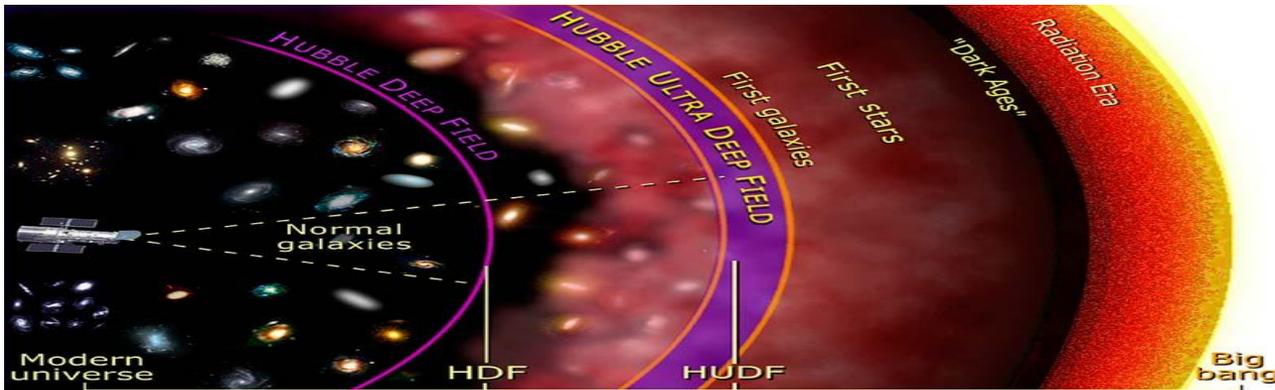


Overview of Infrared Medium-deep Survey

M. Im

연구단 연구목표

- 우주의 나이 38만년 - 8억년 (적색편이 $z > 6.5$) → 미지의 세계, 우주의 암흑시대
- 최초의 별, 은하, 퀘이사가 형성되던 시기 → 태초의 천체 (우주의 아담과 이브)를 관측하여 천체 형성의 역사의 시작을 연구이해
- 인간과 우리 세계에 대한 이해 증진 → 현대천문학 주요 연구과제 (NASA Origin Project).



현재 (137억년)

8억년

38만년 0년

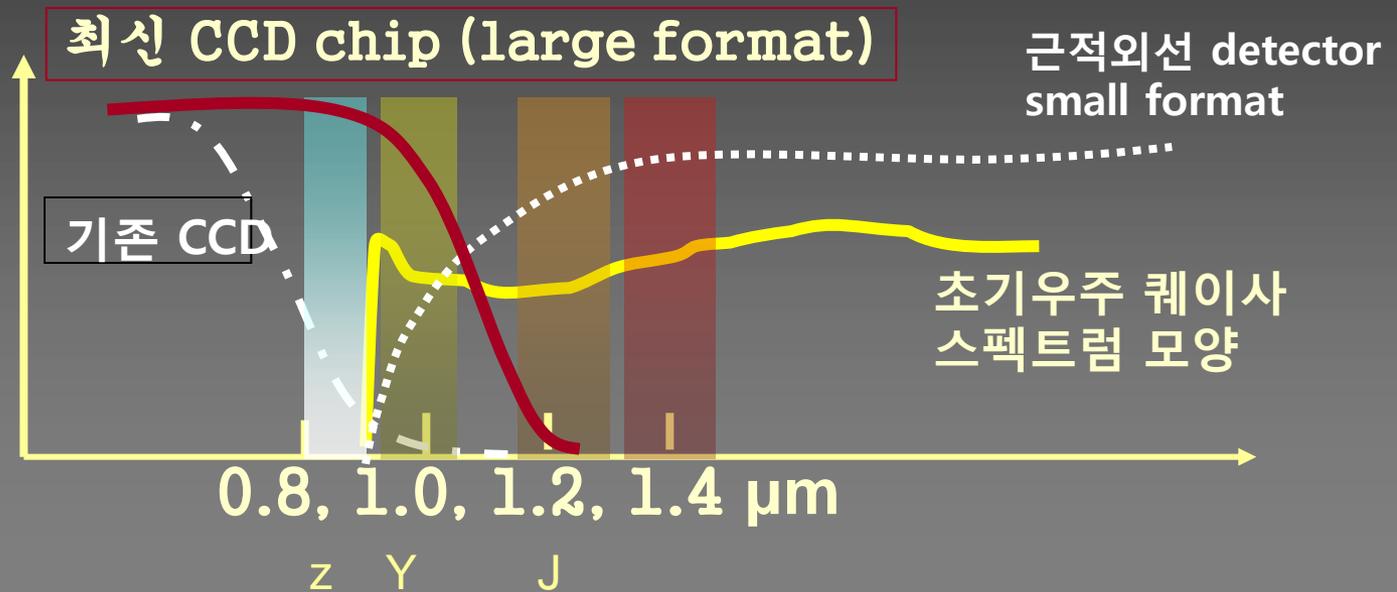
현재 관측된 우주

?

빅뱅직후

초기우주 천체를 연구하려면...

초기우주 천체 스펙트럼과 CCD감도



J < 23 AB 등급: 1평방도 당 약 0.02-1개

광시야 근적외선 천체탐사가 필요

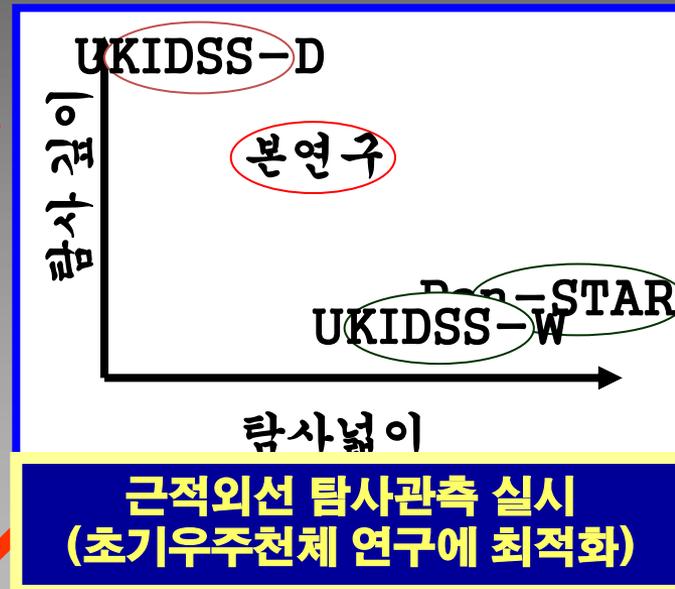
연구단 연구내용



광시야 근적외선
CCD Camera
개발
최신 기술이용



해외망원경
시설활용
광시야 CCD
Camera사용



초기우주 천체 연구분야
세계적 선두그룹으로 도약

관측천문학 및 천문기기개발 인
력양성.

