Clustering Properties of Star Forming Galaxies at z ~ 2

BzK銀河のクラスタリングから探る z～2の星形成銀河の形成と進化

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The universe at z~2

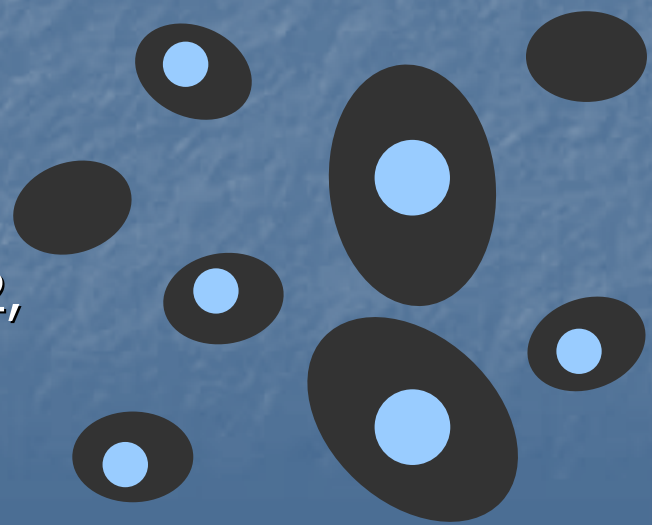
- Galaxy formation and evolution based on the CDM model
  - strong dependence on mass of dark-halo (DH) (Mo & White 2002)

- The era of z~2

  Drastic changes occurred in the galaxy population at z~2
  - The cosmic SFR and the number density of QSO have a peak at z~2 (e.g., Dickinson et al. 2003; Richards et al. 2006)
  - A significant evolution of the Hubble sequence occurred at z=1-2 (Kajisawa & Yamada 2001; Conselice et al. 2005)

- Galaxies at z~2（redshift desert）
  - BzK color selection

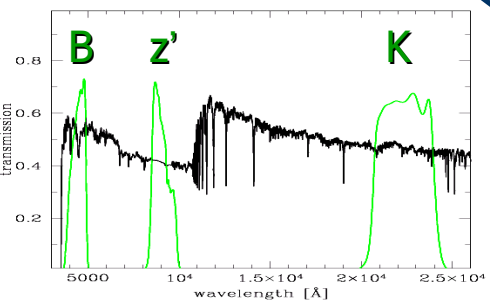
    ⇒ BzK galaxies (Daddi et al. 2004)
  - The only selection method of galaxies at z~2, irrespective of the amount of dust extinction



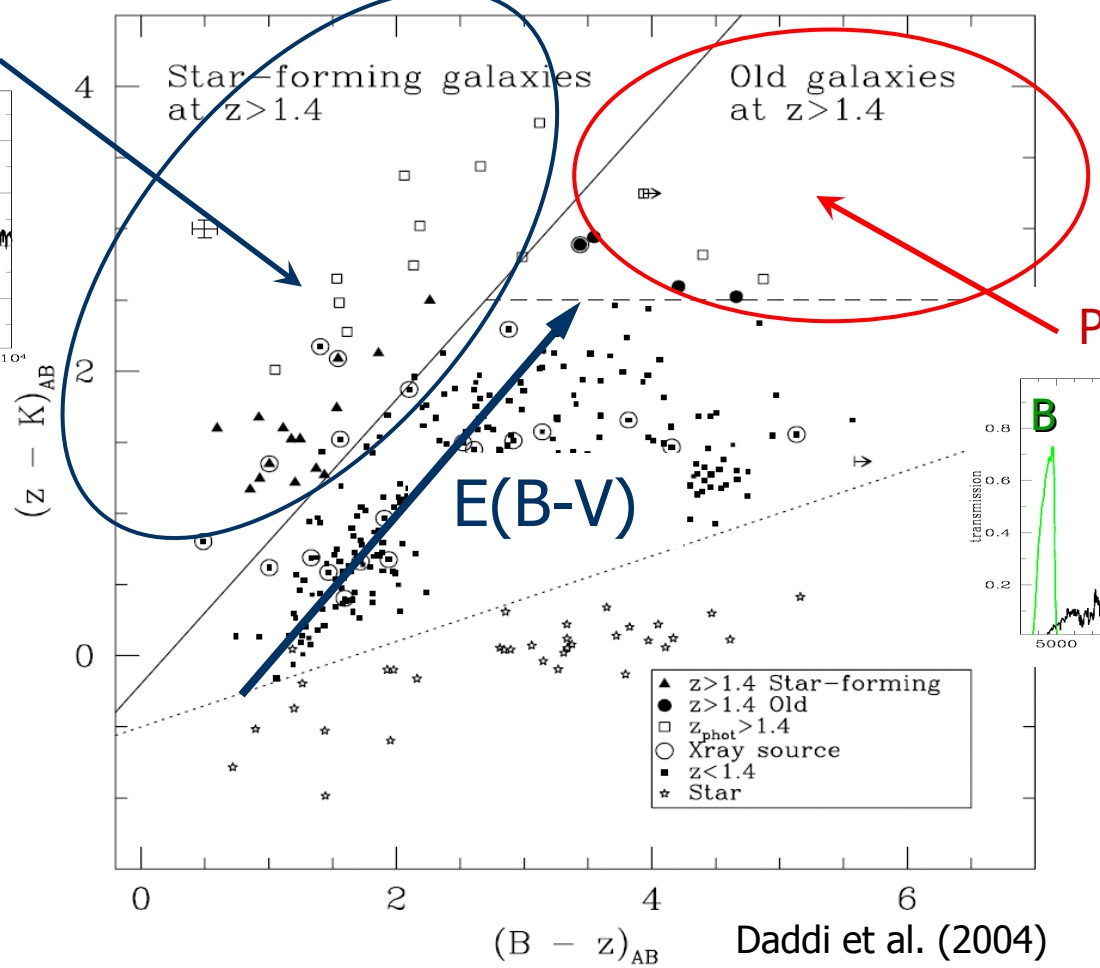
The Mass of dark-haloes hosting galaxies at z~2 is inferred from clustering strength.

