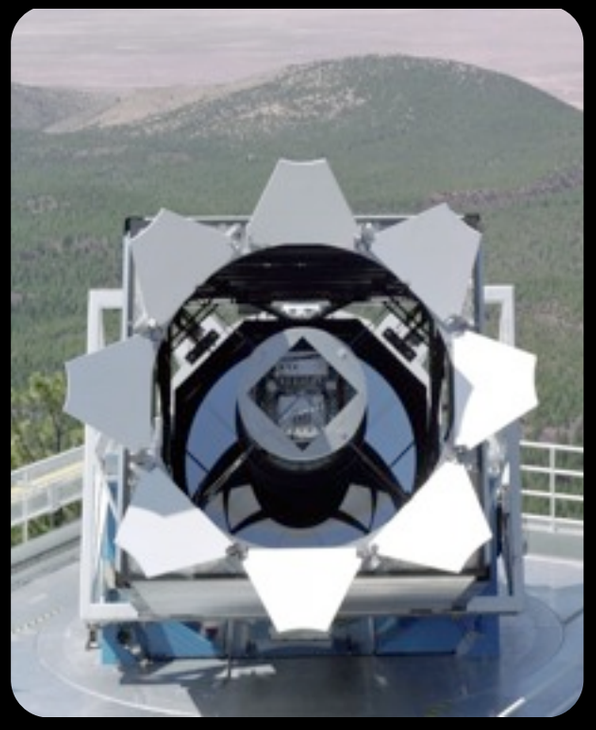
The Luminosity Function of Galaxies in SDSS Commissioning Data

Blanton et al. 2001, AJ, 121, 2358



Chelsea Sharon

Ph 689: 9/24/2009

"This quantitative characterization of the local galaxy population provides the basic data that a theory of galaxy formation must account for and an essential baseline for studies of galaxy evolution at higher redshifts."

-This Paper

Outline

- What is the SDSS (in brief)
- Terminology
- Nitty-gritty details
- Sample Characterization

The Sloan Digital Sky Survey

Deep, 5-color survey of nearly one quarter of the sky with comprehensive spectroscopic follow-up

This Paper (commissioning)	Goals	Data Release 7 (June 2009)
11,275 galaxies	1,000,000 galaxies (100,000 QSO's)	929,550 galaxies (121,363 QSO's)
230 deg^2	10,313 deg^2 (π steradians)	9,380 deg^2
r^*=17.6	r'=23	r'=22.2

Terminology

- Filters
  - *u**, *g**, *r**, *i**, and *z**
- On Measuring Magnitudes
  - Surface Brightness, Luminosity, and the Petrosian Magnitude
- Luminosity Function
  - Schechter Function