연구단 구성 (2008. 6 ~)

연구단장 (임명신)

서브그룹리더: 박수종 (기기개발), 김웅태 (이론/전산)

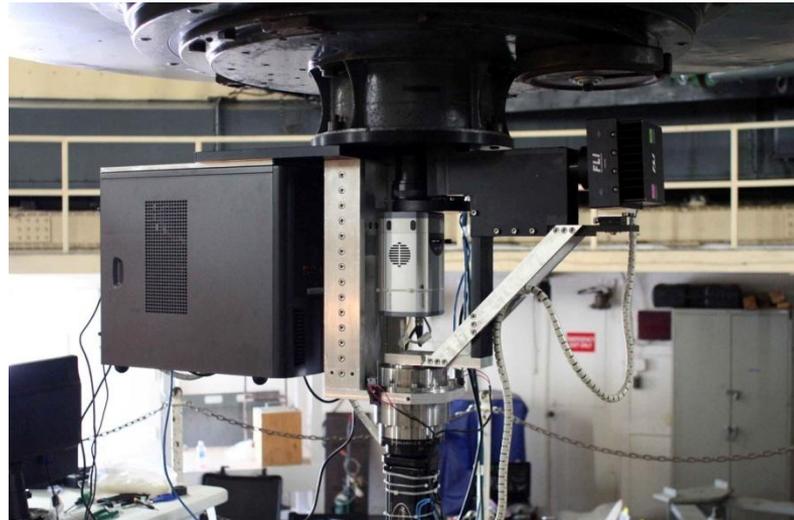
박사후 연구원: 4명

연구조원: ~20 명, 사무간사: 1명

약 25명

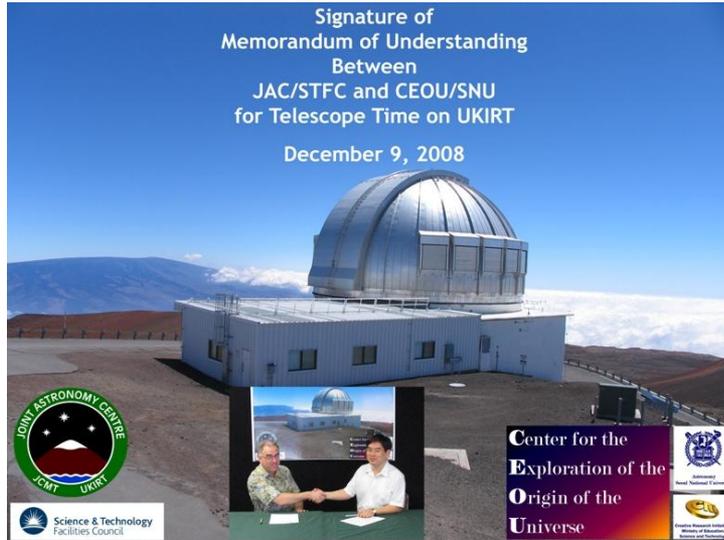


Facilities : CQUEAN



- **Kyunghee Univ.(S. Pak)/SNU**
- **NIR sensitive (~ 1 micron)**
- **Custom is and iz filters**
- tailored for high-z QSO selection
- **Focal Reducer (3x, 5' x 5')**
- **Auto-guiding system**
- **Installed on the 2.1m at McDonald Observatory**

Facilities : UKIRT



- 4-m IR Telescope (Hawaii Manua Kea; 4192m above sea level)
- **Largest NIR telescope** in the northern hemisphere
- MOU in 2008. 12
- 120 nights used : mostly J-band Infrared Medium-deep Survey, Transients

CEOU Facilities



Maidanak 1.5m
with SNUCAM
(ugrizY, UBVRI)



McDonald
2.1-m with
CQUEAN
(grizY, is/iz)



BOAO 1.8m
(UBVRI + JHK)



UKIRT
3.9-m
(zYJHK)

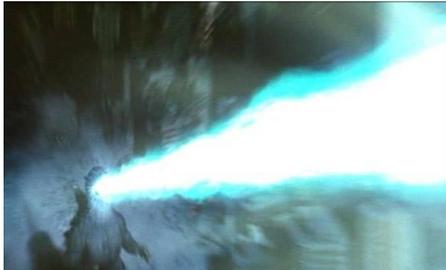


Mt. Lemmon
1m (BVRIzY)

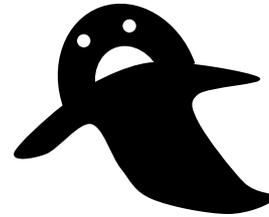
<http://ceou.snu.ac.kr>

Extreme Objects in the Universe

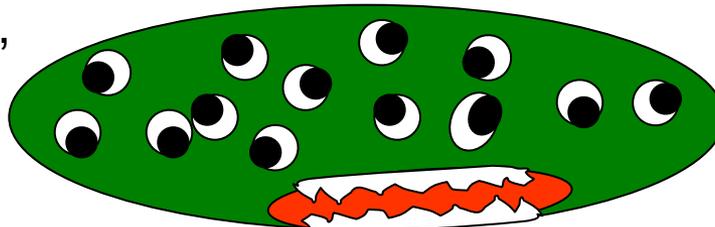
- Monsters in the Universe can answer the question!



