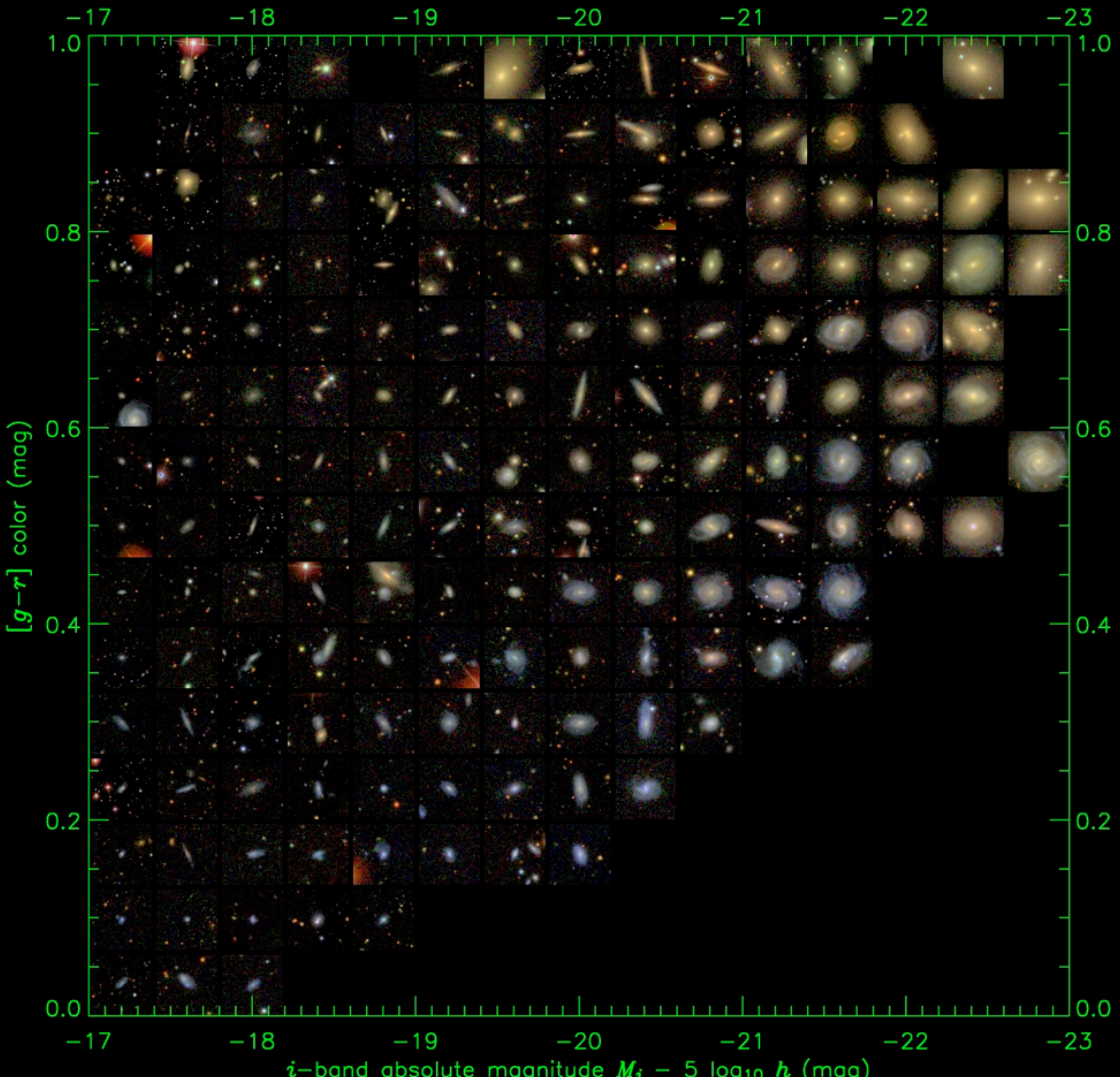


Hogg & Blanton (2005)

CLUSTERING OF UV-SELECTED GALAXIES AT Z<1

Star formation and environment

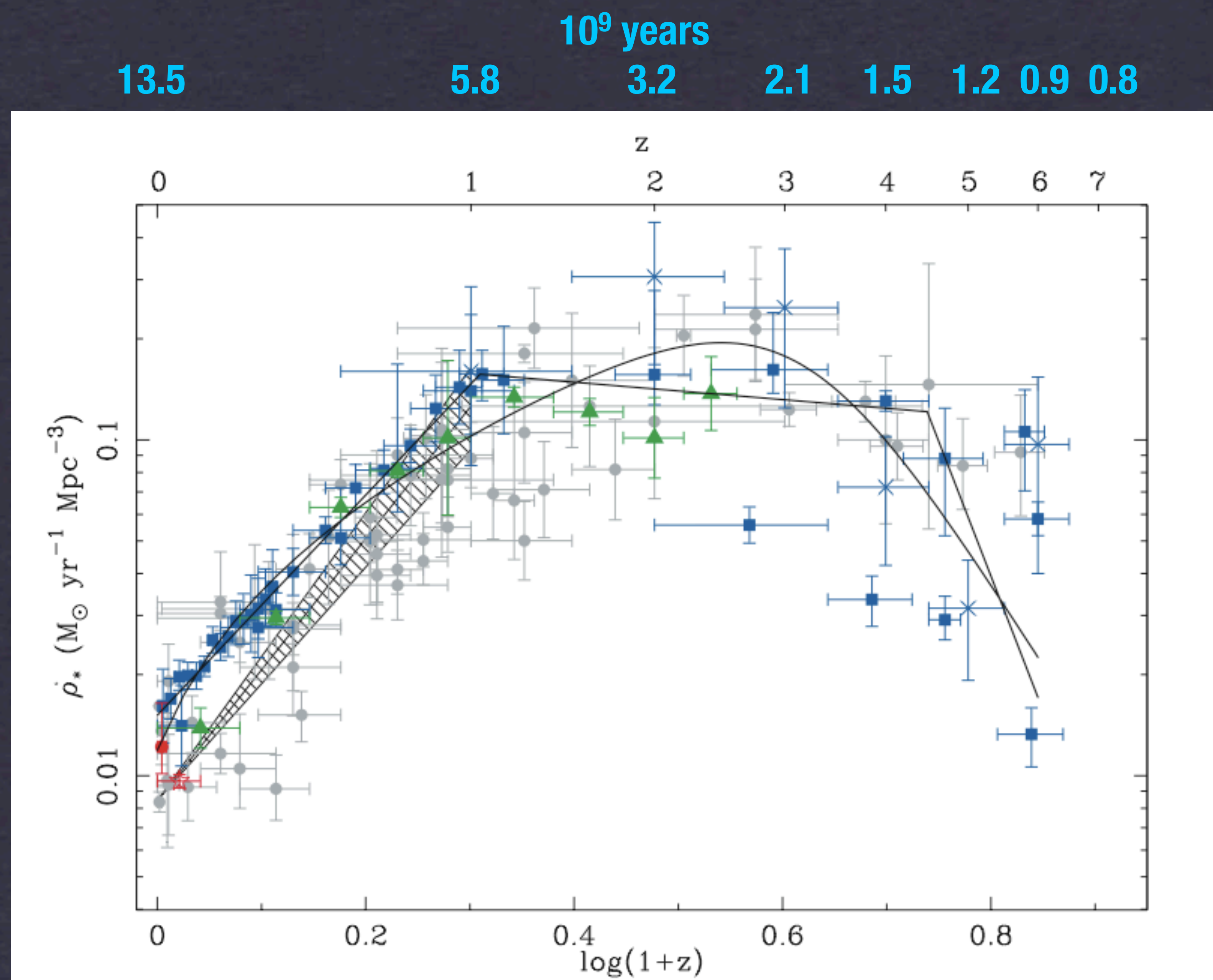
Sébastien HEINIS

Cosmic Star Formation Rate evolution

- Cosmic Star Formation Rate as a probe for galaxy formation and evolution

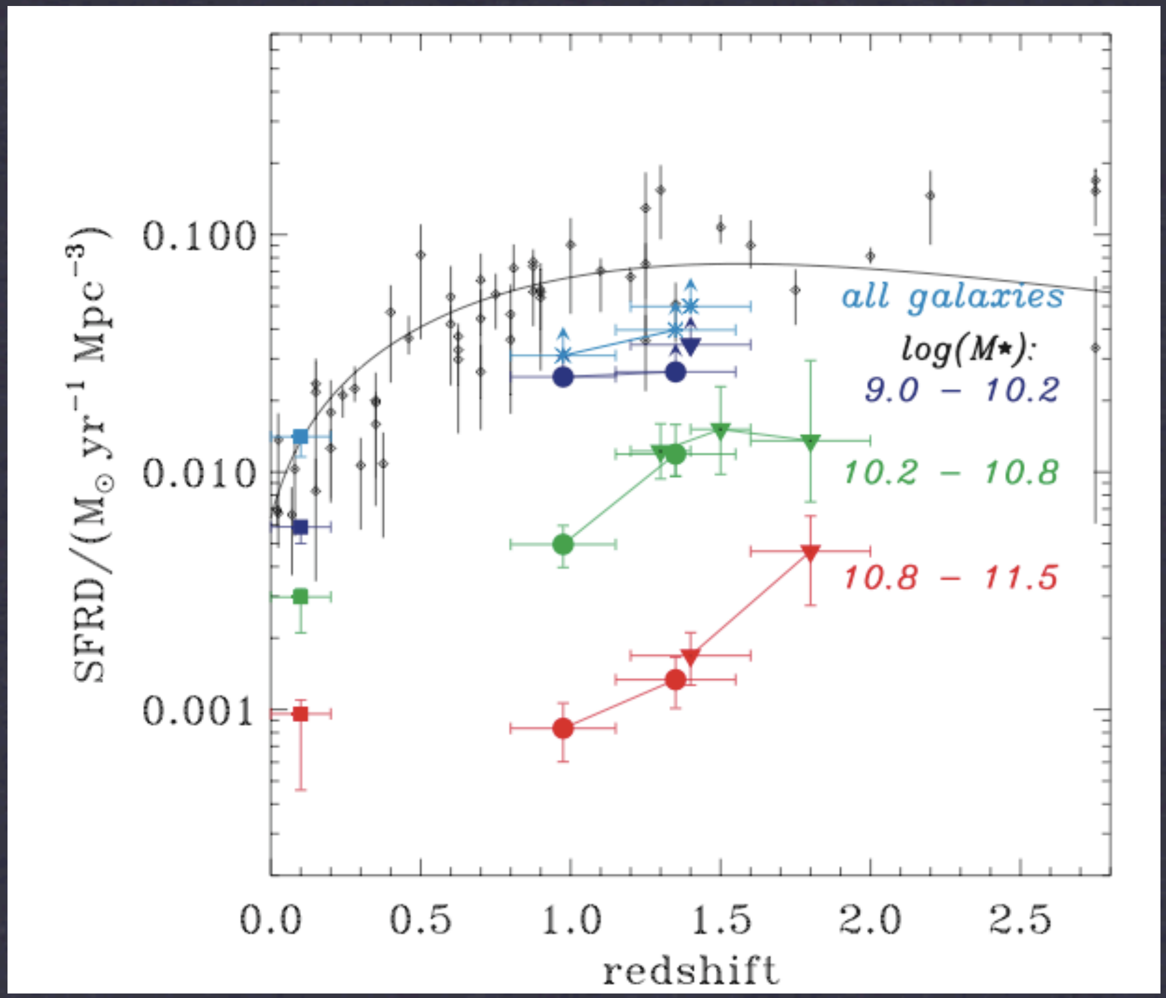
- SFR decreasing strongly since ~ 7 billions years

- Time evolution of galaxies' contribution to SFR ?

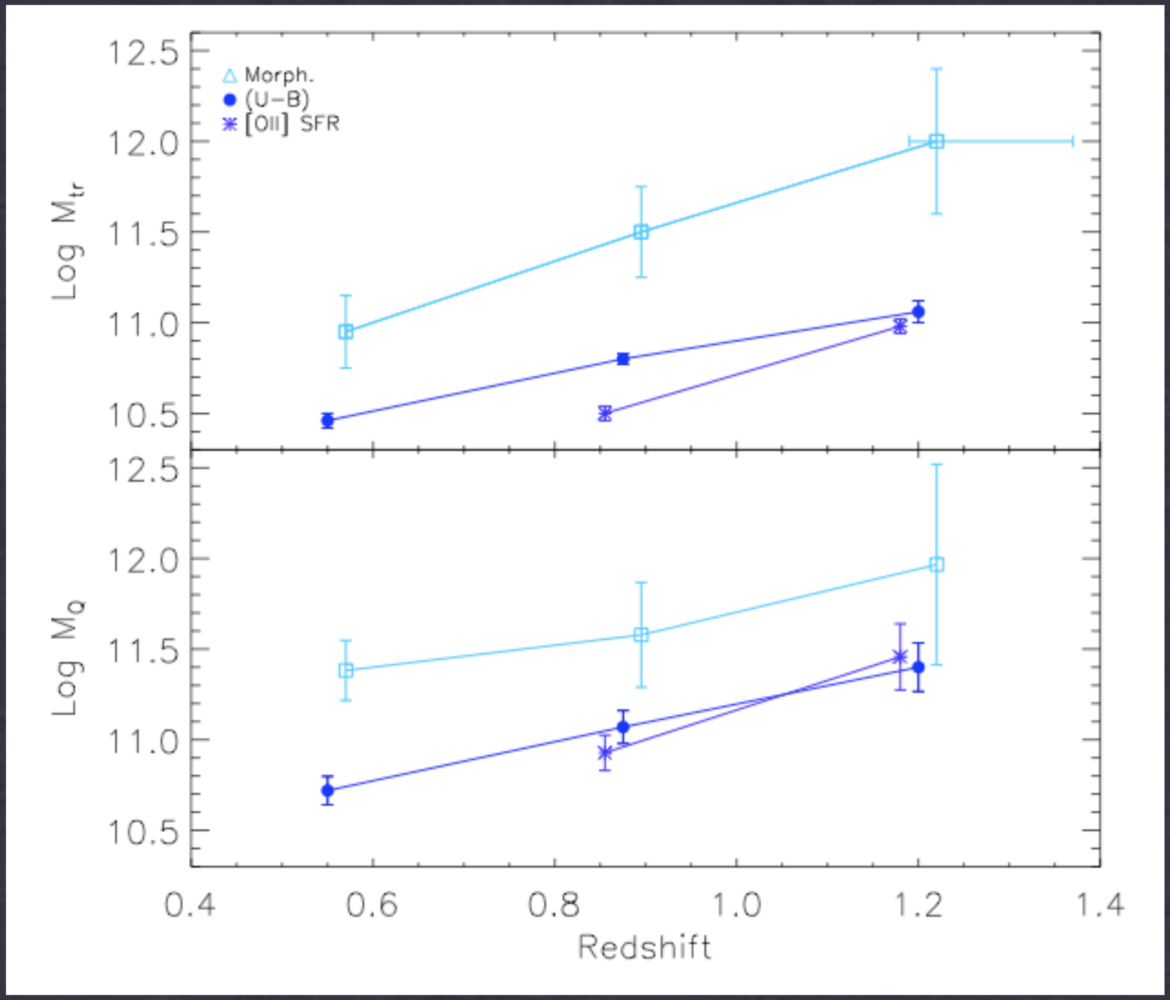


Hopkins & Beacom (2006)

Downsizing of galaxy formation



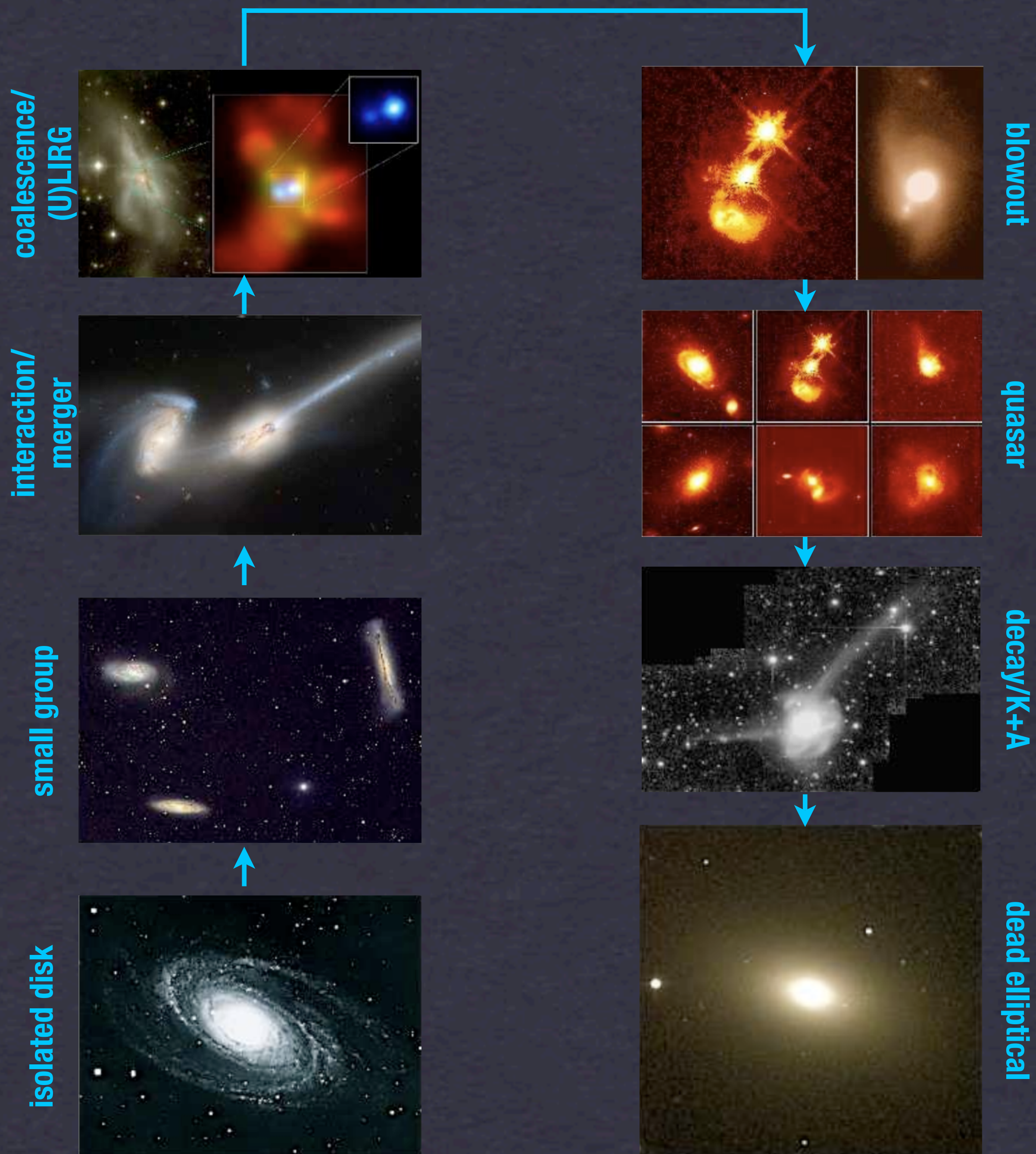
Juneau et al (2005)



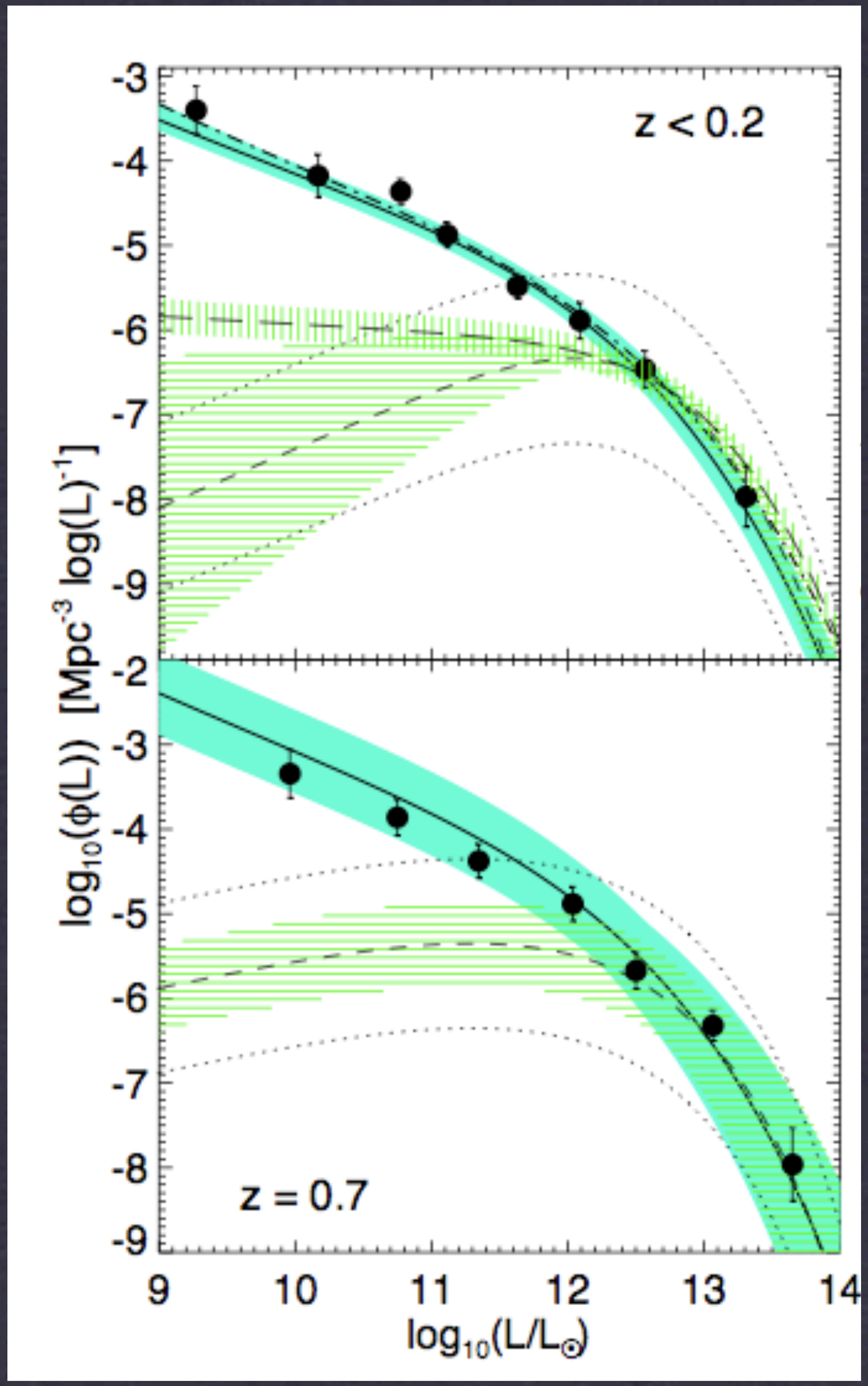
Bundy et al (2005)

- Downsizing: "more massive galaxies form at higher redshift" (Cowie et al 1996)
- Galaxies stop actively forming stars sooner if more massive
- Physical mecanisms responsible ?

Downsizing - Internal processes
AGN Feedback I



Adapted from Hopkins et al (2008)



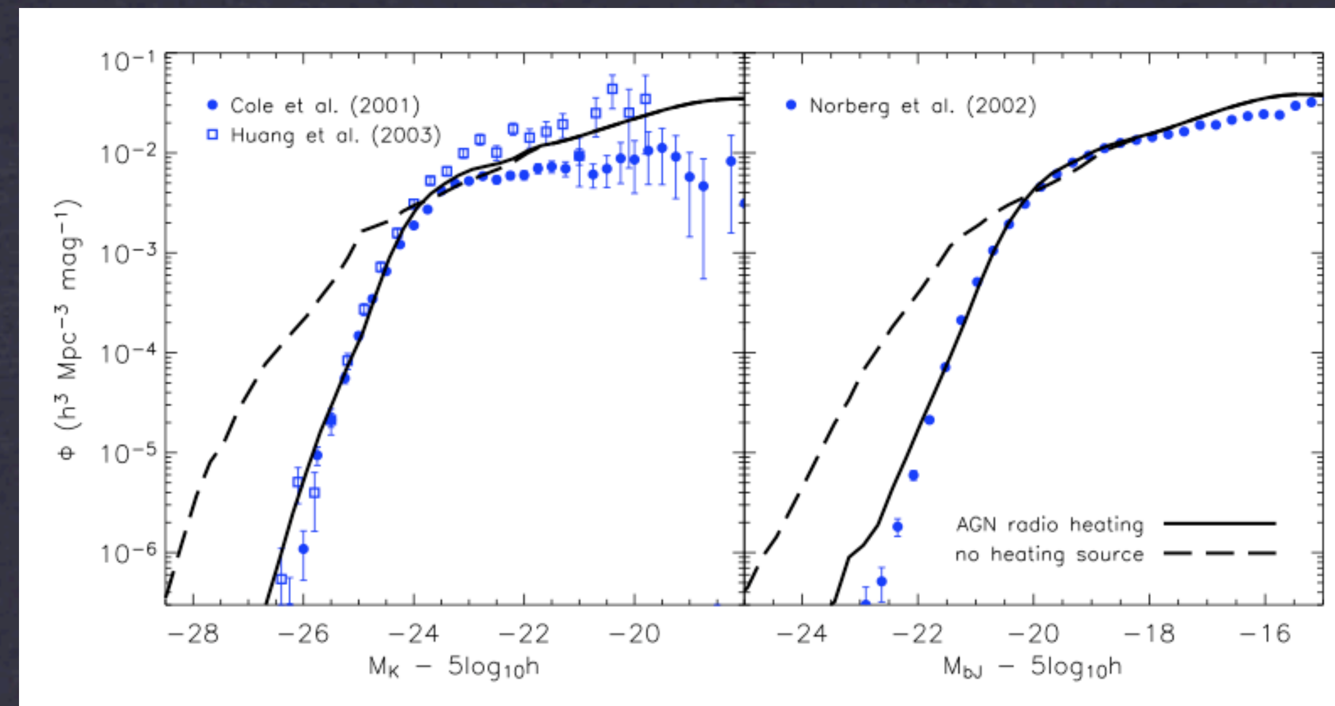
Hopkins et al (2006)

- Galaxy mergers trigger AGN activity
- AGN feedback quenches star formation

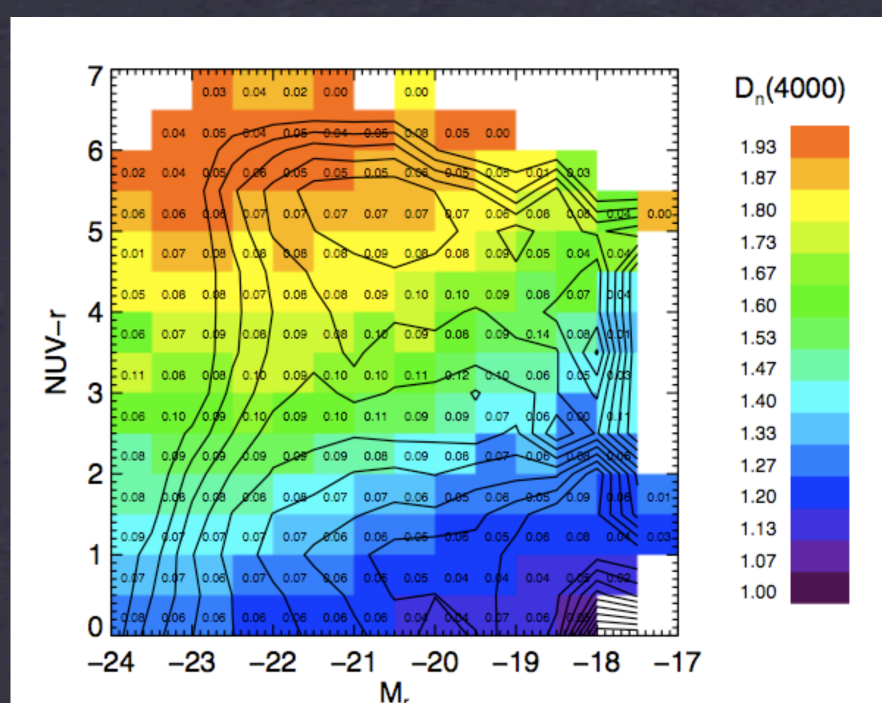
Downsizing - Internal processes
AGN Feedback II