BzK galaxies @ 1.4<z<2.5

Star-forming BzKs

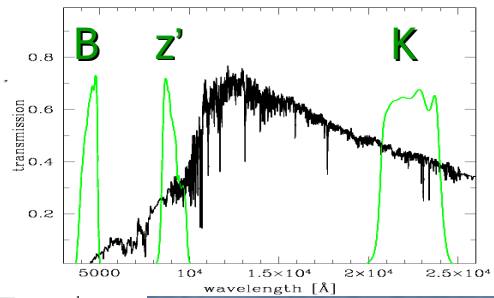


Bruzual & Charlot (2003)

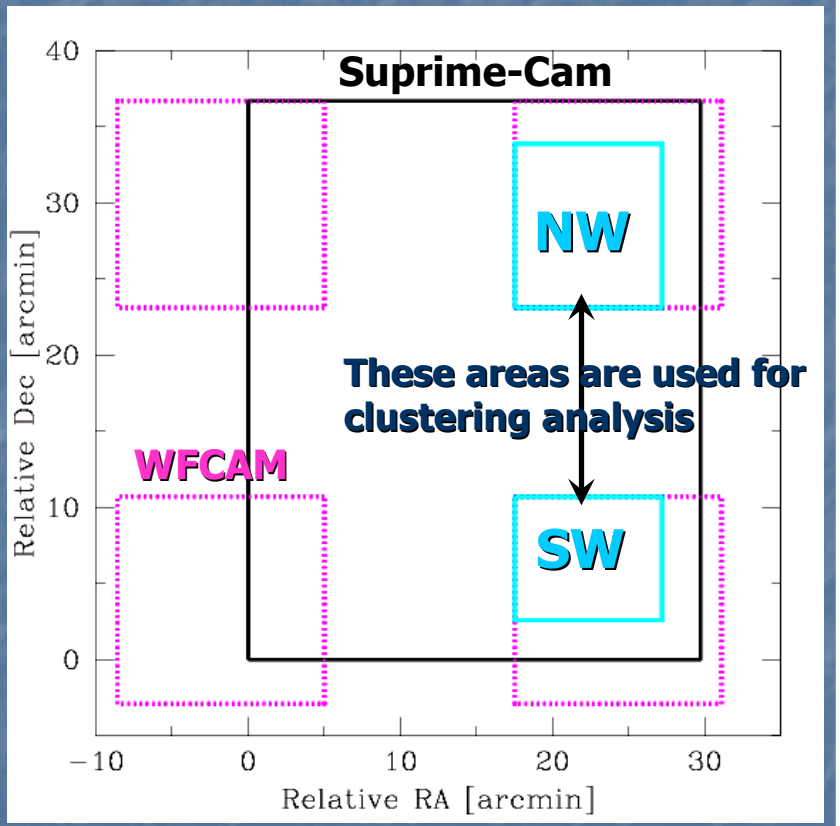


Daddi et al. (2004)

