



Galaxy Formation session

Probing large-scale structures at $z < 1.6$ by HSC wide-field survey

Masao Hayashi (NAOJ)

PASJ Publications of the
Astronomical Society of Japan

The whole picture of the large-scale structure of the CL1604 supercluster at $z \sim 0.9$

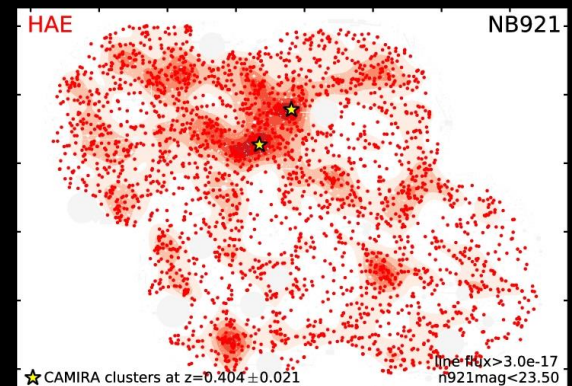
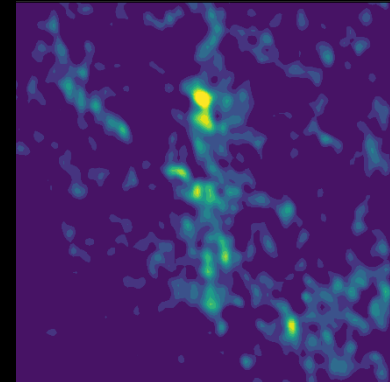
Masao Hayashi ✉, Yusei Koyama, Tadayuki Kodama, Yutaka Komiyama, Yen-Ting Lin,
Satoshi Miyazaki, Rhythm Shimakawa, Tomoko L Suzuki, Ichi Tanaka, Moegi Yamamoto,
Naoaki Yamamoto

2019, PASJ, in press (arXiv:1905.13437)

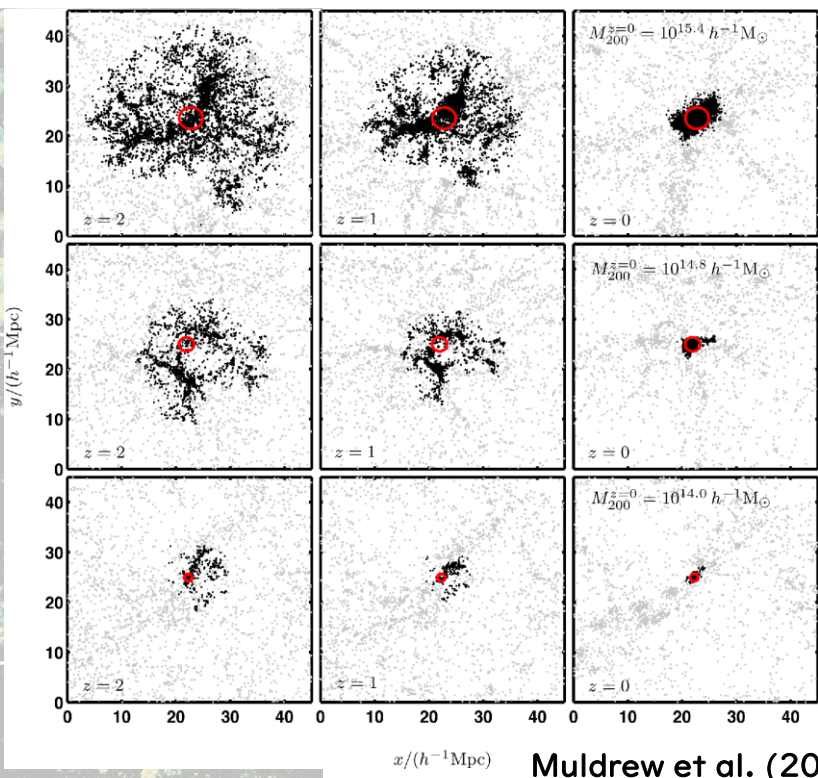
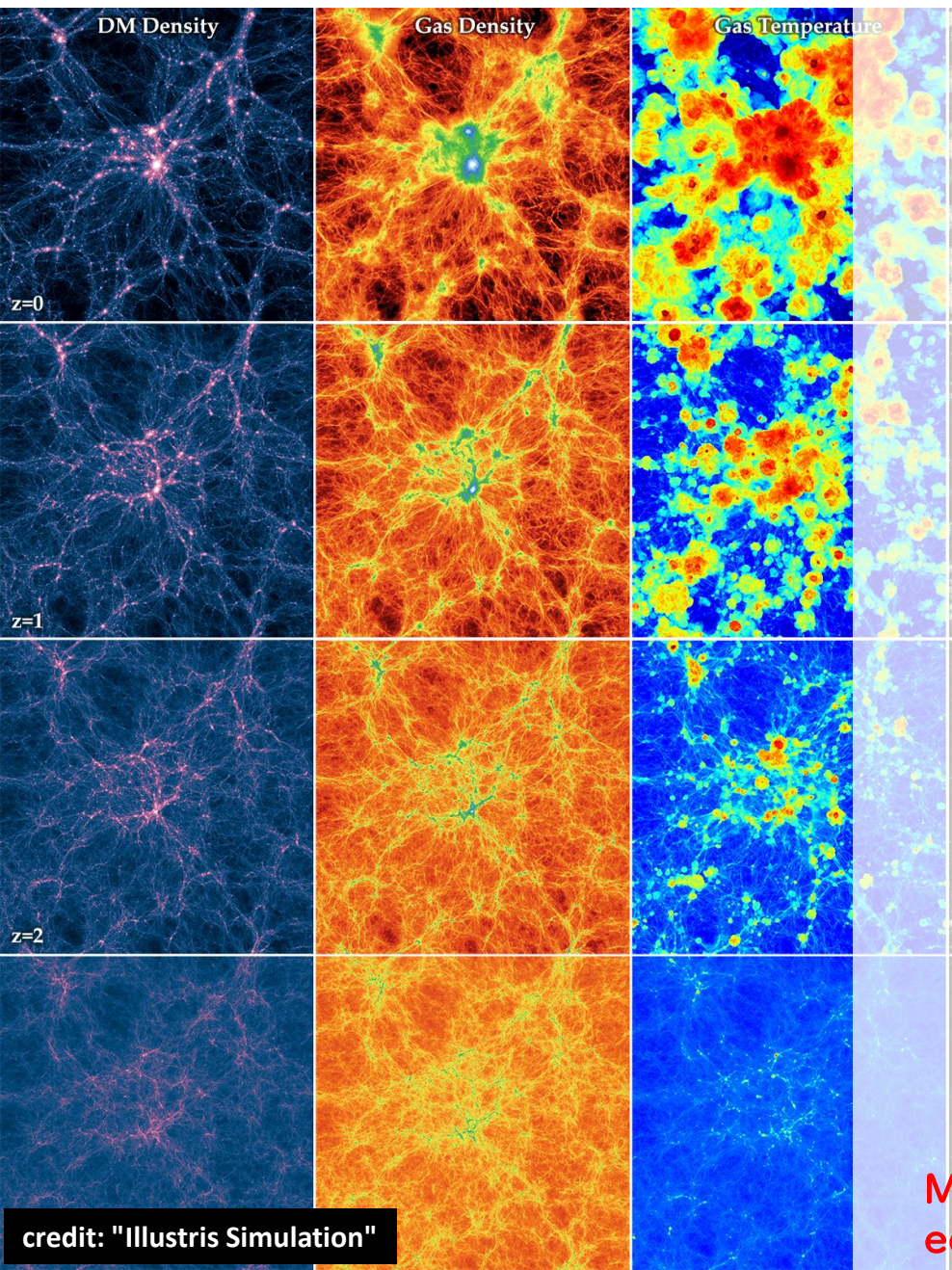
A 16 deg^2 survey of emission-line galaxies at $z < 1.5$ in HSC-SSP Public Data Release 1

