Flux/Magnitude-limited and Volume-limited samples

Surveys typically have a flux limit (i.e., minimum detectable flux) that corresponds to integration time and instrument sensitivity.

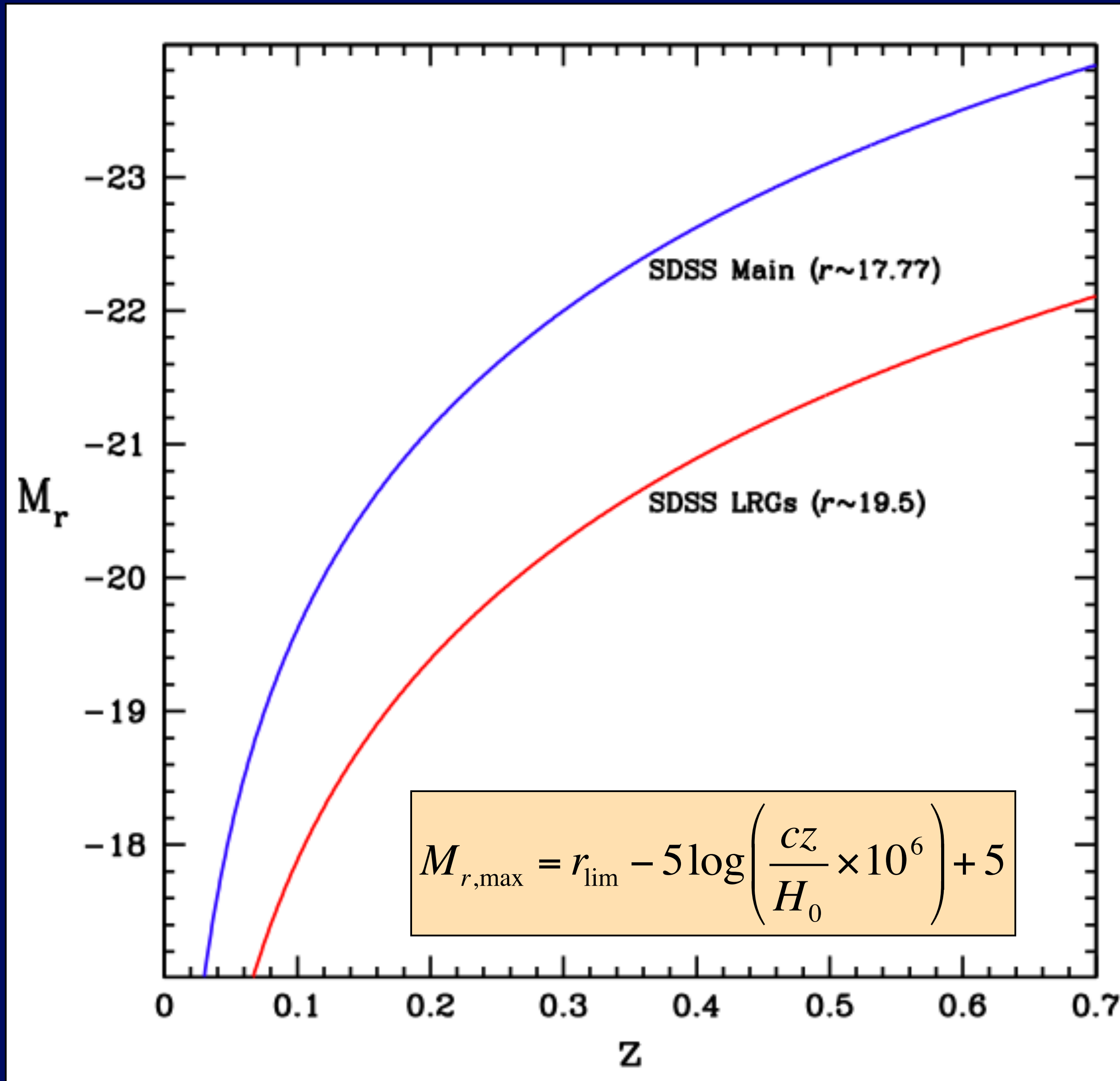
SDSS imaging detected galaxies down to *r ~ 22.2*
(telescope diameter=2.5m, integration time=54.1s)

SDSS spectra were taken for galaxies down to *r ~ 17.77*
(integration time=45-60min)

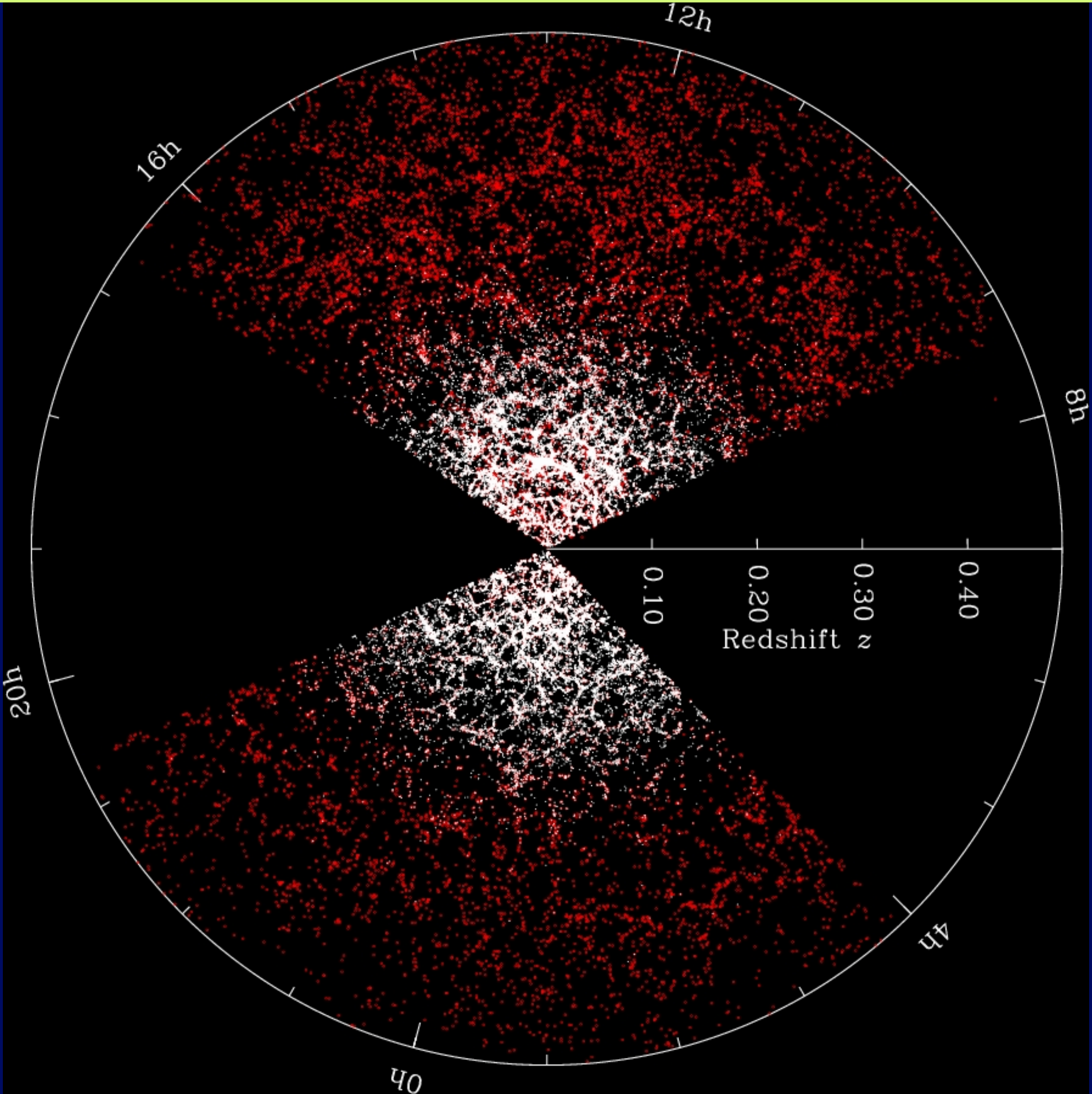
$$f = \frac{L}{4\pi d^2} \rightarrow L_{\min} = 4\pi d^2 f_{\lim}$$

$$m - M = 5\log d - 5 \rightarrow M_{\max} = m_{\lim} - 5\log d + 5$$

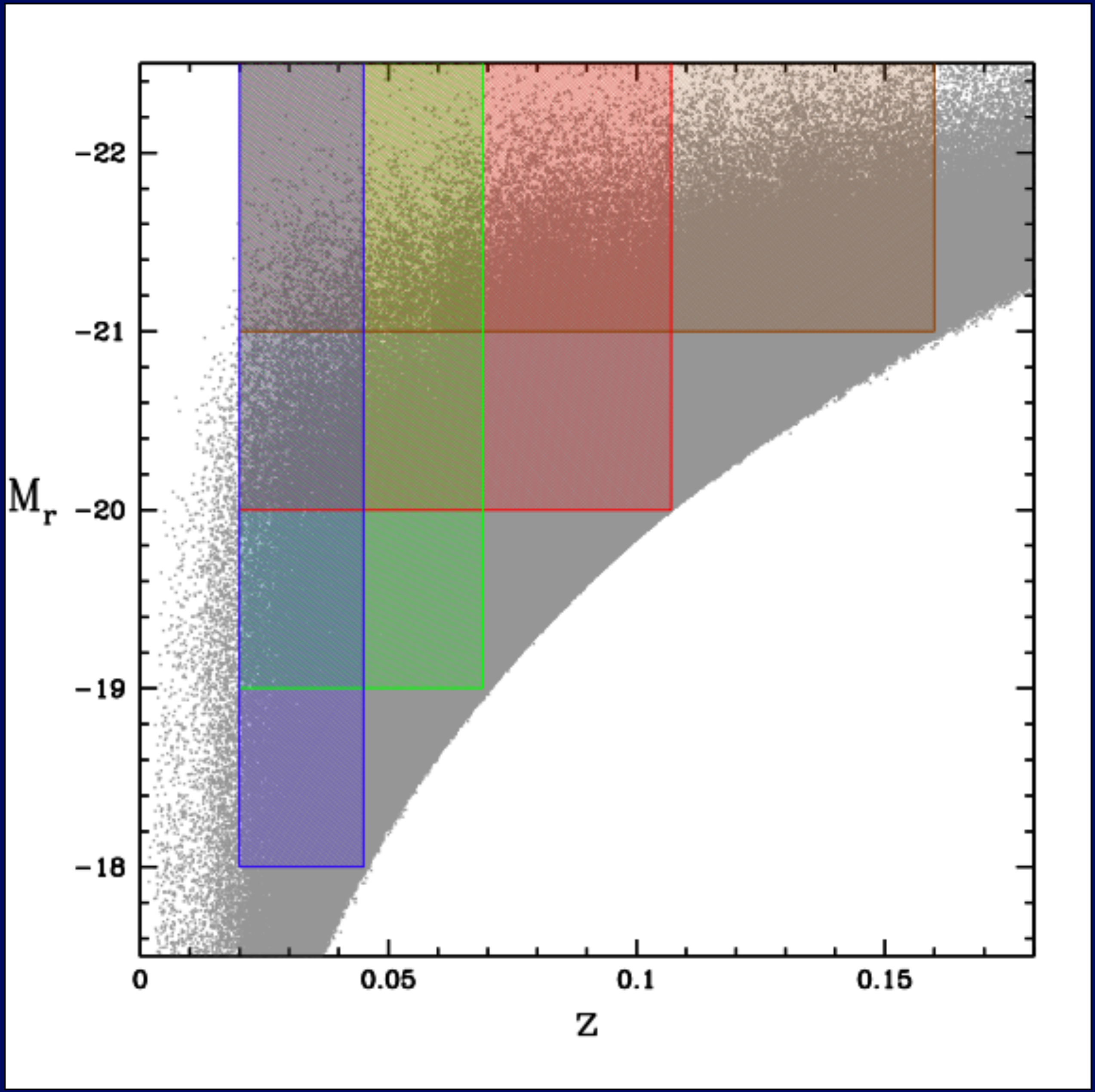
Flux/Magnitude-limited and Volume-limited samples



