

Cosmology Near & Far : Science with WFMOS

(May 19 , 2008 @ Kona)

Wide-field Observation of Distant Clusters of Galaxies

Yusei Koyama (Univ. of Tokyo)

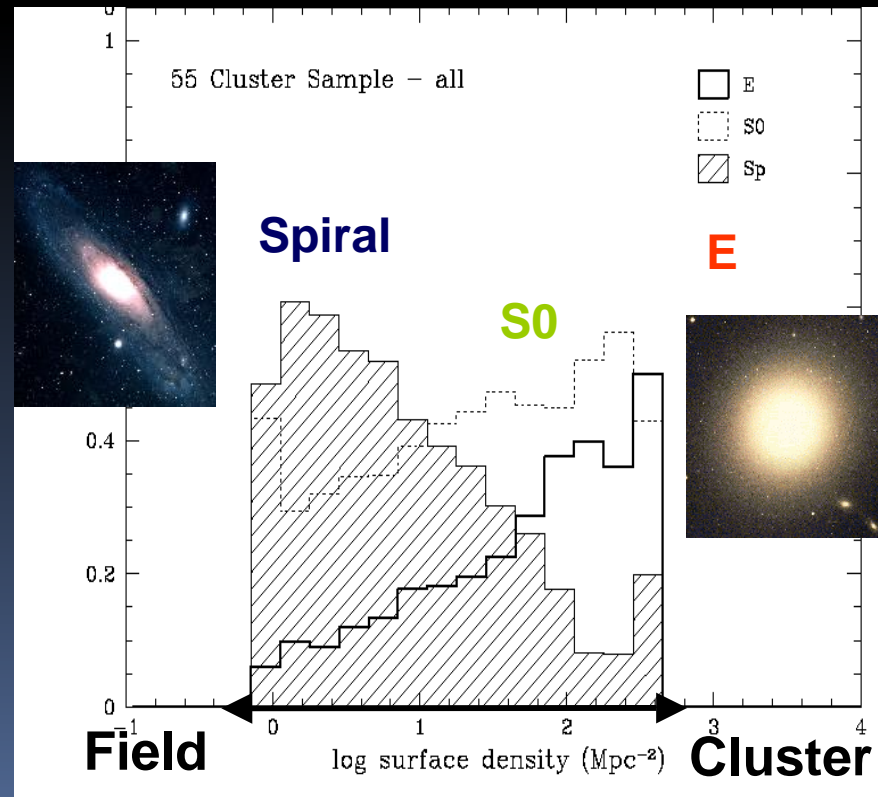
T. Kodama (NAOJ) , K. Shimasaku (Univ. of Tokyo)

S. Okamura (Univ. of Tokyo) , M. Tanaka (ESO),

AKARI CLEVL Team (H.M. Lee et al.)

Environment Dependence of Galaxy Properties

Morphology-Density Relation in the Local Universe



low density

- blue color
- high SF

high density

- red color
- low SF

(Dressler et al. 1997, 1980)

When, where, how the dependence is established ?

Galaxy Evolution in high-density environment

Galaxy transformation in high-density environment



Field



transformation



Cluster / Group

Physical Processes ?

- **Ram-pressure stripping**
(Gunn & Gott 1972)
- **Galaxy-galaxy interaction**
(Toomre & Toomre 1972)
- **Harassment**
(Moore et al. 1996)
.... etc.

PISCES project

(PI: T. Kodama)

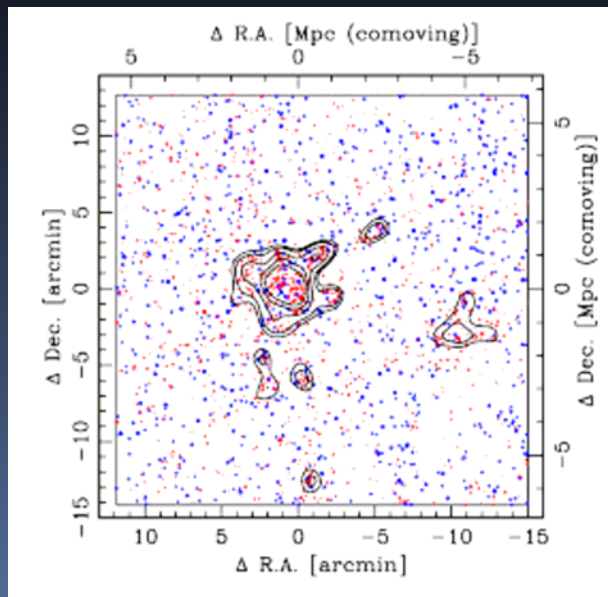
See also Kodama-san's talk

Panoramic Imaging and Spectroscopy of Cluster Evolution with Subaru

Prominent large-scale structures are discovered in the distant universe

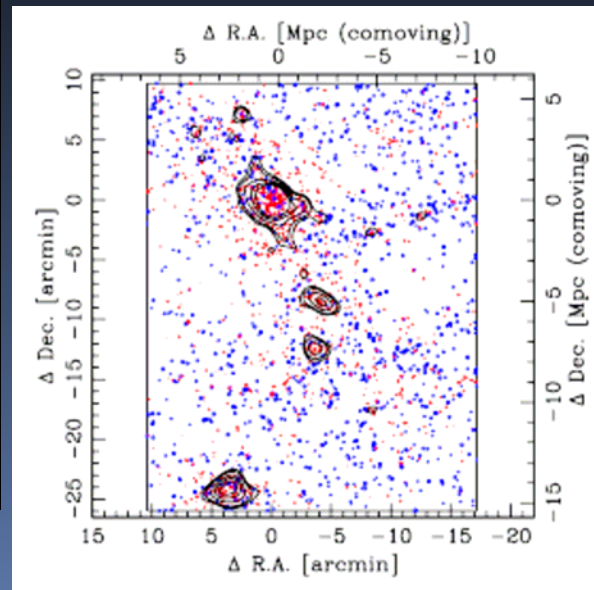
→ can investigate various environments at once!