Masao Hayashi ✉, Masayuki Tanaka, Rhythm Shimakawa, Hisanori Furusawa,
Rieko Momose, Yusei Koyama, John D Silverman, Tadayuki Kodama, Yutaka Komiyama,
Alexie Leauthaud Yen-Ting Lin, Satoshi Miyazaki, Tohru Nagao, Atsushi J Nishizawa,
Masami Ouchi, Takatoshi Shibuya, Ken-ichi Tadaki, Kiyoto Yabe

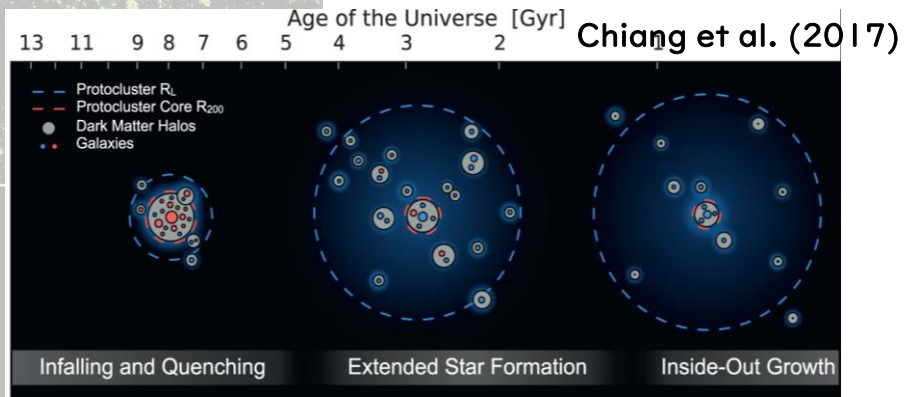
2018, PASJ, 70, S17



Galaxies have evolved along with the growth of large-scale structures



Muldrew et al. (2015)



Chiang et al. (2017)

Much wider area at higher- z contributes to each galaxy cluster at lower- z

credit: "Illustris Simulation"

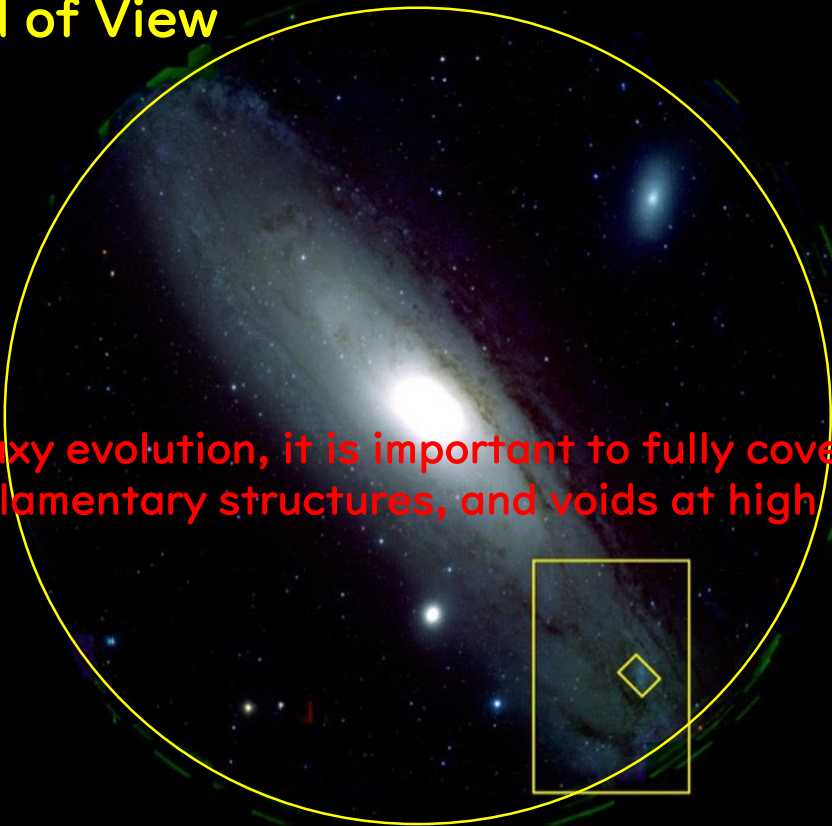
HSC/Subaru is a powerful instrument to reveal the growth of LSSs

credit: "NAOJ"

very large Field of View



Typical Apparent Diameter of the Moon (0.5 degrees)



To understand the role of environment in the galaxy evolution, it is important to fully cover various environments including galaxy clusters, filamentary structures, and voids at high redshifts



