SWIMS Science Workshop (2015/9/17-18 @IoA)

& Medium-

SWIMS-18 Narrow-Band Survey Near and Far

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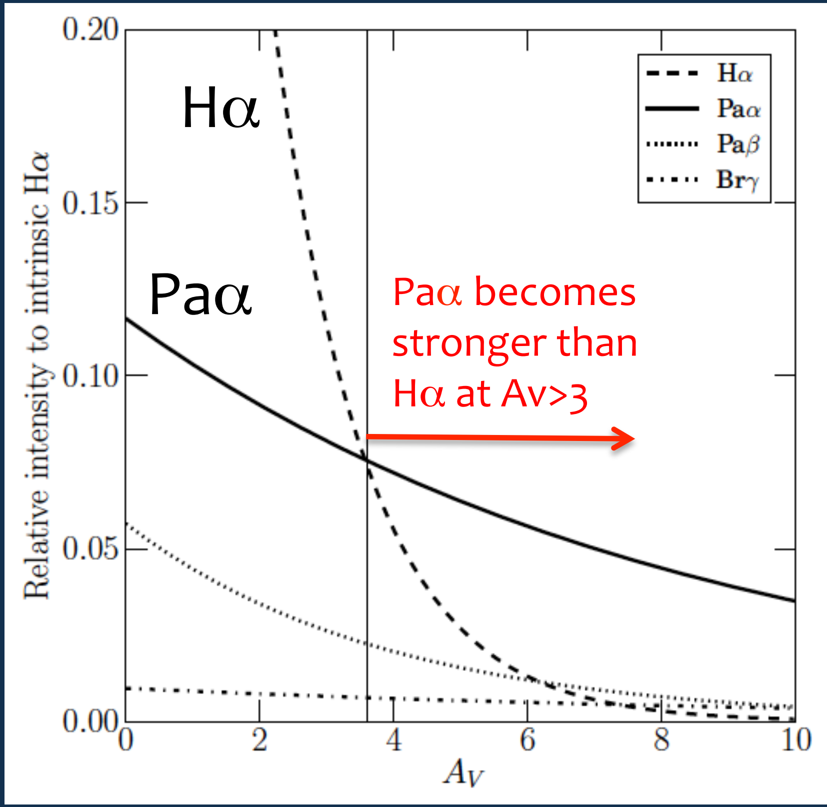
Outline (proposal)

1. Pa-α imaging of ~3000 nearby SF galaxies
2. ~10-deg^2 SWIMS-18 medium-band survey

PARADISES-SWIMS :

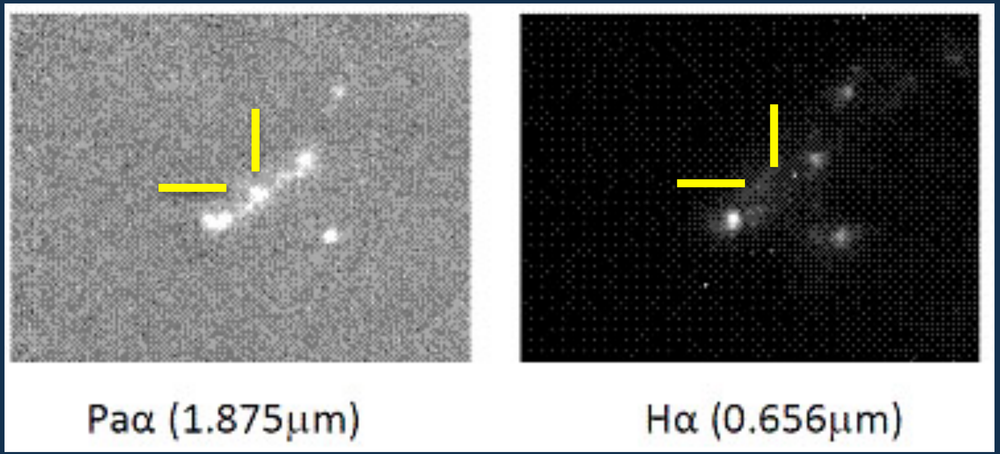
Pa-Alpha Resolved Activity and Dynamics of Infrared Selected Extreme Starbursts with SWIMS

Why Pa-α (λ=1.875um) ?



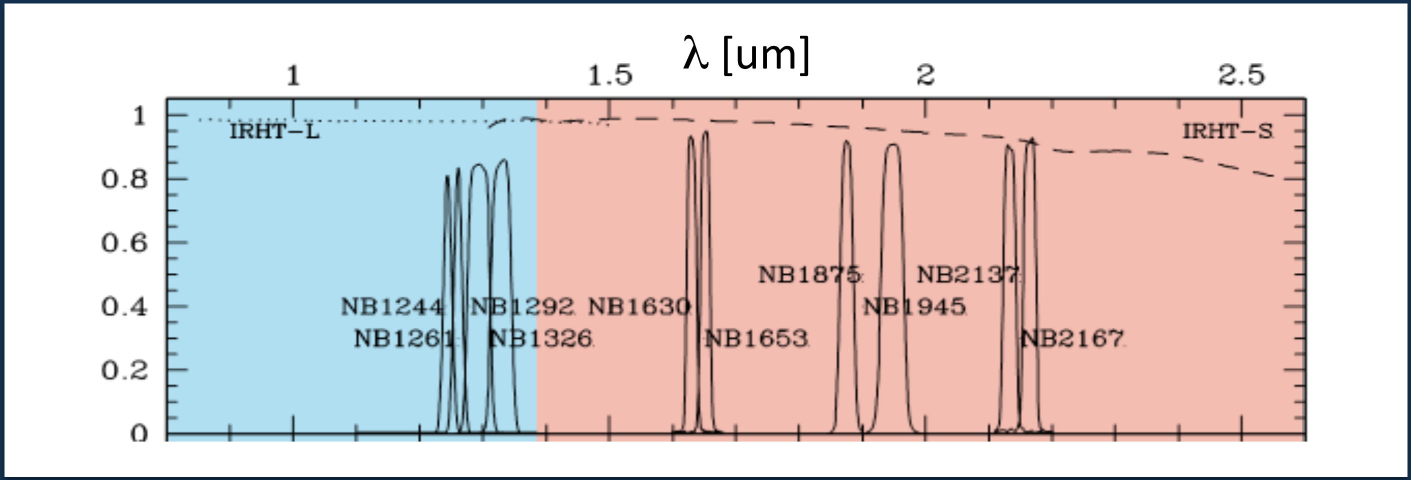
K. Tateuchi (PhD thesis, 2014)

- (Almost) free from dust extinction compared with UV, [OII], Hα, etc.
- MIR-FIR observations (from space) always suffer from their poor spatial resolution.
- Paα is ideal tool to spatially resolve dusty SF regions within galaxies.



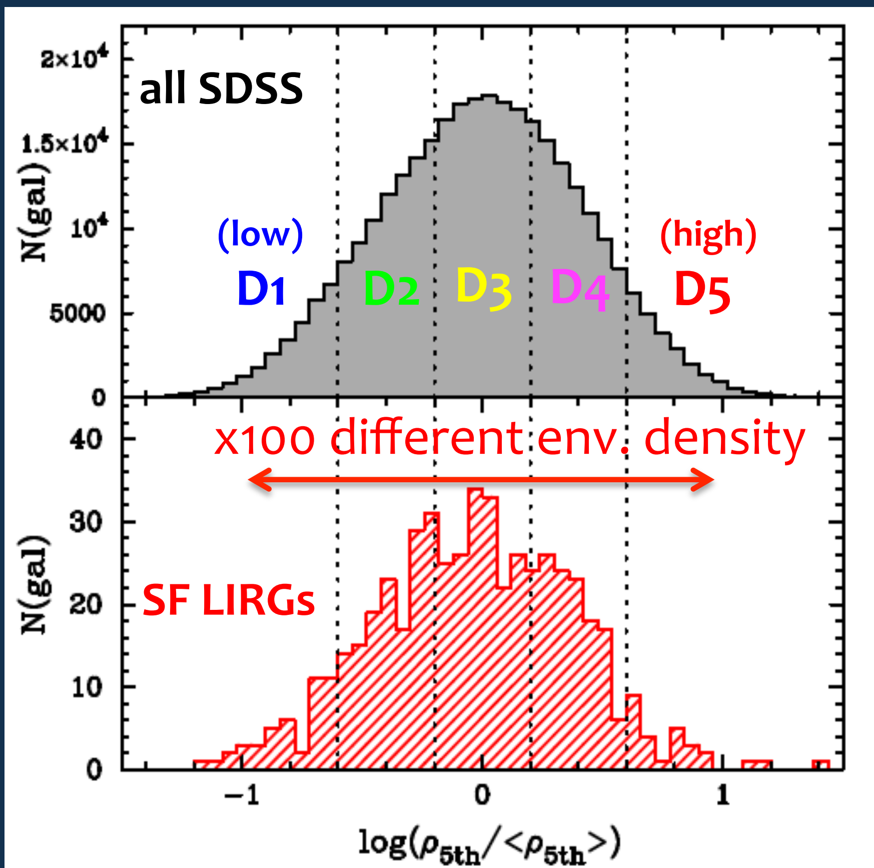
ANIR/mini-TAO observation of "Taffy-I" by Komugi et al. (2012)

