Clustering Properties of Lyman-break galaxies at z ～ 3 based on SXDS and UKIDSS UDS

Makiko Yoshida (Tokyo University)

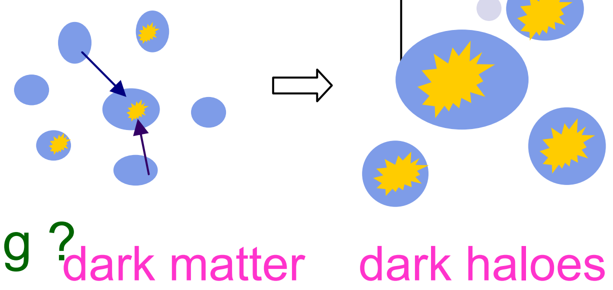
Kazuhiro Shimasaku, Sadanori Okamura (Tokyo University),
Kazuhiro Sekiguchi, Hisanori Furusawa (NAOJ),
Masami Ouchi (STScI)

Introduction

Galaxy Evolution
— Cold Dark Matter Model

Galaxies are born and evolve in Dark Haloes (DH).

To what dark haloes (given DH mass)
do galaxies of a given SFR, Mstar, dust, …etc belong ?



DH mass ⇔ Clustering strength

We study relation between properties of galaxies and DH mass based on clustering analysis of Lyman-break galaxies.

< Lyman-break galaxies>

- detected by spectral break at Lyman-limit redshifted into optical wavelengths
- young star-forming galaxies with strong UV continuum
- one of the most popular galaxy population at high redshift

<u>z ～ 3</u>

- the highest redshift where ground-based near-IR observation can scope rest-frame optical properties

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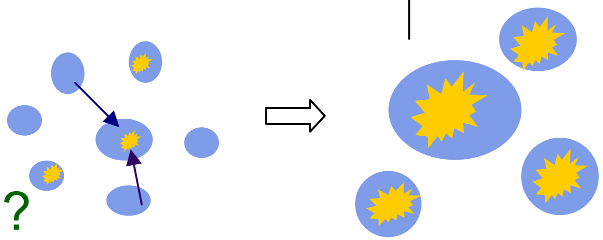

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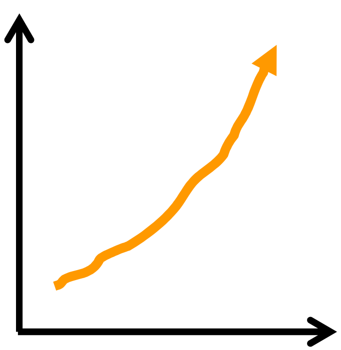

(e.g., Giavalisco & Dickinson 2001; Lee et al. 2006)

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— Cold Dark Matter Model

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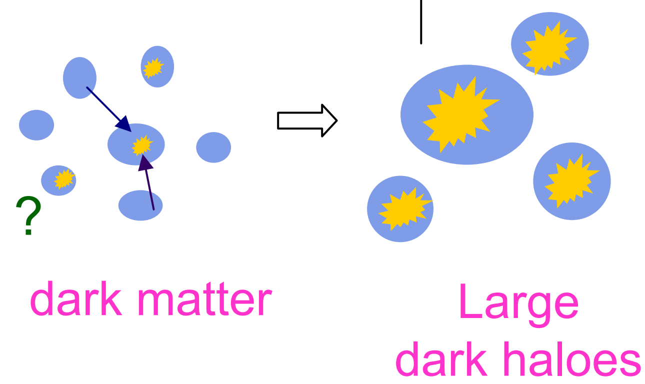

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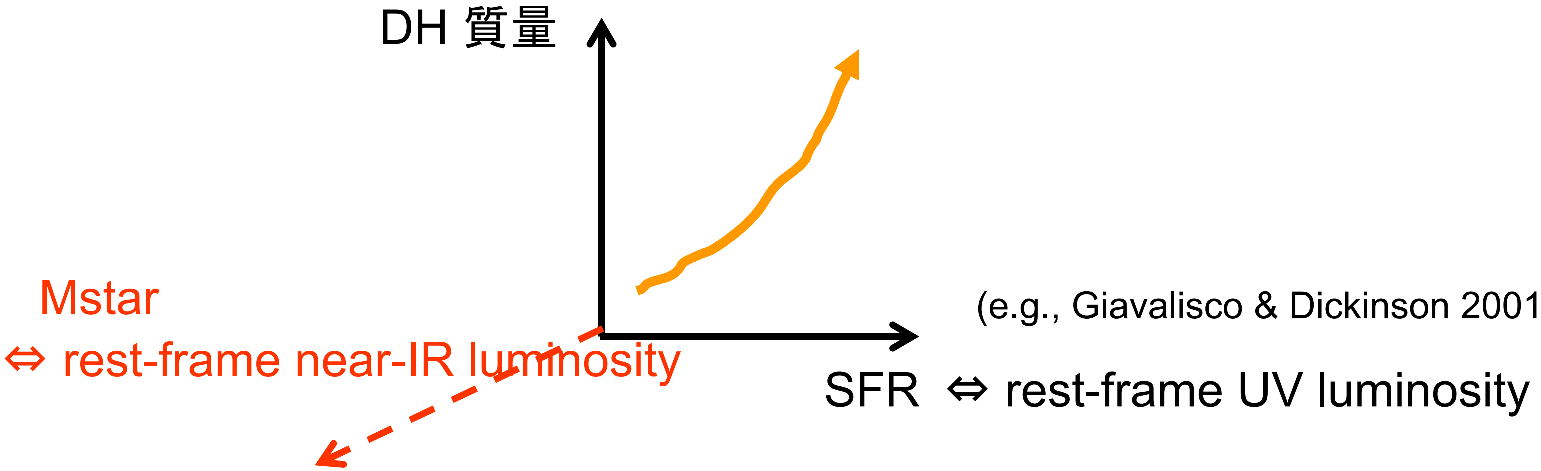

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Data

Optical data： SXDS Project

A project to carry out a multi-wavelength survey for a very large area (～1°).

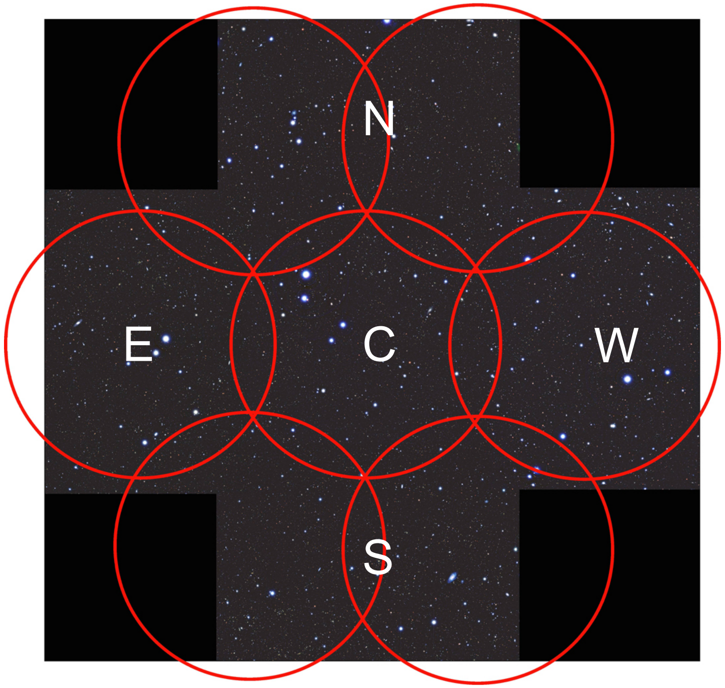
- field: Subaru XMM-Newton Deep Field
  (R.A., Dec) = (2h 18m, -5°)

- optical imaging:
  Subaru / Suprime-Cam

	B	V	R	i'	z'
limit mag. (mag.)	28.44	27.86	27.65	27.10	26.32

- U-band: only SXDF-S 26.97 (mag.)