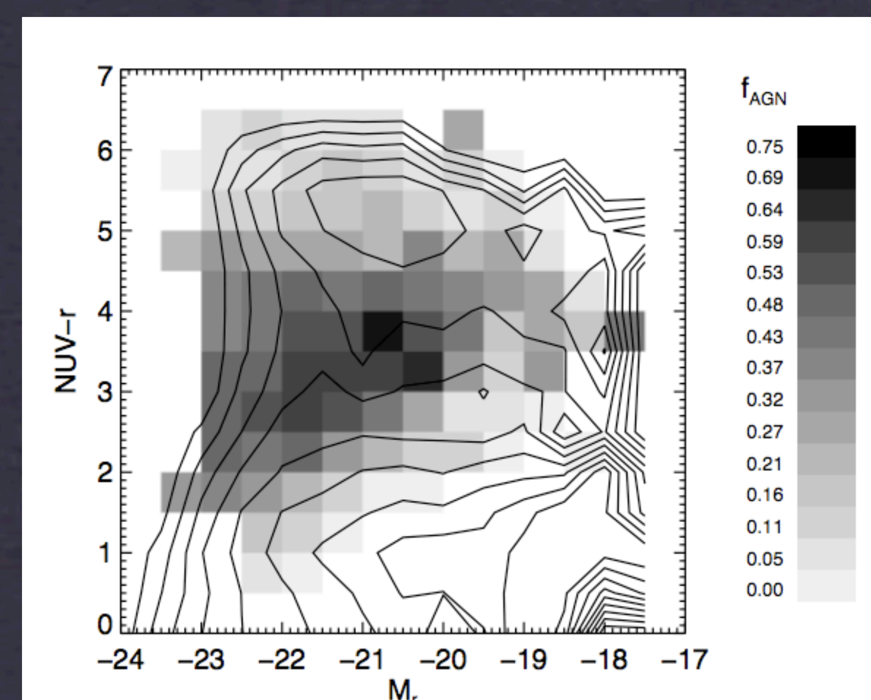
- Use of AGN feedback in simulations helps to agree with observations

- Fraction of objects with AGN peaks in green valley



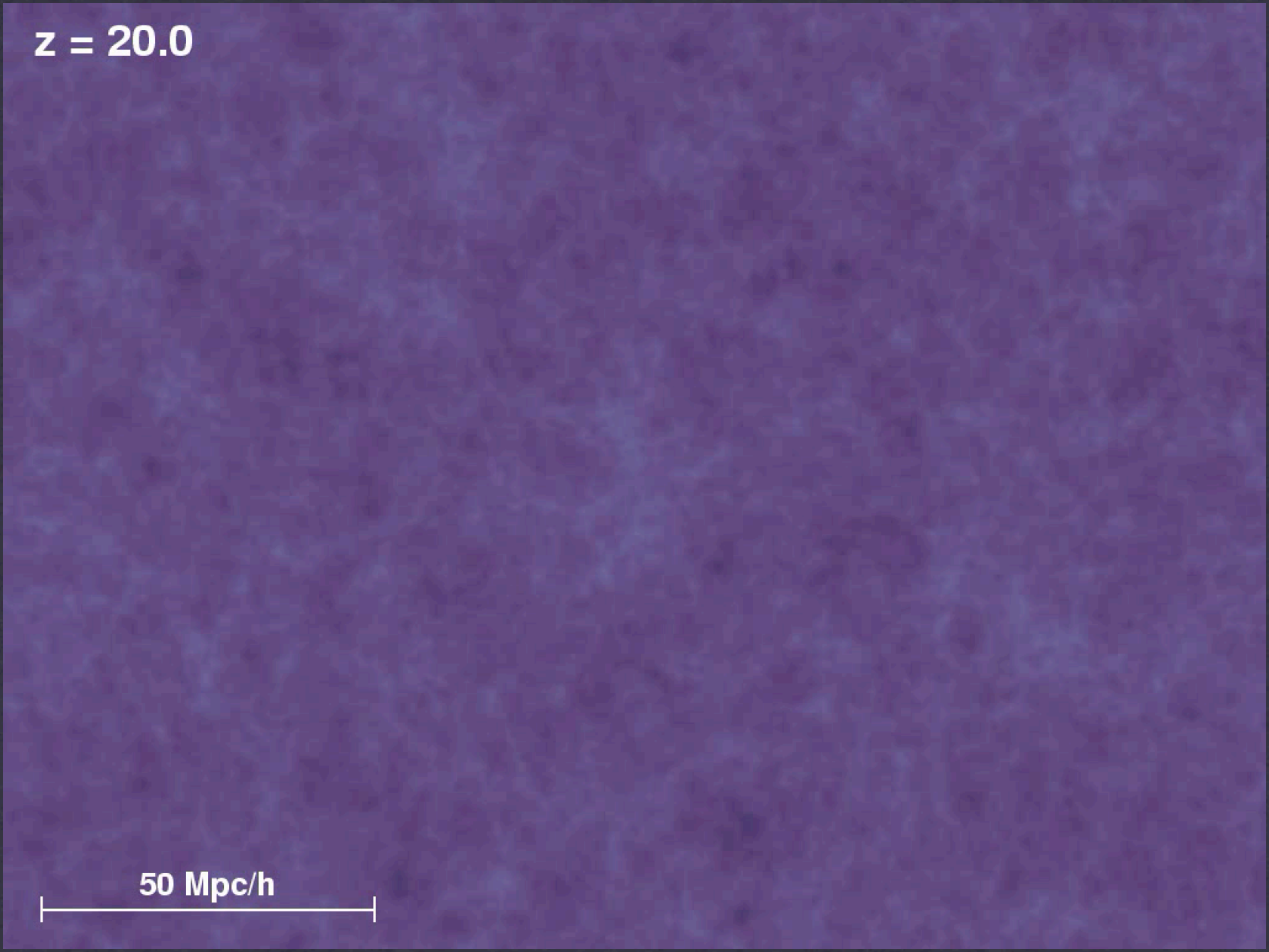
Croton et al (2006)





Martin et al (2007)

Downsizing - Environmental processes
Dark matter and galaxies

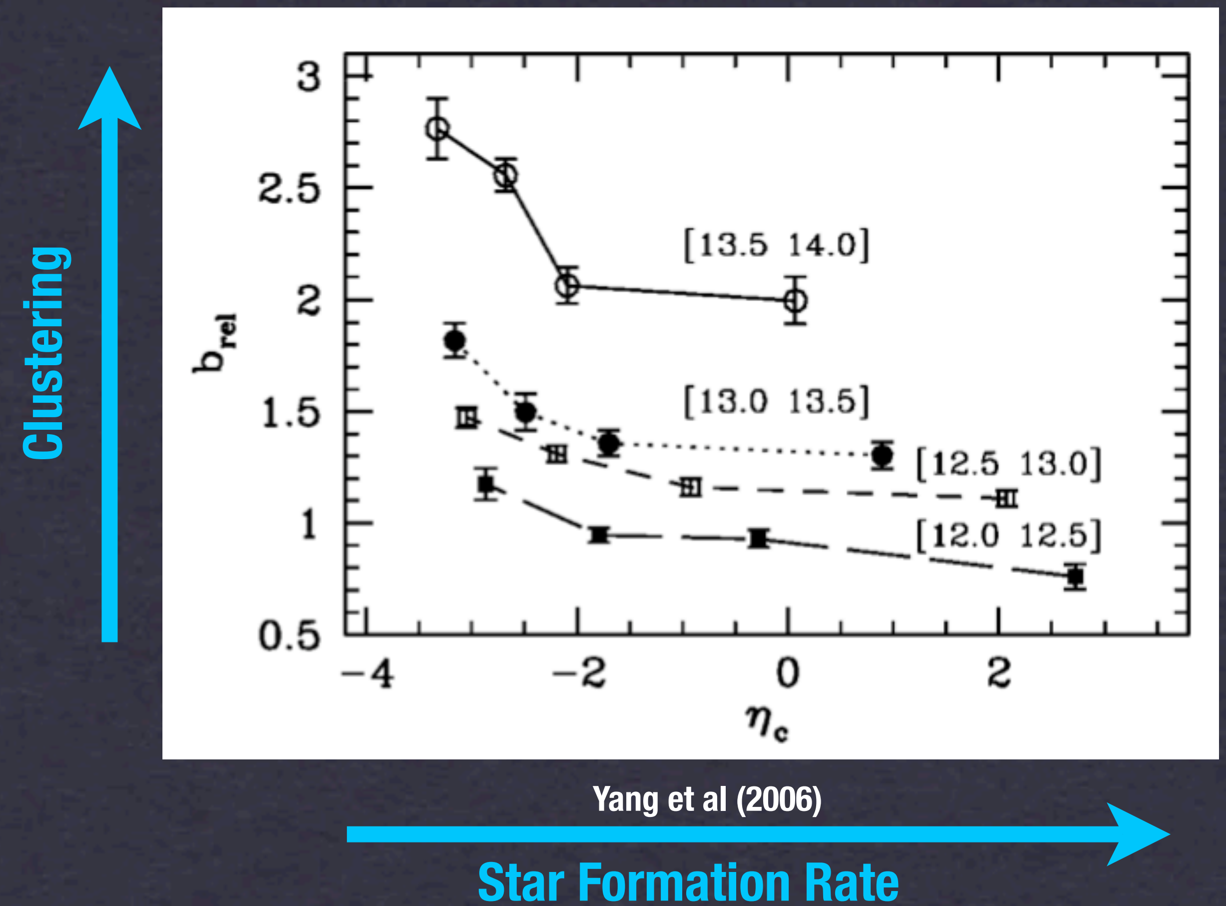


Downsizing - Environmental processes

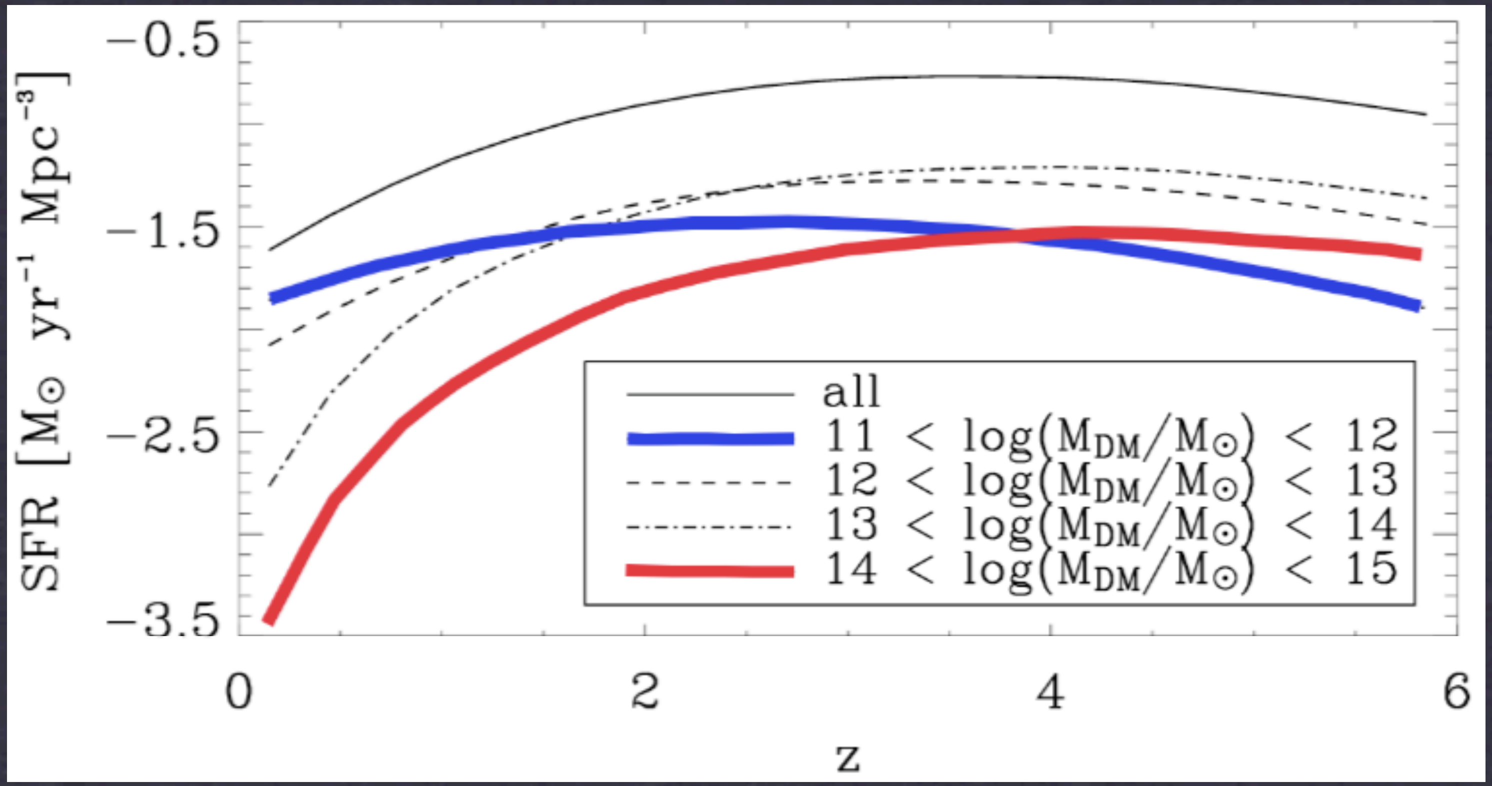
- Simulations: halo properties depend on environment at a fixed halo mass

- Observations: galaxy properties depend on environment at a fixed halo mass

- Simulations involving environmental effects agree well with observations

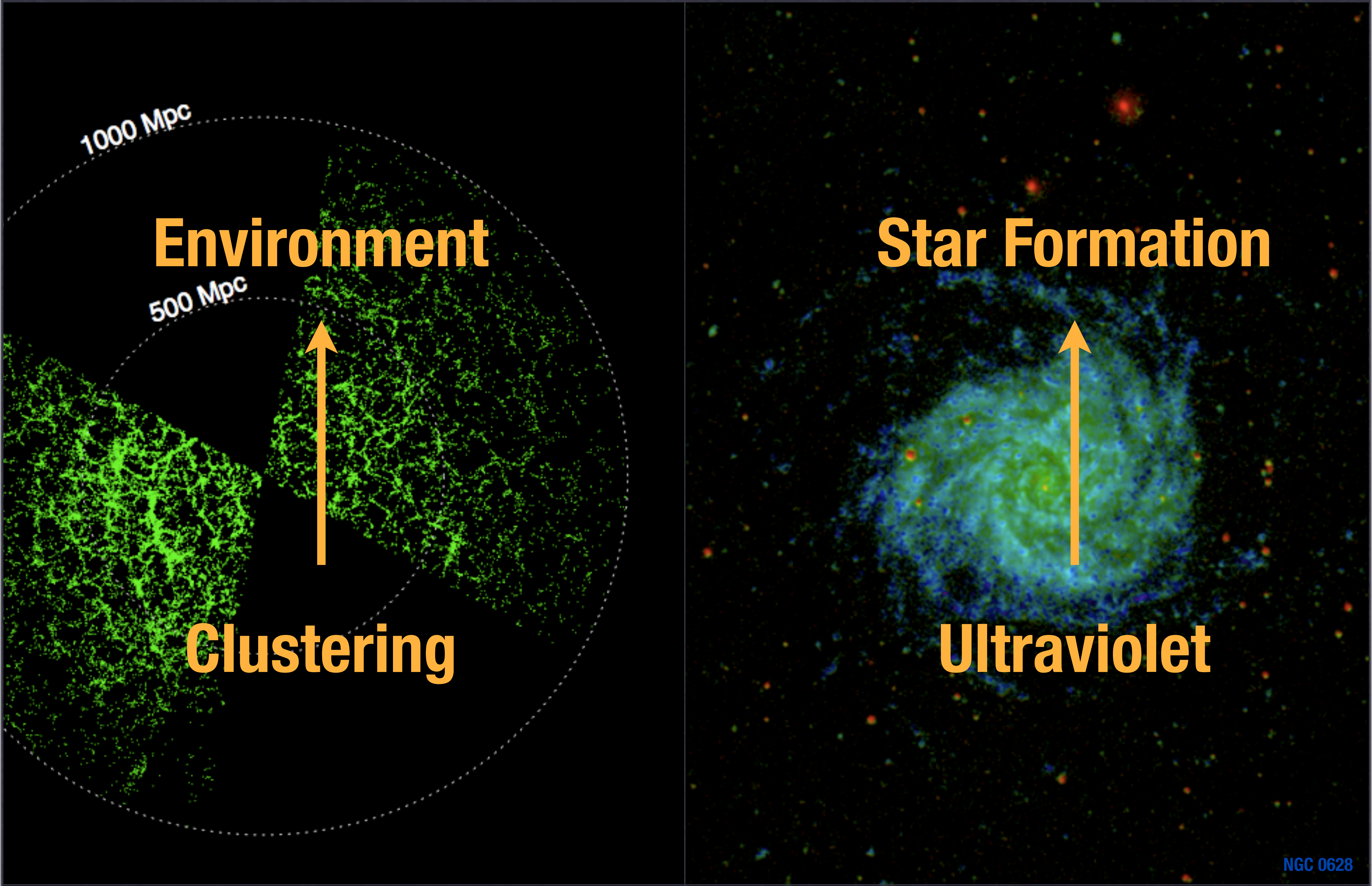


Yang et al (2006)

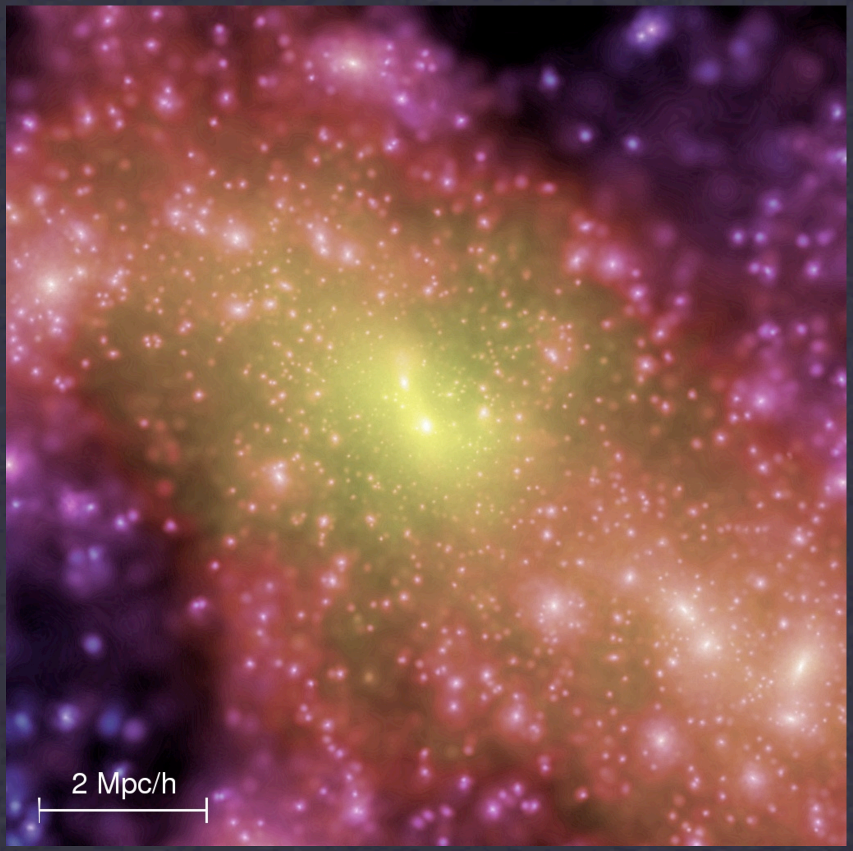


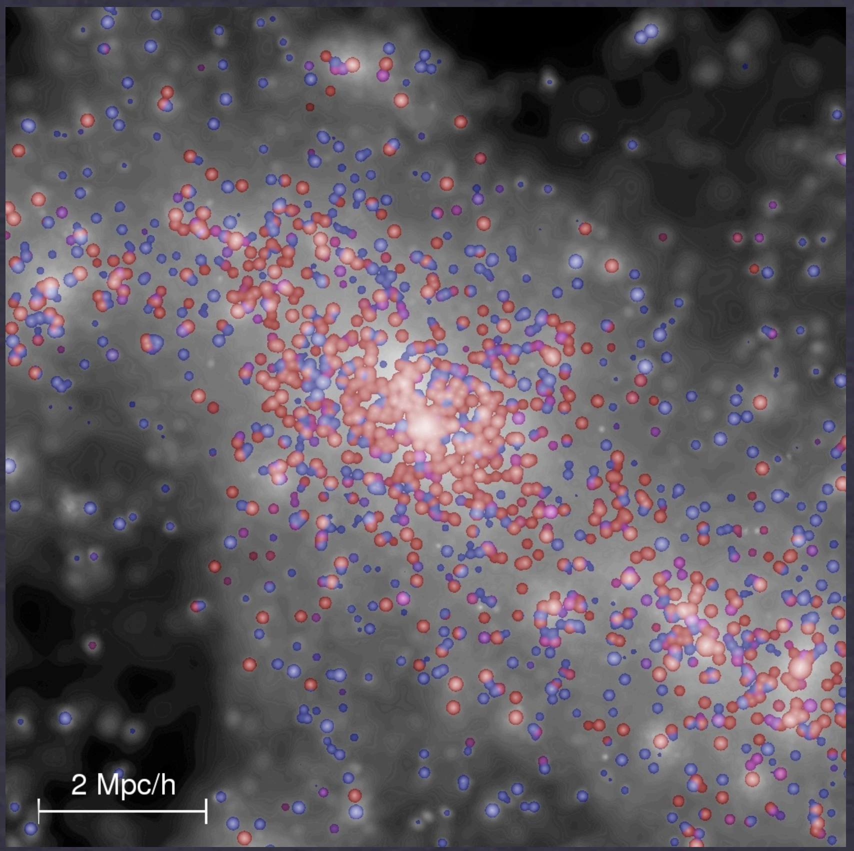
Khochfar & Ostriker (2007)

Links between Star Formation and Environment

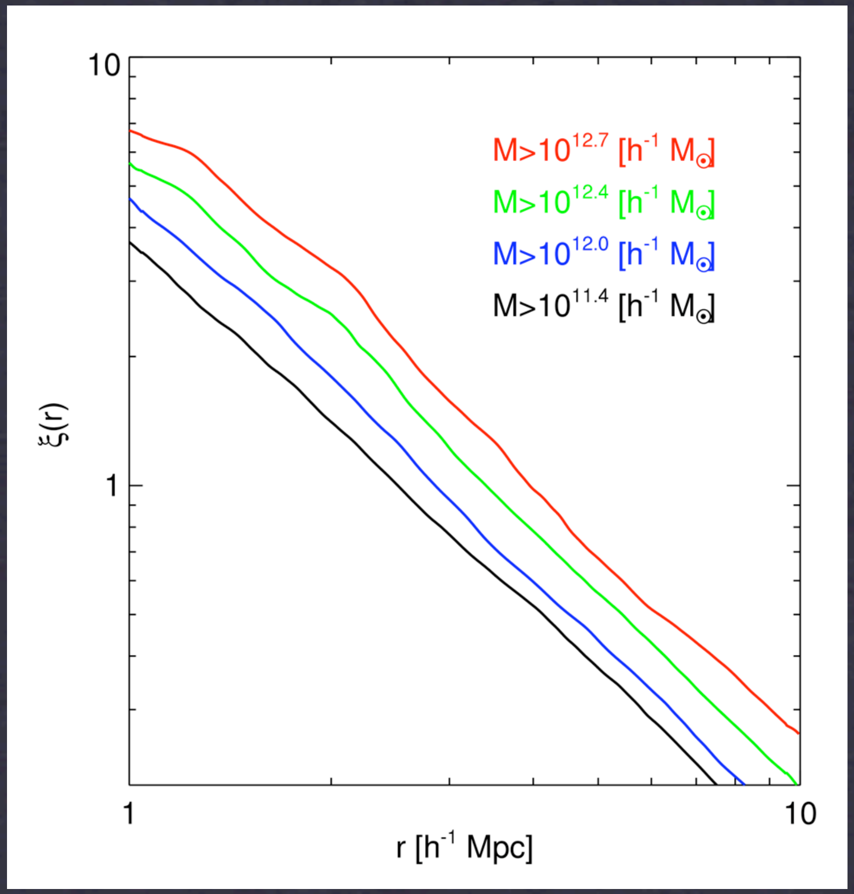


Clustering as a tracer of environment





Springel et al (2005)



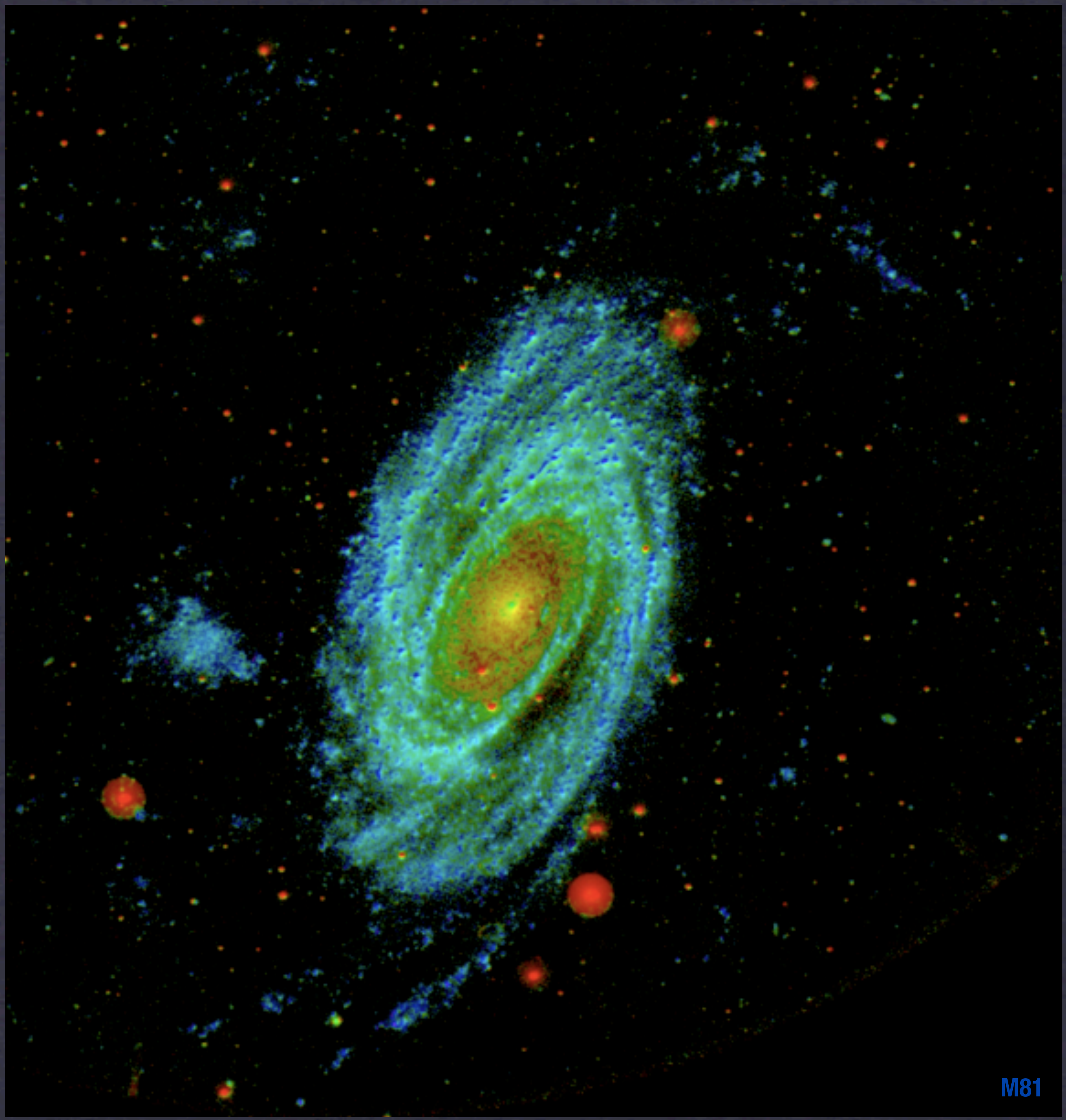
Somerville et al (2001)