Passive BzKs

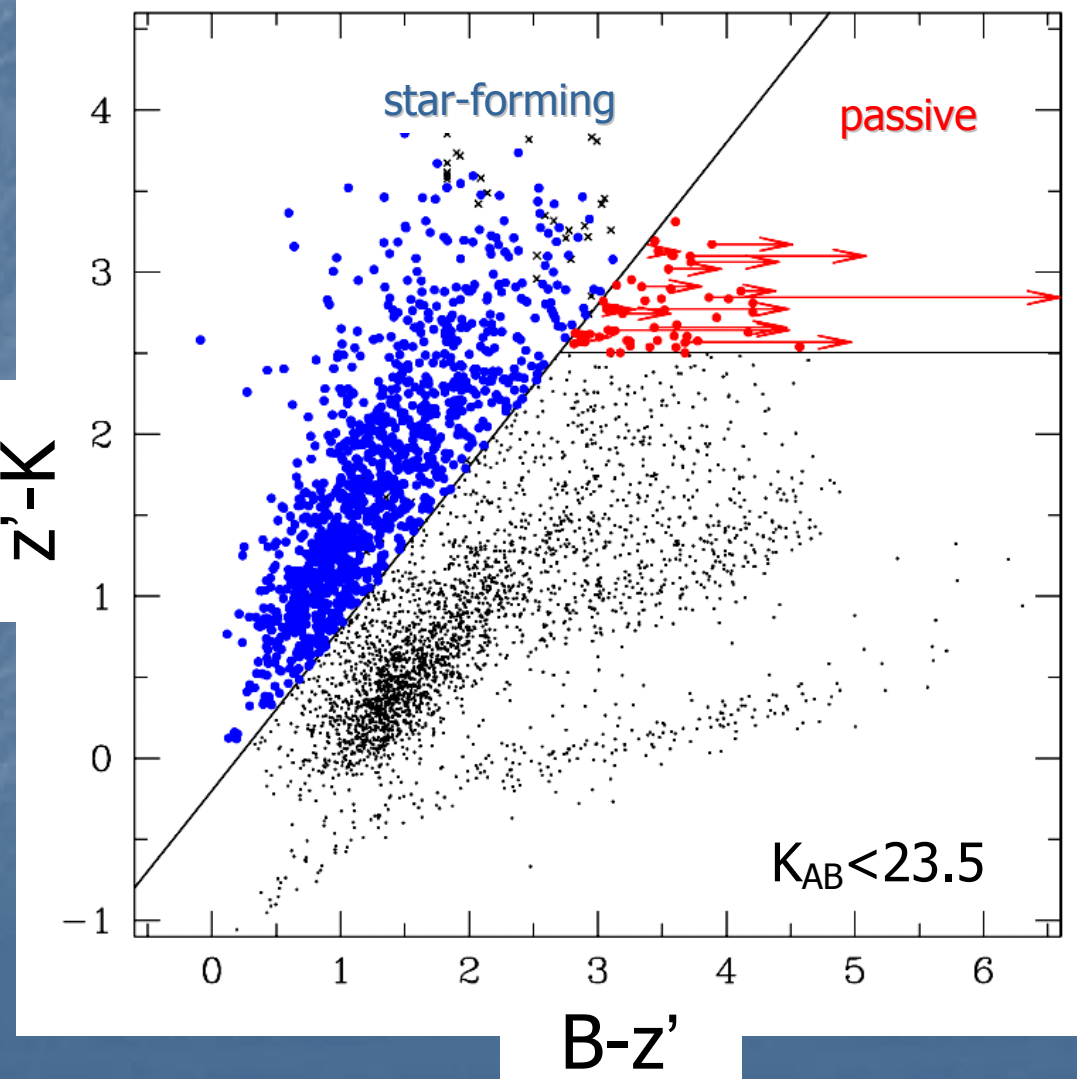


Optical and NIR data in the SDF



- B, z', K
- optical : Subaru/Suprime-Cam
  NIR : UKIRT/WFCAM
- limiting mag.(AB, 2" aperture)
  - B : 28.8 (2σ)
  - z' : 27.0 (2σ)
  - K : 23.5 (5σ)
- seeing : 1.14"
- areas used for clustering analysis
  - NW area : ~100 arcmin^2
  - SW area : ~80 arcmin^2

