The Treasury of the AKARI NEP field

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Presented by (Kevin) Ting-Chi Huang

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June 5th, 2019

Outline

- Introduction
  - AKARI space telescope
- Data
  - NEP survey
- Studies
  - AGN/SF separation
  - Cluster candidates
- Summary

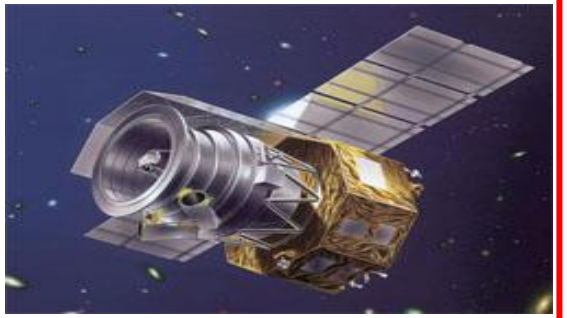
Introduction

AKARI space telescope

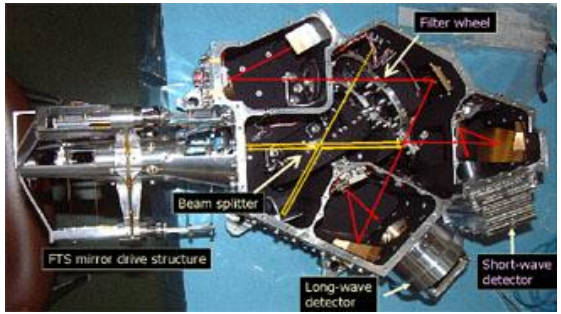
Introduction: AKARI

A space telescope made by JAXA. (2006~2011)

Far Infrared Surveyor (FIS)



Infrared Camera (IRC)



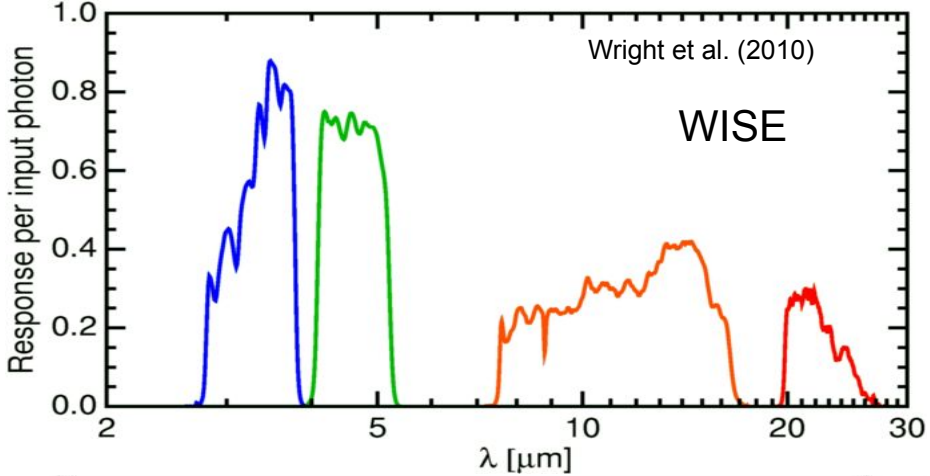
AKARI space telescope

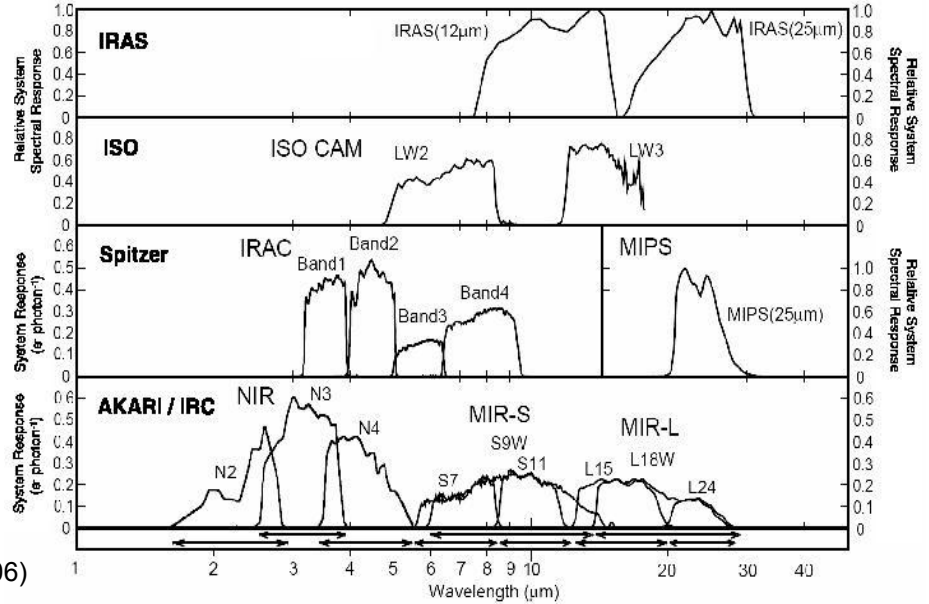
Credit: JAXA

Introduction: AKARI's advantage

Other IR Observatories including WISE and Spitzer have only 4 bands in mid-IR, and they have observation gap in general.

AKARI IRC has 9 bands with continuous wavelength coverage in mid-IR, so that we are able to avoid the uncertainties from interpolation in SED fitting.