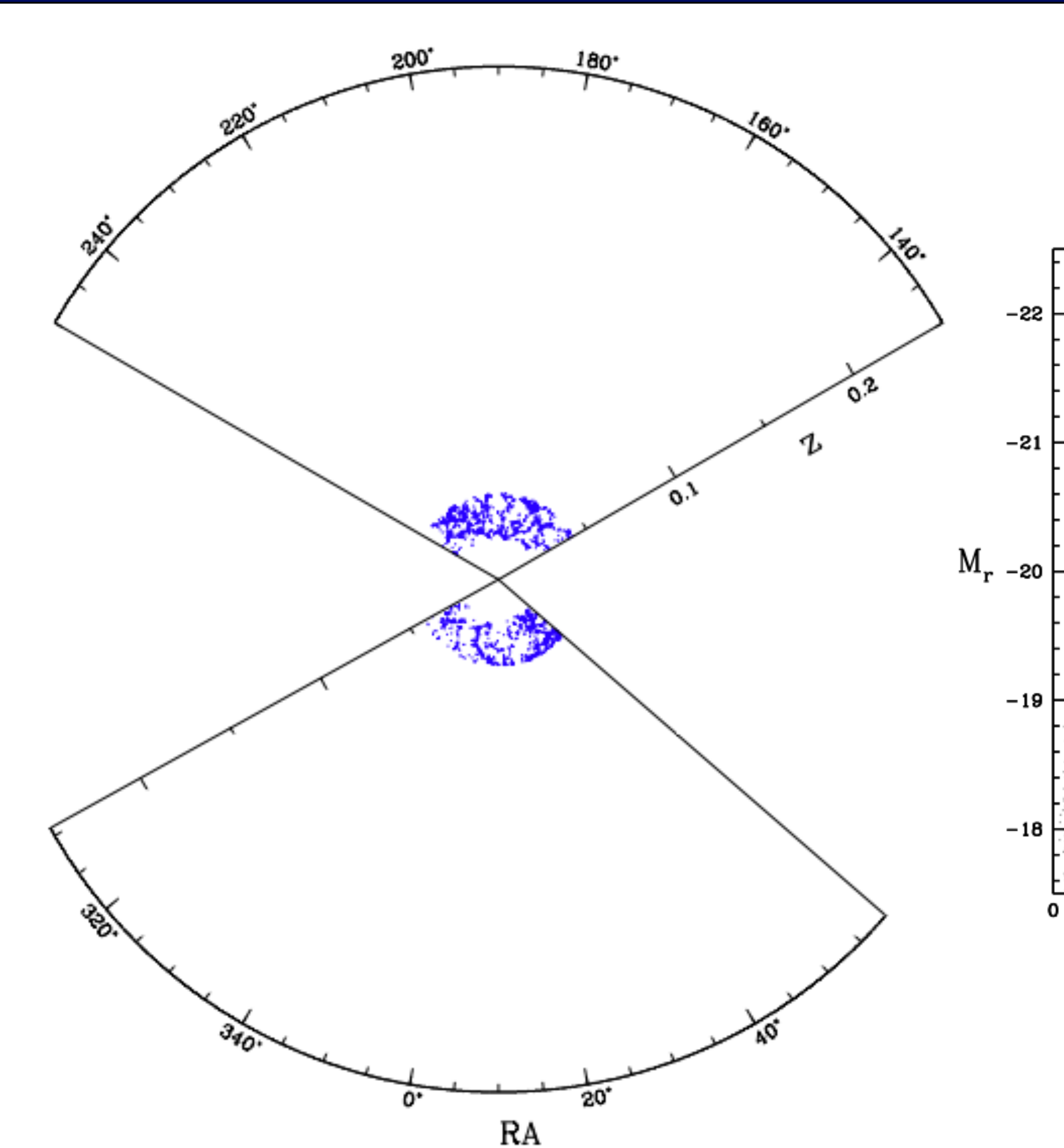
Flux/Magnitude-limited and Volume-limited samples

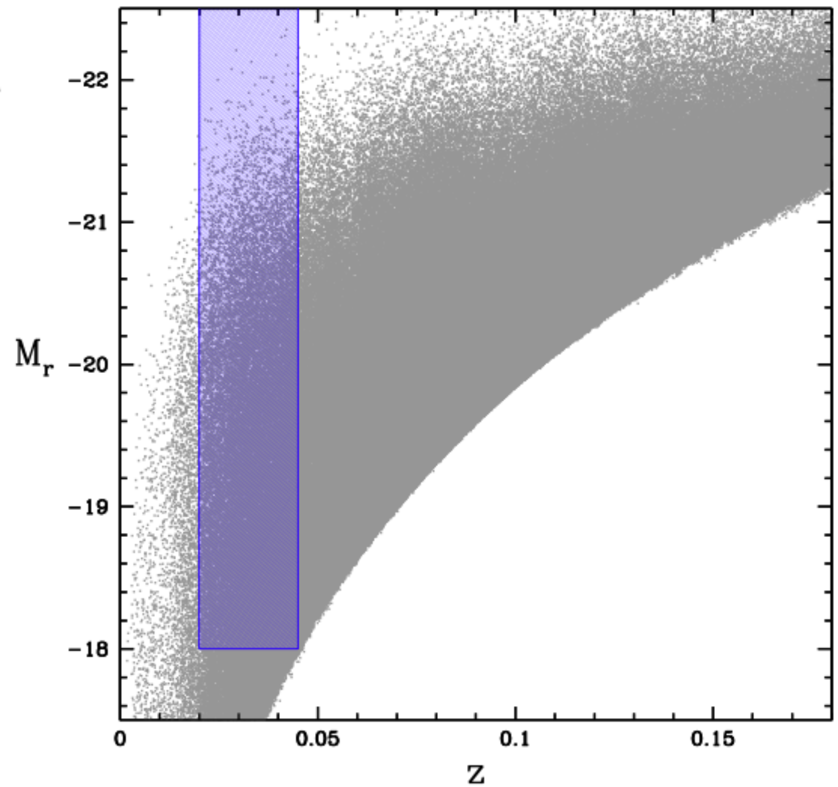


Flux/Magnitude-limited and Volume-limited samples



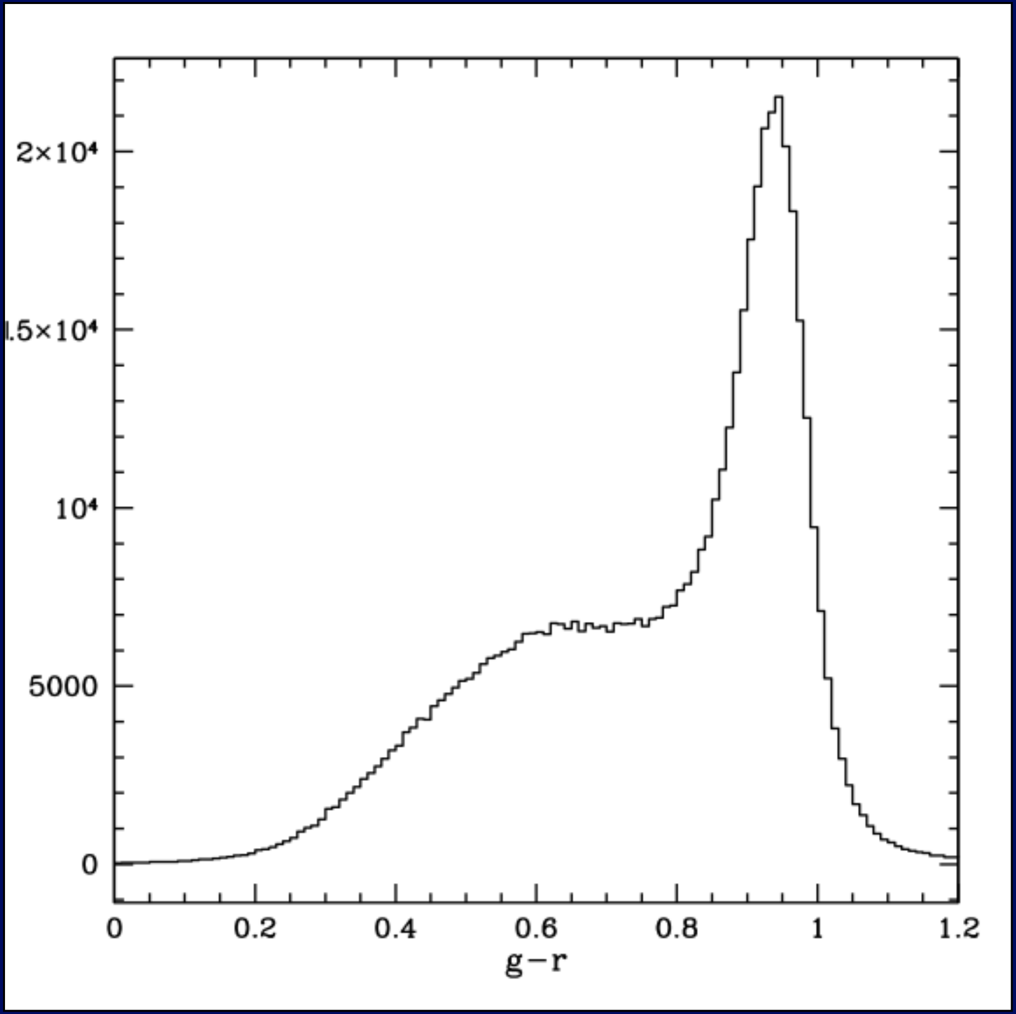
Flux/Magnitude-limited and Volume-limited samples





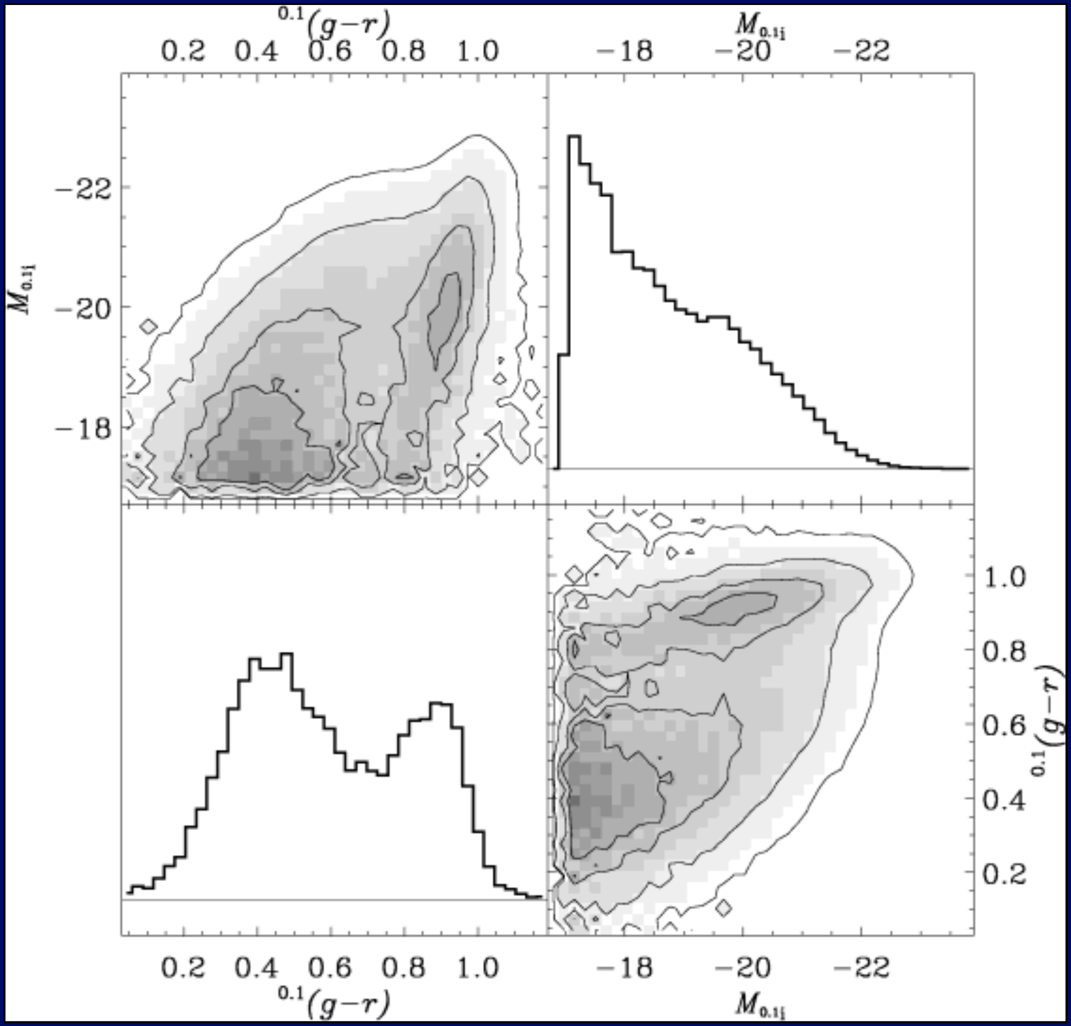
A simple example

What is the fraction of red and blue galaxies in the universe?