- survey area (U － z’): 740 arcmin^2



Survey area of
optical (Subaru/Suprime-Cam),
And X-ray (XMM-Newton)

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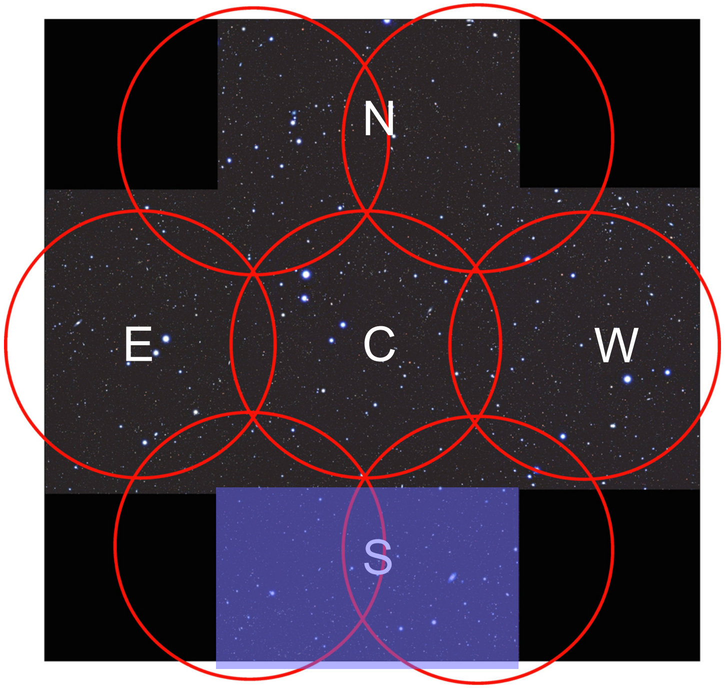


Survey area of U-band

Near-IR data： UKIDSS Ultra Deep Survey

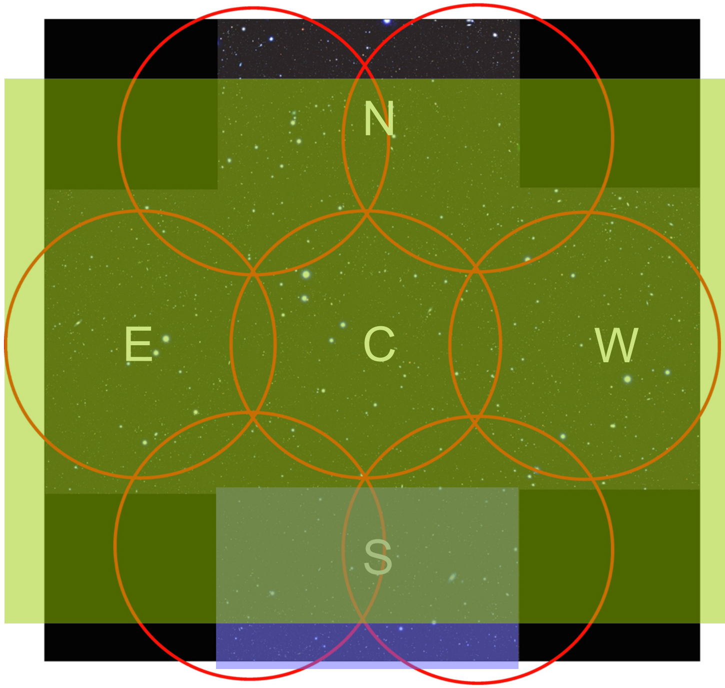
A project to carry out a multi-wavelength survey for a very large area (～1°).

- field: Subaru XMM-Newton Deep Field
  (R.A., Dec) = (2h 18m, -5°)

- near-IR imaging:
  UKIRT / WFCAM

	J	K
limit mag (mag.)	24.22	24.02

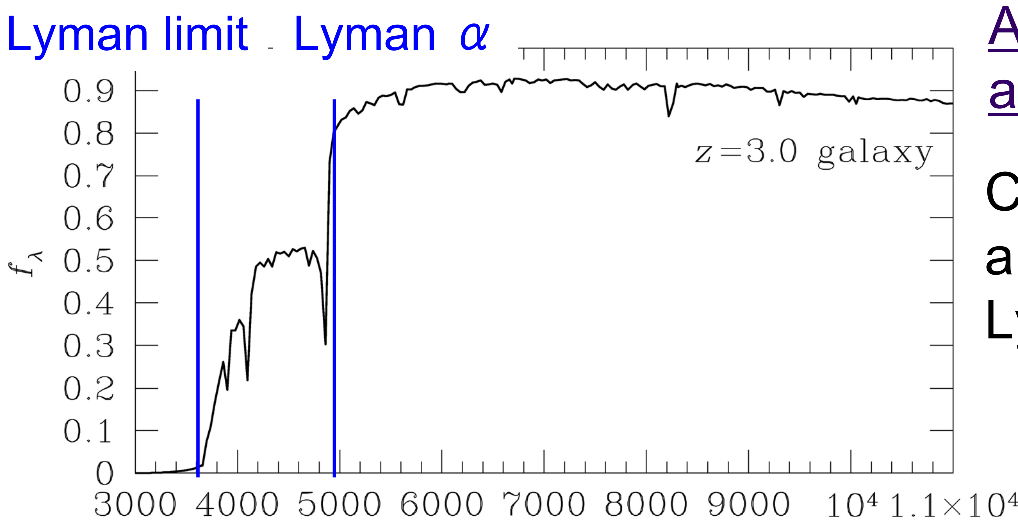
- survey area (U – z’, J, K): 561 $arcmin^2$



