VIEW OF HIGH REDSHIFT UNIVERSE FROM INFRARED MEDIUM-DEEP SURVEY

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2017.03.03

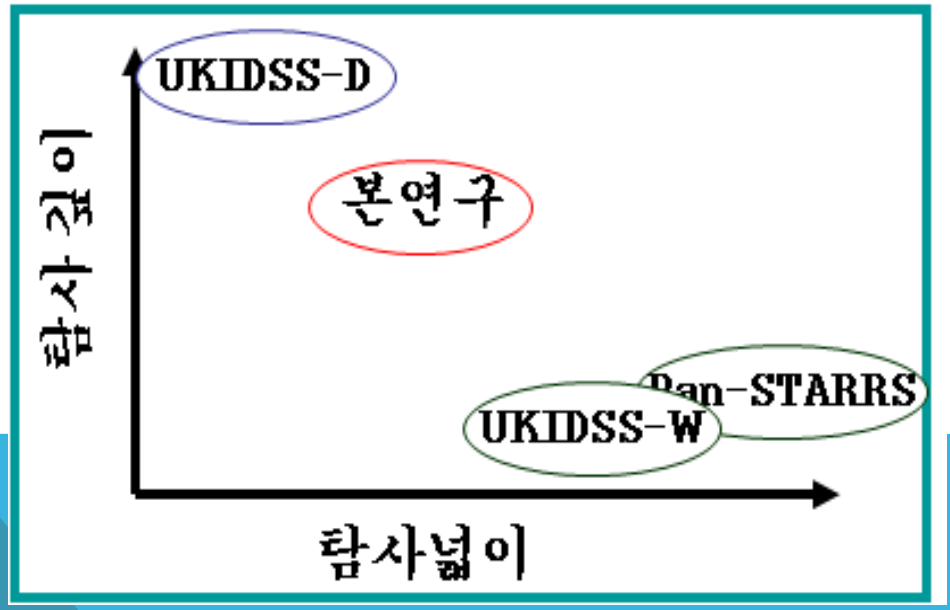
2017 중대형망원경 사용자 워크샵

INFRARED MEDIUM-DEEP SURVEY

우리나라 연구진이 주도하는 대규모 근적외선 탐사관측

1. 탐사의 깊이: 23 AB mag
2. 탐사의 넓이: 140 deg^2
3. 관측파장: 0.9 – 1.2 micron

→ 수십 – 수백의 초기우주 천체



INFRARED MEDIUM-DEEP SURVEY현황

- 140 deg2 지역에 대한 탐사관측 완료(2010 - 2013)
  - UKIRT 4m 및 McDonald 2.1m망원경 활용
  - 초기우주 퀘이사(z=5-7) 후보 약 200개
  - 원시은하단(z=0.7 – 1.5)후보 약 1000개

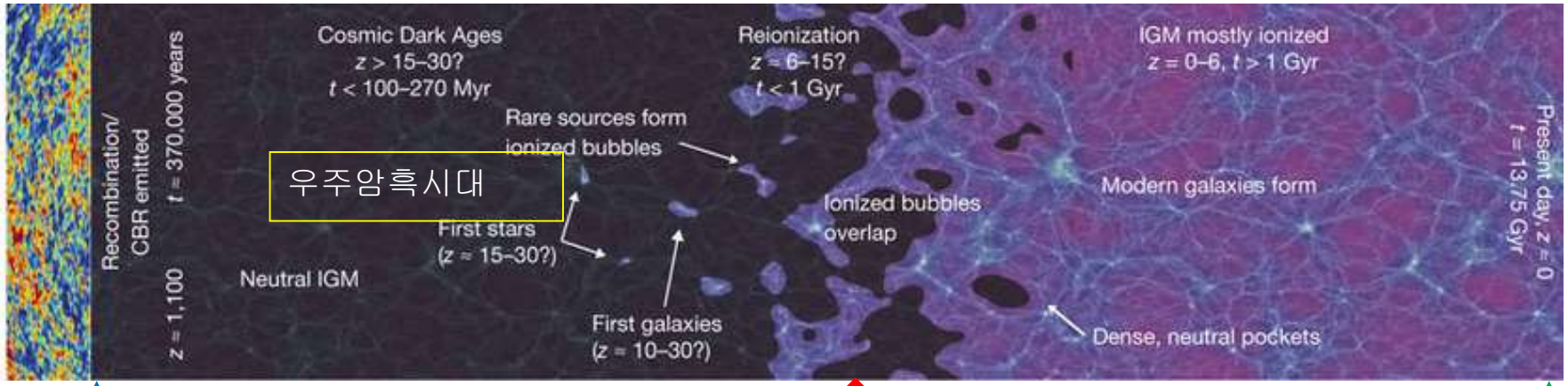
- 후보천체 후속분광관측
  - Gemini 8m 및 Magellan 6.5m망원경 활용
  - 초기우주 퀘이사(~20개)
  - 원시은하단(~10개)

