Biased galaxy formation and evolution in two frontier clusters at z=1.6?

5.39

Galaxy Formation 2011

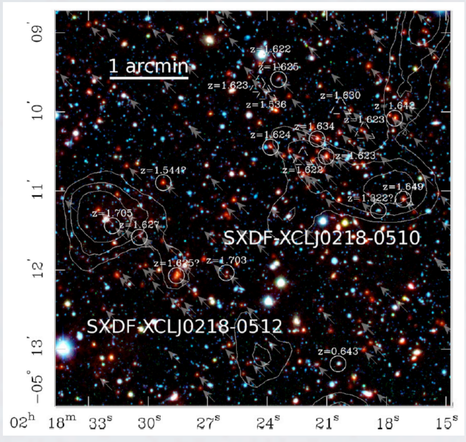
Ken-ichi Tadaki [1], T. Kodama [2,3], M. Hayashi [2], Y. Koyama [2], K. Ota [4], M. Tanaka [5], C. Papovich [6], M. Brodwin [7], M. Iye [1]

[1] University of Tokyo, [2] NAOJ, [3] Subaru Telescope, [4] Kyoto University, [5] IPMU, [6] Texas A&M University, [7] Harvard-Smithsonian

Abstract

We present panoramic narrow-band surveys of [OII] emitters in two frontier high-z clusters at z ~ 1.6 (CIGJ0218-0510 and CI0332-2742) with Suprime-Cam on Subaru telescope. Both surveys cover about 800 arcmin^2 area each, and reached a 3-sigma limiting line flux of 2.0 x 10^{-17}erg s^{-1} cm^{-2}, corresponding to a dust-uncorrected star formation rate of 5 $M_\odot$ yr^{-1}. In CIGJ0218-0510 (z=1.62), we identified more than 300 [OII] emitters on the basis of narrow-band excess and photometric redshifts. We also sampled quiescent galaxies on the color-color diagram. We find that the star forming activity in the cluster cores is very high, and that the ratio of the [OII] emitters to the quiescent galaxies increases towards higher density regions. This opposite trend at high-z to the one in the local Universe suggests that galaxy formation and evolution is biased and accelerated in high density regions at high redshift.

CIGJ0218.3-0510 cluster at z=1.62

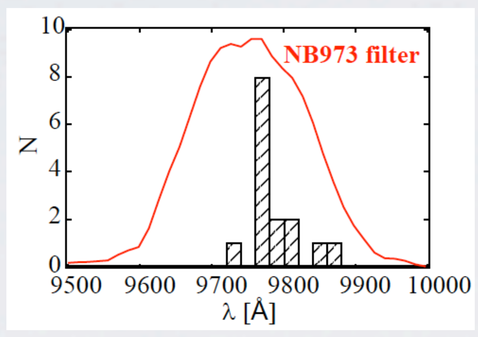


Tanaka et al. 2010

$L_X=(3.4\pm1.6)\times10^{43}$ erg s^{-1}

The redshift distribution of spectroscopically confirmed galaxies

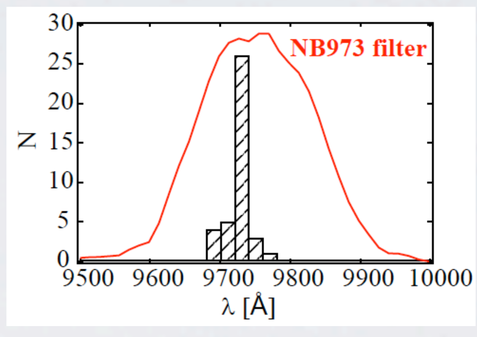
15 galaxies with spec-z (Papovich et al. 2010, Tanaka et al. 2010)

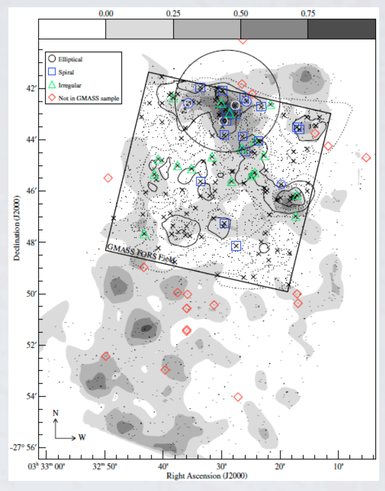


CI0332-2742 at z=1.61

Overdensity region (Kurk et al. 2009)

42 galaxies with spec-z





Kurk et al. 2009

NB973filter can detect the [OII] emission line from star-forming galaxies at z=1.57-1.64.

