Properties of Large Equivalent Width Objects

SSA22 AT Z=3.1

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Our wide-area (2.4deg^2 in total) and deep narrow-band survey detected ~2000 LAEs and reveal that there are a number of large EW objects in "SSA22" and general fields EW_0>=240Å; 240 LAEs at SSA22, 95 LAEs at general fields). In order to discriminate the origin of large EW objects, first we should make large EW samples which include objects enhanced for EW by mechanism of Lyman alpha scattering and/or galactic superwind. We measured the both Lyman alpha emission and continuum components by pseudo total magnitude (2.5 × kron radius of SExtractor software) as the Lyman alpha emission of these objects have extended shape. (Noteworthy, we measured Lyman alpha emission and continuum within a given aperture in previous work. When we focus on the EW at the exact position where the star-formation occur to know the stellar age, this measurement is effective.) In results, we found the larger number of high EW objects by this method than that by previous method and the ratio of large EW objects (EW_0=400-700Å) to small EW objects (EW_0<100Å) is 1.6 times larger in "SSA22" fields than general fields. Furthermore we investigate the statistic properties of these objects such as the size of Lyman alpha emission, Luminosity Function and colors.

1. Observation

We conducted wide-area (2.4deg2 in total) and deep narrow-band survey with Suprime-Cam of Subaru Telescope.

Field	Number of LAEs	Volume (Mpc^3)	Density (Mpc^3)
SSA22	1438	9.9 * 10^5	1.4 * 10^{-3}
General Fields	764	7.7 * 10^5	0.99 * 10^{-3}
SDF	196	1.6 * 10^5	1.2 * 10^{-3}
GOODS-N	186	1.9 * 10^5	0.98 * 10^{-3}
SXDS	382	4.2 * 10^5	0.90 * 10^{-3}

Number density of LAEs in SSA22 region is 1.5 times larger than it in general fields.

SSA22 region is a high-density region of LAEs

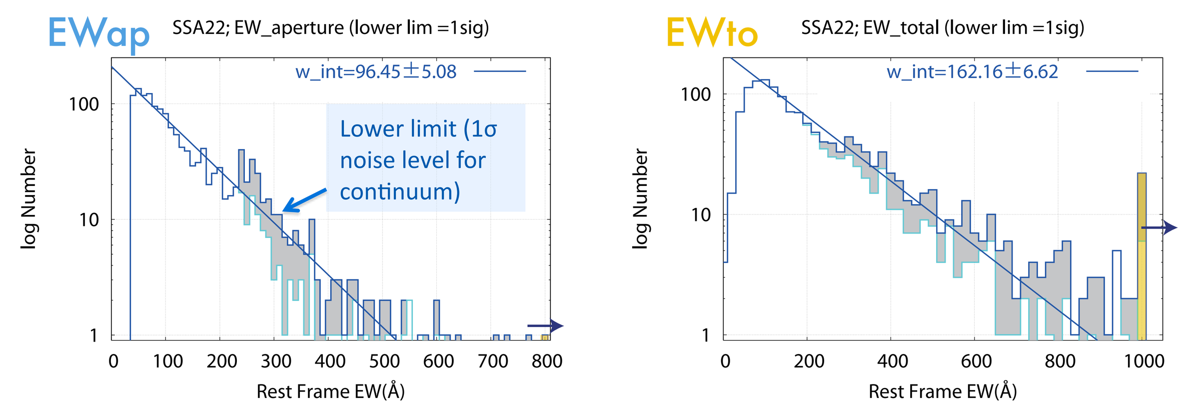
2. Calculation of EW

We calculated EW of our detected LAEs by two methods.