SCIENCE HIGHLIGHTS

High redshift quasars

High redshift galaxy clusters/galaxies

우주의 재이온화: 은하 **OR** 퀘이사**?**



우주나이 37만년

우주공간의 중성화
우주배경복사 방출

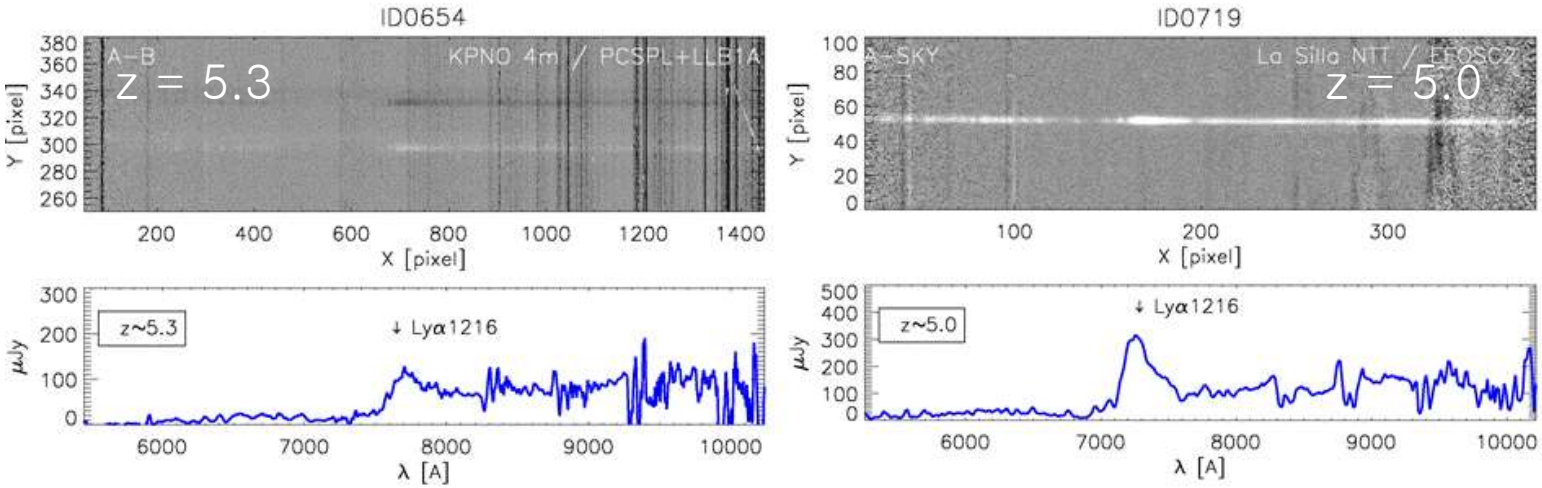
우주나이 약 10억 년

별/은하/퀘이사 탄생
우주의 재이온화
어떤 천체가 재이온화의 주역?

