THE EVOLUTION OF THE GALAXY MASS ASSEMBLY AND STAR FORMATION ACTIVITY FROM $Z=1$ TO $Z=0$ AS A FUNCTION OF ENVIRONMENT

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Outlines

* THE GALAXY STELLAR MASS FUNCTION
  * its importance
  * in different global environments
  * at different cosmic times

* THE STAR FORMATION RATE- MASS RELATION
  * its importance
  * in different global environments
  * at different cosmic times
Wide field Nearby Galaxy-cluster Survey (WINGS - Fasano+ 2006):

* 0.04 < z < 0.07
* Spectroscopic data of 21 clusters
* Morphologies determined on V images, automatic classification with MORPHOT (Fasano+ 2011)
* Stellar masses determined using the relation between L_B and B-V color (Bell & De Jong 2001), Kroupa (2001) IMF adopted
* Mass limited sample, limit: log(M/M_{sun}) > 9.8
Samples used @ intermediate-z

**ESO Distant Cluster Survey (EDisCS - White+ 2005):**

* 0.5<z<0.8
* Spetroscopic and photo-z data of clusters and groups
* Morphologies determined using HST images, visual classification
* Stellar masses determined using the relation between L_B and B-V color (Bell & De Jong 2001), Kroupa (2001) IMF adopted
* Mass limited sample, limit: log(M/Msun)>10.2
Samples used @ intermediate-z

**ESO Distant Cluster Survey (EDisCS - White+ 2005):**
- 0.5<z<0.8
- Spectroscopic and photo-z data of clusters and groups
- Morphologies determined using HST images, visual classification
- Stellar masses determined using the relation between $L_B$ and $B-V$ color (Bell & De Jong 2001), Kroupa (2001) IMF adopted
- Mass limited sample, limit: log($M/M_{\odot}$)>10.2

**IMACS Cluster Building Survey (ICBS - Oemler+ 2012):**
- 0.25<z<0.5
- Spectroscopic data of clusters, groups and field
- Stellar masses determined using the relation between $L_B$ and $B-V$ color (Bell & De Jong 2001), Kroupa (2001) IMF adopted
- Mass limited sample, limit: log($M/M_{\odot}$)>10.55
The MF in the field


For high mass galaxies, the evolution of the total mass function from $z = 1$ to $z = 0$ is relatively modest. Low mass galaxies evolve more than high mass galaxies.
Several studies have analyzed separately galaxies of different types (according to colors, star formation activity, structural parameters, morphologies).
Evolution of the MF of each morphological type
What drives the evolution?

- mergers
- harassment
- environmental mass segregation of infalling galaxies
- star formation
- morphological transformation
What drives the evolution?
What drives the evolution?

Mass growth of galaxies due to star formation in both cluster galaxies and in galaxies infalling from the cluster surrounding areas. This process is accompanied also by the morphological transformation from one type to the other.
The red/blue MF

$$(U - B)_{\text{vega}} \geq 1.10 + 0.075 \times \log\left(\frac{M \times 1.12}{10^{10}M_{\odot}}\right) - 0.18 \times z - 0.88(2)$$

Peng+ (2010)
\[(U - B)_{\text{vega}} \geq 1.10 + 0.075 \times \log \left( \frac{M \times 1.12}{10^{10}M_\odot} \right) - 0.18 \times z - 0.88(2) \]

Peng et al. (2010)

### ICBS - $M_k \geq 10^{10.55}M_\odot$

<table>
<thead>
<tr>
<th></th>
<th>red $%_{\text{obs}}$</th>
<th>red $%_w$</th>
<th>blue $%_{\text{obs}}$</th>
<th>blue $%_w$</th>
</tr>
</thead>
<tbody>
<tr>
<td>cluster regions</td>
<td>71.0±3.6%</td>
<td>72.8±2.5%</td>
<td>29.0±3.6%</td>
<td>27.2±2.5%</td>
</tr>
<tr>
<td>cluster outskirts</td>
<td>55.4±3.9%</td>
<td>56.5±2.6%</td>
<td>44.6±3.9%</td>
<td>43.5±2.6%</td>
</tr>
<tr>
<td>groups</td>
<td>52.7±5.7%</td>
<td>52.5±3.8%</td>
<td>47.3±5.7%</td>
<td>47.5±3.8%</td>
</tr>
<tr>
<td>pure field</td>
<td>38.4±4.2%</td>
<td>38.8±2.6%</td>
<td>61.6±4.2%</td>
<td>61.2±2.6%</td>
</tr>
</tbody>
</table>
The red/blue MF