BzK galaxies in the SDF

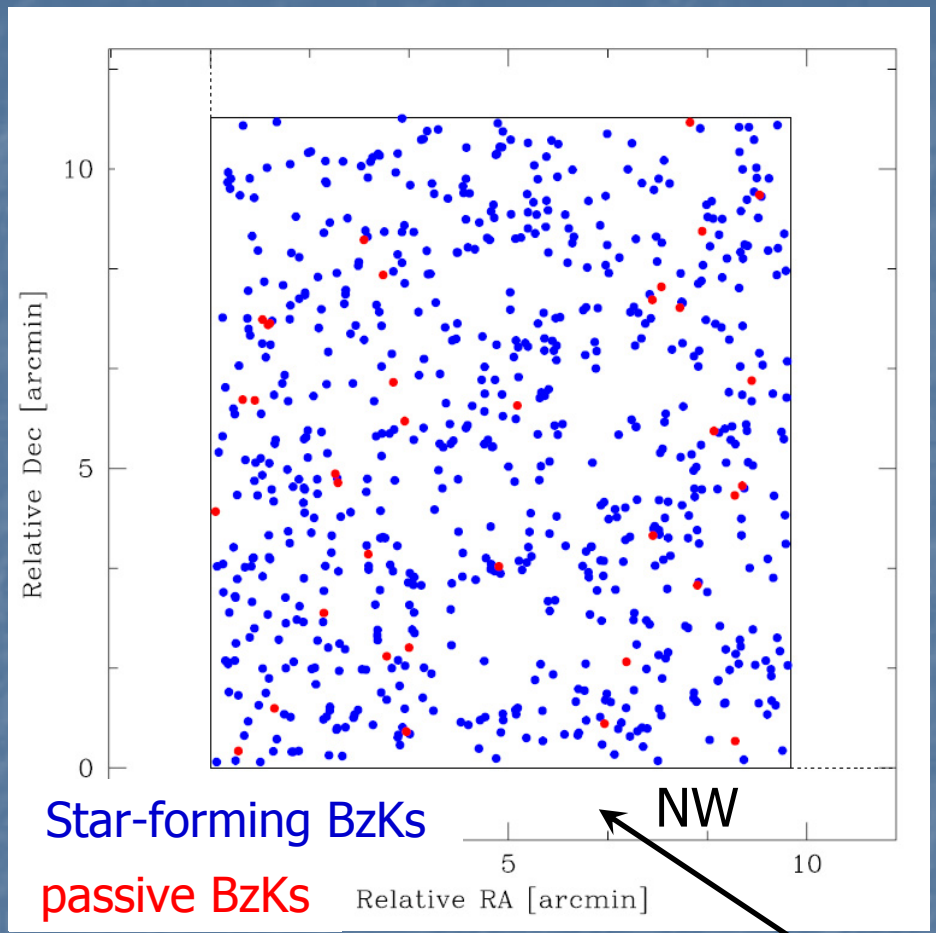


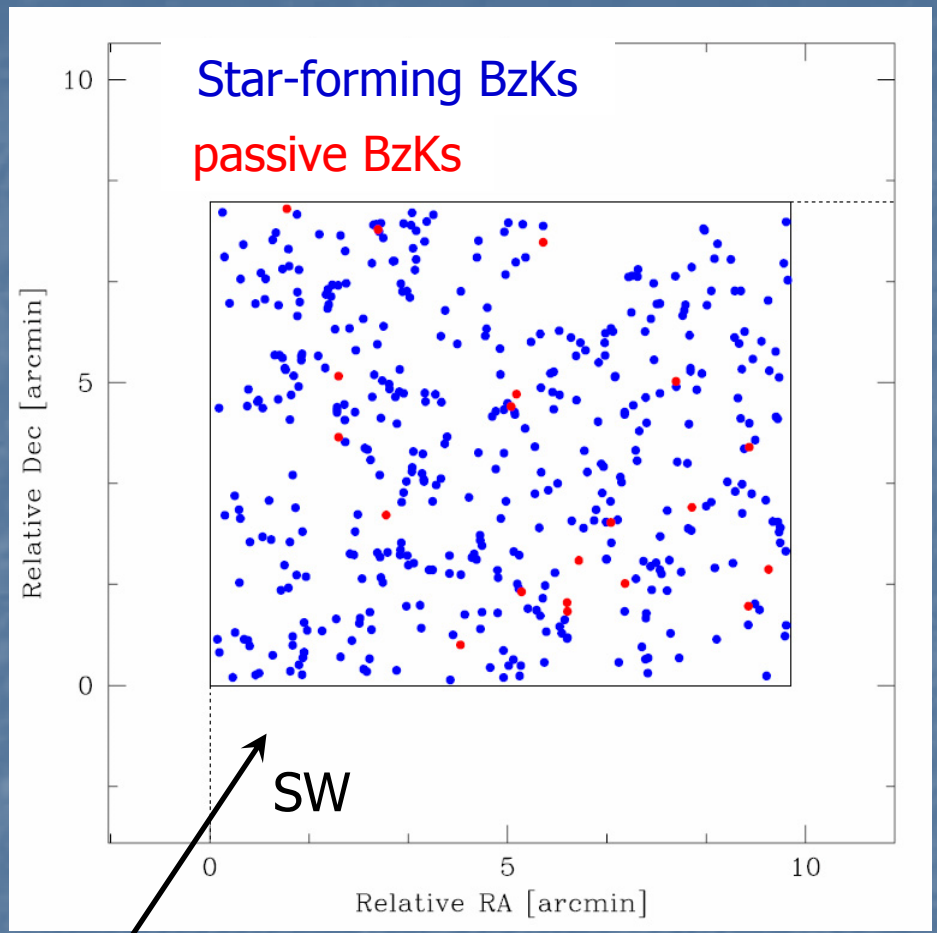
K_{AB}≦23.2 BzK's samples

	SW	NW	total
Star-forming	419	673	1092
Passive	20	36	56

(The limiting magitude of the samples is total magnitude.)