Enormous Explosion:
Gamma Ray Burst (GRB),
and other explosions

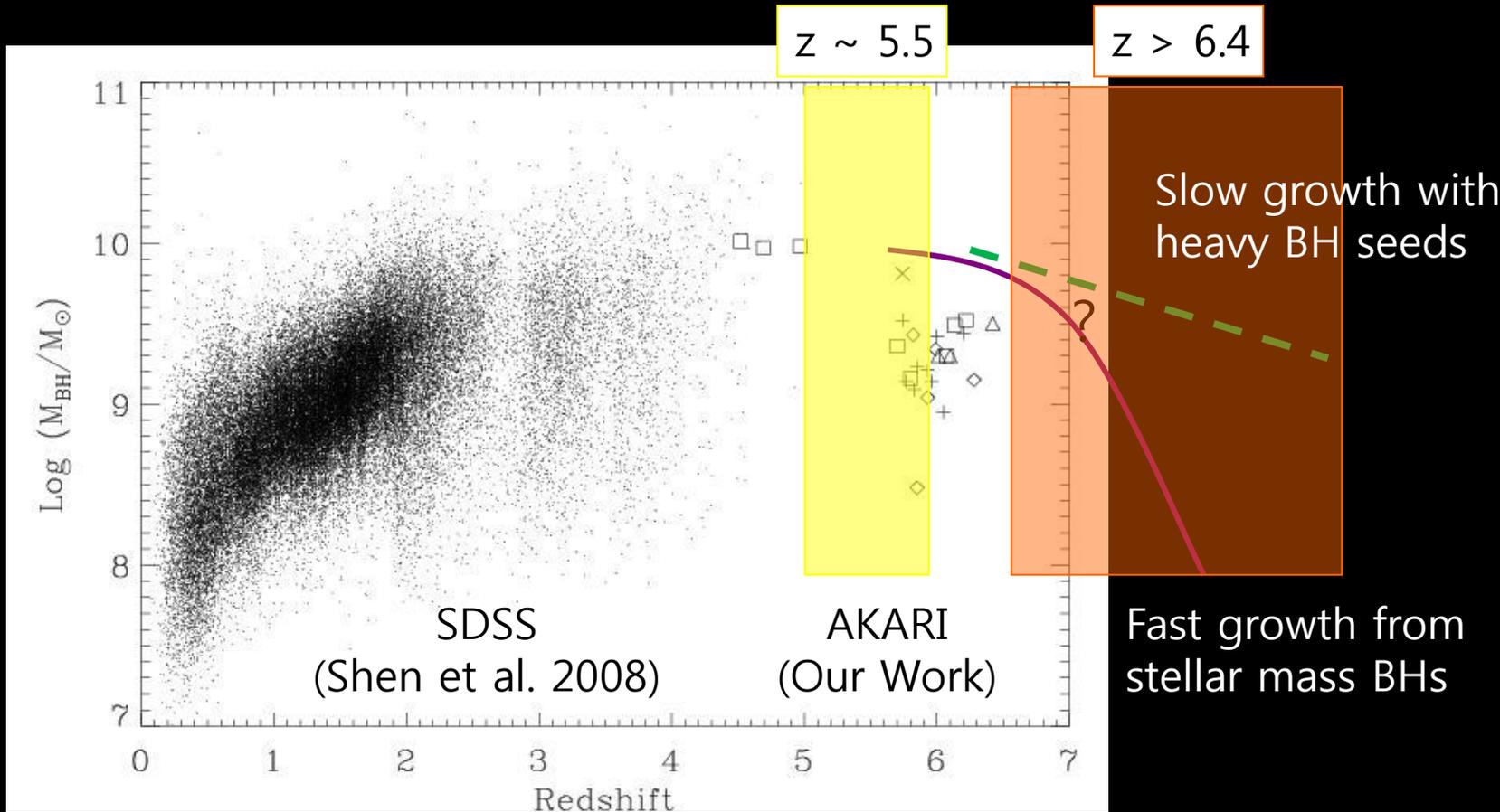


Ghosts of Star:
Supermassive Black Holes

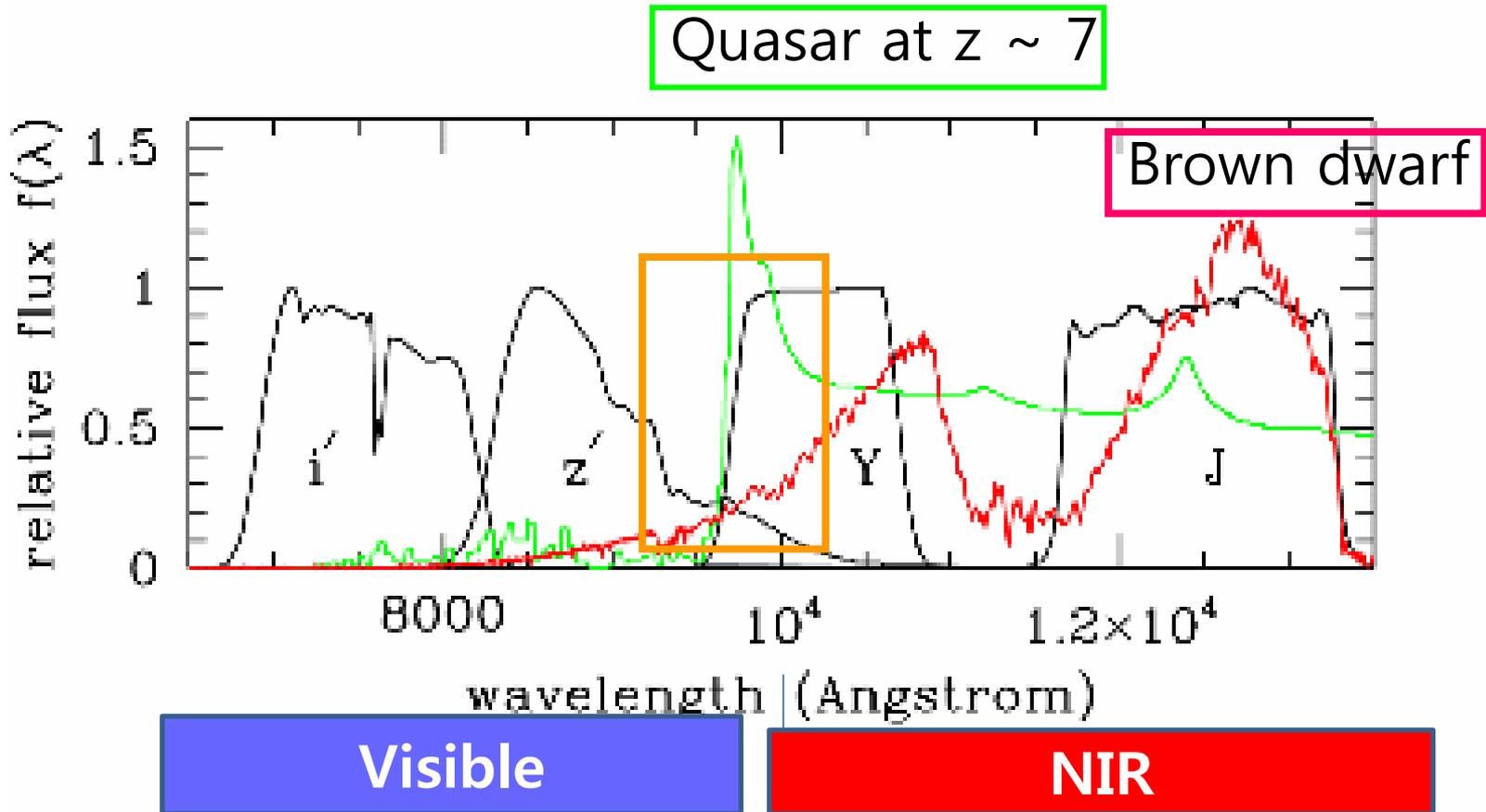


The Most Massive Astronomical Object:
Proto-clusters of Galaxies

How did SMBHs grew?



