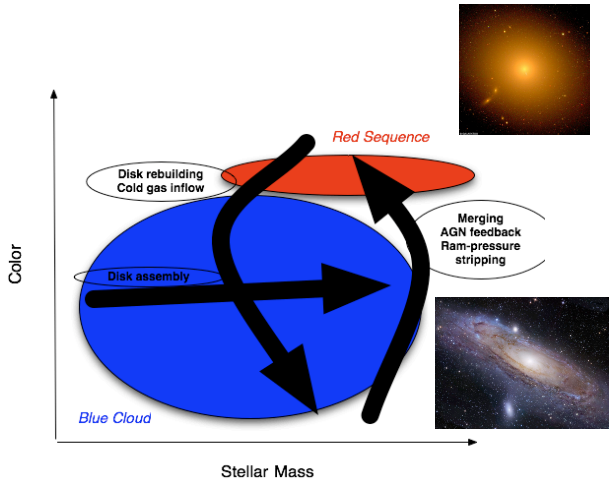
Morphologies of galaxies in intermediate redshift clusters

M. Huertas-Company, G. Soucail, G. Foex, R. Pelló

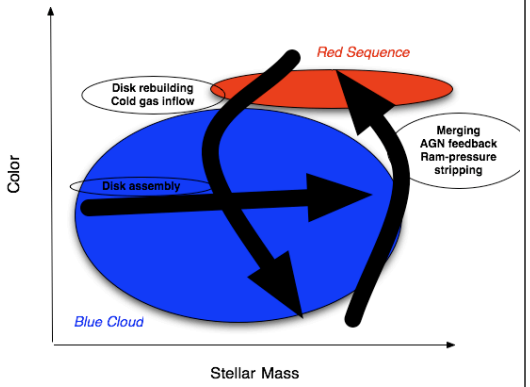
ESO - Chile

Morphology/Color bimodality



Some opened questions

- Ellipticals?
  - how and when did they form their stars? downsizing: more massive galaxies formed stars faster. AGN feedback?
  - when were they assembled? strong size evolution of passive galaxies. Dry major/minor mergers?
- Spirals?
  - inside the blue cloud: disk rebuilding?
  - from the blue cloud to the red sequence?
  - already formed at z~1?



clusters: laboratories for testing effects of environment

- highest density in the universe
- laboratories for studying the effects of the surrounding environment in the morphological transformation of galaxies
  - **when and how E-T galaxies were assembled?**
- *requirements:*
  - high angular resolution (morphology)
  - spectroscopy (cluster membership)

Sample

Wide imaging: ~ 12 Mpc @ z~0.5
(see Gael's talk)

9 massive clusters at z~0.5

4 photometric bands (g,r,i,z)

Completeness: r=25

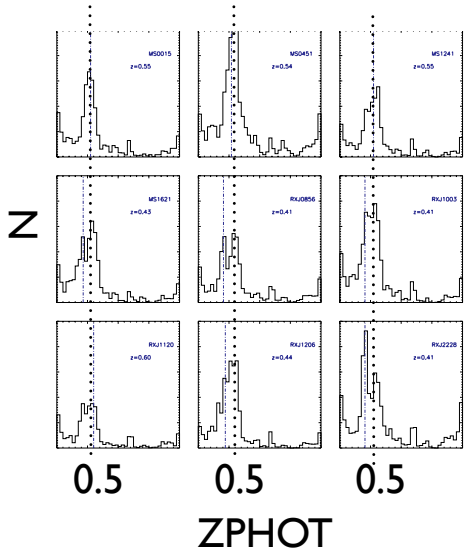
Stellar mass completeness: 50% at Log(M/Msol)=9.5 (red galaxies)

cluster membership

- photometric redshifts, HyperZ, 4 filters: g, r, i, z
- 2 selection criteria:

$$|z_{phot} - z_{cluster}| < 0.1$$

$$P_{clust} = \int_{z_{cluster}-0.1}^{z_{cluster}+0.1} P(z)dz > 0.55$$



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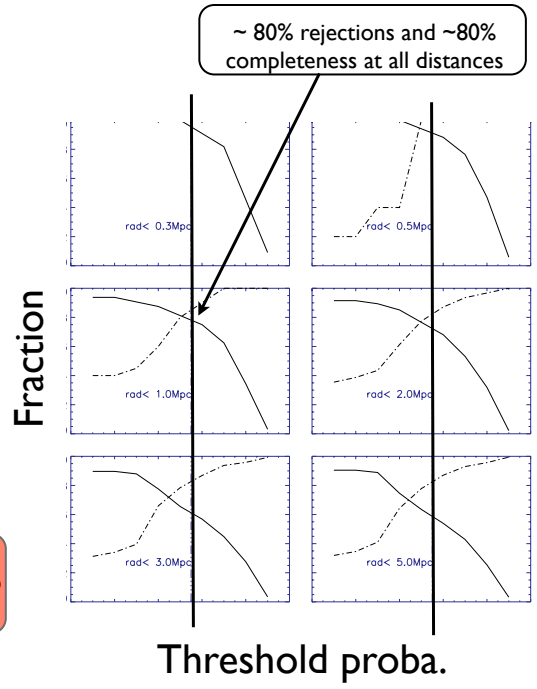
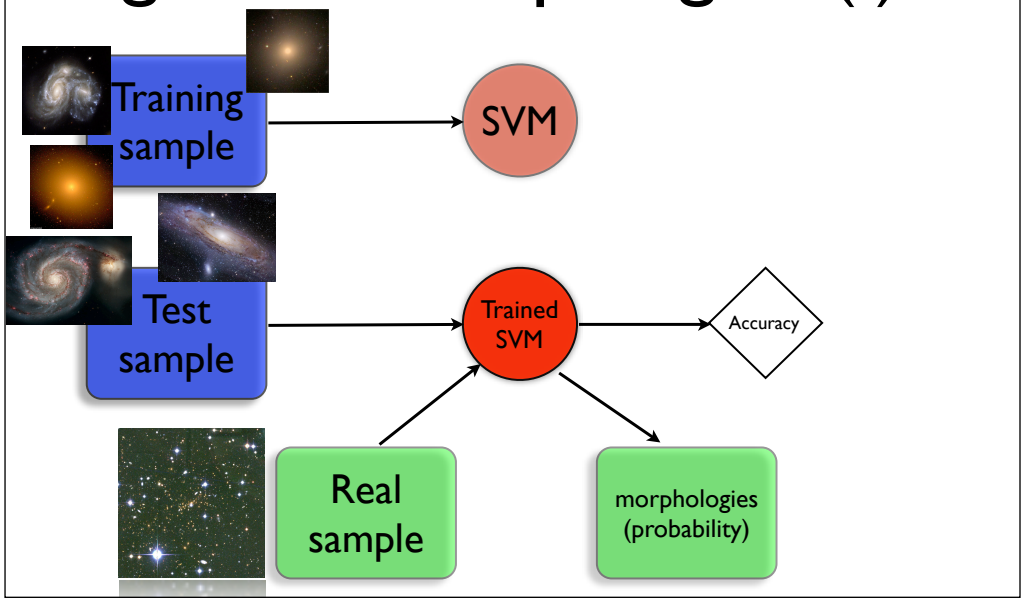
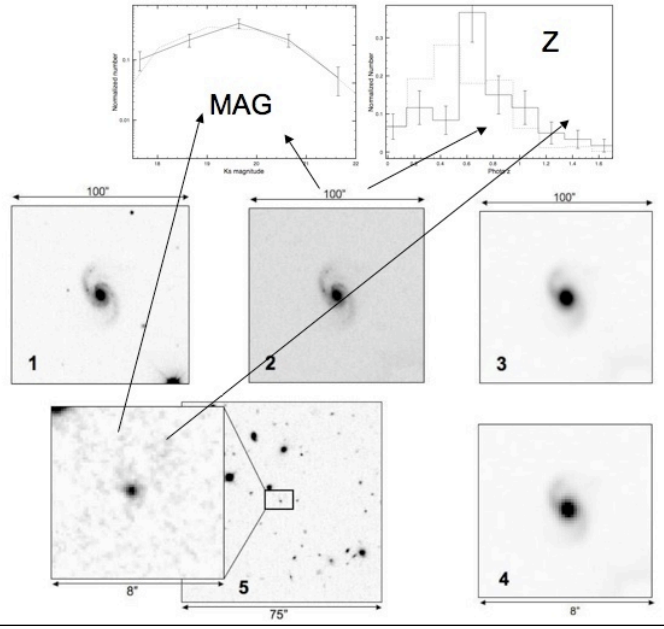


