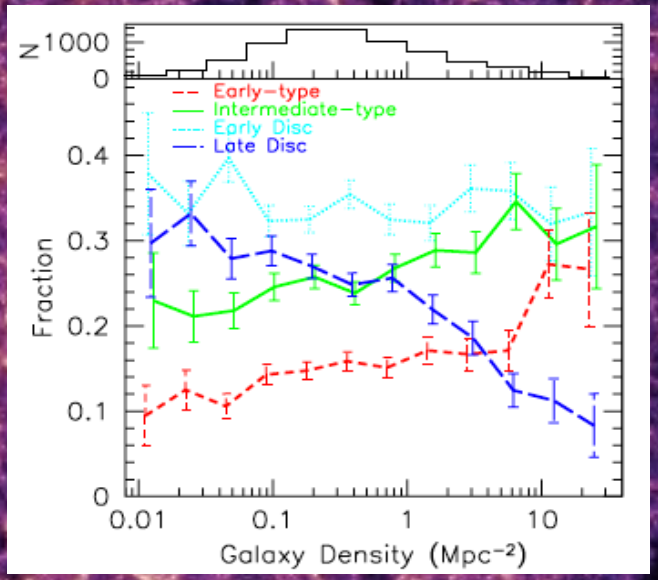
Subaru international partnership science & instrumentation workshop

(2017/3/23, NAOJ/Mitaka)

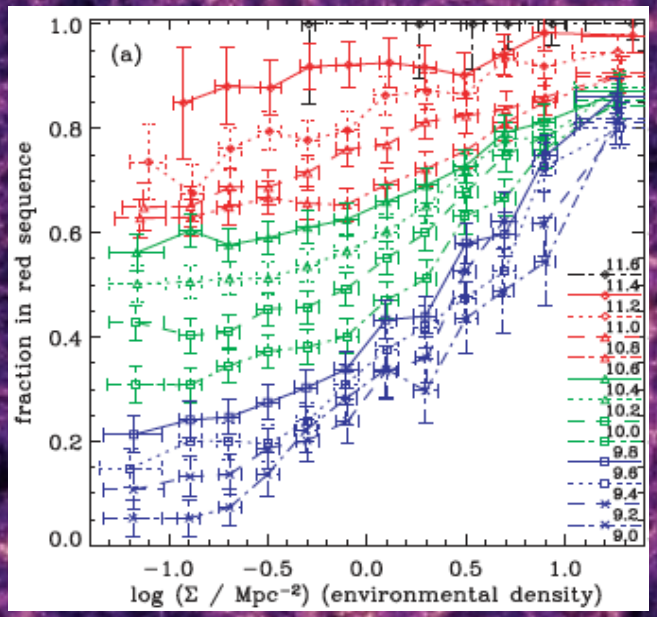
An overview of galaxy cluster/ environment science with Subaru

Yusei Koyama (Subaru Telescope)

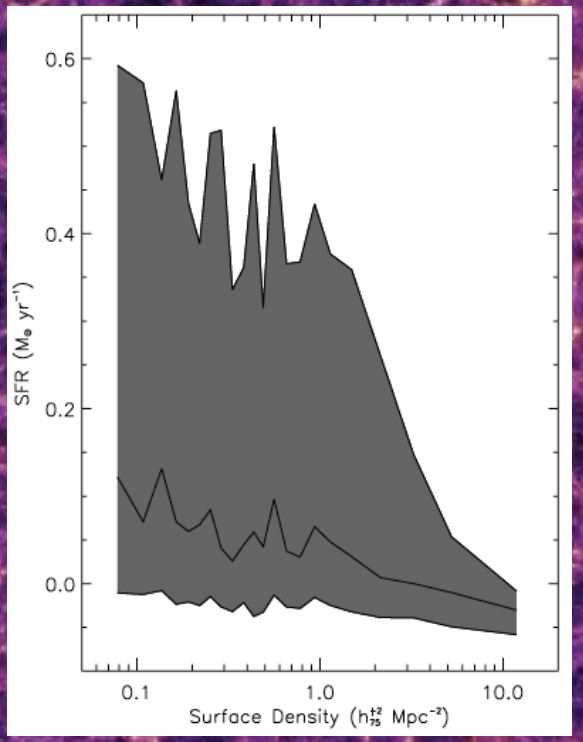
Galaxy evolution & environment



Morphology vs. environment
(Goto+2003)



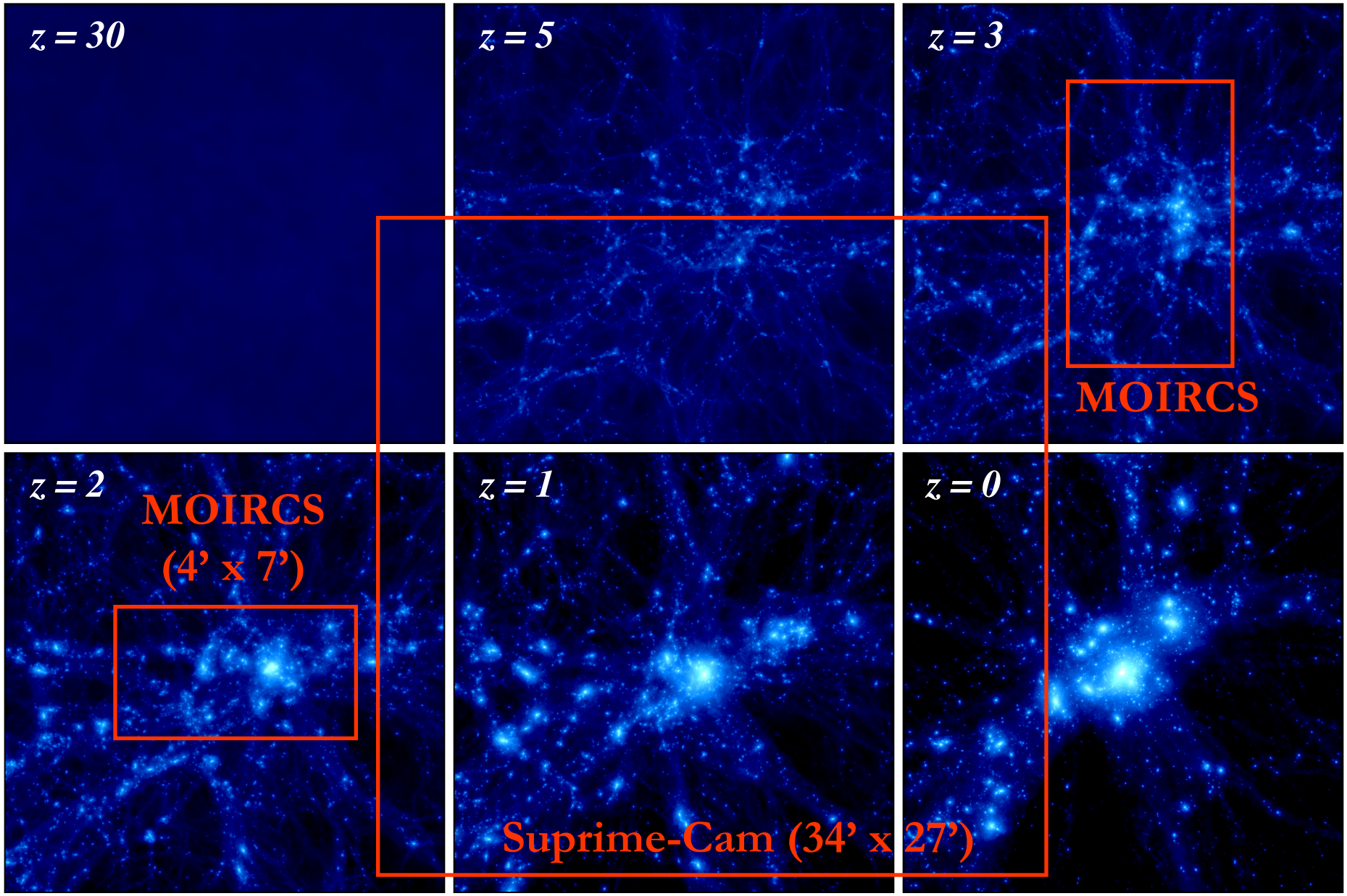
color vs. environment
(Baldry+2006)



SFR vs. environment
(Gomez+2003)

Key question: the origin of environmental effects
(when/how are these strong trends established?)