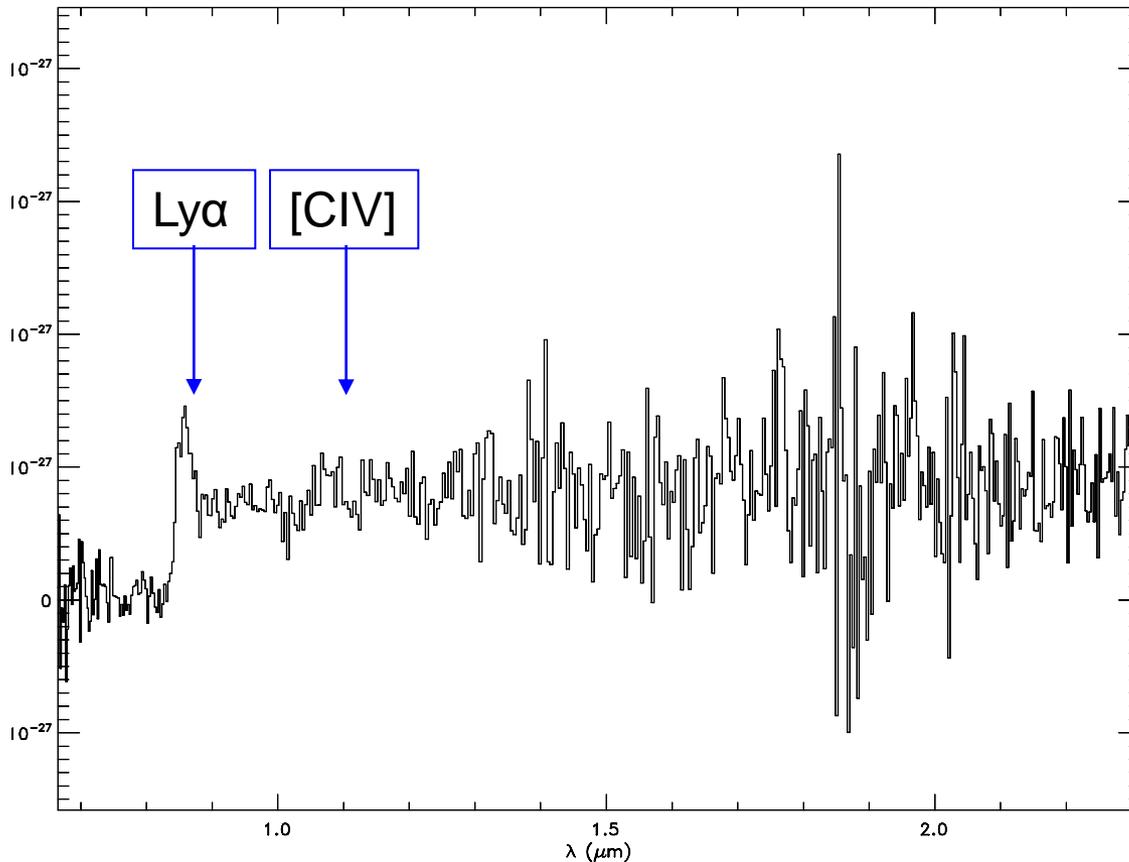
Search Method of High Redshift Quasars



CQUEAN 및 UKIRT로 imaging survey → 퀘이사 후보 선별
→ 분광관측 (e.g., 9 nights of 4-m time this year)

초기우주 퀘이사 발견

IMS J014837.64+060020.0 at $z=6.0$



IRTF spectrum of IMS J014837.64+060020.0

- 2011년 1월 발견
- 초기우주 이온화 상태 연구, Supermassive Black Hole 성장과정 연구



CFHQS J2329-0301 @ $z=6.43$



SDSS J1148+5251 @ $z=6.42$



ULAS J1319+0950 @ $z=6.43$

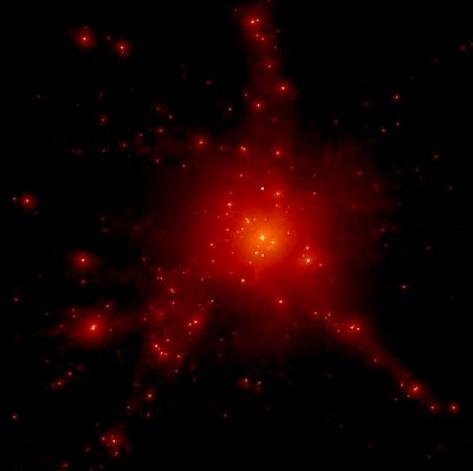
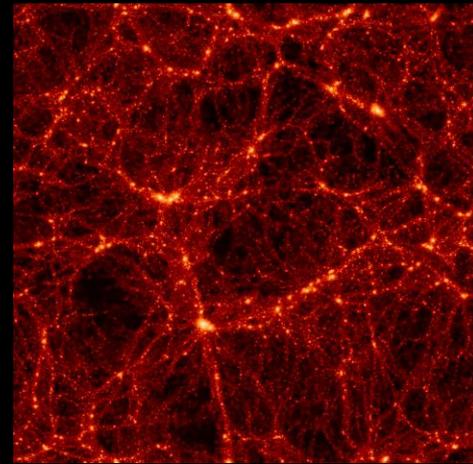
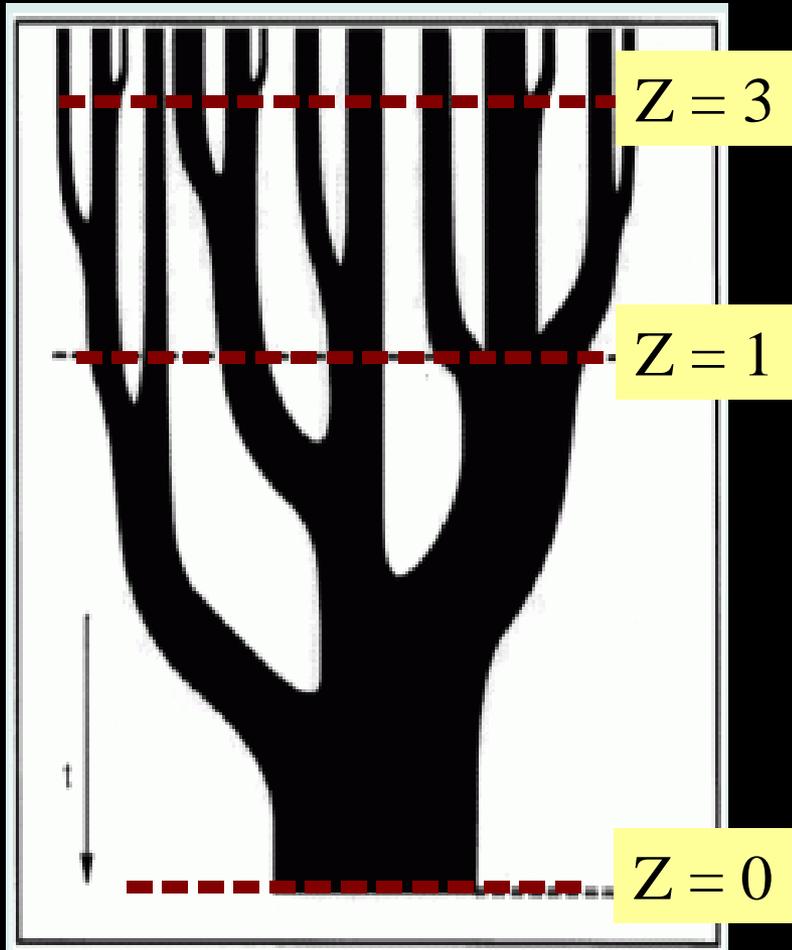


IMS J0148+0600 @ $z=6.03$



SDSS J0841+2905 @ $z=5.96$

SMBH-SMBH Merging

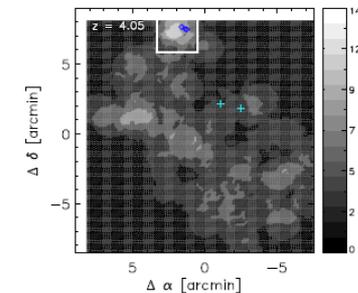
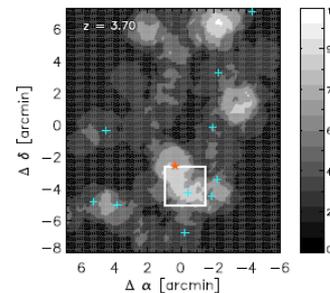
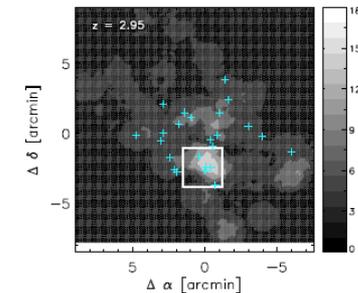
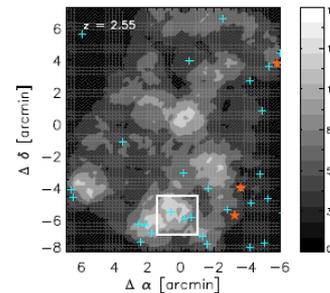
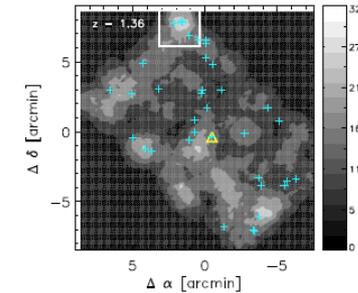
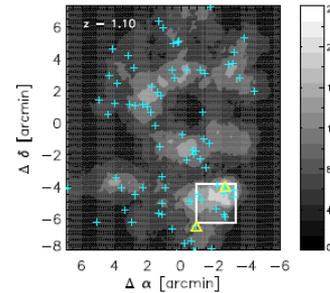


AGN Feedback
Gravitational
Wave!