Suprime-Cam

First Light Release
January 1999



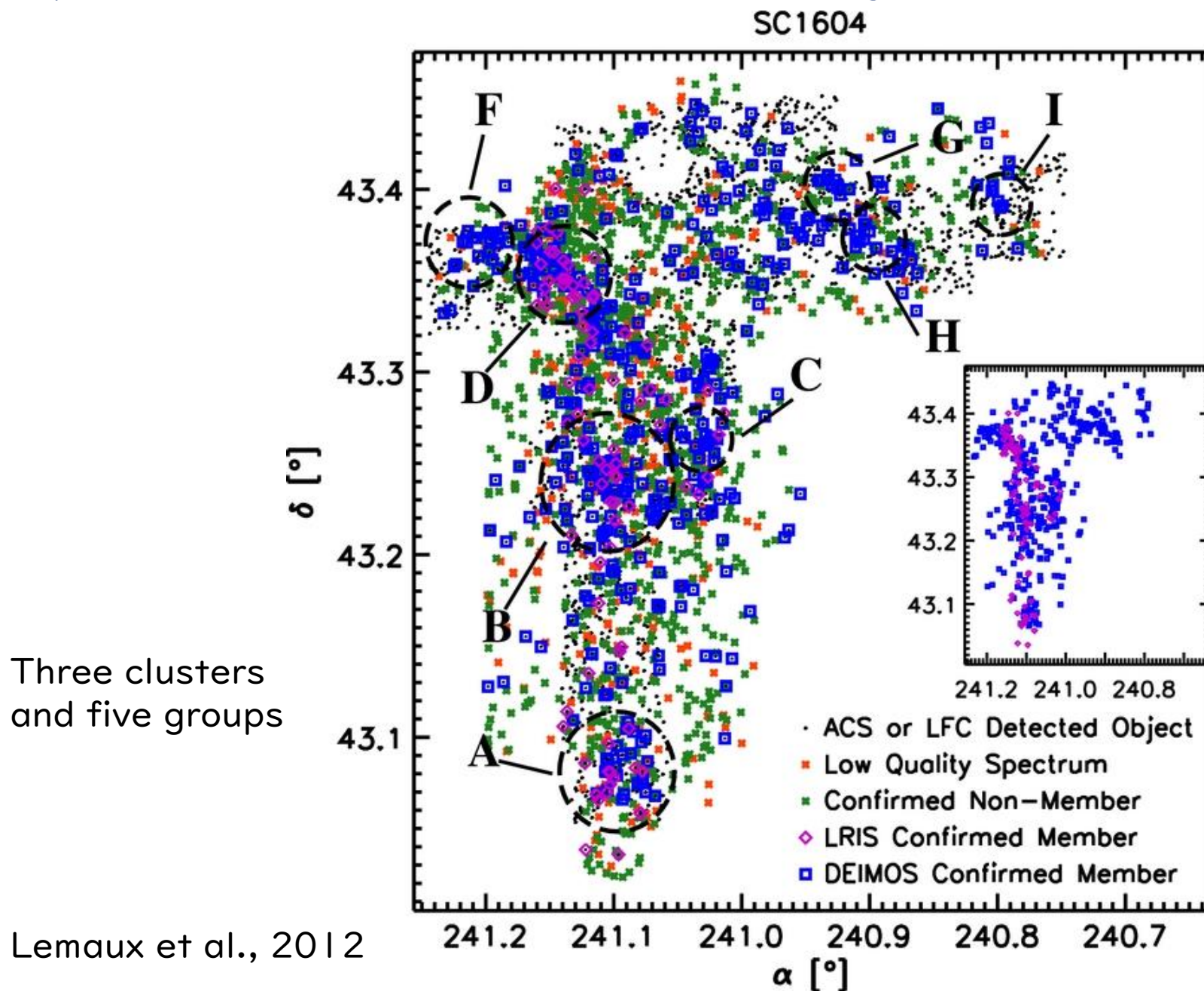
Suprime-Cam

Image Release
September 2001

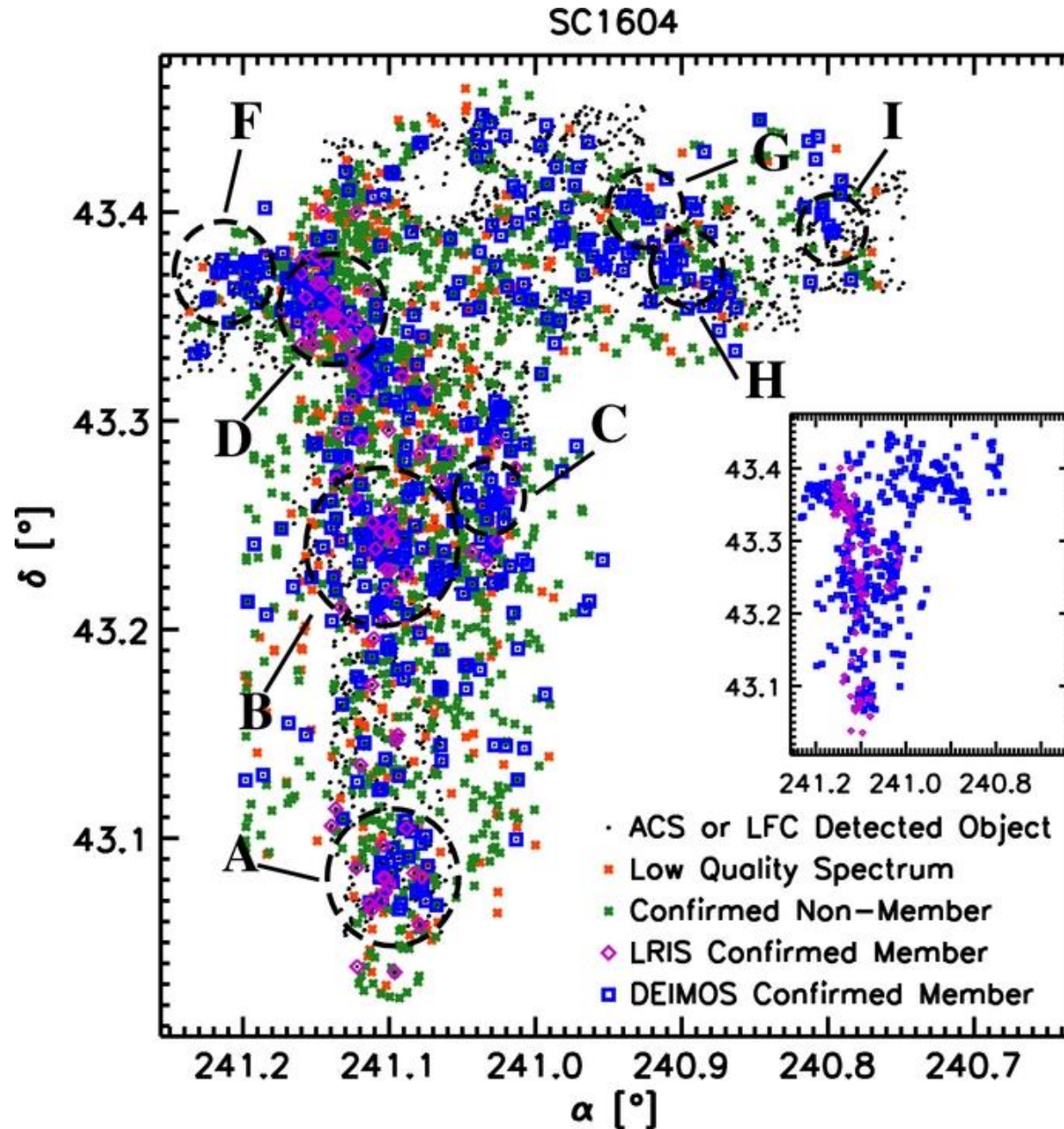
Hyper Suprime-Cam

Image Release
July 2013

Supercluster CL I 604 @ $z \sim 0.9$: one of the highest- z LSSs ever known



Supercluster CL I 604 @ $z \sim 0.9$: one of the highest- z LSSs ever known



Supercluster CL I 604 @ $z \sim 0.9$: one of the highest- z LSSs ever known

HSC-SSP Wide-layer

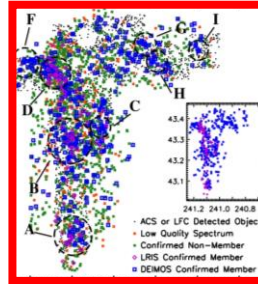
DR1 S16A internal release

g, r, i, z, y

photoz (ephor_ab)