Big advantage of Subaru

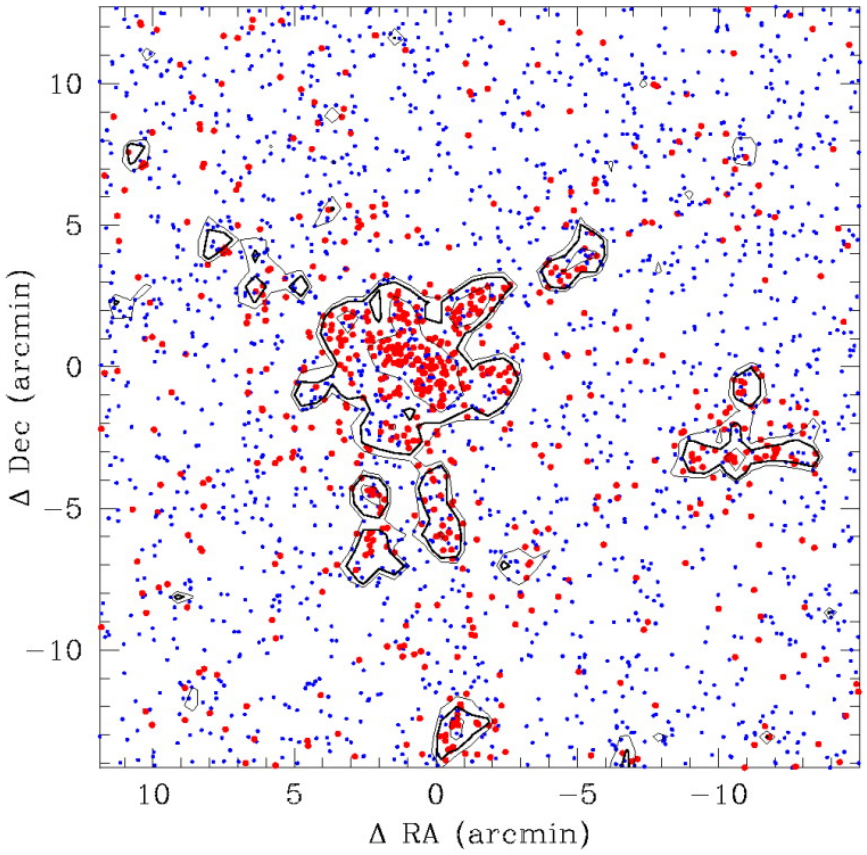


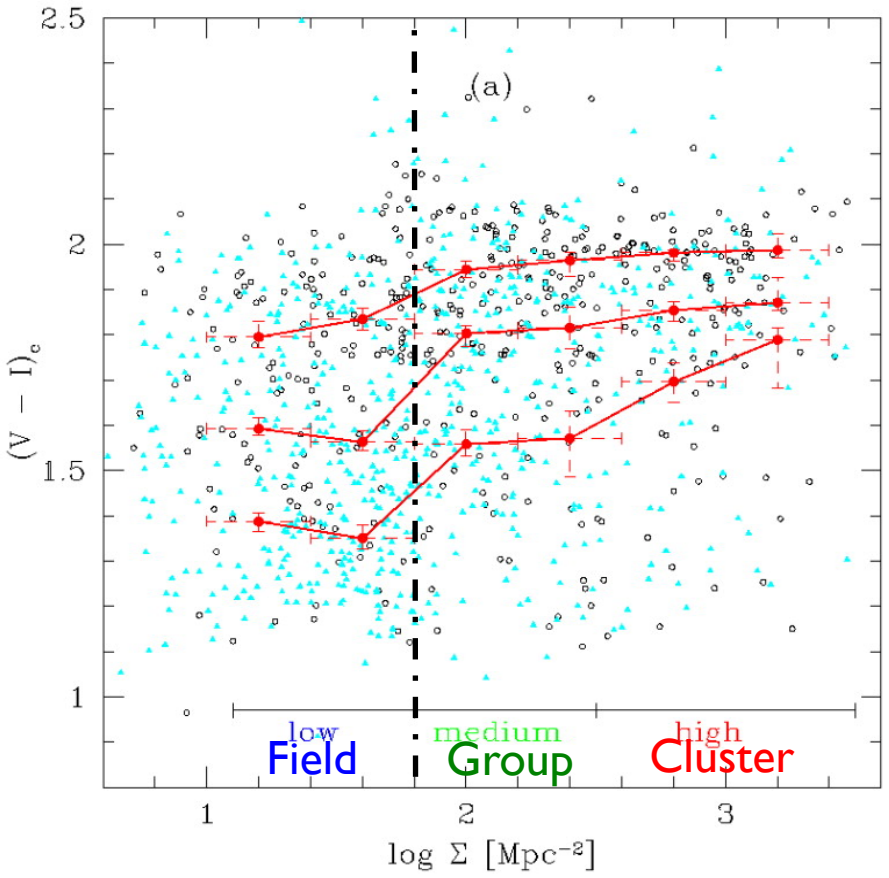
M=6×10^14 Msun, 20Mpc×20Mpc (co-moving)

Yahagi et al. (2005)

Panoramic view of distant clusters

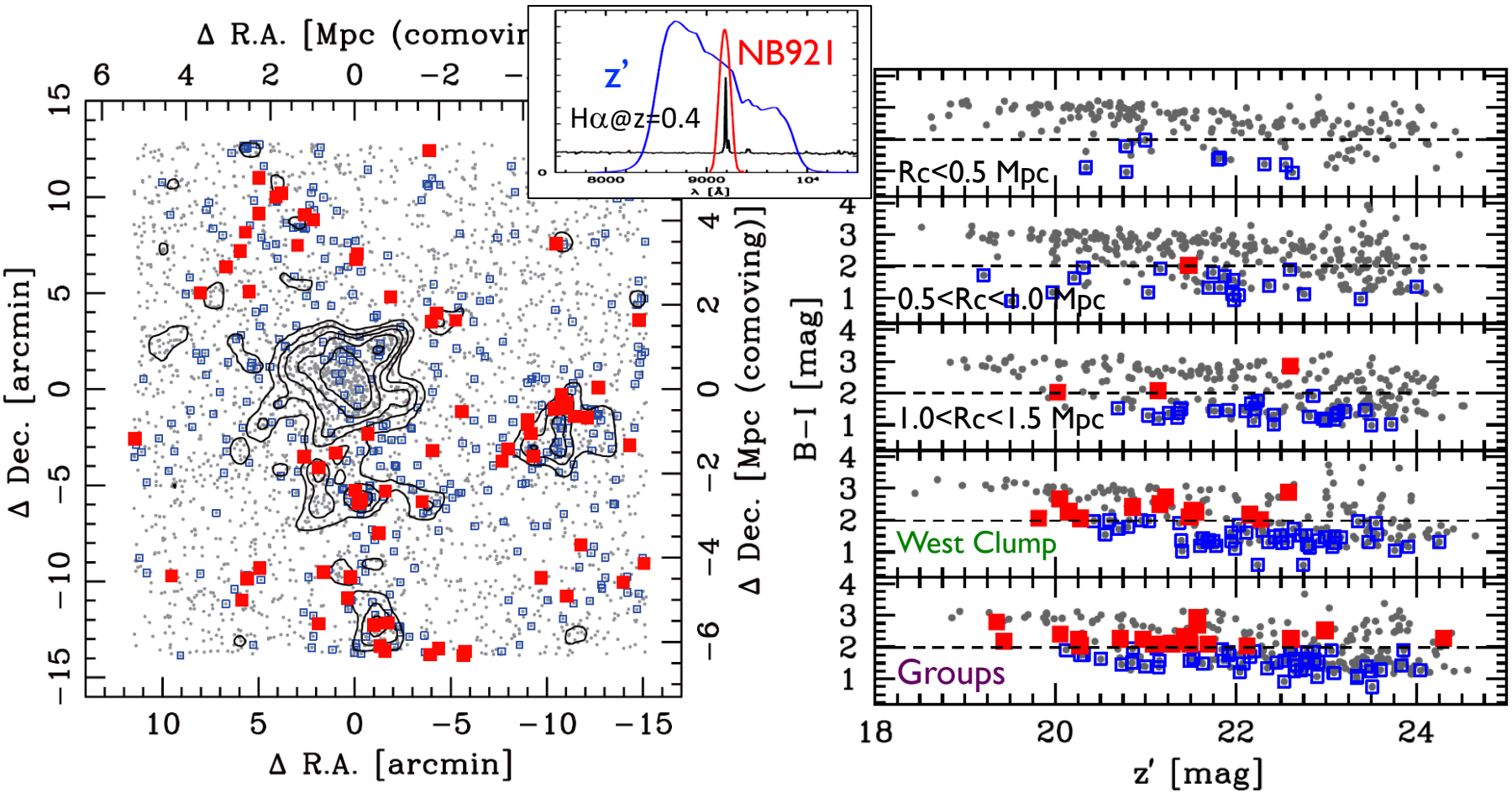
Colors of galaxies start to change from relatively low-density groups.