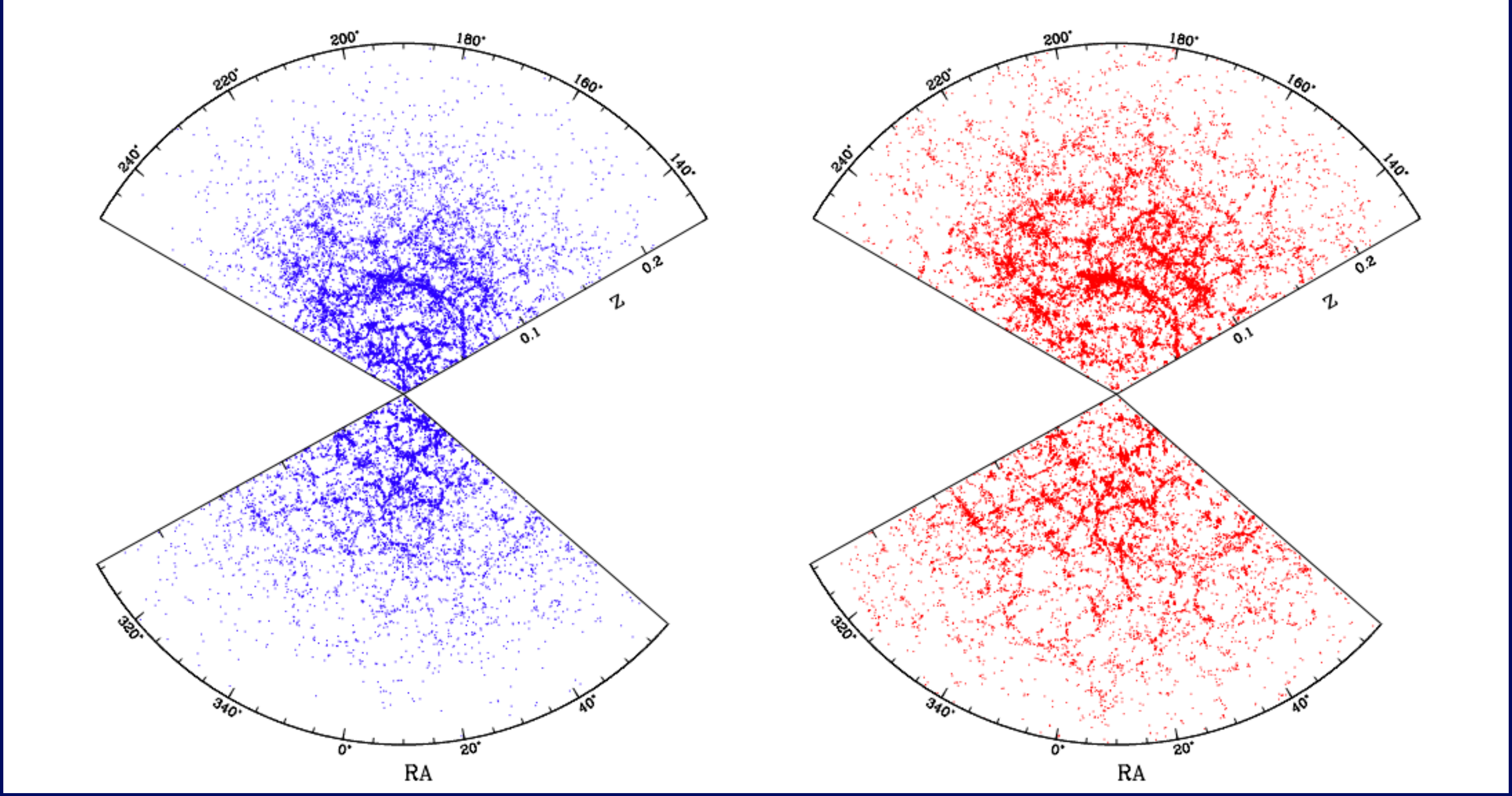


A simple example

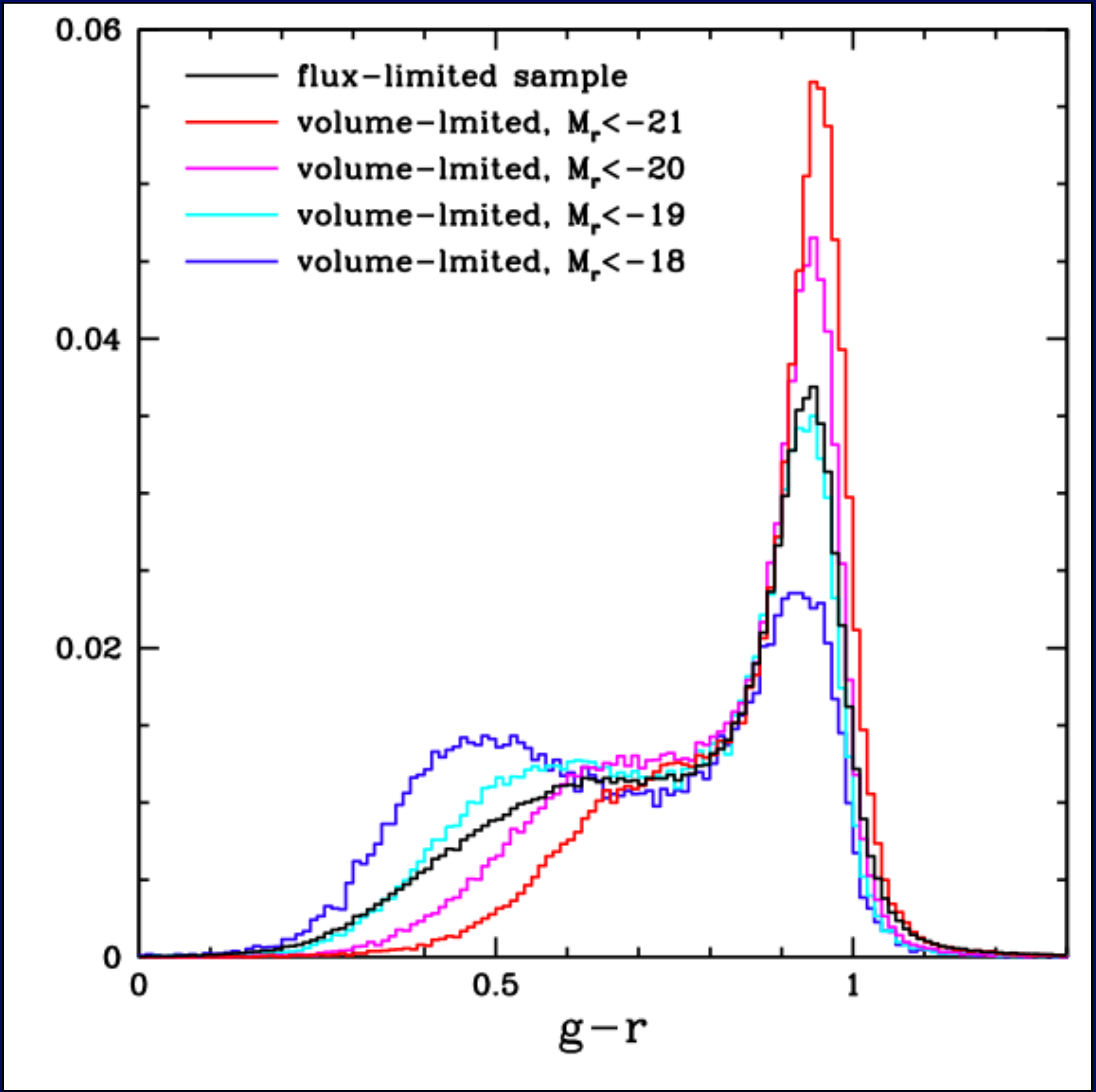
What is the fraction of red and blue galaxies in the universe?



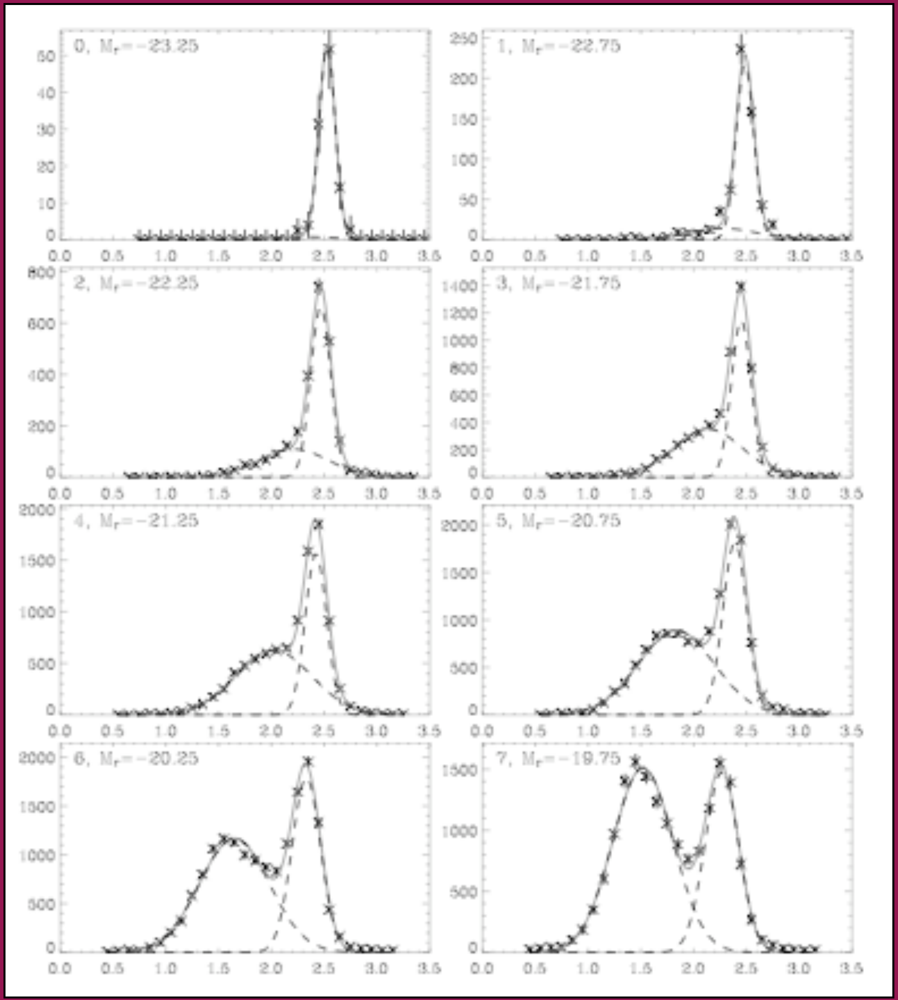
A simple example

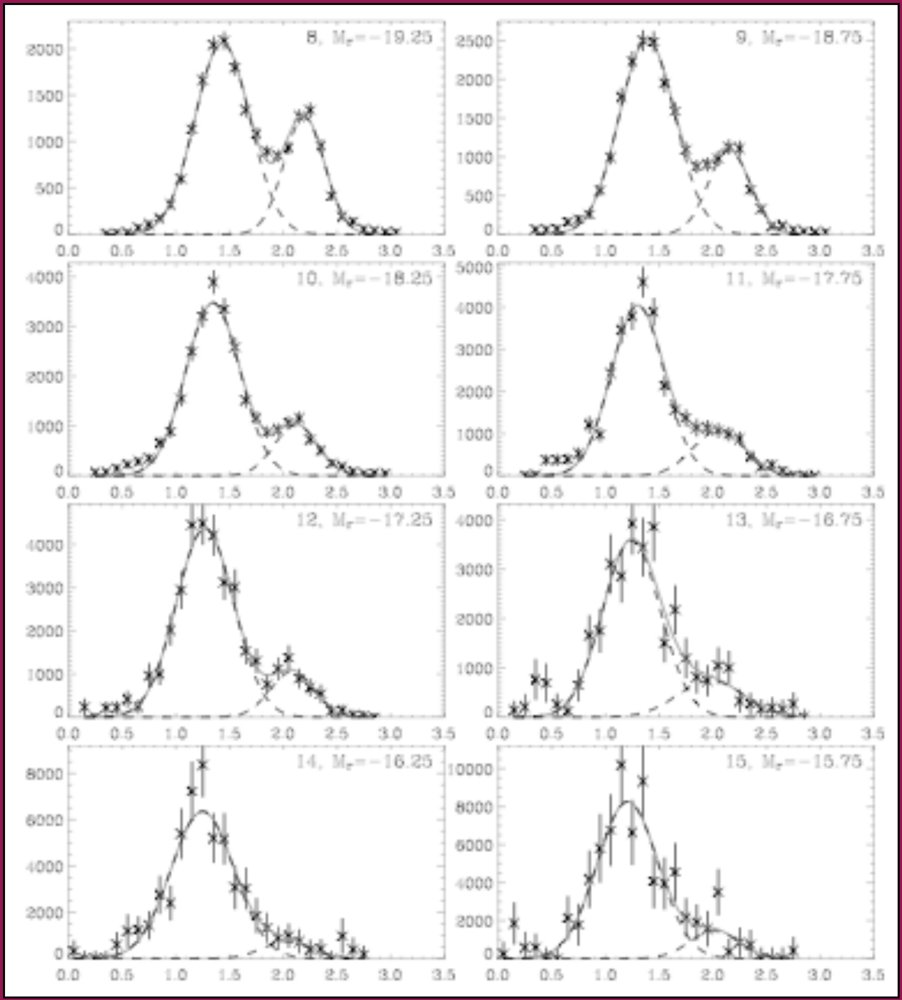


A simple example



Bimodality

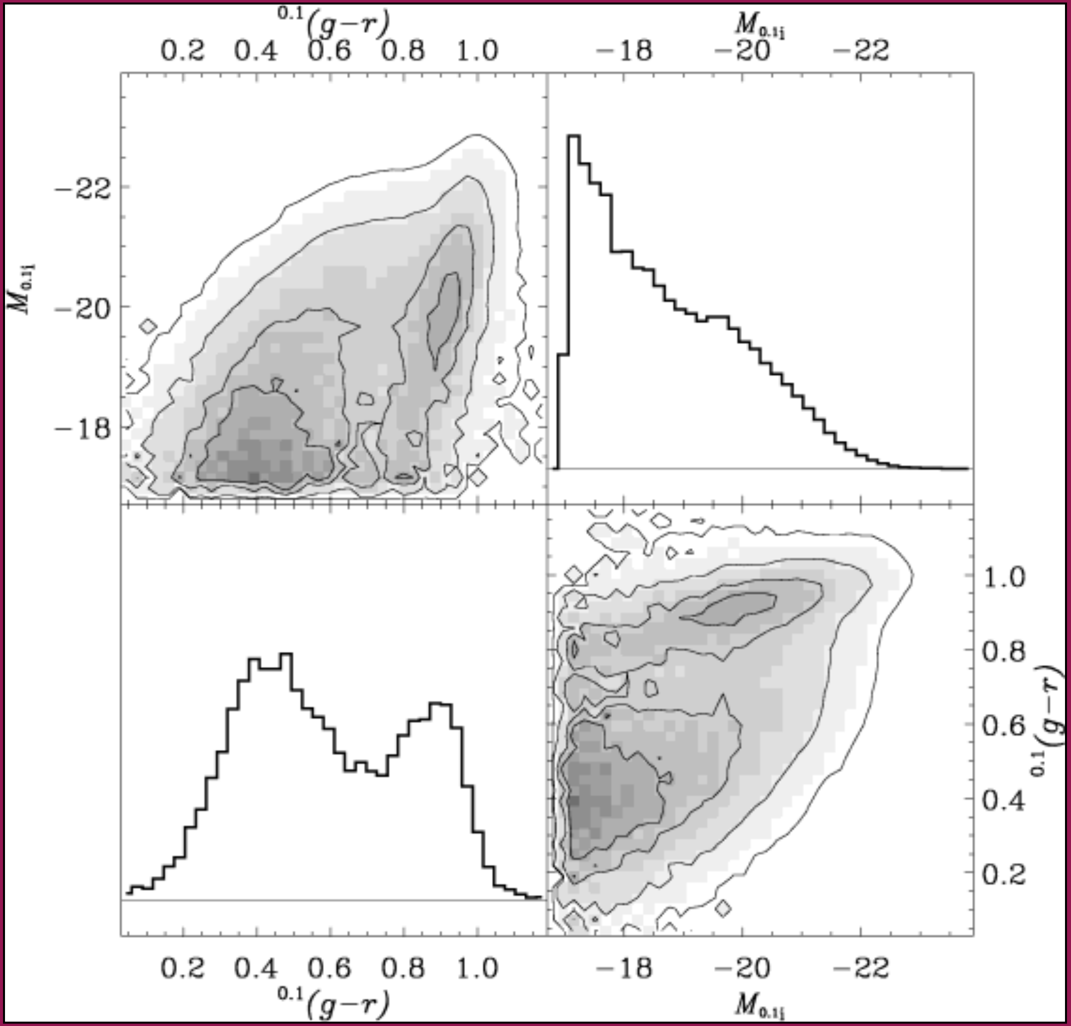




Baldry et al. (2004)

