Search for extreme emission line galaxies at 1<z<3 using Subaru/HSC multi-band catalog

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Abstract :

Detailed physical processes of the cosmic reionization are yet to be understood. Currently, young galaxies with high specific star formation rates and low metallicity are thought to play a major role. These galaxies often exhibit a strong [OIII] λ 5007 Å emission line and referred to as extreme emission line galaxies (EELGs). Recent JWST observations reveal that EELGs are common at z>~6, but Lower redshift EELGs at 0 < z < 3 are useful objects to study their properties in greater detail. EELGs in the local universe are first identified as green peas, and they have been examined extensively to date. However, our understanding of intermediate redshift EELGs at 1 < z < 3 is very limited. We here investigate statistical properties of EELGs at 1<z<3 such as stellar mass, star formation rate, environment, etc., using a deep and wide multi-wavelength catalog called u2k, which combined HSC-SSP g, r, i, z, y-band data, and u-band and near-infrared data from our collaborating surveys. As a preliminary analysis, we select EELG candidates with strong [OIII] λ 5007 Å (EW>1000 Å) from a small patch of the data. We identify 17 candidates after visual screening to eliminate artifacts and estimated their emission line strengths (in terms of equivalent width). In our poster, we describe this preliminary analysis. We also discuss future prospects of using PFS to measure metallicity and ionization properties of EELGs.

Background :

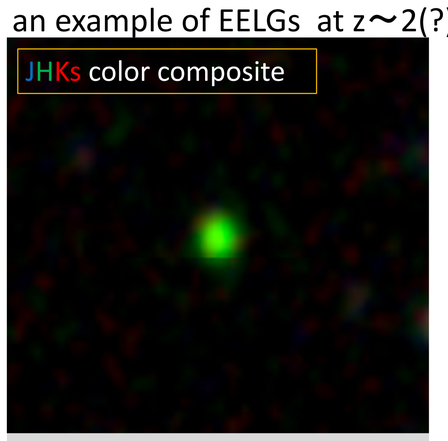
What is EELGs

- Extreme emission line galaxies(EELGs) are unique galaxies often caused by strong [OIII]+Hβ emission line.
- EELGs have some characteristic properties
  - high specific SFR
  - young
  - low mass

High z star-forming galaxies analogy

- EELGs show high LyC escape fractions ranging from 1-50%

an example of EELGs at z～2(?)



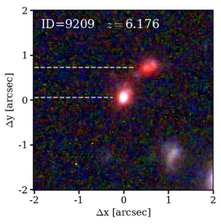
Key questions

SDSS has already observed enough

local universe(z～0)

Cardamone et al. 2009

high redshift (z>6)



Matthee et al. 2023

Deep observation by JWST are underway.

the sample size of especially extreme ELGs(like EW([OIII]5007)>1000Å) is limited in intermediate redshift(1<z<3)
→missing link between high redshift and local universe

our study porpose

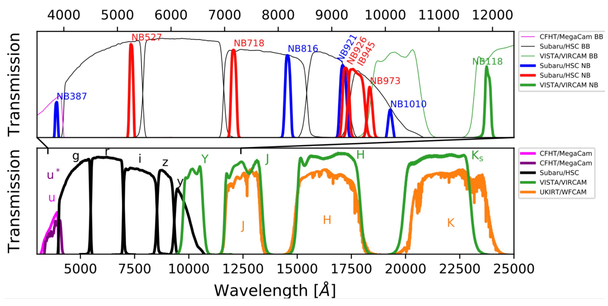
Extends the statistical properties of EELGs the local universe to the intermediate z!

Data and Method

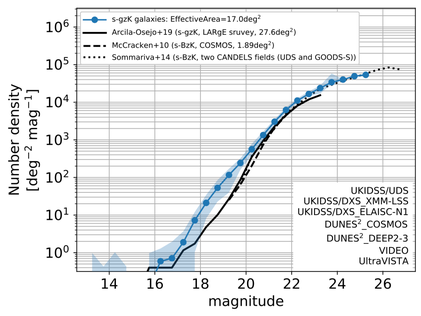
Data : u2k

HSC deep field					Ultra VISTA deep field		
g	r	i	z	y	J	H	Ks
27.5	27.1	26.8	26.3	25.3	25.4	25.0	24.7

5σ,2” detection limit



u2k all filters



the number counts of star-forming gzK galaxies

- Area : ～ 17 deg^2 (COSMOS, XMM-LSS(UDS),ELAIAS-N1 and DEEP2-F3)
- Depth : ～ 25 mag (SDSS : ～ 21 mag)
- multi color : u-band to K-band

u2k is a good catalog for finding lots of EELGs at wide redshifts!

