The Structural Properties of Cluster Galaxies at $z = 1.62$ and the Morphology-Density Relation

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Thanks to my CANDELS collaborators
Outline

1. Cluster Discovery

2. Data

3. Analysis
   - Papovich et al. 2012
   - Bassett et al. 2012 (submitted)
   - Other Clusters
Simultaneously discovered by Tanaka et al. and Papovich et al. in 2010.

Discovered as an overdensity of galaxies with red IRAC ([3.6$\mu$m] − [4.5$\mu$m])$_{AB}$ colors.

Chandra reveals weak extended emission surrounding single dominant point source.

Combined spectroscopy from both groups provides 13 galaxies with $1.62 < z_{sp} < 1.65$. 
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CANDELS Observations

- Typical CANDELS image from HST WFC3 F125W band (roughly B-band rest frame at z=1.6)
- Galaxy surface brightness profiles fit with GALFIT (Peng et al. 2002)
- Simulations using fake galaxies show GALFIT results to be accurate within 20% for typical galaxies in our sample to \( \sim 23^{rd} \) magnitude
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We used a color-color selection based on V-J versus U-V as described in Williams et al. (2009) for this redshift:

$$(z - J)_{AB} \geq 1.3 \text{mag}$$
$$(J - [3.6])_{AB} \leq 2.1 \text{mag}$$
$$(z - J)_{AB} \geq 0.5 + 0.55(J - [3.6])_{AB}$$

to select quiescent galaxies.

Papovich et al. (2012)
Cluster defined as within 1.5 Mpc of the cluster core
Field defined as outside 3.0 Mpc of the cluster core
We find a lack of compact, quiescent galaxies in the cluster

Papovich et al. (2012)
There already exists a clear red sequence and a color-mass relation at this redshift.

High Sérsic objects are more likely to be massive, red, and quiescent.

Environmental effects appear weak contrasting with low redshift (for example, see Hogg et al 2004)
Environmental Dependence on Quiescent Galaxy Sérsic Indices

- Sérsic indices of cluster galaxies are *smaller* than those in the field.
- This trend is dominated by intermediate mass galaxies on the outskirts of the cluster.

![Sérsic Index vs Cumulative Fraction](image)

Bassett et al. (submitted)
Environmental Dependence on Quiescent Galaxy Effective Radii

- Larger effective radii in the cluster are also dominated by galaxies in the outskirts.
- These galaxies have sizes and structures more consistent with star forming disks.

Bassett et al. (submitted)
Other Clusters

XMMU J2235.3-2557

Mullis et al. 2005

z-FOURGE $K< 24.8$, $z=2.1-2.3$

Spitler et al. 2012
Summary

- Galaxy cluster detected as overdensity of red galaxies, likely still in process of virializing.
- Among quiescent galaxies, those found in the cluster are less compact and have larger effective radii.
- This trend is driven by galaxies in the outer regions of the cluster which are morphologically similar to star forming disks. This is likely an environmental effect.
All 4 Spitzer IRAC Bands
UKIRT J & K
Subaru B, R, i, and z
Photometric Redshifts using EAZY
SED fitting with BC03 on 10 band photometry
24 likely cluster members were targeted by IMACS on Magellan.

Redshifts were measured for 11 of these objects based on [OII] emission.

Dynamical mass estimate from these observations is $\sim 4 \times 10^{14} M_\odot$.
Typical CANDELS image from HST WFC3 F125W band (roughly B-band rest frame at z=1.6)

Galaxy surface brightness profiles fit with GALFIT (Peng et al. 2002)

Simulations using fake galaxies show GALFIT results to be reliable to ~ 23rd magnitude

Bassett et al. (submitted)