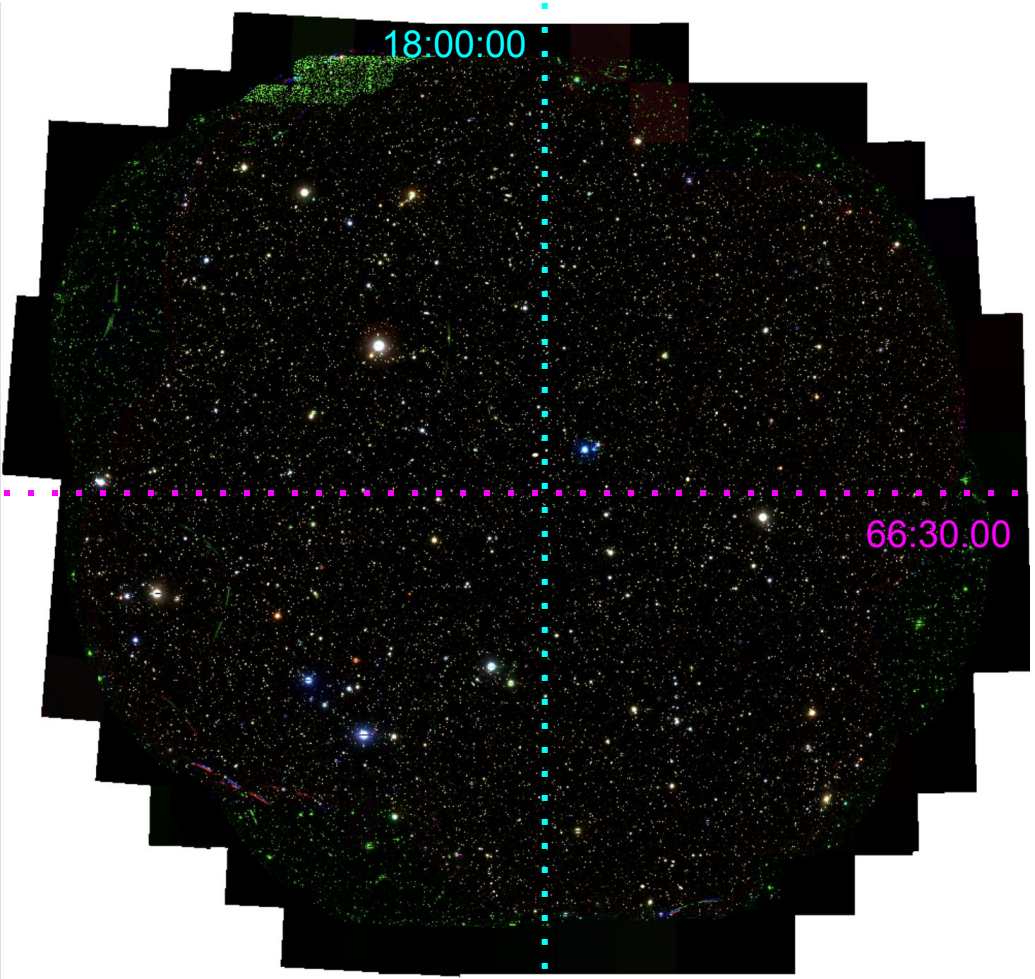




Matsuhara et al. (2006)

Data

The AKARI NEP survey



AKARI North Ecliptic Pole (NEP) field

- 5.4 square degree
- ~72000 AKARI-HSC sources
- CFHT MegaCam/u*,g',r',i',z'
- Subaru HSC/g, r, i, z, Y
- KPNO 2.1 FLAMINGOS/J, H
- CFHT WIRCam/Y, J, Ks
- AKARI IRC/ 9 bands
- WISE W1, W2, W3, W4
- Spitzer IRAC 3.6 and 4.5
- Herschel PACS/100,160
- Herschel SPIRE/250,350,500

Current status of the NEP research

NEP deep

- ❖ AKARI catalog: K. Murata et al. 2013
- ❖ Optical data (CFHT) and photo-z: N. Oi et al. 2014
- ❖ Near-infrared data (KPNO): K. Imai et al. 2014 and Y. Jeon et al. 2014
- ❖ X-ray data (Chandra): M. Krumpe et al. 2015
- ❖ Luminosity function: T. Goto et al. 2015
- ❖ AGN selection: T.-C. Huang et al. 2017

NEP Wide

- ❖ AKARI catalog: S.-J. Kim et al. 2012
- ❖ Optical data (HSC): N. Oi et al. 2018
- ❖ Far-infrared data (Herschel): C. Pearson et al. 2019
- ❖ Luminosity function: T. Goto et al. 2019
- ➢ Band-merged catalog: Seong-Jin Kim, Nagisa Oi
- ➢ Photo-z: Simon Ho
- ➢ AGN fraction and SED fitting: Tina Wang
- ➢ Cluster candidates: Ting-Chi Huang
- ➢ Data server: Ho-Seong Hwang
- ➢ Morphology: Eunbin Kim, Matt Malkan