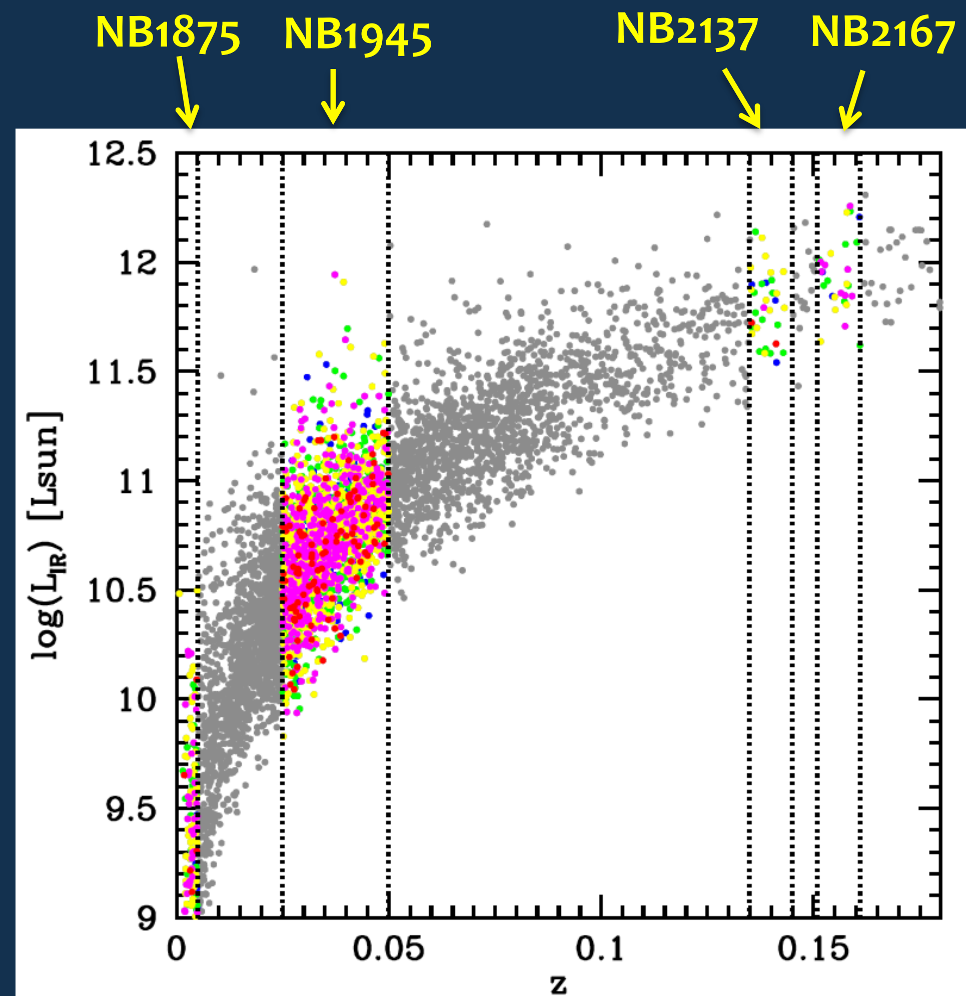
SWIMS NB filters



NB name	λc [um]	Δλ	z(OII)	z(Hβ)	z(OIII)	z(Hα)	z(Paα)
NB1244	1.244	0.012	2.337	1.559	1.484	0.895	--
NB1261	1.261	0.012	2.384	1.595	1.519	0.922	--
NB1630	1.630	0.016	3.374	2.354	2.256	1.484	--
NB1653	1.653	0.016	3.436	2.401	2.302	1.519	--
NB1875	1.875	0.020	4.031	2.857	2.744	1.857	0.00
NB1945	1.945	0.040	4.219	3.001	2.885	1.964	0.037
NB2137	2.137	0.021	4.734	3.396	3.268	2.256	0.140
NB2167	2.167	0.021	4.814	3.458	3.328	2.302	0.156

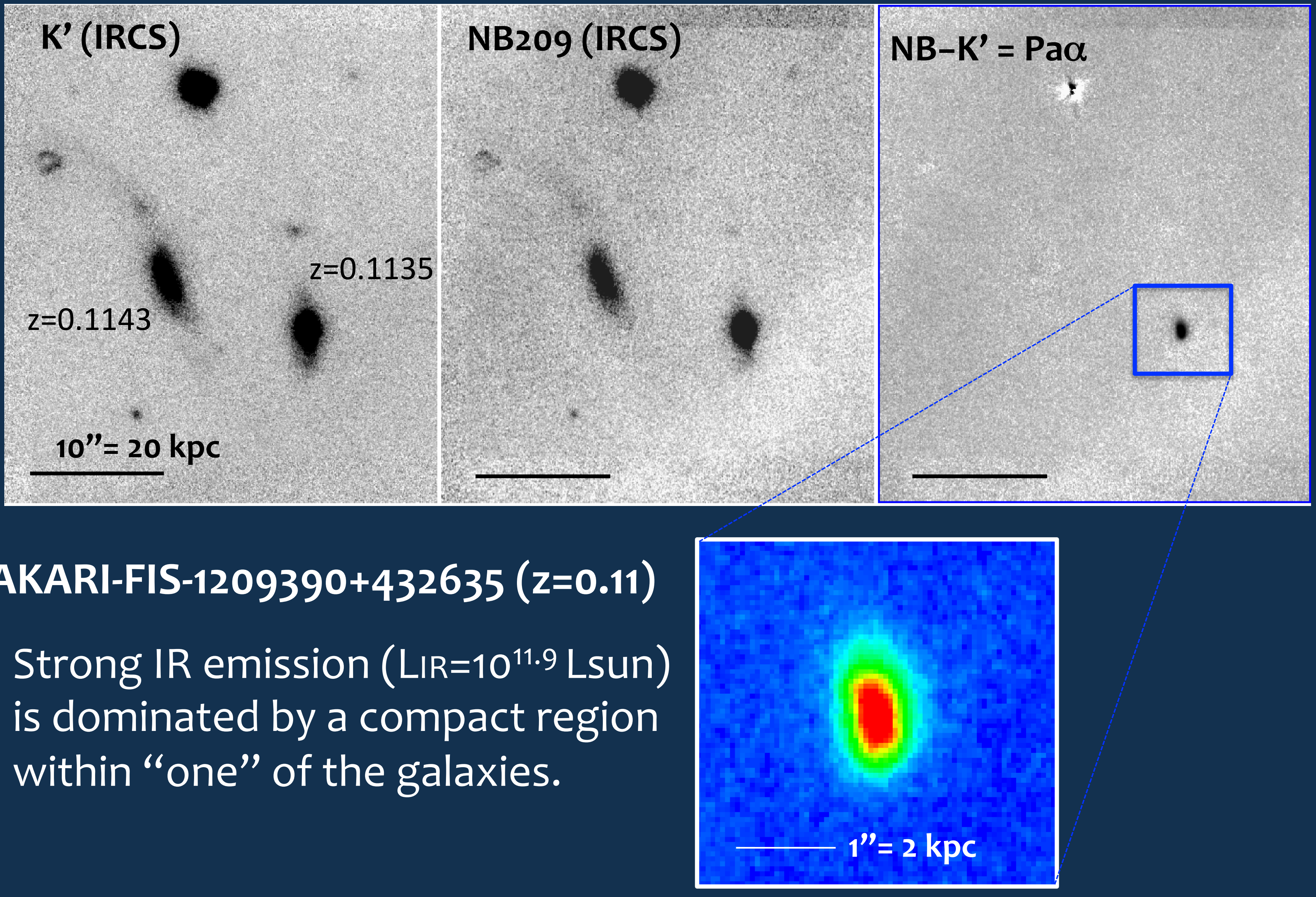
IR galaxies in all environment





We can select IR galaxies from wide environment & IR luminosity.