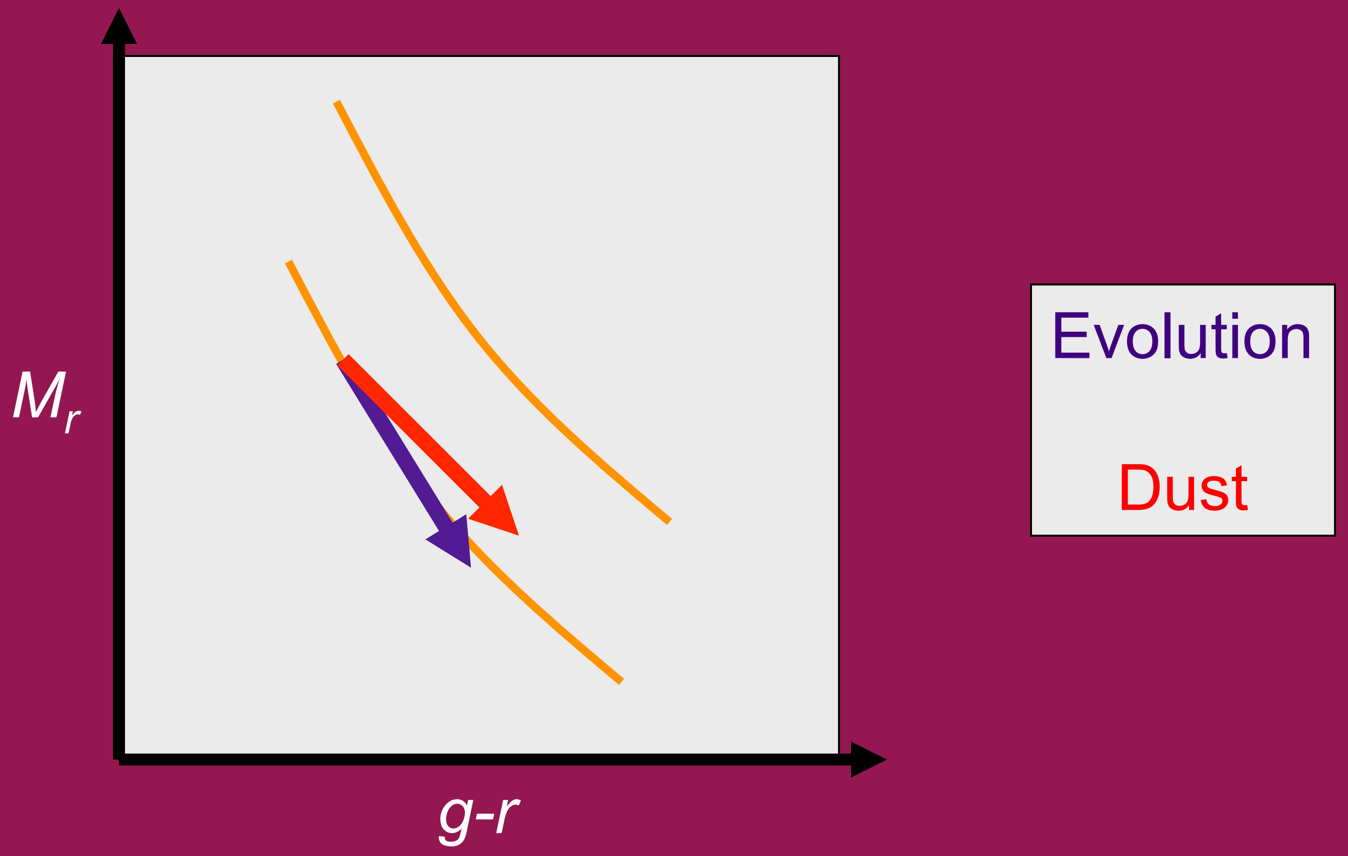
u-r

Bimodality



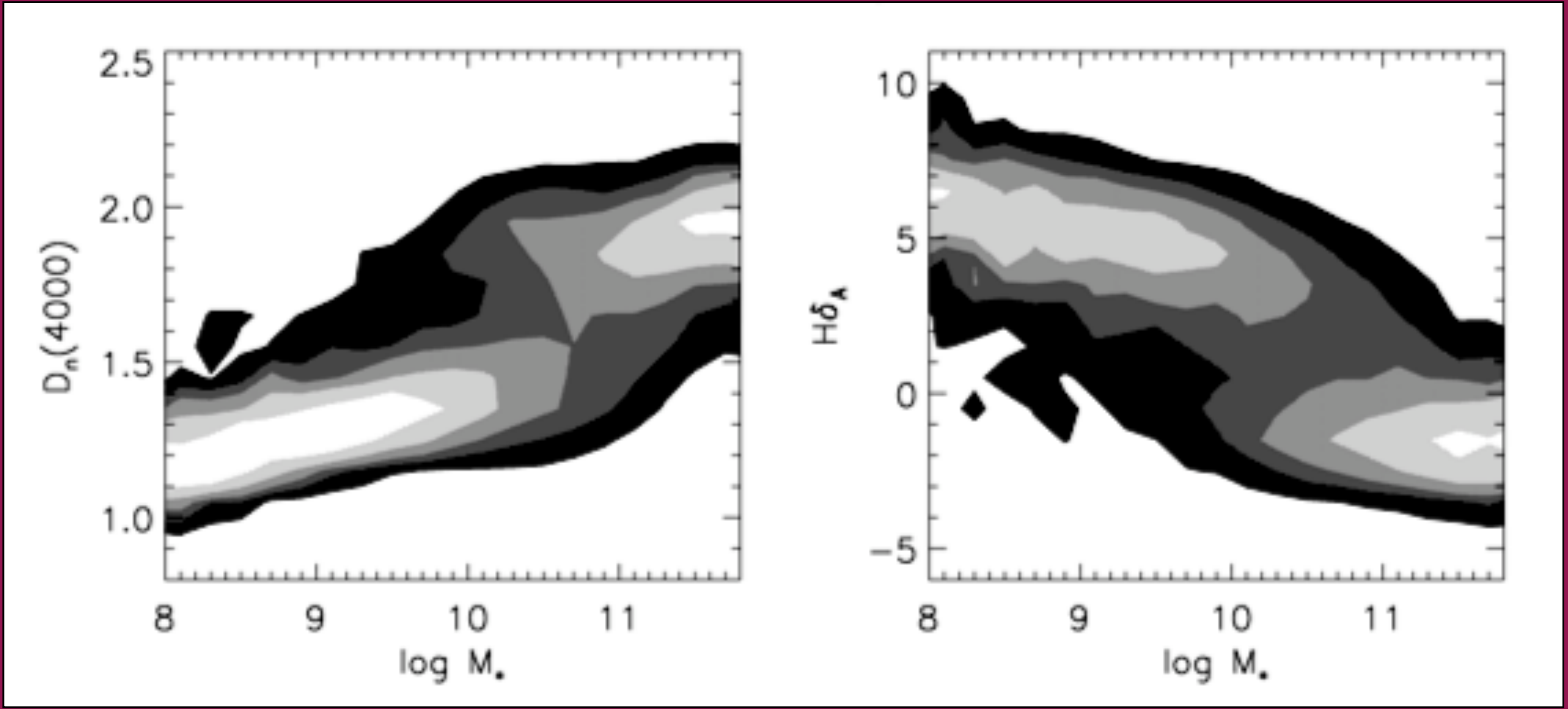
Blanton et al. (2004)

Stellar mass



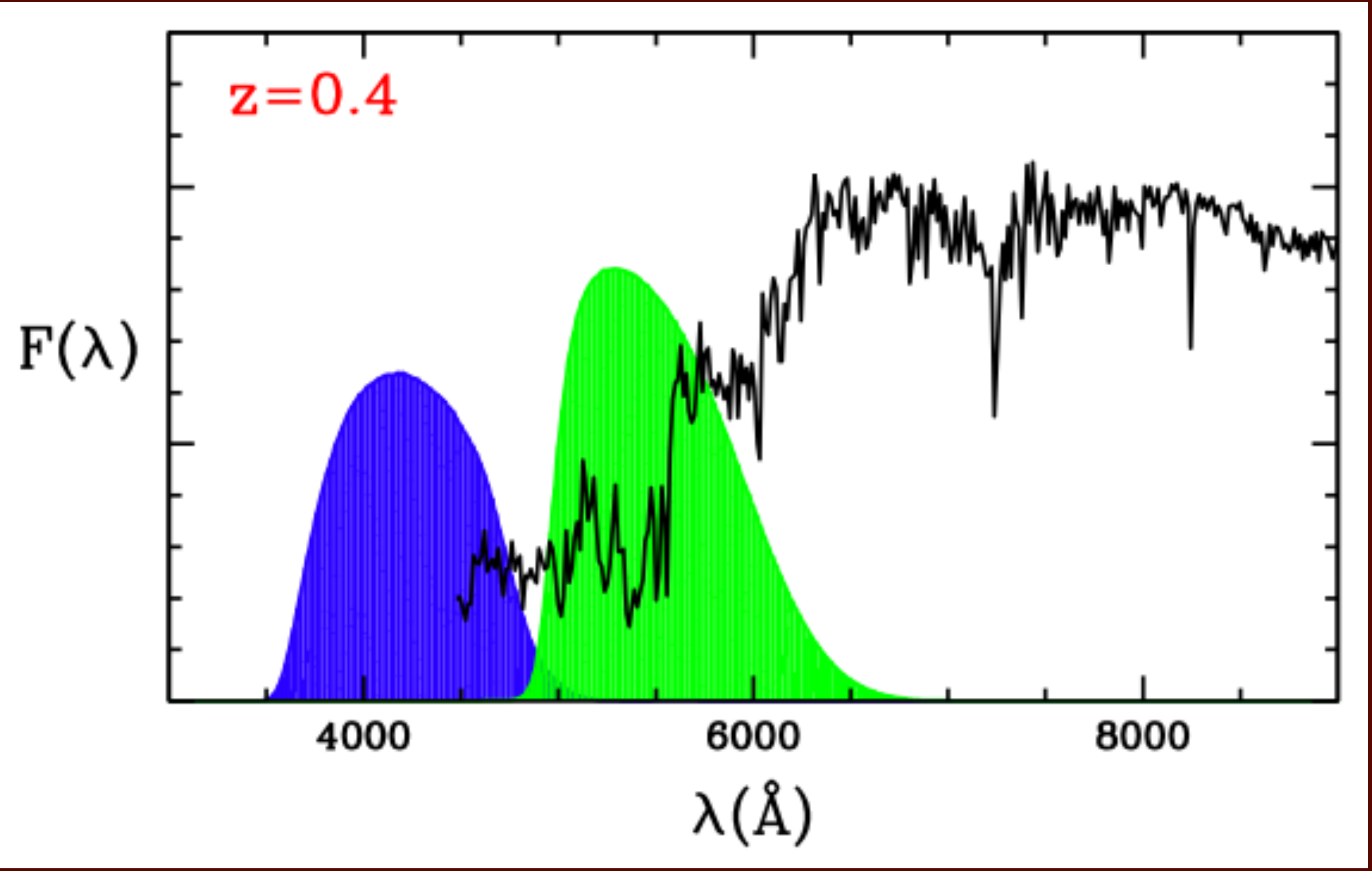
Bell & de Jong (2001)