Suprime-Cam/Subaru study of A851cluster at z=0.4
(Kodama+2001; see also Tanaka+2005, Koyama+2008)

Panoramic Hα view of distant clusters with Suprime-Cam + NB imaging

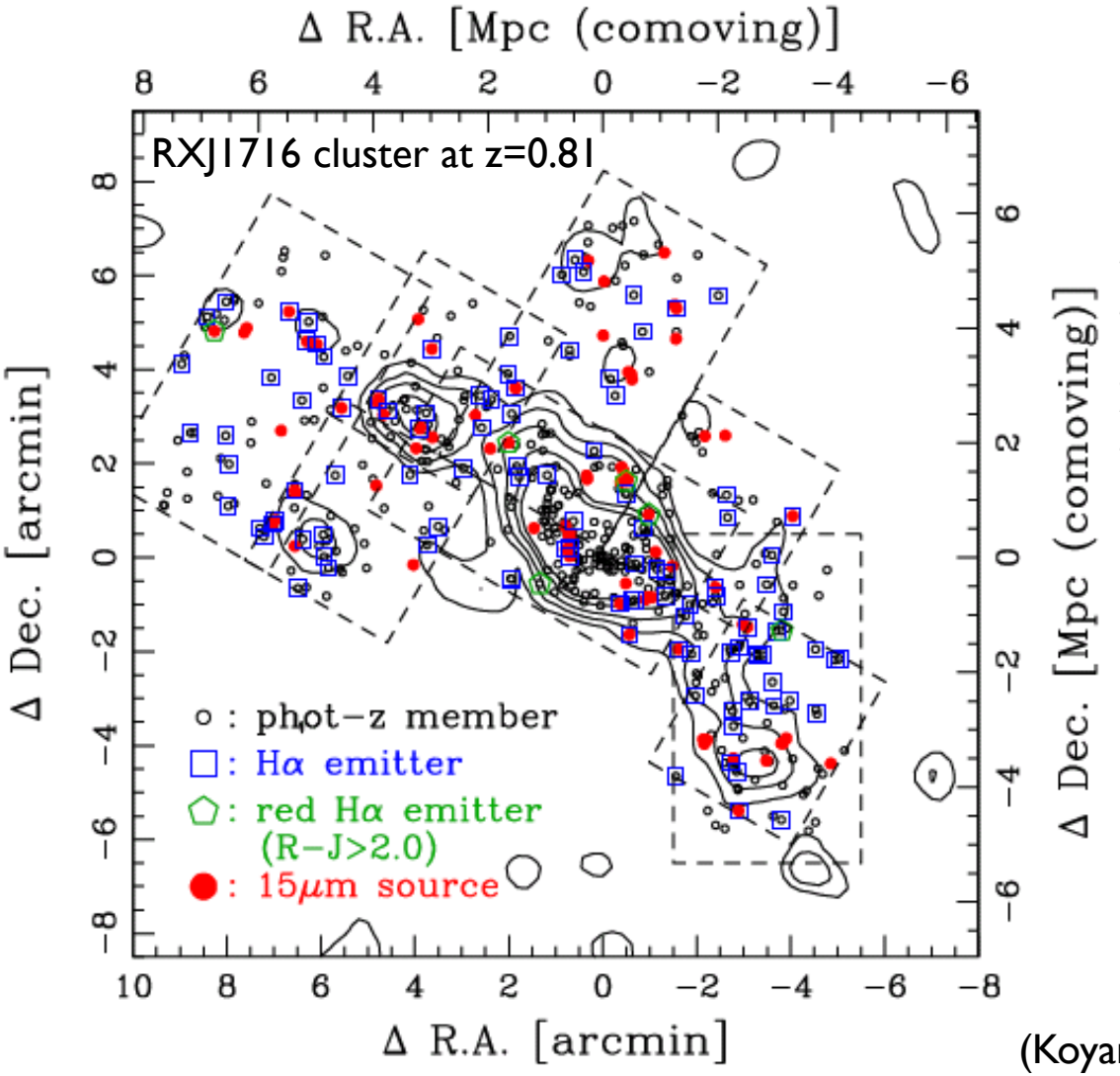


■: red HAE (B-I>2)
□: blue HAEs (B-I<2)

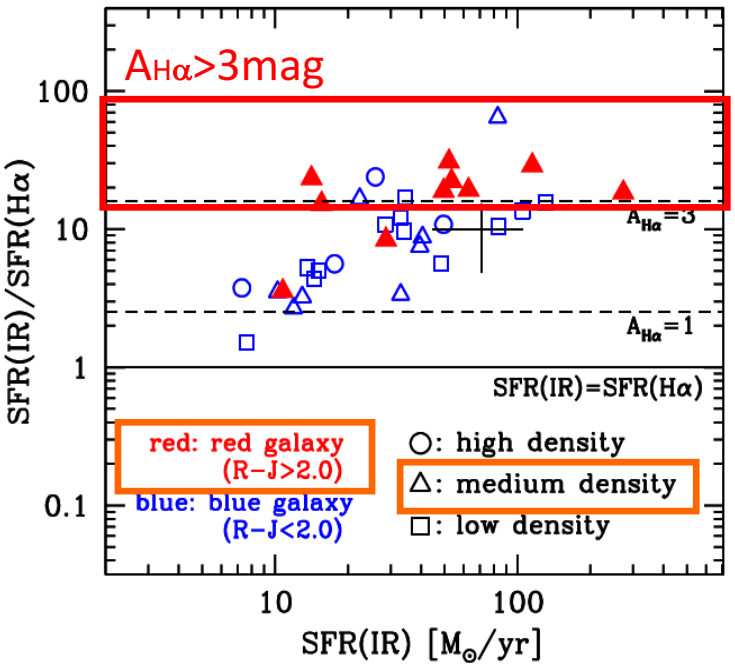
Strong clustering of "red HAEs" in group-scale (=transition) environment (Koyama+2011)

Red Hα emitters = dusty SF galaxies

A key population under the influence of environmental effects?