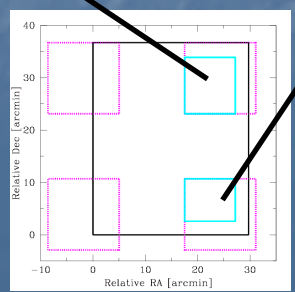
Celestial distribution of BzKs





NW

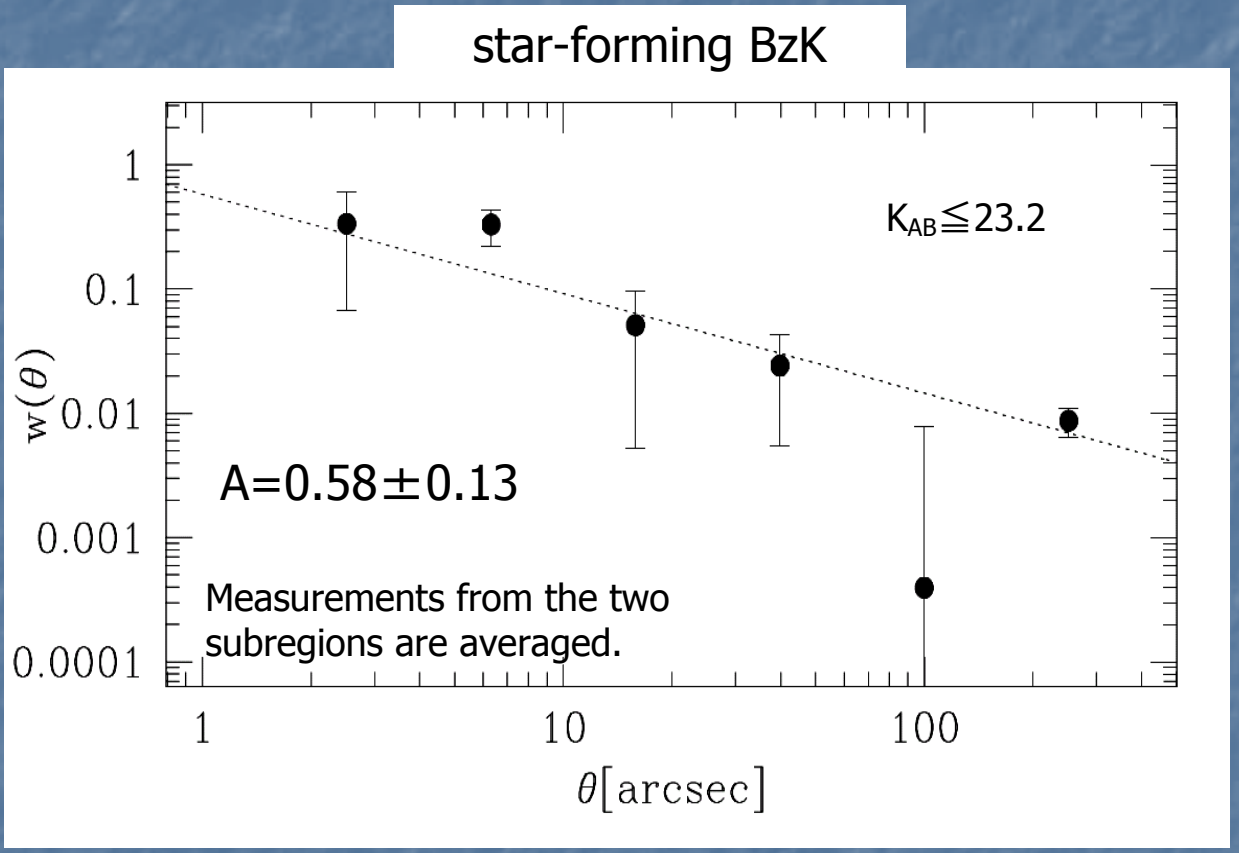
SW



$K_{AB} \leqq 23.2$ samples

	SW	NW	total
Star-forming	419	673	1092
Passive	20	36	56

Angular correlation function of star-forming BzKs

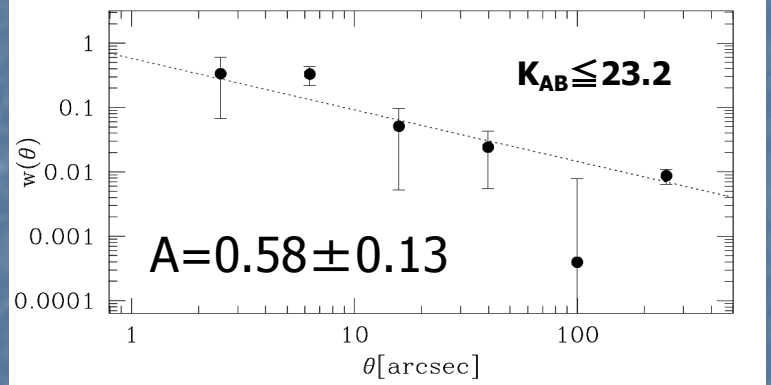


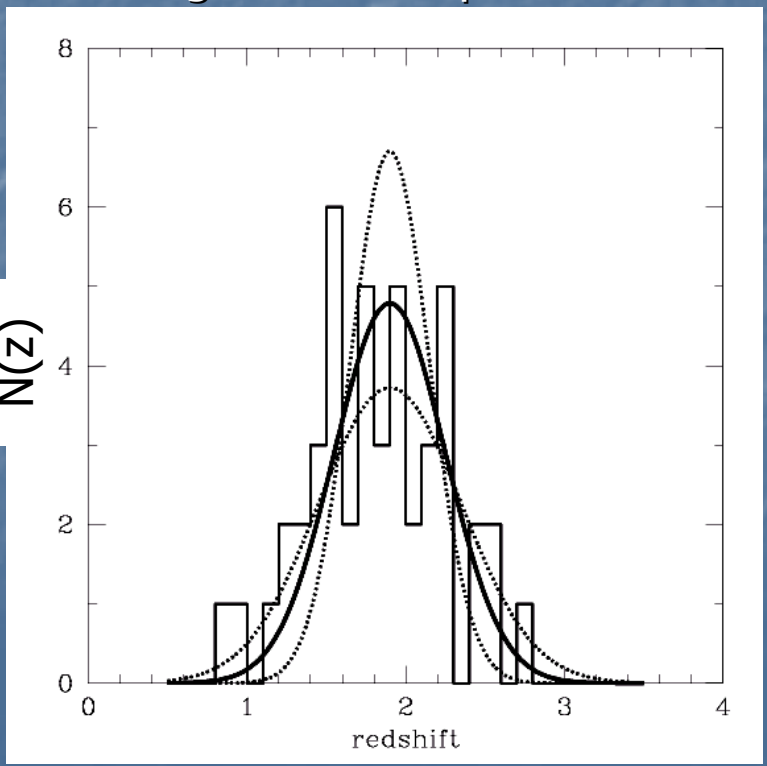
- ACF is assumed to be power law, $W(\theta)=A\,\theta^{-0.8}$
- Errors are estimated using bootstrap resample method (Error bars are 1σ)
- The sample of passive BzKs is too small to obtain a reliable result

Translation of ACF into SCF

- ACF ⇒ Spatial Correlation Function (SCF)
  - $\xi(r)=(r/r_0)^{-1.8}$
    r_0: correlation length
  - If redshift distribution is known,
    r_0 is culculated from amplitude of the ACF
    using Limber's equation.