(Hierarchical Galaxy Formation Models)

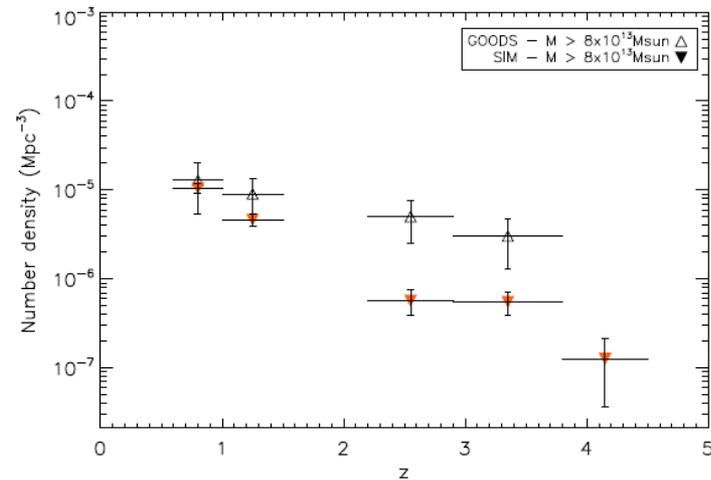
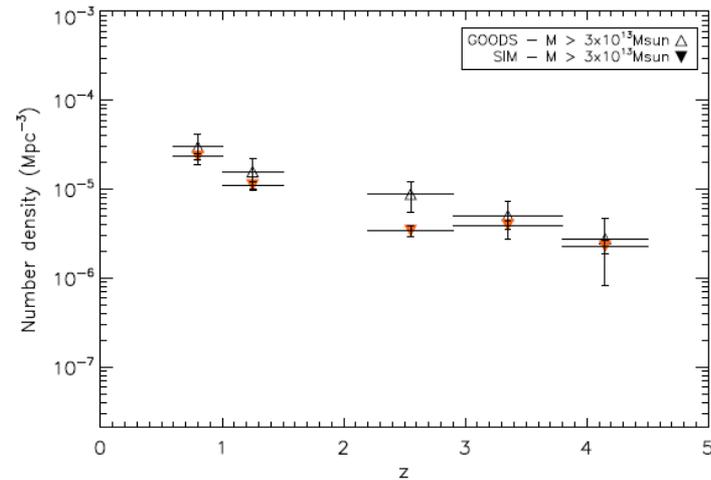
Discovery of Proto-Clusters

- Earlier work is extended
- 49 massive structure of galaxies (MSGs) discovered in GOODS fields (Kang & Im, 2012 submitted)



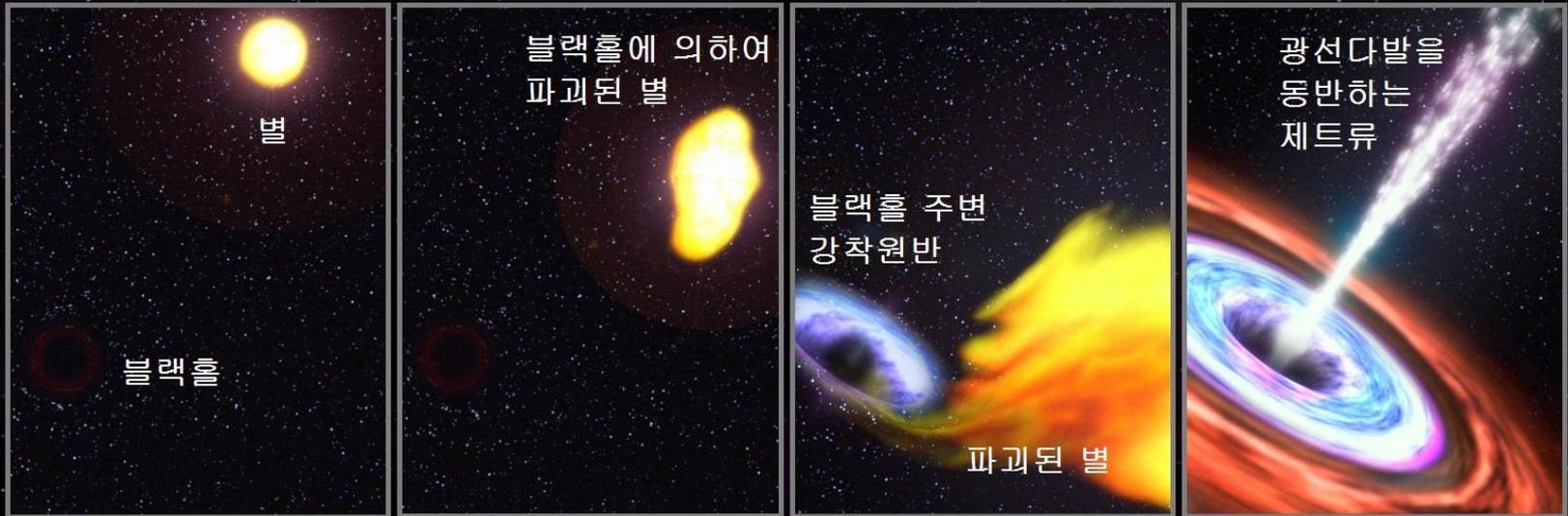
Implication to Λ CDM Cosmology

- Comparison with Millennium Simulation data (red points)
- Too many MSGs at high redshift \rightarrow problem with Λ CDM cosmology?
- High- z cluster search + study of galaxy properties ongoing



Tidal Disruption of a Star by a Supermassive Black Hole

Swift J1644+57: 거대질량 블랙홀과 별의 파괴현상



1. 39억 년 떨어진 곳에 있는 어떤 은하의 중심부에 위치한 거대질량 블랙홀 근처로 태양 크기의 별이 다가선다.
2. 블랙홀로 너무 가까이 간 별이 블랙홀의 강력한 중력때문에 파괴된다.
3. 파괴된 별의 잔해 일부가 거대질량 블랙홀 주변으로 몰려들면서 강착원반을 형성한다. 나머지 잔해는 우주공간으로 흩어진다.
4. 강착원반이 강력한 자기장을 만들면서 자기장 축으로 강한 제트를 뿜어낸다. 이 제트에서 매우 밝은 광선다발이 방사된다.