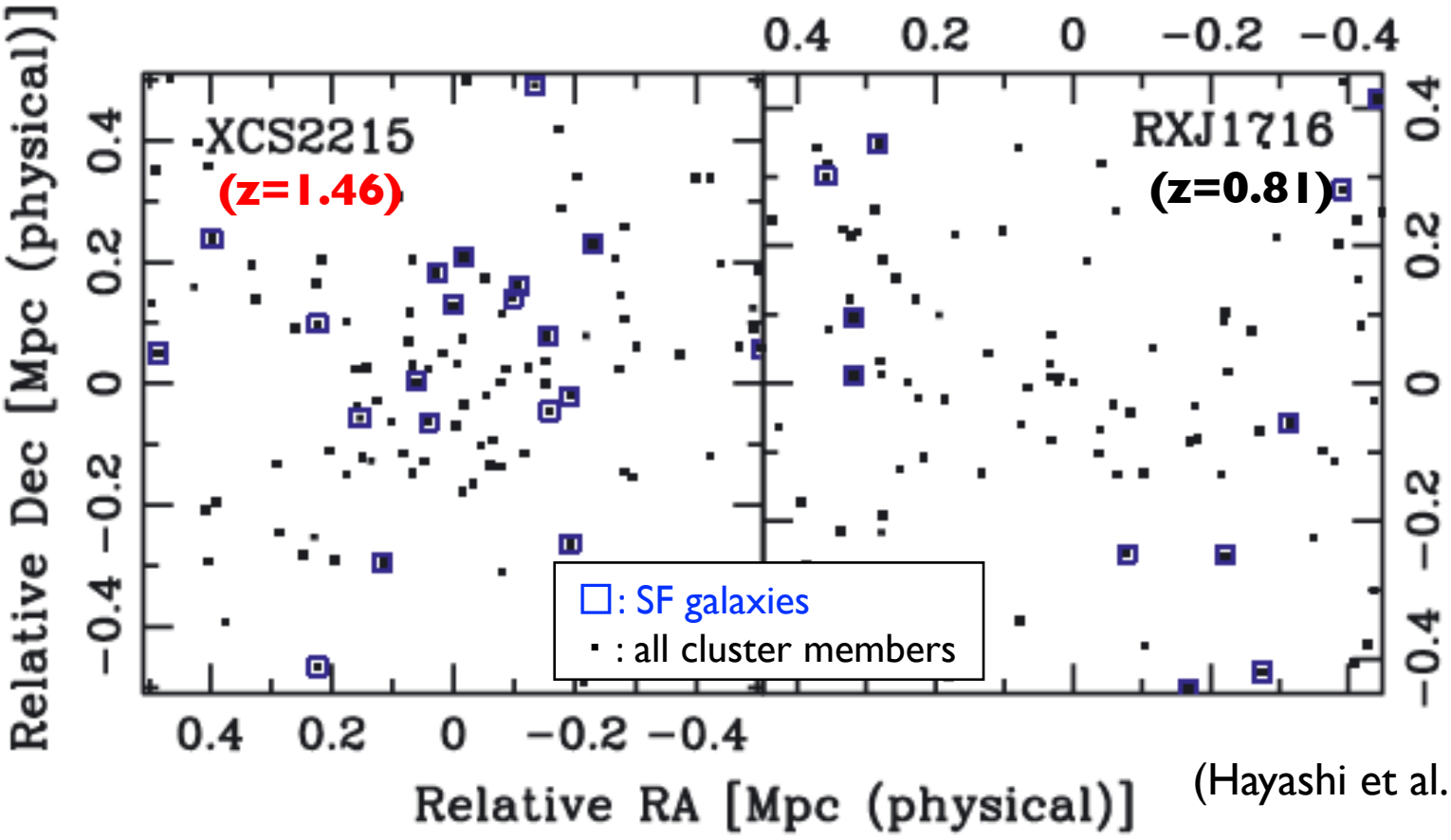
Hα+MIR detected galaxies only



Extremely dusty galaxies in cluster outskirts, revealed by wide-field Hα (MOIRCS) + MIR (AKARI) in collaboration with Korean team.

(Koyama+2008; 2010, see poster by I. Tanaka-san)

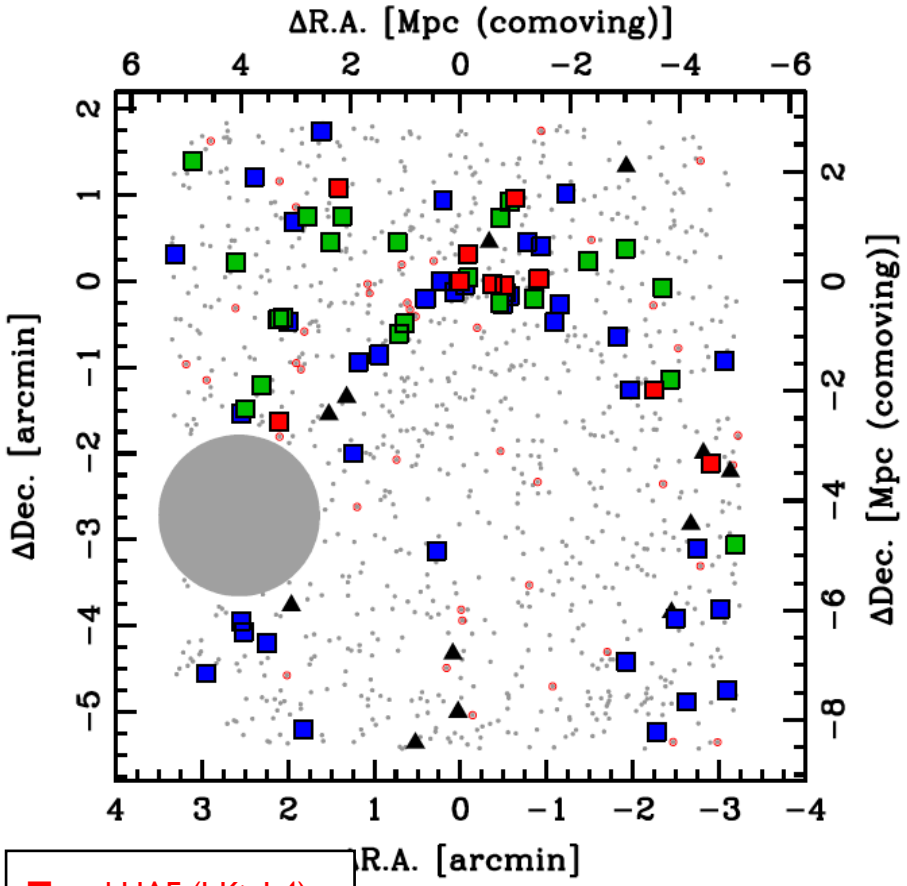
Surprisingly high SF activity in the core of galaxy clusters at z>1.5

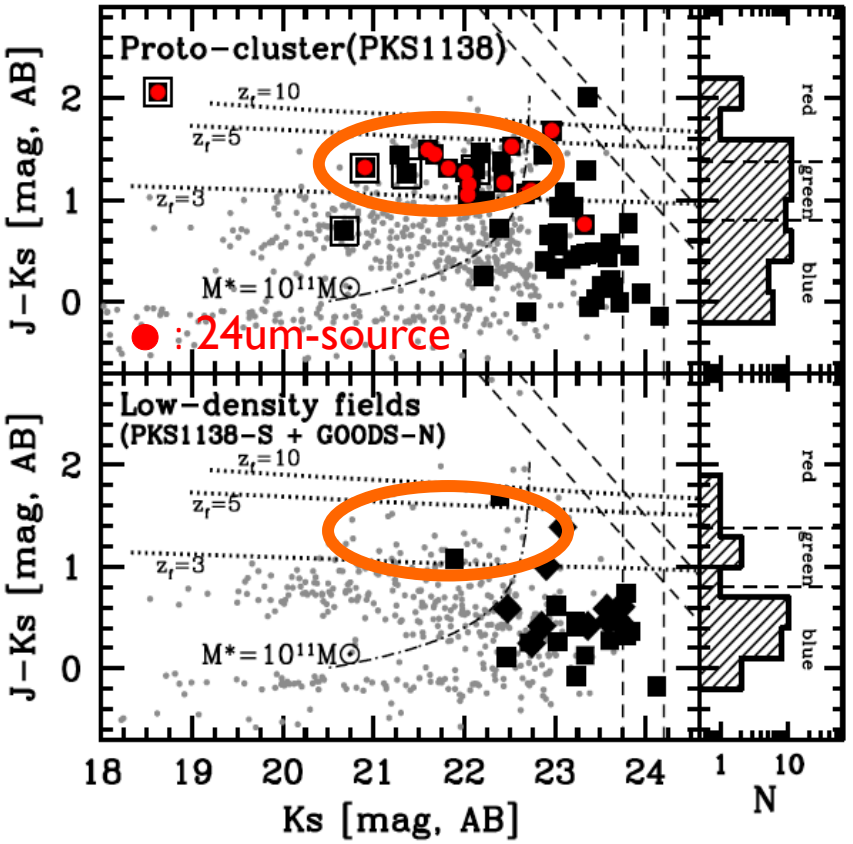


(Hayashi et al. 2010)