ACF



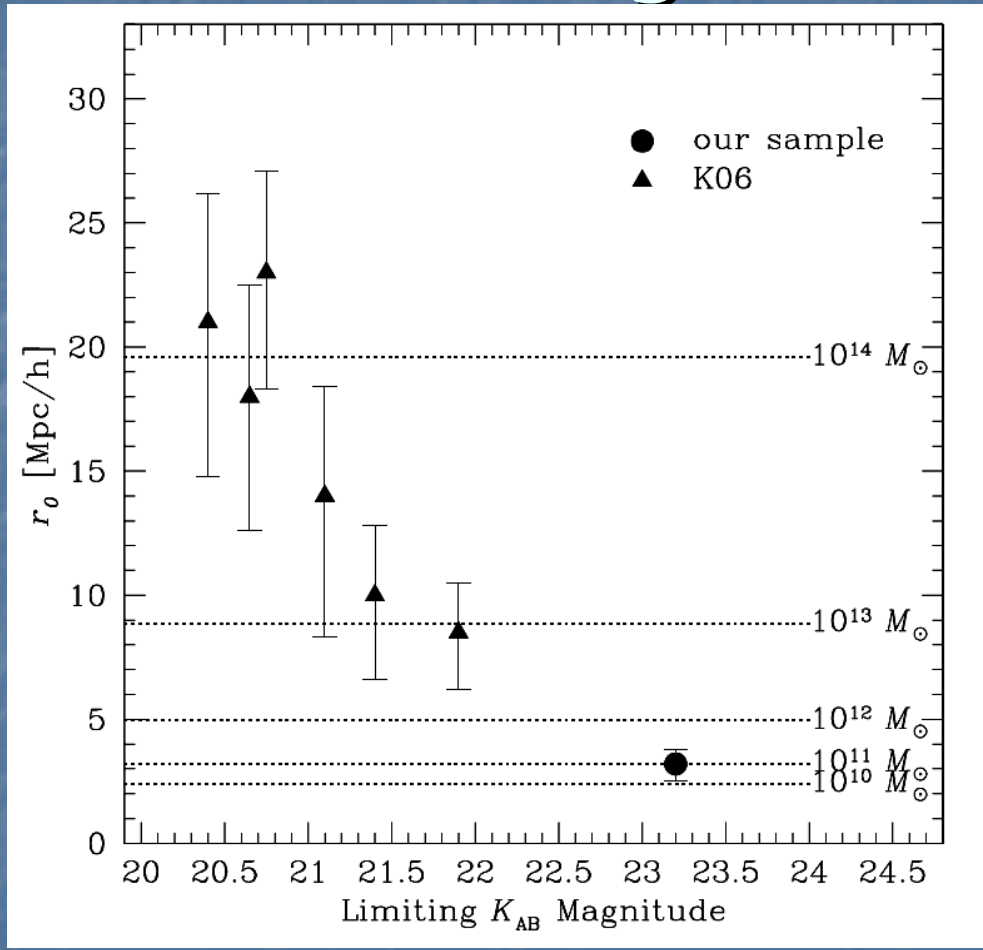


- N(z) of star-forming BzKs is assumed to be a Gaussian with z_c=1.9、σ=0.35±0.1.
- Histogram of N(z) shows that of star-forming BzKs with K<22.
  （spectroscopic redshifts are contained.）

(Daddi et al. 2004)