Bimodality

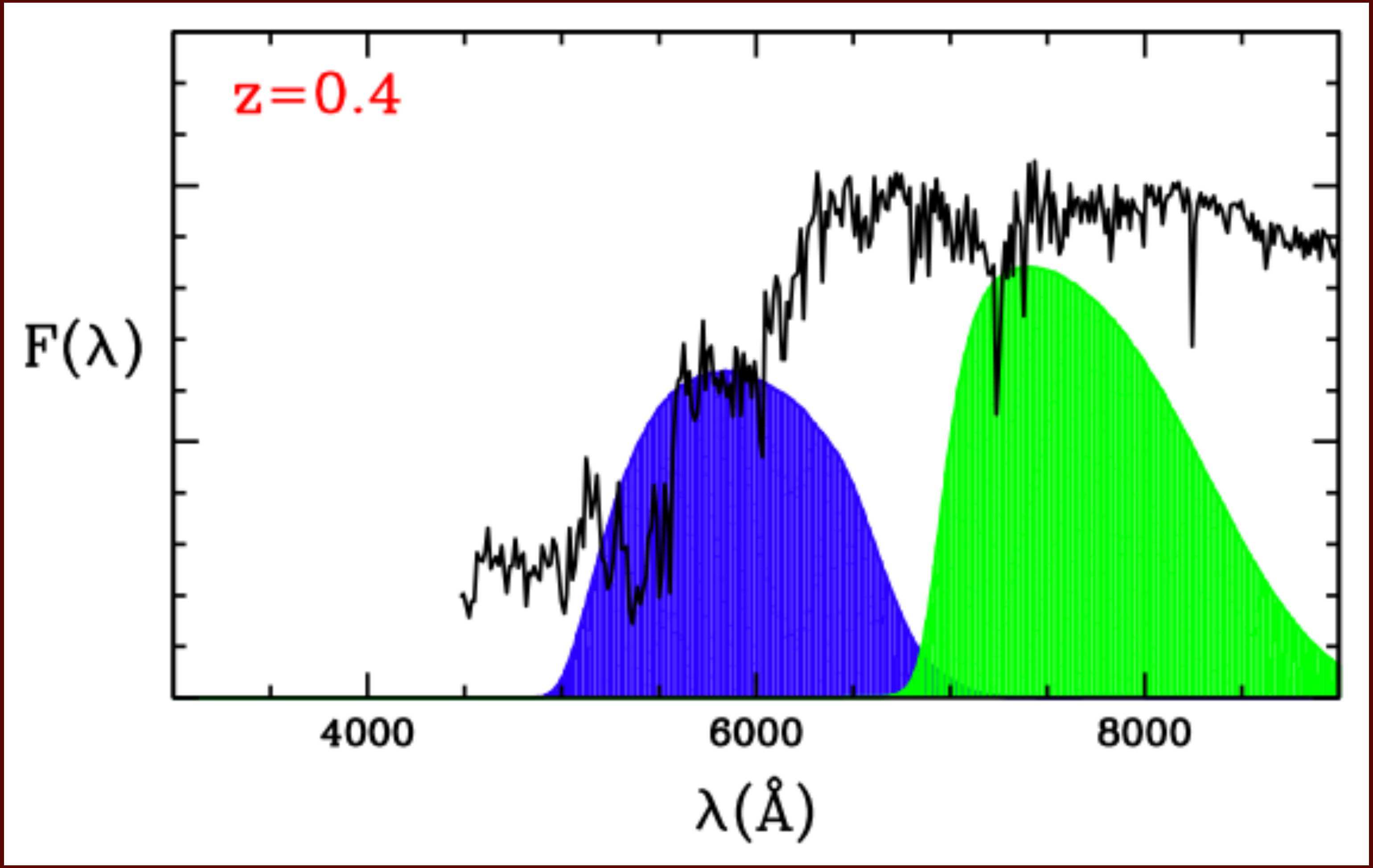


Kauffmann et al. (2004)

K-corrections



K-corrections



K-corrections

Galaxy magnitudes at different redshifts cannot be compared directly because photometric filters cover a different part of the rest-frame galaxy spectrum.

$$\frac{\lambda_{\text{observed}}}{\lambda_{\text{emitted}}} = 1 + z$$

$$\frac{f_{\text{intrinsic}}}{f_{\text{observed}}} = \frac{\int_0^\infty F(\lambda) S(\lambda) d\lambda}{\int_0^\infty F\left(\frac{\lambda}{1+z}\right) S(\lambda) \frac{d\lambda}{1+z}}$$

K-corrections

$$m_{\text{intrinsic}} = m_{\text{observed}} - K(z)$$

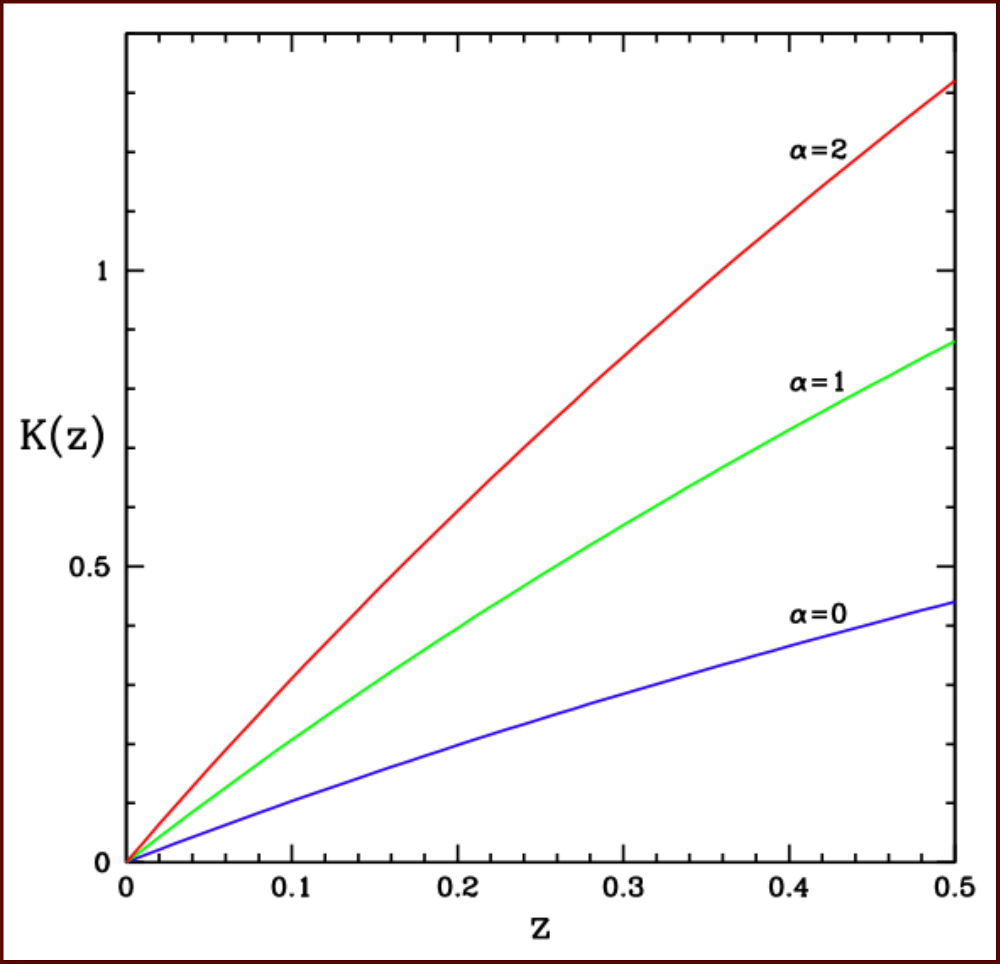
$$K(z) = 2.5\log\left((1+z)\frac{\int_0^\infty F(\lambda)S(\lambda)d\lambda}{\int_0^\infty F\left(\frac{\lambda}{1+z}\right)S(\lambda)d\lambda} \right)$$

$$= 2.5\log(1+z) + 2.5\log\left(\frac{\int_0^\infty F(\lambda)S(\lambda)d\lambda}{\int_0^\infty F\left(\frac{\lambda}{1+z}\right)S(\lambda)d\lambda} \right)$$

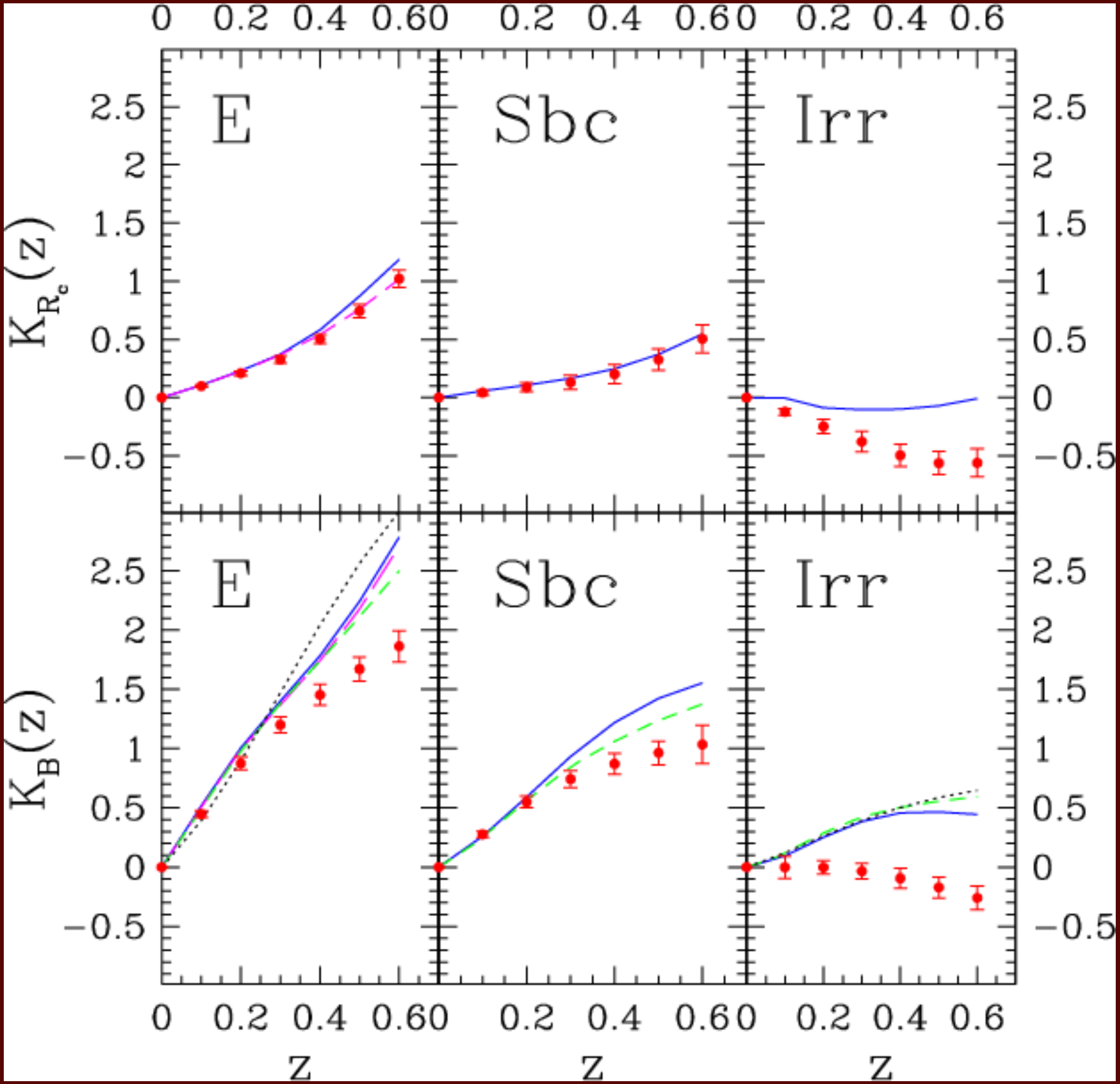
K-corrections

$$F(\lambda) = C\lambda^{\alpha}$$

$$K(z) = 2.5(\alpha + 1)\log(1 + z)$$



K-corrections

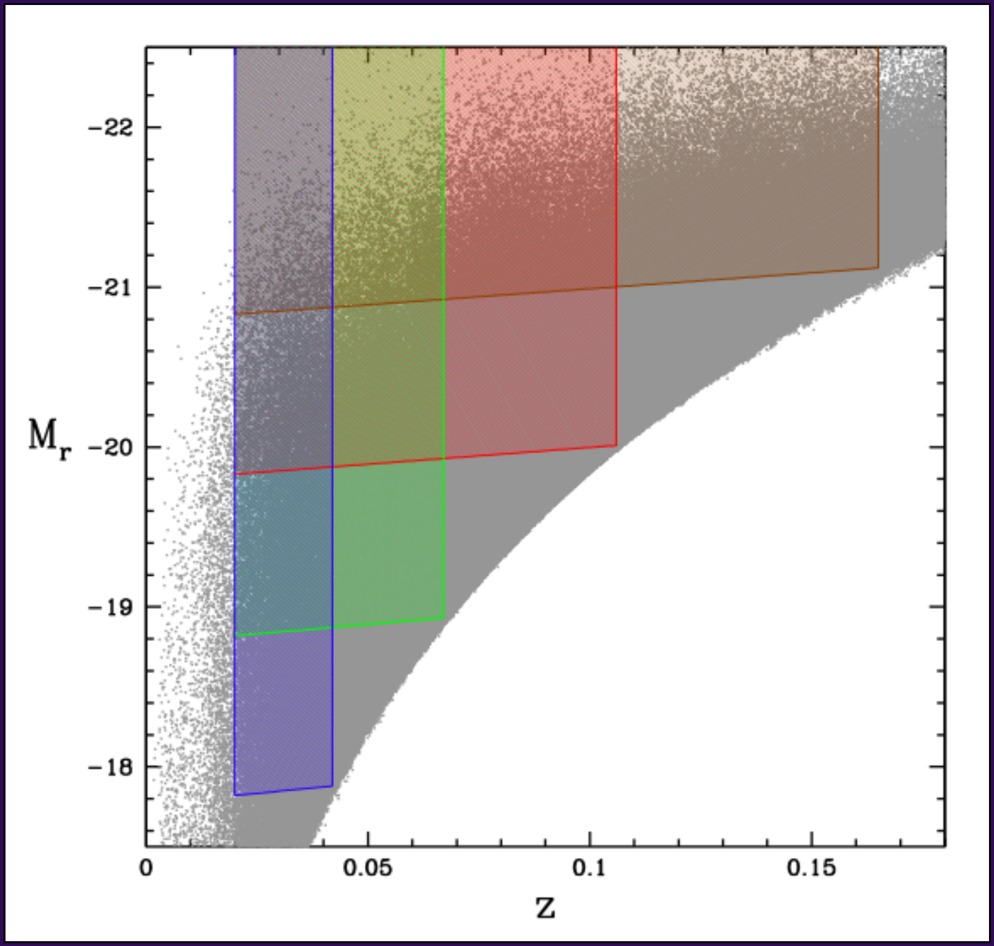


De Lapparent et al. (2003)

Evolution corrections

Galaxy luminosities evolve with redshift, making it difficult to compare galaxies at different redshifts.