(see also e.g. Hilton+2010; Tran+2010; Hayashi+2011; Tadaki+2012; Brodwin+2013; Smail+2014; Ma+2015)

Red & massive SF galaxies in the core of z>2 proto-cluster environment



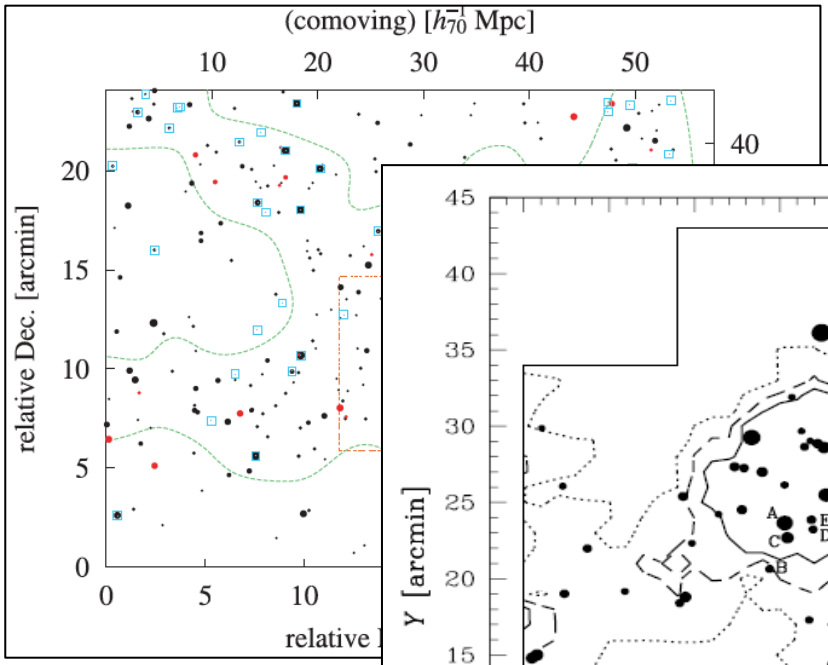


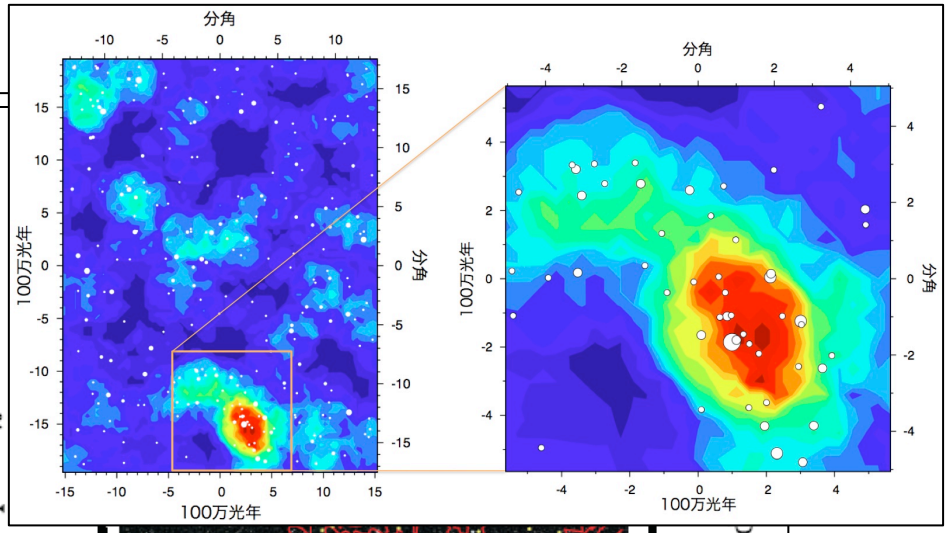
Subaru MOIRCS Hα survey of a proto-cluster at z=2.2 (Koyama+2013)

(see also e.g. Kajisawa+2006; Kodama+2007; M.Tanaka+2010; I.Tanaka+2011; Hayashi+2012; 2016; Shimakawa+2014 for z~2 proto-cluster studies with Subaru)

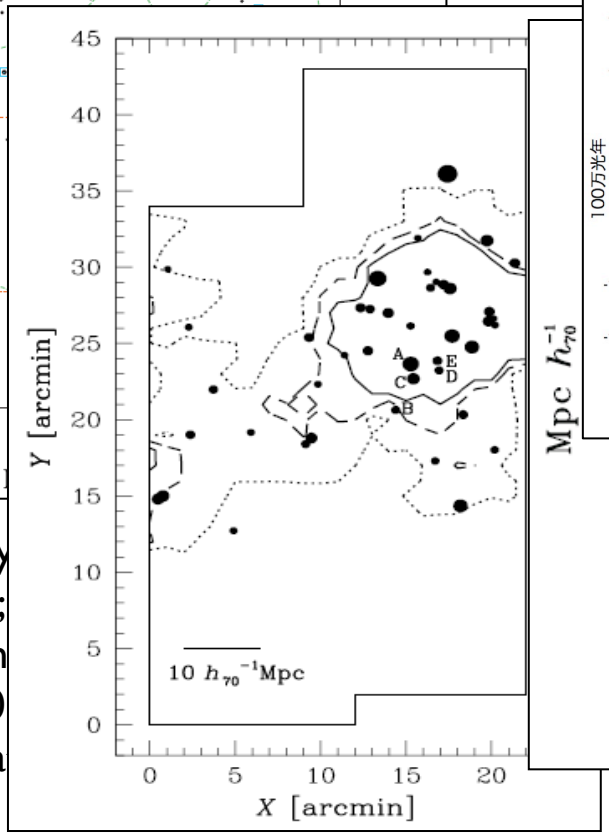
Discovery of z>3 clusters/structures with Subaru LAE/LBG survey

z=6.1 structure in SDF (Toshikawa+2012; 2014)