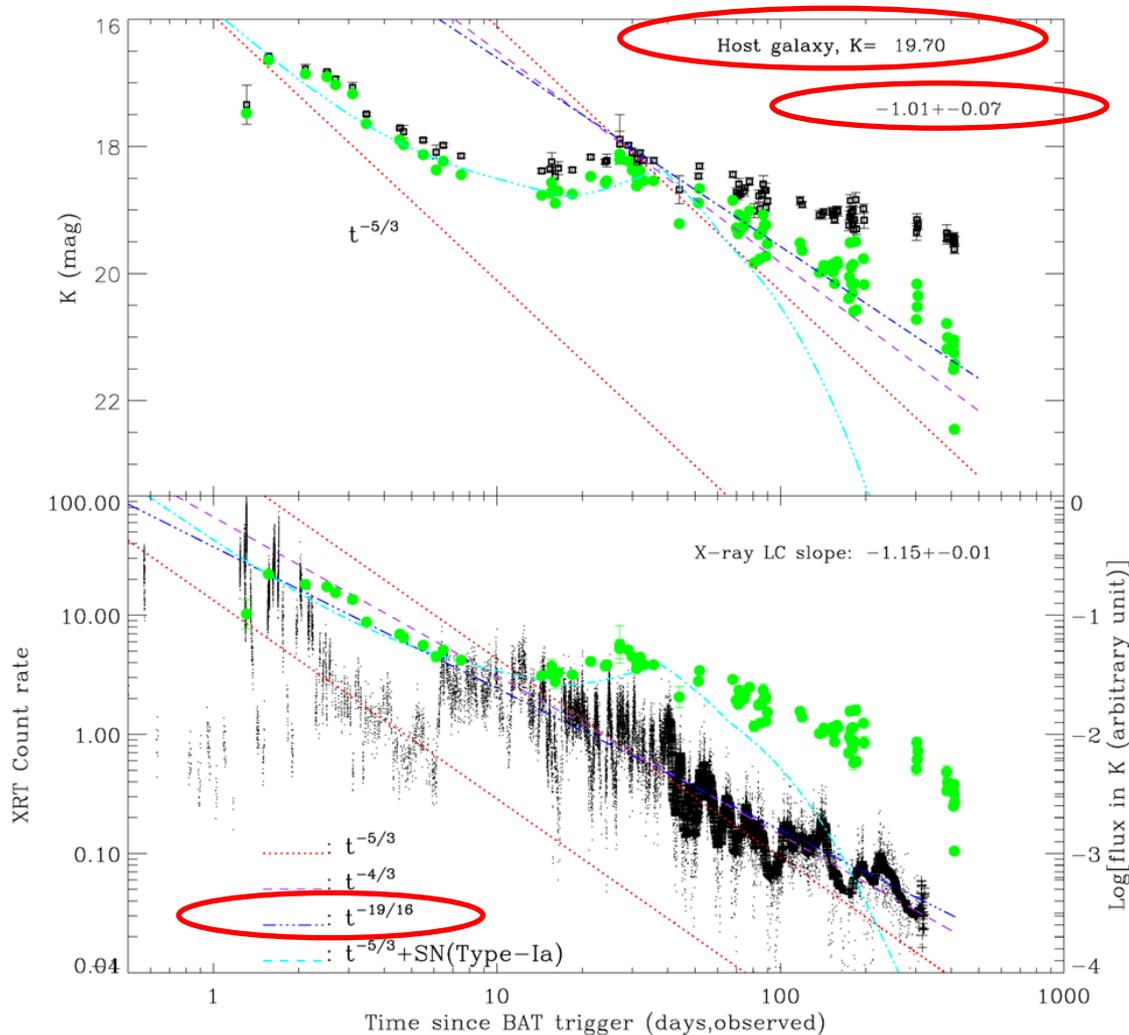
한글자막: 서울대학교 초기우주천체연구단

Burrows et al.

Credit: NASA/Goddard Space Flight Center/Swift

Many predictions (Hills 1975; Lee, H. M. & Kim, S. 1996; and many other theory papers + some obs. evidences)

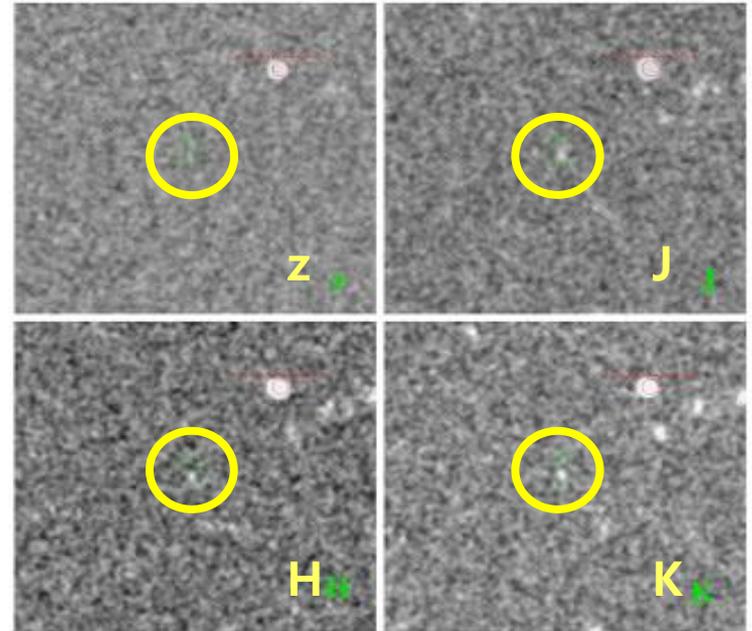
Light Curve of Swift J1644+57 (2/12/2013)



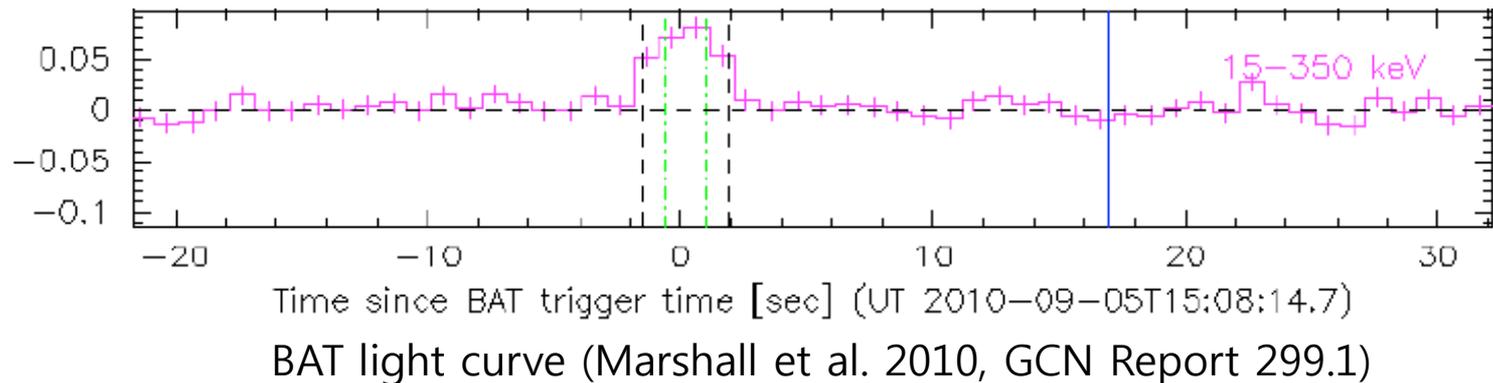
- Host galaxy:
K=19.7 mag
- X-ray and K-band light decay $\sim t^{5/3}$
➔ TD prediction??
- Data are still being taken
- See also Y. Yoon's presentation
($M_{\text{BH}} \sim 10^7 M_{\odot}$!)