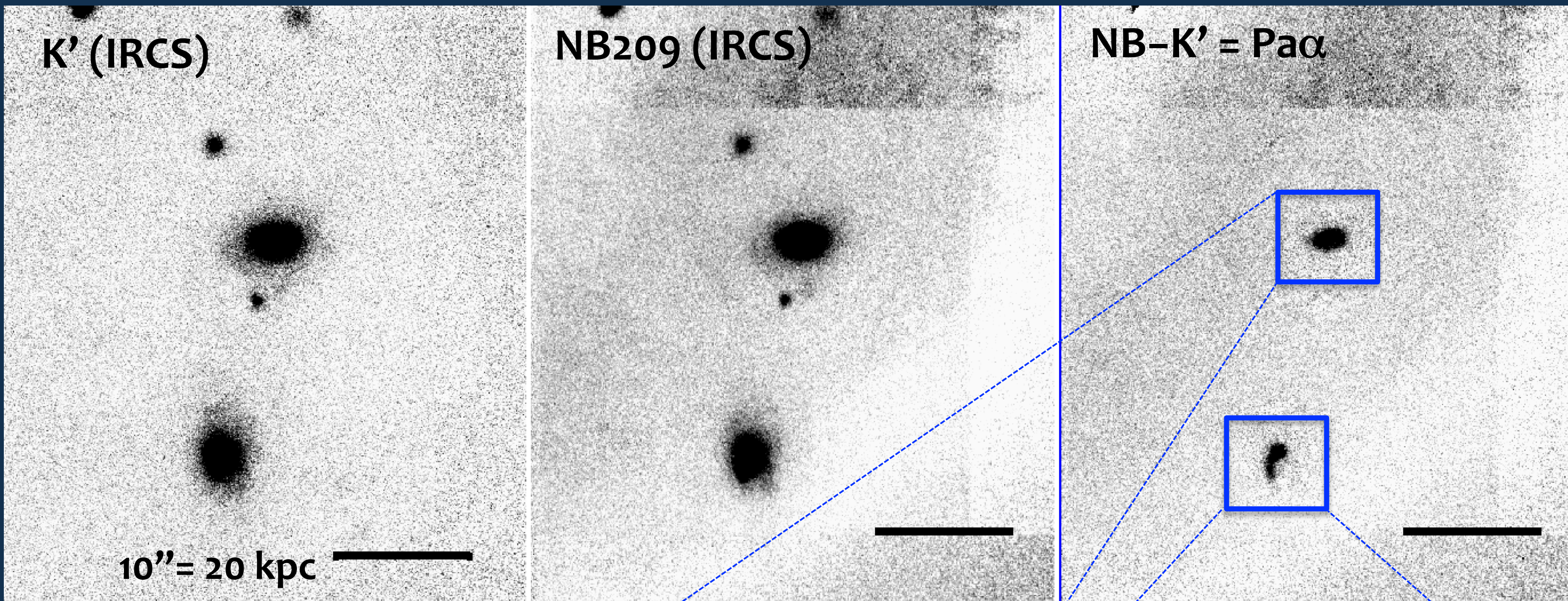
Our experience with IRCS/MOIRCS



AKARI-FIS-1209390+432635 (z=0.11)

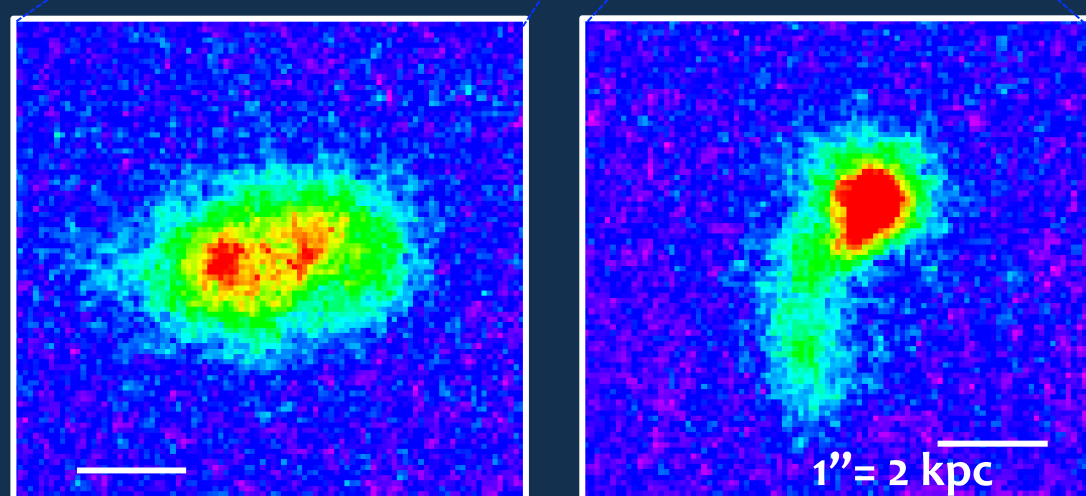
Strong IR emission ($L_{IR}=10^{11.9}$ Lsun) is dominated by a compact region within "one" of the galaxies.

Our experience with IRCS/MOIRCS



AKARI-FIS-1318102+041922
(z=0.11, logLIR=11.9)

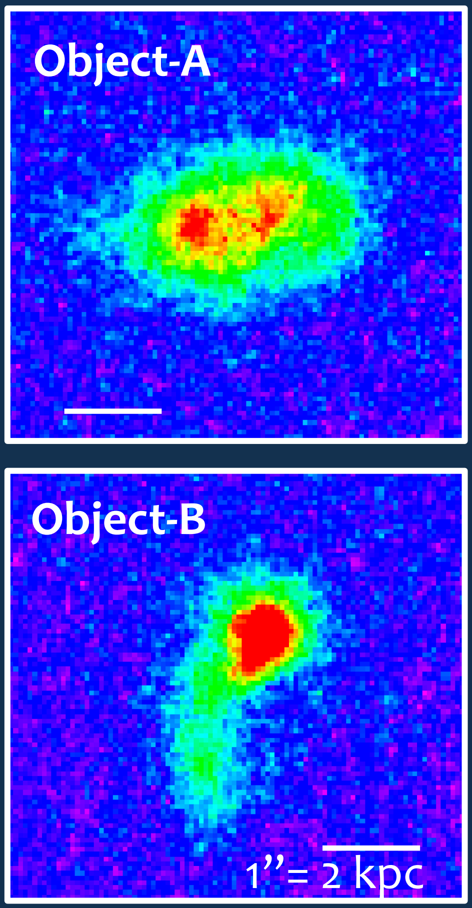
SWIMS-IFU can also unveil their kinematics and "real" geometry of dust extinction via Paα/Paβ ratio.