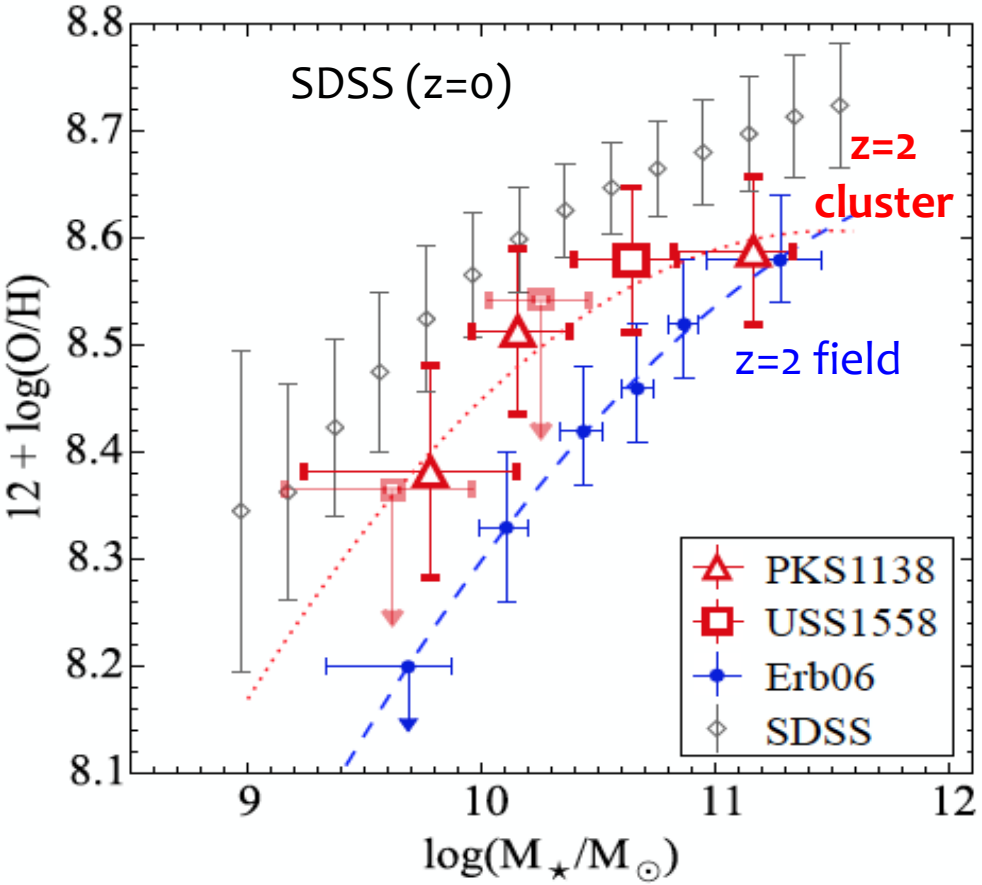
SSA22 at z=3.1 (Hay
Matsuda+2005; 2011;
Tamura+2009; Uchim
Kubo+2013; 2015; 20
Micheva+2017; Mawa



z=5.7 structure in SXDF (Ouchi+2005)

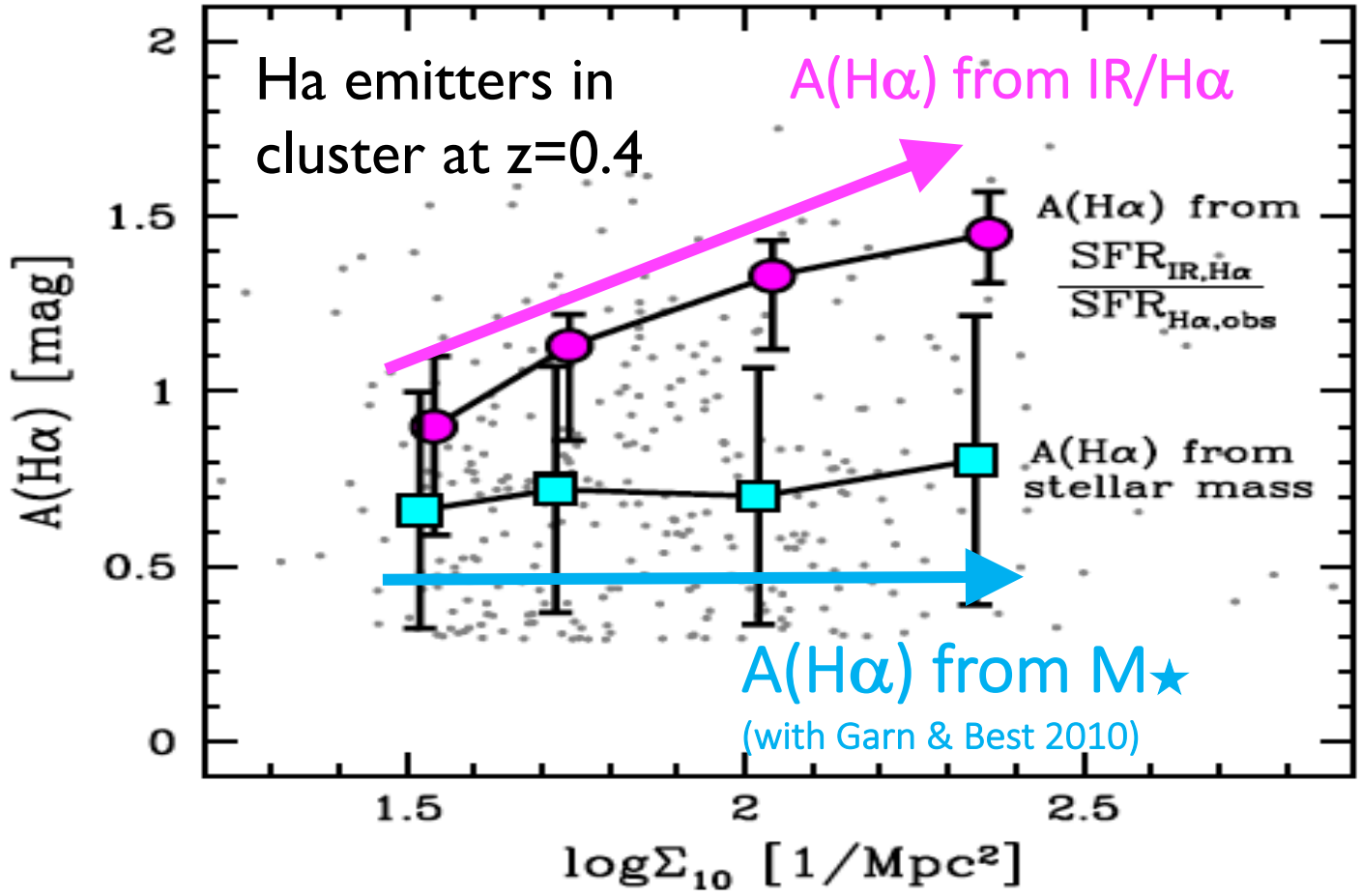
z=4.9 structure in SDF (Shimasaku+2003)

Hint of environmental impacts (1): ISM properties / chemical abundance?



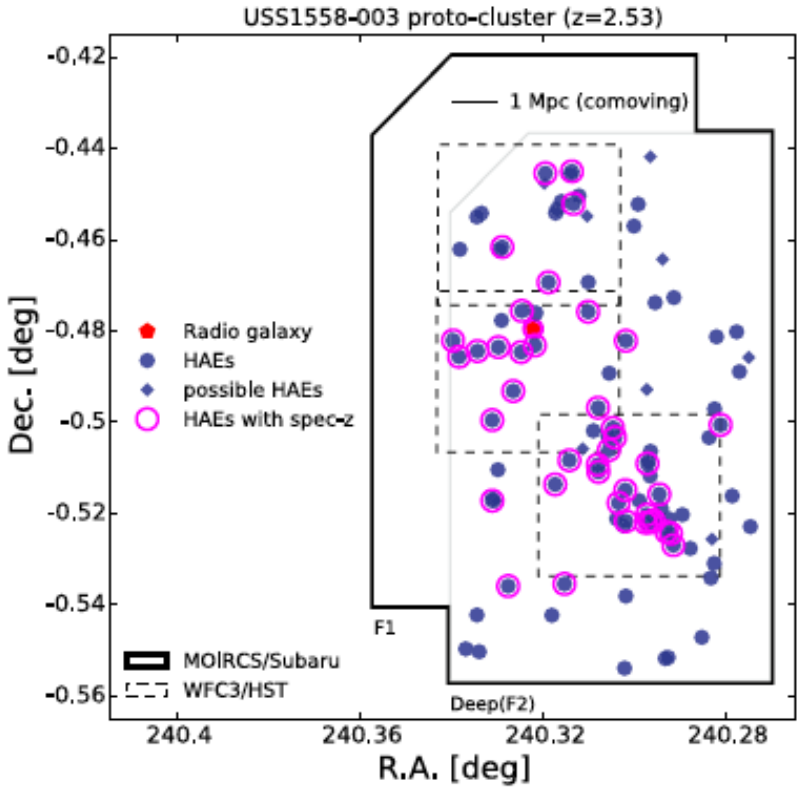
Environmental dependence of mass-metallicity relation? (Shimakawa+2015; see also Kulas+2014; but see Valentino+ 2015; Kacprzak+2015; Tran+2015)