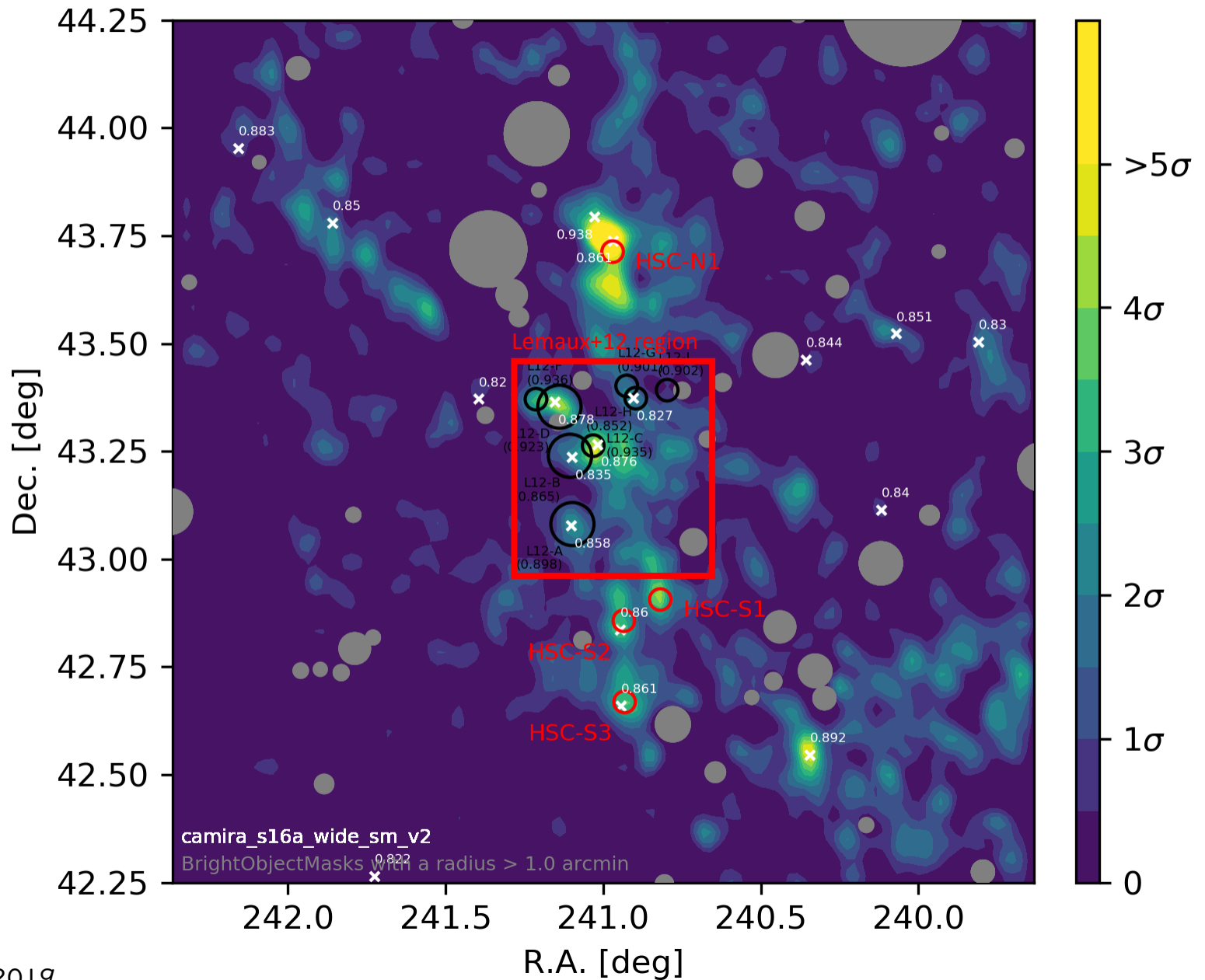
HSC FoV

Lemaux+12 region



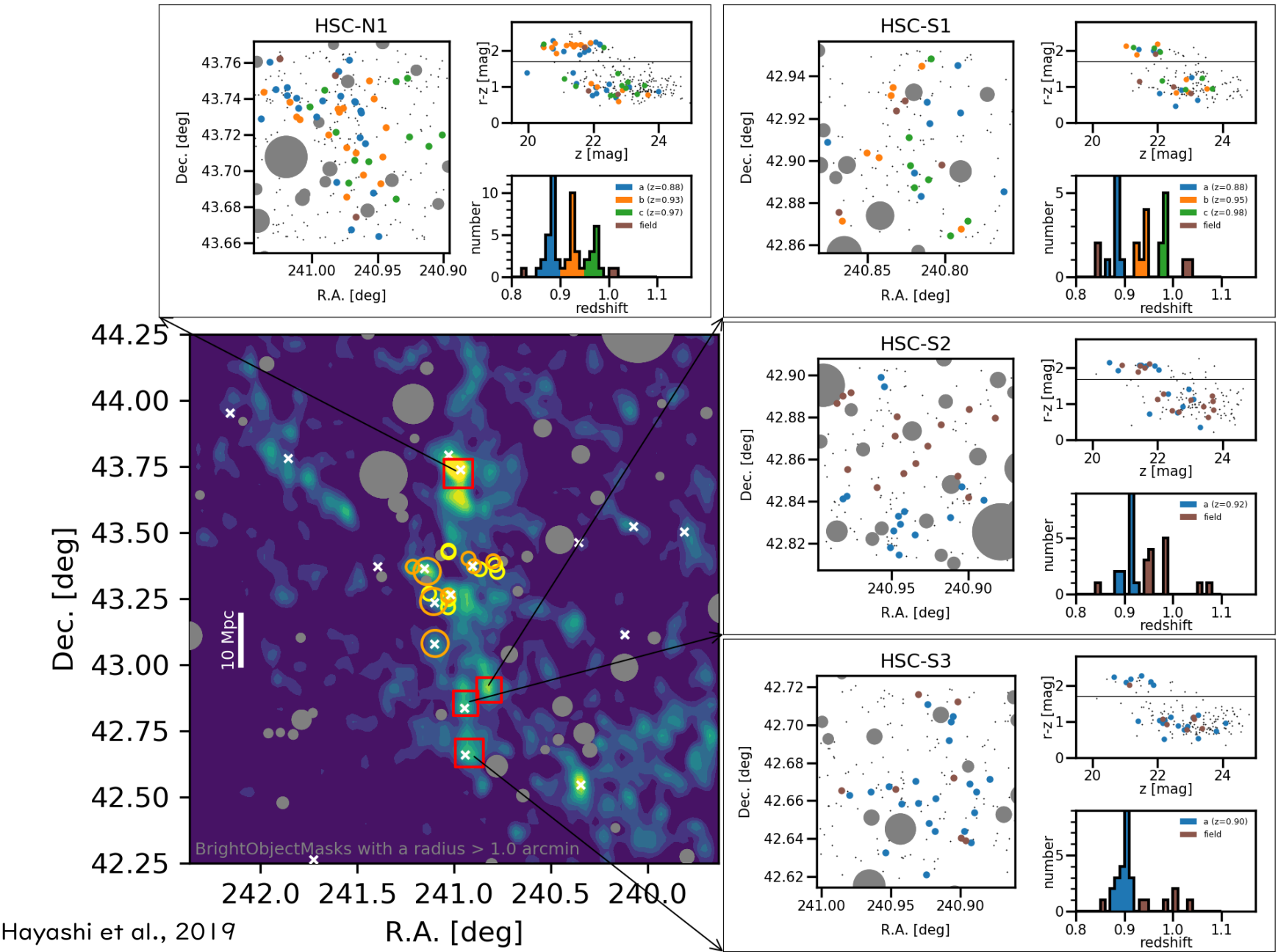
Galaxies with photoz (ephor_ab) = 0.85–0.95