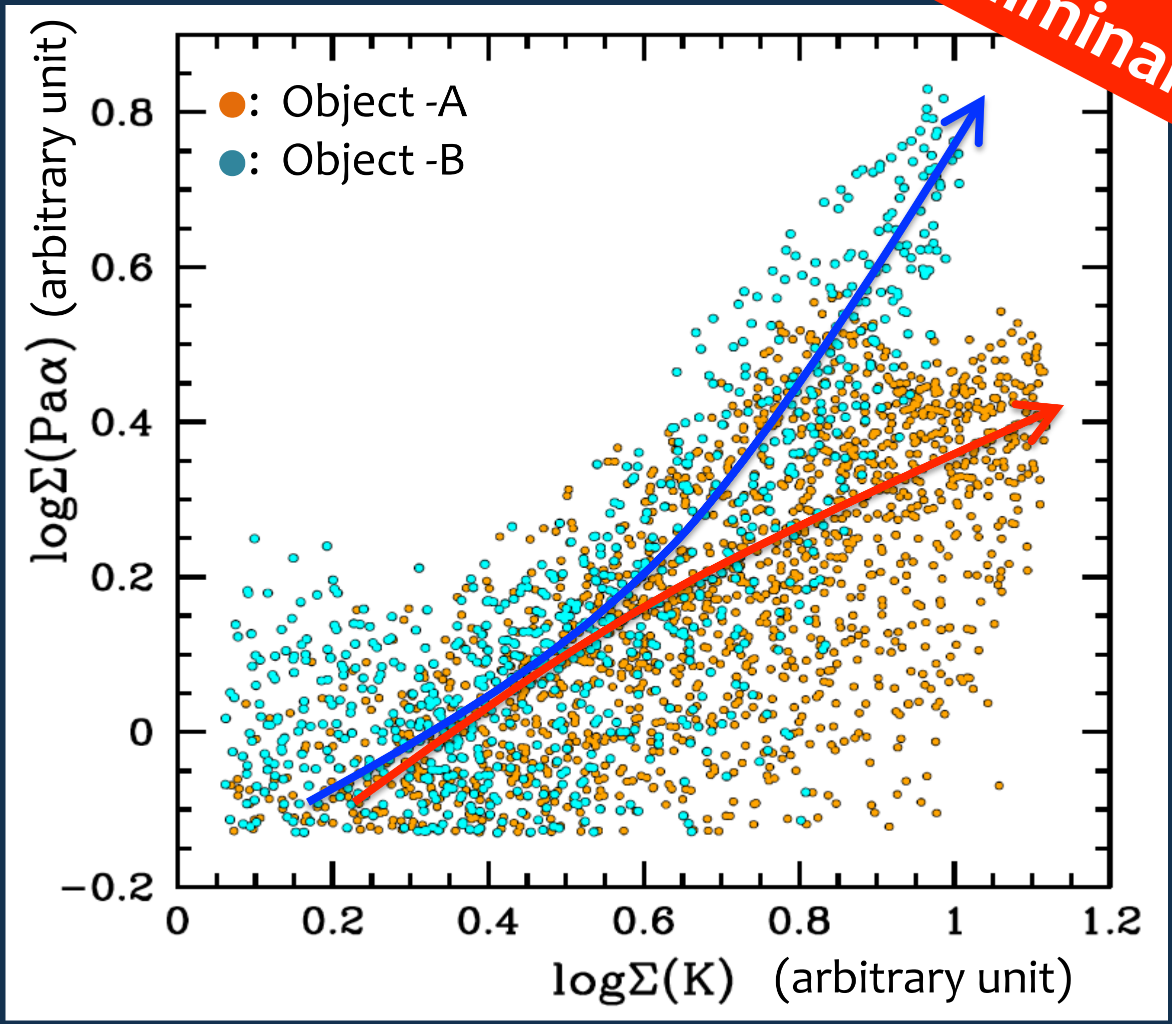


"Pixel-by-pixel" SF Main Sequence

Preliminary

AKARI-FIS-1318102+041922
(z=0.11, logLIR=11.9)





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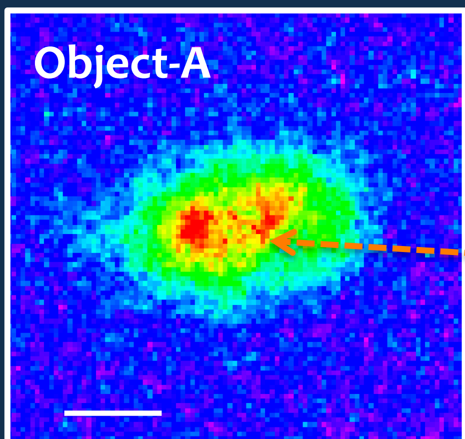
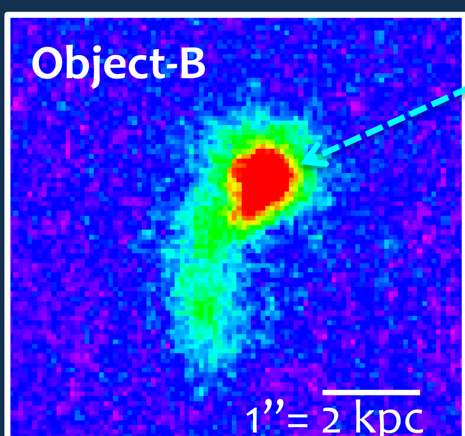
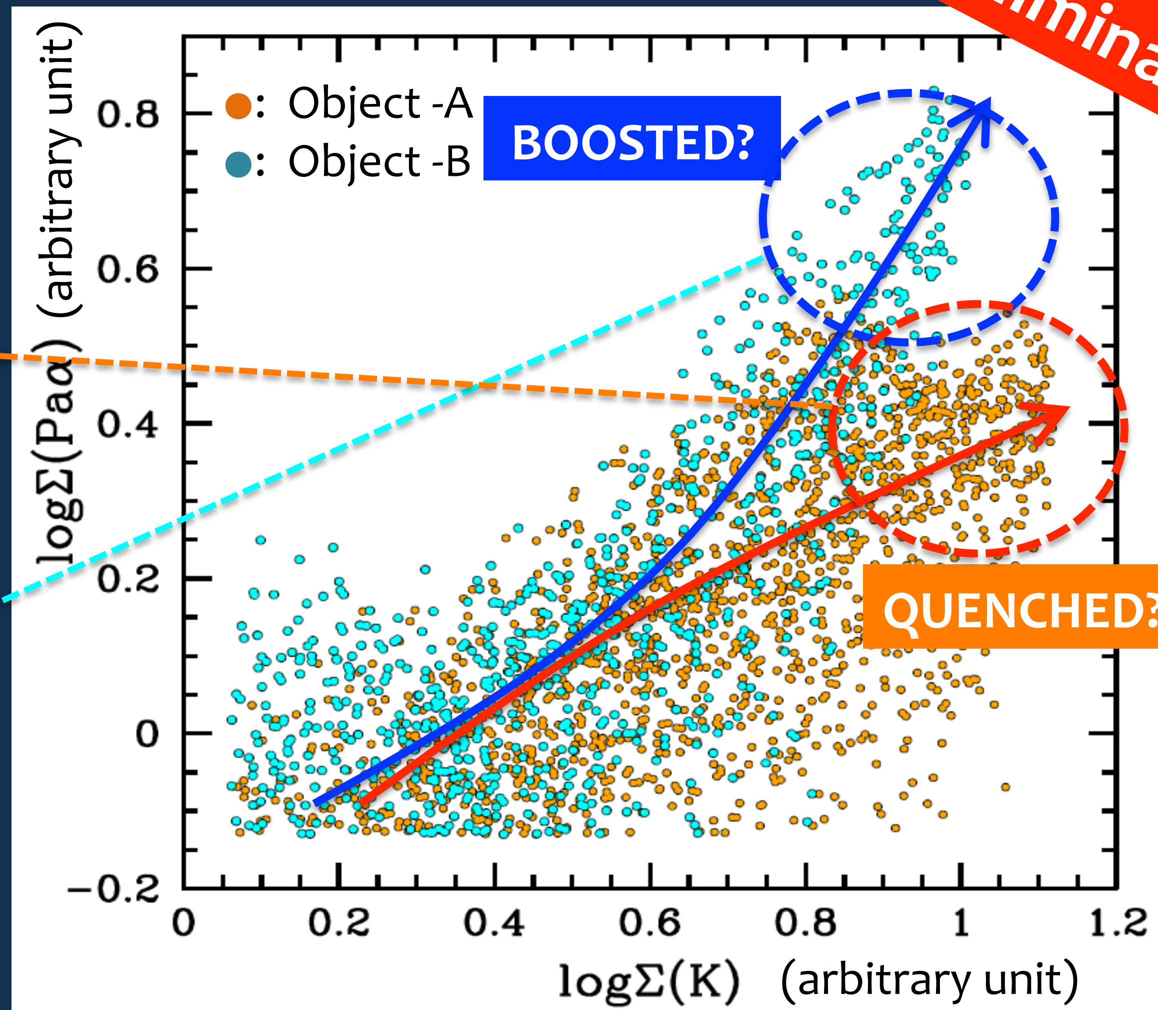






Preliminary

PARADISES survey design

- **Step1 : Paα imaging for ~3000 nearby galaxies**

  (note: SAMI → ~3000 IFU targets, MANGA → ~10000 IFU targets)

  - Highest priority on AKARI sources (i.e. L(IR)).
  - Sample must cover wide environmental range.
  - Sample will be selected widely from SFR-M★ plane.
  - J (10min), K(7min), NB1945 (20min) for each target.
  - 40 min x 3000 targets = **2000 hours**

- **Step2 : IFU follow-up**
  - Assume MANGA/SAMI will do most works in optical range.
  - Focus on VERY dusty ~100 (?) galaxies with e.g. Av>5.
  - 2 hrs x 100 = **200 hours**

Science goals

- Paα size (compactness of SF) vs. environment
  - environmental impacts on SF geometry & mode.
- Paα morphologies along merger sequence
  - IR-selected galaxy sample includes various merger stages
- Effects of AGNs (feedback) on disk SF activity
  - Many AKARI sources accompany AGNs (on BPT diagram).
- Star-forming satellites and environment
  - SWIMS FoV allows to detect faint satellites around the galaxy.

⋮

Strengths

- Huge legacy value in terms of synergy with other big surveys (e.g. SDSS, 2dF, GAMA, SAMI, MANGA, AKARI, GALEX, ALFALFA, COLD-GASS, …)

  - Remember: most of these "big" surveys target $z \sim 0.05$ galaxies.

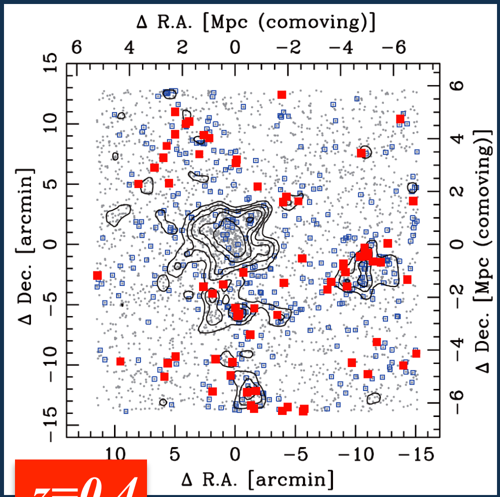
- Low-z ($z<0.05$) Paα is NOT observable from other ground based telescopes – we can take full advantage of the TAO site !
- Assuming that TAO can devote a large amount of time for "SURVEY" programmes, this low-z Paα survey is ideally suited for TAO.