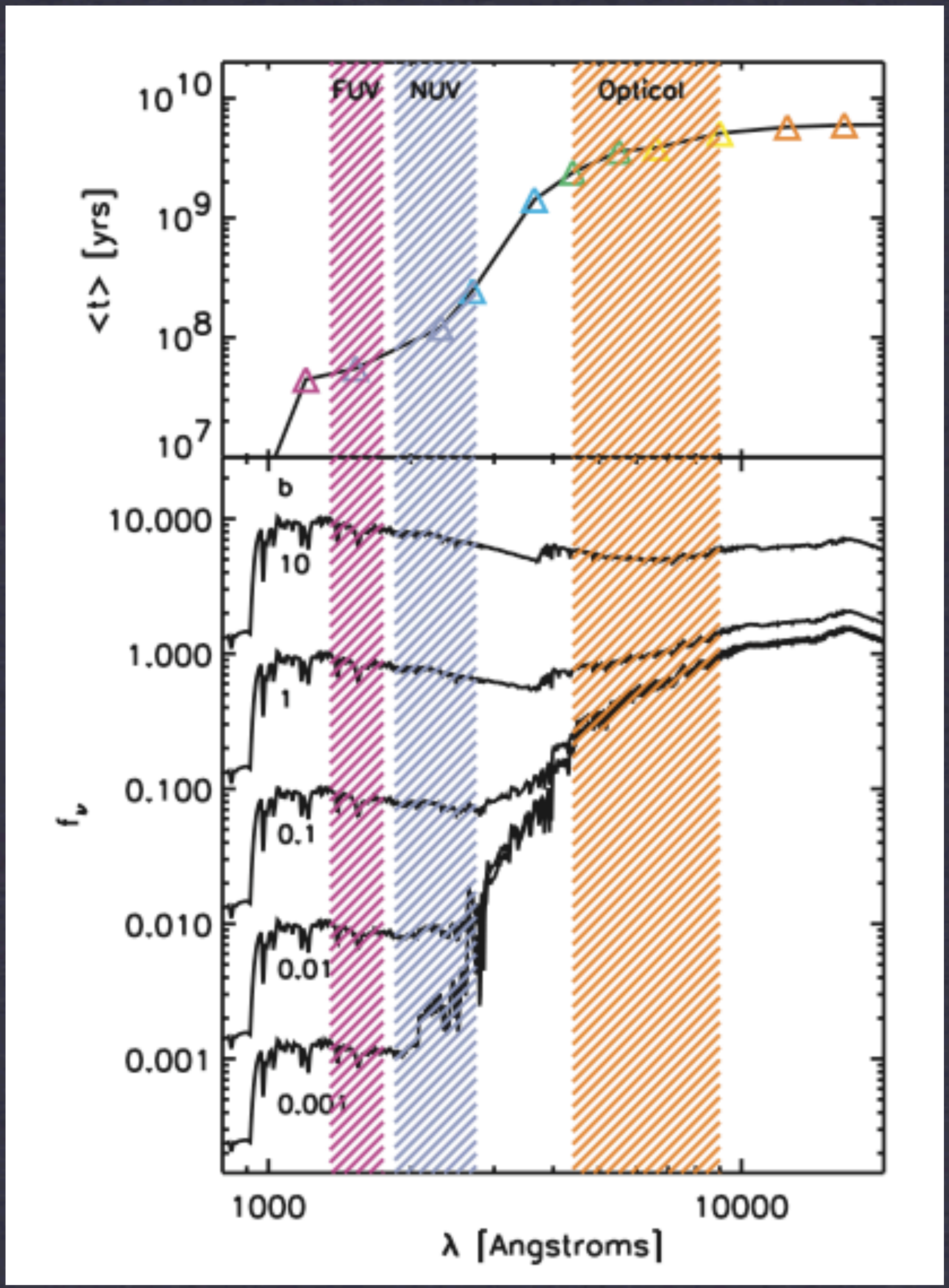
- Galaxies reside in Dark Matter haloes

- Galaxy distribution reflects their host haloes distribution

- Haloes distribution depends on halo mass

Ultraviolet as a tracer of star formation

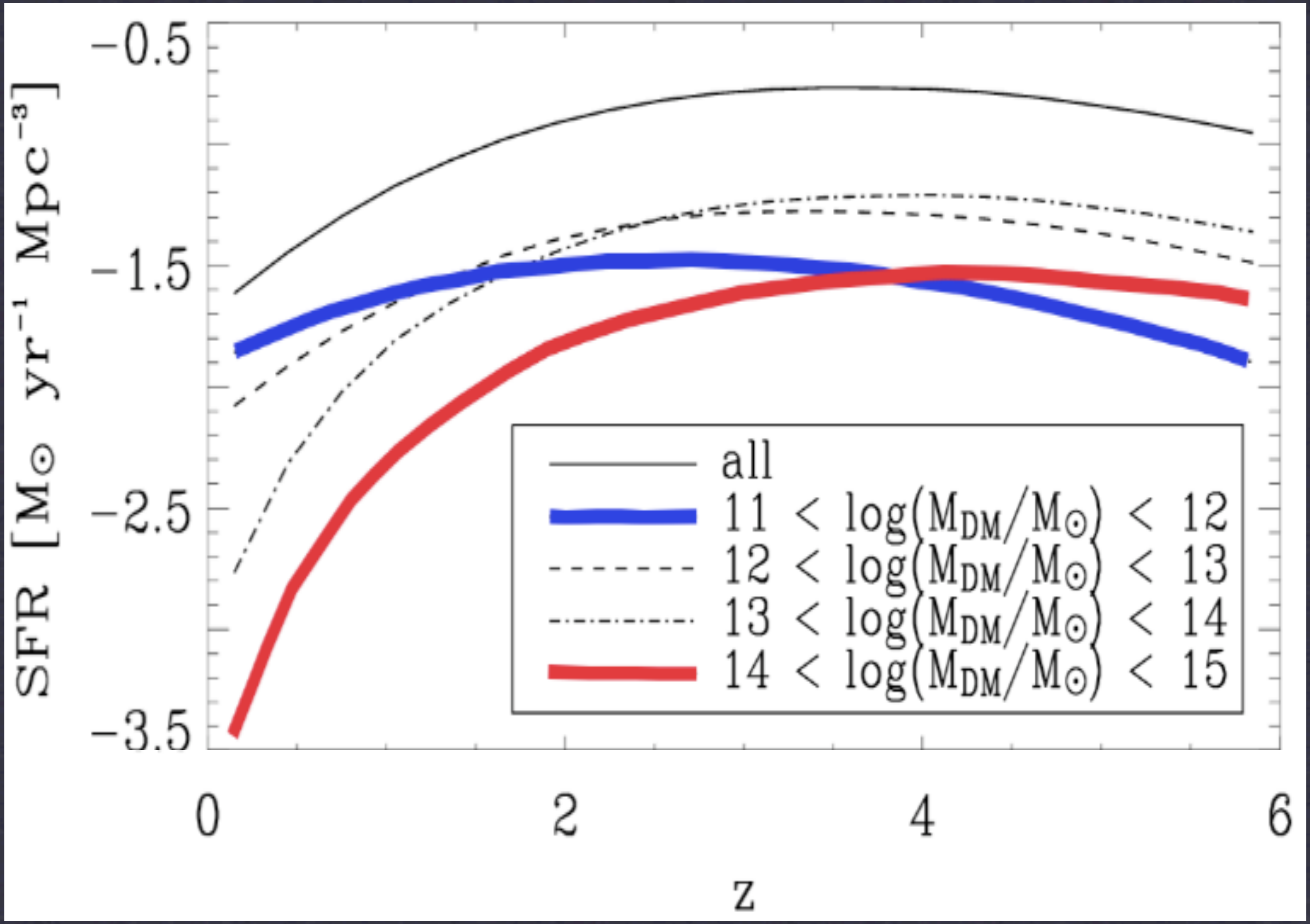




Martin et al (2005)

Ultraviolet as a tracer of star formation from z = 6 to z = 0

- UV galaxy samples available from z ~ 6 to z = 0
- Clustering of LBGs studied at z > 1.5
- Extension at lower redshifts with GALEX data



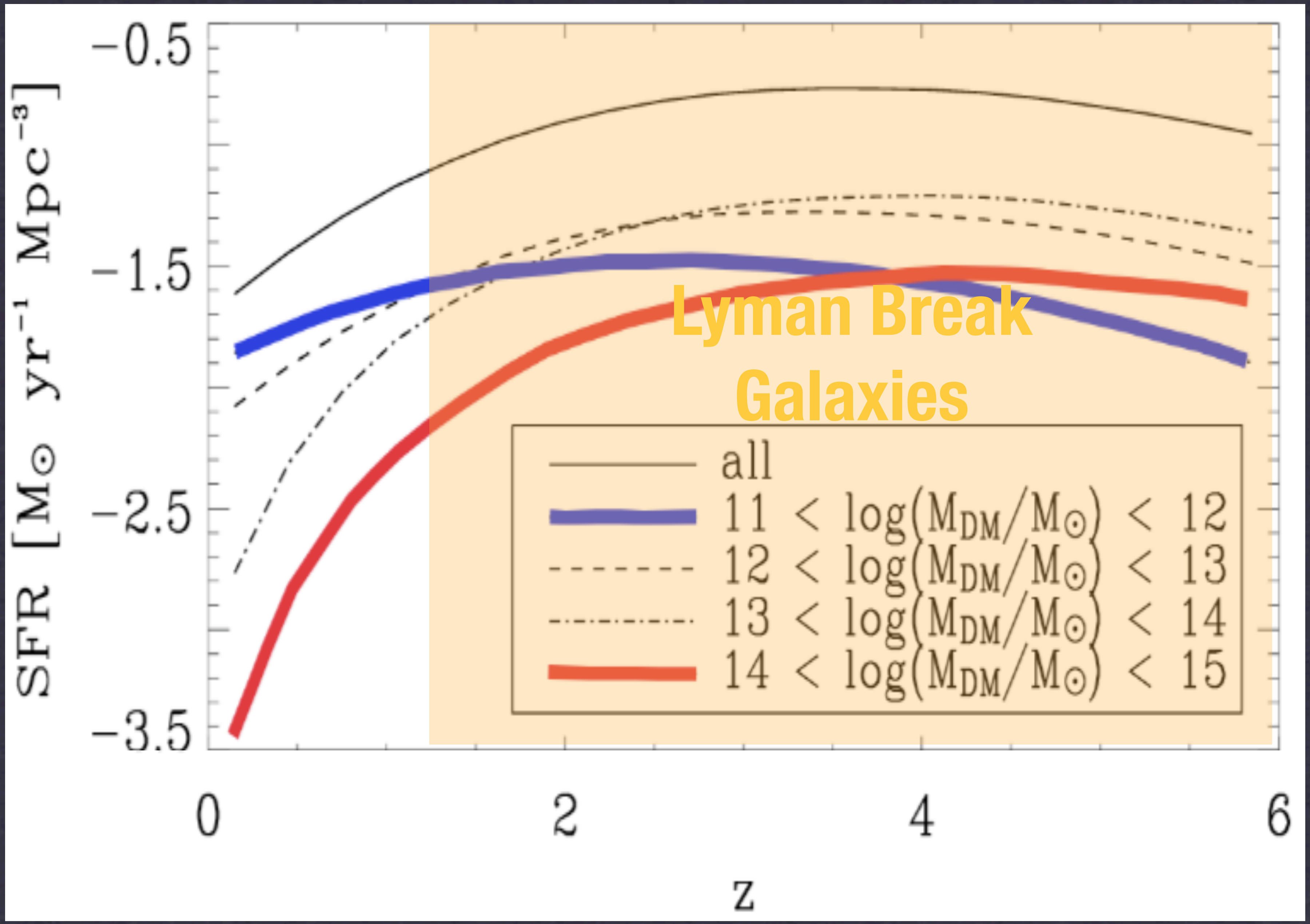
Khochfar & Ostriker (2007)

Ultraviolet as a tracer of star formation from z = 6 to z = 0

- UV galaxy samples available from z ~ 6 to z = 0

- Clustering of LBGs studied at z > 1.5

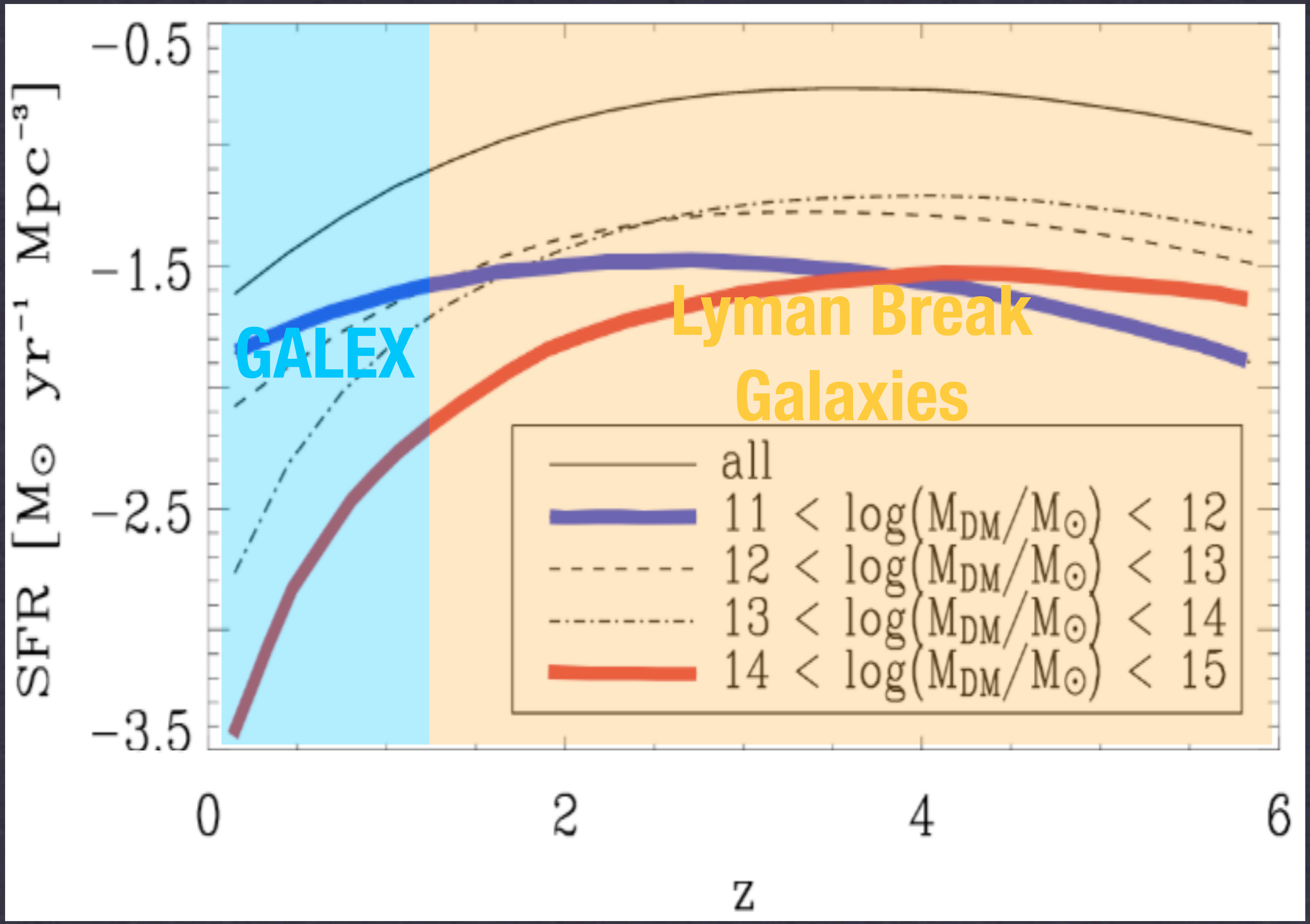
- Extension at lower redshifts with GALEX data



Khochfar & Ostriker (2007)

Ultraviolet as a tracer of star formation from z = 6 to z = 0

- UV galaxy samples available from z ~ 6 to z = 0
- Clustering of LBGs studied at z > 1.5
- Extension at lower redshifts with GALEX data



Khochfar & Ostriker (2007)

Outline

I. Data samples

Galex presentation

Samples: MIS r-selected / AIS UV selected

II. Correlation function basics

III. Results from MIS full sample

NUV-r cuts: Star Formation History tracer

IV. Results from AIS UV-selected sample

NUV luminosity and NUV-R cuts

V. Conclusion

Acknowledgements

Thanks to:

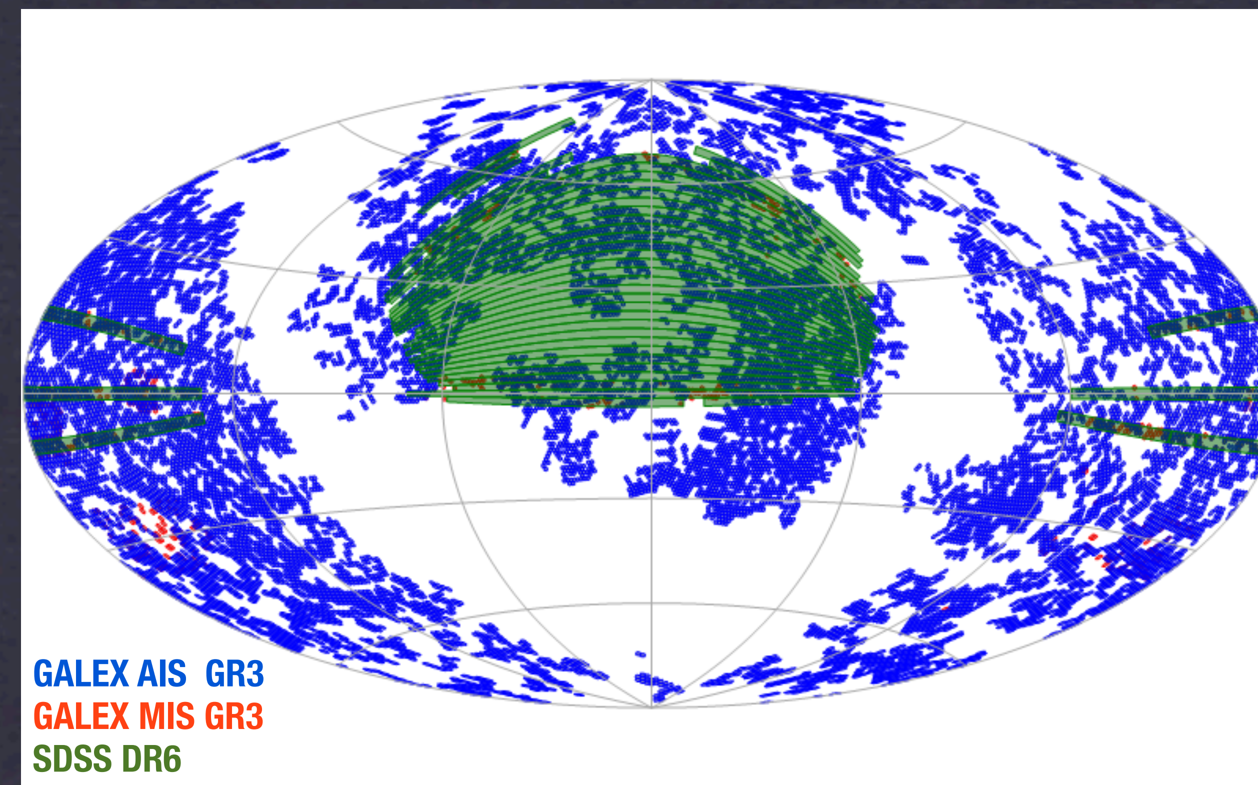
Bruno Milliard
Stéphane Arnouts

Alex Szalay
Tamás Budavári

Miguel Aragón-Calvo
Samuel Carliles
Jayant Gupchup
Manuchehr Taghizadeh Popp
Ching-Wa Yip

GALEX
A presentation

- Imaging, spectroscopy
- 2 bands: FUV (1540 Å) NUV (2315 Å)
- FOV 1.2 degrees



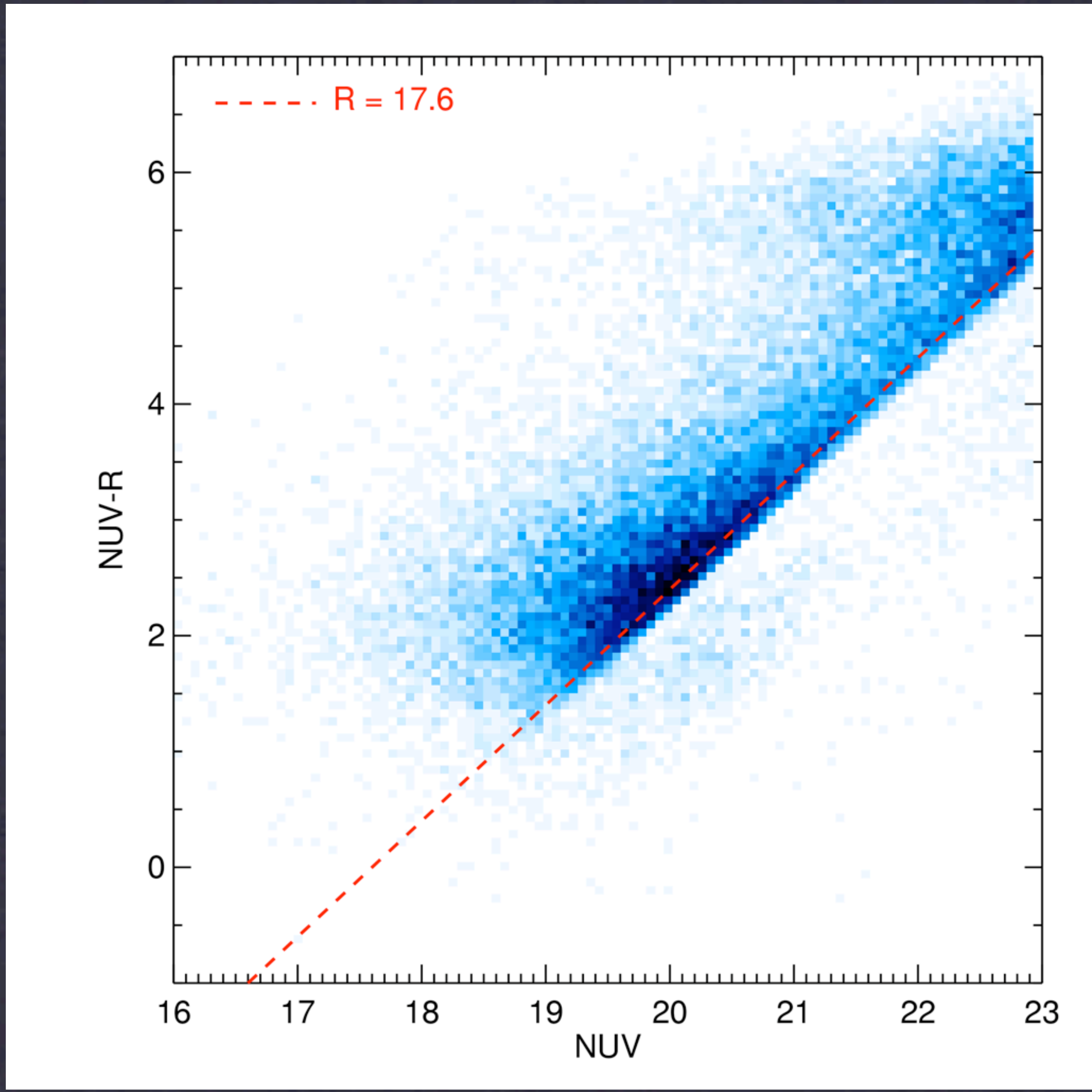
Survey	Area (sqdeg)	# of Objects	<FUV exptime> (s)	<NUV exptime> (s)
AIS	13,566	83,358,979	111	111
MIS	880	13,586,221	1,780	2,232
DIS	113	2,971,137	21,210	26,387
NGS	304	3,853,946	2,232	2,595
GII	318	4,224,949	2,393	3,331

GALEX Galaxy Evolution Explorer

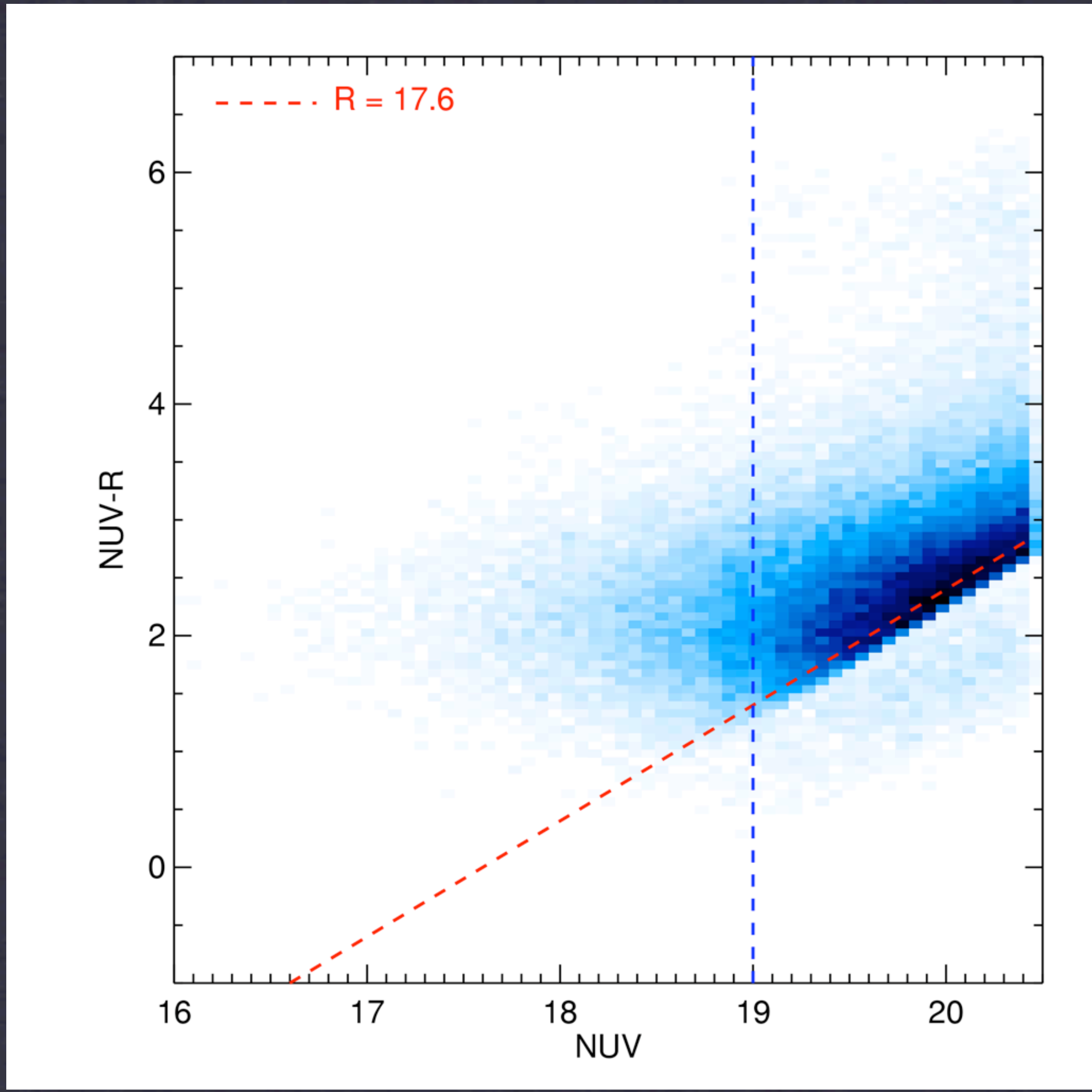
Sample(s) selection

- GALEX GR3 data cross-matched to SDSS DR6 (4 arcsec radius)
- Objects with only one GALEX-SDSS counterpart
- SDSS spectrocopic galaxies with r<17.6