Passive luminosity evolution: galaxies fade with time as their stellar populations age (*i.e, no new star formation*)



Luminosity Function

THE ASTROPHYSICAL JOURNAL, 203:297–306, 1976 January 15

AN ANALYTIC EXPRESSION FOR THE LUMINOSITY FUNCTION FOR GALAXIES*

PAUL SCHECHTER
California Institute of Technology and the Institute for Advanced Study
Received 1975 April 29; revised 1975 June 30

ABSTRACT

A new analytic approximation for the luminosity function for galaxies is proposed, which shows good agreement with both a luminosity distribution for bright nearby galaxies and a con luminosity distribution for cluster galaxies. The analytic expression is proportional to $L^{-5/4}$ where L^* is a characteristic luminosity corresponding to a characteristic absolute mag $M^*_{B(0)} = -20.6$. For an individual cluster, the characteristic magnitude may be dete with an accuracy of ~0.25 mag, suggesting its use as a standard candle. The analytic exp is used to compute an expected richness–absolute magnitude correlation for first ranked galaxies and an expected dispersion, which are compared with the data of Sandage and

Subject headings: galaxies: clusters of — galaxies: photometry

We propose here a new analytic approximation for the luminosity function for galaxies. Letting $\varphi(L)dL$ be number of galaxies per unit volume in the luminosity interval from L to $L + dL$, we investigate the expression

$$\varphi(L)dL = \varphi^*(L/L^*)^{\alpha} \exp(-L/L^*)d(L/L^*) \qquad (1)$$

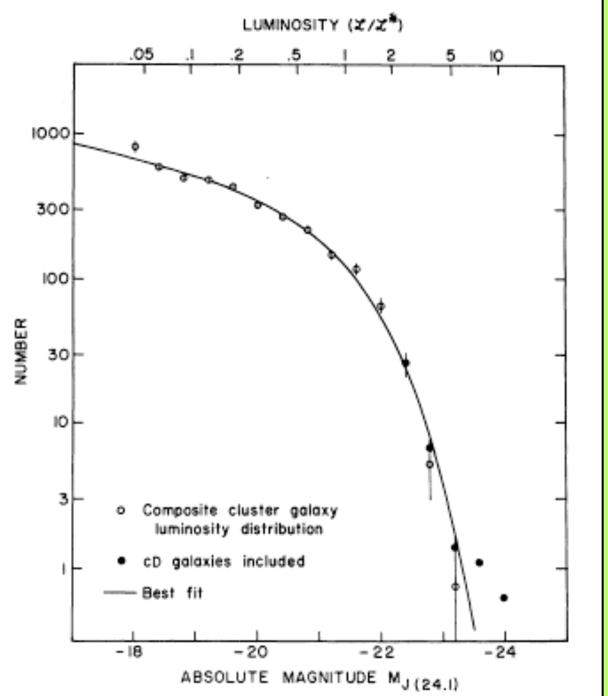
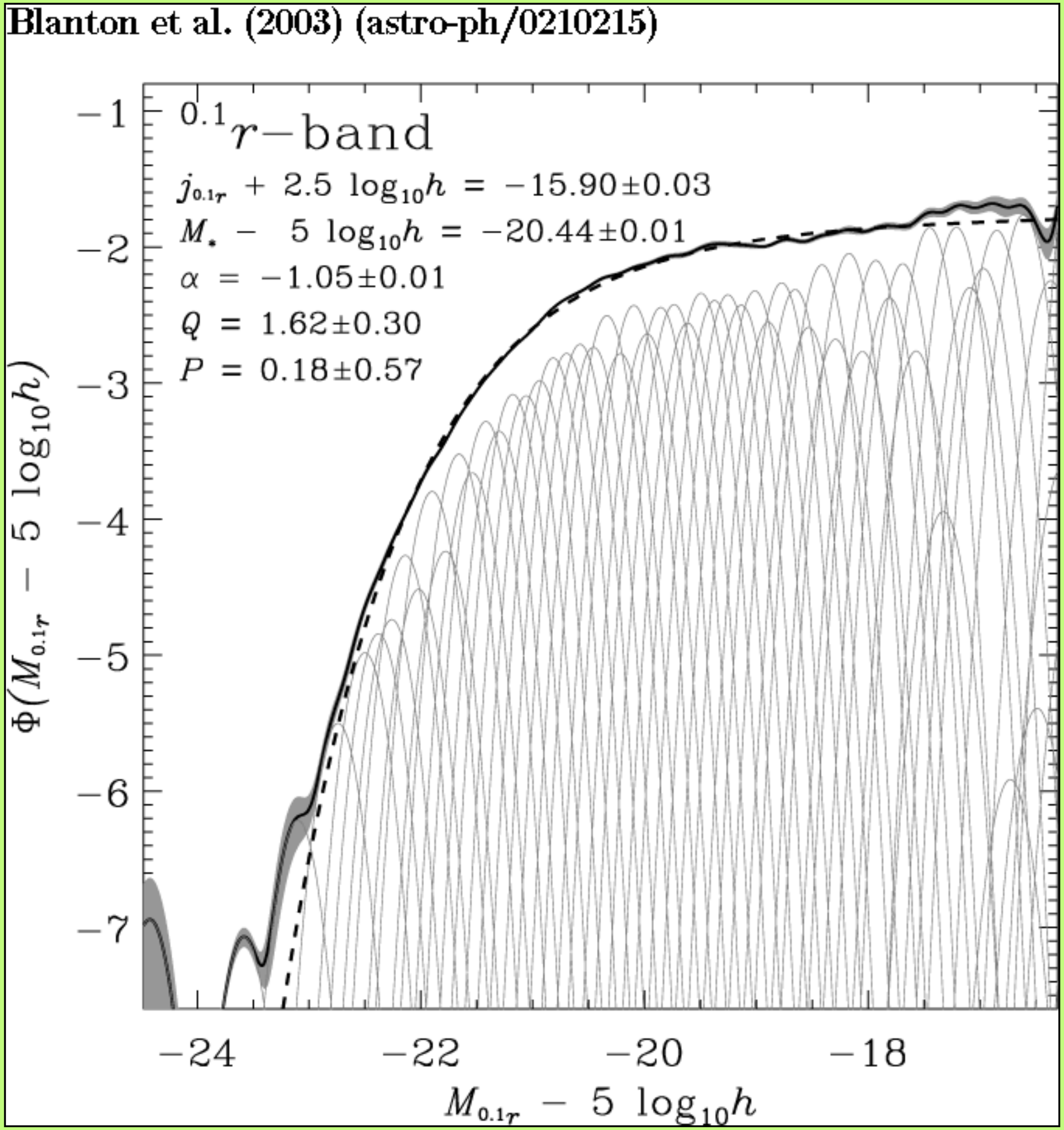


FIG. 2.—Best fit of analytic expression to observed composite cluster galaxy luminosity distribution. Filled circles show the effect of including cD galaxies in composite.

Luminosity Function

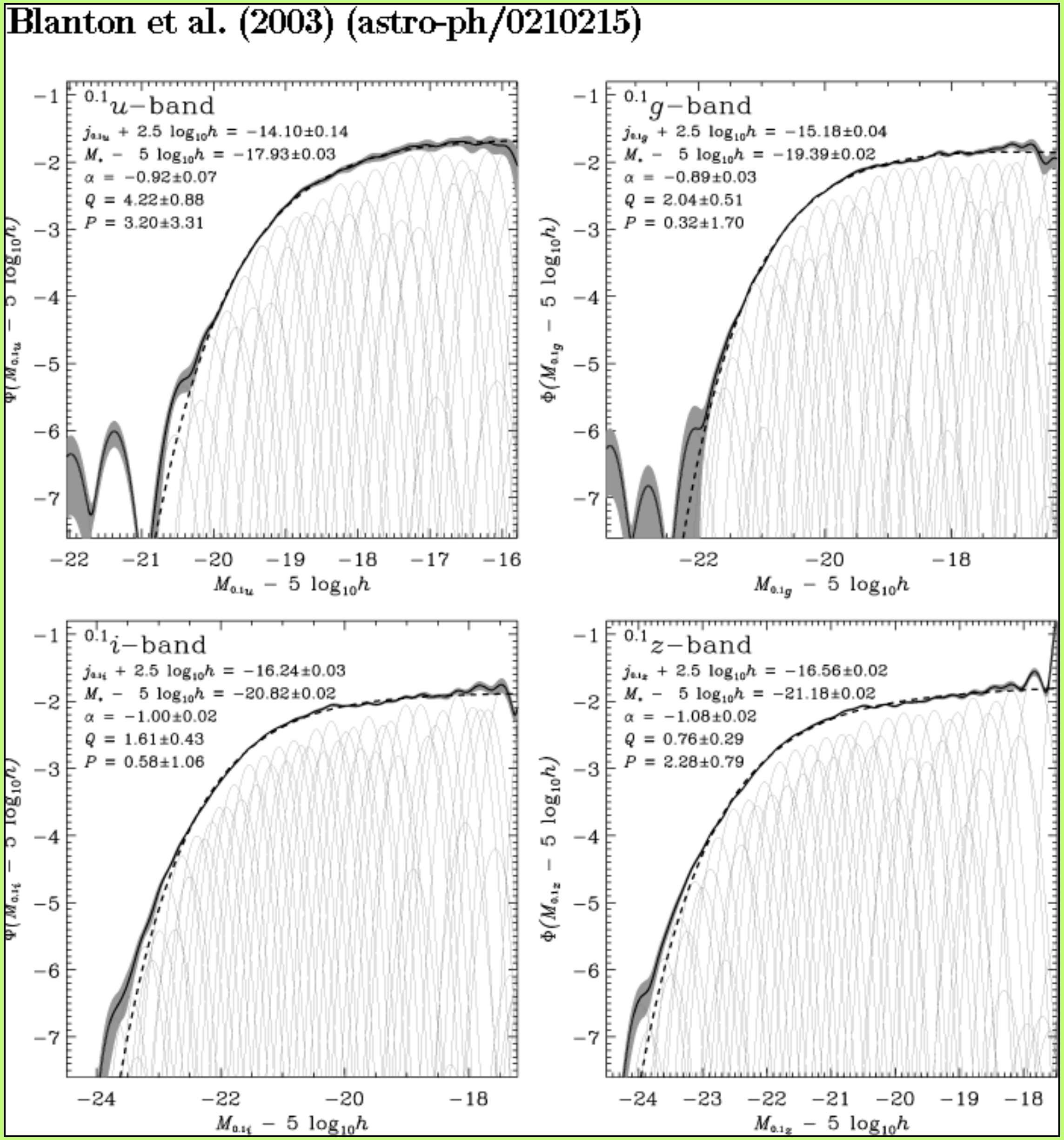
$$\Phi(L) = \frac{\Phi_*}{L_*}\left(\frac{L}{L_*}\right)^{\alpha} \exp\left(-\frac{L}{L_*}\right)$$

Luminosity Function



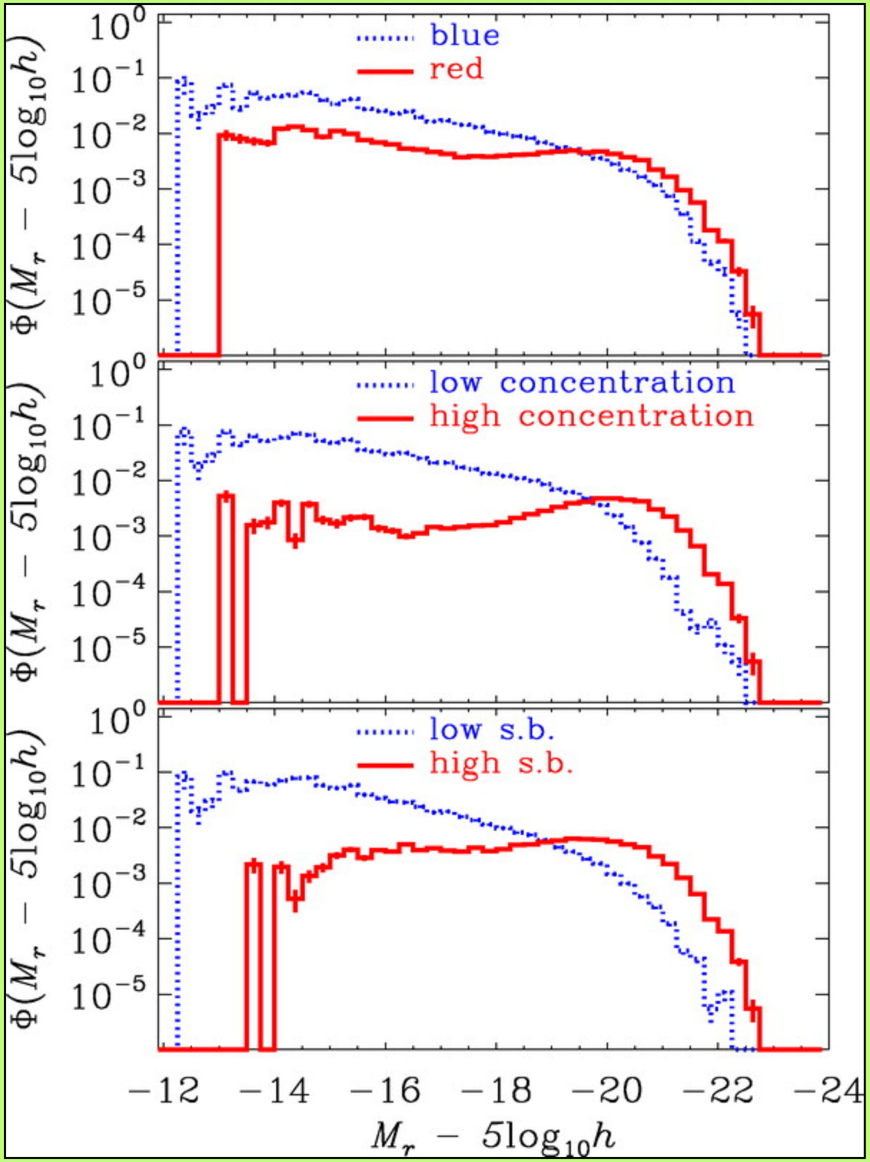
Blanton et al. (2003)