CL0939 ($z=0.41$)



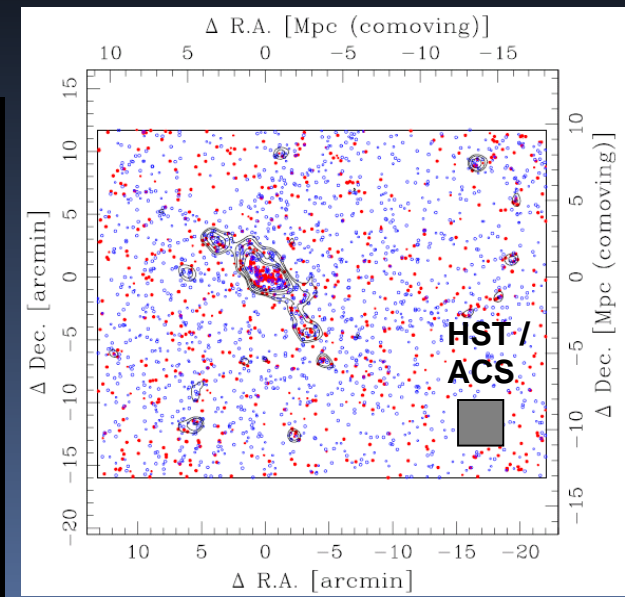
Kodama et al. 2005

CL0016 ($z=0.55$)



Tanaka et al. 2005

RXJ1716 ($z=0.81$)



Koyama et al. 2007

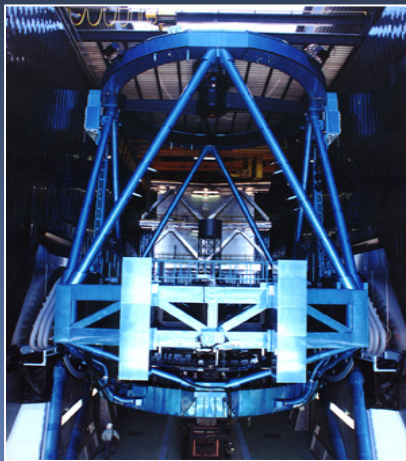
This study

Panoramic and multi-wavelength study

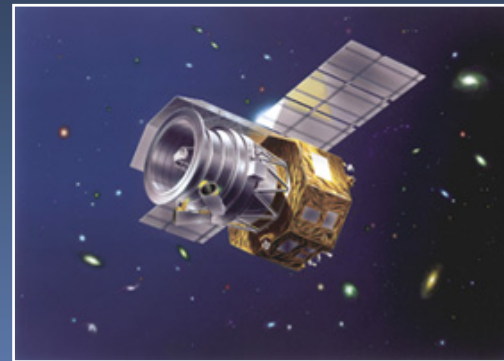
of a distant galaxy cluster RXJ1716 ($z=0.81$)

- (1) : wide-field **optical** imaging with Subaru
 - study the color and environment of galaxies

- (2) : wide-field **IR** imaging with AKARI
 - investigate (dusty) SF activity of galaxies

