Red Star Forming Galaxies in Distant Clusters: a key population under environmental effect?

MAHALO-Subaru collaboration

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MAHALO-Subaru
(PI: T. Kodama; see talk by K. Tadaki, M. Hayashi)

“Panoramic + Hα + MIR” approach
# a subsample of our MAHALO targets #

<table>
<thead>
<tr>
<th>Target</th>
<th>z</th>
<th>Subaru Hα NB</th>
<th>MIR</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL0939+4713</td>
<td>0.41</td>
<td>NB921/S-Cam</td>
<td>MIPS/Spitzer</td>
<td>Koyama et al. 2011</td>
</tr>
<tr>
<td>RXJ1716+6708</td>
<td>0.81</td>
<td>NB119/MOIRCS</td>
<td>IRC/AKARI</td>
<td>Koyama et al. 2010</td>
</tr>
<tr>
<td>4C65.22</td>
<td>1.52</td>
<td>NB1657/MOIRCS</td>
<td>IRC/AKARI</td>
<td>Koyama et al. in prep.</td>
</tr>
<tr>
<td>Q0835+580</td>
<td>1.53</td>
<td>NB1657/MOIRCS</td>
<td>MIPS/Spitzer</td>
<td>Shimakawa et al. in prep.</td>
</tr>
<tr>
<td>PKS1138-262</td>
<td>2.16</td>
<td>NB2071/MOIRCS</td>
<td>MIPS/Spitzer</td>
<td>Koyama et al. 2012</td>
</tr>
<tr>
<td>4C23.56</td>
<td>2.48</td>
<td>NB2288/MOIRCS</td>
<td>MIPS/Spitzer</td>
<td>Tanaka et al. 2011</td>
</tr>
</tbody>
</table>

✓ Panoramic: cover wide range in environment
✓ Hα study: locally well-calibrated SF indicator
✓ IR study: sensitive to dust-obscured SF
Panoramic view of A851 (z=0.4) with Subaru

A prominent large-scale structure is discovered by panoramic imaging with Suprime-Cam.

Kodama et al. (2001)

Galaxy transition takes place in “medium-density” groups/filaments.

See also Tanaka et al. (2005)
Koyama et al. (2008)
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Panoramic "Hα view" of A851 with Subaru

>400 HAEs along the large-scale structure

"Red SF galaxies" are preferentially found in the group-scale environment

Panoramic "Hα view" of A851 with Subaru

>400 HAEs along the large-scale structure

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Panoramic $H_\alpha$+MIR view of a $z=0.8$ cluster

Panoramic $H_\alpha$+MIR view of a $z=0.8$ cluster

Panoramic $H\alpha$+MIR view of a $z=0.8$ cluster

Dust-obscured SF in/around z=0.8 cluster

Red HAEs and $15\mu m$ sources are most numerous in group-scale environment.

Dust-obscured SF in/around z=0.8 cluster

Panoramic Hα mapping of a $z=2.16$ proto-cluster

PKS1138-262: talk by e.g. M. Tanaka, N. Hatch, H. Dannerbauer, M. Sanches-Portal ....
“Massive starbursts” in the z=2 proto-cluster

SF galaxies in the proto-cluster show redder colours and higher $M^*$ ($>10^{11}\,M_\odot$) compared to general field galaxies.

(Koyama et al. 2012, submitted)
“Massive starbursts” in the z=2 proto-cluster

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Rest-UV morphologies on colour-$M_*$ plane

HAEs @z=2.2
(PKS1138)

$M$: 24um source
$X$: X-ray source

HST/i-band snapshots
(4''x4''=30 kpc for each)
The "Main Sequence" in cluster environment

Proto-cluster galaxies follow the same "main sequence" as for field galaxies at z=2 (but with excess in its massive end)

Very massive SF galaxies "disappeared" in the z=0.8 cluster (i.e. massive galaxies are already passive)

(Koyama et al. 2012, submitted)
Summary

✔ From z<1 cluster study:
  - SF galaxies 'avoid' cluster core regions.
  - Red SF galaxies (+ MIR bright sources) are numerous in group-scale environment.

✔ From z~2 proto-cluster study:
  - Red, massive starbursts are likely to be more common in cluster (PKS1138).
  - Proto-cluster HAEs follow the same SFR vs M* relation as field SF galaxies with some excess in the massive end.