현재우주

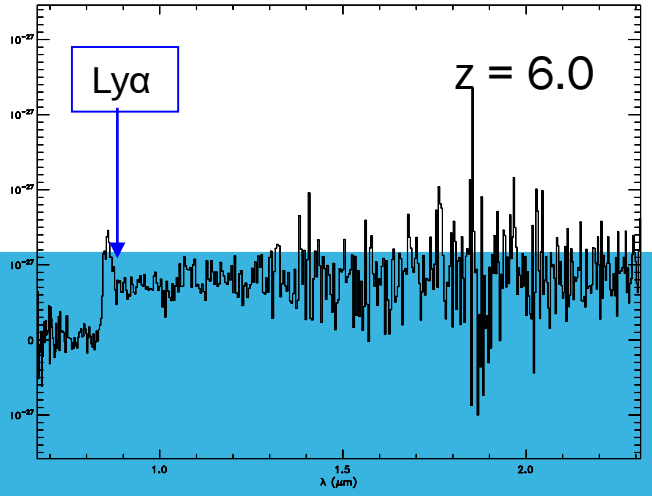
2017. 03. 03

SPECTROSCOPIC CONFIRMATION OF BRIGHT QSOS AT Z ~ 5.5 AND Z ~ 6

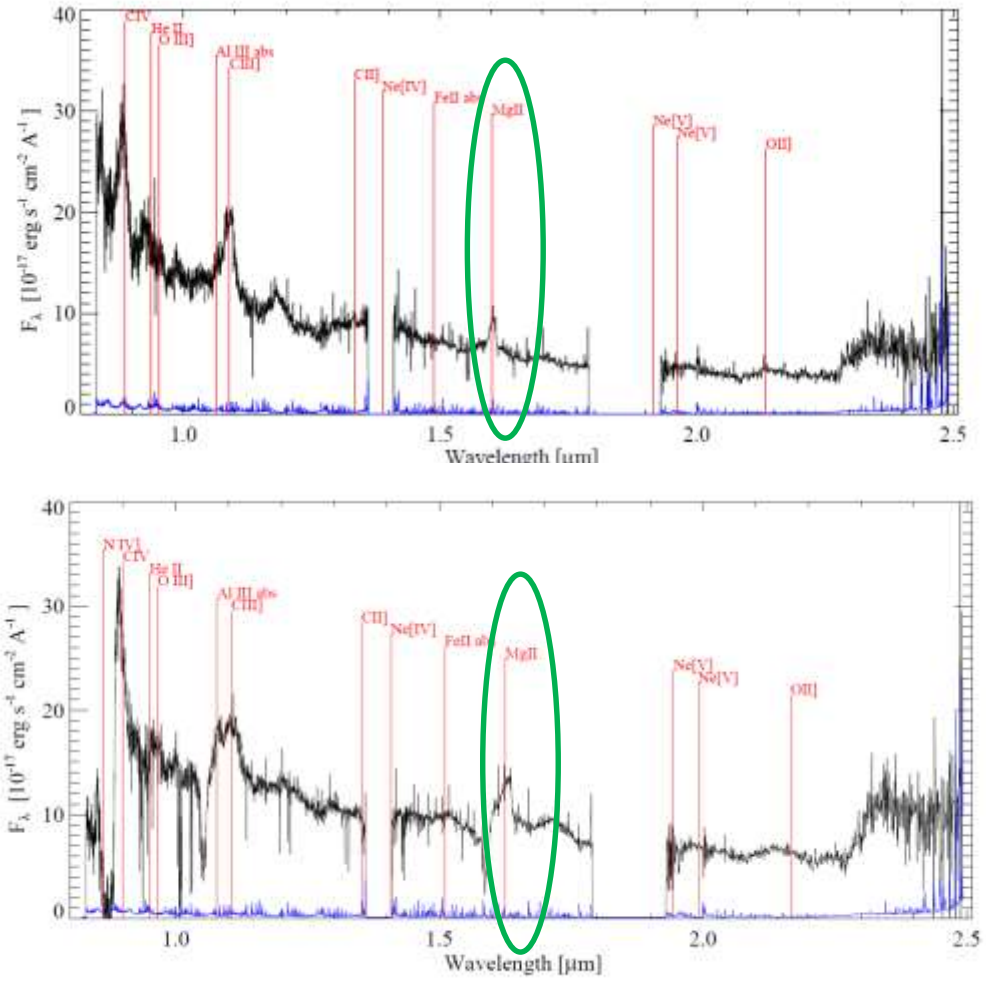


Spectroscopic identification of
8 QSOs at z = 5 – 6
(all with 3-4m class telescopes)

More spectroscopy to come
(BH mass, IGM study)



GEMINI GNIRS + MAGELLAN FIRE SPECTROSCOPY



MgII

M_{BH}

High accretion rate for luminous quasars

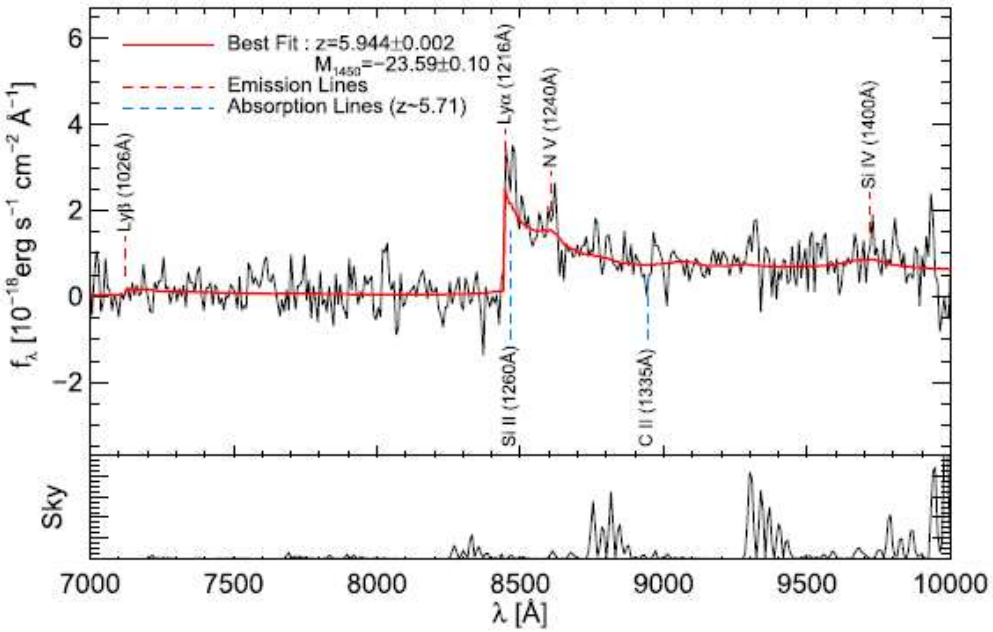
Y Jeon, M Im, YJ Kim, et al. (2017, ApJ submitted)

DISCOVERY OF A FAINT QUASAR AT Z ~ 6 GEMINI-S GMOS

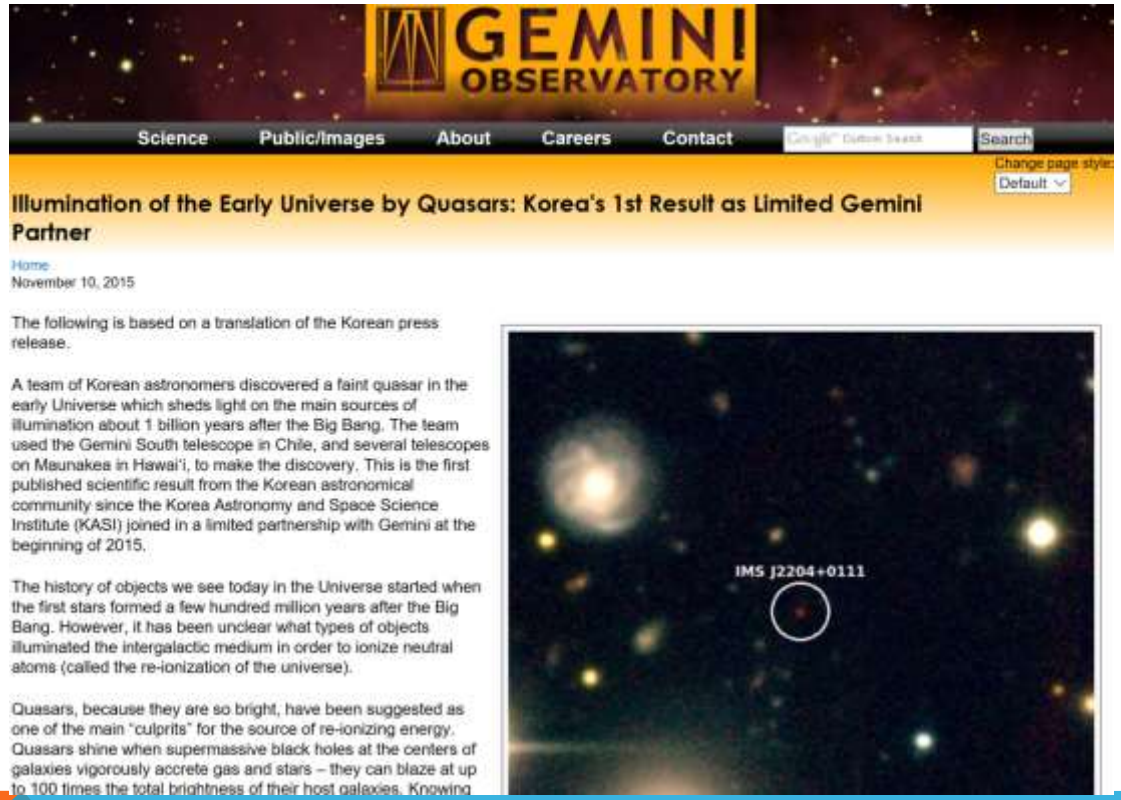
Table 1
Properties of IMS J220417.92+011144.8