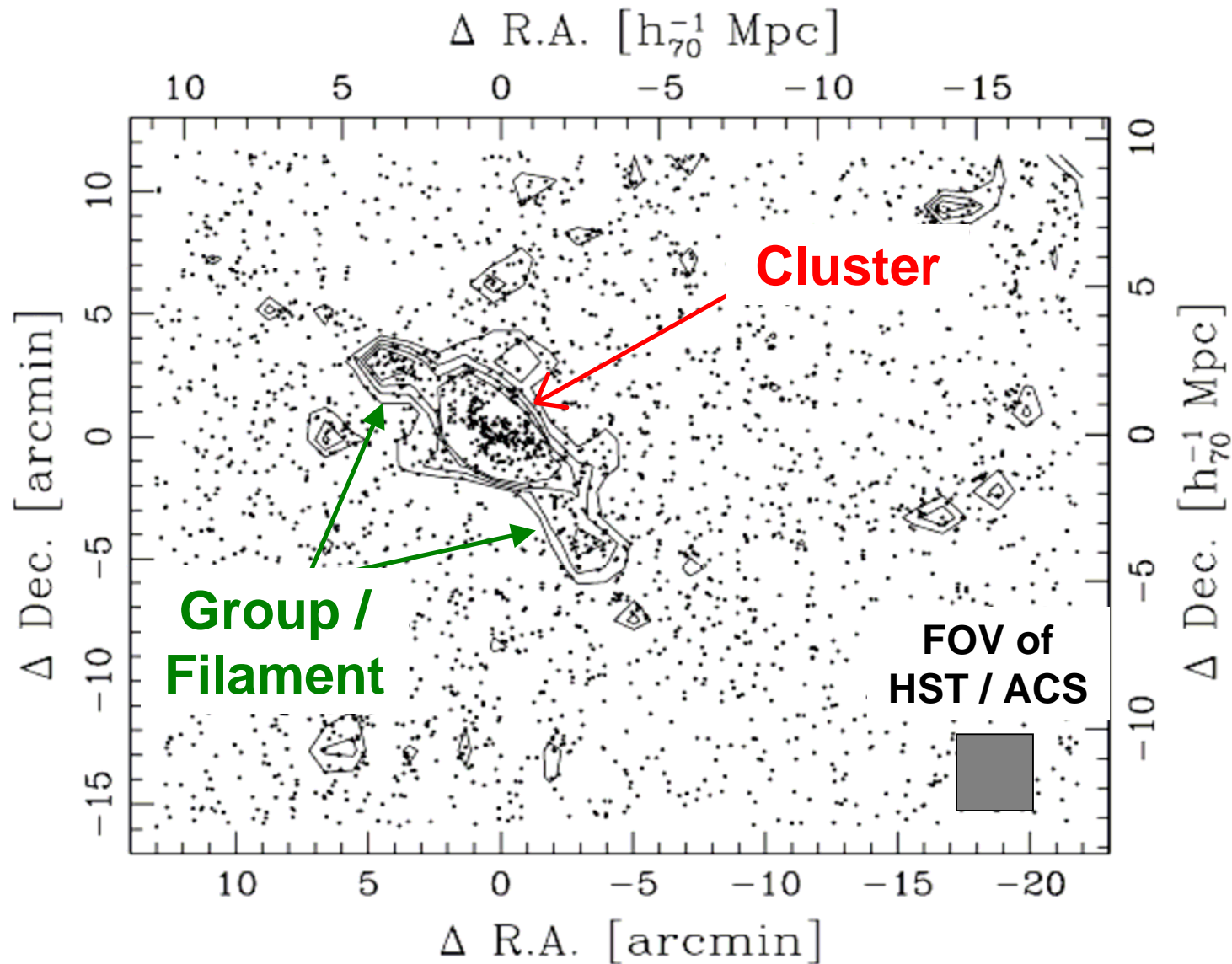


Subaru



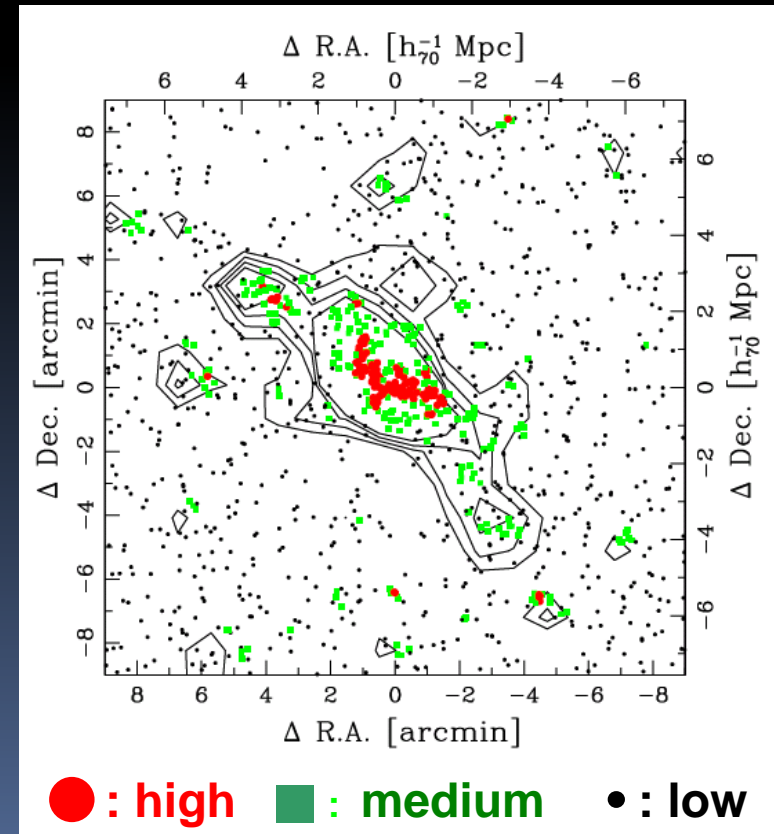
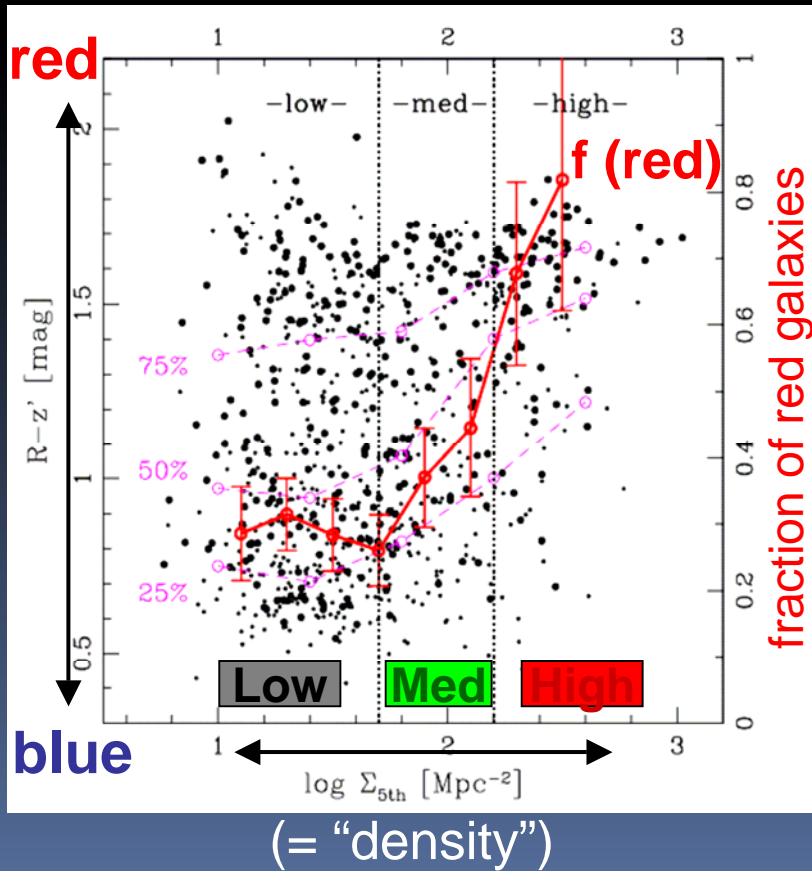
AKARI

Panoramic Optical Imaging of RXJ1716



The environment of galaxy transition

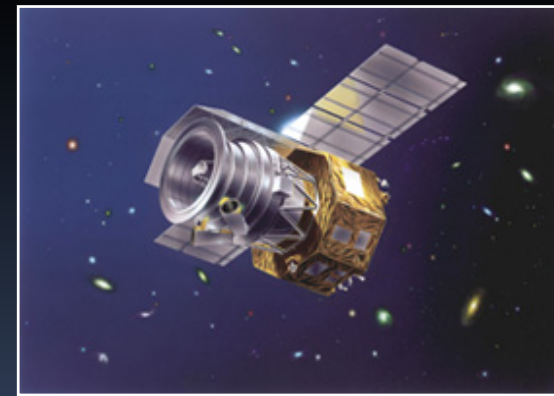
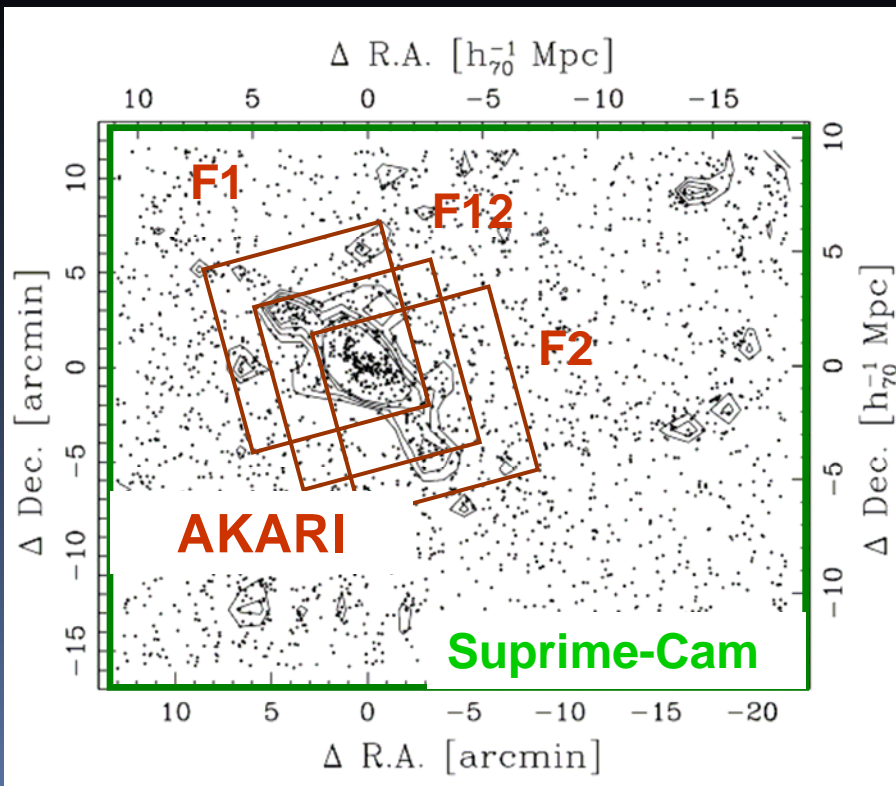
Color distribution starts to change in medium-density environment



Galaxy colors change in groups / filament environment

Next step : IR observation with AKARI

- NEP : good visibility of AKARI → RXJ1716 is intensively observed
- 200arcmin² in total : the widest-field MIR study around $z \sim 1$ cluster