If Lyα photons emitted from star-forming regions are scattered by neutral hydrogen gas and the emission regions are extended,

A) focus on the EW of the exact position where star-formation occurs to know the stellar age
"EWap": EW measured by Lyα emission and continuum fluxes within aperture=2"φ (psf=1".0 at SSA22)

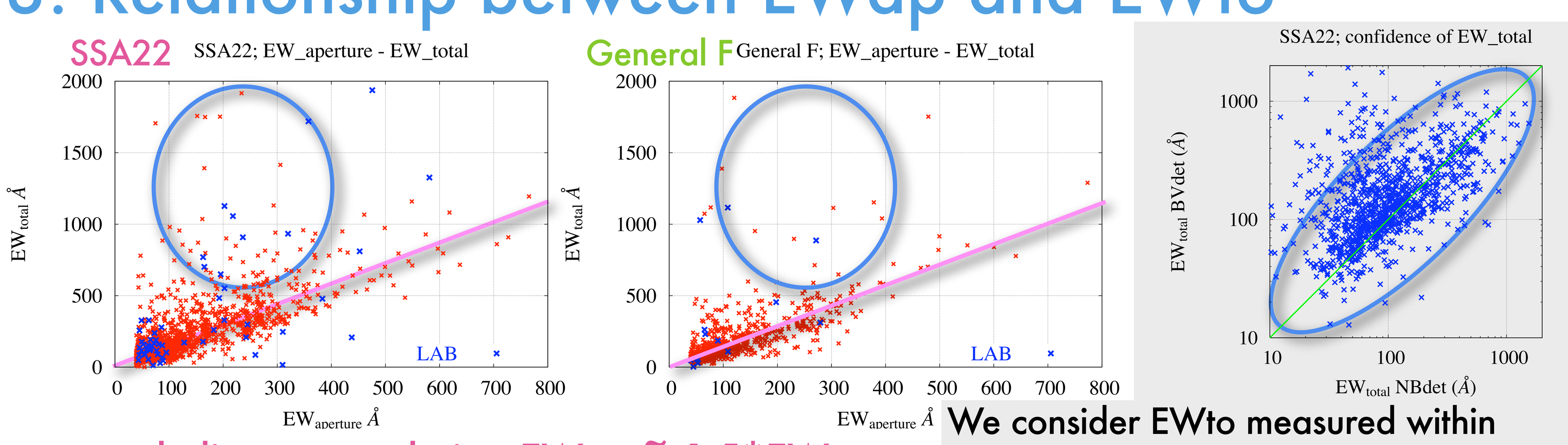
B) include objects enhanced for EW by mechanism of Lyα scattering and/or galactic superwind
"EWto": EW measured by pseudo total magnitudes of Lyα emission (within 2.5*kron radius defined in NB image) and continuum (within 2.5*kron radius defined in BV image)as the Lyα emission of objects have extended shape (using SExtractor)



EWap ≧ 300Å: 104 LAEs
EWto ≧ 300Å: 388 LAEs

Some LAEs have very extended Lyα emission due to Lyα scattering and/or galactic superwind.

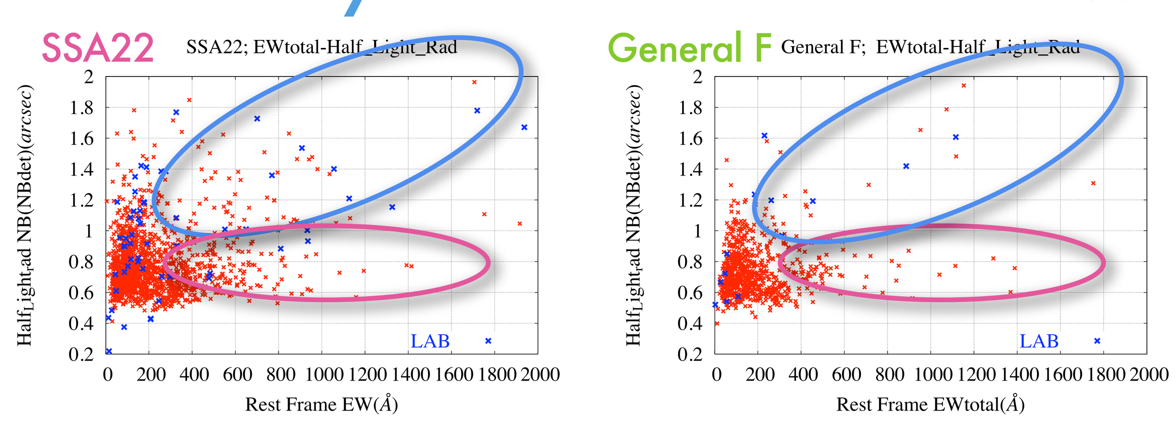
3. Relationship between EWap and EWto



mostly linear correlation EWap ~ 1.5*EWto
→ most LAEs have extended Lyα emission.
objects with extremely extended emission which makes EWto very large.