High-z galaxy survey with SWIMS?

I think NB survey alone cannot provide key science for SWIMS high-z study, but the availability of medium-band filters will make SWIMS extremely unique for high-z galaxy survey.

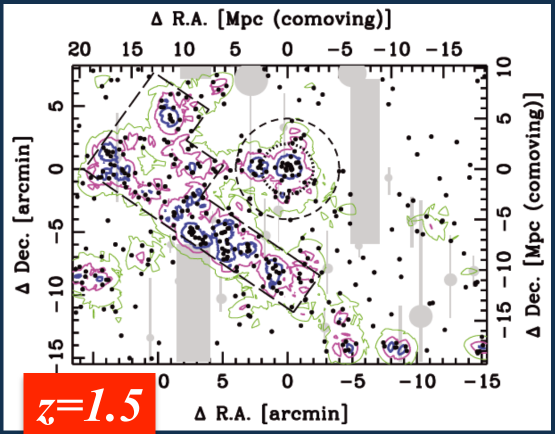
MAHALO-Subaru

MApping H-Alpha and Lines of Oxygen with Subaru (PI: T. Kodama)



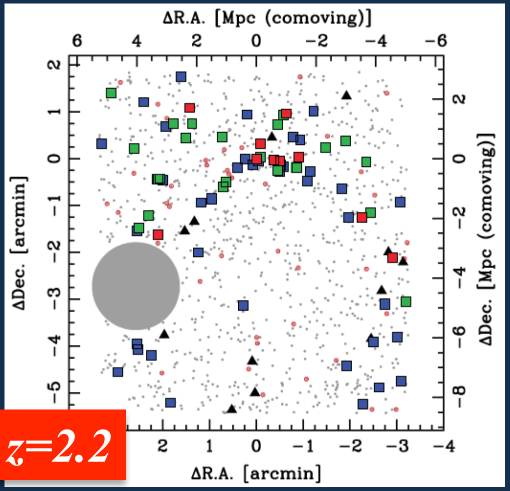
z=0.4

(Koyama+11)



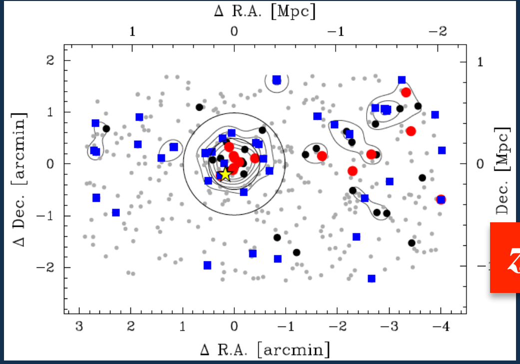
z=1.5

(Hayashi+10, 11)



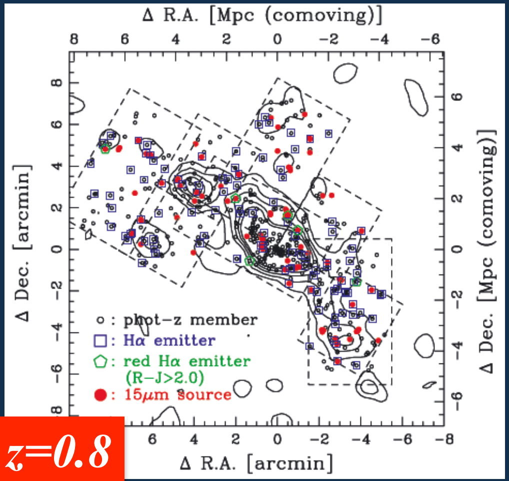
z=2.2

(Koyama+13)



z=1.5

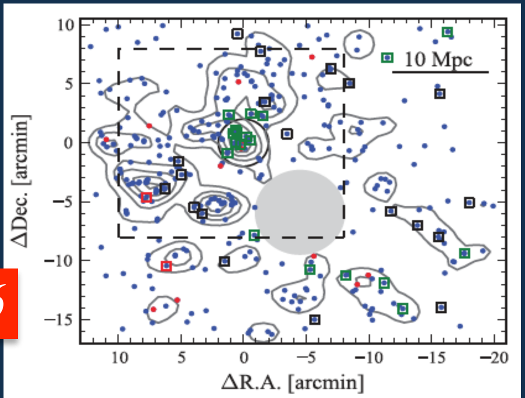
(Tadaki+12)



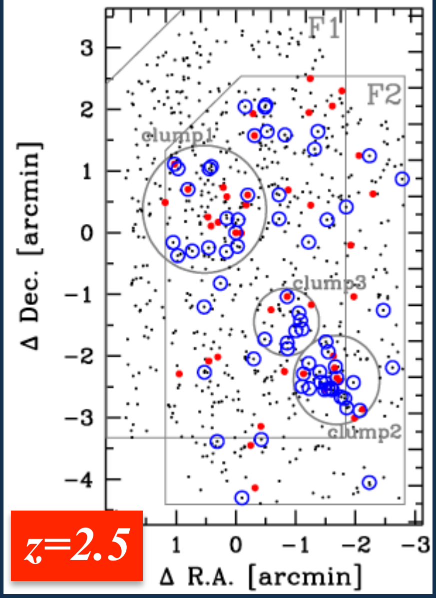
z=0.8

(Koyama+10)

(Koyama+14)



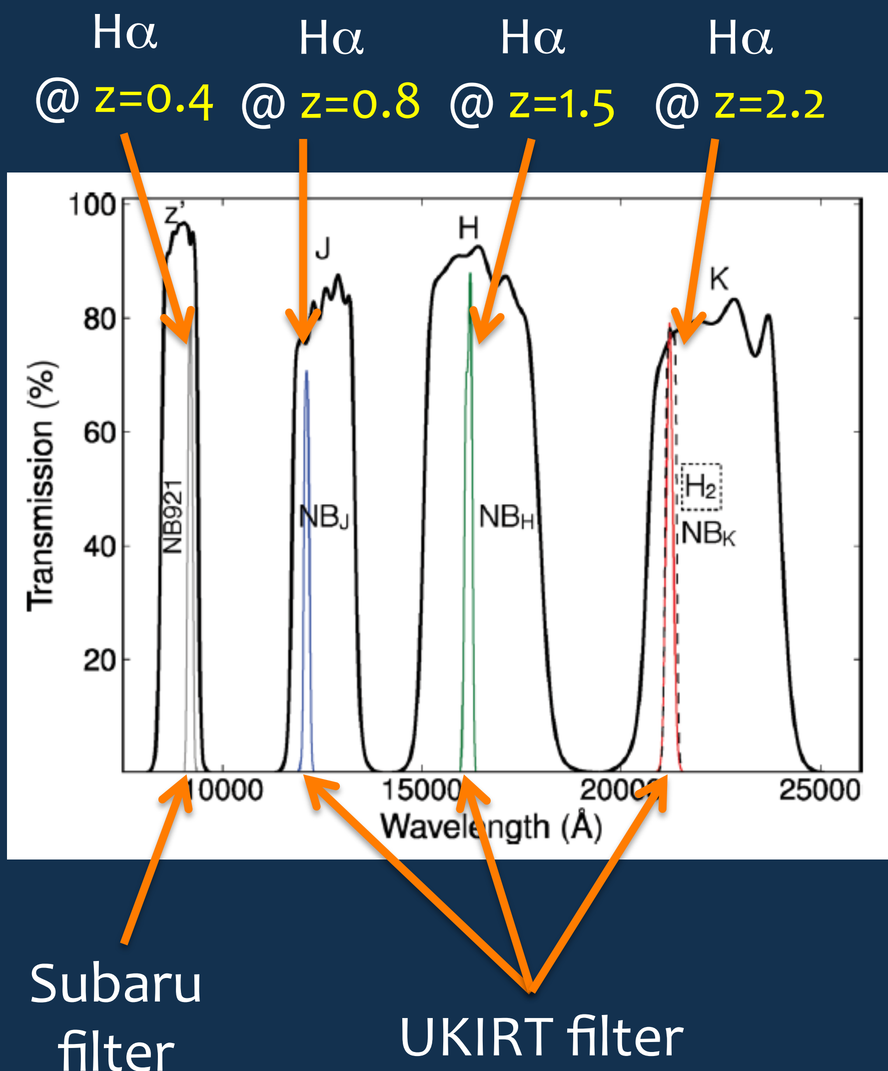
z=1.6



z=2.5

(Hayashi+12)

HiZELS: *High-Z Emission-Line Survey*



Total ~2 deg^2 survey in COSMOS & UDS

now further extending the survey area.