• AKARI (IRC, FoV $\sim 10' \times 10'$)

$$N3 (3\mu\text{m}) = 105$$

min

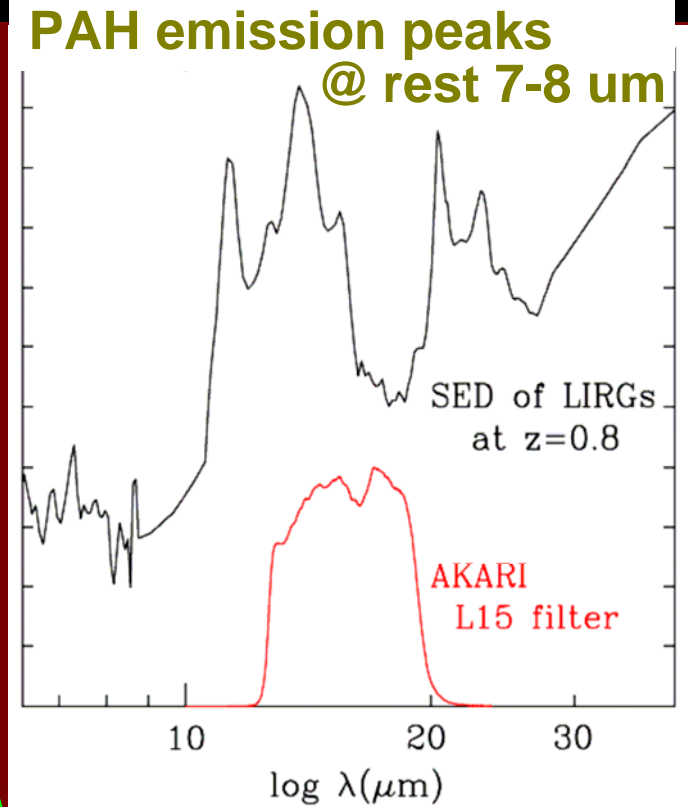
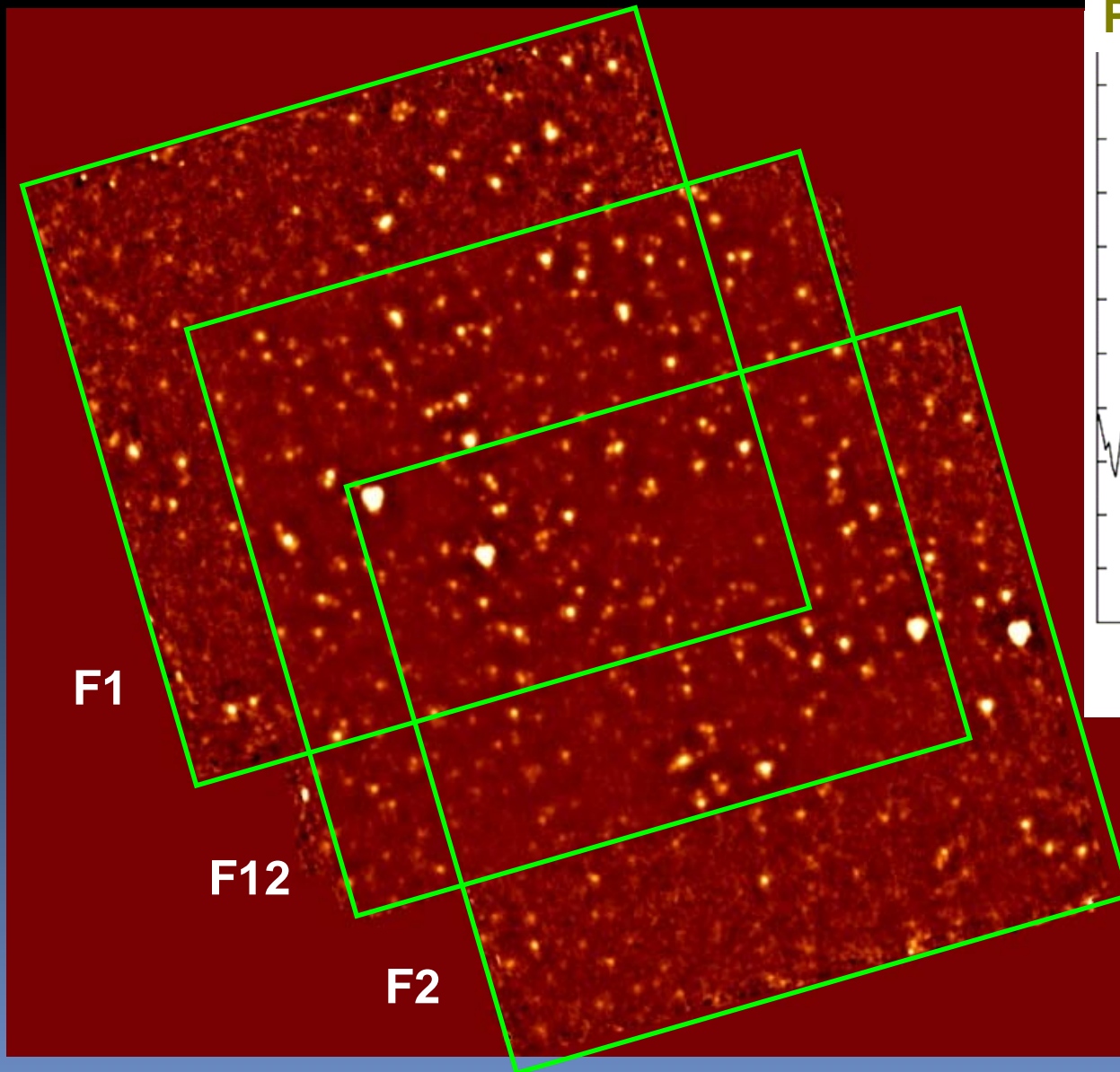
$$S7 (7\mu\text{m}) = 115$$