R.A. Decl. (J2000.0)	i'	z'	Y	J	Redshift	M_{1450}
22:04:17.92 +01:11:44.8	25.26 ± 0.15	22.95 ± 0.07	23.10 ± 0.09	22.34 ± 0.08	5.944 ± 0.002	−23.59 ± 0.10

Figure 2. Postage stamp images of IMS J2204+0112 presented in 6″ × 6″ boxes. From left to right, u^*-, g'-, r'-, i'-, z'-, Y-, and J-band images are shown.



어두운 초기우주 퀘이사 발견과 우주의 재이온화(KIM, IM, ET AL. 2015, APJL)



GEMINI OBSERVATORY

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Illumination of the Early Universe by Quasars: Korea's 1st Result as Limited Gemini Partner

Home
November 10, 2015

The following is based on a translation of the Korean press release.

A team of Korean astronomers discovered a faint quasar in the early Universe which sheds light on the main sources of illumination about 1 billion years after the Big Bang. The team used the Gemini South telescope in Chile, and several telescopes on Maunakea in Hawai'i, to make the discovery. This is the first published scientific result from the Korean astronomical community since the Korea Astronomy and Space Science Institute (KASI) joined in a limited partnership with Gemini at the beginning of 2015.

The history of objects we see today in the Universe started when the first stars formed a few hundred million years after the Big Bang. However, it has been unclear what types of objects illuminated the intergalactic medium in order to ionize neutral atoms (called the re-ionization of the universe).

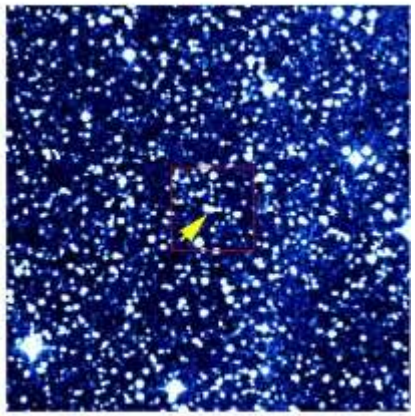
Quasars, because they are so bright, have been suggested as one of the main "culprits" for the source of re-ionizing energy. Quasars shine when supermassive black holes at the centers of galaxies vigorously accrete gas and stars – they can blaze at up to 100 times the total brightness of their host galaxies. Knowing

- 어두운 퀘이사 발견: 세계3번째
- 재이온화 기여도 제시: 세계첫번째
- 국내 언론보도, Gemini천문대 홈페이지에서 소개

2007 → 2017

Quasar in High Galactic Latitude vs Quasar in the Zone of Avoidance

3C273 (High Galactic Latitude Quasar)



SNUQSO J2109+3532
(Quasar in the Zone of Avoidance)