Supercluster CL I 604 @ $z \sim 0.9$: one of the highest- z LSSs ever known

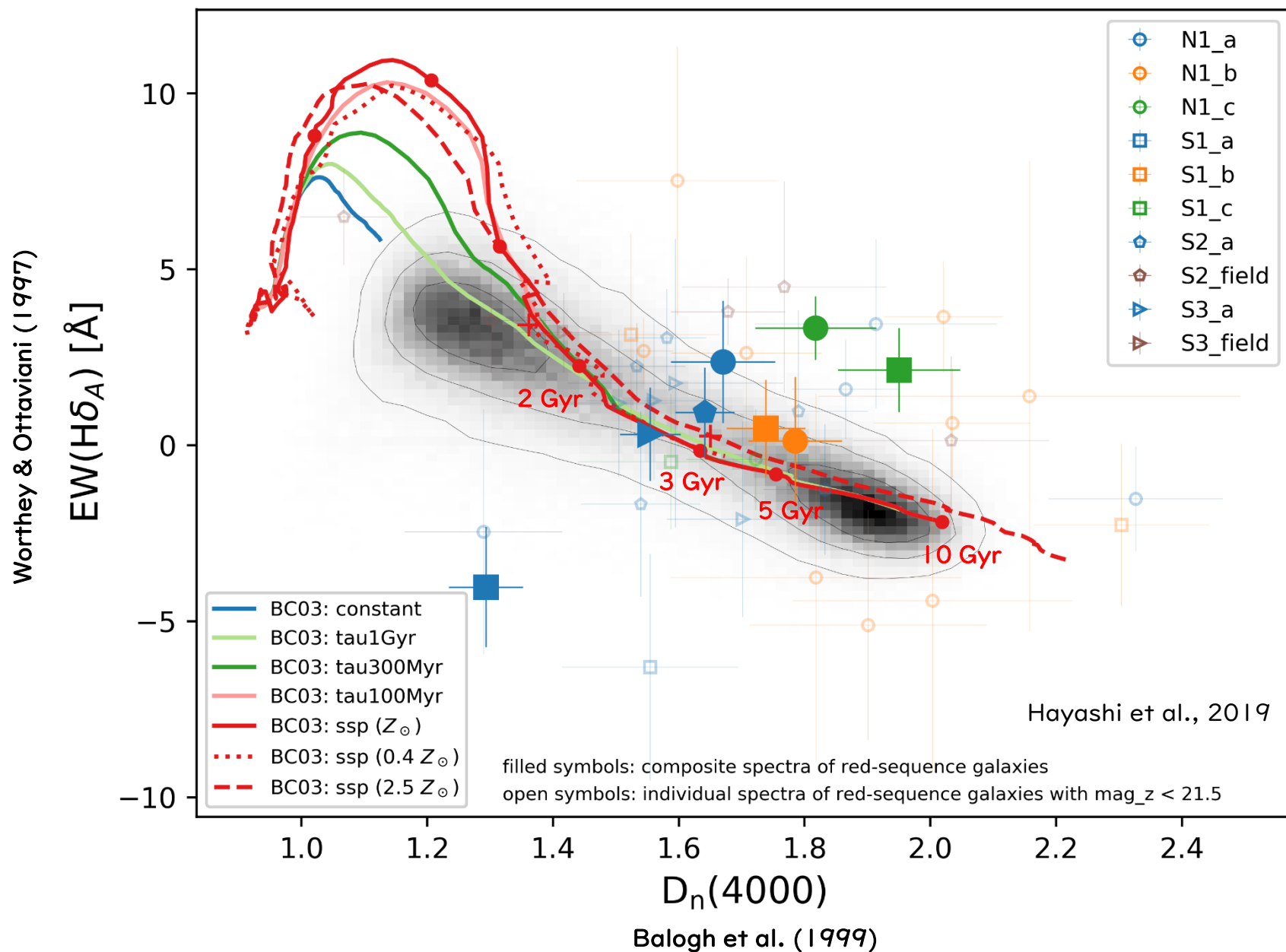


Spectroscopic follow-up observations with Subaru/FOCAS and Gemini-N/GMOS

55 red-sequence galaxies and 82 star-forming galaxies are confirmed



Stellar population of red-sequence galaxies



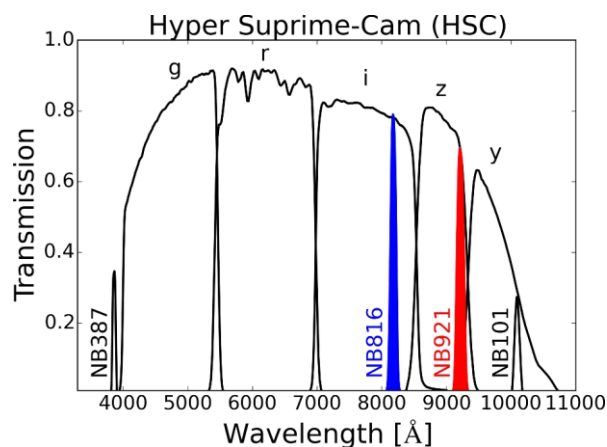
Large samples of emission-line galaxies at $z < 1.6$ from HSC-SSP survey

PDR1 catalogs ►

- 8054 H α emitters at $z = 0.25$ and 0.40
- 8656 [OIII] emitters at $z = 0.63$ and 0.84
- 16877 [OII] emitters at $z = 1.19$ and 1.47

<https://hsc.mtk.nao.ac.jp/ssp/>

Data from two NB filters are available in PDR1

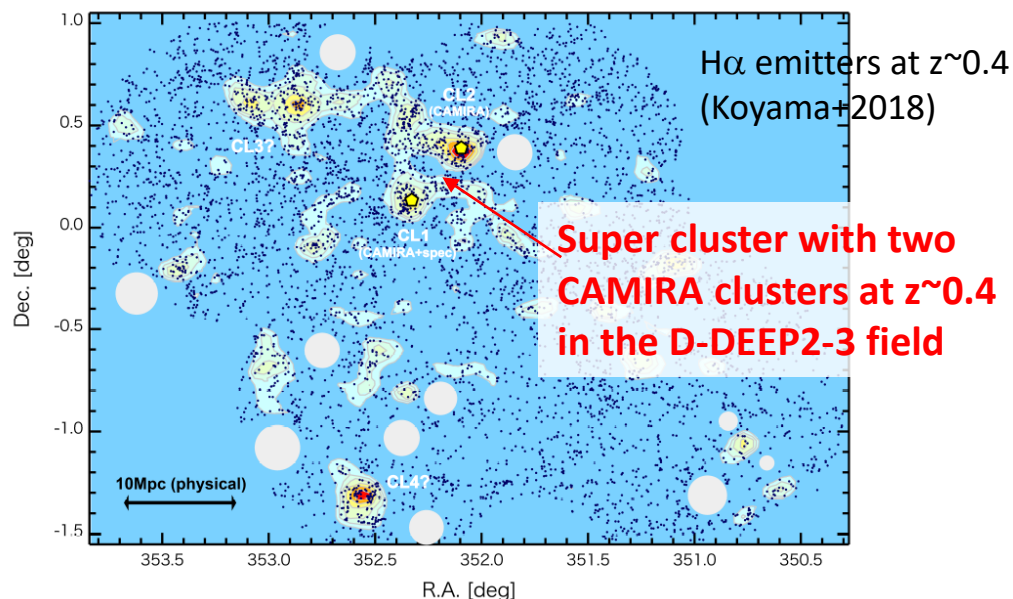


Field*	Narrowband filter		
	NB816		
	Area [†] [deg ²]	Integration [hr]	Limit mag. [‡]
UD-COSMOS	—	—	—
UD-SXDS	1.43	4.0	25.2
D-COSMOS	—	—	—
D-DEEP2-3	4.25	1.0	24.8
D-ELAIS-N1	—	—	—
Total area	5.68		
	NB921		
	Area [†] [deg ²]	Integration [hr]	Limit mag. [‡]
UD-COSMOS	1.47(1.54)	7.0	25.1
UD-SXDS	1.49	4.8	25.1
D-COSMOS	2.27(2.91)	2.0	24.8
D-DEEP2-3	5.63	1.0	24.6
D-ELAIS-N1	5.37	1.0	24.6
Total area	16.2		