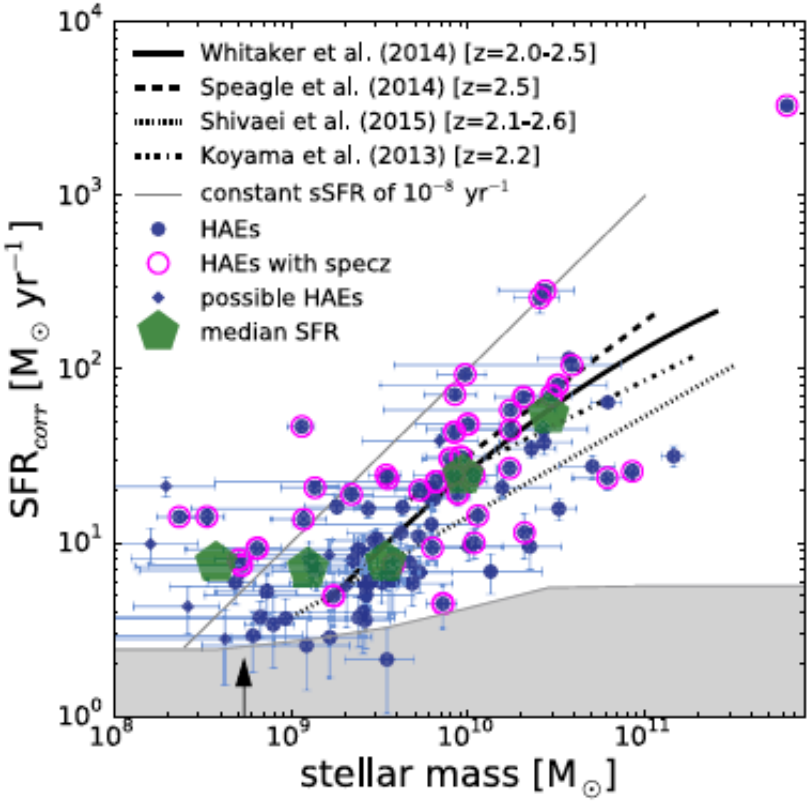
Hint of environmental impacts (2): Dust extinction / dust properties



(Koyama et al. 2013; see also Sobral+2016)

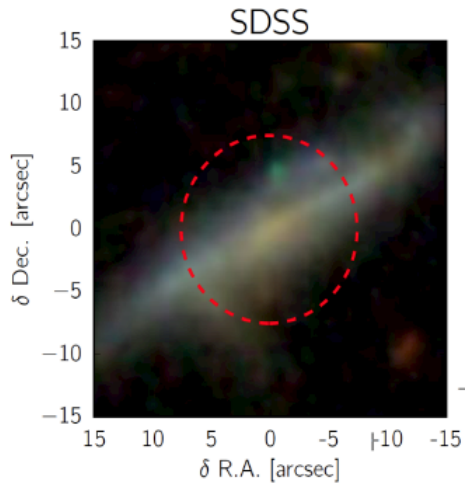
Hint of environmental impacts (3): Starbursts in low-M galaxies?

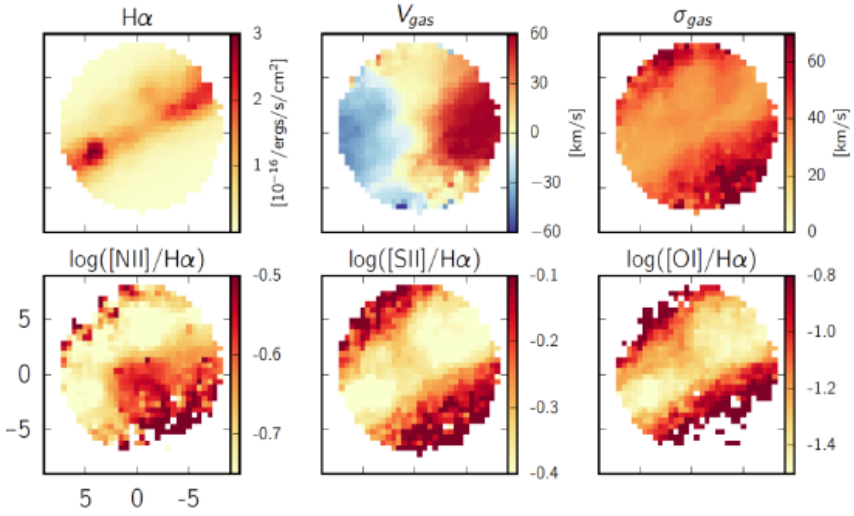


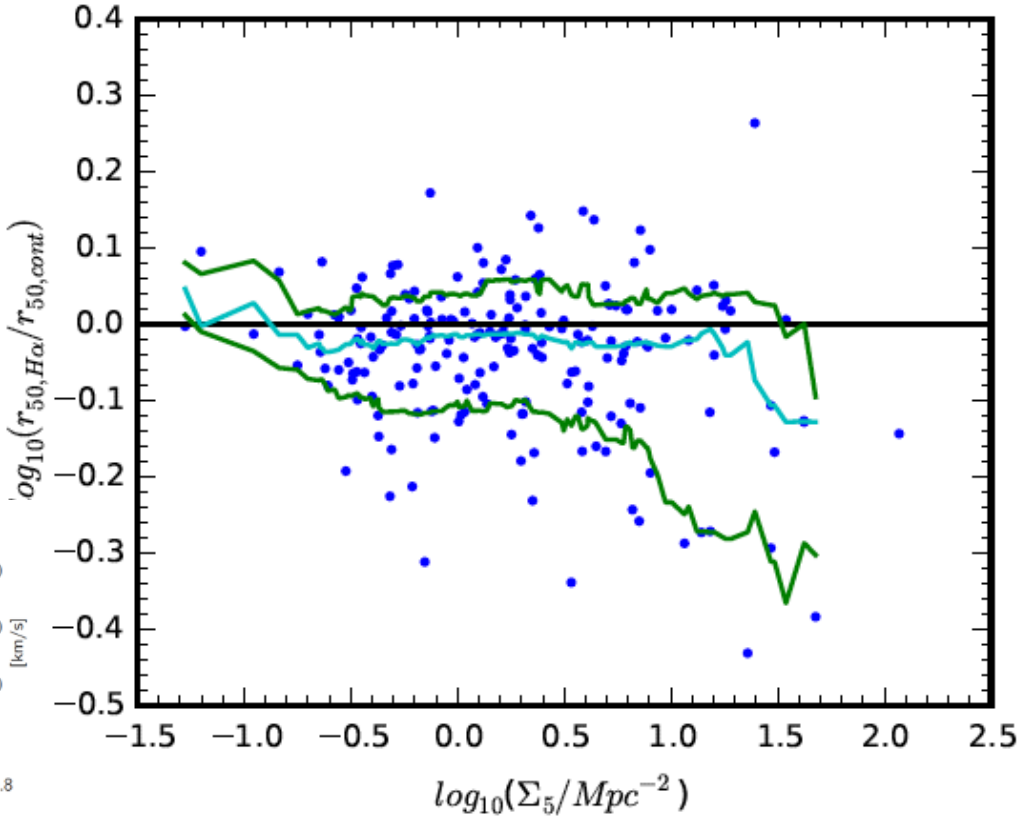


10-hrs MOIRCS NB imaging + HST image unveiled very low-mass star-bursting population in USS1558 cluster at z=2.53 (Hayashi et al. 2016)