min

$$L15 (15\mu\text{m}) = 120$$

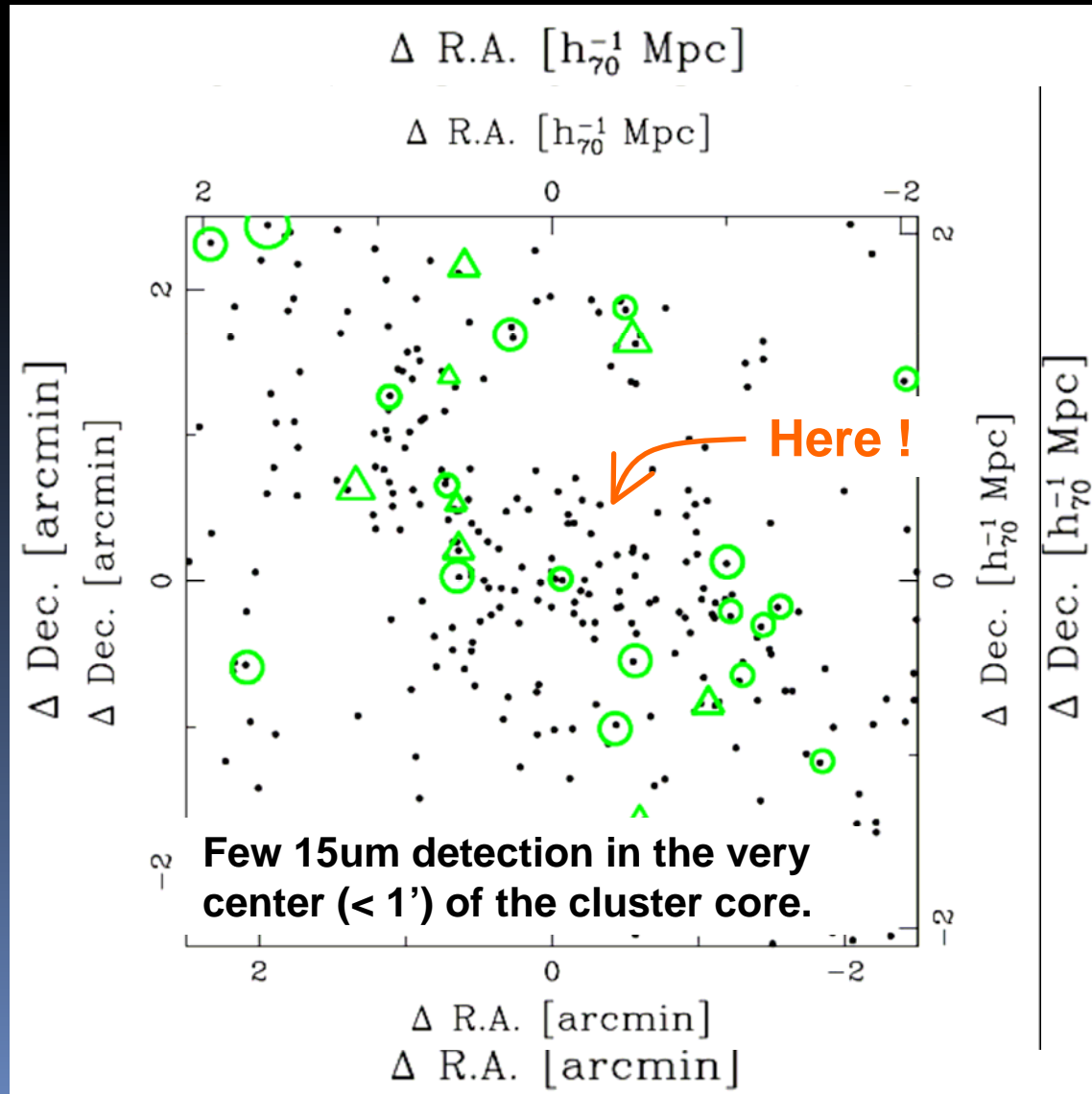
min

15um image of RXJ1716 cluster

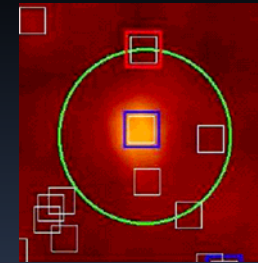


mapping dusty SF with
SFR > 20 Msun/year

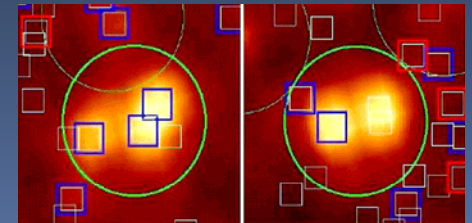
Distribution of 15um member galaxies



○ : "resolved"
members



△ : "unresolved"
members



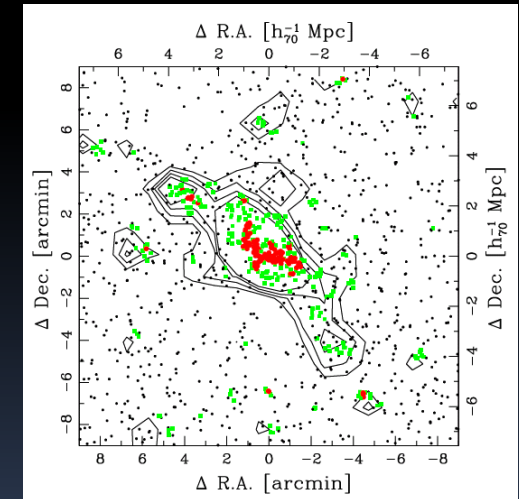
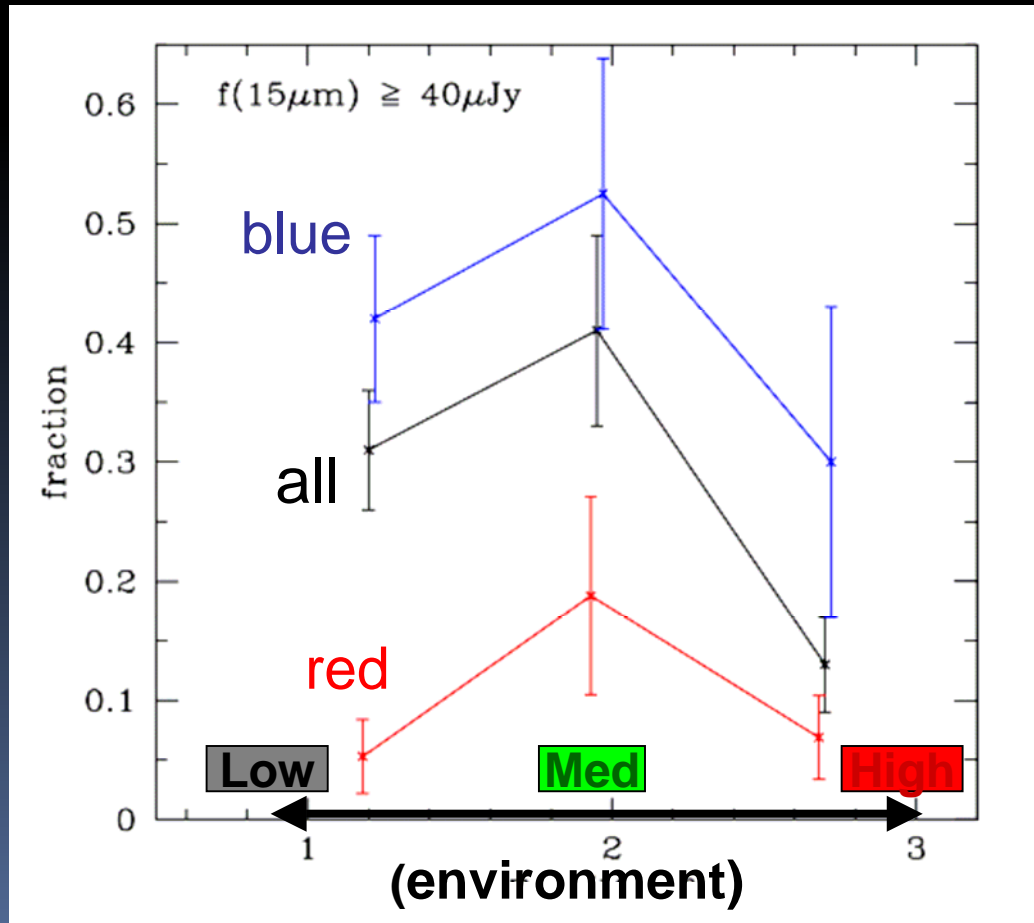
The environment of 15um sources