correlation length (r_0) ⇒ DH mass

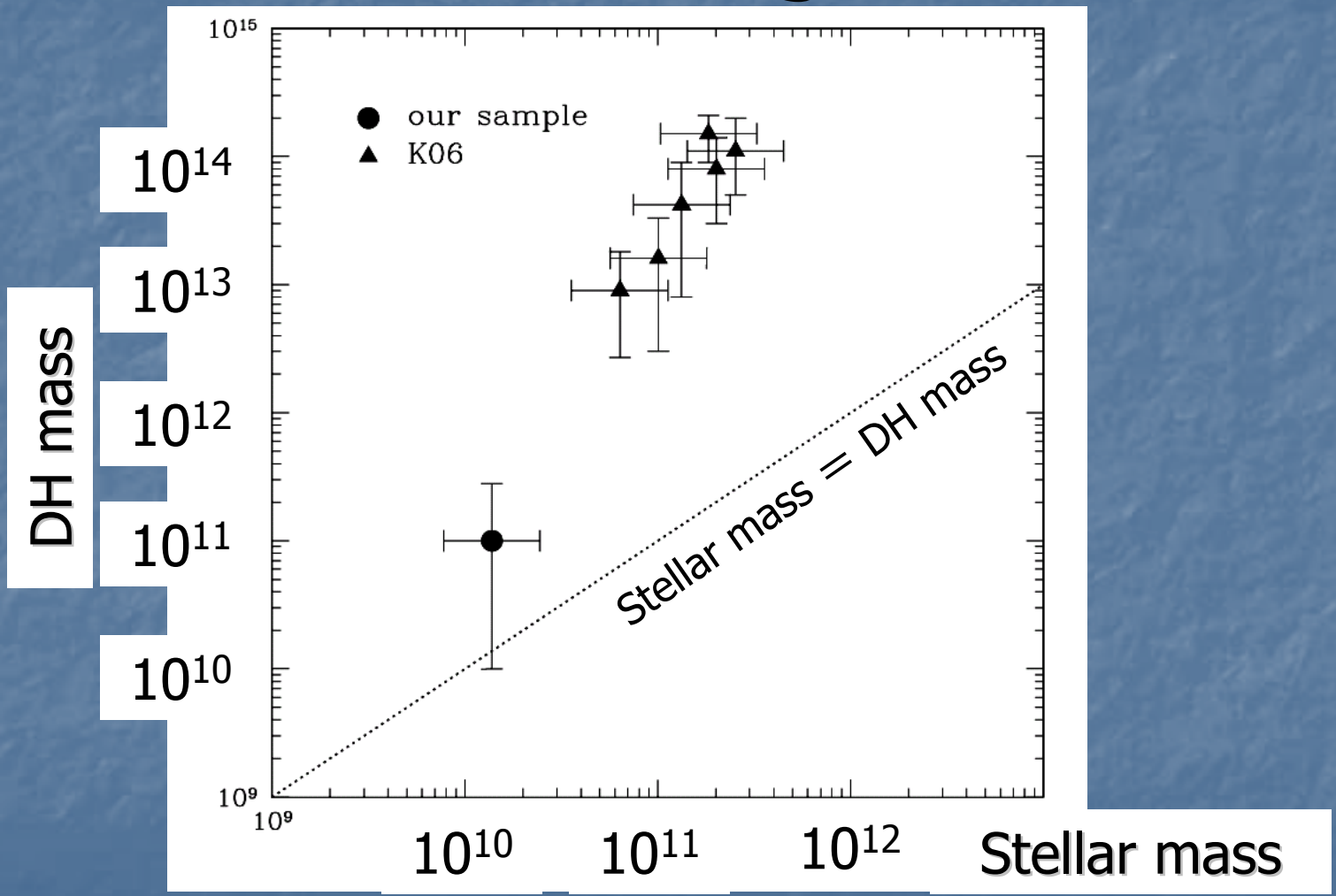
correlation length (r_0) and DH mass of star-forming BzKs



The r_0 of bright BzKs is calculated from the ACF given in Kong et al. (2006) (K06).

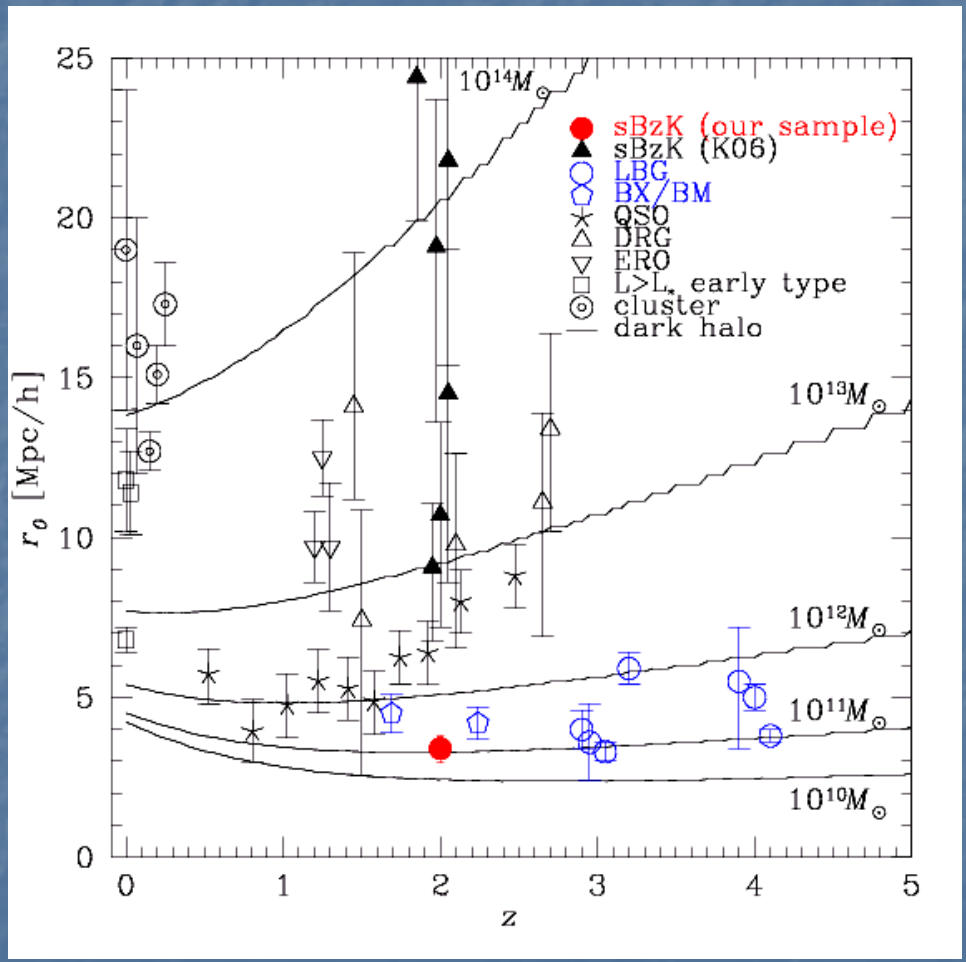
Brighter star-forming BzKs are hosted by more massive dark haloes.