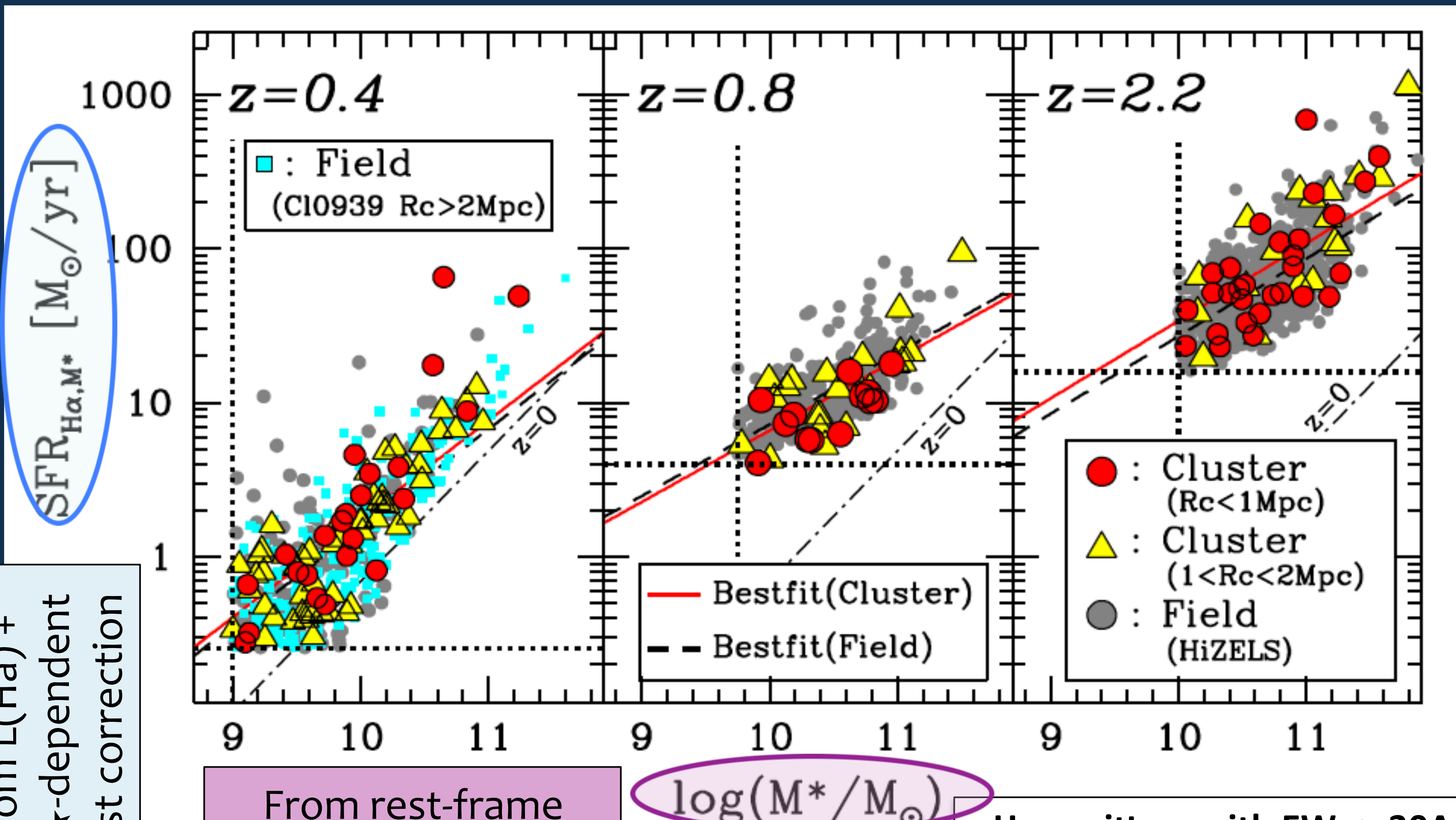
Filter NB	Field C/U	Detect (3σ)	W/colours #	Emitters (3Σ)	Stars #	Artefacts #	Hα #
NB921	C	155 542	148 702	2819	247	–	521
NB921	U	236 718	198 256	6957	775	–	1221
NB_J	C	32 345	31 661	700	40	46	425
NB_J	U	21 233	19 916	551	49	30	212
NB_H	C	65 912	64 453	723	60	63	327
NB_H	U	26 084	23 503	418	23	5	188
NB_K	C	99 395	98 085	1359	78	56	588
NB_K	U	28 276	26 062	399	28	10	184
H_2	C	1054	940	52	3	2	31
H_2	U	1193	1059	33	7	1	14

~500-2000 Hα emitters at each redshift, providing excellent comparison sample for our MAHALO cluster samples.

Sobral et al. (2013)

MAHALO (cluster) vs. HiZELS (field)

The MS location is always independent of environment since z~2



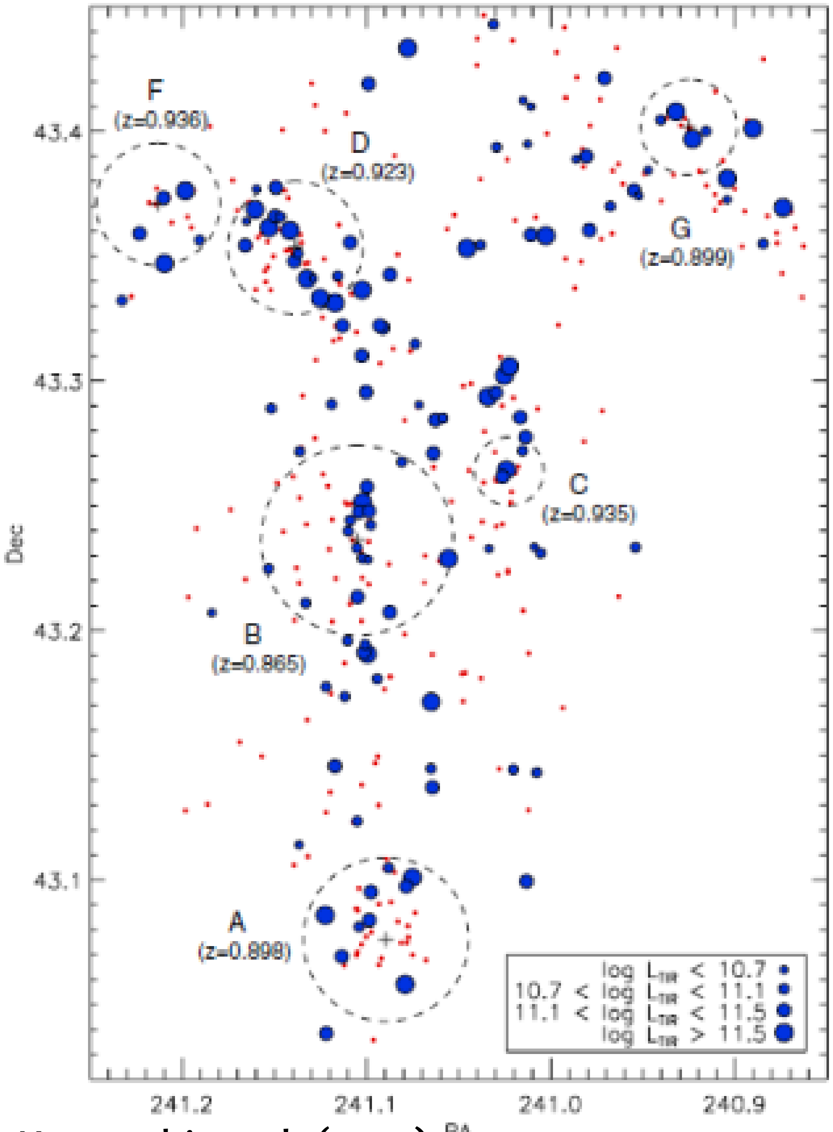
From L(Ha) +
M★-dependent
dust correction

From rest-frame
R-band photometry
+ M/L correction

Hα emitters with EWr > 30A

(Koyama et al. 2013, MNRAS, 434, 423)

Good for some special targets…



Kocevski et al. (2011)

CL1604+43
(z=0.895, 0.922)