AGN/SFG separation in the AKARI NEP deep field

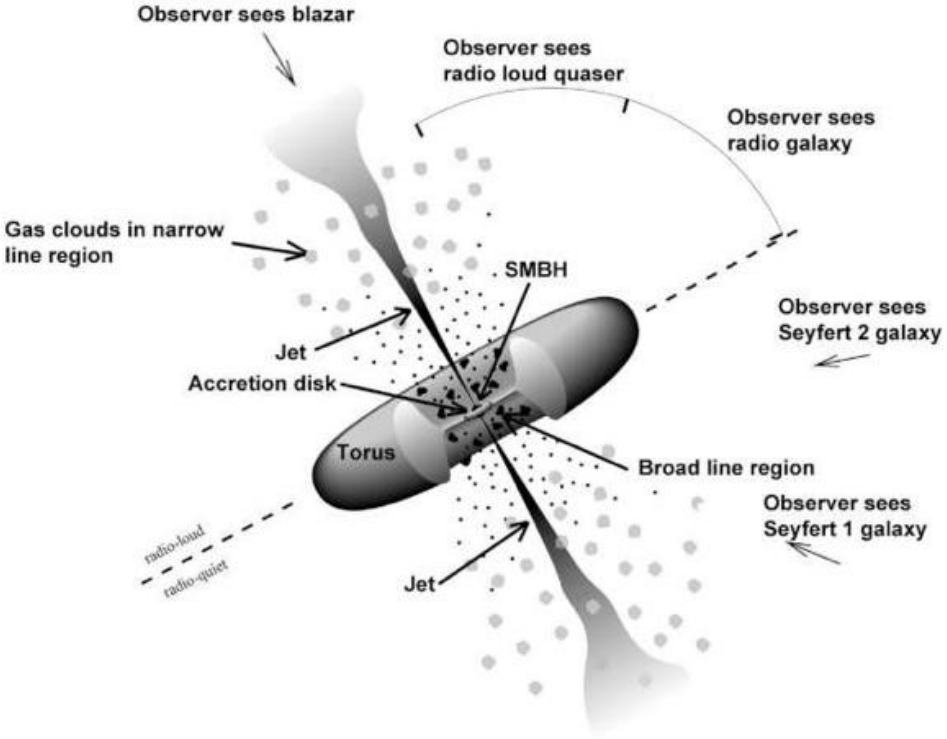
MNRAS 471, 4239

AGN/SFG separation

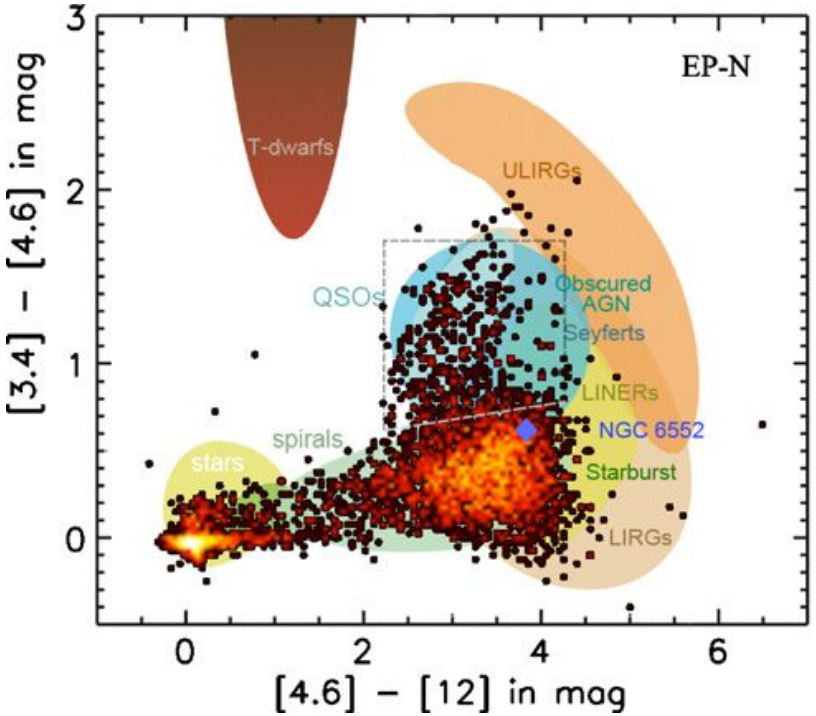
Active Galactic Nucleus (AGN) plays an important role in galaxy evolution.

Because of the dusty torus, AGN tends to be obscured and be missed in UV, optical and soft X-ray observations.

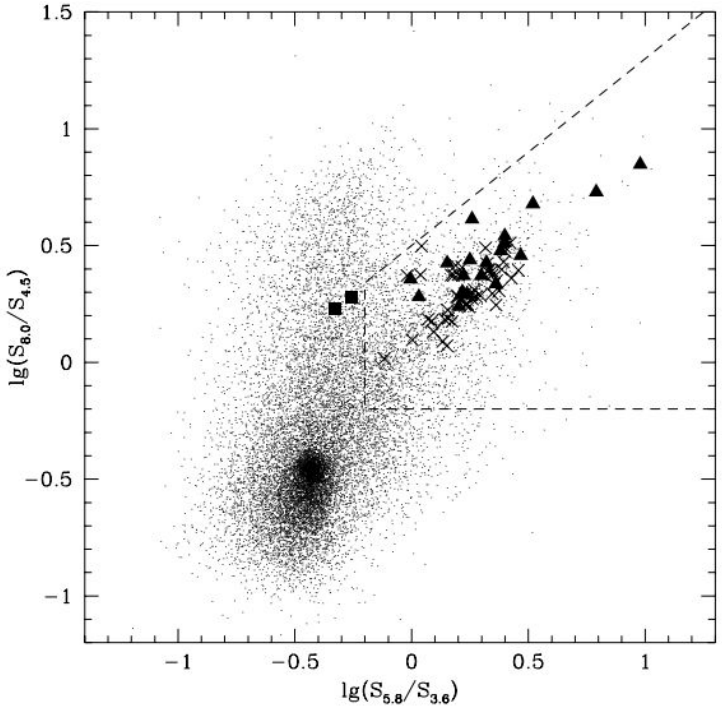
However, we can use infrared to observe obscured AGNs.