2007

- 1.8m
- 15 mag
- z ~ 0.3

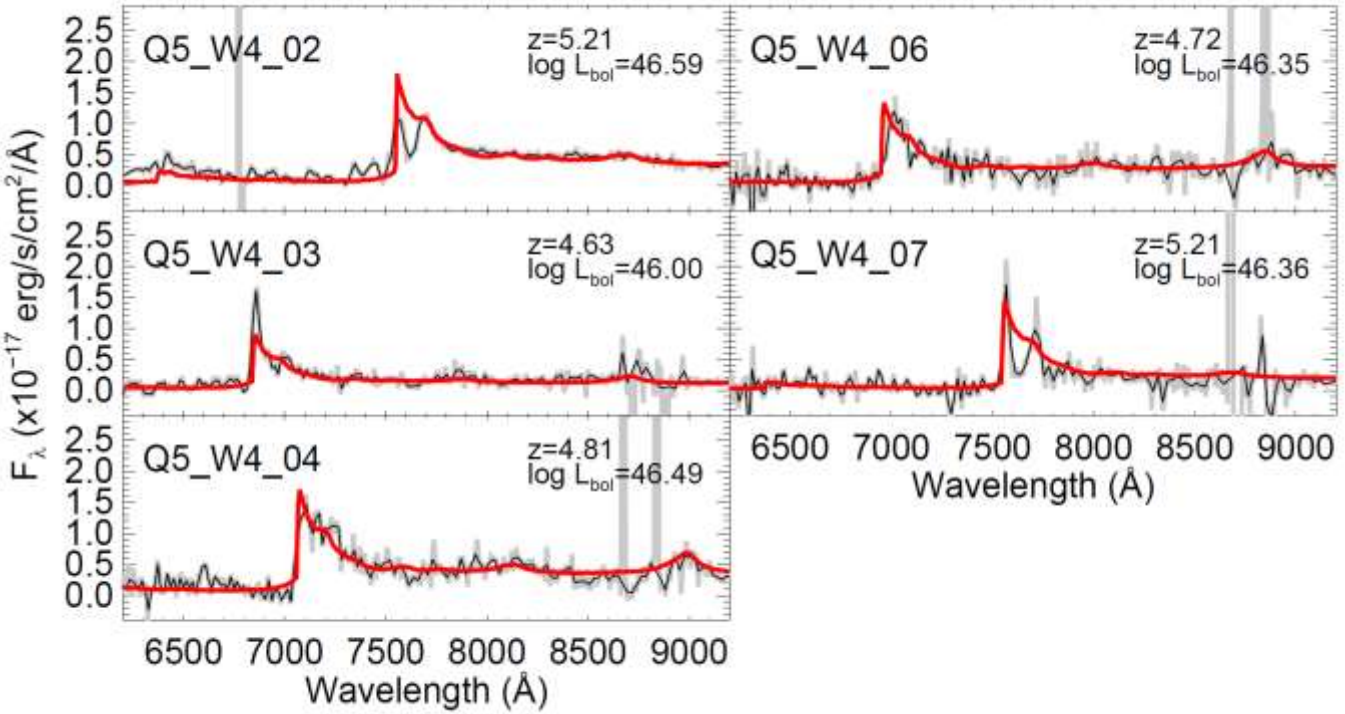
2017

- 8.0m
- 23 mag
- z ~ 6

1000X increase in sensitivity!