MIS full sample: 15,839 galaxies



AIS UV-selected sample: 12,118 galaxies

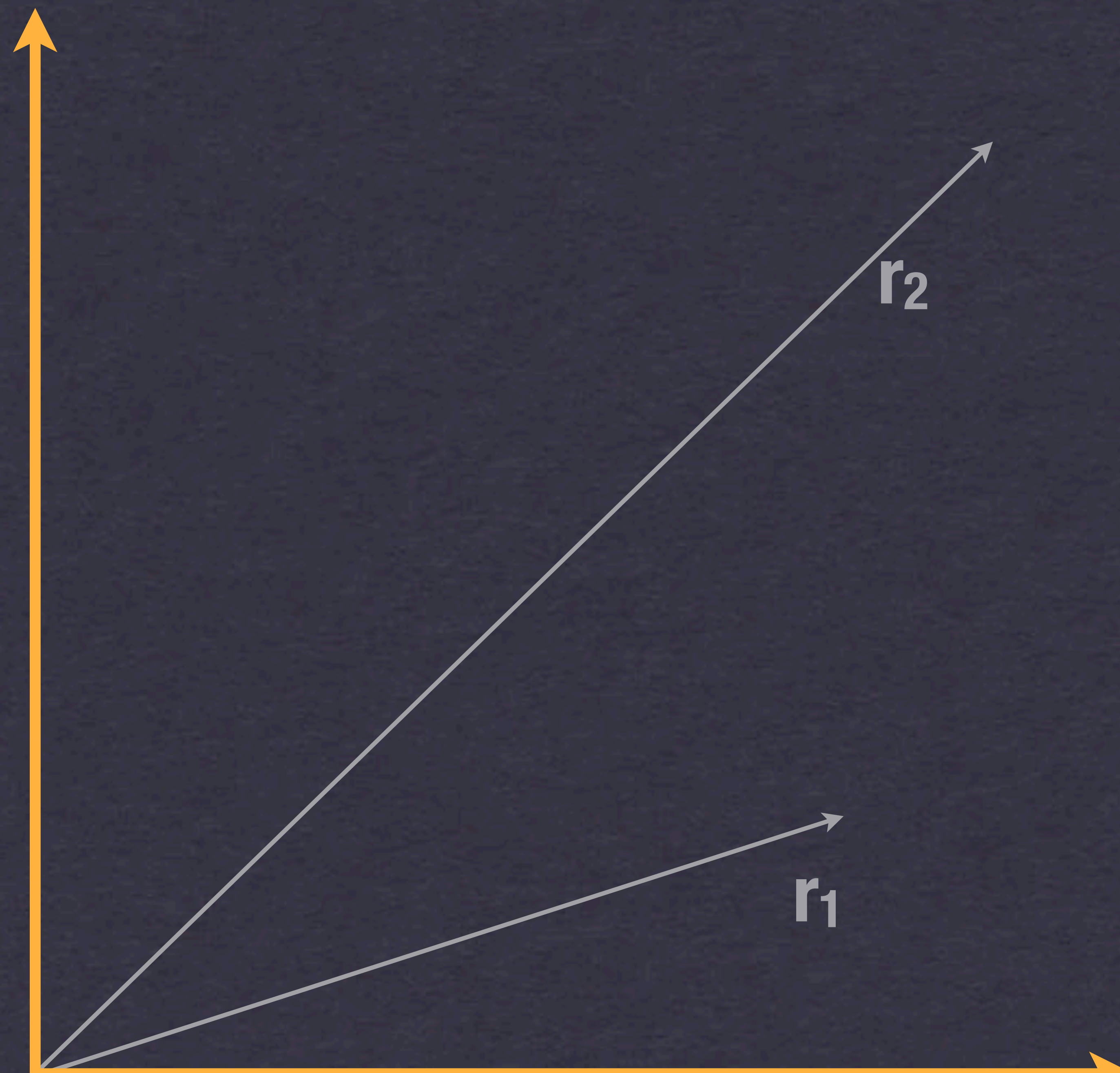


3D correlation function

- Correlation function: excess of pairs with respect to random at a given scale

- Estimator: Landy & Szalay (1993)

$$\xi(r_p\,,\,\pi) = \frac{DD - 2DR + RR}{RR}$$

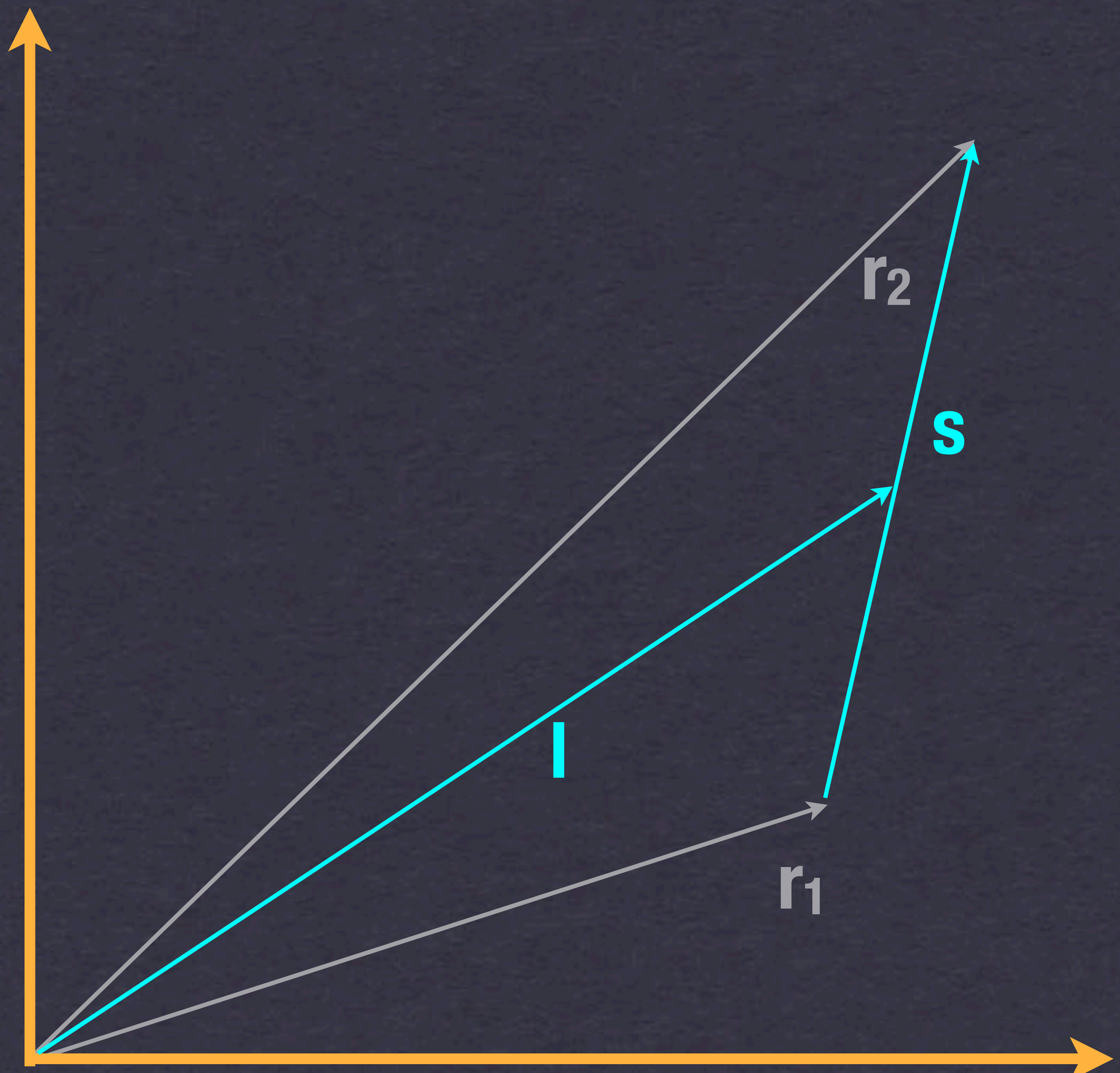


3D correlation function

- Correlation function: excess of pairs with respect to random at a given scale

- Estimator: Landy & Szalay (1993)

$$\xi(r_p\,,\,\pi) = \frac{DD - 2DR + RR}{RR}$$

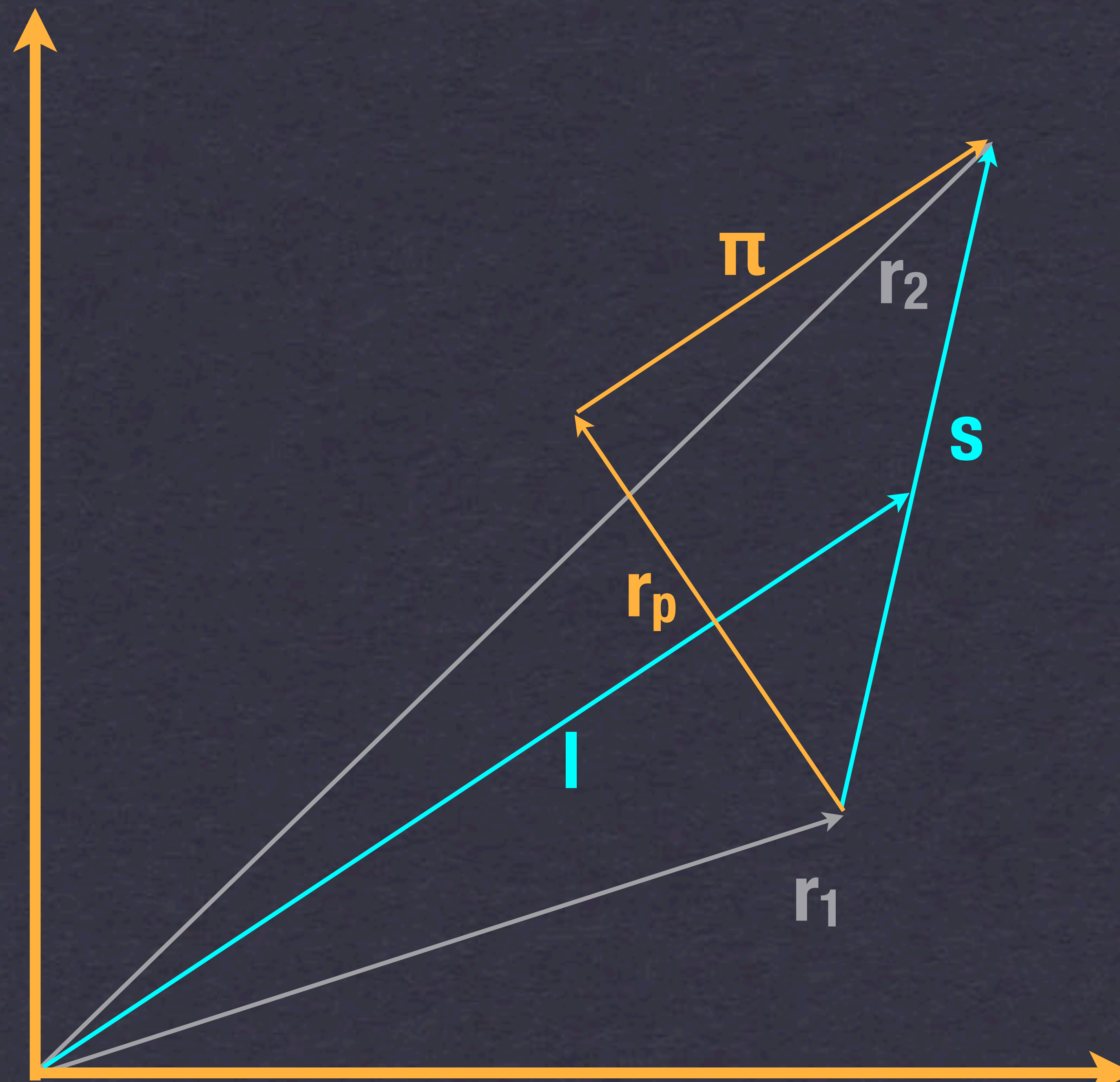


3D correlation function

- Correlation function: excess of pairs with respect to random at a given scale

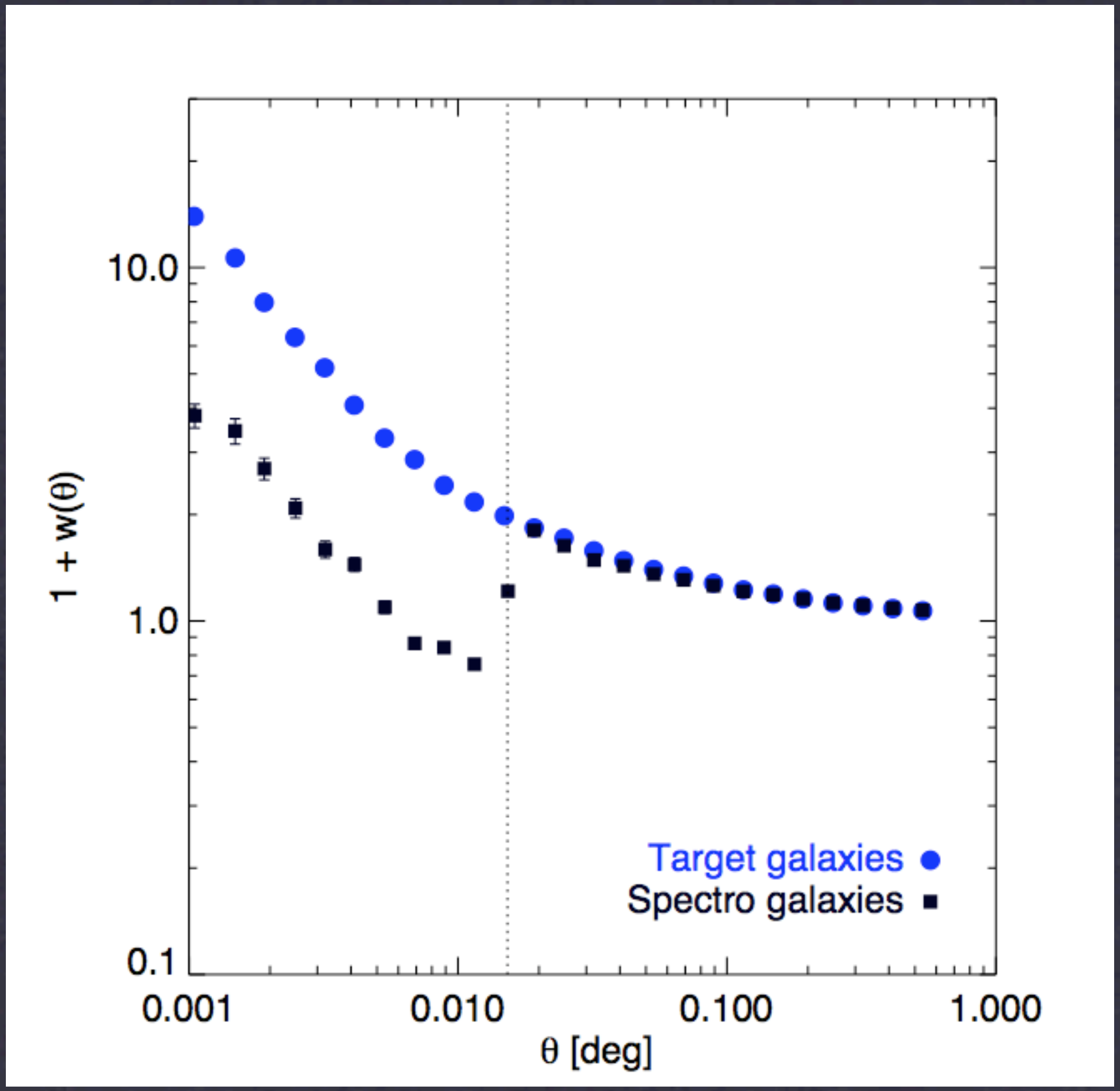
- Estimator: Landy & Szalay (1993)

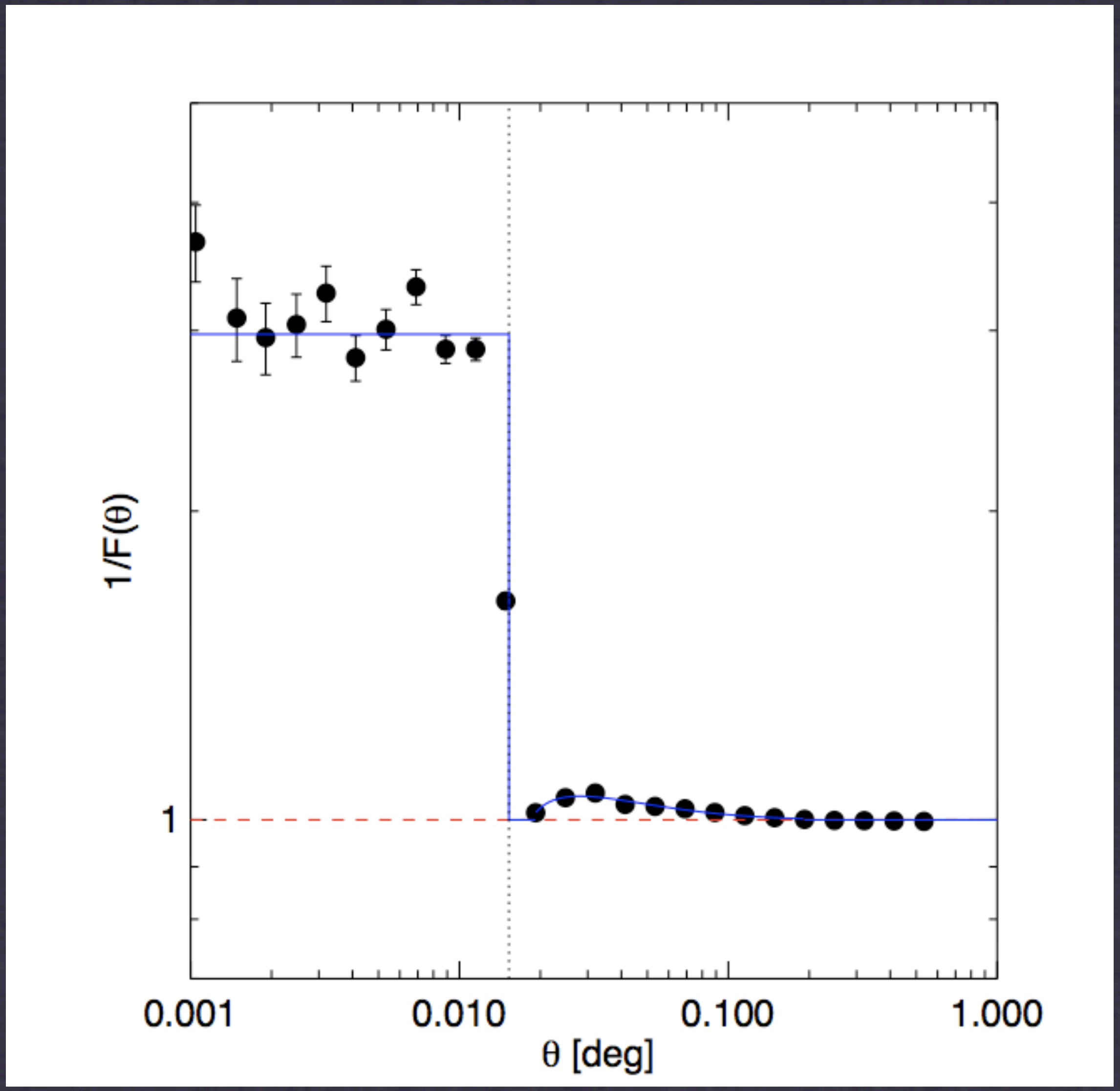
$$\xi(r_p , \pi) = \frac{DD - 2DR + RR}{RR}$$



Fiber collision correction

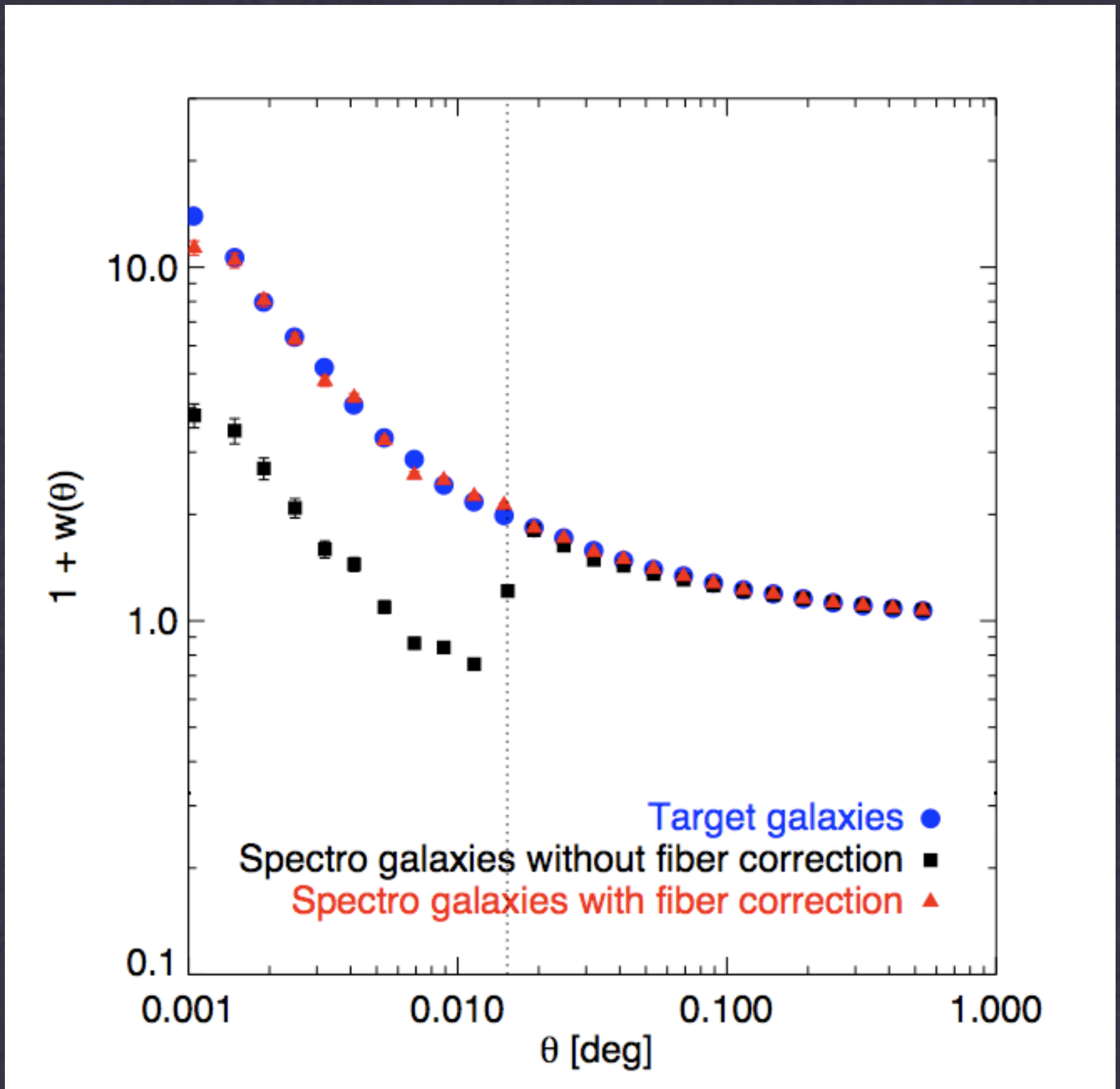
- Finite fiber size constraints: fiber collision at θ < 55 arcsec
- Statistical approach (Hawkins et al, 2003; Li et al, 2006)
- Use angular correlation function from target and spectroscopic galaxies