AGN/SFG separation



Jarrett et al. (2011)



Lacy et al. (2004)

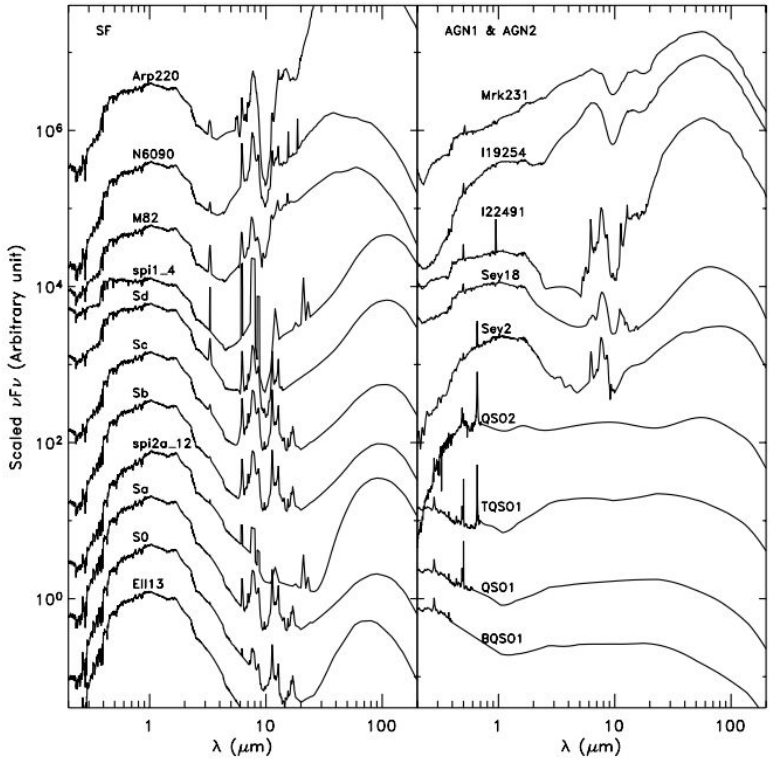
AGN/SFG separation

Star-forming galaxies (SFGs)

Polycyclic aromatic hydrocarbon (PAH) emission features at 3.3, 6.2, 7.7, 8.6, and 11.3μm

Stellar component from UV to NIR

Polletta et al. (2007)

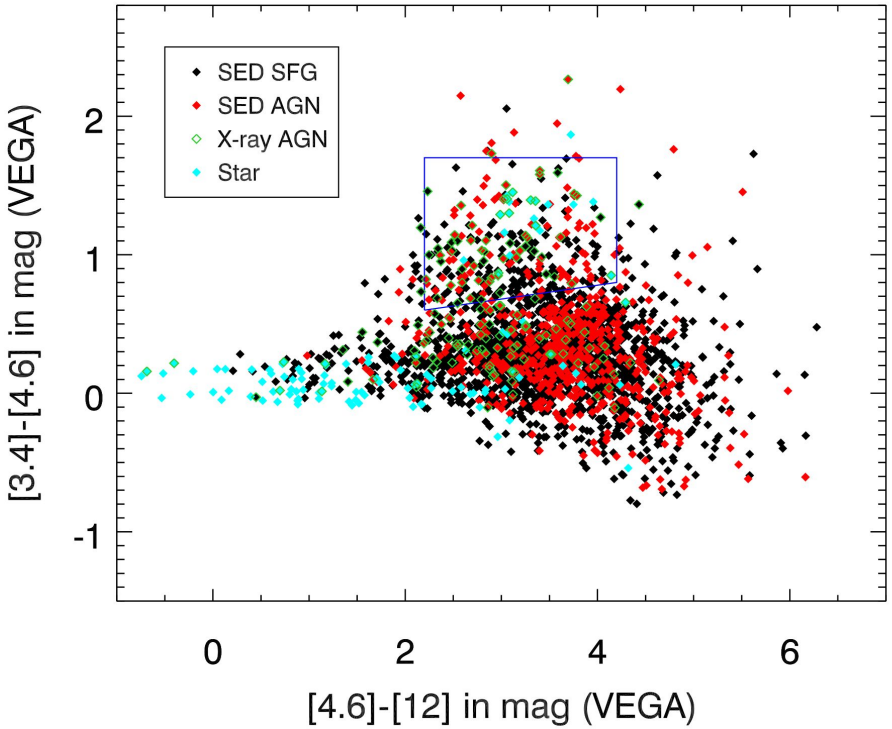


Active Galactic Nuclei (AGN)

Warm dust continuum emission in IR due to blackbody radiation (A power law spectrum)