NB1244

NB1261

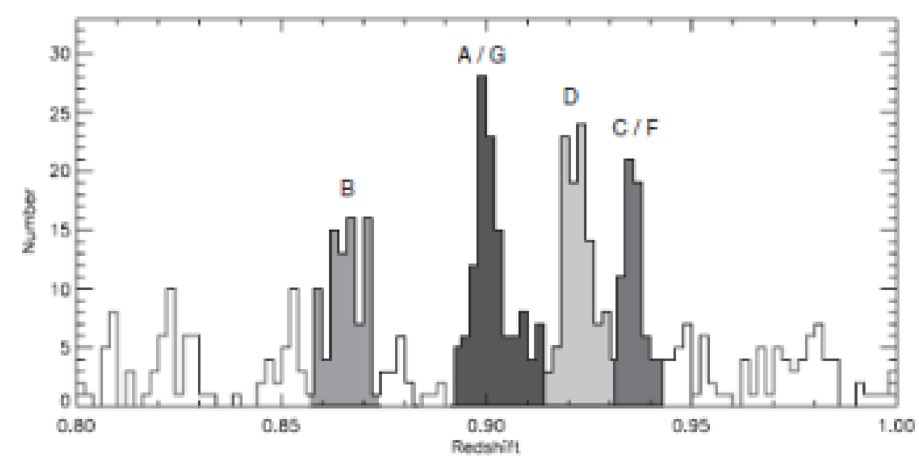


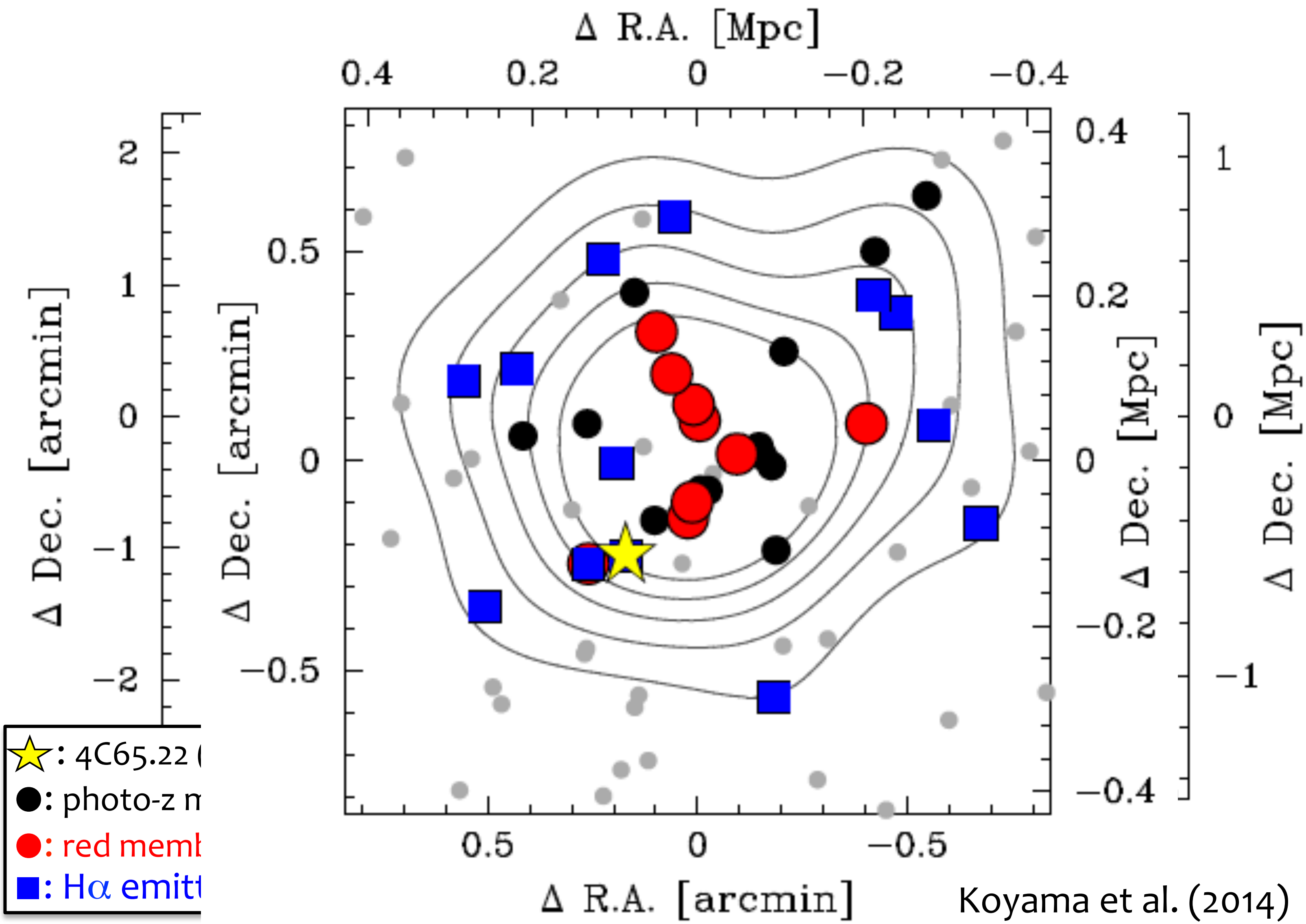
Figure 2. Redshift distribution of the Cl1604 supercluster.

Table 1
Properties of Galaxy Clusters and Groups in the Cl1604 Supercluster

ID	Name	R.A. (J2000)	Decl. (J2000)	z	σ_v (km s^{-1})	R_{vir} arcmin/(h_{70}^{-1} Mpc)	N_{gal} ($R < 2R_{vir}$)
A	Cl1604+4304	241.097473	43.081150	0.898	703 ± 110	1.969/0.92	40
B	Cl1604+4314	241.105050	43.239611	0.865	783 ± 74	2.261/1.05	62
C	Cl1604+4316	241.031623	43.263130	0.935	304 ± 36	0.824/0.39	13
D	Cl1604+4321	241.138651	43.353430	0.923	582 ± 167	1.594/0.75	60
F	Cl1605+4322	241.213137	43.370908	0.936	543 ± 220	1.470/0.70	16
G	Cl1604+4324	240.925080	43.401718	0.901	409 ± 86	1.143/0.53	15

(From Kodama-san's presentation)

Beyond MAHALO-Subaru?

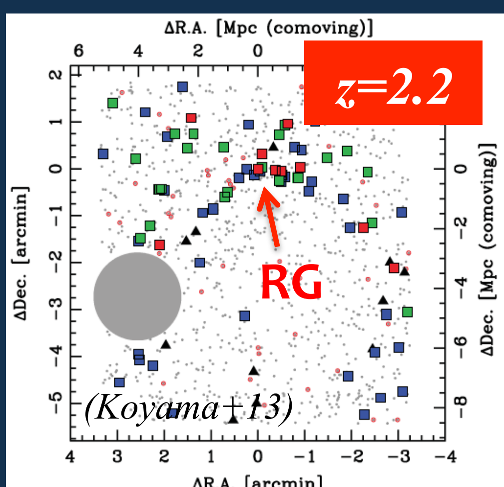


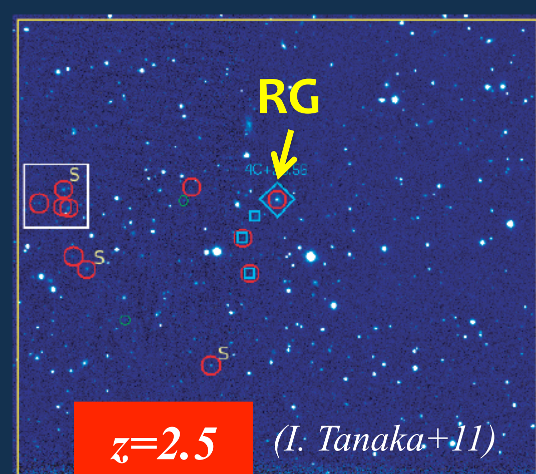
Koyama et al. (2014)

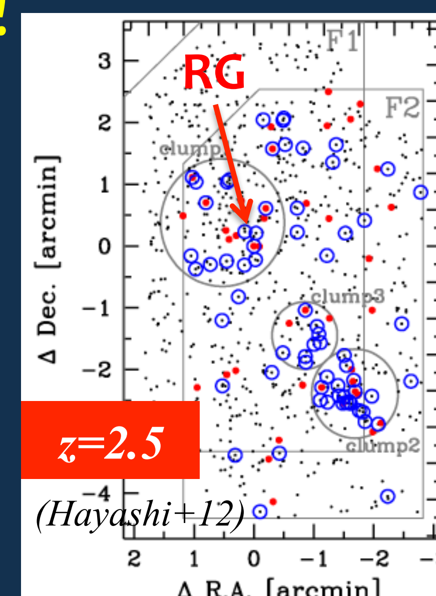
Beyond MAHALO-Subaru?

- NB survey is a very powerful tool for selecting SF galaxies, but no information for non-SF galaxies.
  - spectroscopy: hard, broad-band photo-z: not very reliable.
- Most of our "cluster" targets at z>2 are HzRG field, which brings more bias for our understanding.

→ Deep & panoramic MEDIUM-BAND survey with SWIMS to map both SF/non-SF gals out to z~5 !