large fractions of 15um detection in the medium-density environment

f
(15um)

high

low

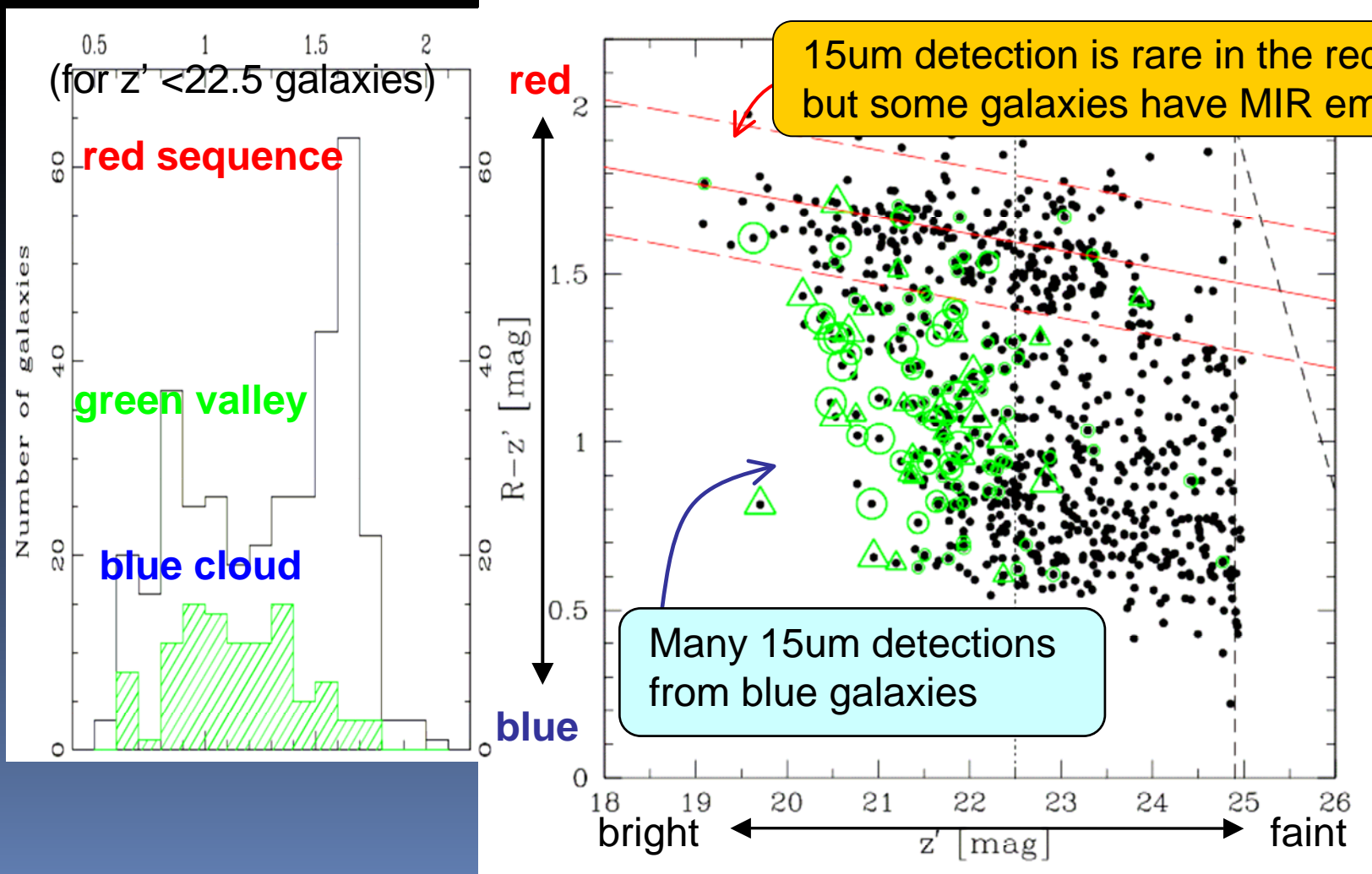


Enhancement of SF activity in the groups / filament ! ?

Link to the optical color transition ! ?