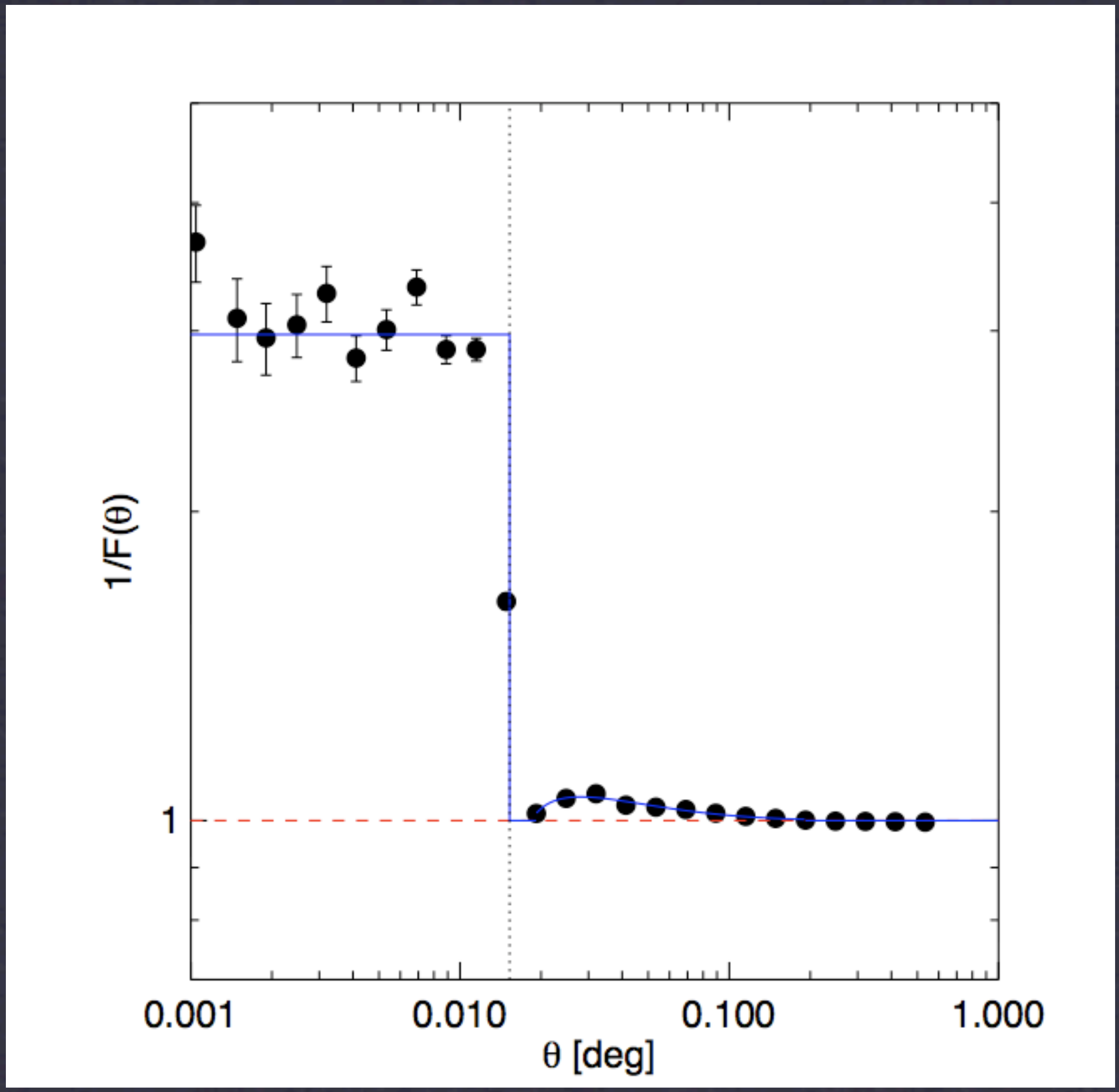




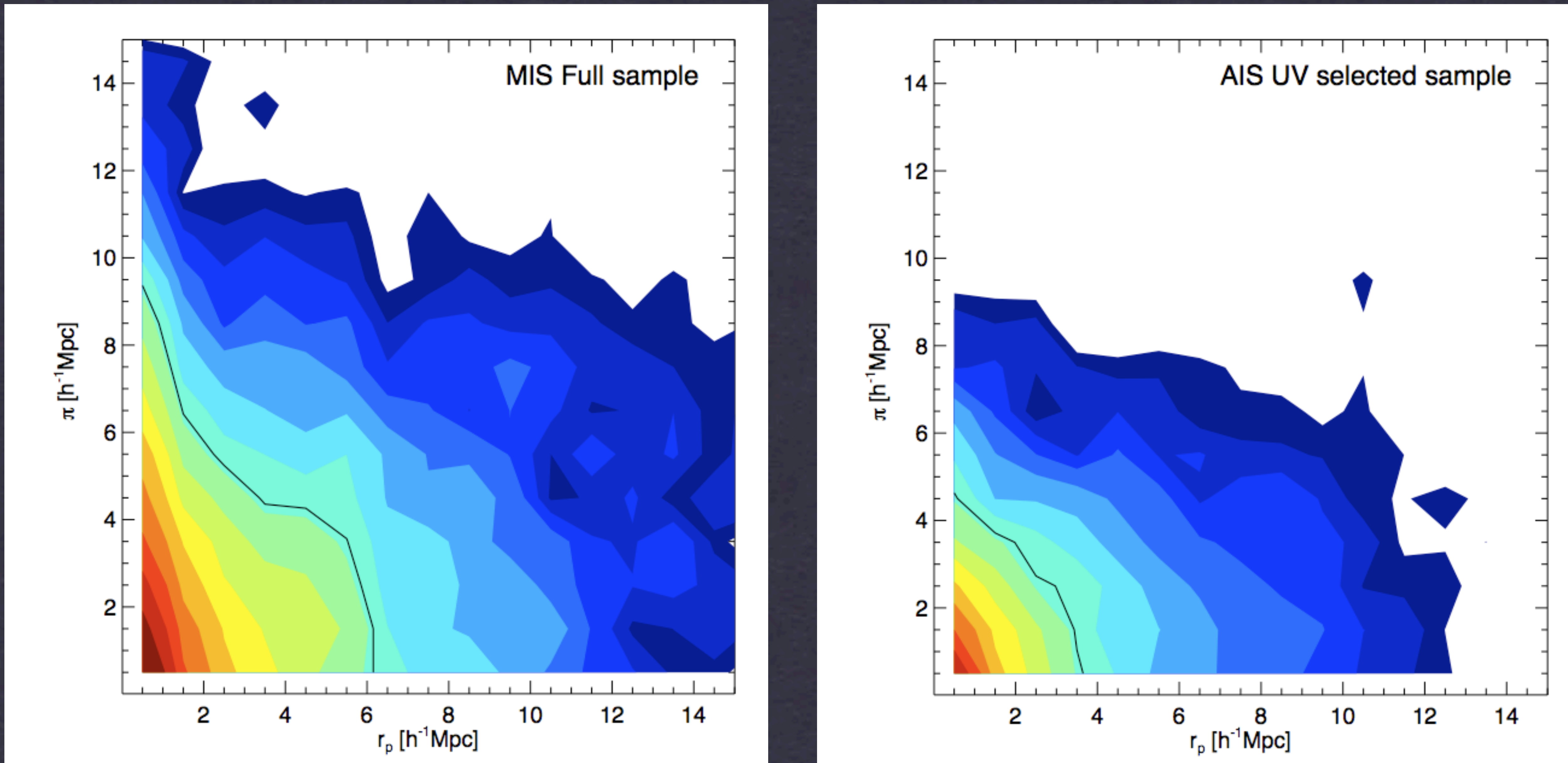
Fiber collision correction

- Finite fiber size constraints: fiber collision at θ < 55 arcsec
- Statistical approach (Hawkins et al, 2003; Li et al, 2006)
- Use angular correlation function from target and spectroscopic galaxies



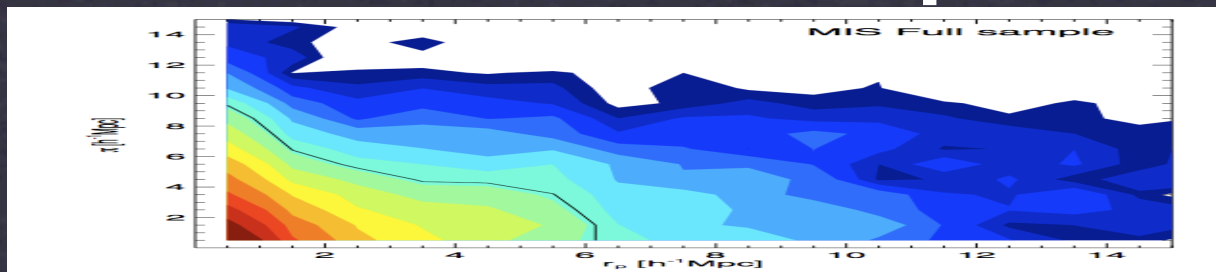


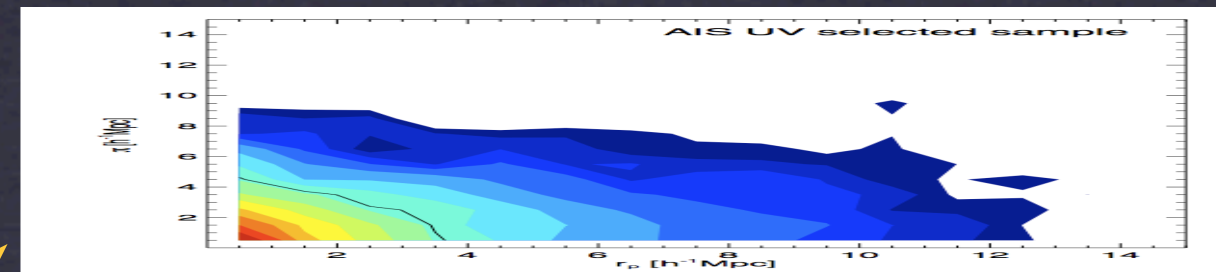
Redshift space correlation functions

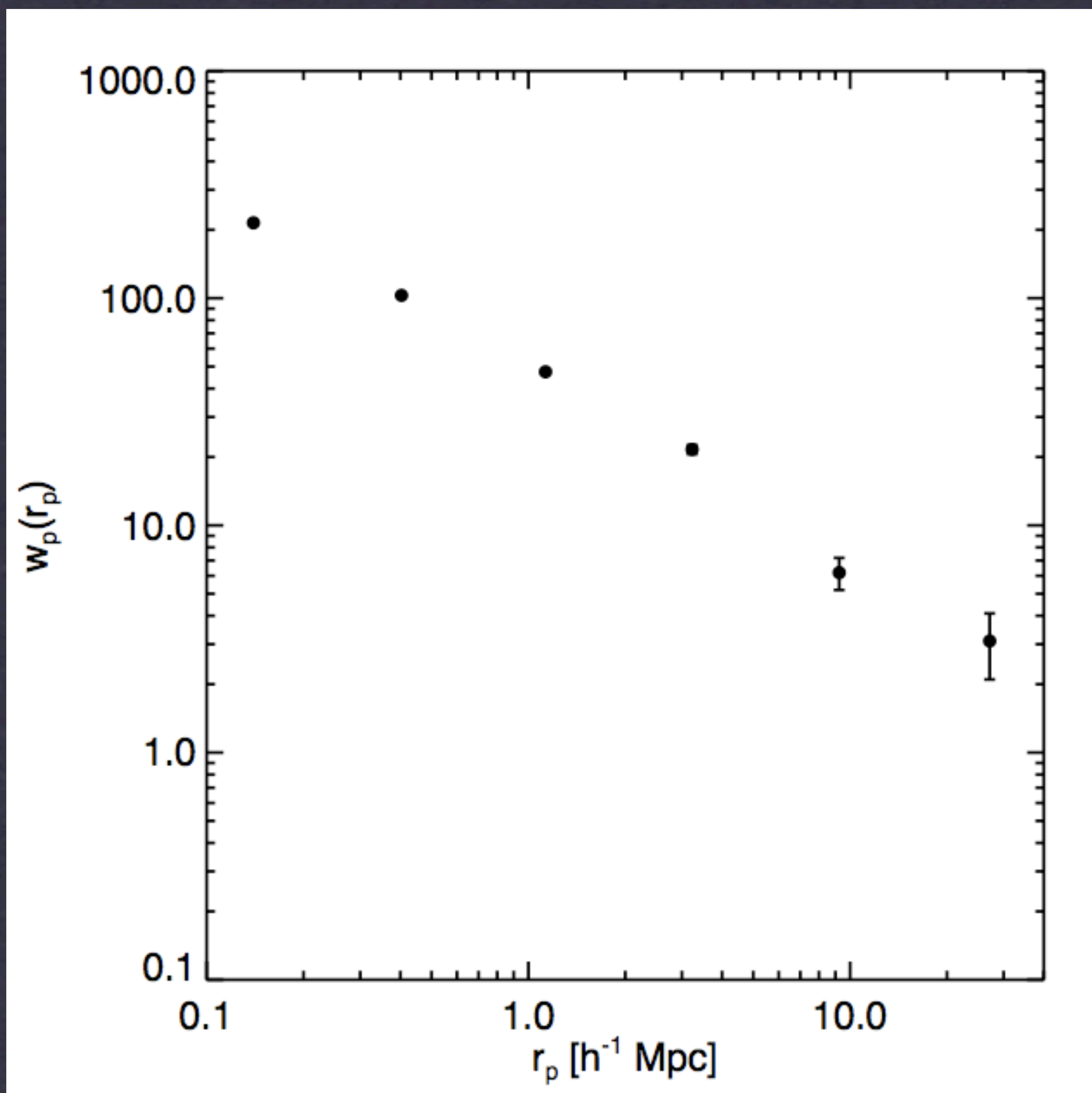


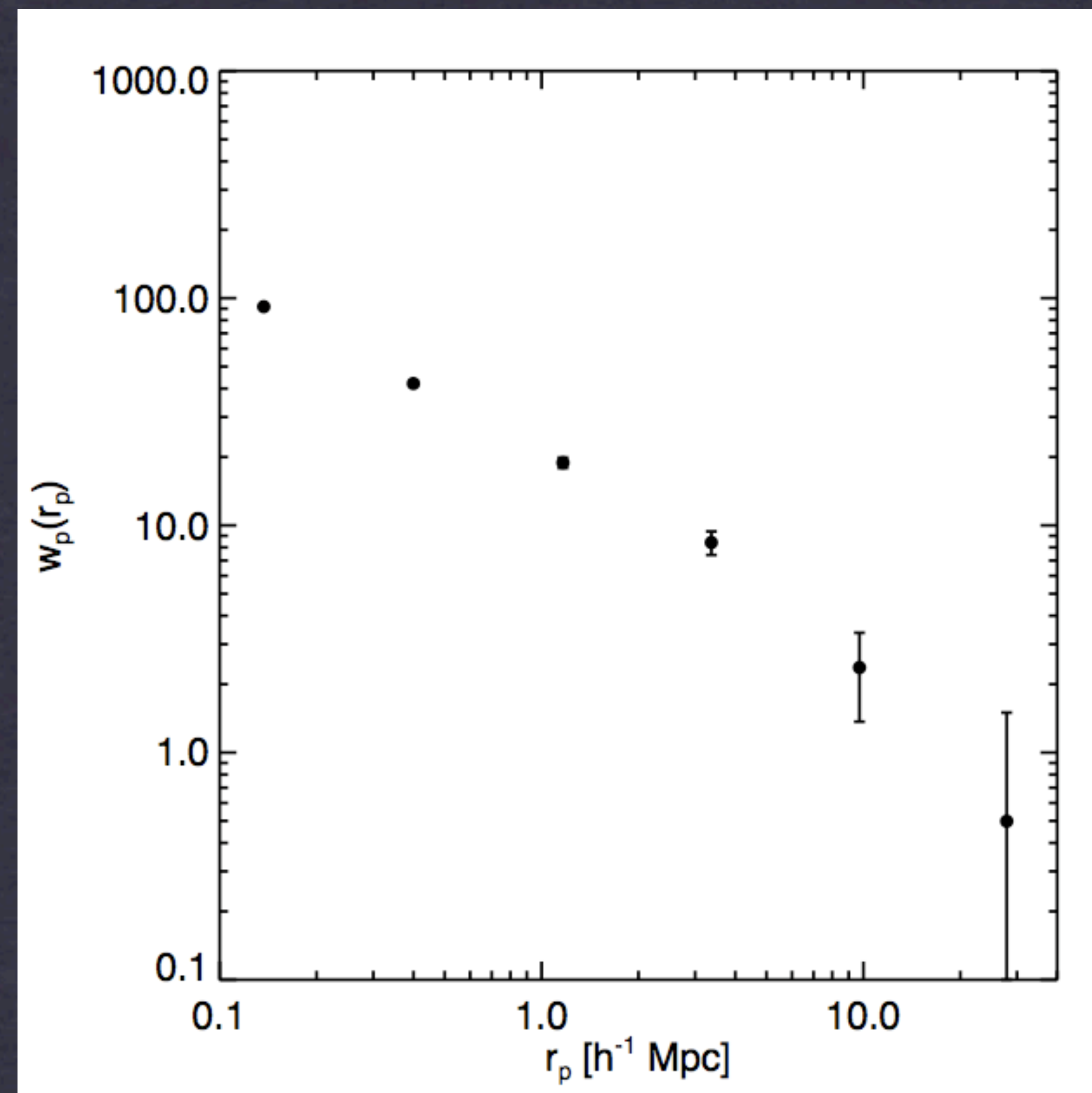
- Redshift space correlation functions show effects due to peculiar velocities:
  - small scales (fingers of God)
  - large scales (coherent infall)

Redshift space correlation functions to real space correlation functions





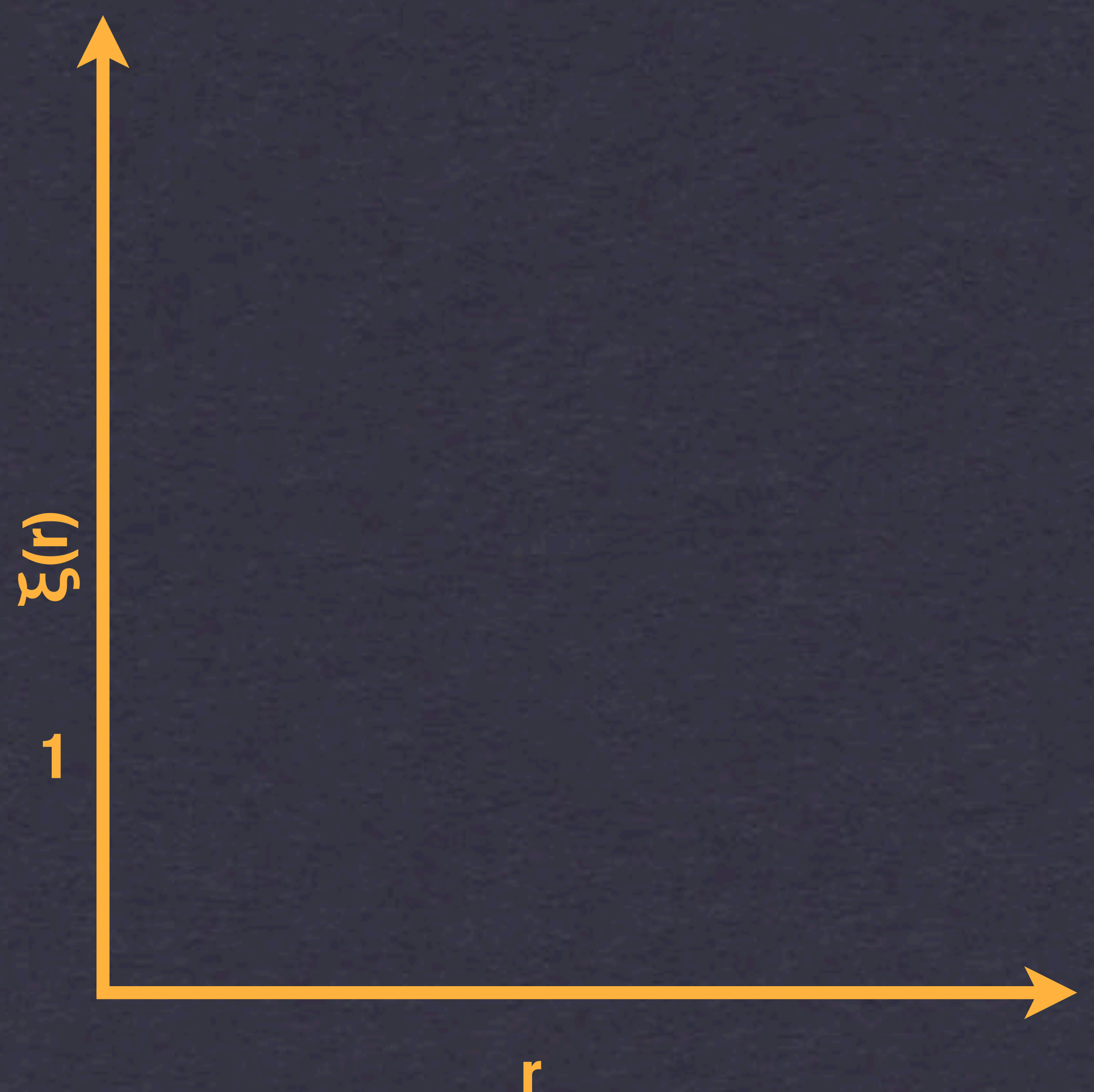




Projected correlation function $w_p(r_p)$ ⟶ Real space correlation function $\xi(r)$

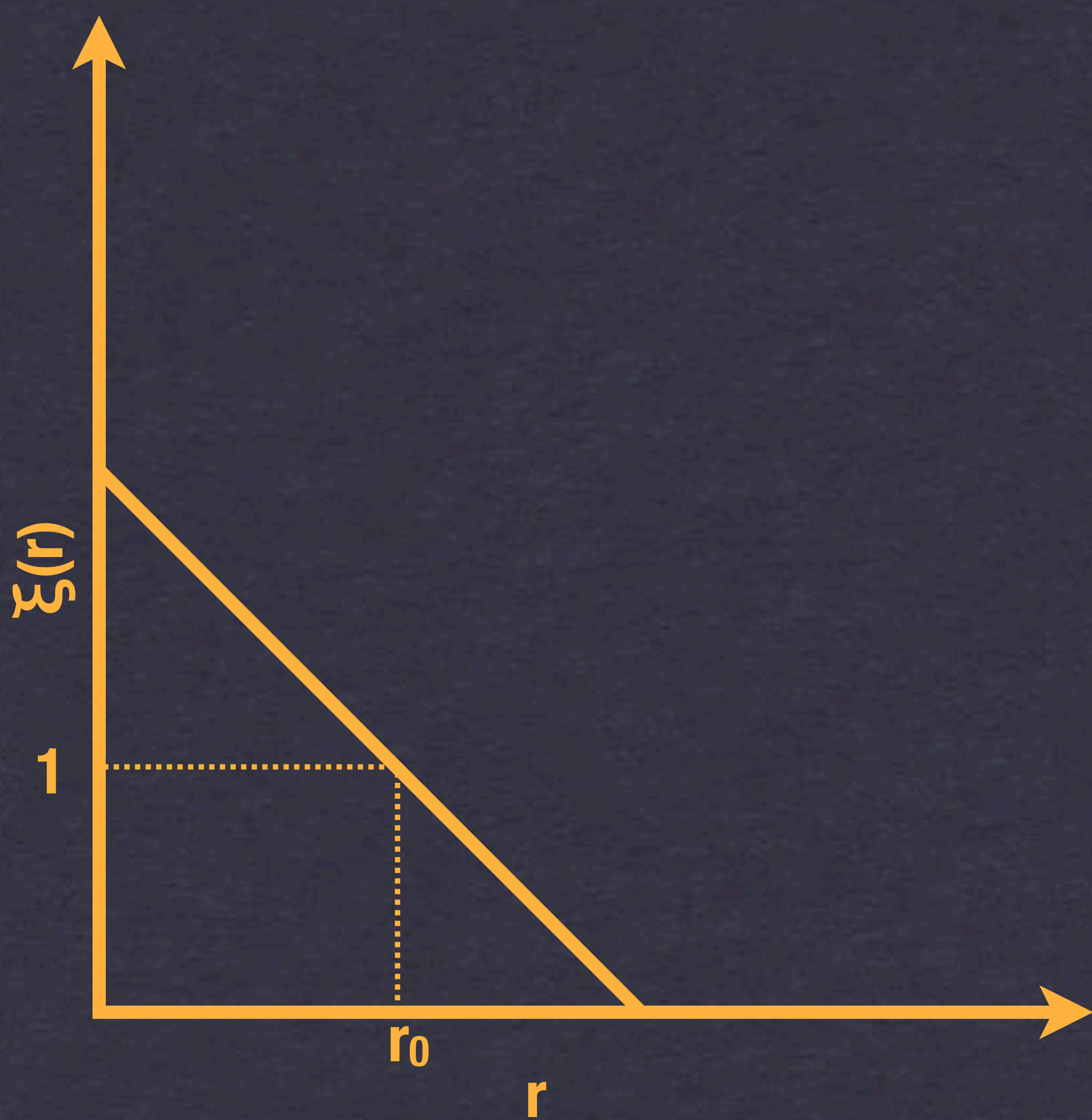
Correlation function as a power law

- $\xi(r) = (r/r_0)^{-\gamma}$
- r_0 correlation length: strength of the correlation
- γ slope: balance between small and large scales



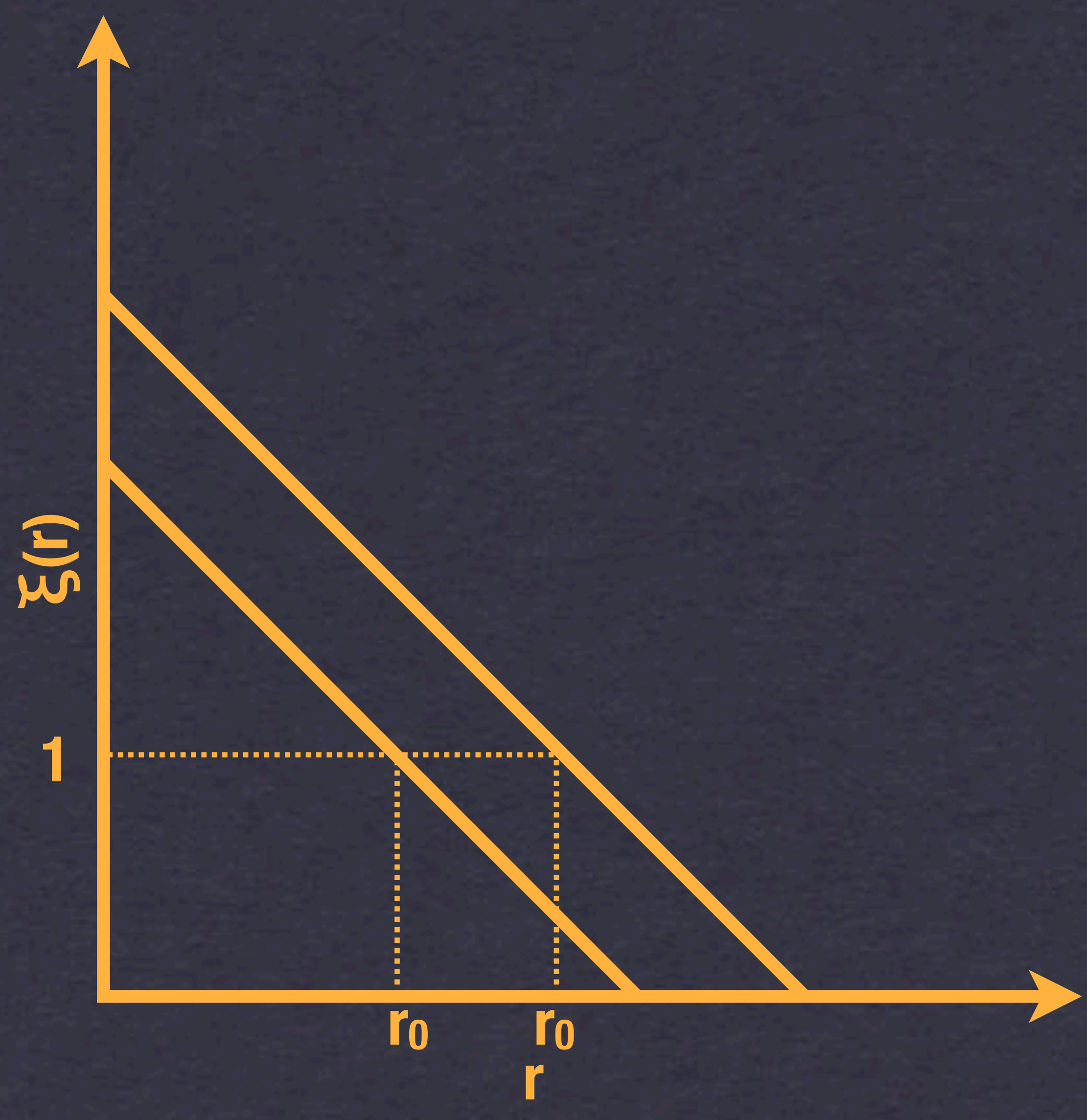
Correlation function as a power law

- $\xi(r) = (r/r_0)^{-\gamma}$
- r_0 correlation length: strength of the correlation
- γ slope: balance between small and large scales