Silicate absorption at 9.7μm

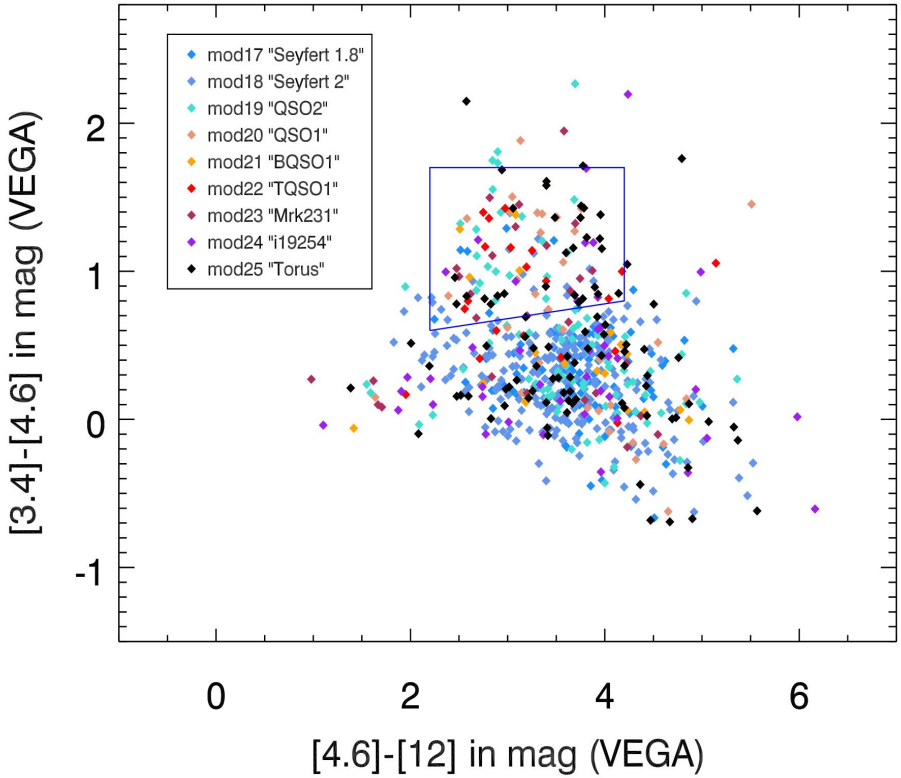
Results: Comparison with color-color diagram



- AGN selection criteria in WISE color-color diagram. (Jarrett et al. 2011)
- X-ray AGN catalog from Chandra NEP field survey. (Krumpe et al. 2014)
- Star-Galaxy separation by CLASS_STAR parameter of 0.9 in SExtractor.

The criteria are defined to cover QSOs, so moderately luminous AGNs and ULIRGs are missed.

Results: Comparison with color-color diagram

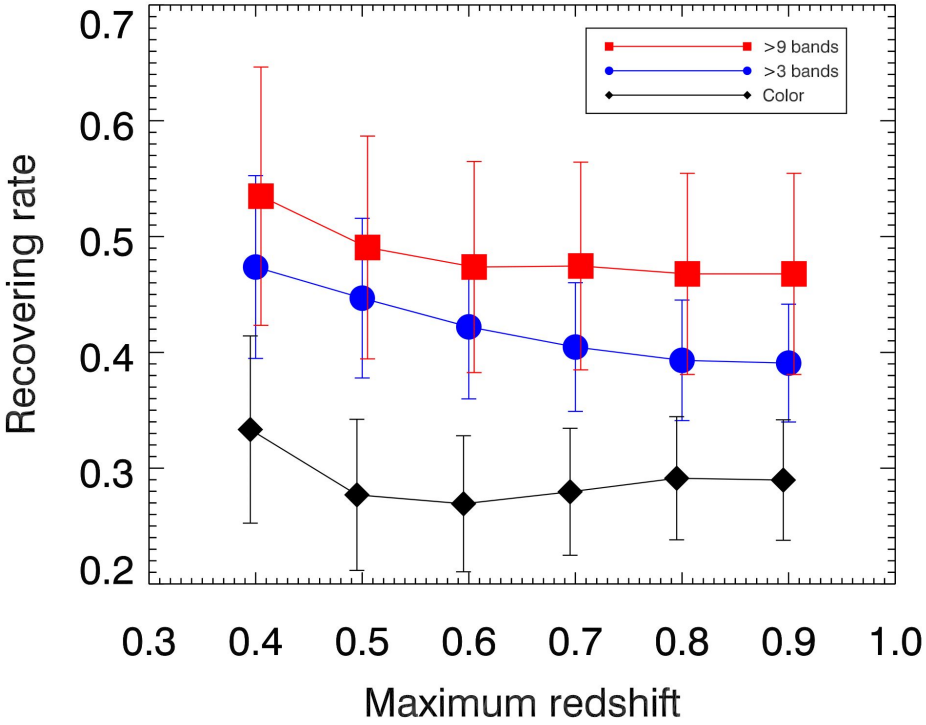


- SED AGNs in WISE color-color diagram. (Jarrett et al. 2011)
- 9 best-fitting models are plotted in different colors.

The objects outside the box are mainly Seyfert 1.8 and Seyfert 2.

SED fitting could capture the host-dominated or moderately luminous AGNs, which color methods usually miss.

Results: X-ray examination and recovering rate



- 254 X-ray AGNs.
- Comparison of AGN selection between SED fitting and color box in X-ray AGN samples.

The fraction of AGN selected in the 254-X-ray-AGN sample is defined to be recovering rate.

SED fitting has higher recovering rate than color-color diagram selection.