We consider EWto measured within radius for continuum flux defined in NB image as conservative case(EWtoNBdet).
Most of objects are measured accurately, while some objects are overestimated.
It is necessary to check some large EWto objects.

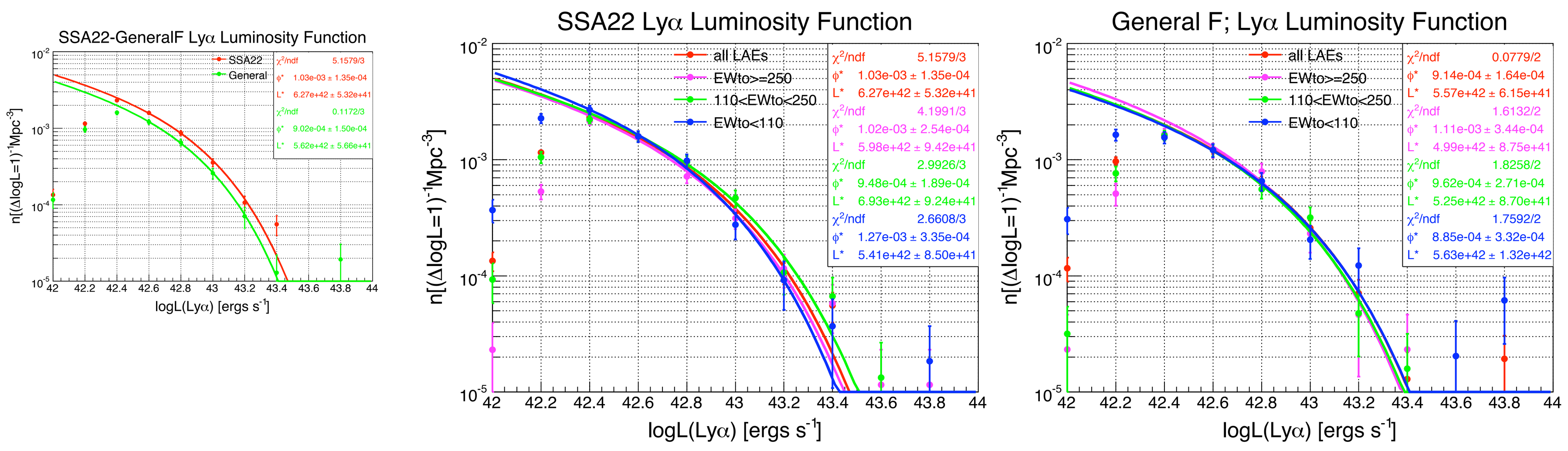
4. Size of Lyα as a Function of EWto



Some large EWto objects have compact Lyα emission,

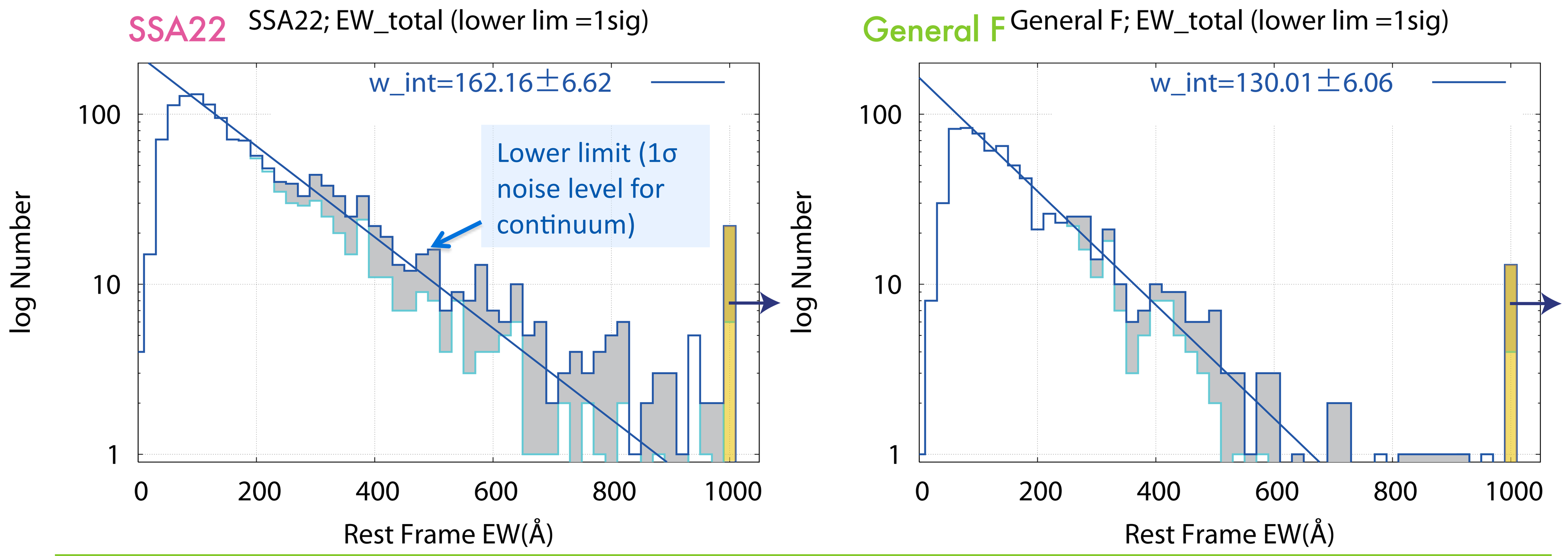
Others have extended Lyα emission.

5. Luminosity Function of Lyα as a Function of EWto



There are no significant differences in the shape of Lyα luminosity function between large EWto objects and small EWto objects.