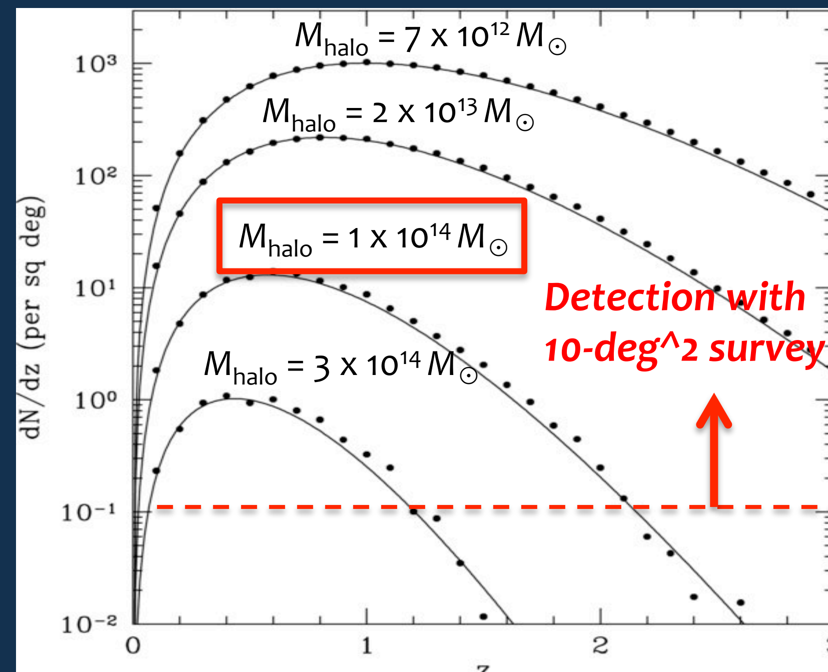




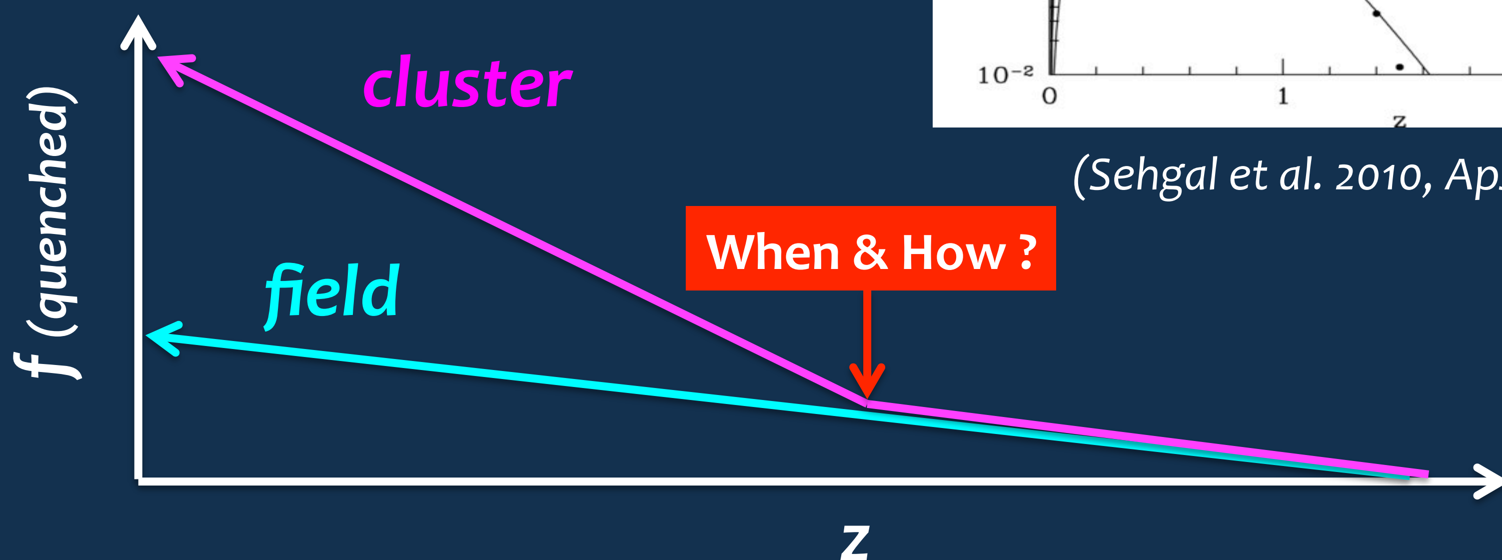
Proposal & Science goals

- 10-deg^2 survey with full 9 medium bands of SWIMS.

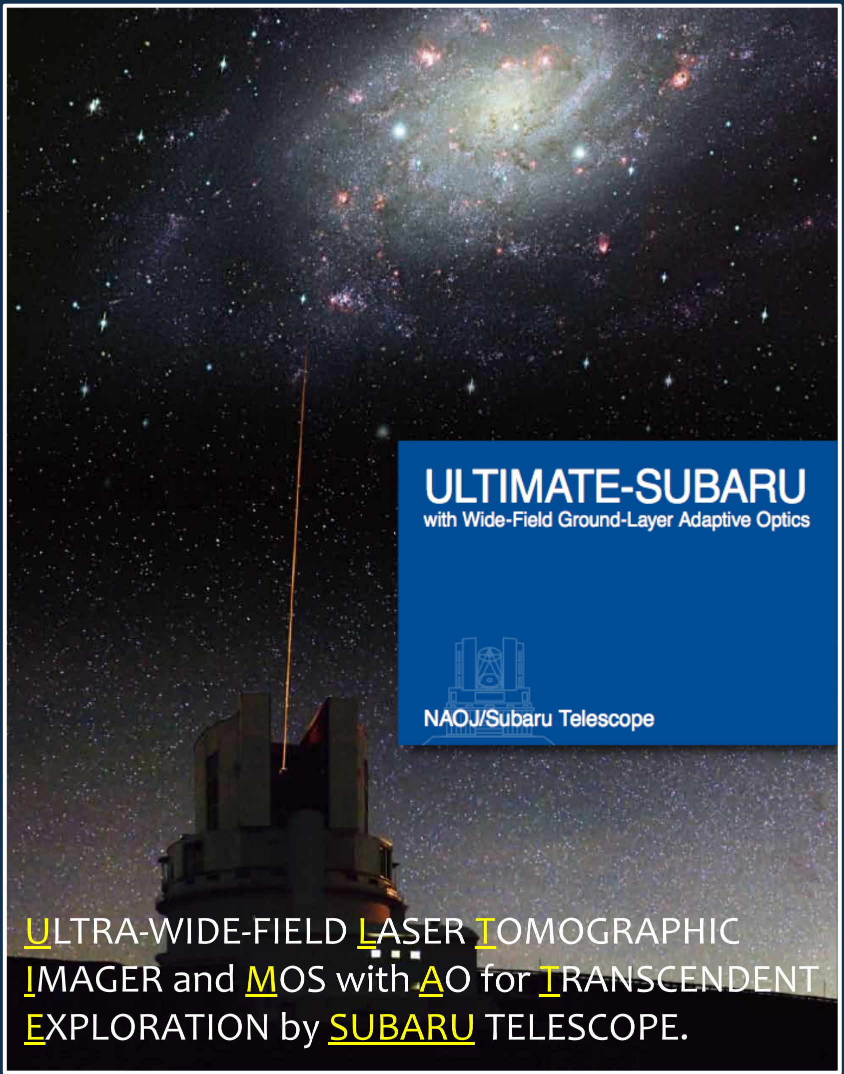
  (e.g. 5hr x 360 ptg = 1800 hrs)
- Complete census of relative fraction of “passive” and “SF” galaxies out to z>3.



(Sehgal et al. 2010, ApJ, 709, 920)



ULTIMATE-Subaru



- Next-gen AO system for Subaru in 2020s (GLAO).
- ~0.2" spatial resolution (@K-band) across ~15' FoV.
- Factor ~2-3x improvement in PSF size and sensitivity.
- Huge area + medium-deep survey with SWIMS/TAO
- High-resolution + ultra-deep follow-up "SURVEY" with Subaru ! (imaging and/or spectroscopy)

Summary

- SWIMS NBs can provide an unique opportunity for low-z Pa-α survey. I believe it should become one of the "legacy" survey plans for SWIMS.
- SWIMS NBs can also be used for Hα survey of some high-z "special" targets (e.g. clusters), but there already exist similar big surveys, and so I guess NB survey alone won't be the KEY high-z science.
- Huge-area medium-band survey will be the most powerful point of SWIMS legacy survey. My particular interest is to identify the first appearance of environmental effects on galaxies, by tracking down the relative fraction of passive/SF galaxies out to z~5.