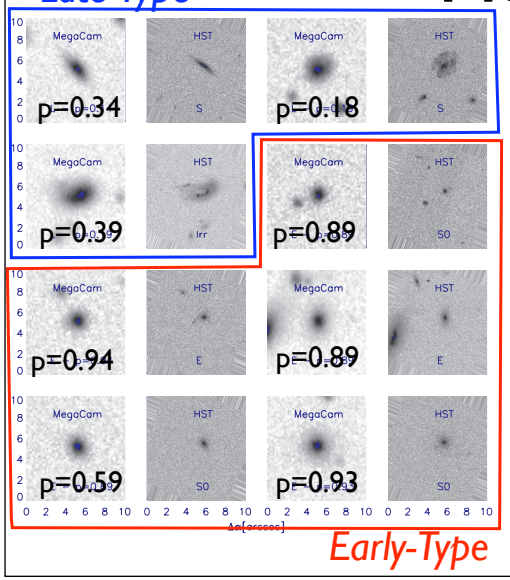
galSVM morpholgies (I)

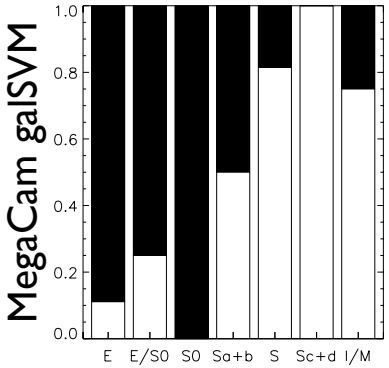


galSVM morphologies (II)

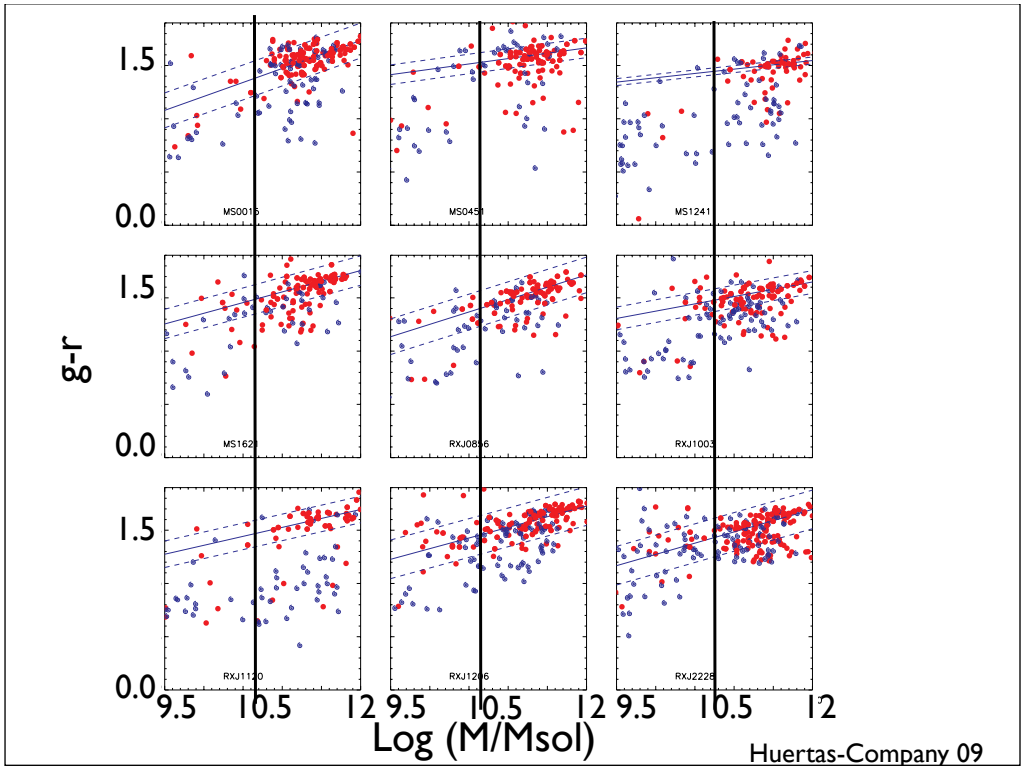


Cross-checking with HST





(Moran et al. 03)