6. EWto Distribution of LAEs



EWto Distribution in SSA22 have flatter slope than it in General Fields
N = C*exp (-EW/w_0): SSA22 w_0 = 162.16 ± 6.62, General Fields w_0 = 130.01 ± 6.06

Ratio of the LAE number within each range of EWto to that within EWto<100Å

Field	100≦EWto<200	200≦EWto<400	400≦EWto<700	EWto≧700
SSA22	1.11 ± 0.08	0.920 ± 0.066	0.393 ± 0.037	0.170 ± 0.022
General Fields	1.09 ± 0.10	0.709 ± 0.070	0.230 ± 0.034	0.098 ± 0.021

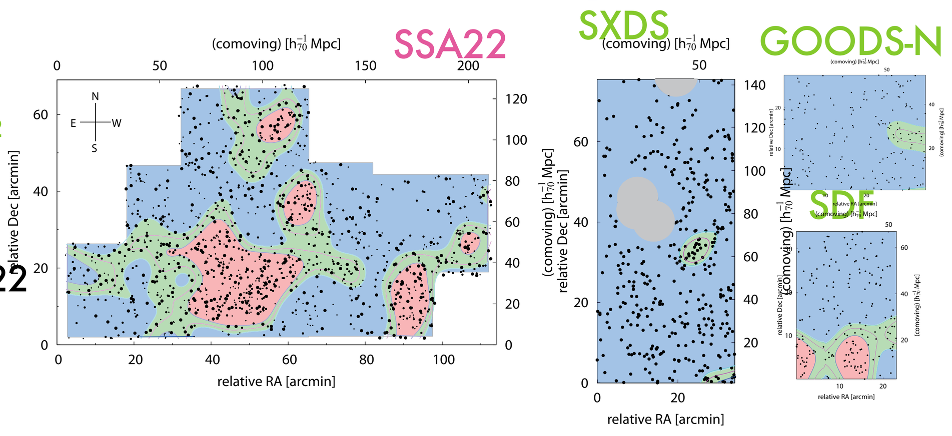
Higher ratio of large EWto LAEs in SSA22 than it in General fields.