Observation and Data

Instrument	Subaru / Suprime-Cam	
Filter	z_R	NB973
Integration (min)	327	780
Seeing	0.7"	1.0"
Limiting (AB,5σ,2")	25.4	25.5

BVRiz	Subaru / Suprime-Cam (Furusawa et al. 2008)
JHK	UKIRT / WFCAM (UKIDSS)
X-ray	XMM-Newton (Ueda et al. 2008)

Observation and Data

Instrument	Subaru / Suprime-Cam			
Filter	r'	z'	z_R	NB973
Integration (min)	86	56	130	320
Seeing	0.72"			
Limiting (AB,5σ,1.4")	27.43	25.72	25.33	25.39

In only GOODS-South region, we used GOODS-MUSYC catalog (Santini et al. 2009).

Target selection

[OII] emitter selection → 364 [OII] emitters

(1) NB selection : we adopted the excess in the narrow-band of Σ>2.5 (Bunker et al. 1995).
(2) phot-z selection : 1.52<z_{phot}<1.62

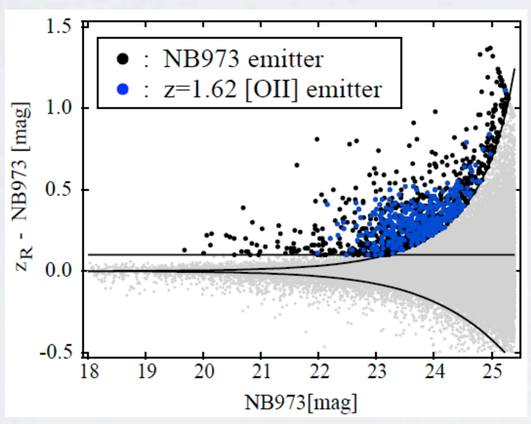


photo-z code : "Hyperz" (Bolzonella et al. 2000)

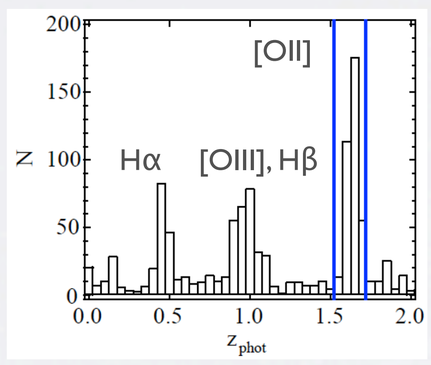
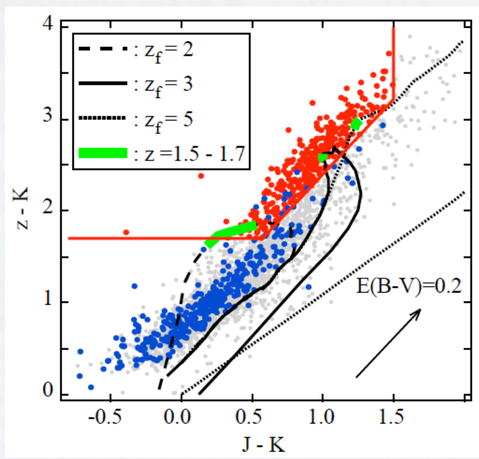


photo-z accuracy
σz ~ 0.03
assuming that these [OII] emitters are in z=1.62.