g-r
1.5
0.0
MS0015
MS0451
MS1241
MS1621
RXJ0836
RXJ1003
RXJ1120
RXJ1206
RXJ2228
9.5
10.5
12
Log (M/Msol)
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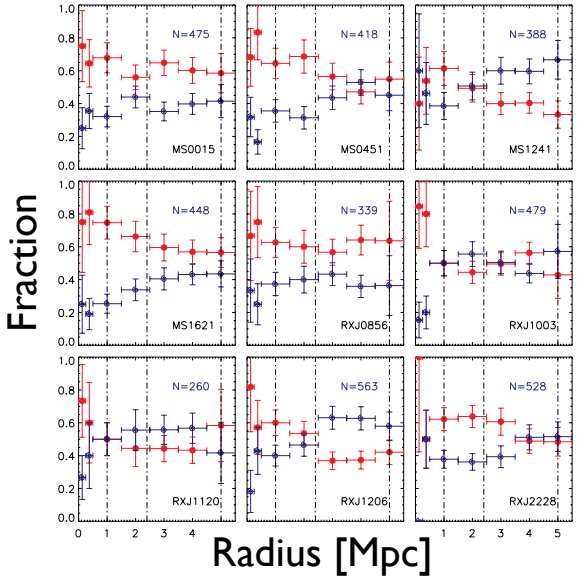
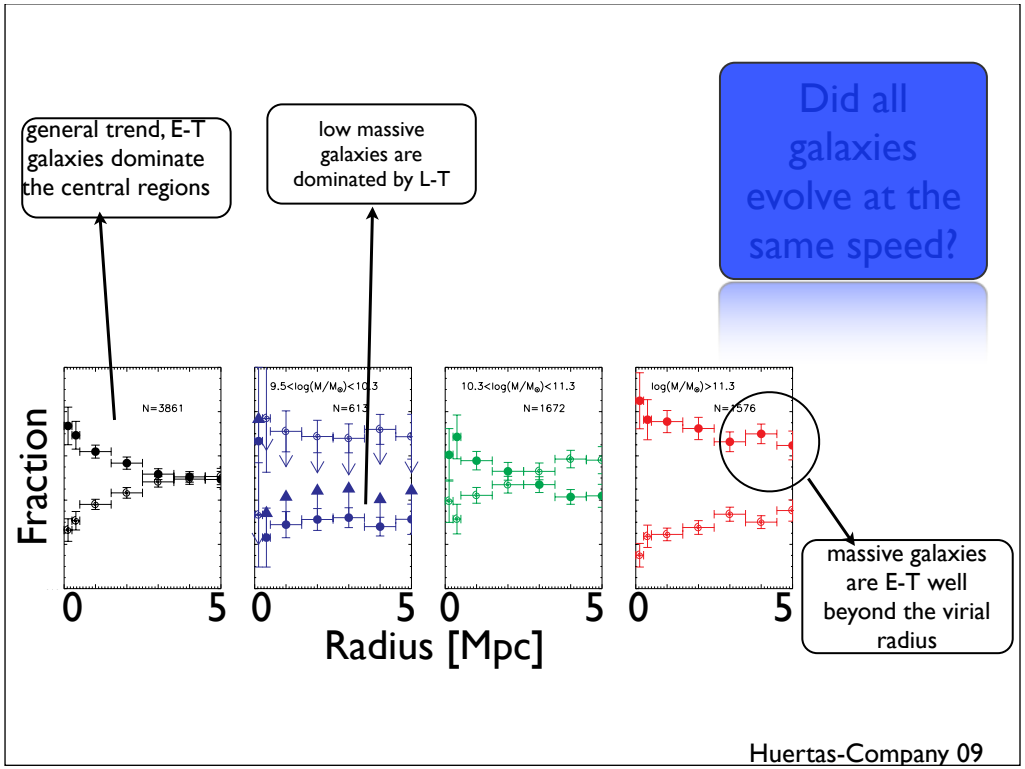


E-T galaxies dominate the central regions

Did all galaxies evolve at the same speed?

What dominates the morphological transformation?