GRB 100905A

- BAT alert at 2010, Sept. 5
- UKIRT follow-up, 15min after the burst (z,J,H,K)
→ NIR afterglow (z-drop)

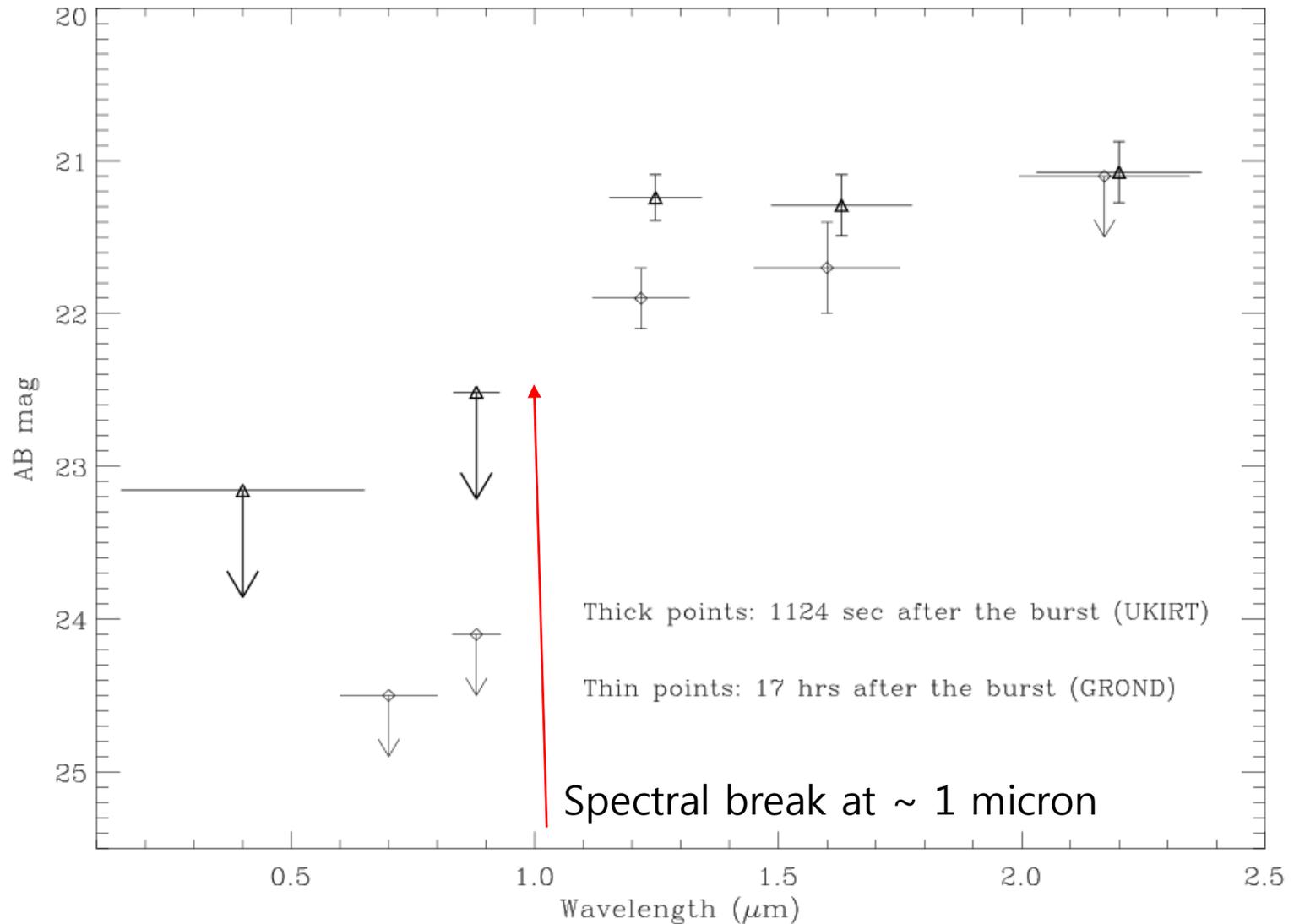


(Im et al. 2010, GCN Circ.11222)

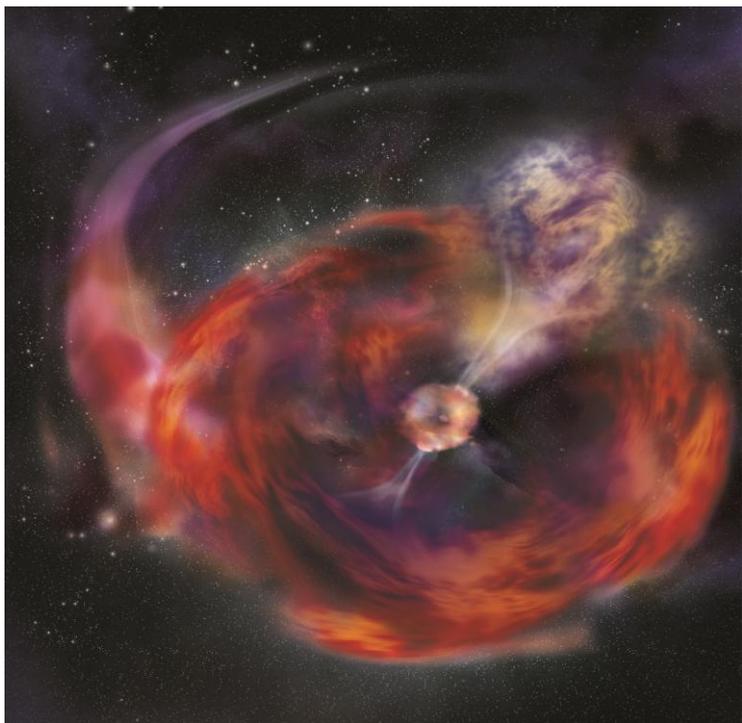


BAT light curve (Marshall et al. 2010, GCN Report 299.1)