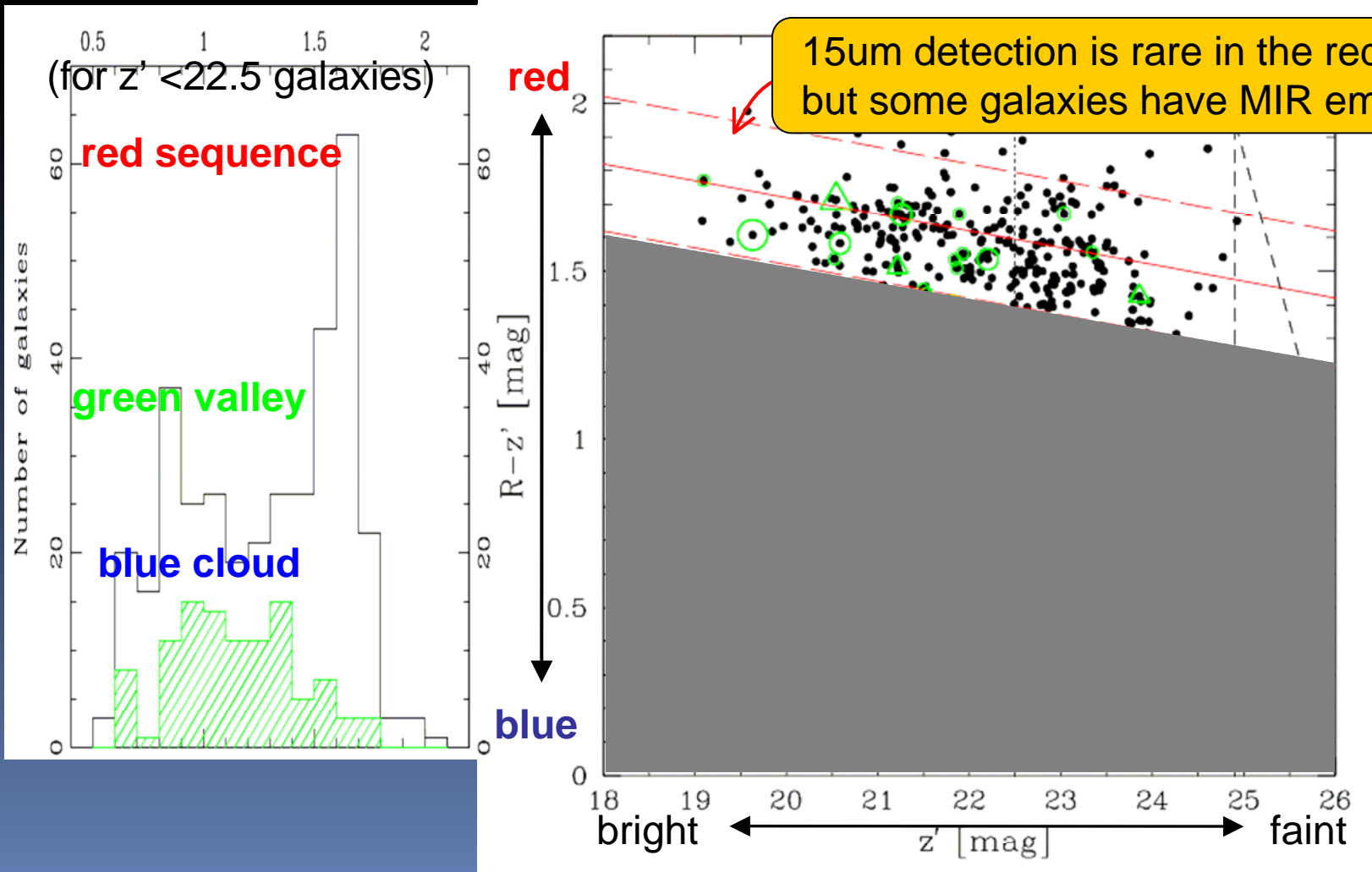
Optical colors of 15um members

15um members on the color-magnitude diagram



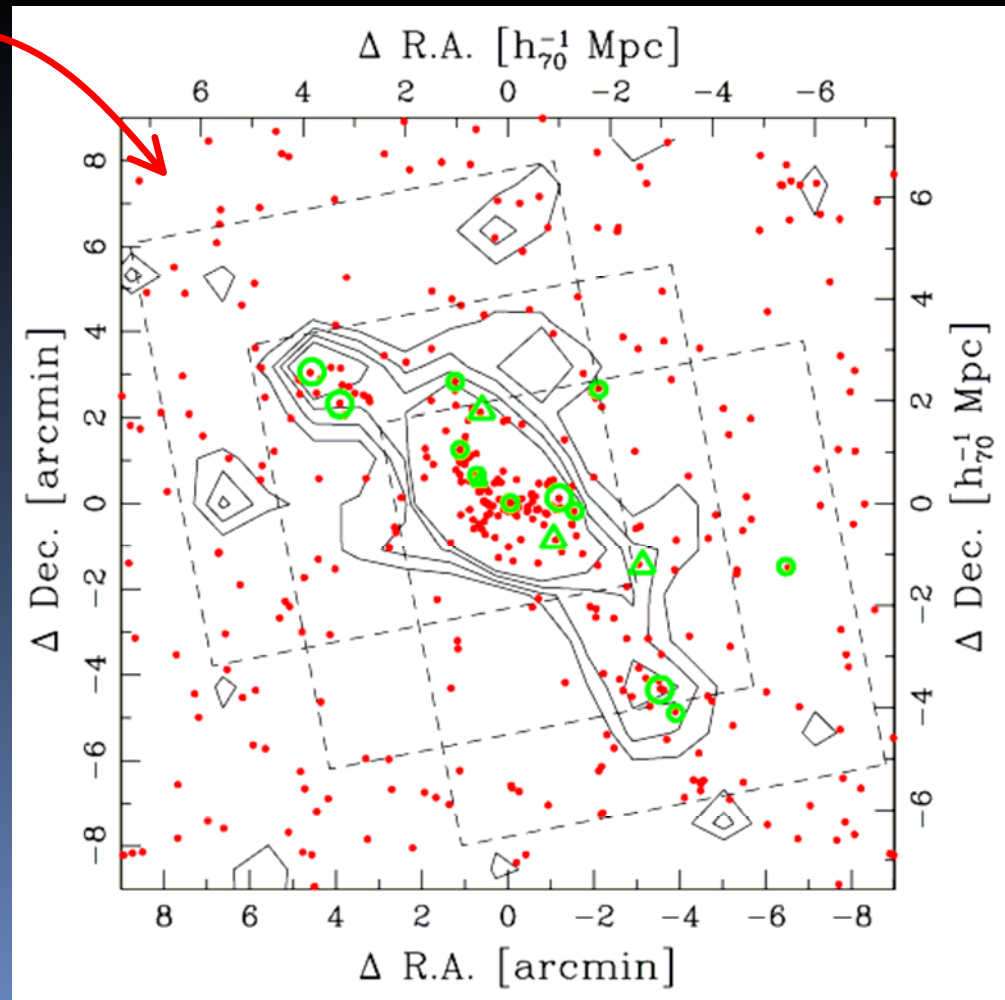
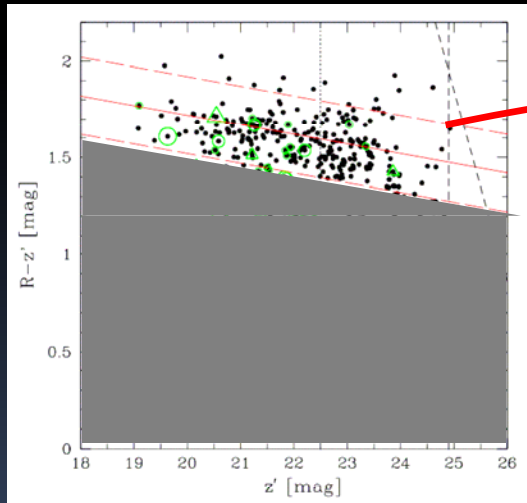
Optical colors of 15um members

15um members on the color-magnitude diagram



“Optically red” star forming galaxies

Dusty SF galaxies are distributed in the filament !
→ Dusty SF is induced inner the filaments ! ?



- : all red galaxies
- △ : 15 μ m detected gals among them
(= dusty SF gals.)

“Intensely” star forming galaxies

High SSFR galaxies are also found in the medium-density env.

$z' \sim$ stellar mass (Mstar)

L15 \sim star formation rate

(SFR)