The stellar mass and DH mass of star-forming BzKs



The mass of dark-haloes largely increases with the stellar mass.

Comparison of correlation length with other galaxy populations



- faint (K_{AB}<23.2) star-forming BzK
- BX/BM @ z~2
- LBG @ z~3

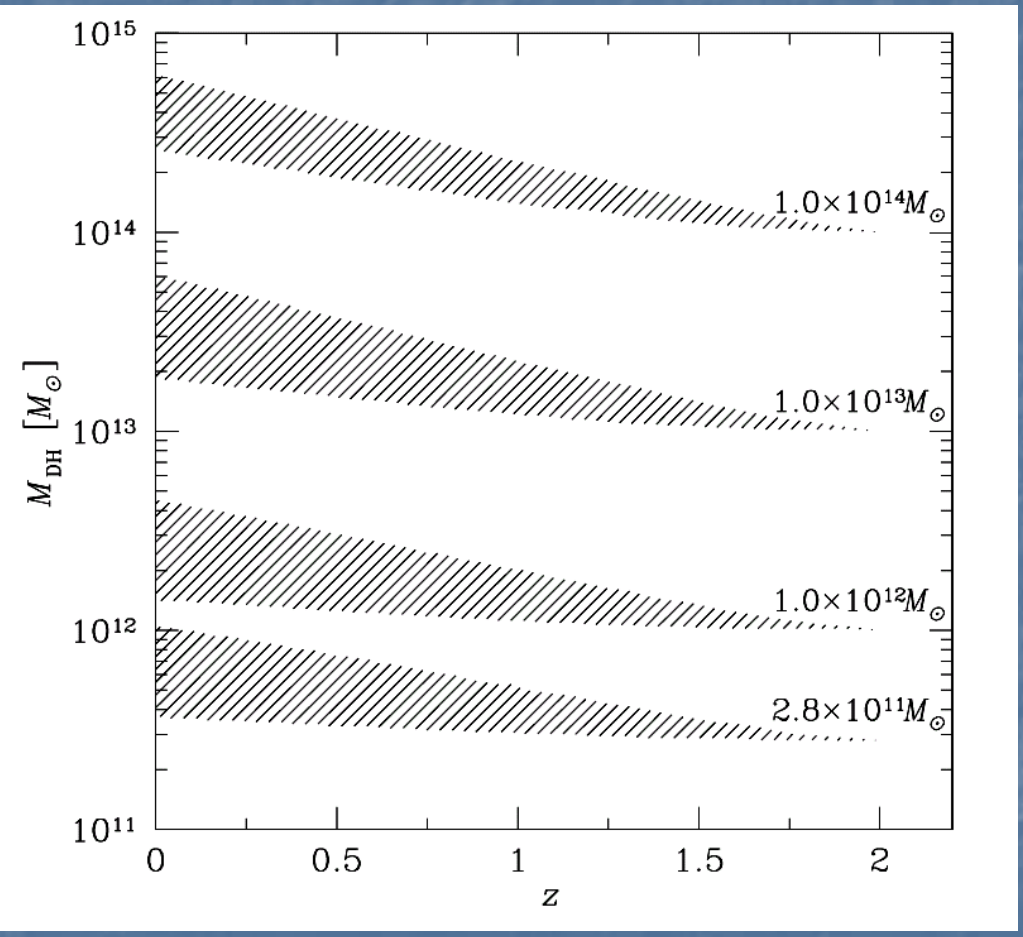
⇒ M_{DH}~10^{11}Msun

- bright (K_{AB}<21.9) star-forming BzK
- ERO @ z~1-2
- DRG @ z~2-3
- cluster @ z~0

⇒ M_{DH}~$10^{13\text{-}14}$Msun

Faint star-forming BzKs and optically selected star-forming galaxies at z~2 are similar populations.

Present-day descendants of star-forming BzKs



- **extended Press-Schechter formalism**

This formalism predicts the mass growth of dark-haloes.

- **K_{AB}<20.4**

$M_{DH}(z=2) = 1.6\times10^{14}$ Msun ⇒
$M_{DH}(z\sim0) = 4.3\text{-}9.3\times10^{14}$ Msun

- **K_{AB}<23.2**

$M_{DH}(z=2) = 2.8\times10^{11}$ Msun ⇒
$M_{DH}(z\sim0) = 3.7\text{-}10.0\times10^{11}$ Msun

Star-forming BzKs evolve into galaxies over a wide range of mass, depending on their apparent K brightness.

summary

- Faint star-forming BzKs are hosted by less massive dark haloes with ~ 10^{11} Msun, while bright star-forming BzKs are hosted by massive dark haloes with ~ $10^{13\text{-}14}$ Msun.
- The mass of dark-haloes largely increases with the stellar mass of star-forming BzKs.
- Faint star-forming BzKs are similar populations to LBGs (BXs/BMs) at z~2, and then evolve to be less massive galaxies with $10^{11\text{-}12}$ Msun in the local universe.
- Bright star-forming BzKs evolve to be galaxies in massive clusters.

"Luminosity dependent clustering of star-forming BzK galaxies at redshift 2", Hayashi et al. 2007, astro-ph/0701637 (accepted in ApJ)