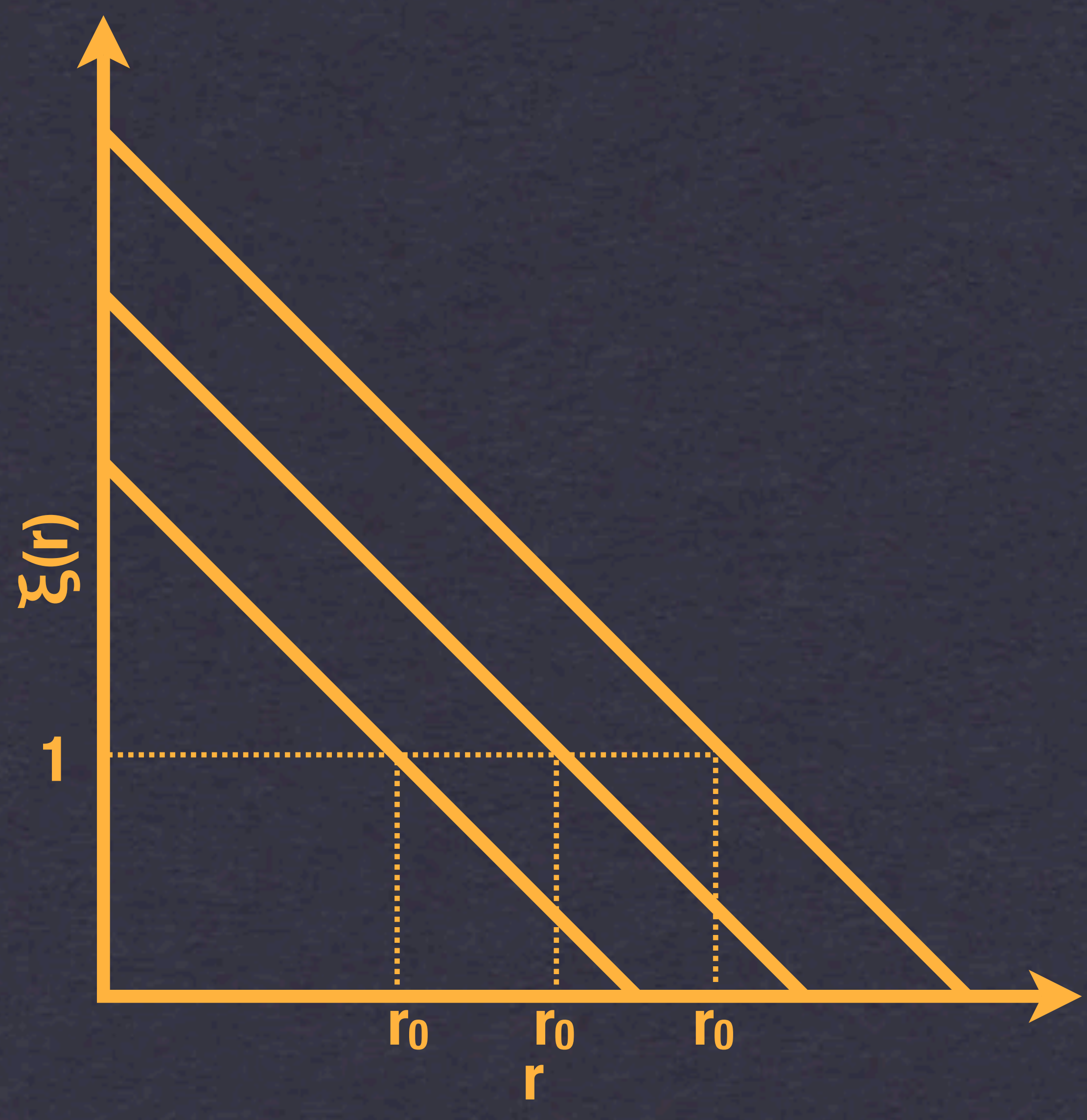
Correlation function as a power law

- $\xi(r) = (r/r_0)^{-\gamma}$
- r_0 correlation length: strength of the correlation
- γ slope: balance between small and large scales



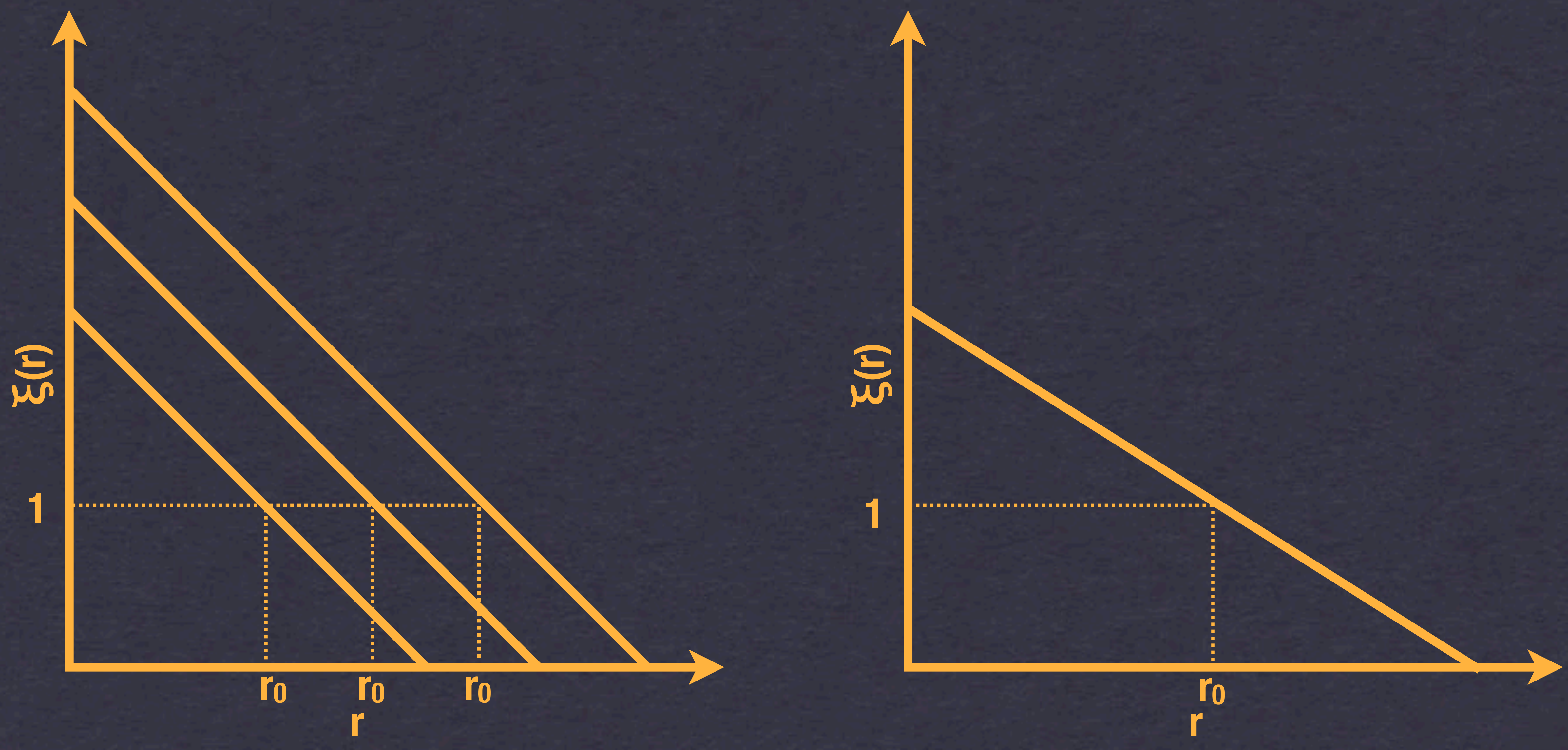
Correlation function as a power law

- $\xi(r) = (r/r_0)^{-\gamma}$
- r_0 correlation length: strength of the correlation
- γ slope: balance between small and large scales



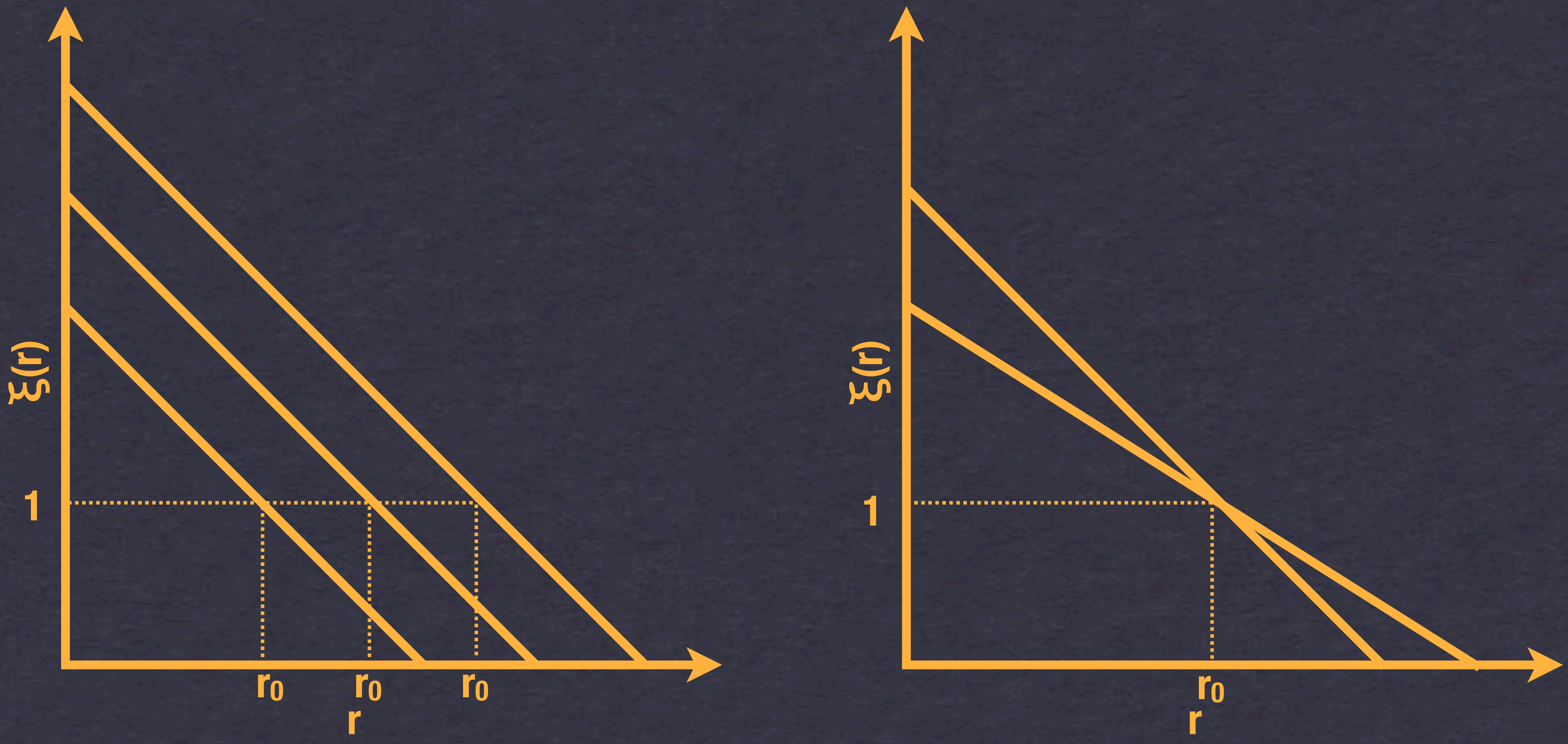
Correlation function as a power law

- $\xi(r) = (r/r_0)^{-\gamma}$
- r_0 correlation length: strength of the correlation
- γ slope: balance between small and large scales



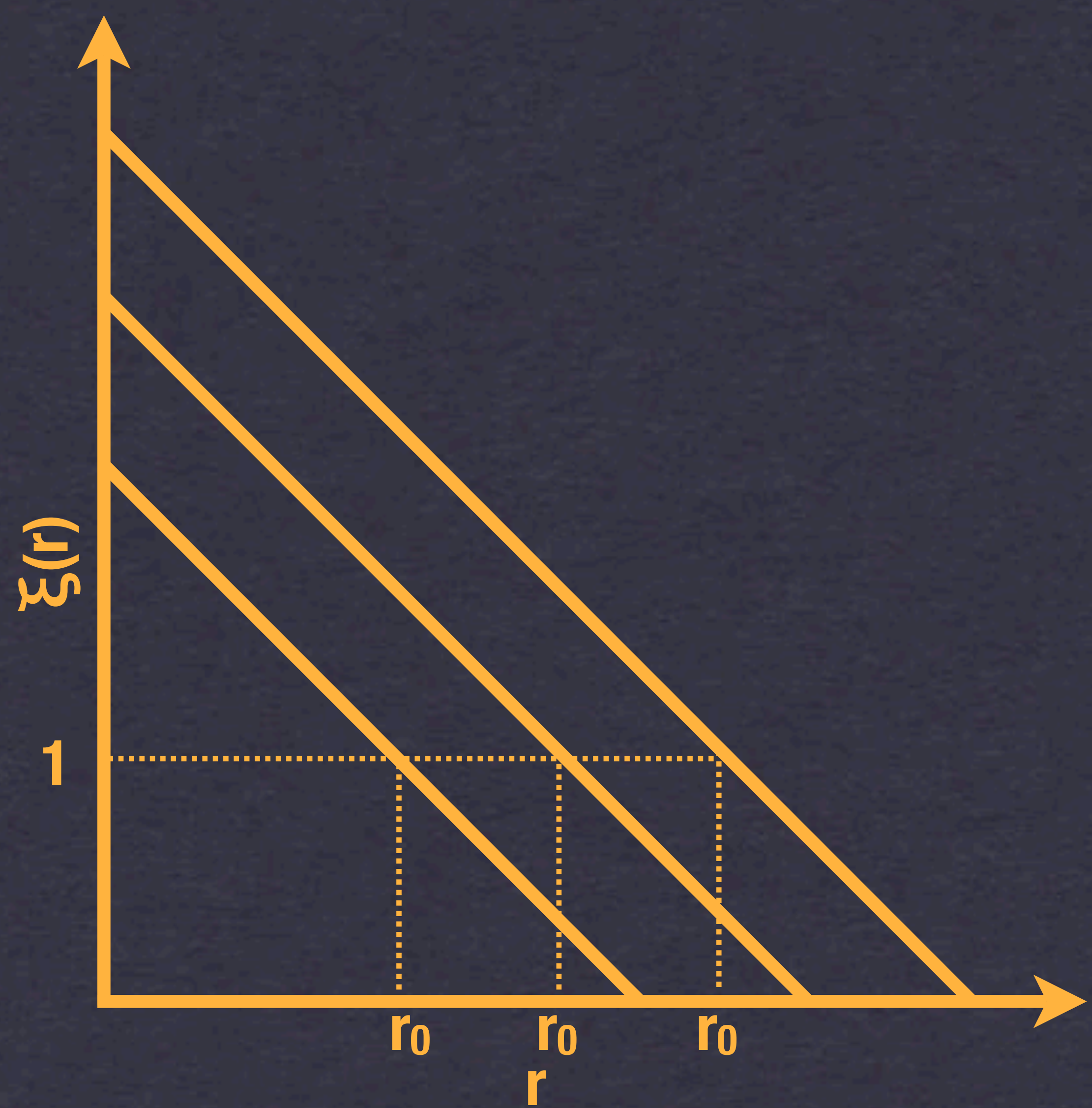
Correlation function as a power law

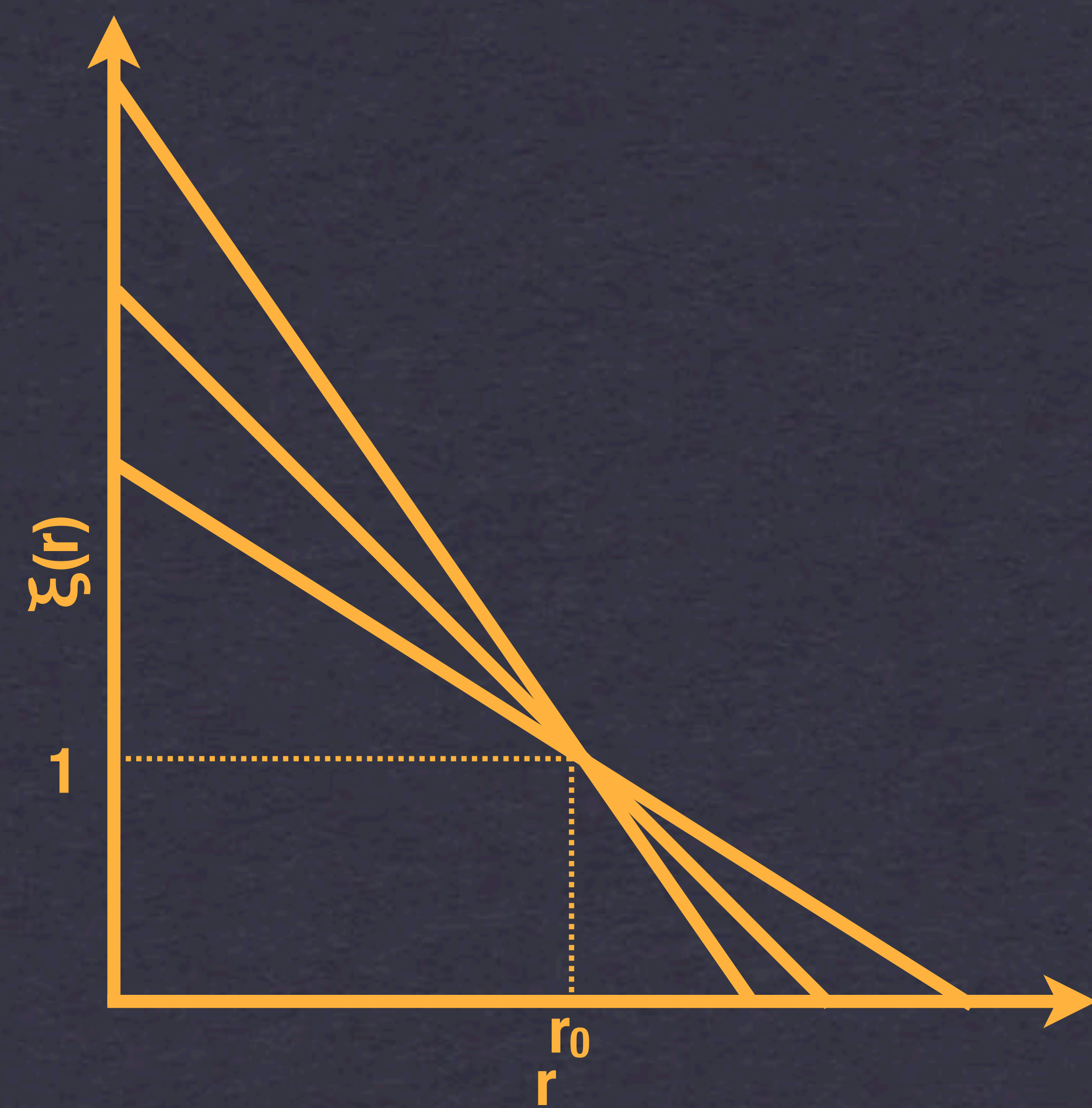
- $\xi(r) = (r/r_0)^{-\gamma}$
- r_0 correlation length: strength of the correlation
- γ slope: balance between small and large scales



Correlation function as a power law

- $\xi(r) = (r/r_0)^{-\gamma}$
- r_0 correlation length: strength of the correlation
- γ slope: balance between small and large scales

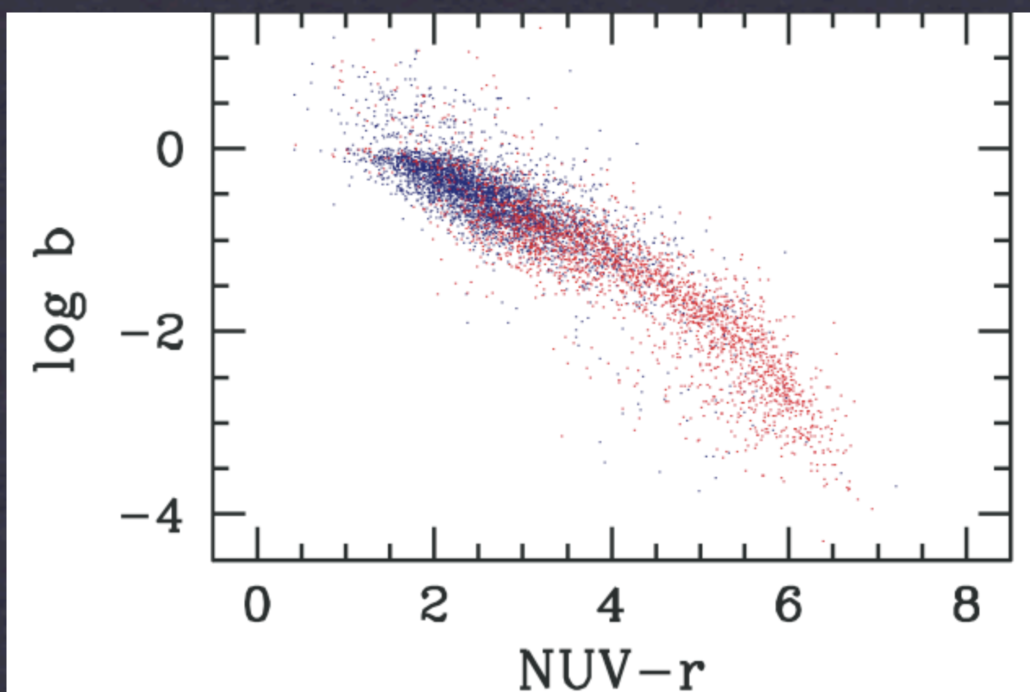




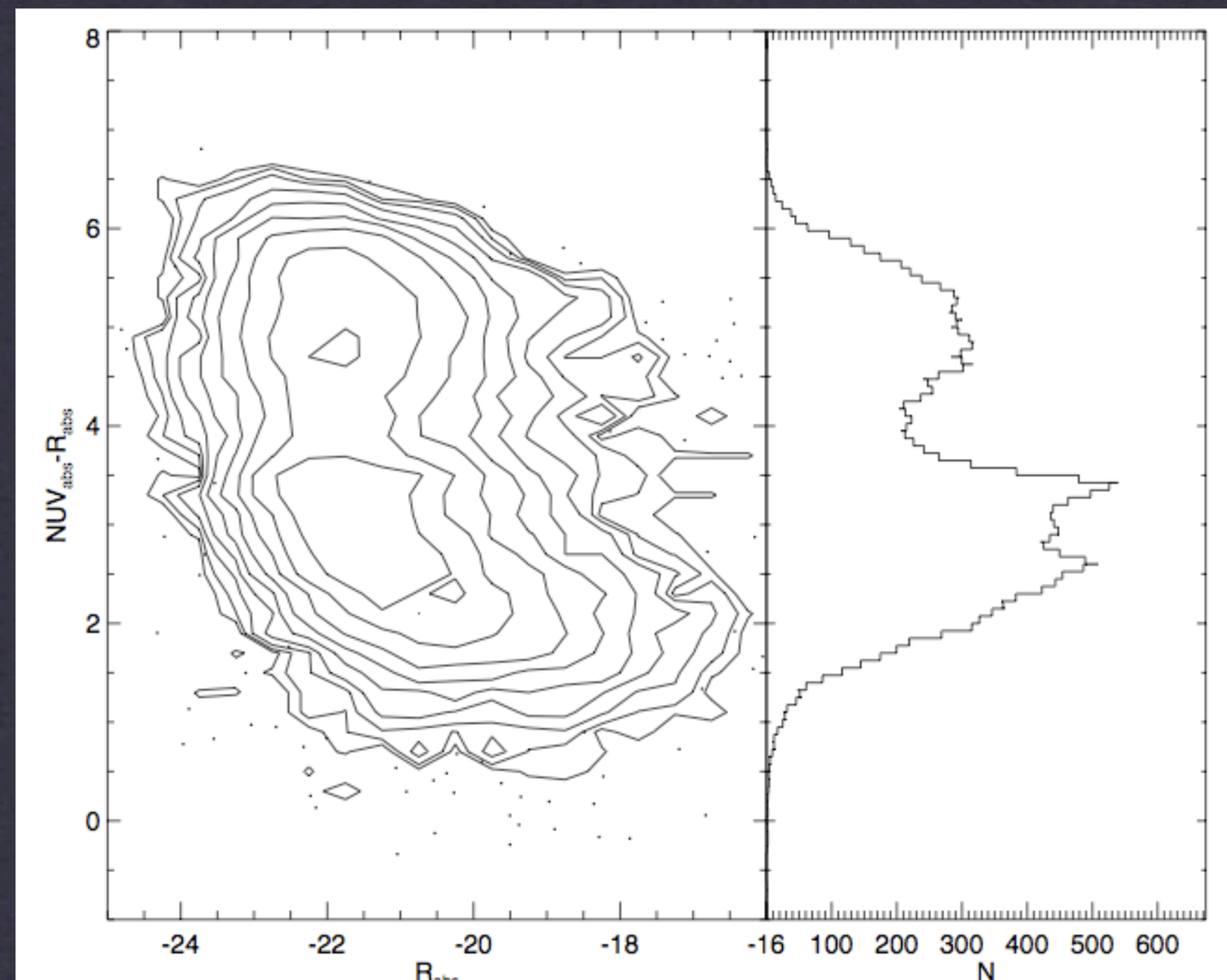
MIS Full sample
NUV - R cuts

- b = SFR_{recent} / ⟨ SFR ⟩

- NUV - R color traces Star Formation History



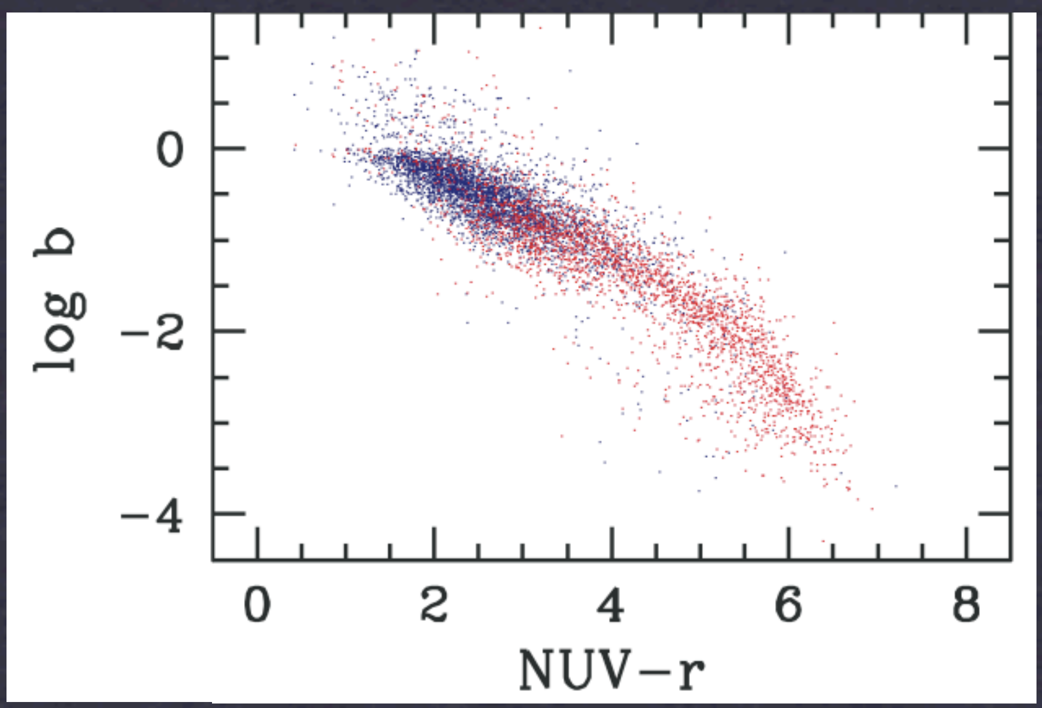
Salim et al (2005)