Method : Broad-band color selection

[OIII]λ5007 emission (16000Å at z~2.2)

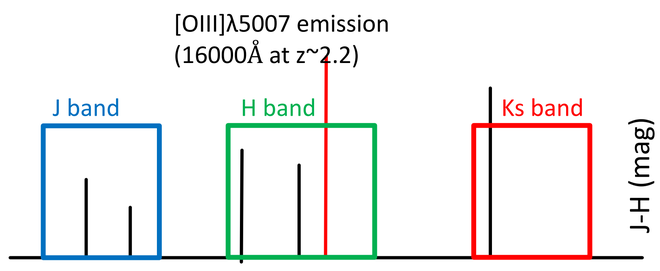
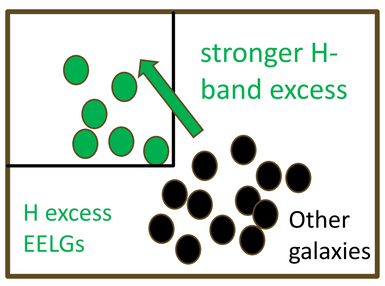


Image of H band excess EELGs spectrum at z～2

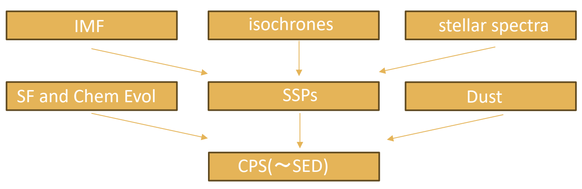
J – H – Ks two-color diagram



Ex) H-band excess
flux_H > flux_J → J - H > 0
flux_H > flux_Ks→ H - Ks < 0
this way can detect faint galaxies covering wide wavelength range

The broad-band selection is particularly suited to find people with strong EW!

Method : Stellar Population Synthes(SPS)



schematic illustration of SPS technique

1. SSP reproduced by combining IMF, Isochrone, stellar spectra, etc.
2. CSP(～SED) reproduced by combining SSPs, SFH, Dust etc.

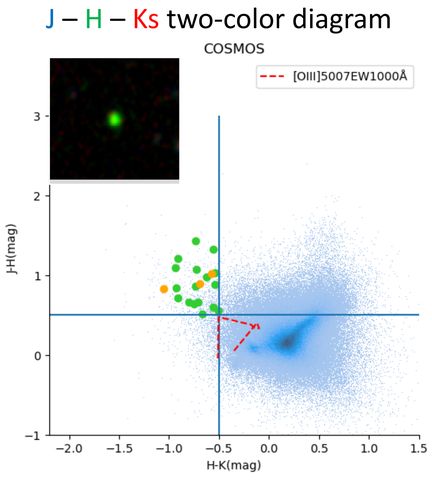
We can estimate various remove SED of galaxies!

Result

Preliminary analysis

Sample Selection

J – H – Ks two-color diagram



u2k cosmos data (1114987 objects)

↓ Broad-band selection

H-excess EELG(H-EELG) candidates (863bjects)

↓ visual inspection

candidates with artifacts removed (17 objects)

↓ matching spec-z catalog with 1’’

final H-EELGs candidates match spec-z catalog (3 objects)

Selection criteria
EW([OIII]+Hβ) > 1000Å
J-H>0.5
H-Ks<-0.5

now, we search for h-EELGs. so h band include strong[OIII] emission and Ks-band include strong Ha emission
→carry out photometric SED fitting using EAZY-py without H and Ks band

Results

photo-z distribution

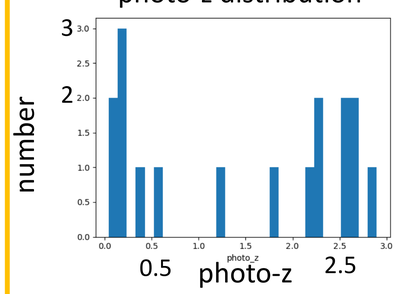
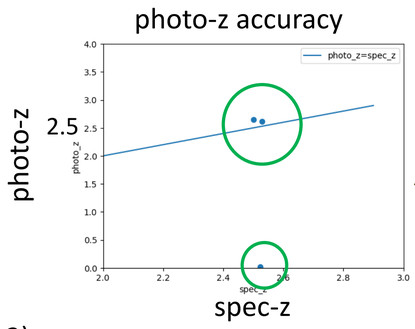
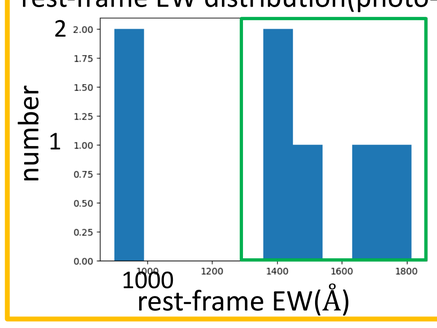


photo-z accuracy



the accuracy of photo-z is not so bad

rest-frame EW distribution(photo-z>2)



we identified 5 EELGs with rest-frame EW([OIII]+Hβ)>1000Å per ～ 1.3 deg²

Future work

Using the criteria set up with FSPS this time, we updated the catalog to version 2 and explored EELGs in other regions and at different wavelengths. While the preliminary analysis targeted an area of approximately 1.3 square degrees, the entire u2k covers about 17 square degrees, resulting in an expected sample size increase of about 13 times. For the identified emission line galaxies, we investigate redshifts, specific star formation rates, stellar masses, and environments using EAZY and other fitting codes. Additionally, the broad wavelength coverage from the g-band to the J-band enabled by PFS observations allows for the extensive spectroscopy of [OIII] emission lines from the EELG candidates discovered by u2k. This facilitates the measurement of metallicity for emission line galaxies in the range of 0 to 1 and is expected to significantly contribute to unraveling the origin of the mass-metallicity relation, particularly on the low-mass side