Survey area by UDS

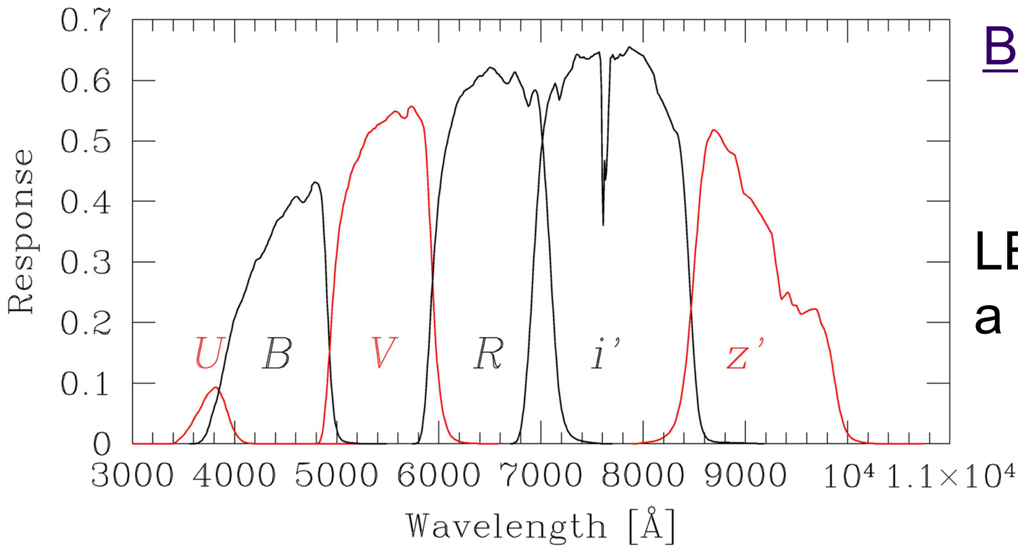
z ~ 3 LBG Sample

Detection of LBGs at z ～ 3



<u>A typical spectrum of a young star-forming galaxy</u>

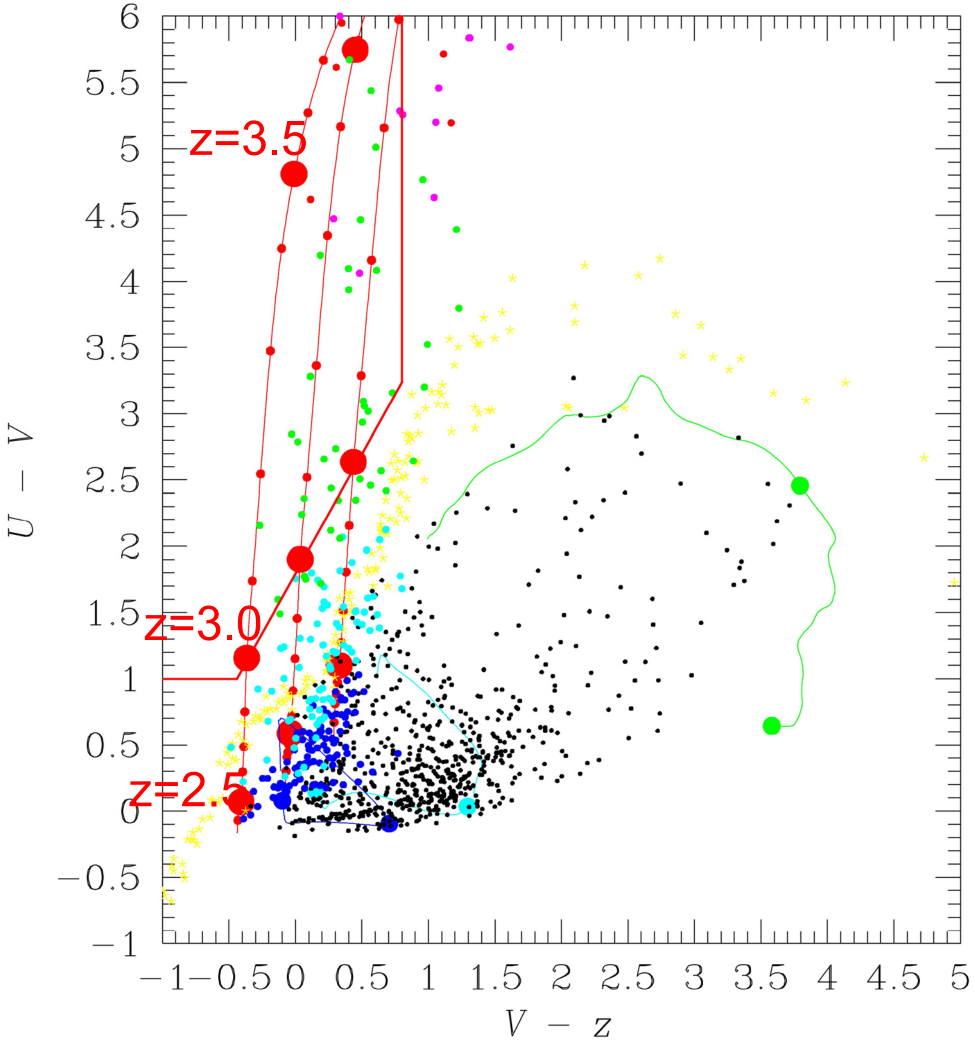
Characterized by
a large spectral break at
Lyman α and Lyman limit.



<u>Broad band</u>

LBGs at z ～ 3 are selected by
a set of U, V, and z bands.

Selection by 2-color diagram



Red lines:

Model spectrum of
a young star−forming galaxies
z = 2 − 3.5

Green, sky blue, blue lines:

Model spectrum of
local elliptical, spiral, irregular galaxies
z = 0 − 2

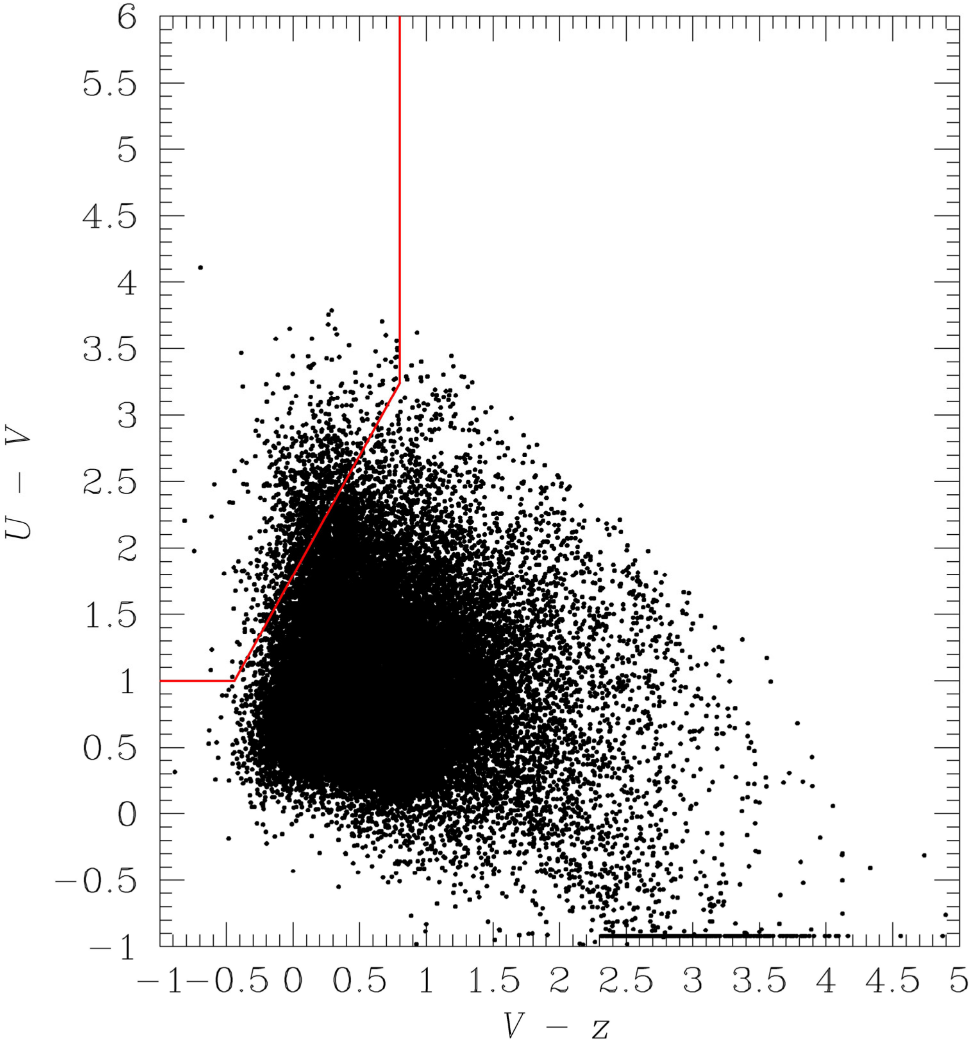
Asterisks:

Galactic stars

- HDF photometric redshift catalog

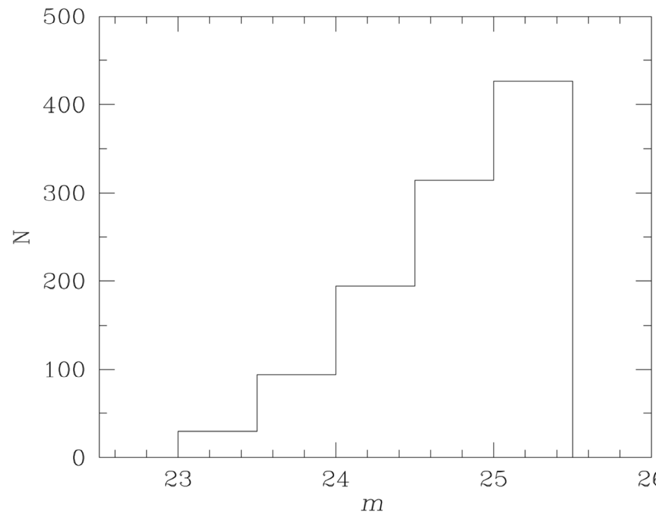
black : z<2.0
blue : 2.0<z<2.5
sky blue : 2.5<z<3.0
green : 3.0<z<3.5
pink : 3.5<z<4.0
red : 4.0<z

Selection by 2-color diagram



● : all of the detected objects

N = 795　(z ≦ 25.5)



J detected: 61

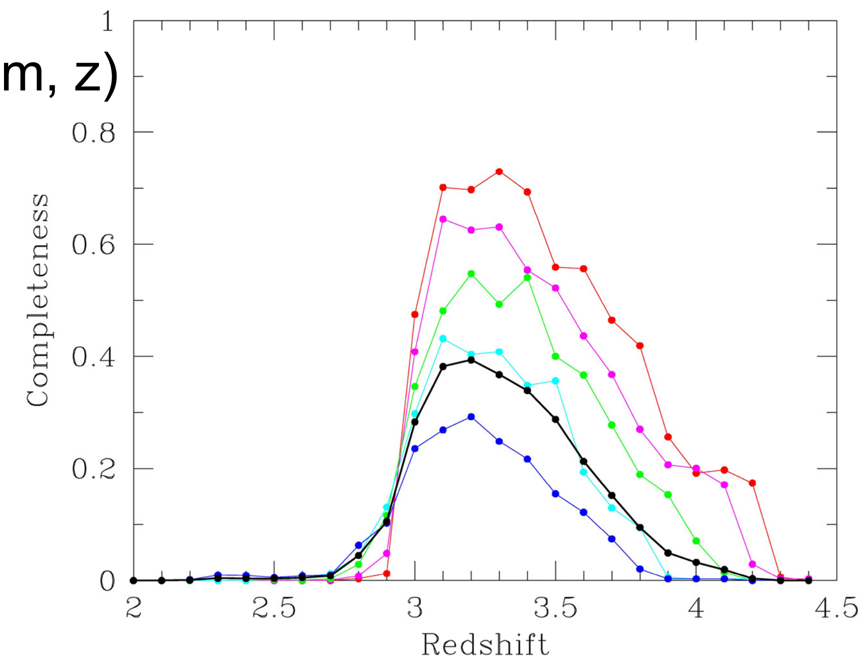
K detected: 144

completeness and contamination

completeness and contamination are estimated by Monte-Carlo simulation.

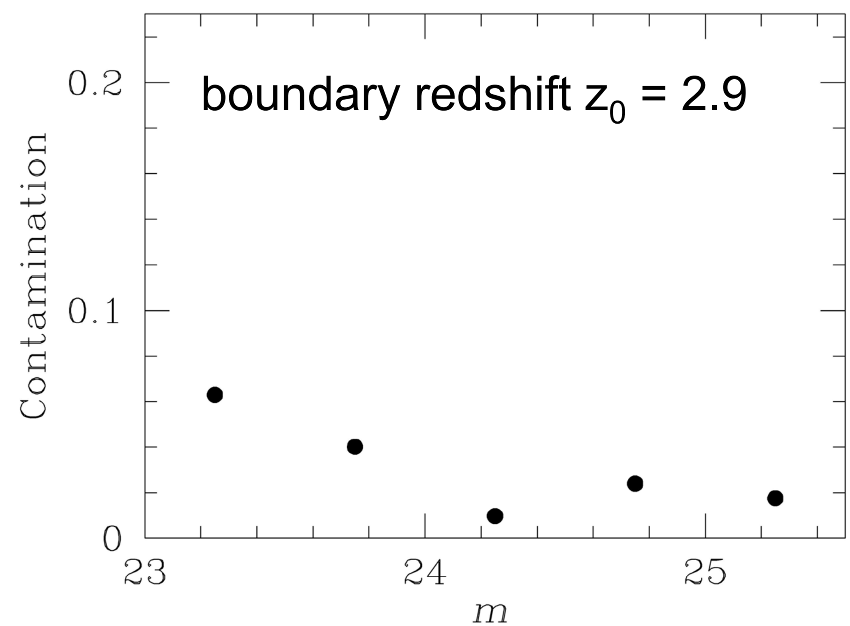
Detection/Selection rate is calculated by artistic galaxies of various mag. and redshift

$p(m, z)$



$\langle z \rangle = 3.3$

HDF-N photo-z catalog is used as Local galaxy catalog.



