z<1.40
Gas accretion
Fading
log(M*/Msol)
Surface Brightness
12
11
10
9
8
16
18
20
22
24
26

Conclusions

- Blue E/S0s represent ~5% of the whole sample of early-type galaxies from z~1. The relative abundance depends on the stellar mass.
- There seems to be a turn-over mass in the properties of blue E/S0s
  - Size
  - SFR
- Different time-scales and physical processes
  - log(M*/Msol)>10.8 blue E/S0s: post-starburst galaxies
  - log(M*/Msol)<10.8 blue E/S0s: minor mergers? staying in the blue-cloud?

Future work

- Follow-up, ESO proposal:
  - FORS/OSIRIS: E+A features + stellar populations
  - SINFONI: Rotation curves