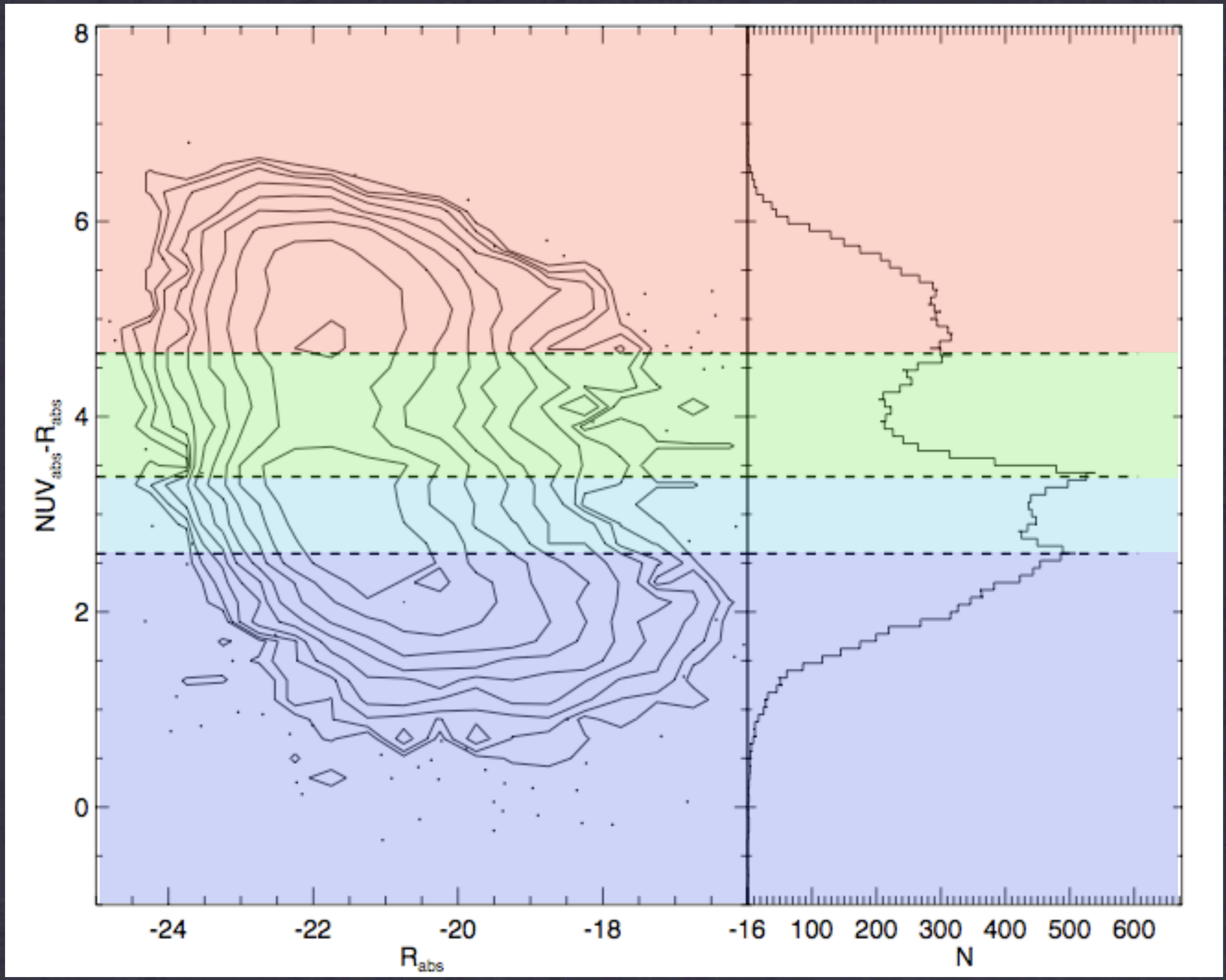
MIS Full sample
NUV - R cuts

- b = $SFR_{recent} / \langle SFR \rangle$

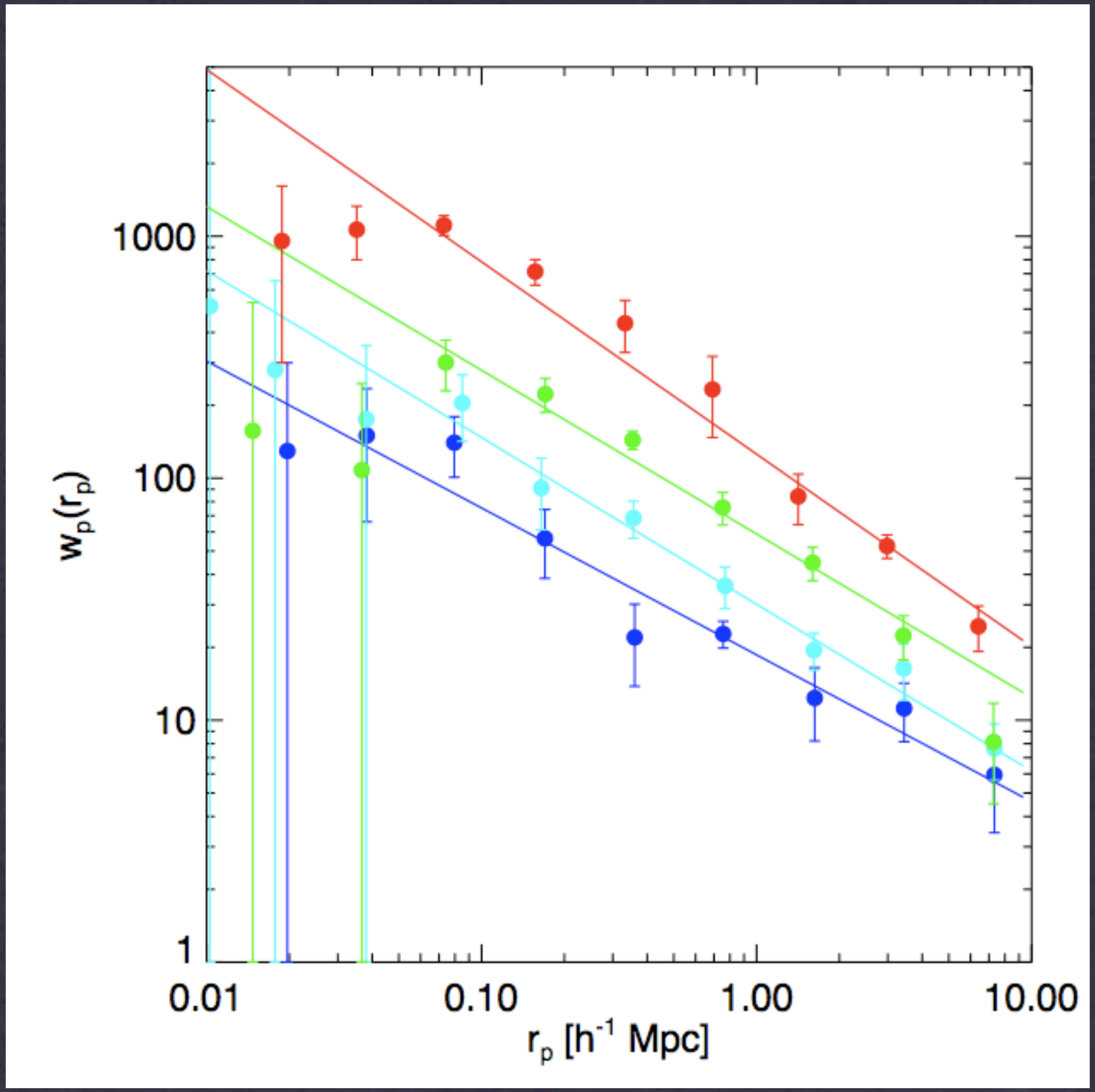
- NUV - R color traces Star Formation History

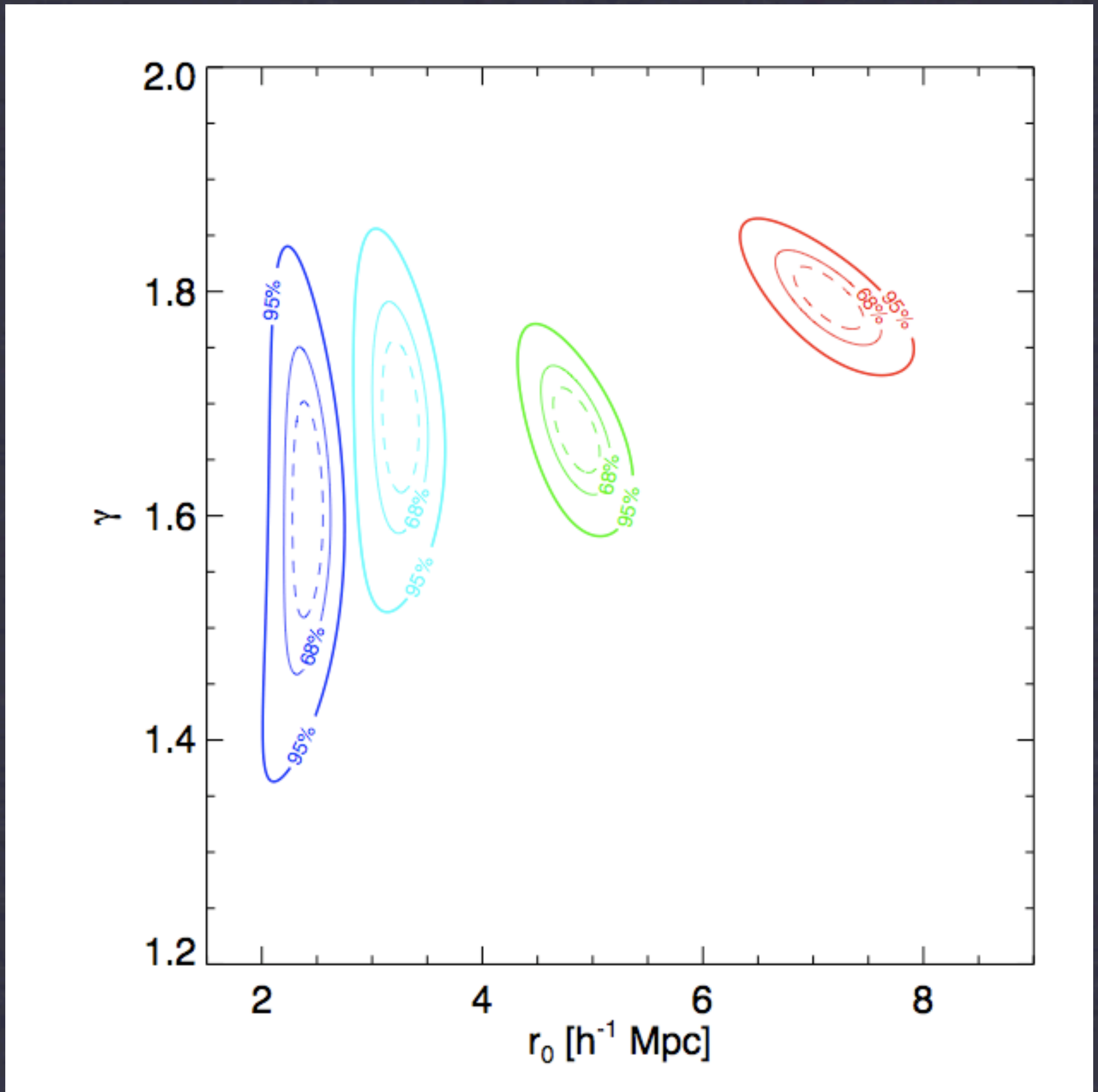


Salim et al (2005)



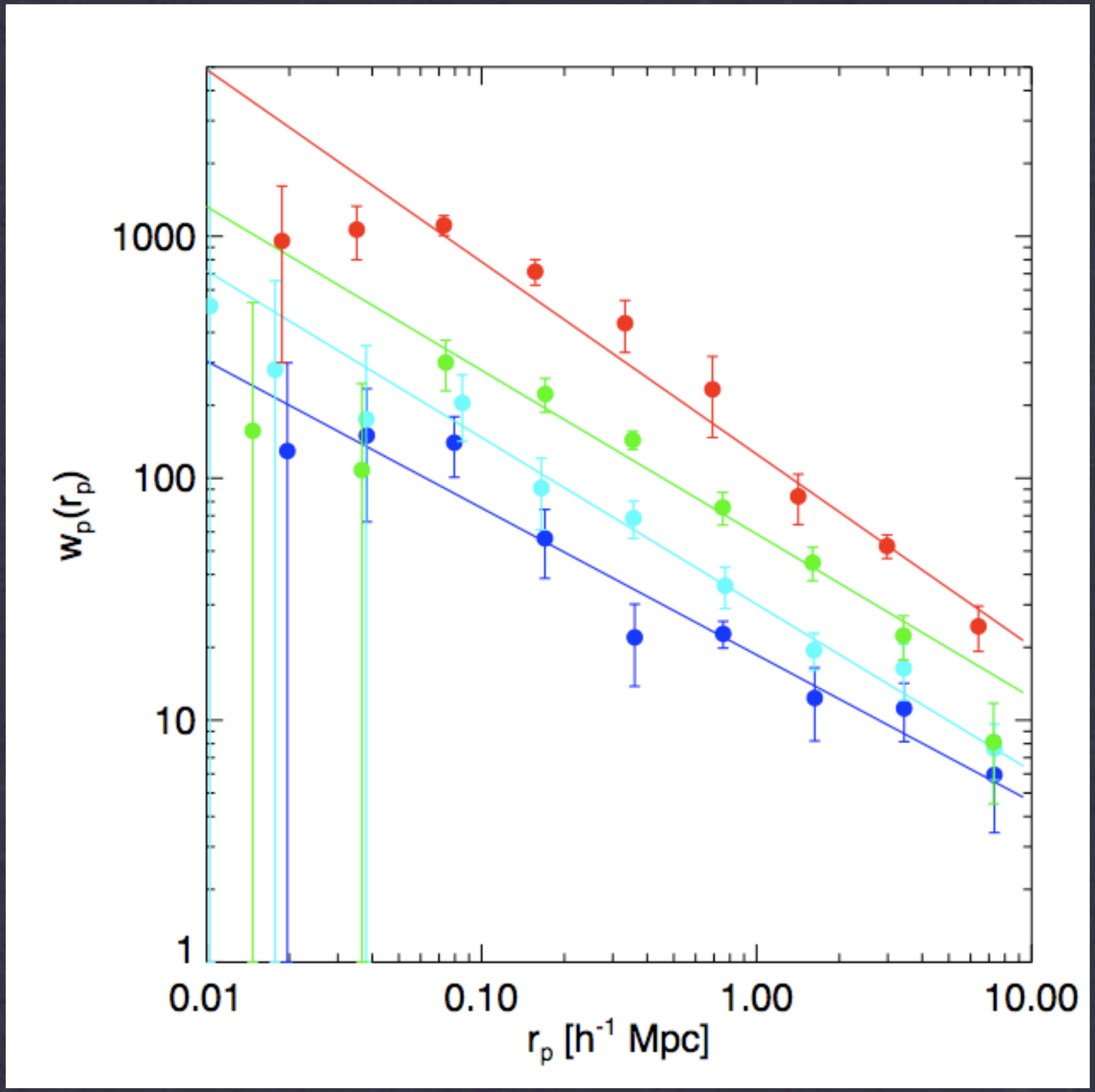
MIS Full sample
NUV - R cuts / results

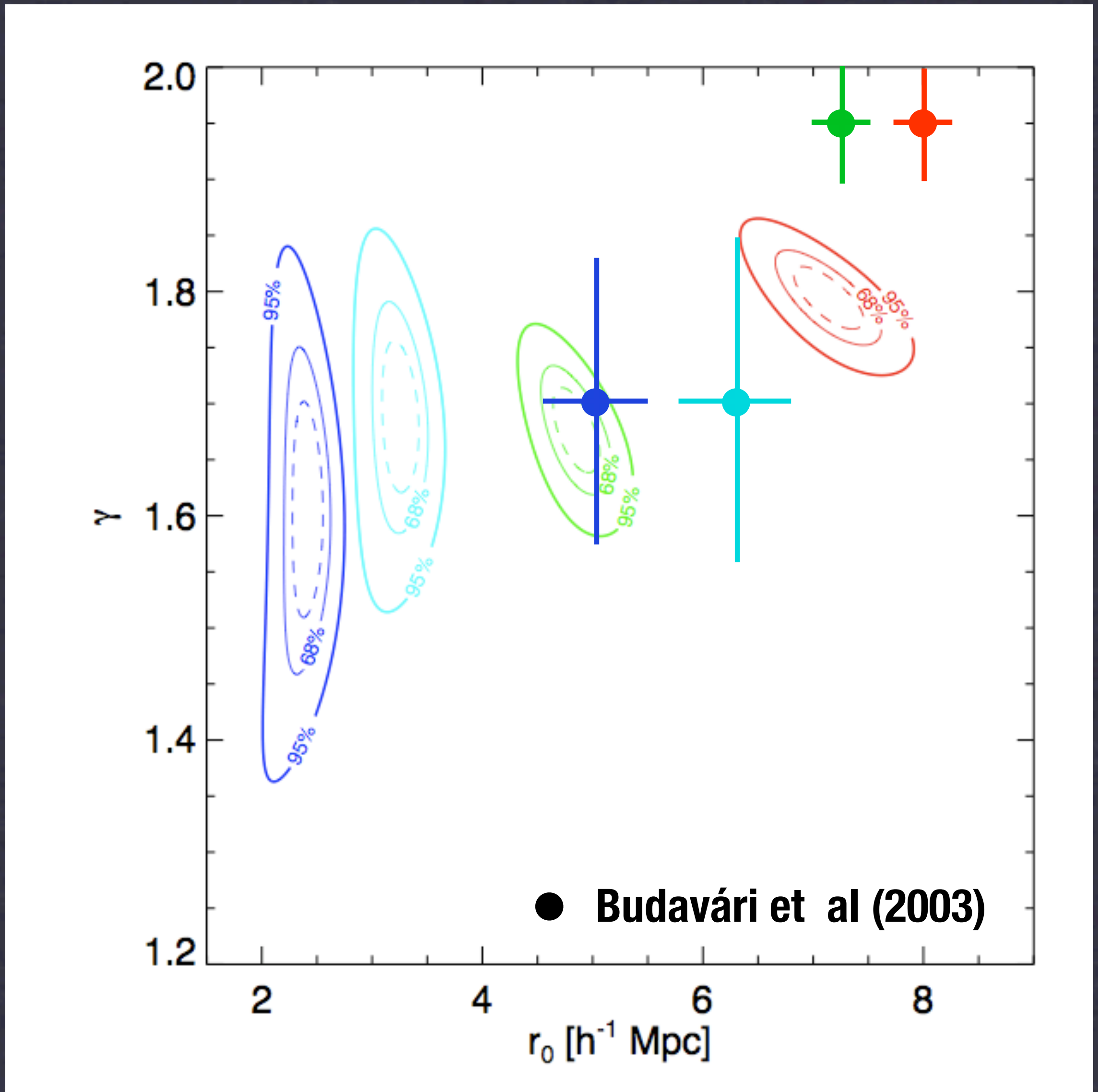




- Steepening of correlation function with NUV-R color (γ increases from ~ 1.6 to 1.8)
- Increase of correlation length with color (r_0 increases from ~2 to 7 h^{-1}Mpc)

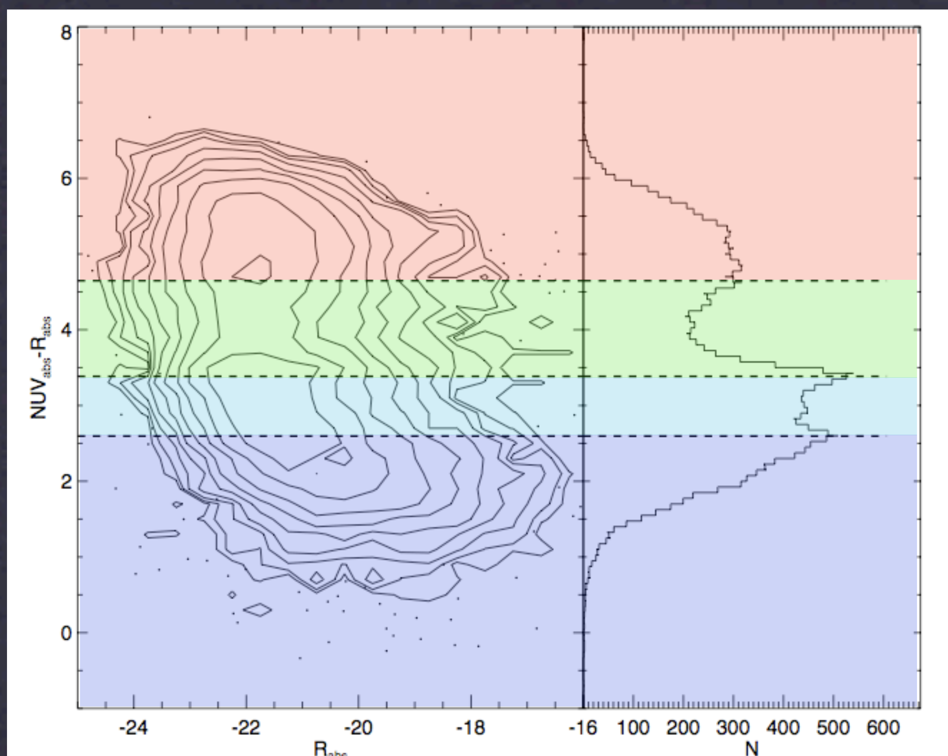
MIS Full sample
NUV - R cuts / results

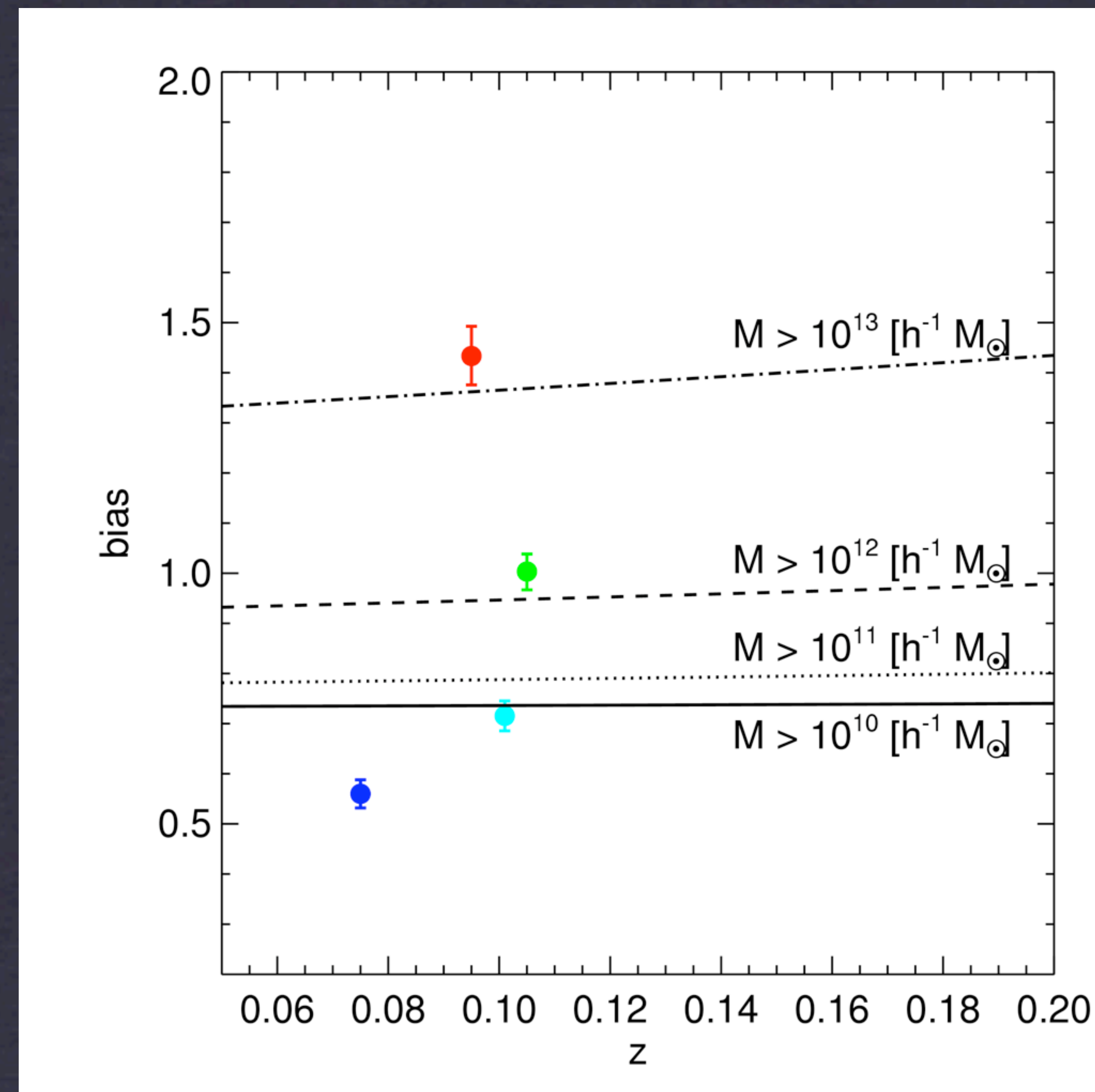




- Steepening of correlation function with NUV-R color (γ increases from ~ 1.6 to 1.8)
- Increase of correlation length with color (r_0 increases from ~2 to 7 h^{-1}Mpc)