Clustering

clustering segregation with UV luminosity

- angular correlation function: $\omega(\theta)$

  $\omega(\theta) = A_\omega \theta^{-\beta}$

- redshift distributions of samples

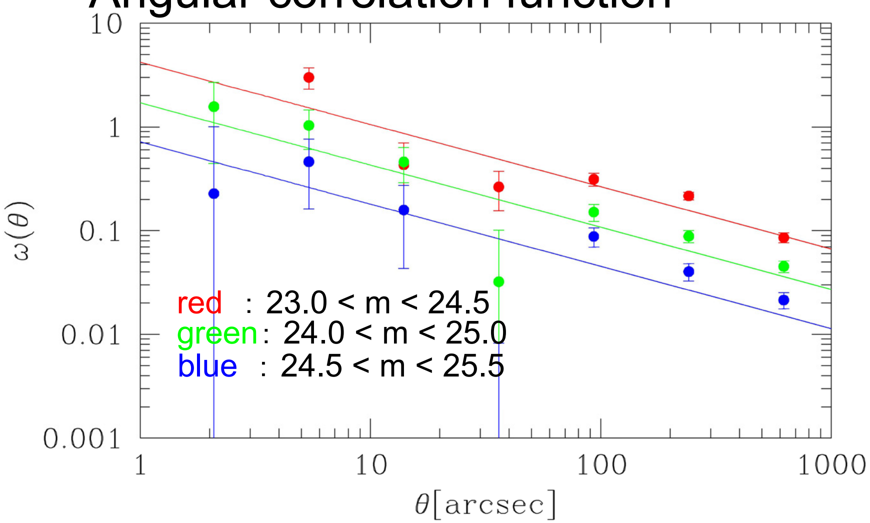
  ← N(z) by simulation

⇒ spacial correlation function $\xi(r)$

  $\xi(r)=(r/r_0)^{-1.6}$

  r_0 : clustering strength

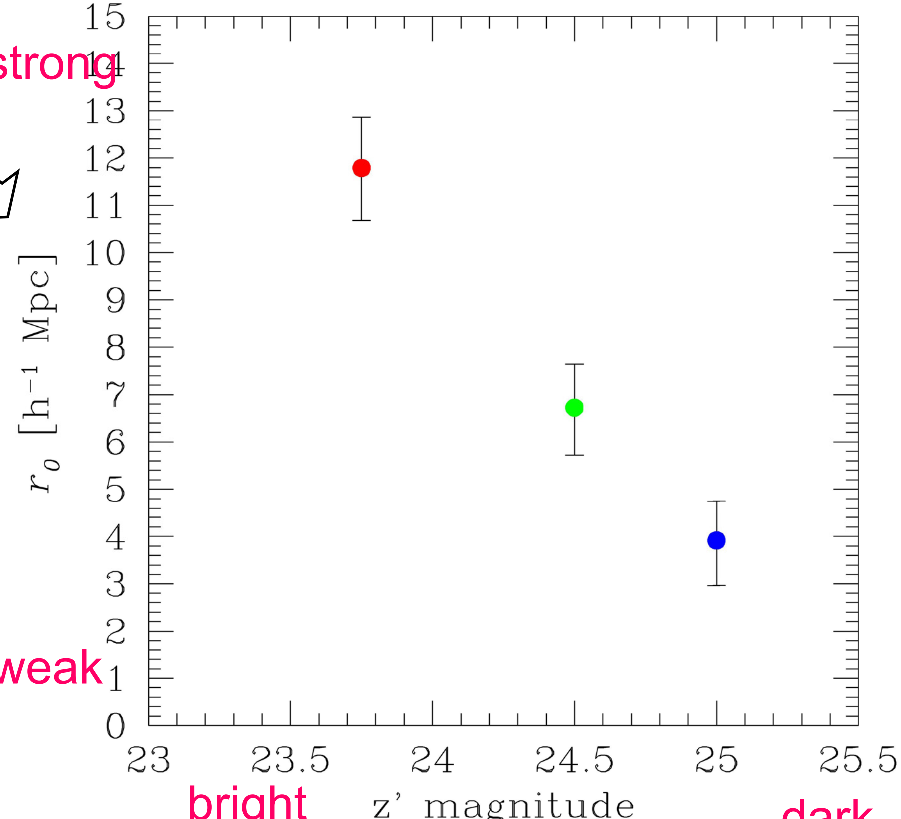
Angular correlation function



Spacial correlation function

strong

weak



bright

dark

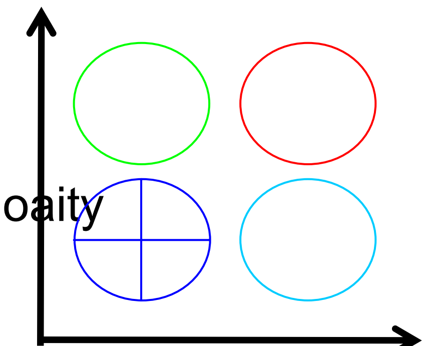
Brighter galaxies in UV belong to DHs of larger mass

clustering segregation with optical luminosity

bright

Rest-frame
optilal luminoaity
(K mag)

dark

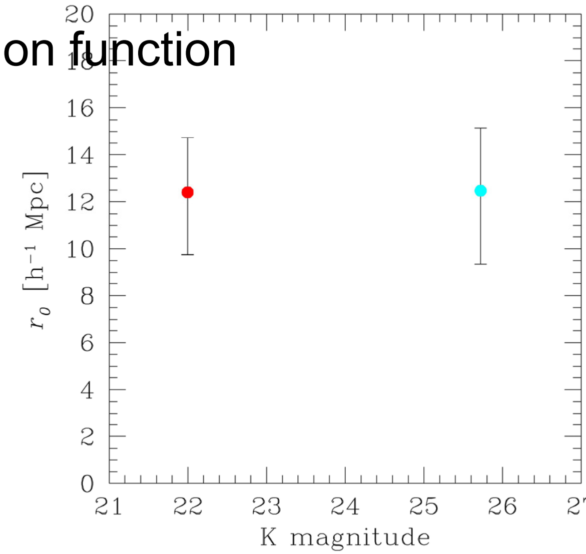


dark

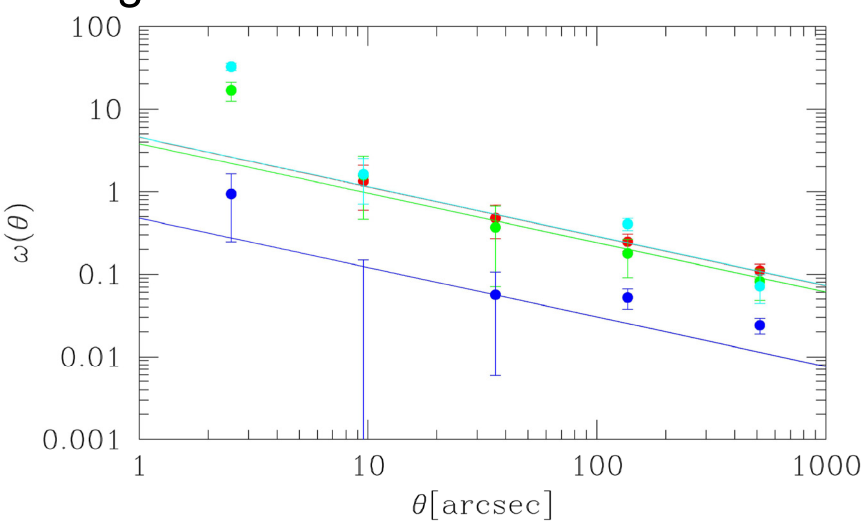
Rest-frame
UV luminosity
(z' mag)