quiescent galaxy selection → 325 passive galaxies

Black lines : model track of elliptical galaxy (Kodama et al. 1999).
We used the J - K vs z' - K color-color diagram to select passively evolving galaxies at z=1.62 .
(1) phot-z selection : 1.57<z_{phot}<1.67
(2) color-color selection :
z' -K >1.7
z' - K > 1.64 (J - K) +0.76
J - K <1.5

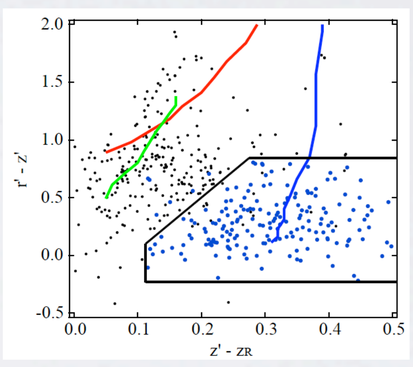


: [OII] emitter
: quiescent galaxy

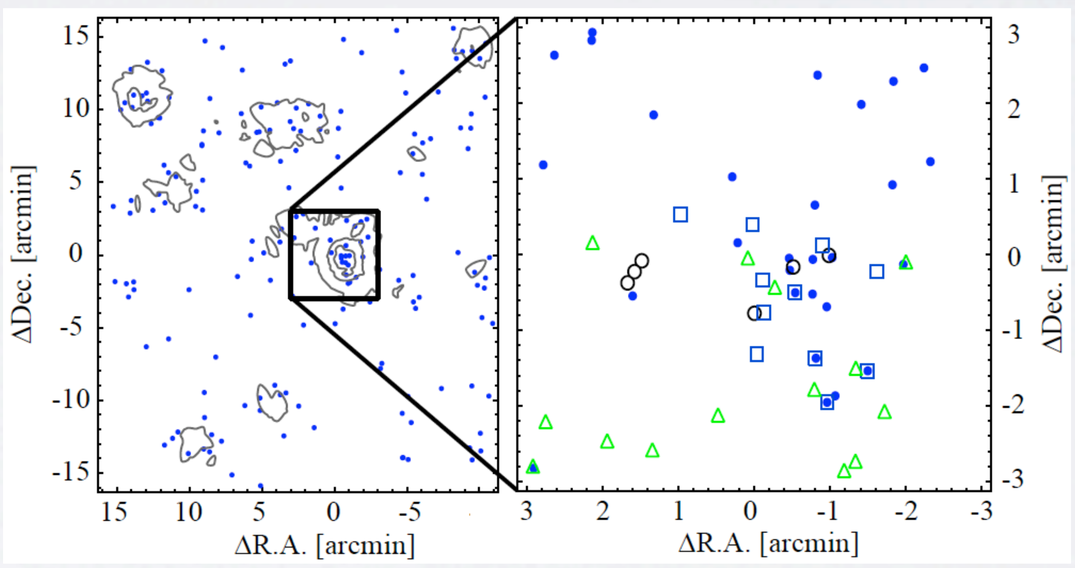
Target selection

(1) 3σ NB excess (z_R-NB973)
(2) z_{spec}=1.60-1.62 or z_{phot}=1.43-2.15 in GOODS-S
r'z'z_R colors in outside field