Luminosity Function



Blanton et al. (2003)

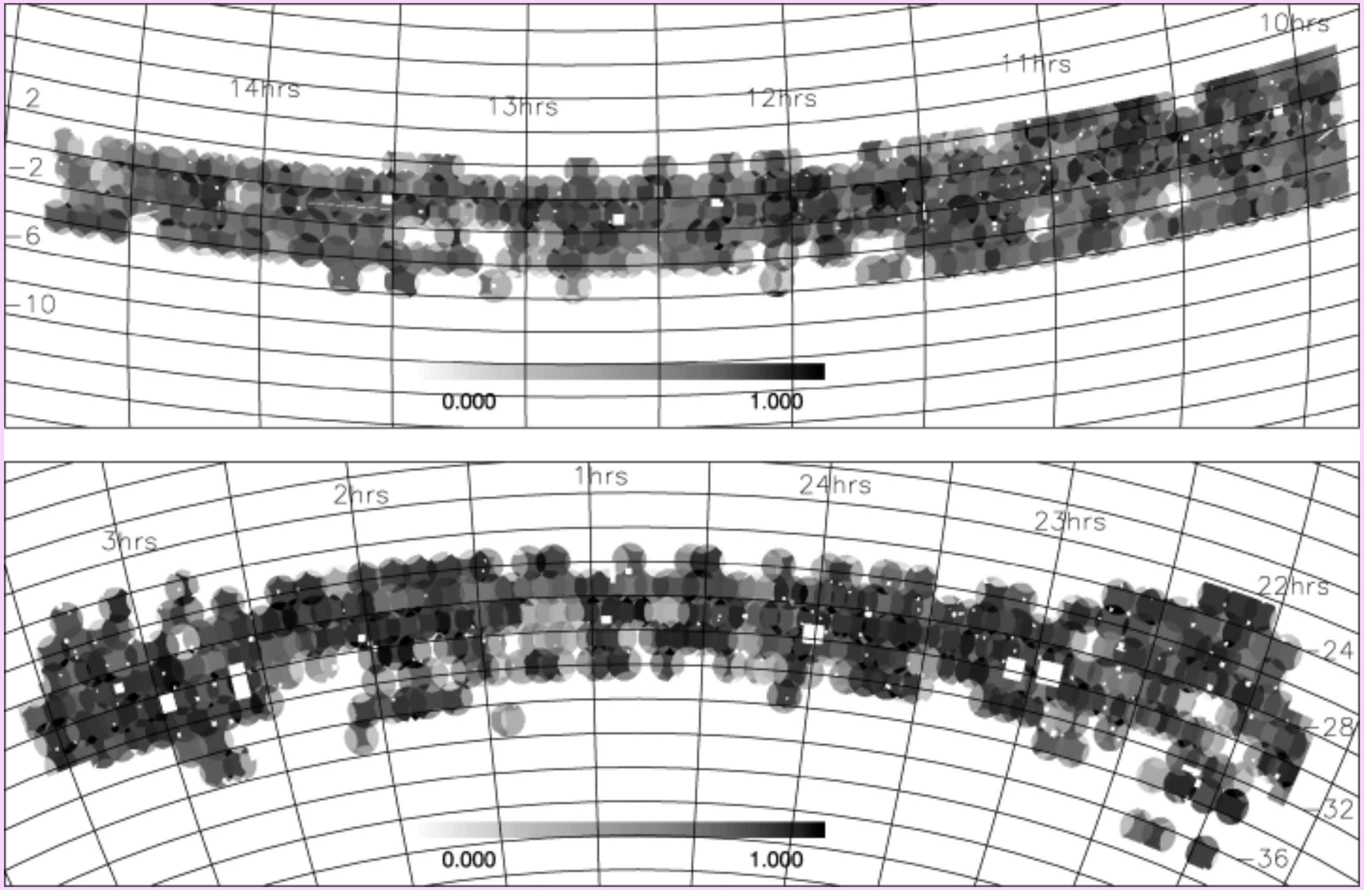
Luminosity Function



Blanton et al. (2005)

Selection Functions

2dFGRS angular selection function

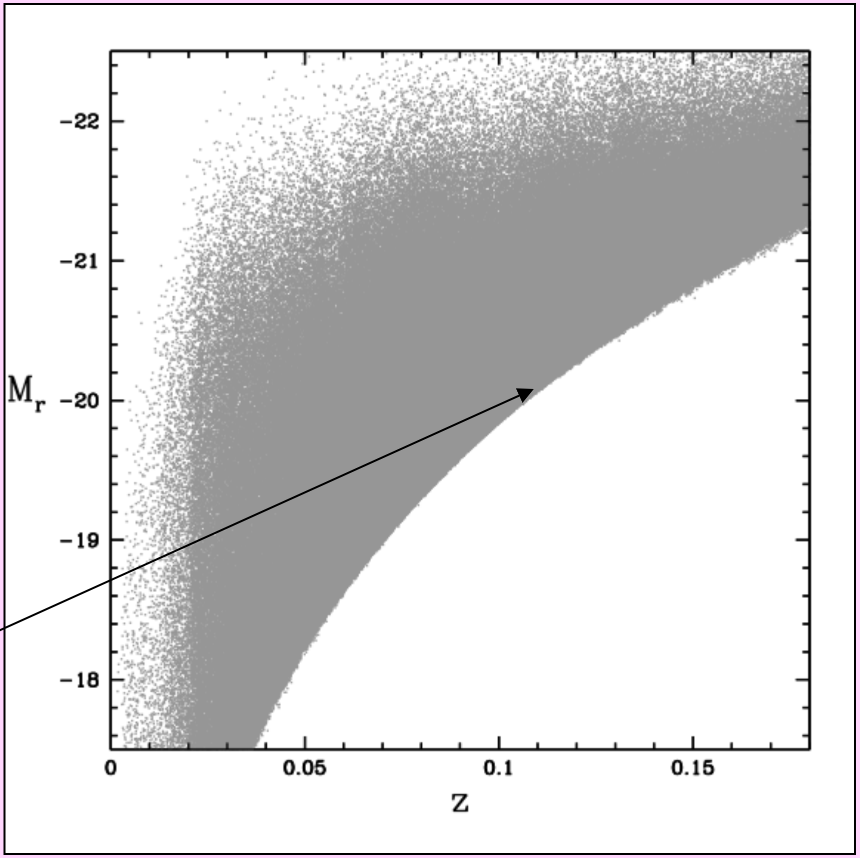


Norberg et al. (2002)

Selection Functions

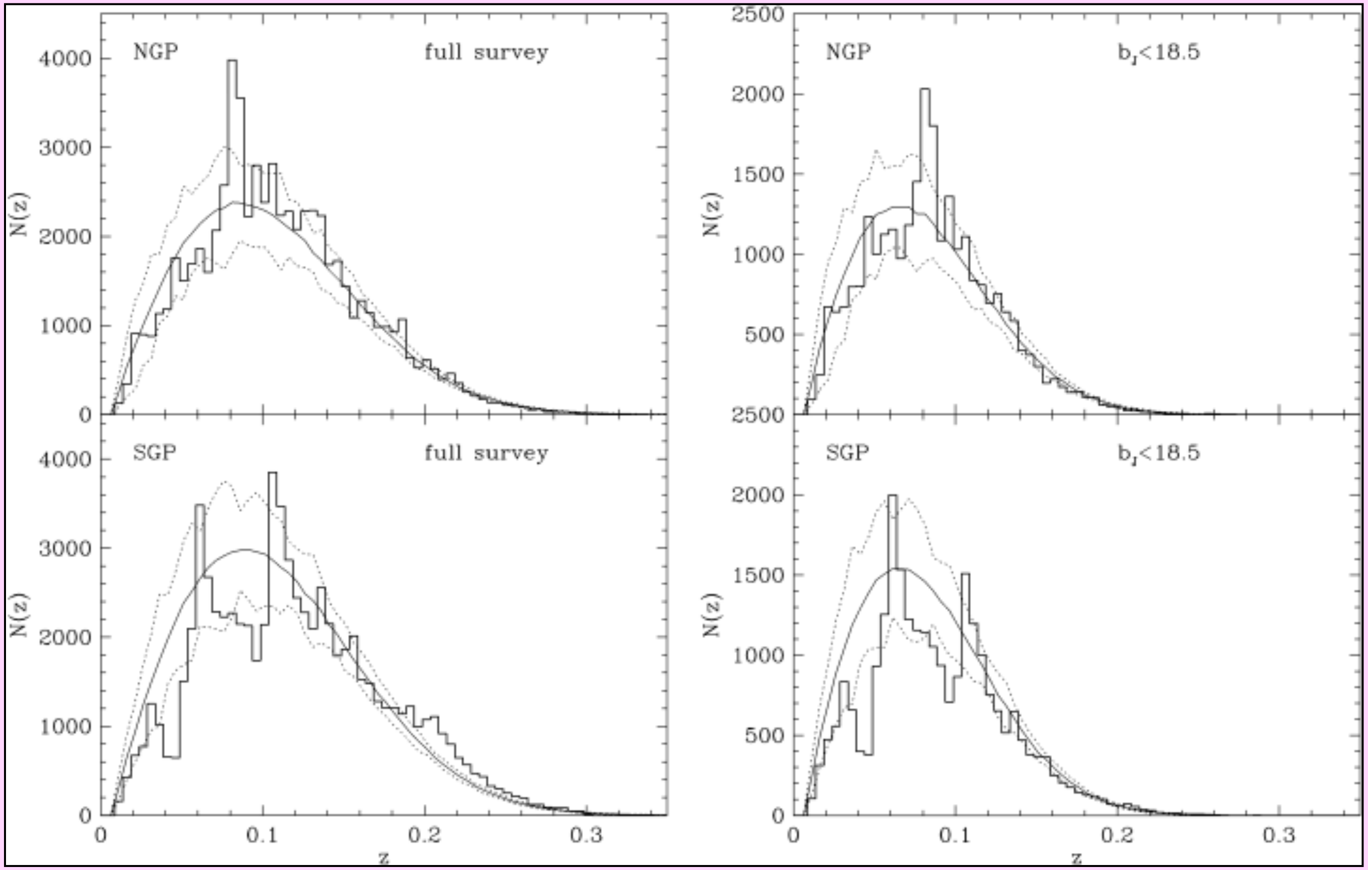
Radial selection function

$$\Phi(z) = \frac{\int_{M_{\max}(z)}^{-\infty} dM\, \Phi(M)}{\int_{M_{\mathrm{cut}}}^{-\infty} dM\, \Phi(M)}$$



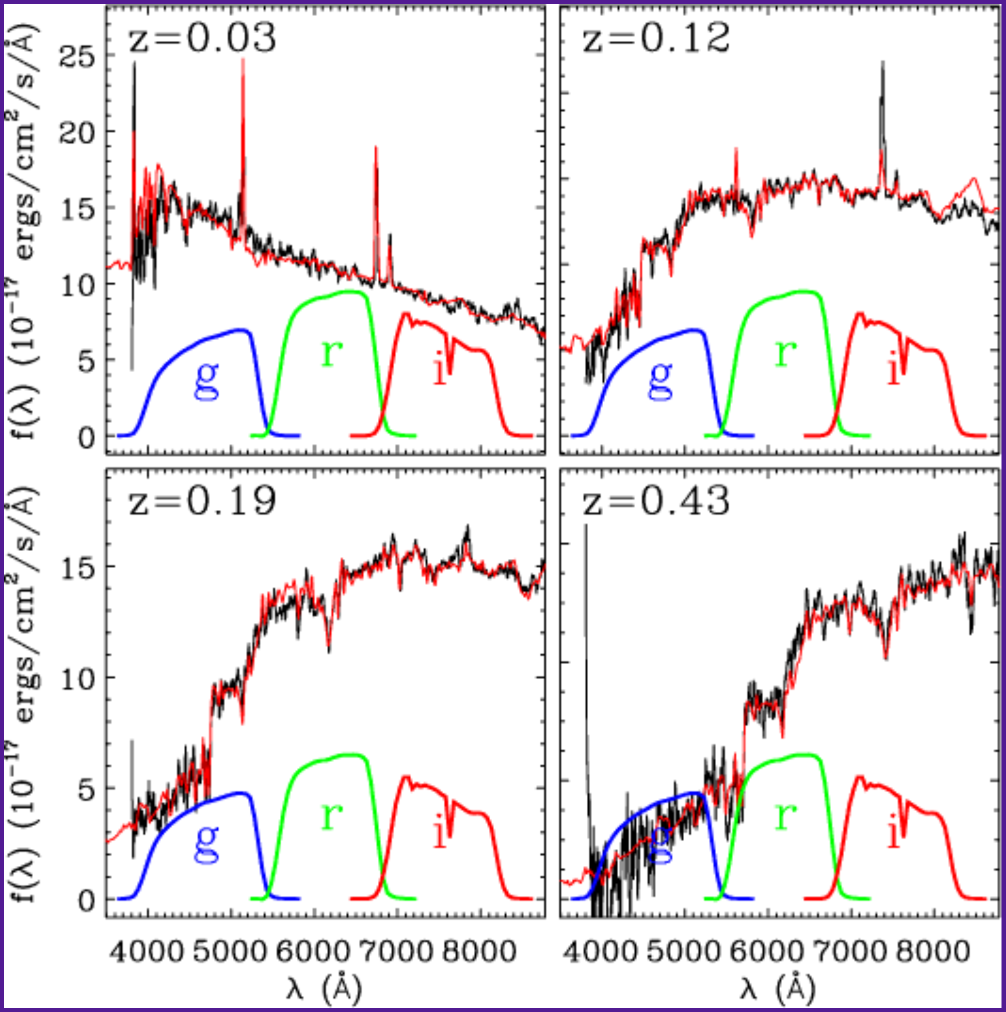
$$M_{\max}(z) = m_{\lim} - 5\log\left(\frac{cz}{H_0}\times 10^6\right) + 5 - K(z)$$