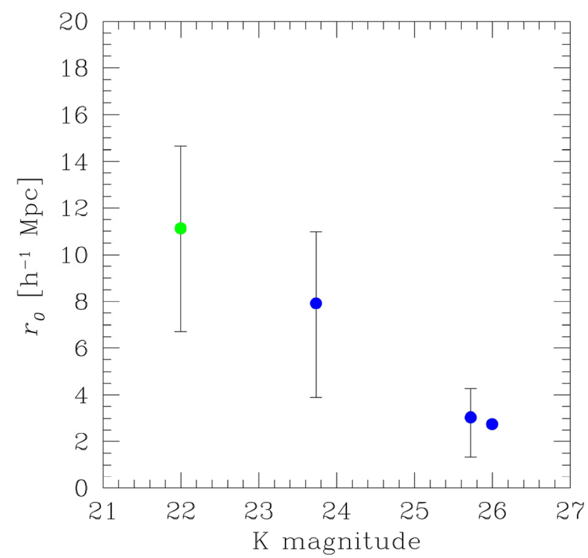
bright

Spacial correlation function

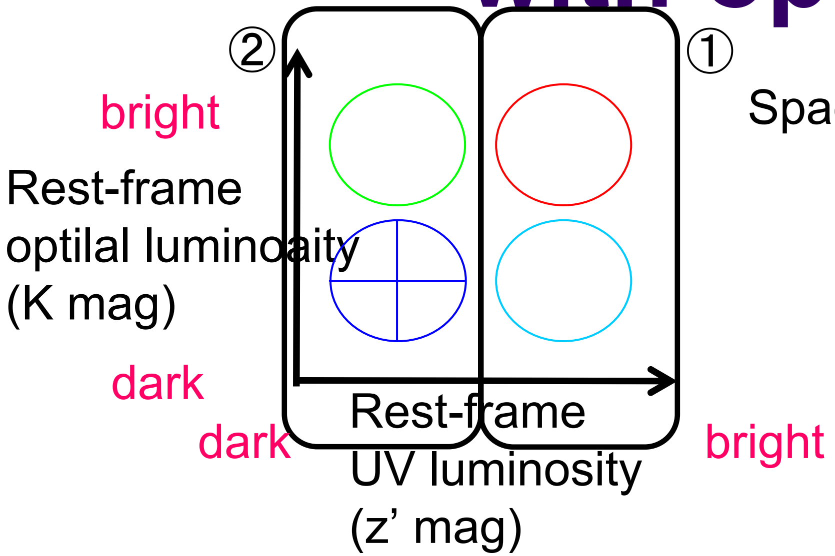


Angular correlation function



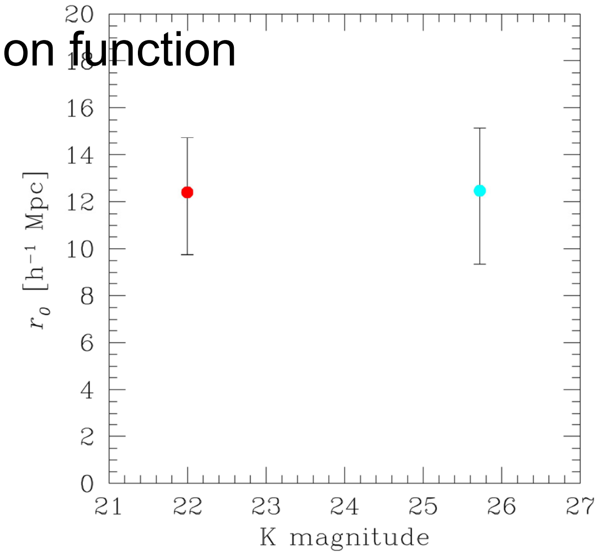


clustering segregation with optical luminosity

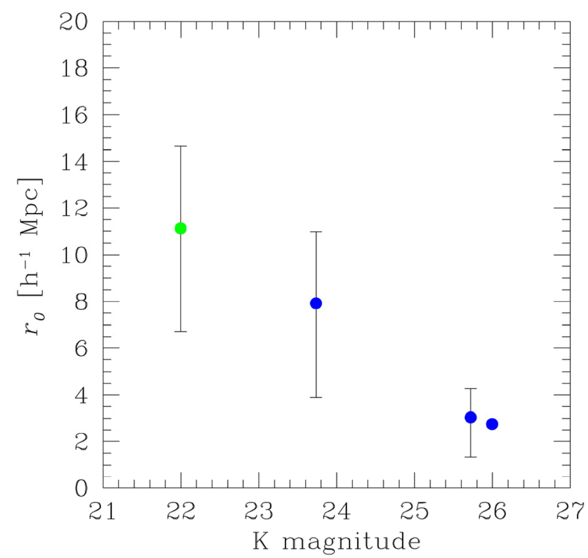


Spacial correlation function

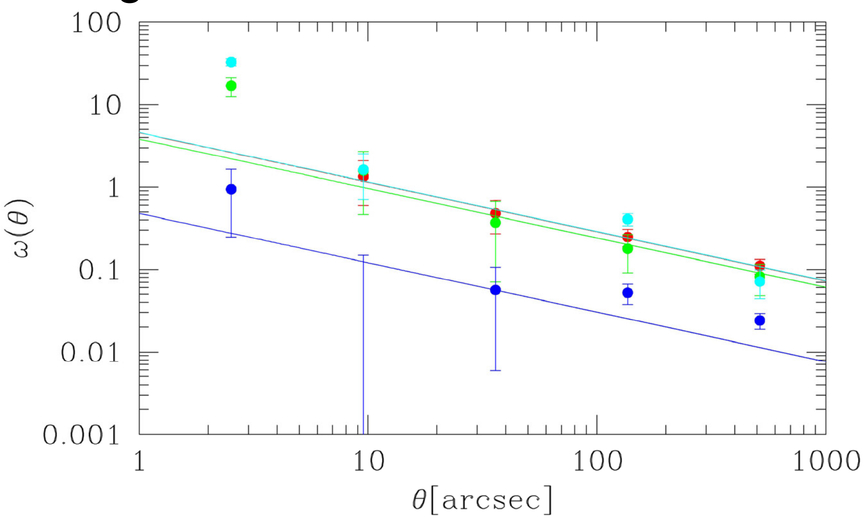
①



②



Angular correlation function

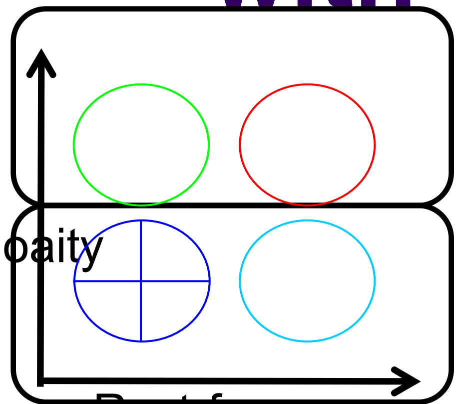


clustering segregation with optical luminosity

bright

Rest-frame optilal luminoaity (K mag)