NB816: 5.68deg² NB921: 16.2deg²

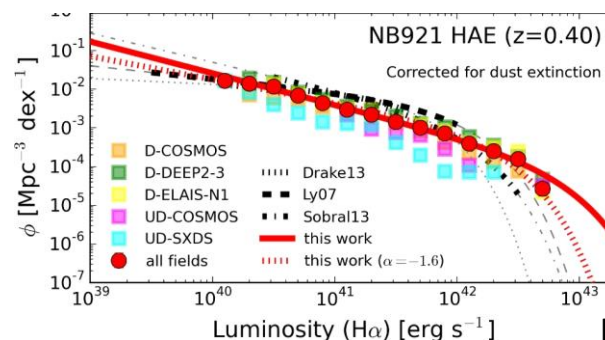
Spatial distribution

- reveal cosmic web at > 50 Mpc scale



Luminosity function


- overcome a field-to-field variance

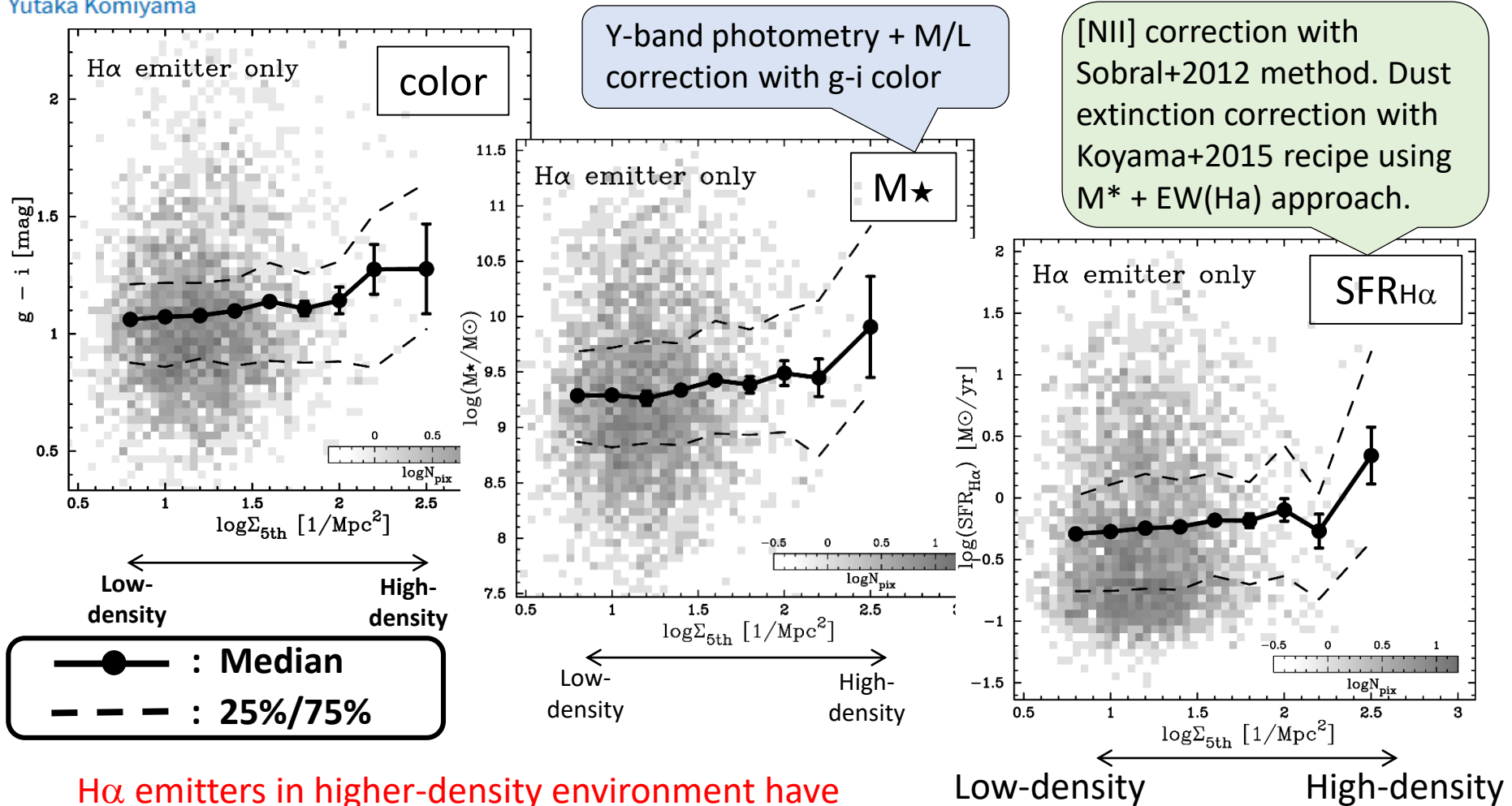


Hayashi+2018

The nature of $H\alpha$ -selected galaxies along the large-scale structure at $z = 0.4$ revealed by Subaru Hyper Suprime-Cam survey

2018, PASJ, 70, S21

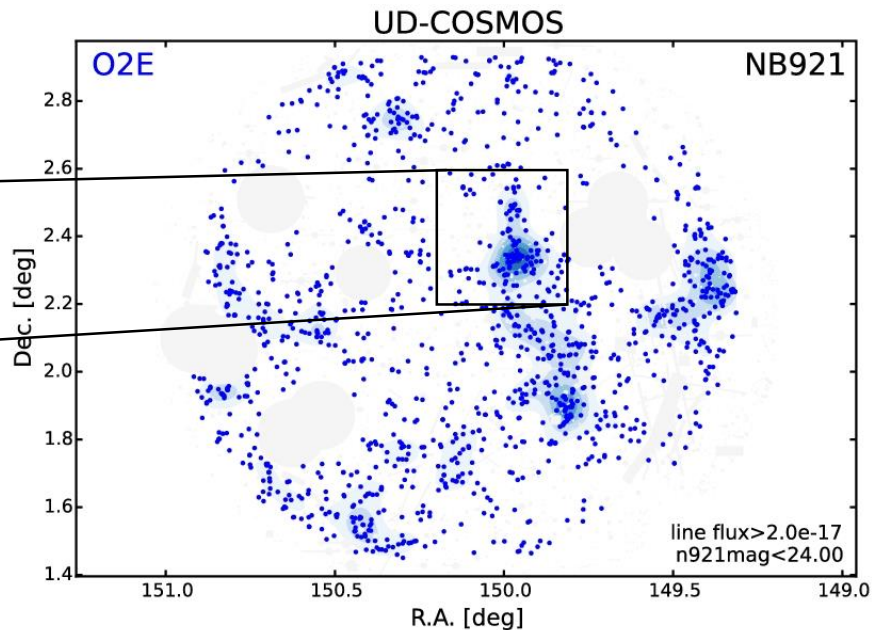
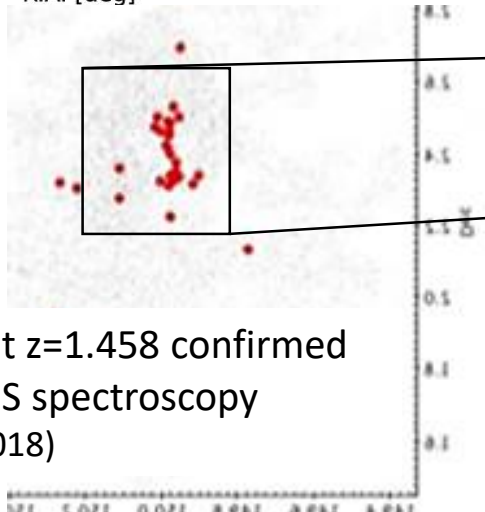
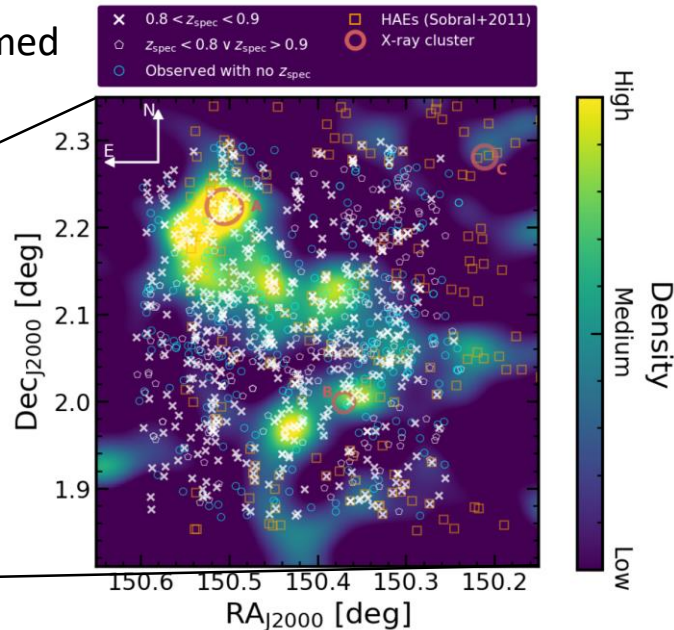
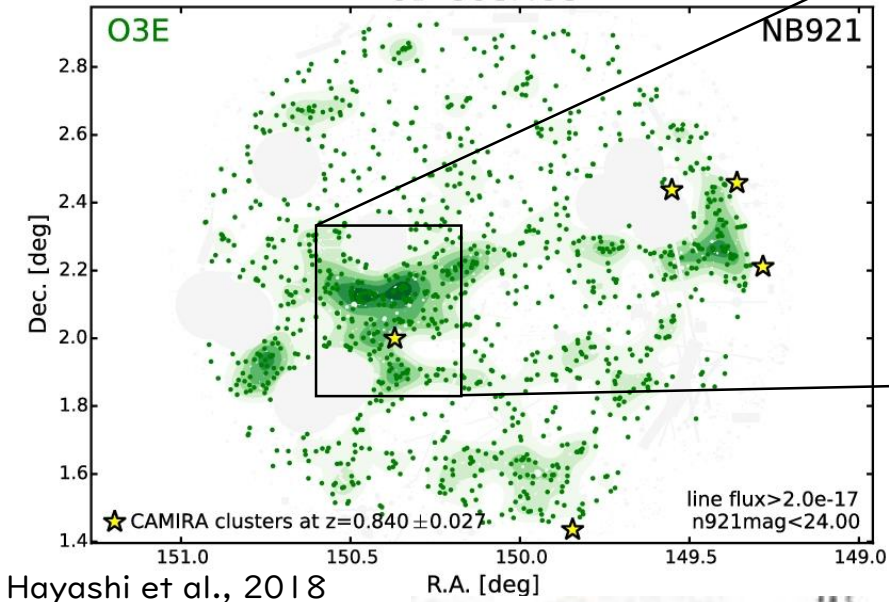
Yusei Koyama , Masao Hayashi, Masayuki Tanaka, Tadayuki Kodama, Rhythm Shimakawa, Moegi Yamamoto, Fumiaki Nakata, Ichi Tanaka, Tomoko L Suzuki, Ken-ichi Tadaki, Atsushi J Nishizawa, Kiyoto Yabe, Yoshiki Toba, Lihwai Lin, Hung-Yu Jian, Yutaka Komiya