2dFGRS radial selection function



Norberg et al. (2002)

Photometric Redshifts



SDSS, Blanton

Photometric Redshifts

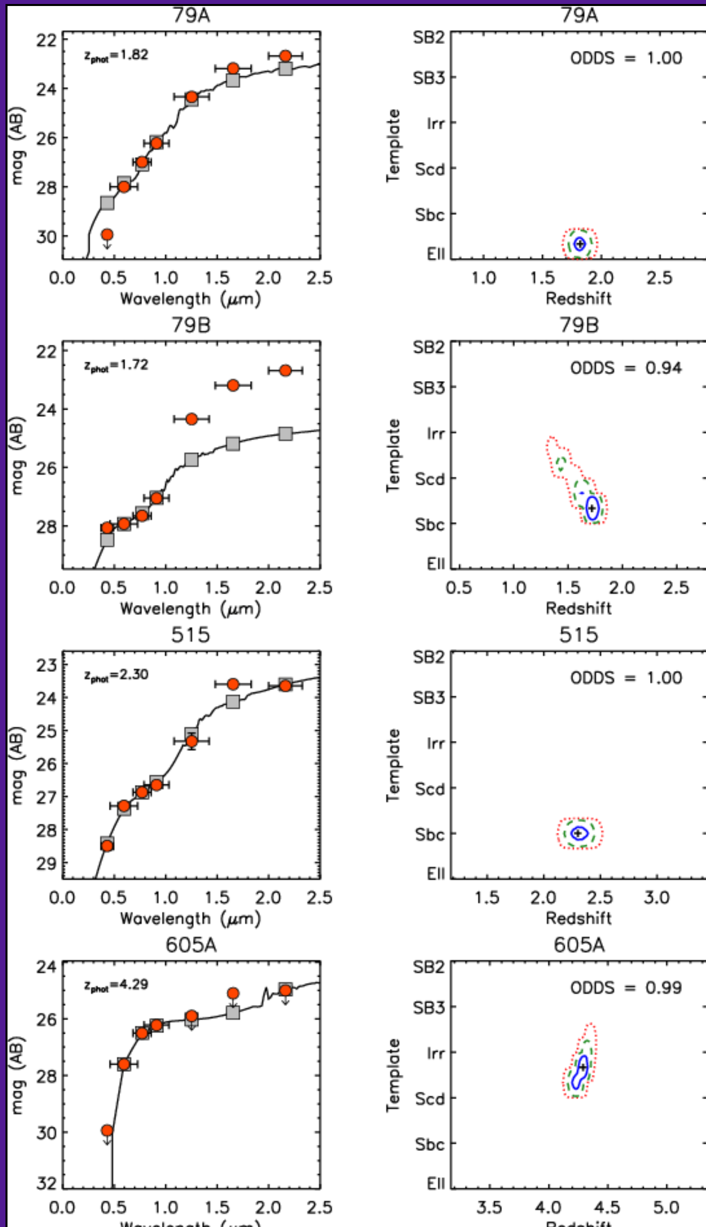
Where spectroscopic data are unavailable, one can still use photometric data in multiple bands to estimate redshift. Galaxy colors depend on:

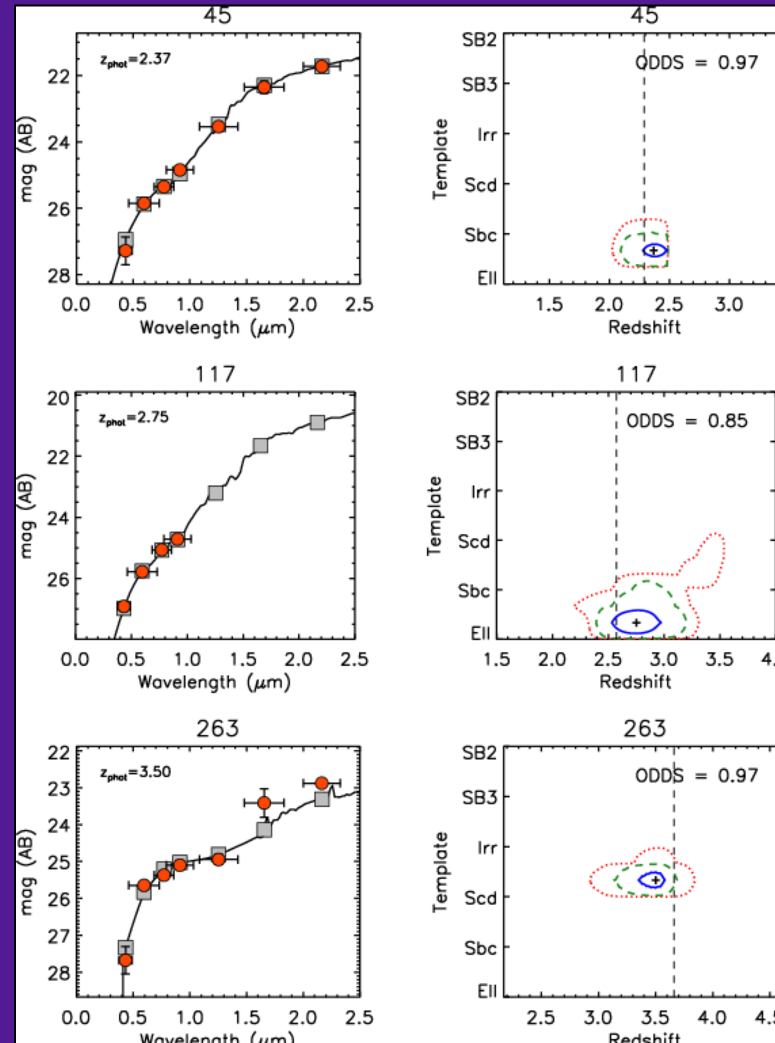
- spectral type of galaxy
- redshift
- reddening due to dust

Since galaxies have a narrow range of spectral types, we can jointly fit for type and redshift.

- the more bands the better!
- photo-z's have accuracy of $\sigma_z \sim 0.1$
- allow us to exploit deep imaging surveys.

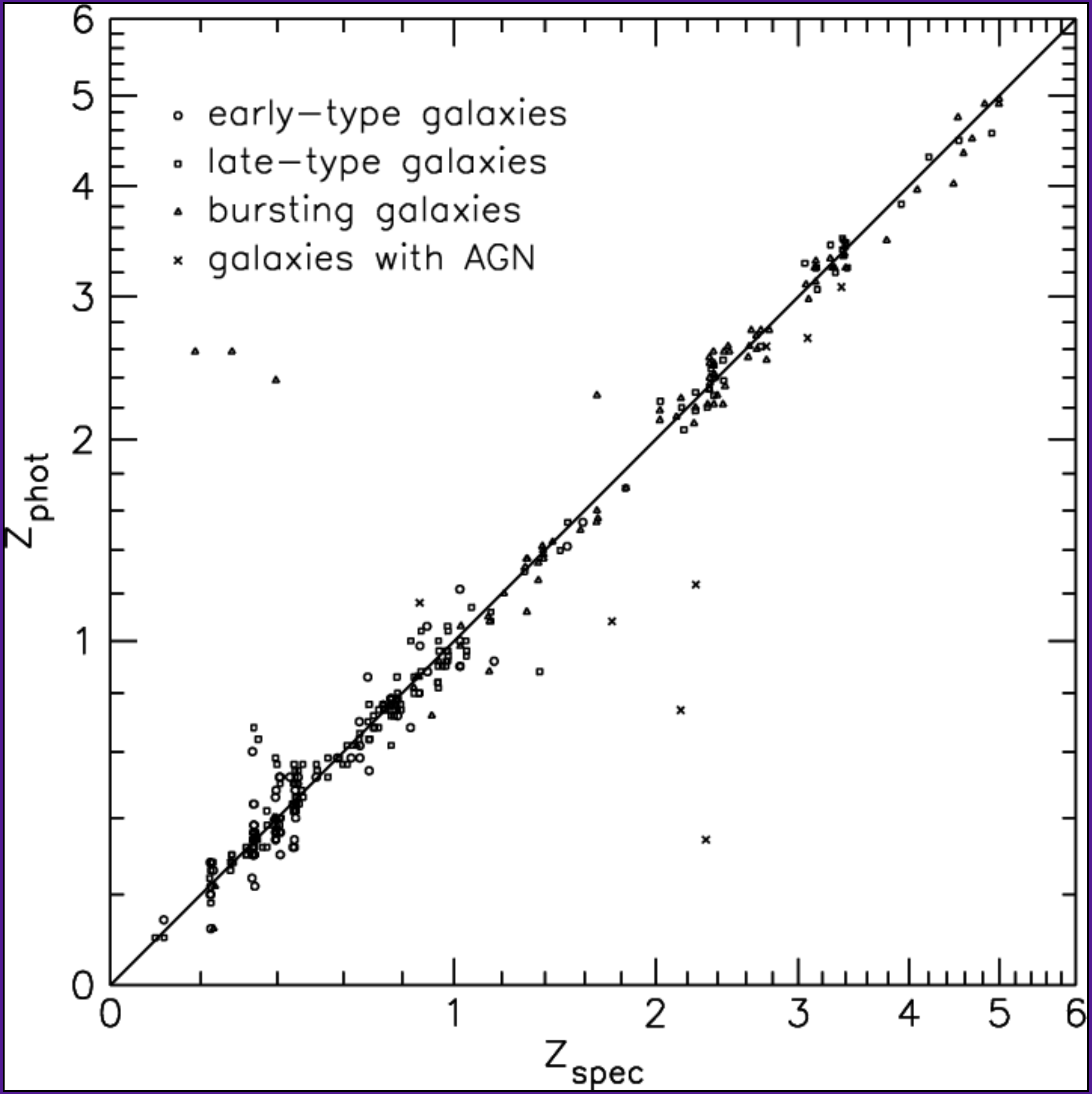
Photometric Redshifts





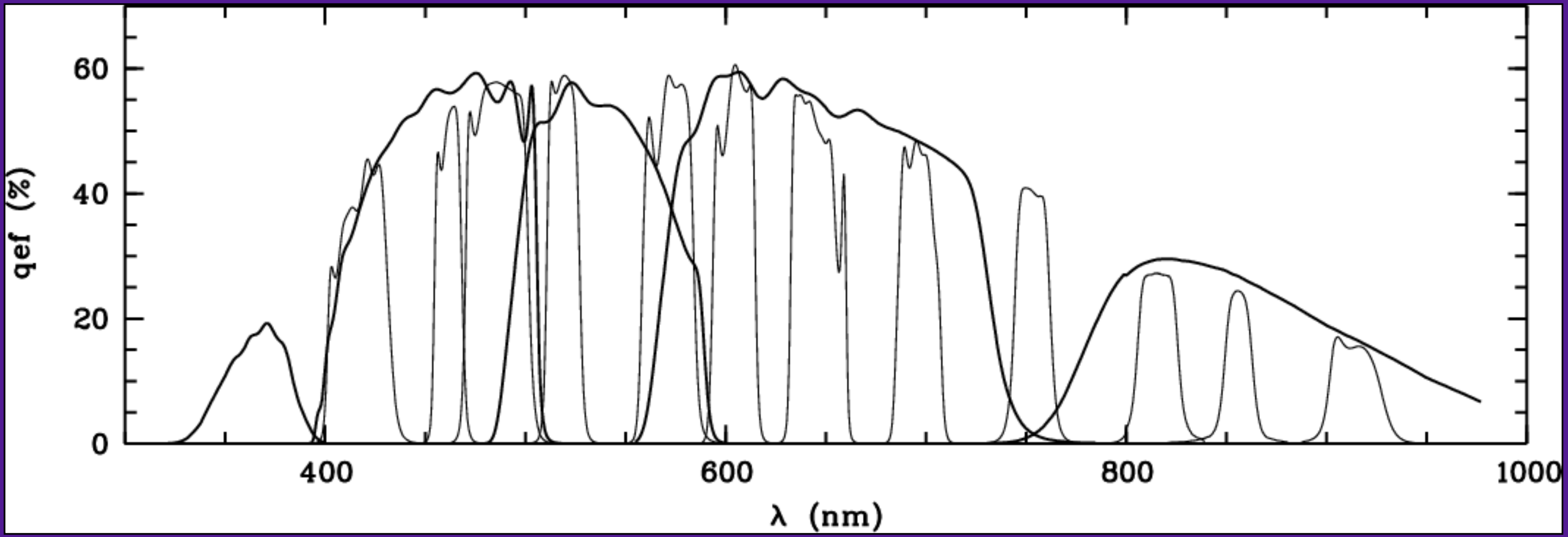
GOODS, Mainieri et al. (2005)

Photometric Redshifts



FORS Deep Field, Gabasch et al. (2004)

COMBO-17 Survey:
- 1 square degree
- 25,000 galaxies
- $\Delta z/z \sim 0.02$



Wolf et al. (2003)