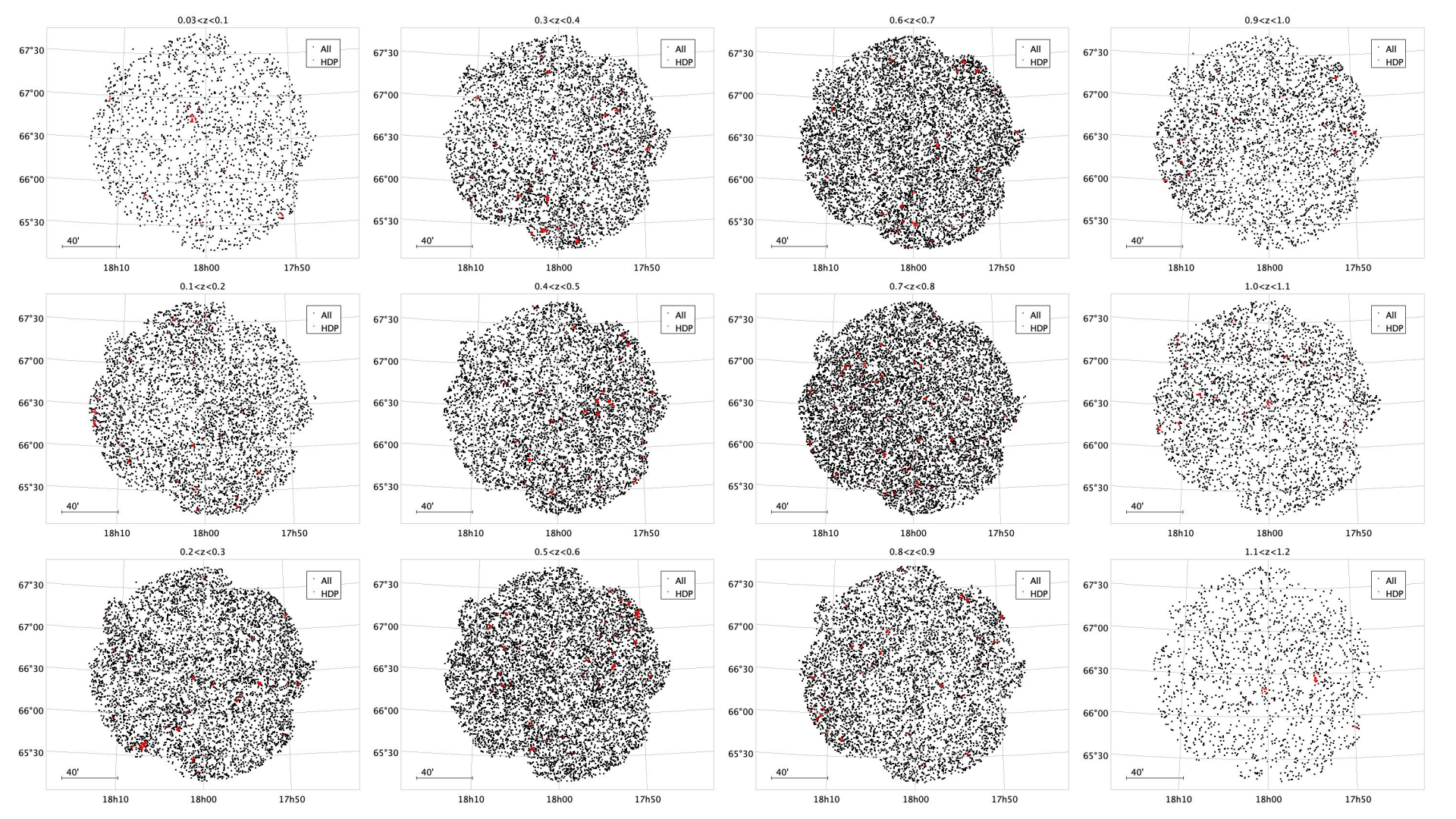
Having as many bands as possible is beneficial in SED fitting.