$z' - L15$

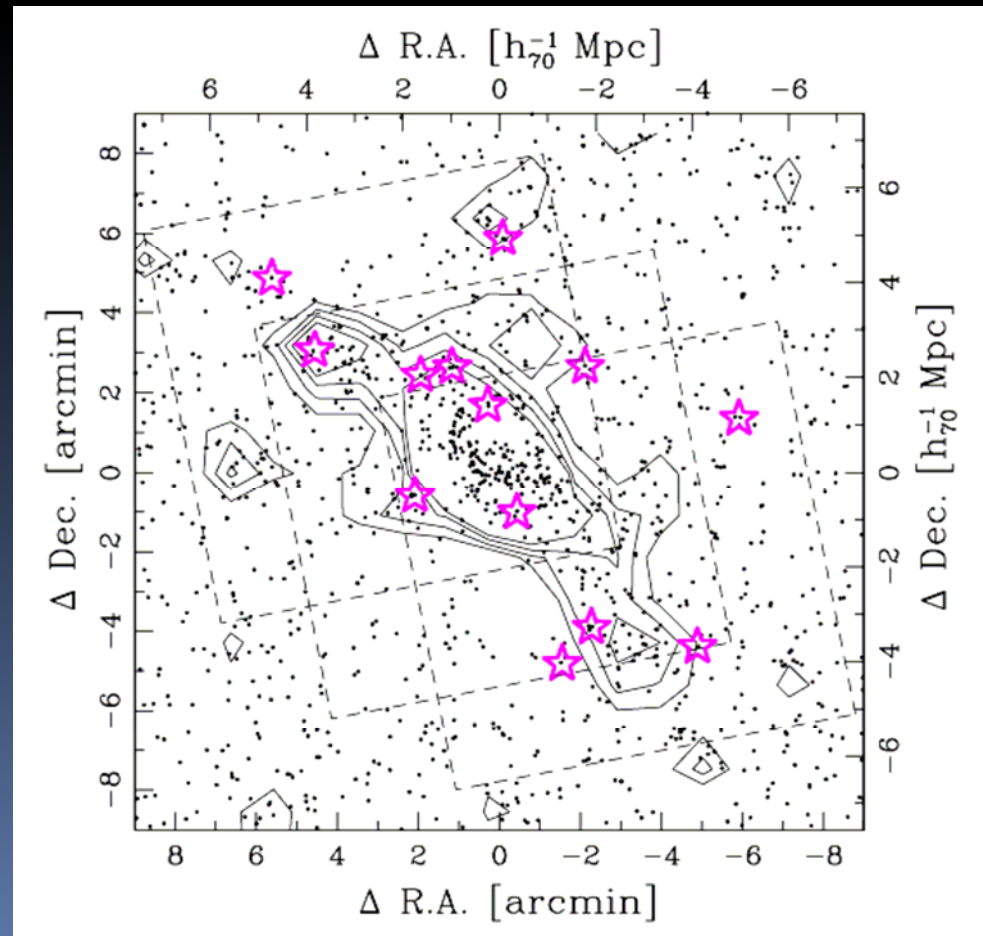
$$= -2.5 \log [f(z') / f(15)]$$

$$\sim \text{SFR} / M(\text{star})$$

“specific star formation rate”

$z' - L15$ value

\Leftrightarrow Efficiency of SF activity



“resolved members” only

Summary

Through the wide-field optical and infrared study, we suggest :

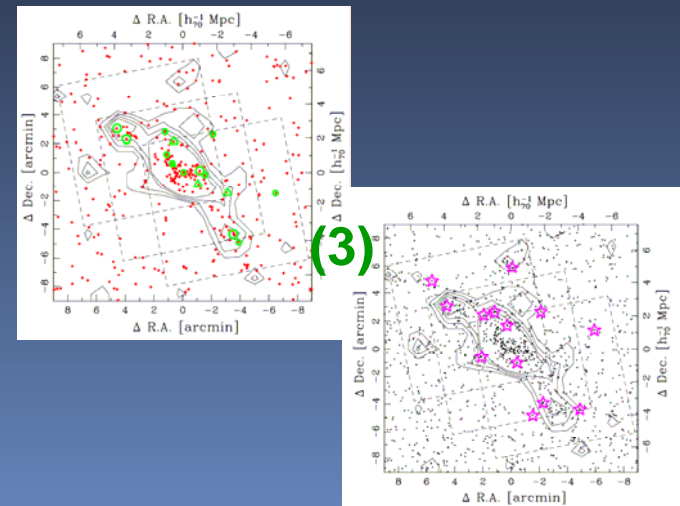
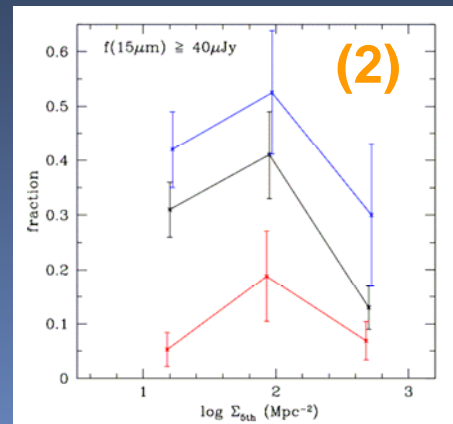
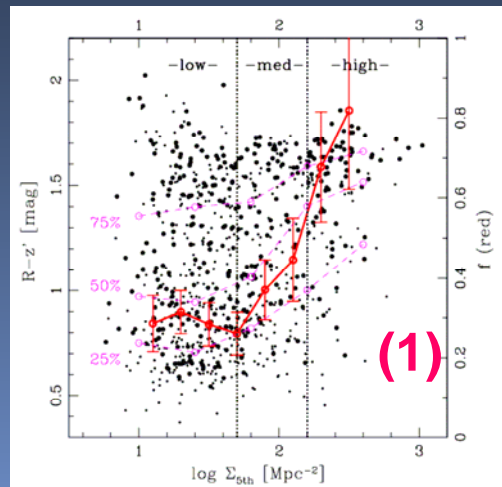
(1) Galaxy colors start to dramatically change in groups / filament

(2) MIR-detected galaxies prefer to live in groups / filament

-- SF activity is enhanced in these environments ?

(3) Dusty / intense SF galaxies also reside inner the filament

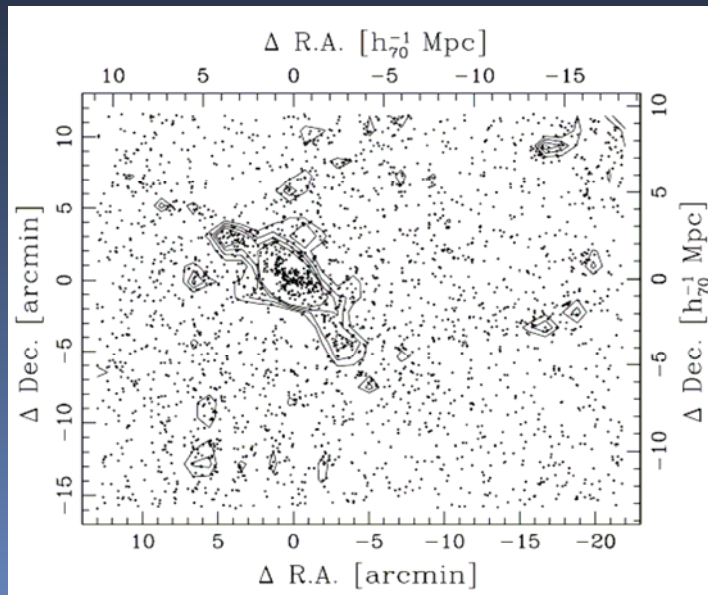
-- galaxy-galaxy interactions (or mergers) are working ?



Science with WFMOS

Constructing a large sample of *group / filament* in the distant universe

- No need to suffer from phot-z contaminations
- IR luminous galaxies in group / filaments live together with post-starburst galaxies ??



Thank you !