SPECTROSCOPIC CONFIRMATION OF Z ~ 5 QUASARS

~10 faint quasars from Gemini/Magellan

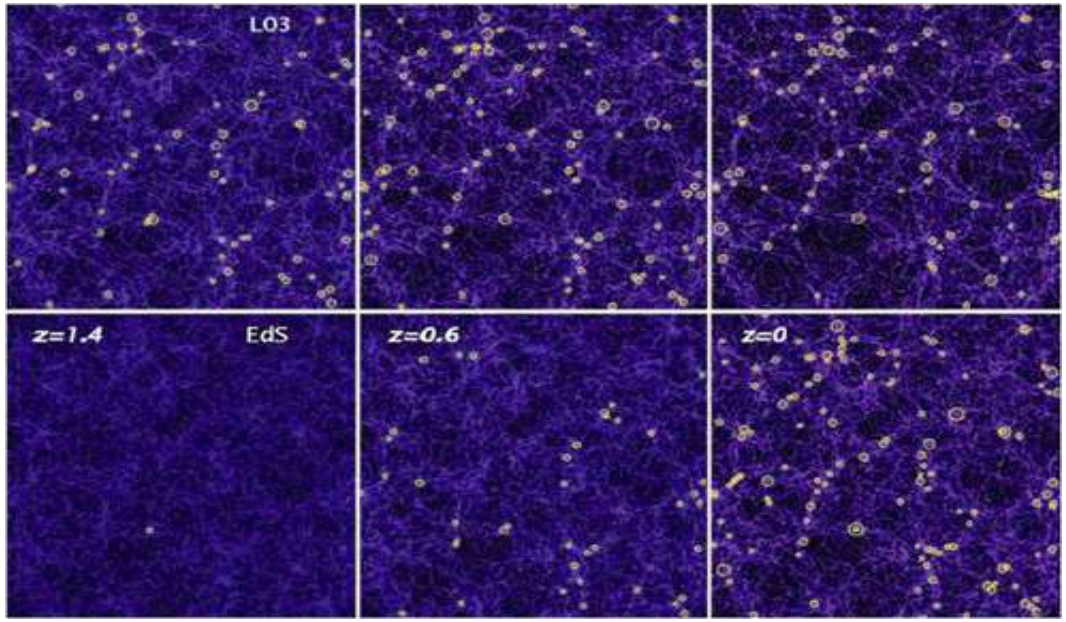


Kim et al. (2017), in prepartion

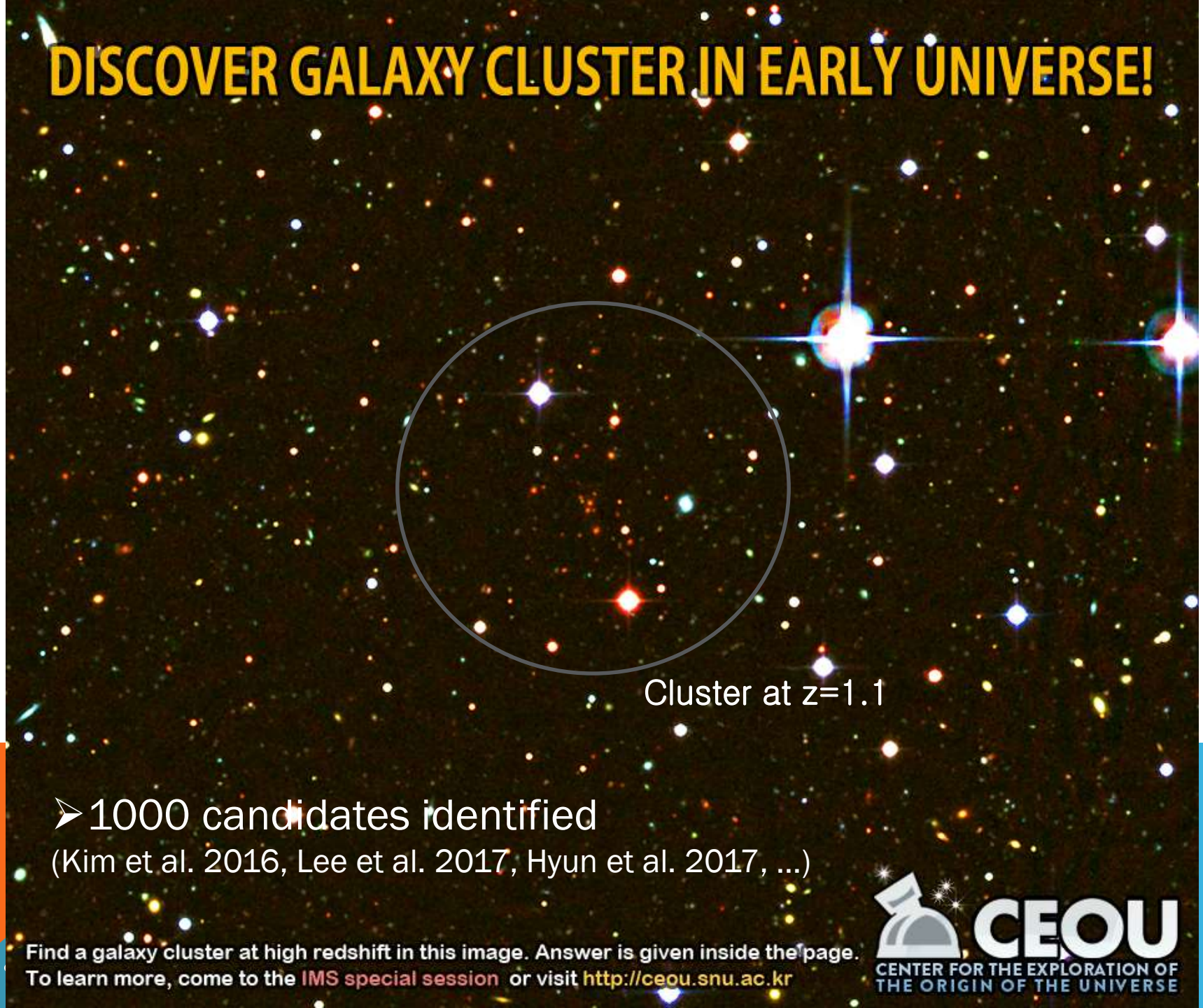
원시은하단과 초은하단을 이용한 은하진화 및 우주론 모델 검증

우주론 모델 1

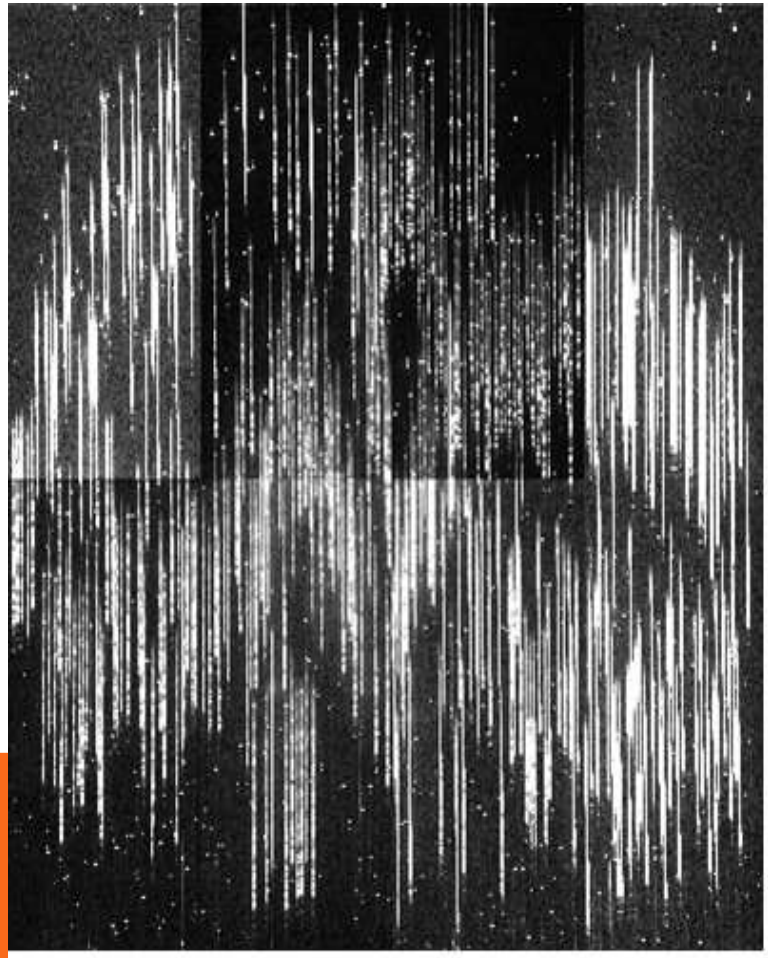
우주론 모델 2

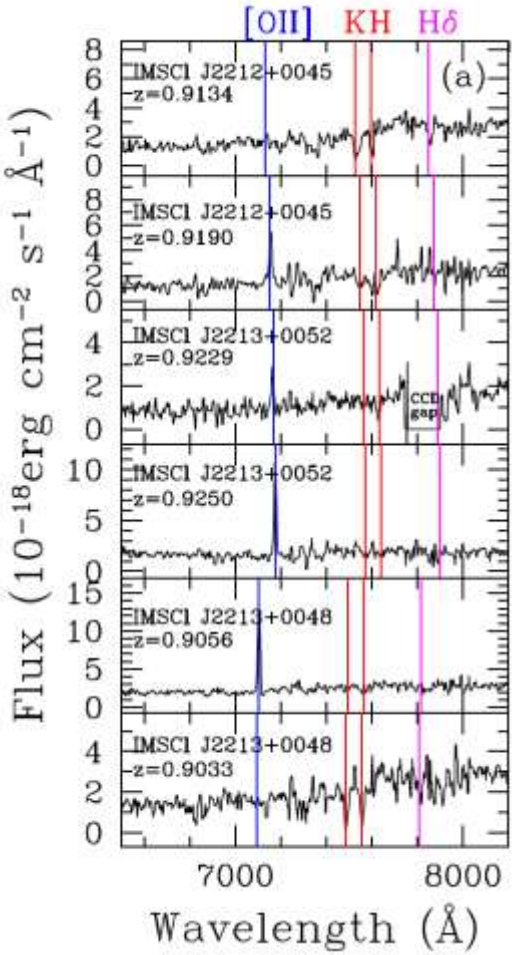


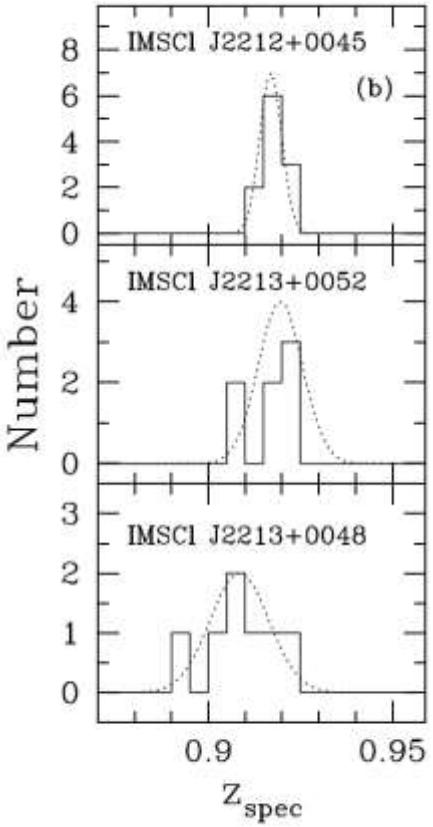
과거 ← 적색이동값 → 현재


DISCOVER GALAXY CLUSTER IN EARLY UNIVERSE!
Cluster at z=1.1
➢1000 candidates identified
(Kim et al. 2016, Lee et al. 2017, Hyun et al. 2017, ...)
Find a galaxy cluster at high redshift in this image. Answer is given inside the page.
To learn more, come to the IMS special session or visit http://ceou.snu.ac.kr
CEOU
CENTER FOR THE EXPLORATION OF THE ORIGIN OF THE UNIVERSE