→ 190 [OII] emitters



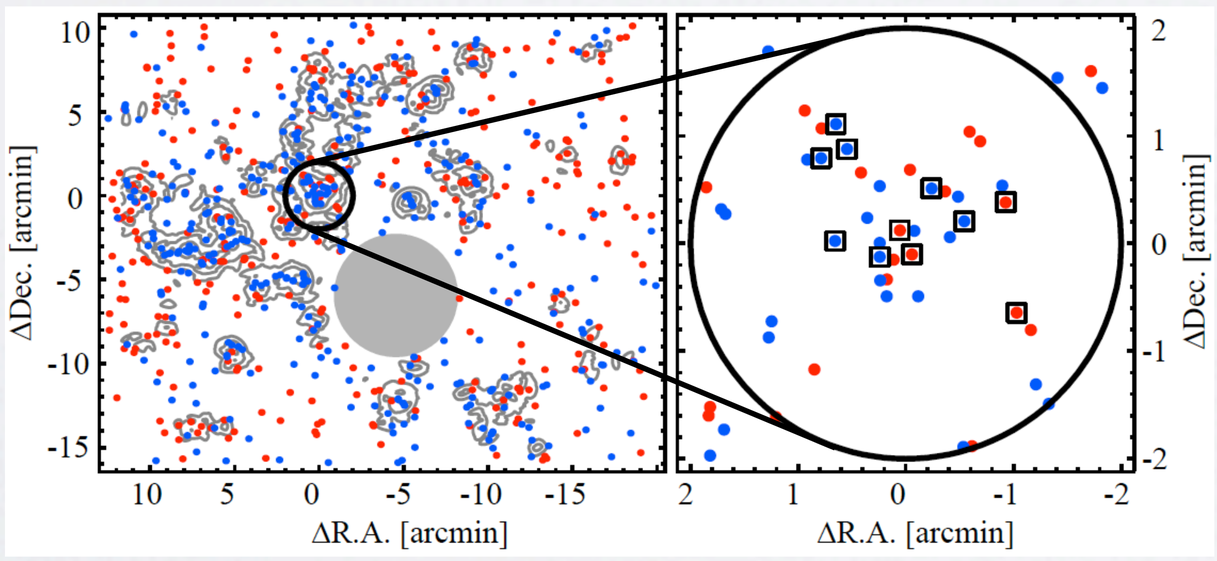
Spatial distribution



We found that there is a overdensity region traced by [OII] emitters. Star formation activity may be biased in the highest density region. For many GMASS samples, [OII] emission are not detected.

GMASS sample with z_{spec}
: Elliptical
: Spiral
: Irregular

Spatial distribution



: [OII] emitter
: quiescent galaxy

(1) We have revealed a gigantic structure surrounding the cluster traced mainly by [OII] emitters. The cluster appears to be embedded in a huge filament extending from North to East/South.
(2) Many [OII] emitters are located within a projected radius of 1 Mpc from the cluster center.

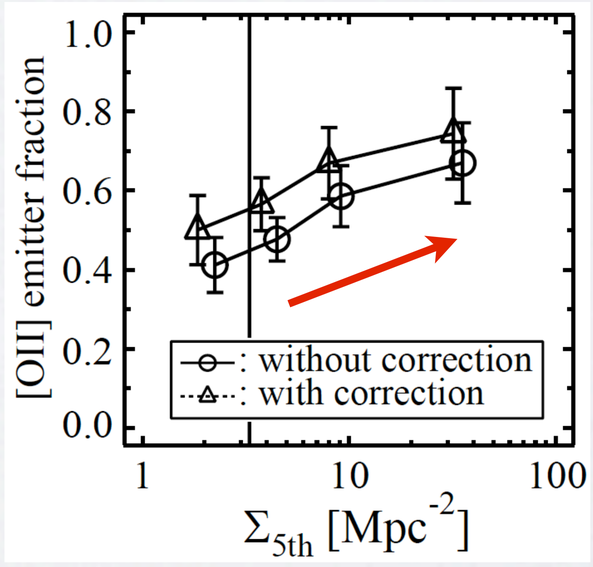
[OII] emitter fraction

We calculated a local density (Σ5th) of each galaxy and the fraction of [OII] emitter. Here we use the combined samples of the [OII] emitters and the quiescent galaxies.

Fraction=$N_{[OII]\ emitter}$ / ($N_{[OII]\ emitter}$+$N_{quiescent}$)

Because the photometric redshift range of the quiescent galaxies that we adopted (Δz_{phot}) is larger than that of [OII] emitters (Δz_{NB}), we corrected for this effect by multiplying $\Delta z_{NB}/\Delta z_{phot}$.

In this field, average number density of our samples is 3.3 Mpc^{-2}.



In the highest density such as the cluster core and clumps, a large portion of galaxies are forming stars actively, and only a small fraction of galaxies may have evolved to a passive phase at z~1.6. **Star formation activity is not suppressed in the dense environment. Rather it may be biased in the cluster core at this high redshift.**