dark



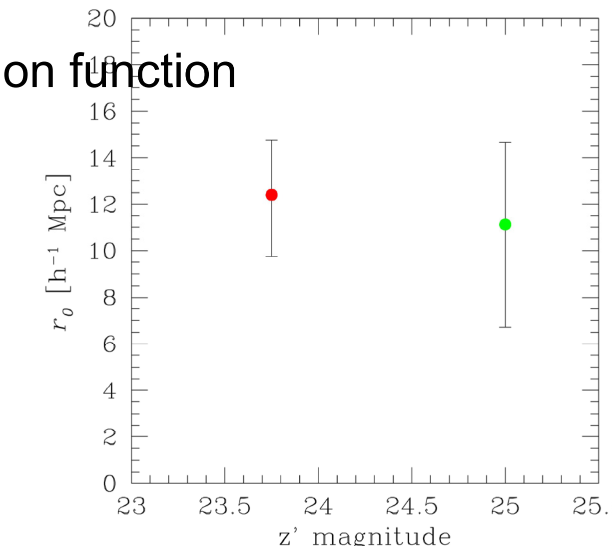
dark

Rest-frame UV luminosity (z' mag)

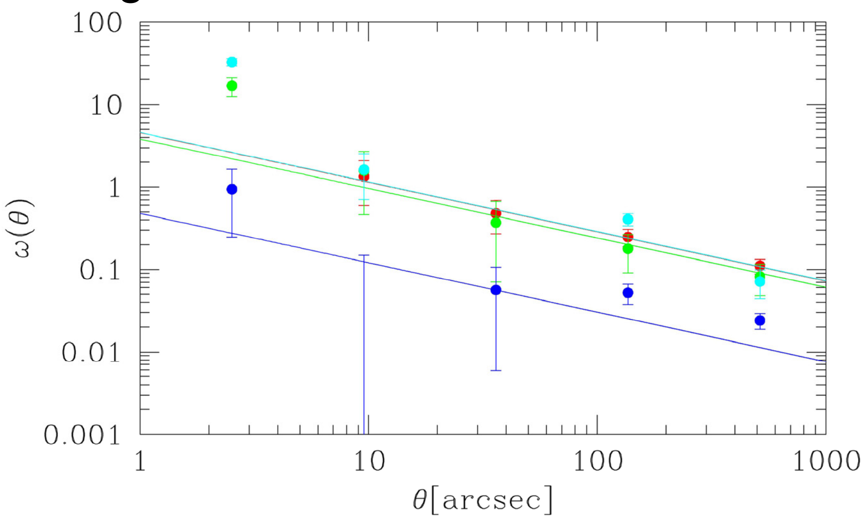
bright

Spacial correlation function

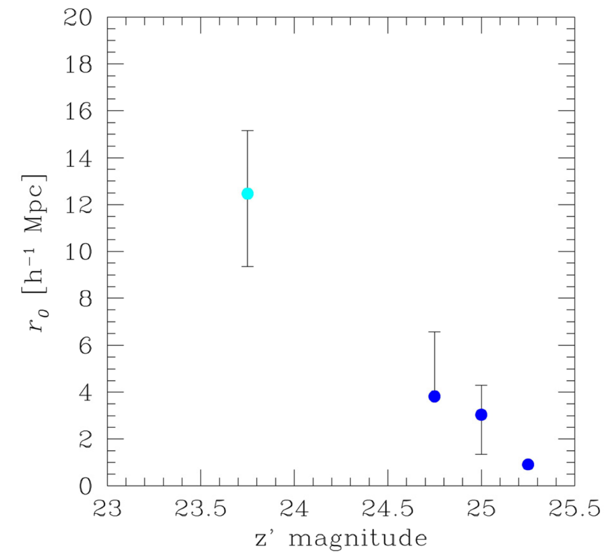
③



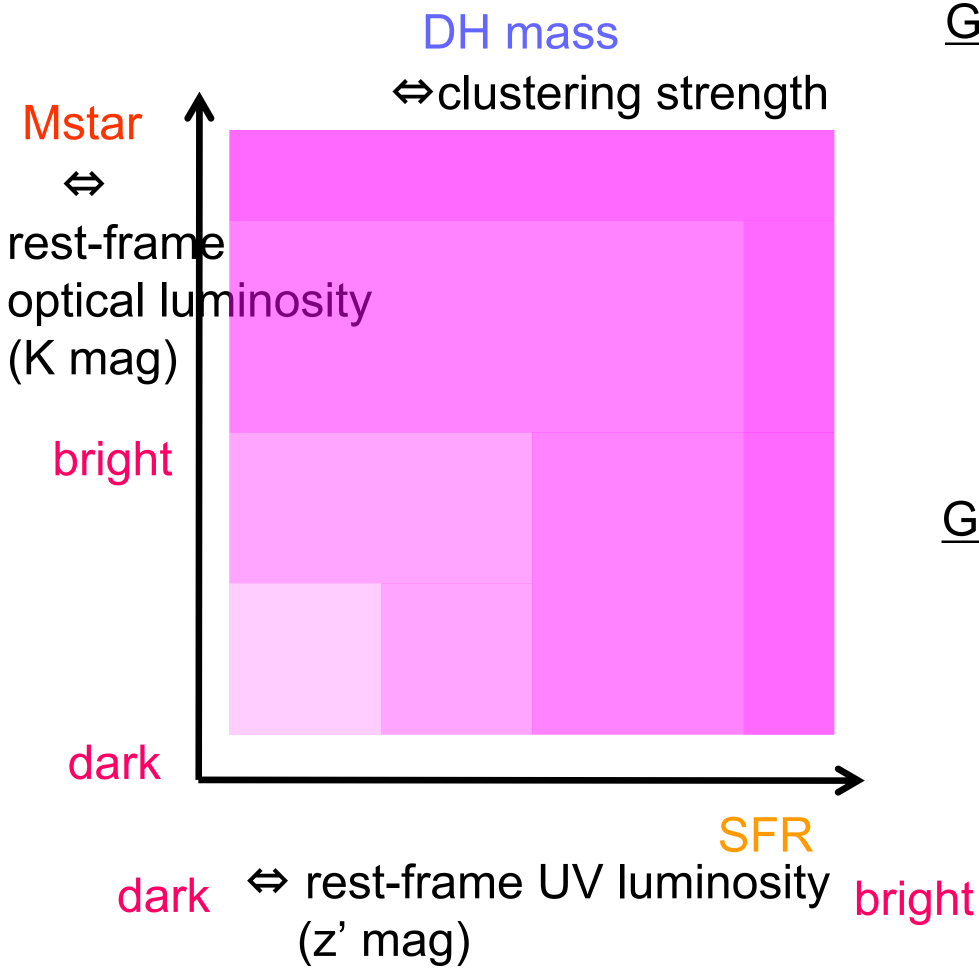
Angular correlation function



④

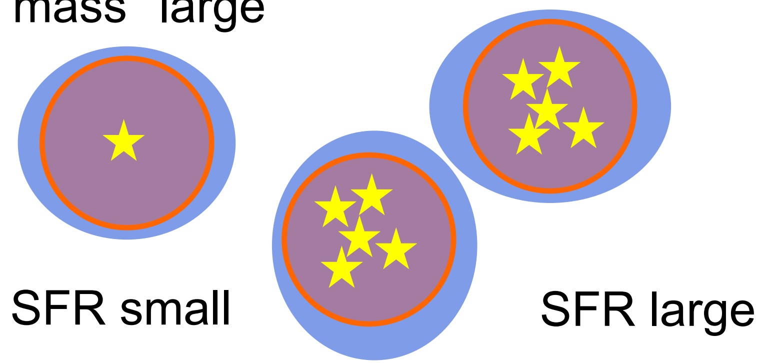


Stellar mass, SFR と DH mass



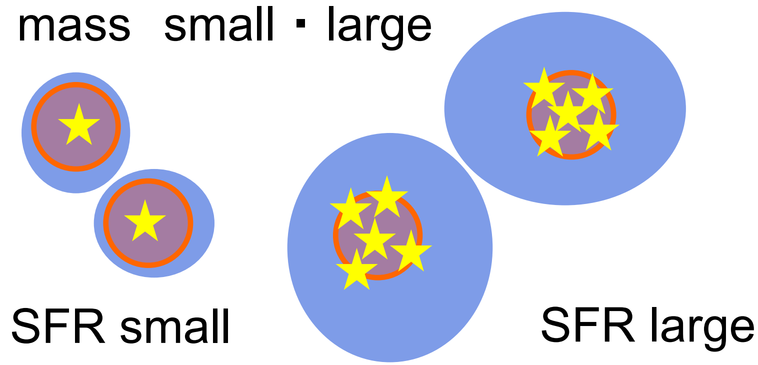
Galaxies of large stellar mass

DH mass　large



Galaxies of small stellar mass

DH mass　small・large



A limit of SFR is determined by DH mass ?

clustering segregation with dust extinction