$H\alpha$ emitters in higher-density environment have redder color, higher M_\star , and higher SFR

Large-scale structures of [OII] and [OIII] emission line galaxies at higher-z including galaxy clusters, filaments, and voids

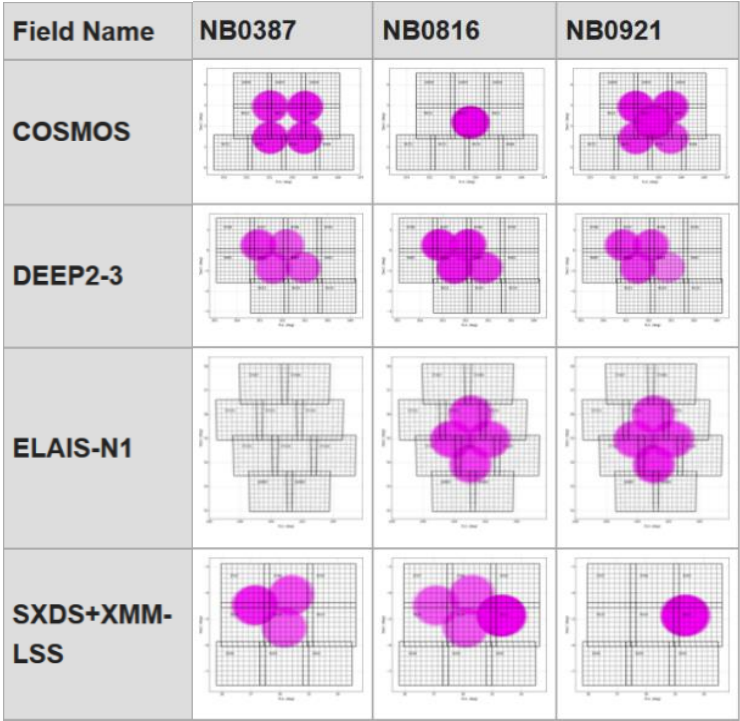
Super cluster at $z=0.84$ confirmed by VLT/VIMOS spectroscopy
Paulino-Afonso et al. (2018)
UD-COSMOS



Updating the catalogs of emission-line galaxies using PDR2 data

<https://hsc.mtk.nao.ac.jp/ssp/>

(1) Wider field coverage



[NB816]

5.68deg² -> 16.3deg²

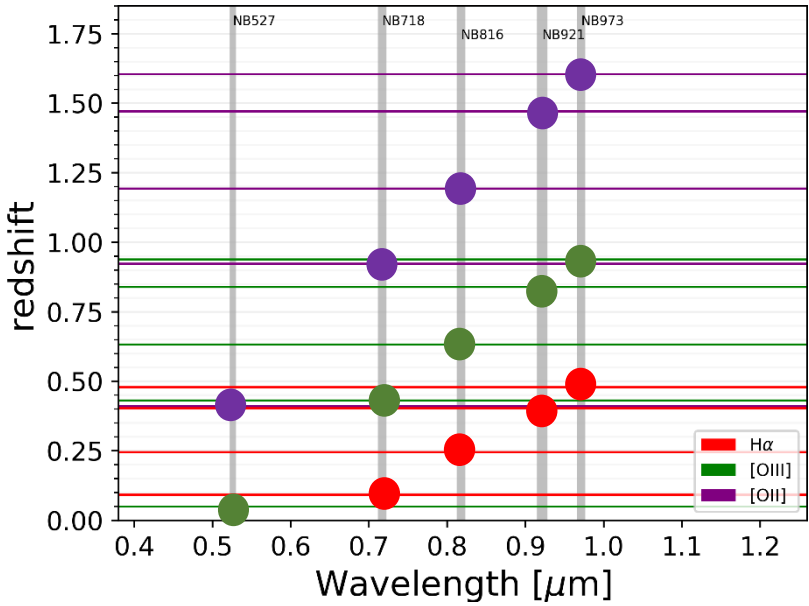
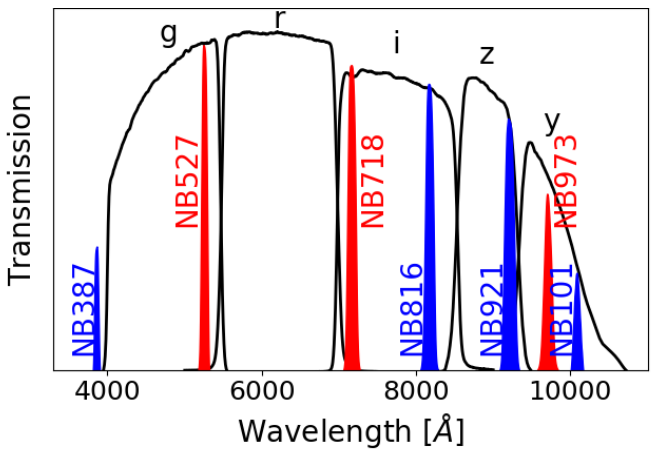
[NB921]