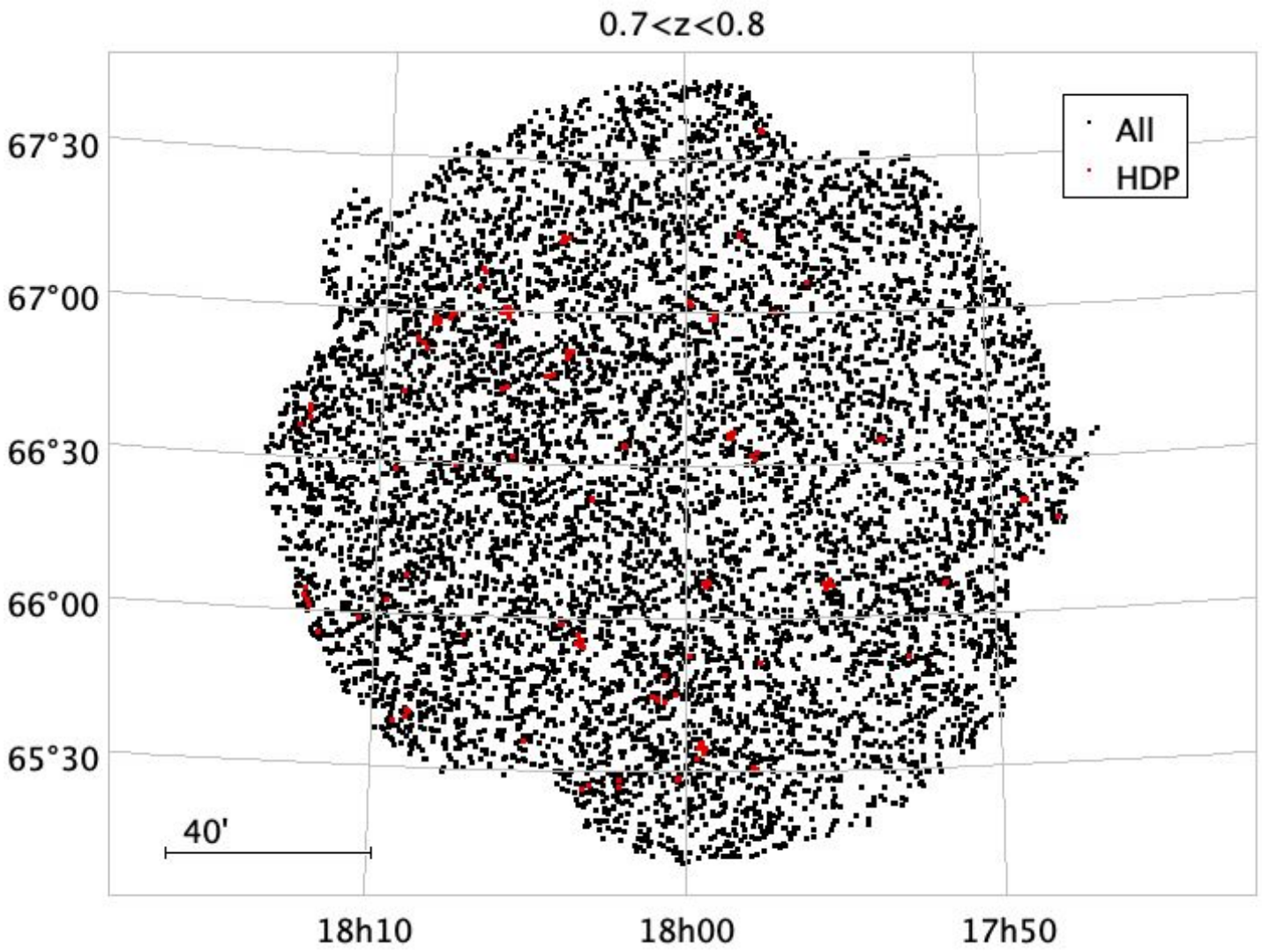
Galaxy cluster selection

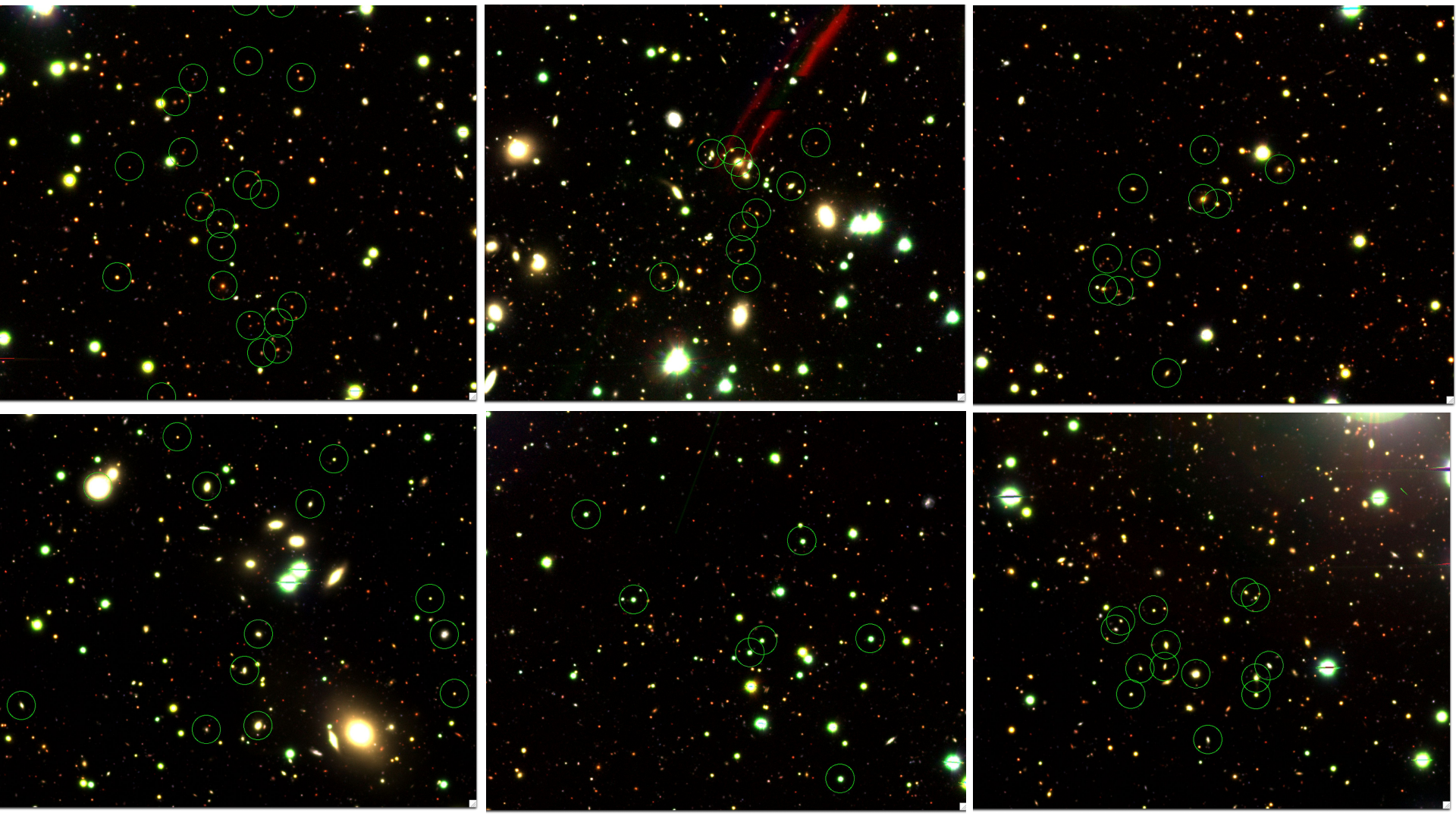
Method

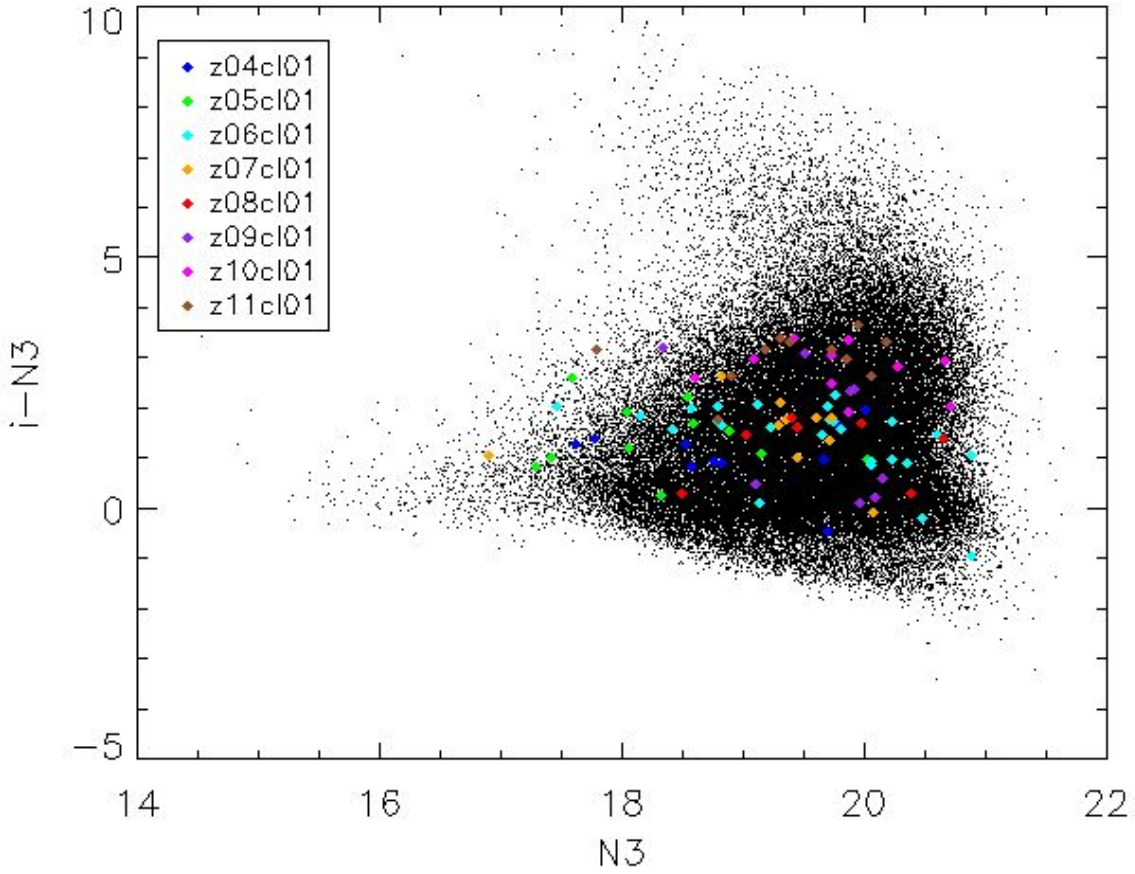
- Redshift bins from 0 to 1.2 (bin size 0.1)
- High density peaks are defined by 3-sigma of the local number density in the 10th-nearest neighborhood.
- Applied friend-of-friend algorithm to high density peaks to obtain cluster candidates. (linking length = 1.5 Mpc, group members > 7)

★ Because the data are still under construction, this result is just preliminary and uncertainty might be high.


0.03<z<0.1
0.3<z<0.4
0.6<z<0.7
0.9<z<1.0
0.1<z<0.2
0.4<z<0.5
0.7<z<0.8
1.0<z<1.1
0.2<z<0.3
0.5<z<0.6
0.8<z<0.9
1.1<z<1.2
All
HDP
40'
67°30
67°00
66°30
66°00
65°30
18h10
18h00
17h50


0.7<z<0.8
All
HDP
67°30
67°00
66°30
66°00
65°30
40'
18h10
18h00
17h50





- 4000 angstrom break.
- Stellar bump at 1.6 micron.

Color evolution can roughly be seen.

Some cluster candidates look promising.

Summary

AKARI NEP field is fruitful with multi-wavelength data from X-ray to far-infrared, especially the 9-band IRC photometry in mid-infrared.

AGN selection by SED fitting with AKARI's 9-band mid-infrared photometry can identify the AGN missed by previous color-color methods.

We have established a method to select galaxy candidates by k-th nearest neighbor density and friend-of-friend algorithm.