E(B-V) ← (R - z') can be used as a indicator

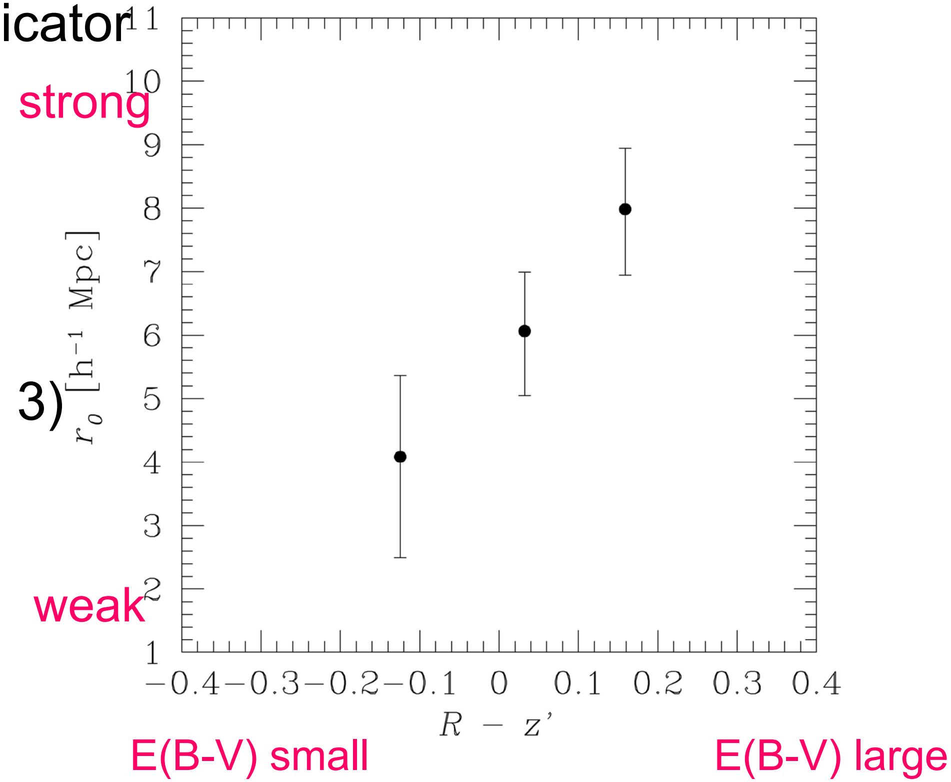
<R - z' > = 0.16 ⇔ E(B-V) ∼ 0.25

<R - z' > = 0.03 ⇔ E(B-V) ∼ 0.15

<R - z' > = -0.12 ⇔ E(B-V) ∼ 0.0

(assuming typical SED of LBGs at z ∼ 3)

Spacial correlation function

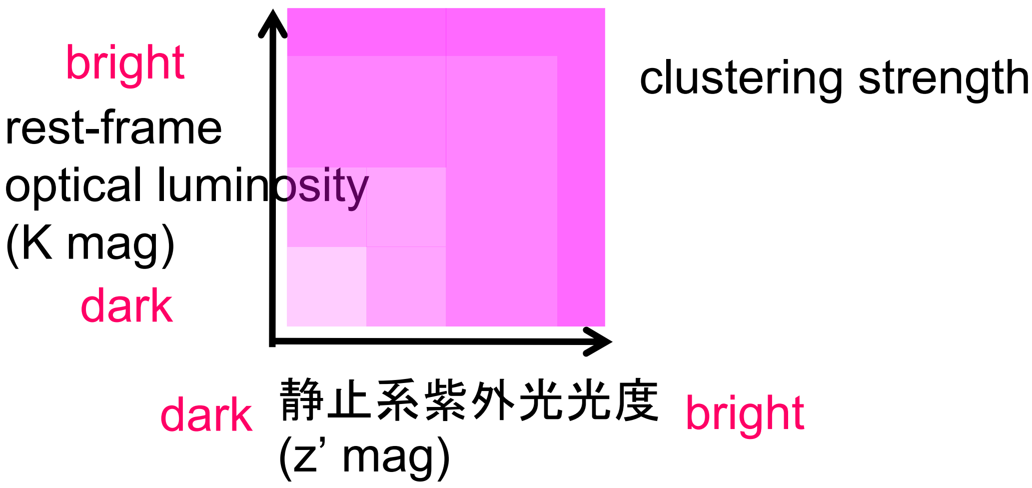


Galaxies with more dust extinction belong to DHs of larger mass.

Summary

We study clustering properties of LBGs at z ∼ 3 in SXDS-S.
（795 arcmin^2, N=, 23.0 < z' < 25.5)

- Optical, UV luminosity and DH mass



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