16.2deg² -> 16.9 deg²

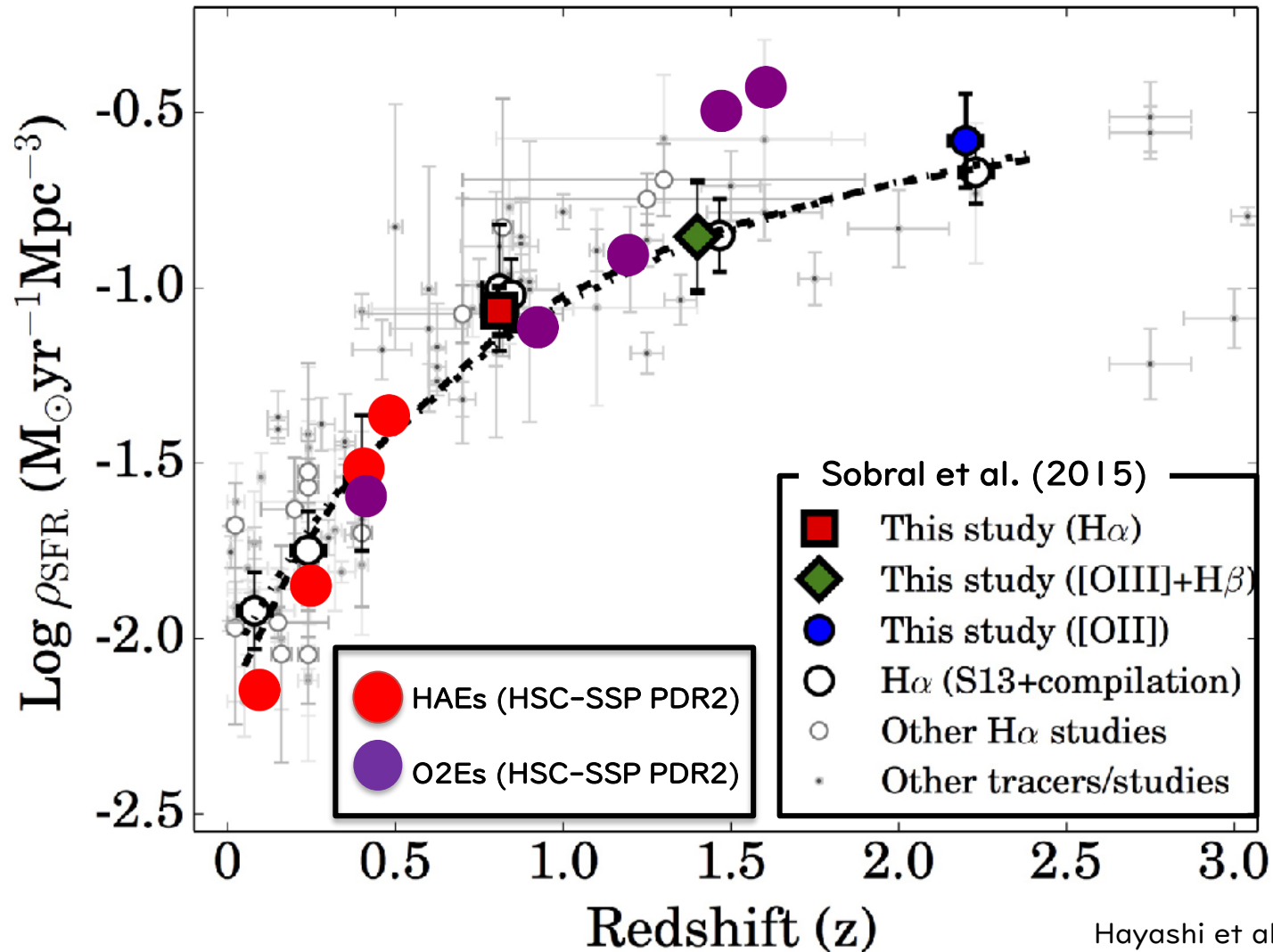
NB101 data are not available yet.

(2) Additional NB filters available (SSP+CHORUS)

CHORUS is an intensive open-use program to conduct imaging observations with several NB filters in SSP-UD fields

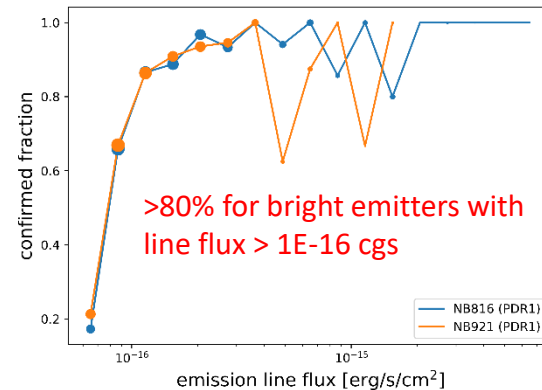


The measurements from our study are plotted on the figure of Sobral et al. (2015)



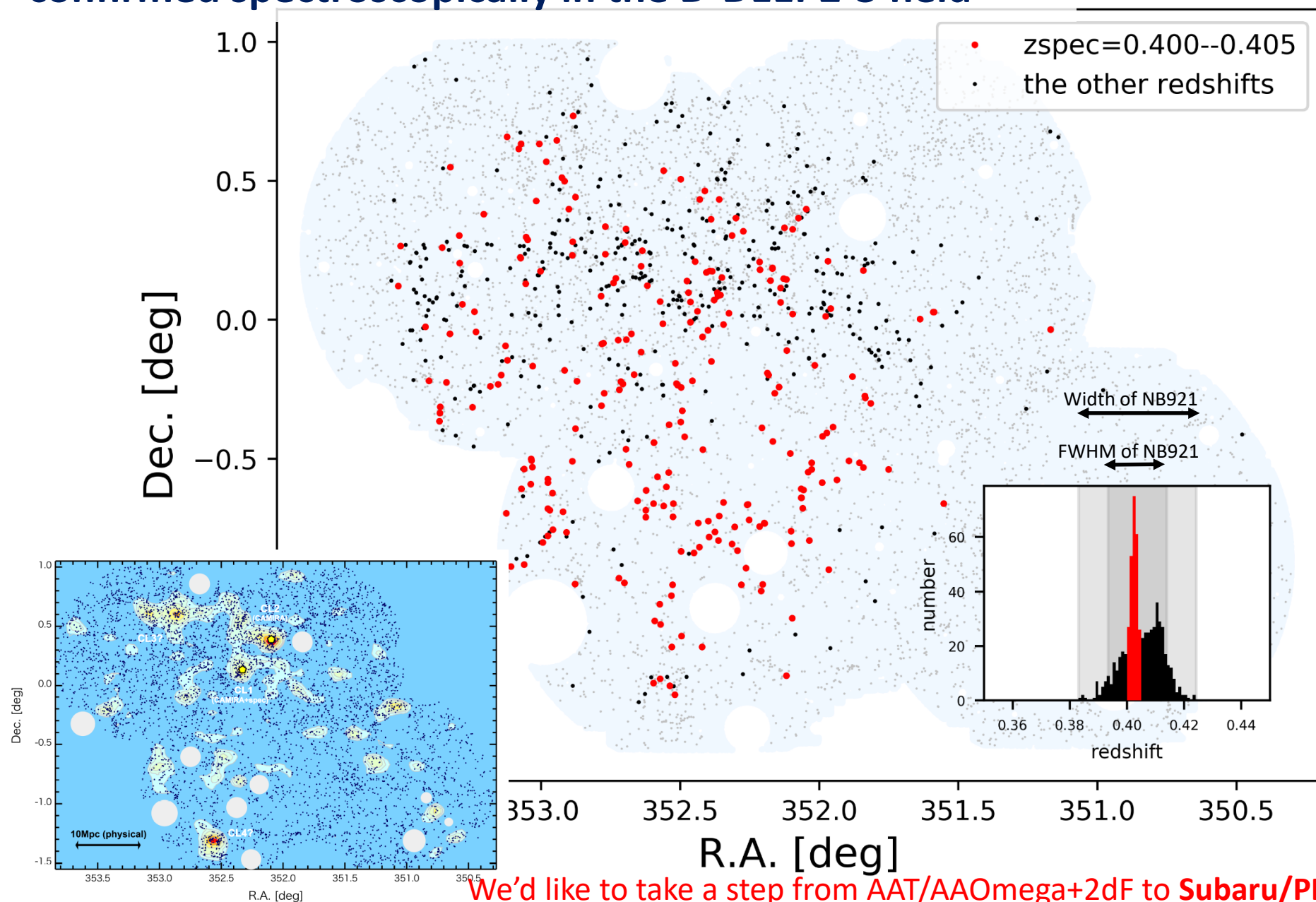
NB816/NB921/NB973 emitters
in the UD-SXDS field

Hayashi et al., in prep



Large-scale structure of H α emission-line galaxies confirmed spectroscopically in the D-DEEP2-3 field

Hayashi et al., in prep



Summary

- HSC is a powerful instrument to reveal the large-scale structures including galaxy clusters, galaxy groups, filaments, and voids.
- Emission-line galaxies selected by HSC narrow-band imaging allow us to do a tomographic mapping of large-scale structures at different redshifts without an effect of projection.
- Spectrograph with both large FoV and multiplicity features such as AAT/AAOmega+2dF and Subaru/PFS is very useful to confirm the large-scale structures and then investigate an environmental dependence of galaxy properties.