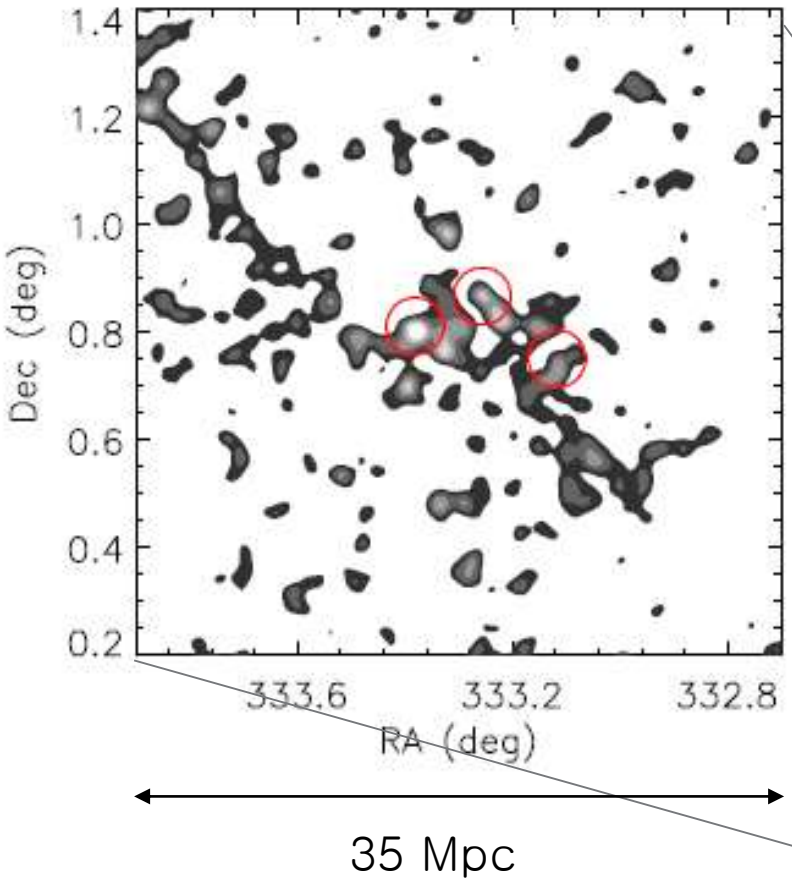
IMACS + GEMINI OBSERVATION

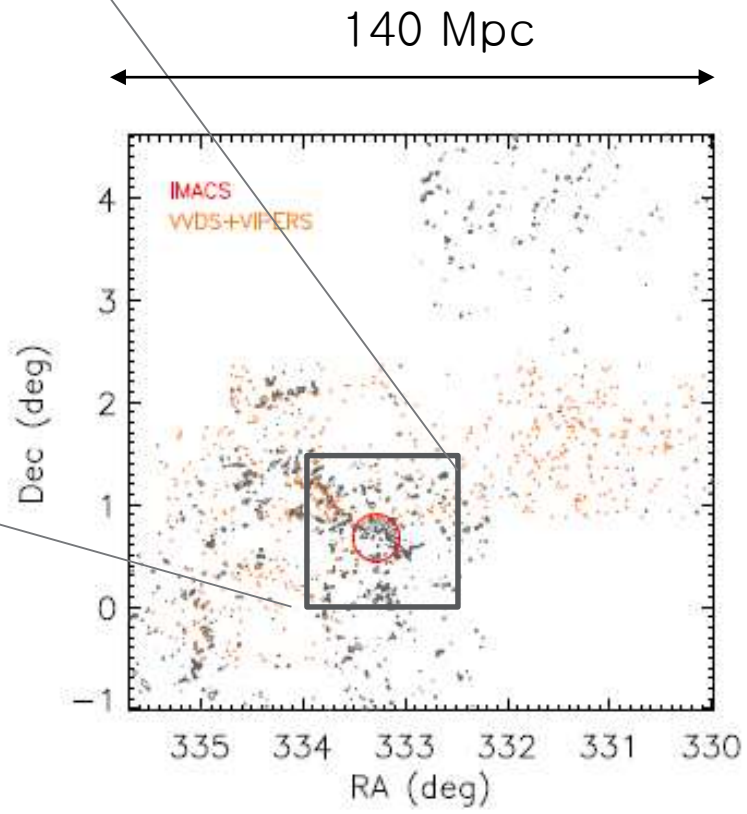






원시 초은하단 발견(**Z=0.9**)과
우주론 검증(**KIM, IM, ET AL. 2016**)





고적색이동 초은하단을 우주론 검증에
실제로 사용한 첫째 사례

현재 10여 개 은하단 정밀분석. 1000개 후보
Lee SK et al. (2017), Hyun M et al. (2017)

PAPERS PUBLISHED OR TO BE PUBLISHED SOON

#	Author	Year	Status	Topic	Facilities
1	Kim, Yongjung et al.	2015	ApJL	QSO at z=6	UKIRT, Gemini
2	Kim, Jae-Woo et al.	2016	ApJL	Supercluster at z=1	UKIRT, Magellan
3	Jeon, Yiseul et al.	2017	Submitted	QSO at z=5.5	UKIRT, Gemini, KPNO 4m, ..
4	Kim, Yongjung et al.	2017	Draft ready	SMBH mass of z=6 QSO	UKIRT, Magellan, Gemini
5	Seong-Kook Lee et al.	2017	Draft ready	Clusters/Sclusters at z=1	UKIRT, Magellan
6	Yoon, Yongmin et al.	2017	Draft soon	Env. of massive QSOs	SDSS, MMT
7	Kim, Jae-Woo et al.	2017	Draft soon	Clusters at z=1	UKIRT, Gemini, Magellan, JCMT

PAPERS IN PREPARATION

#	Authors	Year	Status	Topic	Facilities
8	Lee, Seong-Kook et al.	2017	In preparation	U-dropout galaxies	UKIRT, Gemini
9	Kim, Dohyeong et al.	2017	In preparation	Red quasars	Gemini, IRTF
10	Hyun, Minhee et al.	2017	In preparation	Superclusters at z=1	UKIRT, Magellan, Gemini?
11	Taak, Yoonchan et al.	2017	In preparation	Gravitational lens	Gemini, Magellan, HST
12	Im, Myungshin et al.	2017	In preparation	IMS overview	UKIRT, Gemini, Magellan, HET
	... Many more to come ...				

K-GMT: ~90HRS ALLOCATED, ~50HRS OBSERVED ALL DATA ARE ANALYZED

Facility	Time	PI	Title	Alloc	Status
Gemini	2015A	M Im	Spectroscopic Confirmation of Faint z=6 Quasars	1.0	Kim et al. 2015
Gemini	2015A	SK Lee	Spectroscopic Confirmation of Clusters at z=3	0.5	Lee et al. 2017
MMT	2015A	M Im	Clusters around Extremely Massive BHs	1.0	Yoon et al. 2017
Gemini	2015B	JW Kim	SF Clusters at z=1	8hr	Kim et al. 2017
Gemini	2015B	YS Jeon	NIR spectroscopy of z=5 quasars	5.2hr	Jeon et al. 2017
Gemini	2015B	M Im	NIR imaging of z=7 QSO candidate	2.4hr	Im et al. 2017
Gemini	2015B	DH Kim	BH/host galaxy mass of red quasars	11.0hr	Kim et al. 2017
Gemini	2015B	YC Taak	K-band imaging of strong lens	2.2hr	Taak et al. 2017
Gemini	2016A	M Im	Spectroscopy of z=7 QSO candidate	9hr	Im et al. 2017
Gemini	2016A	M Im	Spectroscopic confirmation of faint z=6 QSO	9hr	Kim et al. 2017
MMT	2016B	JW Kim	Hectospec observation of supercluster at z=1	0.5nt	Paper in prep
Gemini	2016B	YJ Kim	Spectroscopic confirmation of faint z=6 QSO	9hr	Paper in prep
Gemini	2016B	M Im	Spectroscopic confirmation of faint z=5 QSO	8.29hr	Paper in prep

CONCLUSION

Imaging survey is essential to identify interesting objects: UKIRT, LSST, WFIRT…

Spectroscopy with 6-8 m telescopes is the final step in the study: Gemini, MMT, Magellan, …, GMT

Manpower is important: a lot of data to digest