MIS Full sample
NUV - R cuts / Halo masses

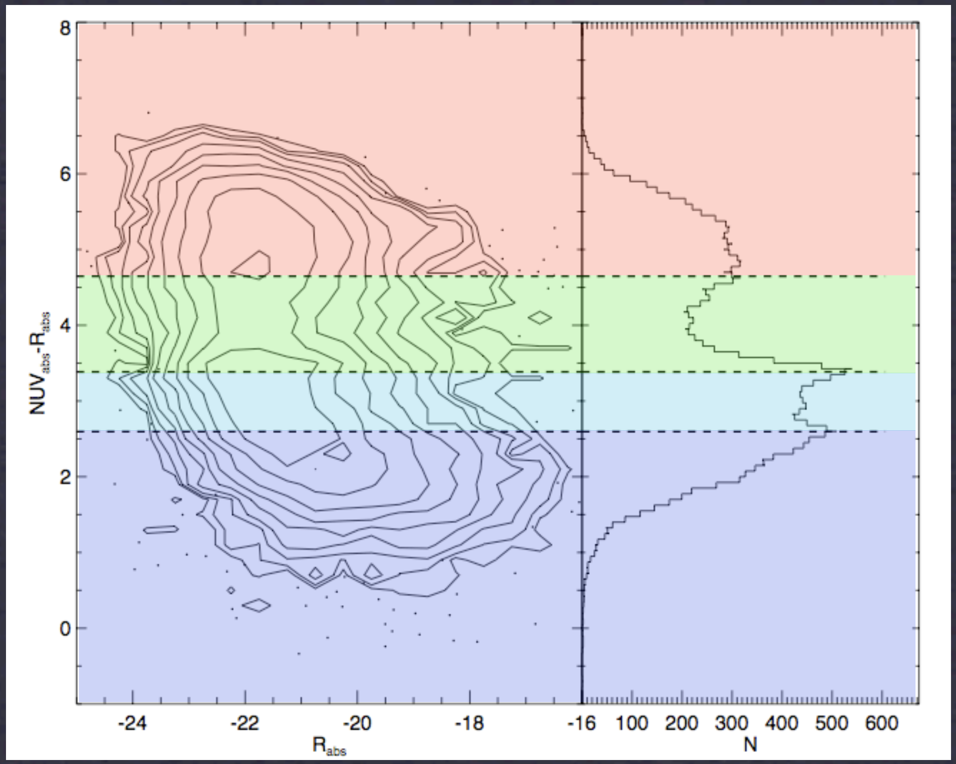


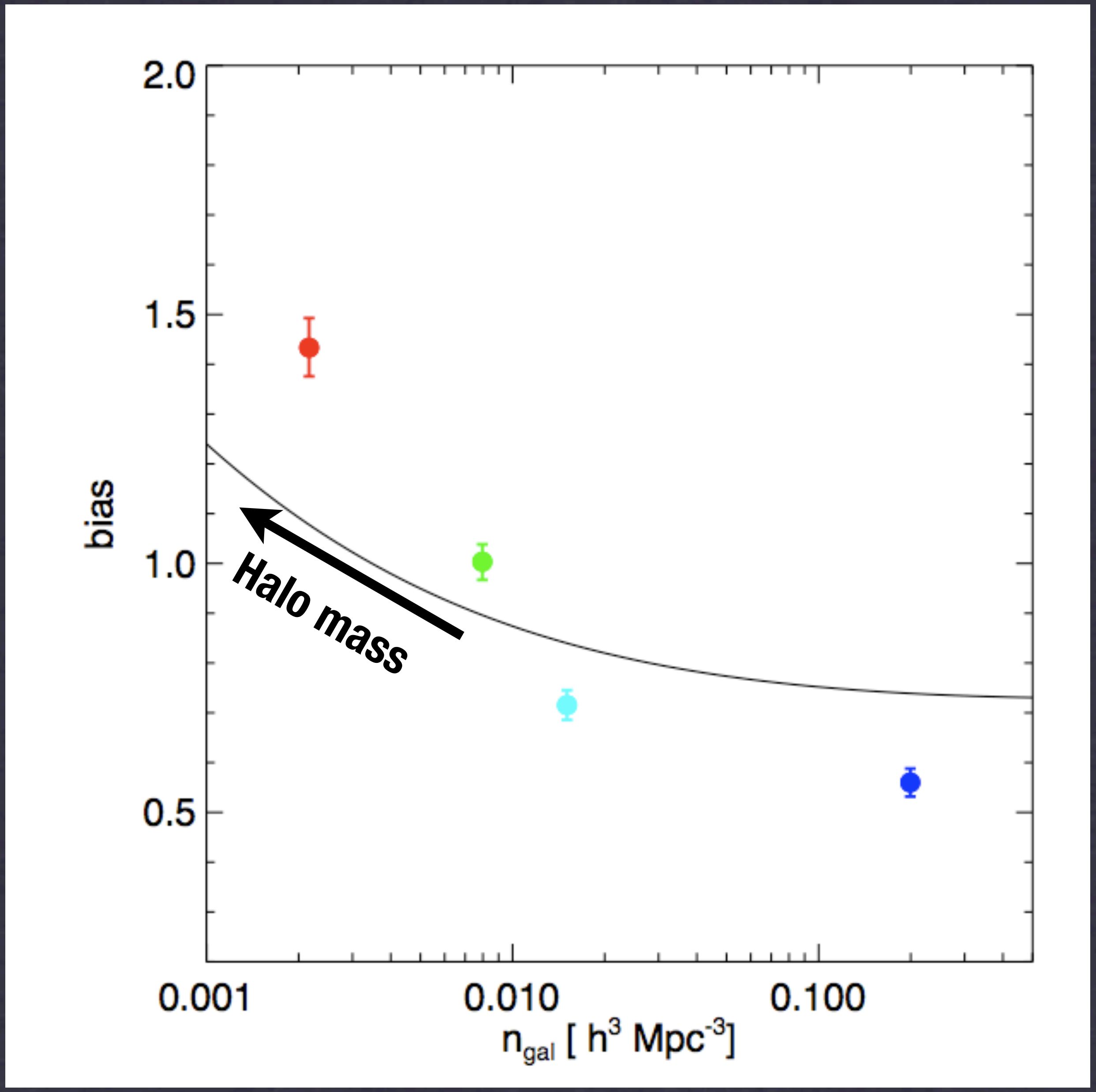


- **Masses of Dark Matter haloes with similar bias range from 10^{10} to 10^{13} h^{-1} $M_\odot$**

- **The more recent the star formation, the less massive the haloes**

MIS Full sample
NUV - R cuts / Halo occupation (crude)

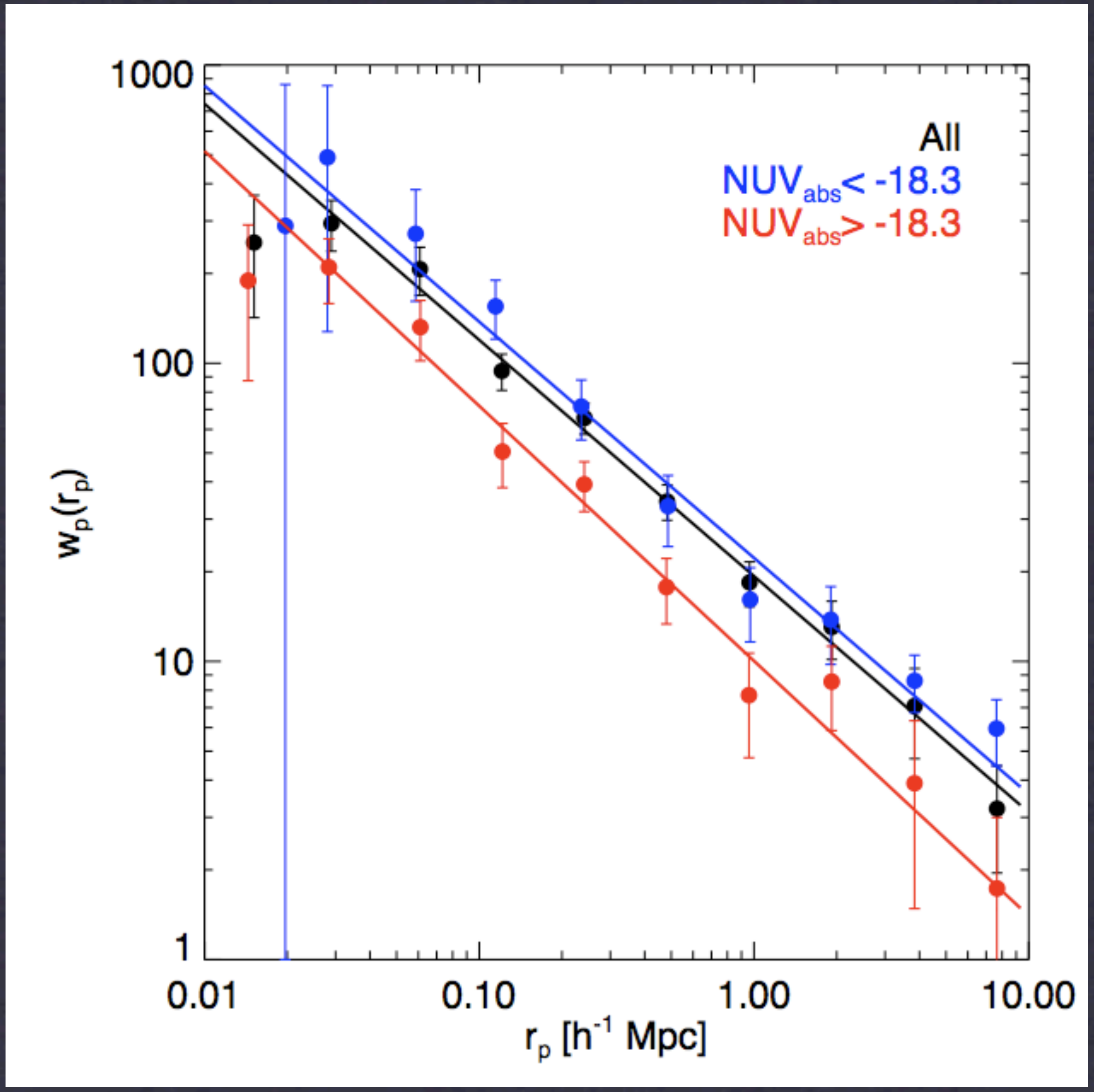


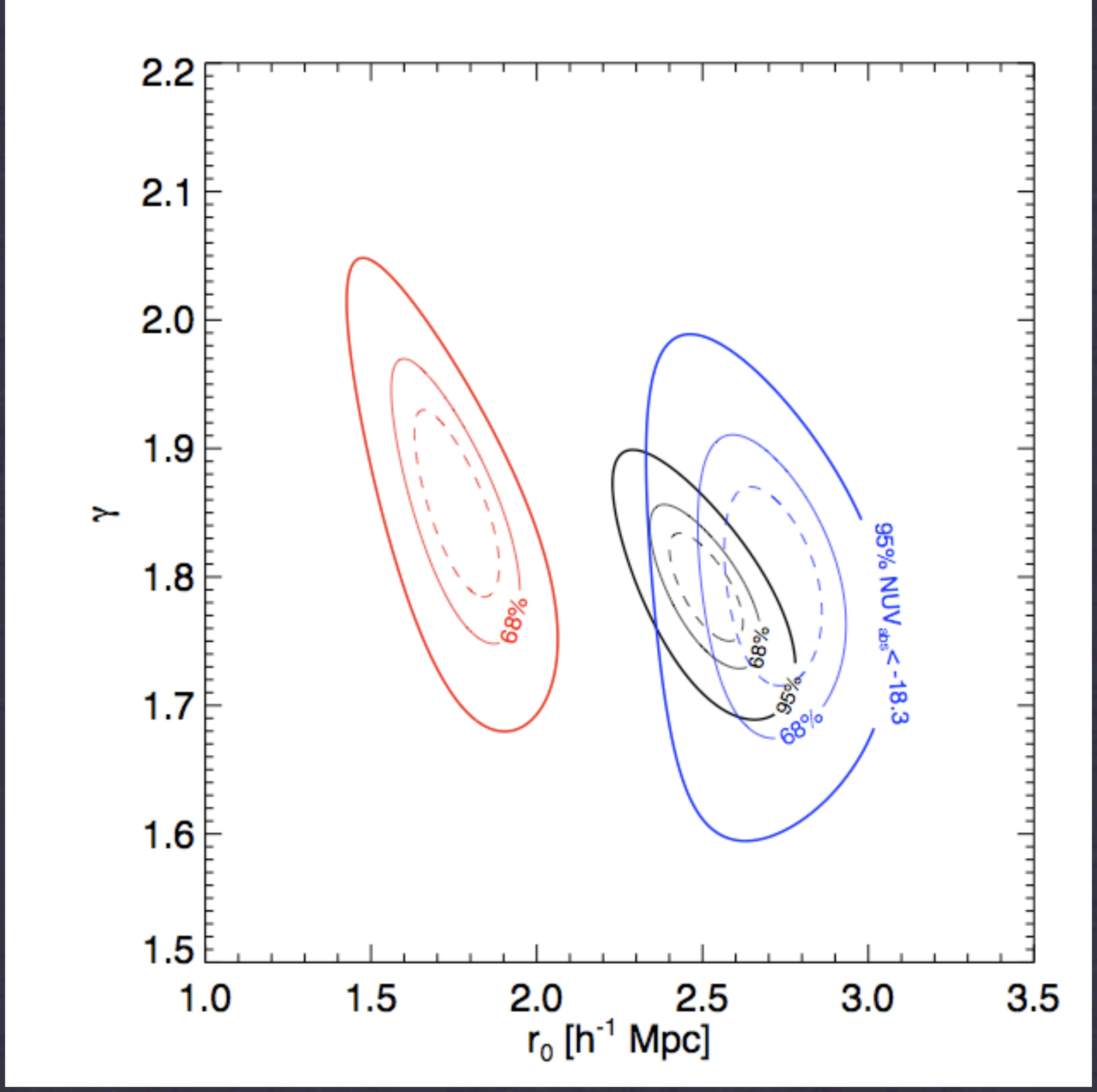


- Mean halo occupation number increases with NUV-R color

- The more recent the star formation, the smaller average number of galaxies per halo

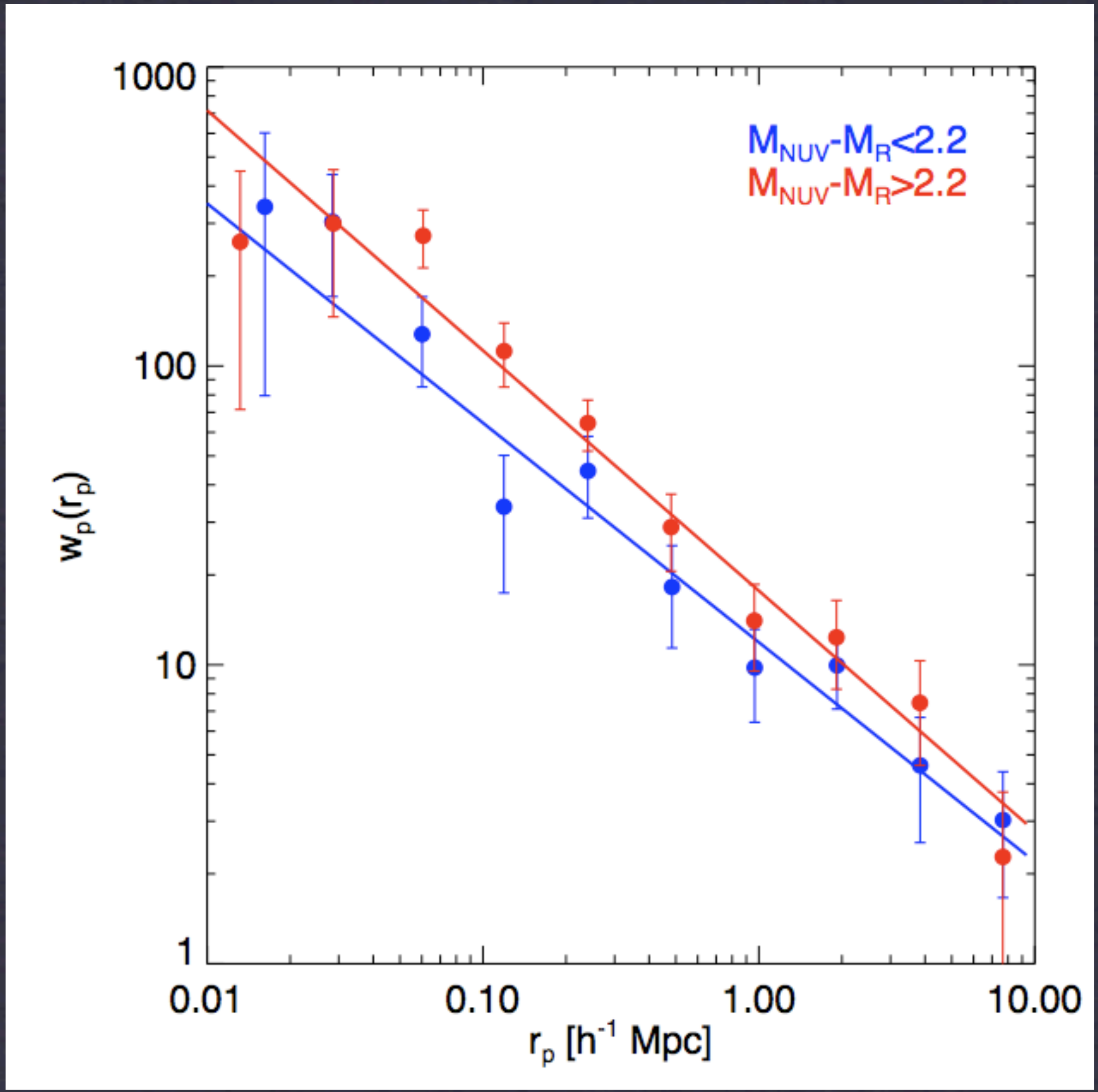
AIS UV selected sample
NUV luminosity cut

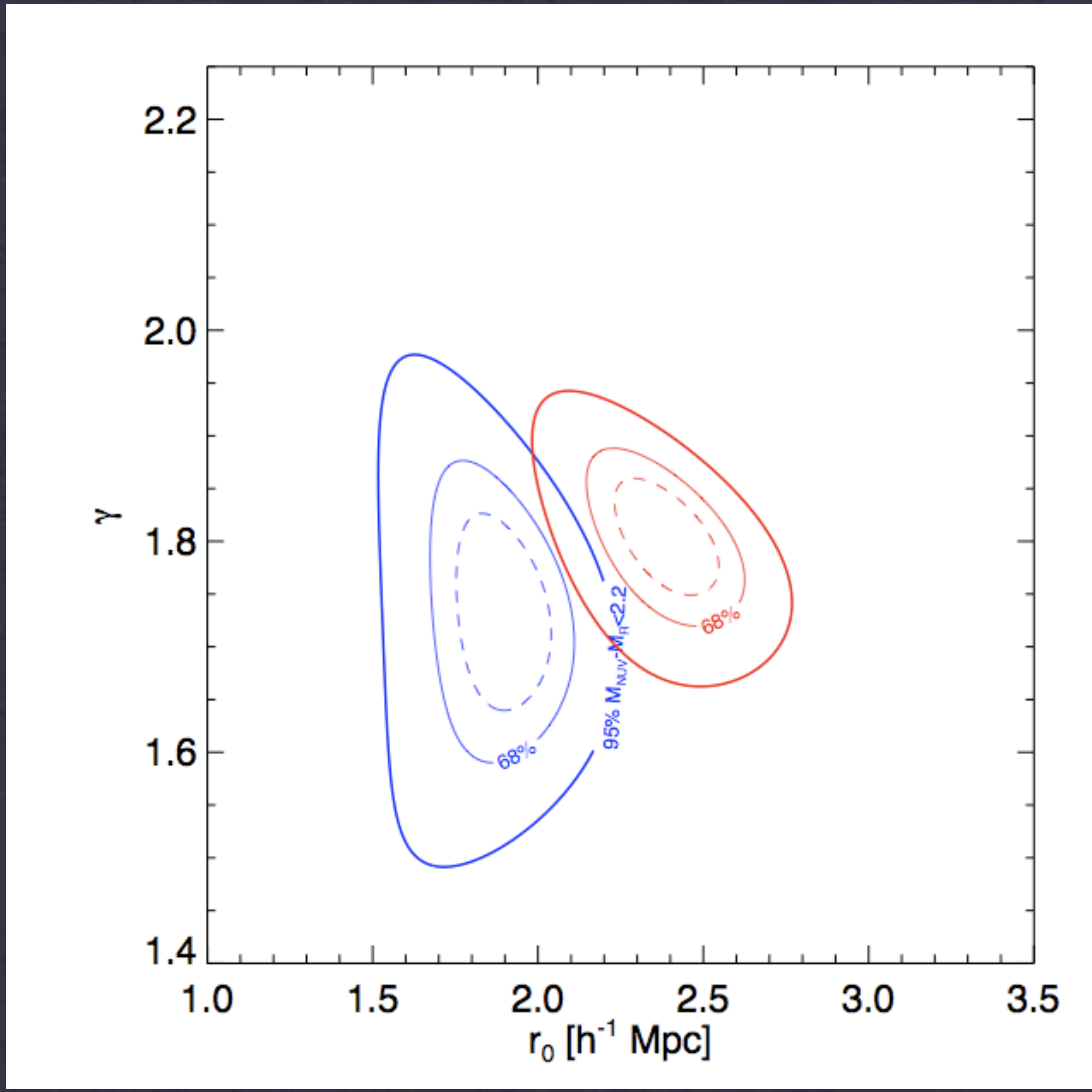




- Slope constant with luminosity (~1.8)
- Increase of correlation length with NUV luminosity (r_0 increases from ~1.7 to 2.7 h^{-1}Mpc)

AIS UV selected sample
NUV - R cut





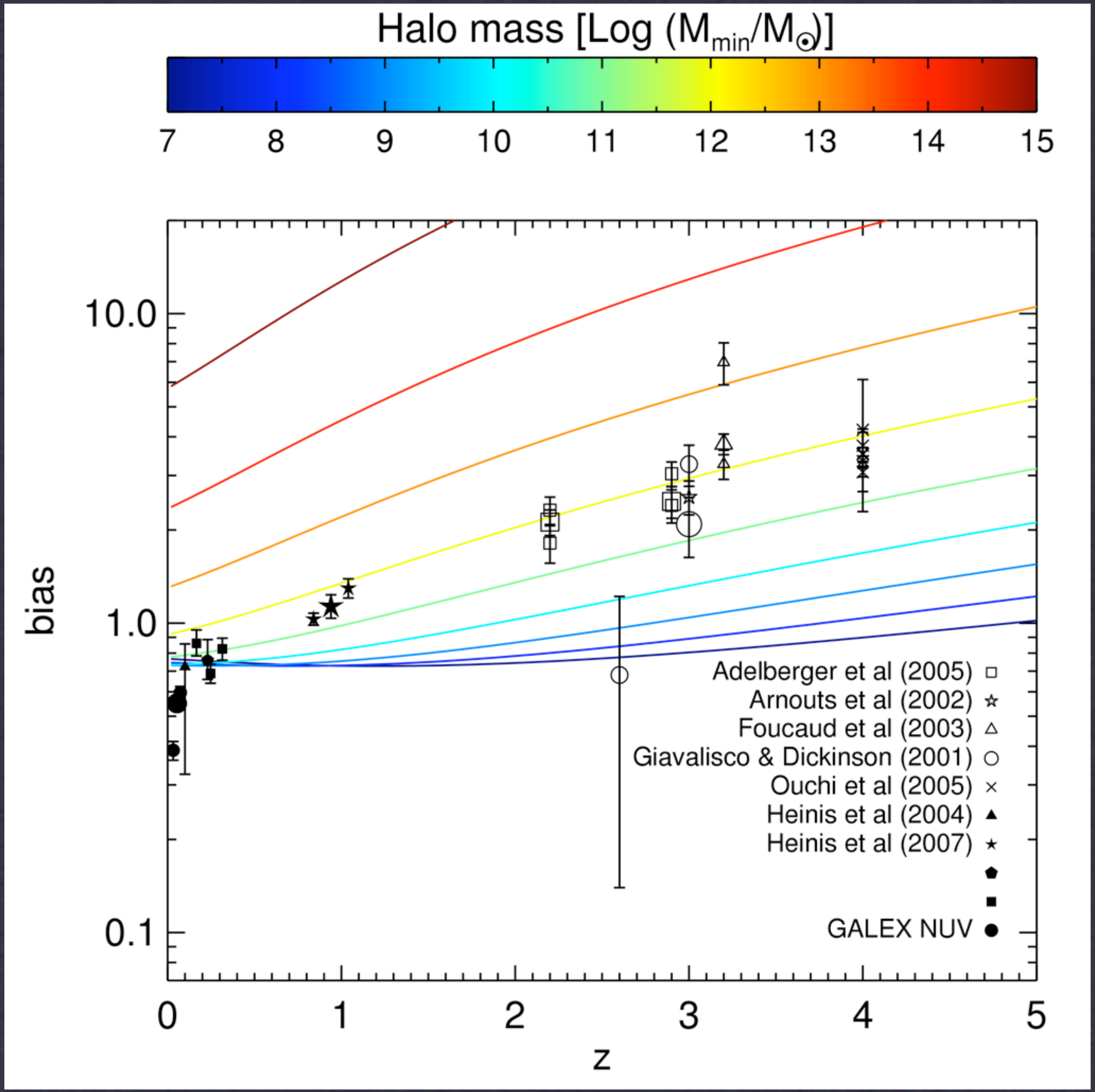
- Slope constant with luminosity (~1.8)
- Slight increase of correlation length with NUV - R color (r_0 increases from ~1.9 to 2.39 h^{-1}Mpc)

Bias evolution of UV-selected star forming galaxies

- Bias of UV-selected star forming galaxies decreases from ~3 at z = 4 to 0.5 at z = 0

- Masses of Dark Matter haloes with similar bias decreases from 10^{12} to 10^{10} h^{-1} $M_\odot$

Migration of star forming galaxies from high mass haloes at high z to low mass haloes at low z

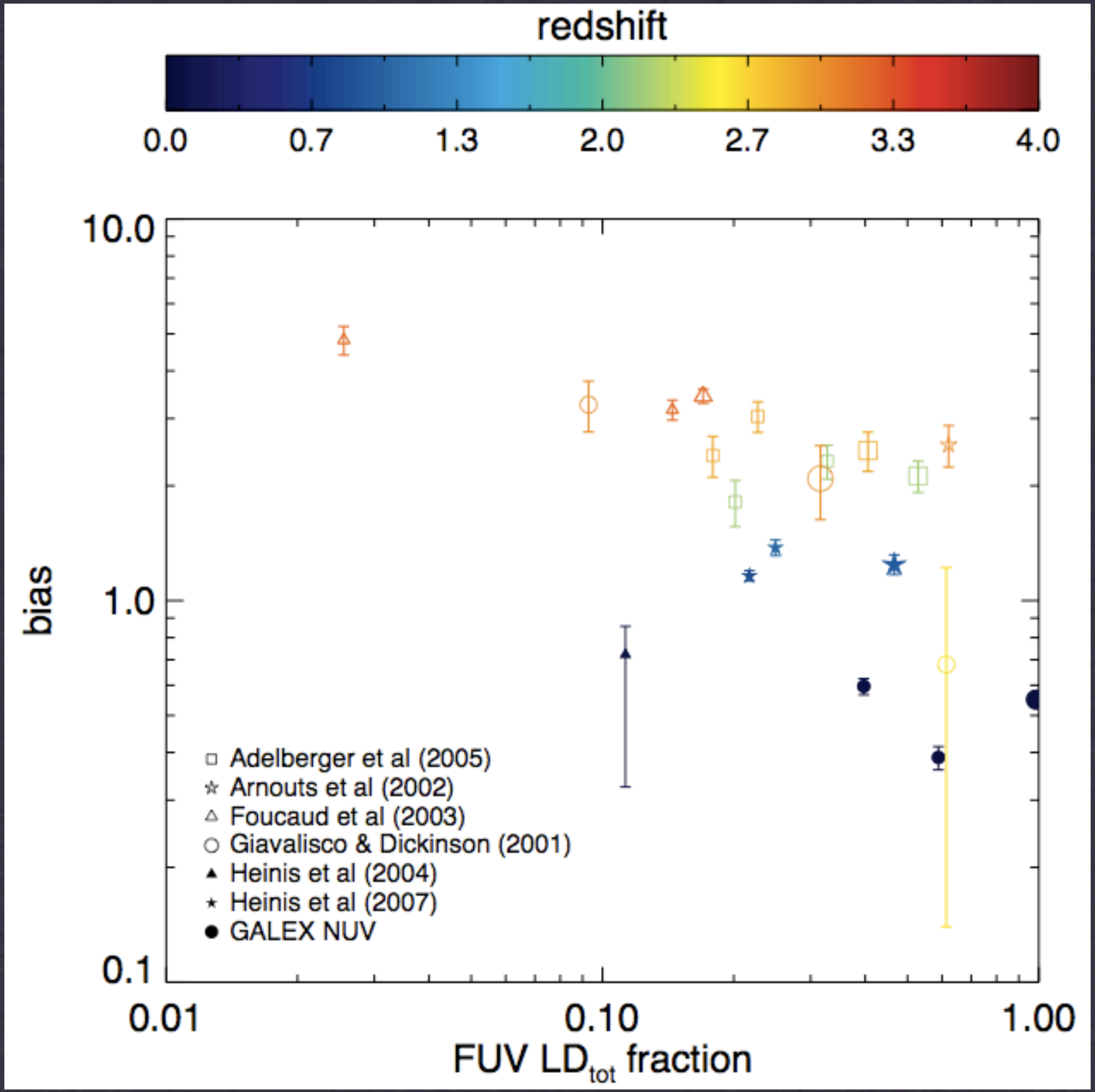


Bias evolution and fraction of FUV luminosity density

- SFR ∝ FUV Luminosity Density
- FUV luminosity density > 0.5 ~ bulk of star formation at a given epoch

Bias of star forming galaxies increases with redshift at a given fraction of FUV luminosity density

Downsizing in terms of dark matter halo mass



Summary

- GALEX data as a tool for linking global star formation and environment

- Use of NUV-R color to link star formation history with environment

  Minimum mass of haloes increases for earlier star formation epochs

  Galaxies in green valley reside in environments similar to small groups

  Average halo occupation increases for earlier star formation epochs

- Use of low redshift UV-selected sample to link star formation intensity with environment

  Clustering strength of UV-selected galaxies increases with redshift

  Minimum mass of haloes hosting UV-selected galaxies increases with redshift

  Bias of UV-selected galaxies increases with redshift at a given fraction of FUV luminosity density fraction