SED Analysis: $z = 7.5 \pm 0.8$

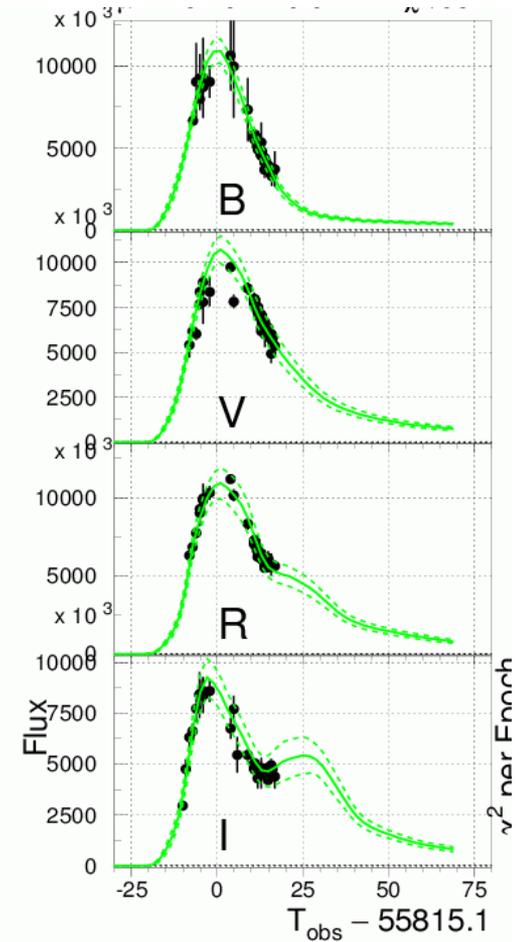
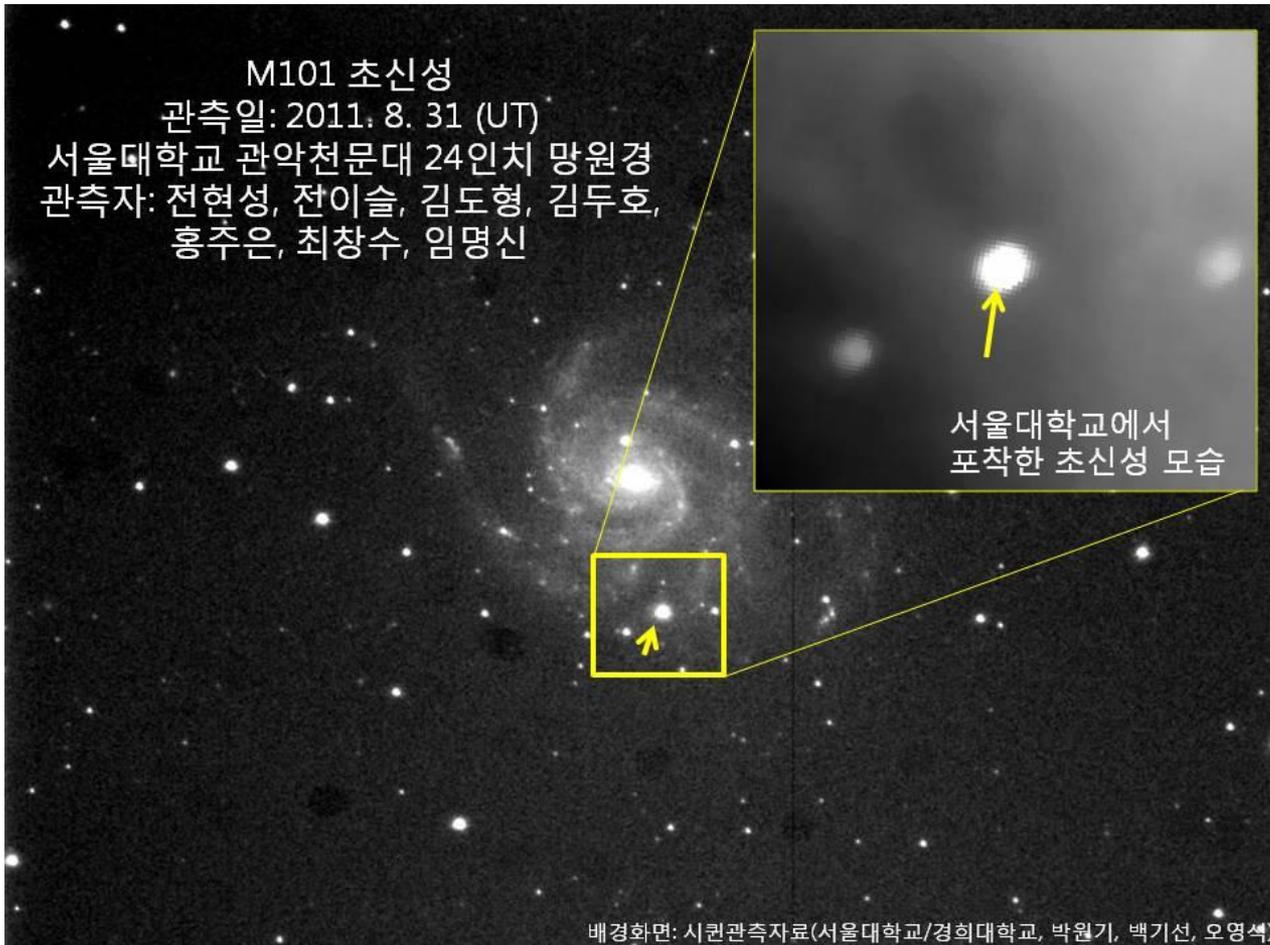


GRB 101225A



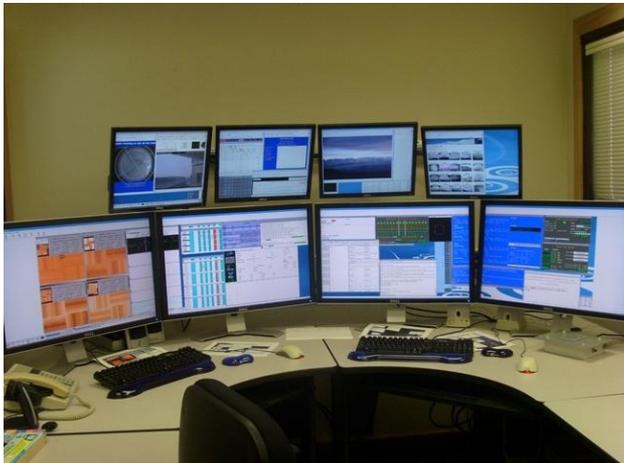
- 연구단 두 번째 Nature논문 (Thone et al. 2011)
- CQUEAN을 이용한 첫 연구성과

M101 SN

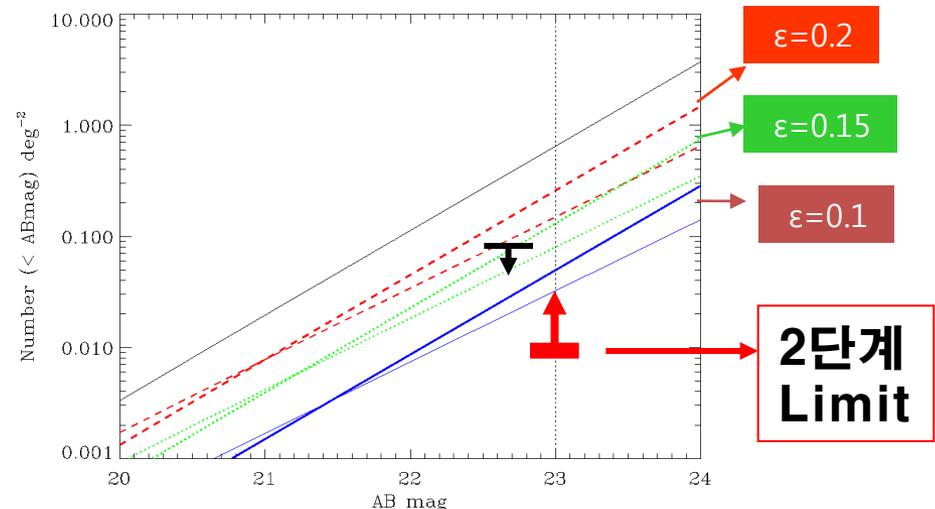


Infrared Medium-deep Survey

- UKIRT 활용: 연간 25일 - 40일(원격관측)
- CQUEAN 관측: McDonald 천문대 2.1m 연간 30-60일
- 약 120평방도에 대한 탐사자료 축적
- 10여 개의 은하단 발견 기대 → 수십 개의 은하단 발견 기대 → 거대블랙홀과 은하의 형성/진화 과정 규명
- UKIRT자료를 이용한 공동연구 환영



UKIRT 원격 관측실



초기우주 퀘이사 수밀도($z > 6.5$)

Overview

- High redshift clusters (김재우)
- Properties of high redshift galaxies (이성국)
- High redshift quasars (전이슬)
- Future NIR survey with UKIRT (김지훈)
- GRB/Transients (윤용민)
- Galactic objects (백기선)
- Gravitational lens (탁윤찬)
- Future project (박수종)