general trend, E-T galaxies dominate the central regions
low massive galaxies are dominated by L-T
Did all galaxies evolve at the same speed?
Fraction
N=3861
9.5<log(M/M⊙)<10.3
N=613
10.3<log(M/M⊙)<11.3
N=1672
log(M/M⊙)>11.3
N=1576
0
5
0
5
0
5
0
5
Radius [Mpc]
massive galaxies are E-T well beyond the virial radius
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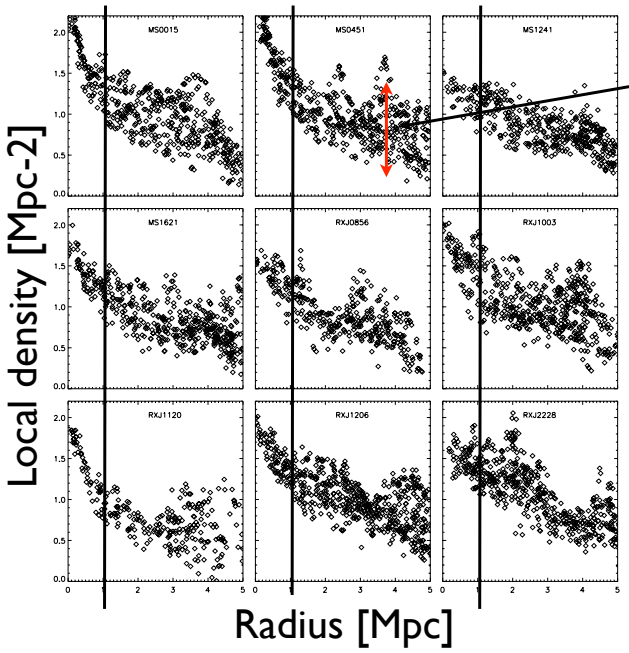
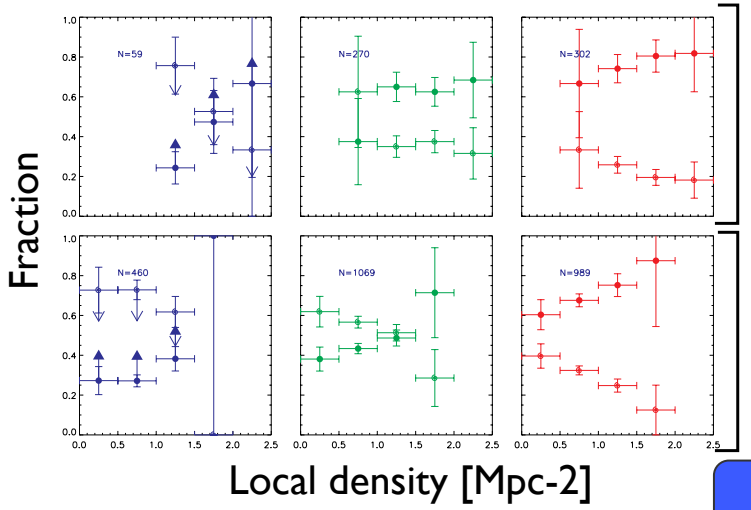


separates effects of local and cluster environments

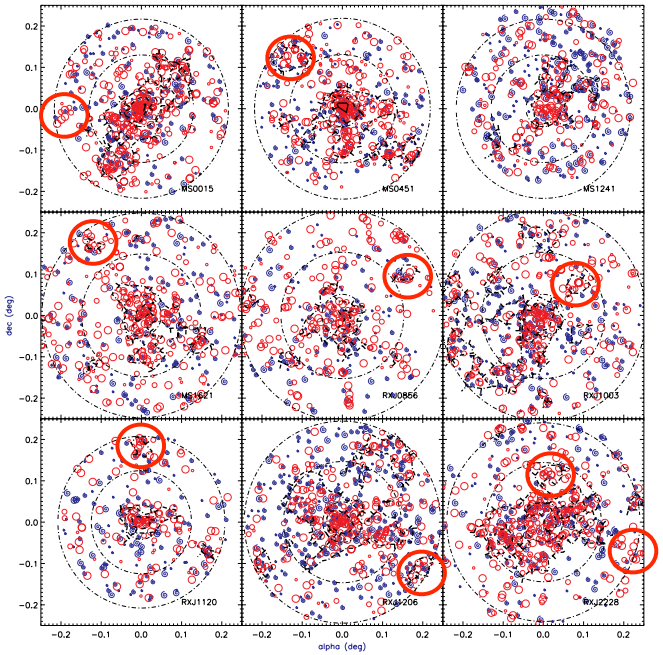
What dominates the morphological transformation?



central region

outskirts

What dominates the morphological transformation?



high density regions in the outskirts are dominated by E-T galaxies

What dominates the morphological transformation?

Conclusions

- morphology density relations @ z~0.5 with a 4m class telescope and no spectroscopy
  - control samples for high-z studies?
- RS already in place at z~0.5
- Massive E-T formed earlier outside the clusters
- Most of the morphological evolution is taking place in intermediate mass galaxies
- What's next?
  - used to find clusters (over densities of E-T galaxies)