Hint of environmental impacts (4): Hα size (i.e. geometry of SF regions)







More compact Hα size for galaxies in higher-density environment from SAMI survey

(Schaefer et al. 2016; *talk by J. Bryant talk*)

Key points

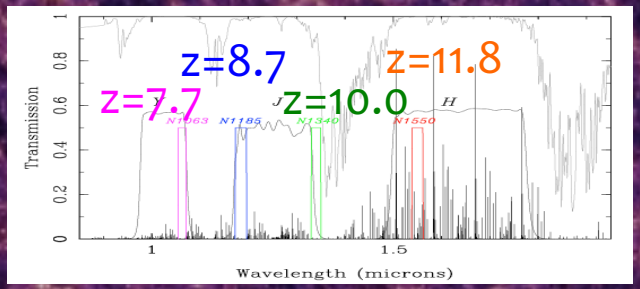
- Subaru + wide-field (+ NB) imaging has been successful in ”discovering” high-z structures.
- The wide field capability will become even stronger with HSC & PFS (optical), and with ULTIMATE-Subaru (NIR).
- Going deeper/sharper/3D are essential step to go beyond the “discovery” phase.
- HSC/PFS collaboration is already well established, while there is a plenty of rooms to join in ULTIMATE as a partner.

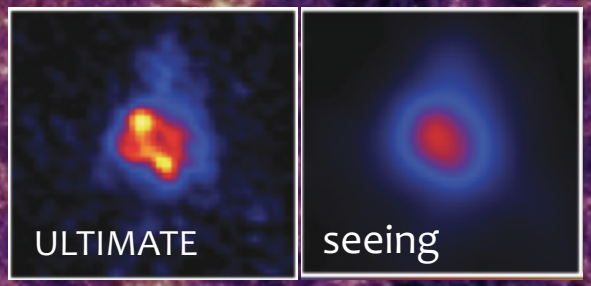
ULTIMATE-Subaru key science : Evolution of the Universe

"Birth, Life, Death" of galaxies in the cradle of large-scale structure

1. First galaxies (birth)

- Unprecedentedly deep NB imaging to detect galaxies a "cosmic dawn" (z>>7).
- Go beyond the depths of JWST.
- Extension of HSC optical NB survey



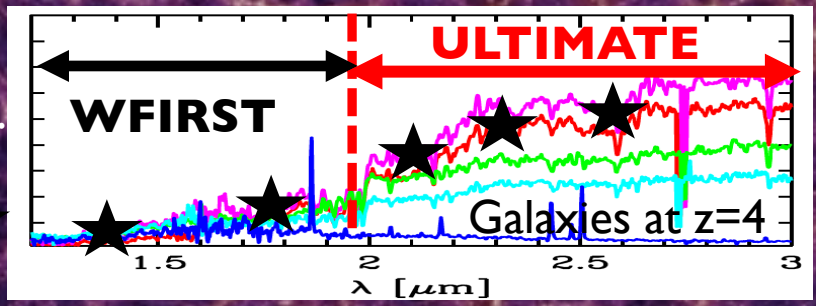


2. Stellar build-up (life)

- Origin of Hubble sequence: bulge, disk, and black hole growth
- Deep & sharp & panoramic NB imaging and 3-D spectroscopy of galaxies at "cosmic noon"(z=0.5-3.5)

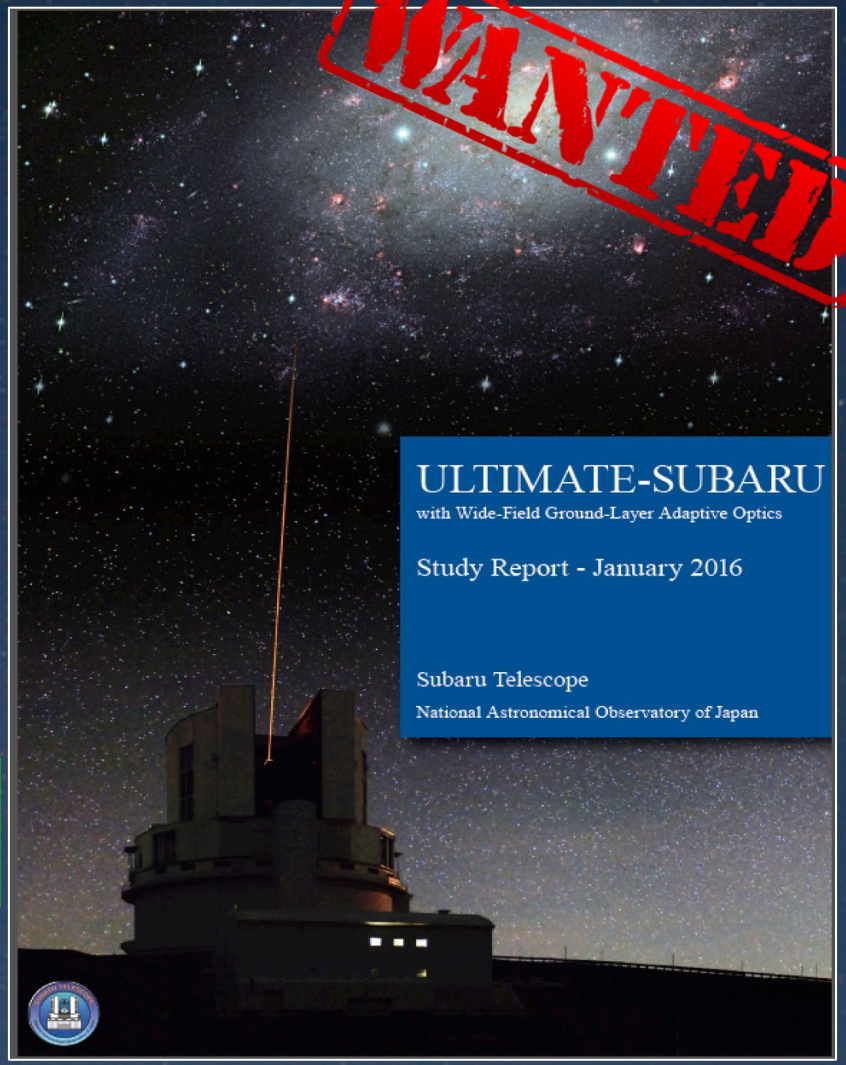
3. Quenching (death)

- Tracking down the "passive" galaxies to z~5 with deep BB/MB imaging (in K-band).
- Environment of dead galaxies: do first galaxies die in isolation or in clusters?
- Great synergy with WFIRST.



Join ULTIMATE science team

- CoDR in 2018.
- Please join ULTIMATE science team taking this opportunity !
  - Contribution from (potential) partner countries is very welcome.
- Please submit your 1-page science document by May 12.
  - We will organize international science team and contact you soon.
- Get LaTeX package from here:
  - http://www.naoj.org/Projects/newdev/ngao/20170316/index.html



Answers to the Questions

- Q1: Science interests?
  - Galaxy formation/evolution, galaxy clusters, environmental effects.
- Q2: On-going collaboration:?
  - HSC work with Taiwanese team. AKARI work with Korean team (in the past).
- Q3: Possibility of short/long-term collaboration?
  - Short term: PFS precursor study with AU facility? Experiencing IFU science with SAMI data (or Subaru archive science including HSC-SSP DR1 data)?
  - Long term: ULTIMATE-Subaru (both science & instrumentation)
- Q4: Size of the project?
  - Short term: A few nights to 10 nights at AAT?
  - Long term: Intensive--SSP class survey with ULTIMATE?
- Q5: Instruments to be used in the collaboration?
  - AAOmega/SAMI (on AAT) for starting collaboration.
  - ULTIMATE WFC or multi-IFU for long term collaboration.
- Q6: Request to Subaru science operation?
  - None. I am in the science operation team…
  - Request for queue? Remote? Reduced data archive…?