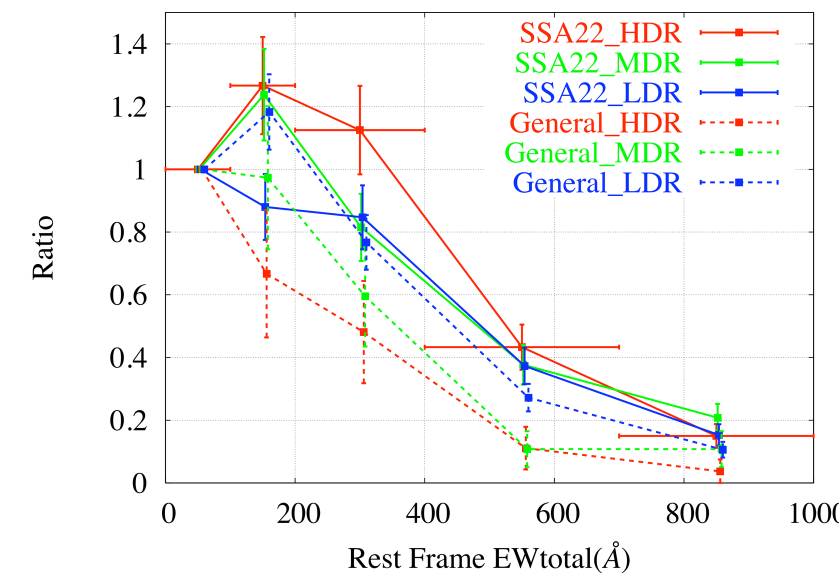
Is the EWto distribution a function of surface density of LAEs
or
Is it an unique characteristic of LAEs in SSA22?
→ We investigate the difference in EWto distribution of samples within given number density range of LAEs.

7. EWto Distribution as a Function of LAE-Density in SSA22

High Density Region: $\rho \geqq 1.15*\rho_{SSA22}$
Medium Density Region: $0.9*\rho_{SSA22} \leqq \rho < 1.15*\rho_{SSA22}$
Low Density Region: $\rho < 0.9*\rho_{SSA22}$

ρ: local number density of LAEs,
ρ_{SSA22}: average number density of LAEs at entire SSA22

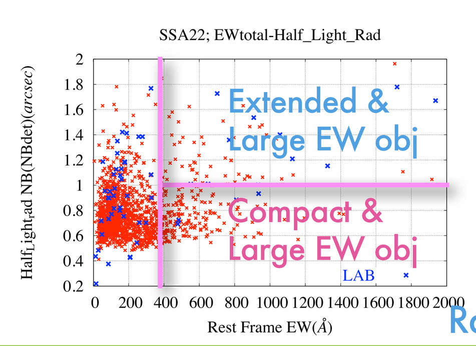




- The most highest ratio of large EWto objects SSA22-HDR.
- No trend is seen in other case.
→ SSA22-HDR → unique region ?

8. Discussion

Characteristics of large EWto objects in SSA22



Among the large EWto objects (EWto ≧ 400Å),
A) Compact Sample
Half_Light_Radius < 1".0
B) Extended Sample
Half_Light_Radius ≧ 1".0

Ratio of the number of LAEs with EWto ≧ 400Å to the number of extended sample

	SSA22	General Fields
Entire Region	**63/225 (0.25±0.04)**	**17/80 (0.21±0.06)**
High Density Region	13/70 (0.19±0.06)	0/4 (0)
Medium Density Region	26/76 (0.34±0.08)	2/8 (0.25±0.20)
Low Density Region	24/79 (0.30±0.07)	15/68 (0.22±0.06)

- No trend of Lyα size toward an increase/decrease in LAE number density.
- More compact sample in HDR than it in LDR???

Hypothesis	Size of Lyα	Lyα - UV size ratio
1. Young / low-metal	compact?	Comparable?
2. Cooling Radiation	extended	More extended than UV?
3. Galactic Wind	extremely extended	Much more extended than UV?

Future work,
to investigate the Lyα - UV size ratio (it is necessary to increase the S/N value of continuum),
the color of large EW objects,
the luminosity function of large EW objects

Summary

We made the large sample of ~2000 LAEs in SSA22 and general fields.
The number density of LAEs in SSA22 region is 1.5 times larger than it in general fields.

We calculated EW of LAEs by two methods: "EWap"- aperture-photometry and "EWto" - total magnitude.
We can newly find a large number of LAEs with high EWto objects which have extremely extended emission.
There are the large EWto objects with compact Lyα emission and extended Lyα emission.
The large EWto LAEs in SSA22 region have higher ratio than in General fields.
→ It is the unique characteristic of SSA22-HDR (?)