\[(U - B)_{\text{Vega}} \geq 1.10 + 0.075 \times \log \left( \frac{M \times 1.12}{10^{10} M_\odot} \right) - 0.18 \times z - 0.88(2) \]

Peng et al. (2010)

In all environments, red and blue galaxies have different MF.
The evolution in different GE from $z \sim 0.4$ to $z \sim 0$.

The evolution of the MF with time is independent of environment.

Field at low-z from PM2GC (Calvi+ in preparation)
SFR-Mass relation in different environments

FIELD: strong correlation between SFR and mass. It shifts to higher SFRs at higher $z$ (e.g. Noeske et al. 2007a, Elbaz et al. 2007, Daddi et al. 2007)

CLUSTERS?                      GROUPS?

EDisCS data
SFR for 24 µm detected:
* from IR luminosity (Finn et al. 2009) using Kennicutt (1998)
* from [OII] luminosity (Poggianti et al. 2008)

\[ SFR_{\text{tot}} = SFR_{\text{IR}} + SFR_{[\text{OII}]} \]

SFR for galaxies without 24 m detection:
* from [OII] luminosity (Poggianti et al. 2008) dust-corrected

Galaxies without 24 µm detection are divided into red and blue:

\[ U-B > -0.032(M_B+21.52)+0.454-0.25 \]

AGN contamination?
SFR-Mass relation

ΔSFR = 1.35 ± 0.15
SFR-Mass relation

24 µm + blue and red emission lines

\[ \Delta \langle SFR \rangle = 1.63 \pm 0.20 \]
SFR-Mass relation

Clusters, groups, field
In clusters, both the total galaxy stellar mass function and that of each morphological type evolve with $z$. There are proportionally more massive galaxies at high-$z$ than at low-$z$.

Galaxy in clusters, groups and field follow the same mass distribution. The galaxy stellar mass function does not vary with the global environment at $z=0.3-0.8$.

In all environments, red and blue galaxies are regulated by different MF. Comparing the MF in different environments separately for blue and red galaxies, no differences are detected.

Comparing the cluster and field MF at high and low $z$, we find that they evolve in the same way. The evolution of the MF with $z$ is independent on environment.
In clusters, both the total galaxy stellar mass function and that of each morphological type evolve with $z$. There are proportionally more massive galaxies at high-$z$ than at low-$z$.

Galaxy in clusters, groups and field follow the same mass distribution. THE GALAXY STELLAR MASS FUNCTION DOES NOT VARY WITH THE GLOBAL ENVIRONMENT AT $z=0.3-0.8$.

In all environments, red and blue galaxies are regulated by different MF. Comparing the MF in different environments separately for blue and red galaxies, no differences are detected.

Comparing the cluster and field MF at high and low $z$, we find that they evolve in the same way. THE EVOLUTION OF THE MF WITH $z$ IS INDEPENDENT ON ENVIRONMENT.

GALAXY PROPERTIES ARE NOT MUCH DEPENDENT OF CLUSTER MASS... BUT DO DEPEND ON LOCAL SCALE PROCESSES....
The relation between SF activity and galaxy mass depends on environment.

There are significant differences between the SF activity of star-forming galaxies of the same mass in different environments.

Clusters show a lower SF activity than the field, not only because they have a pre-existing large population of early-type galaxies passively evolving since high $z$, but because currently star-forming galaxies host an average lower SFR than their field counterparts of similar mass.
thanks for the attention!

based on
Vulcani et al. 2011a (MNARS, 412 246-268)
Vulcani et al. 2011b (MNRAS, submitted)
Vulcani et al. 2010 (ApjL, 710, 1)