Filters

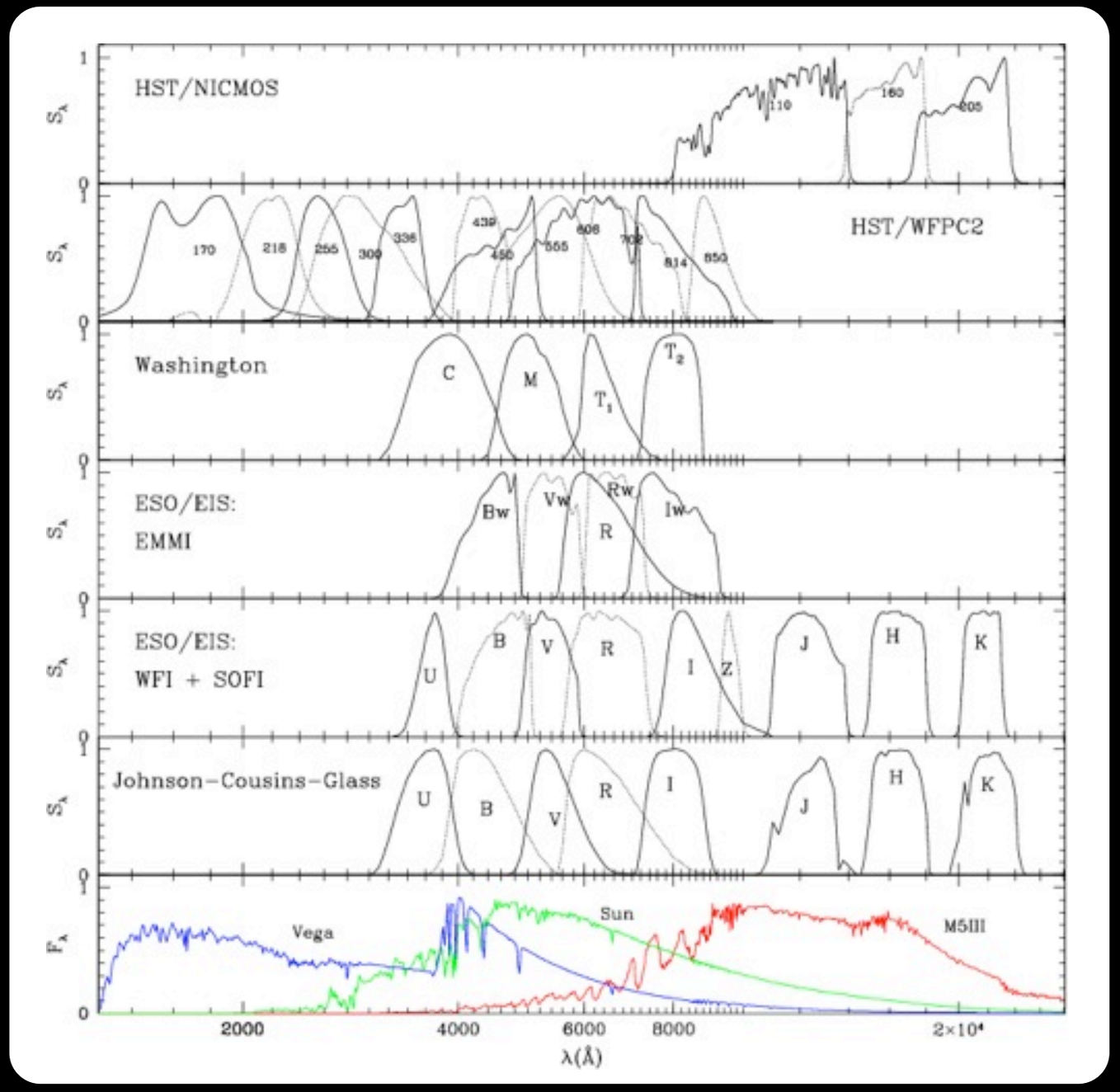


Fig. 1: Girardi et al. 2002
Fig. 2: Bartlemann et al. 2002

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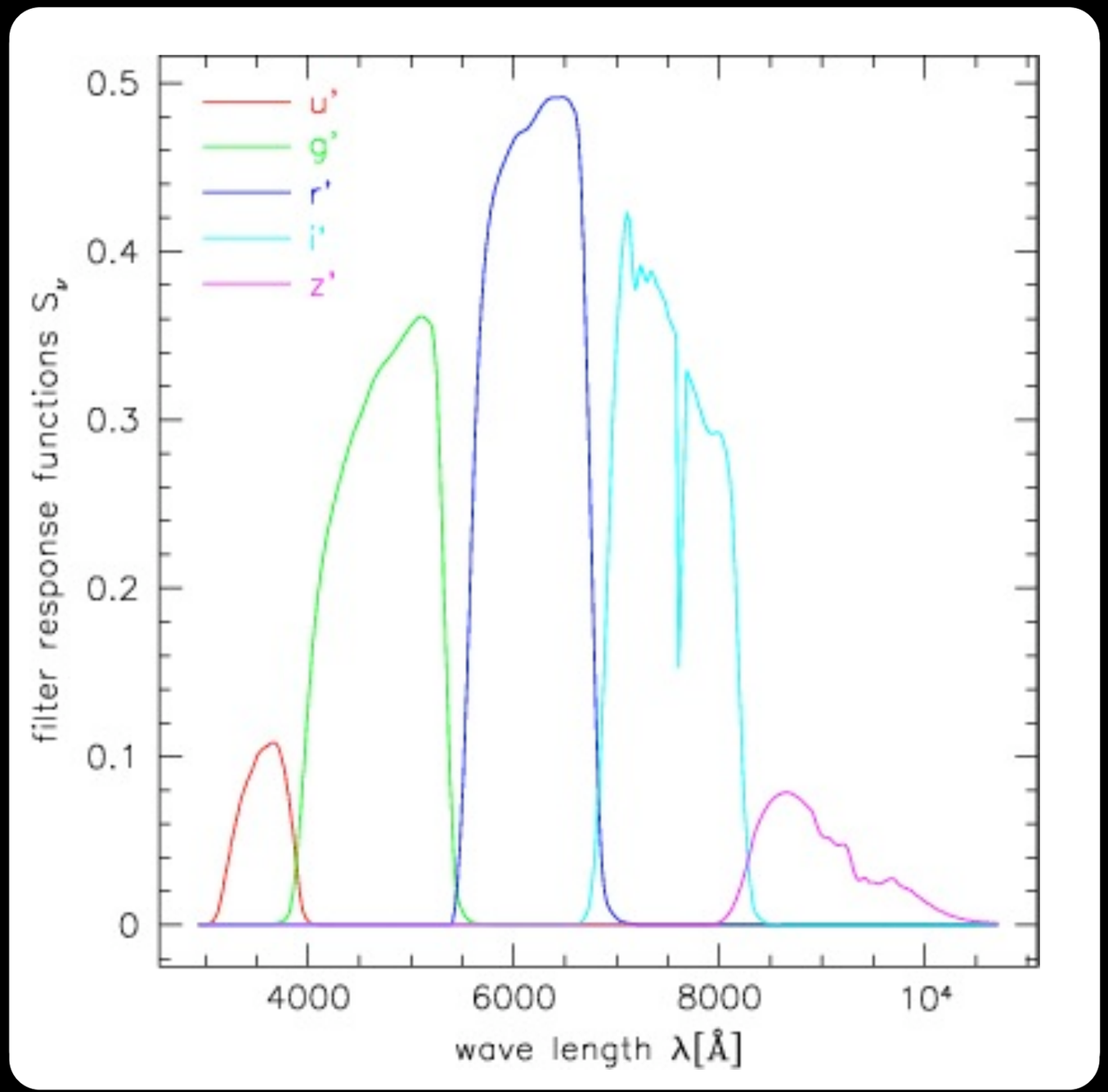

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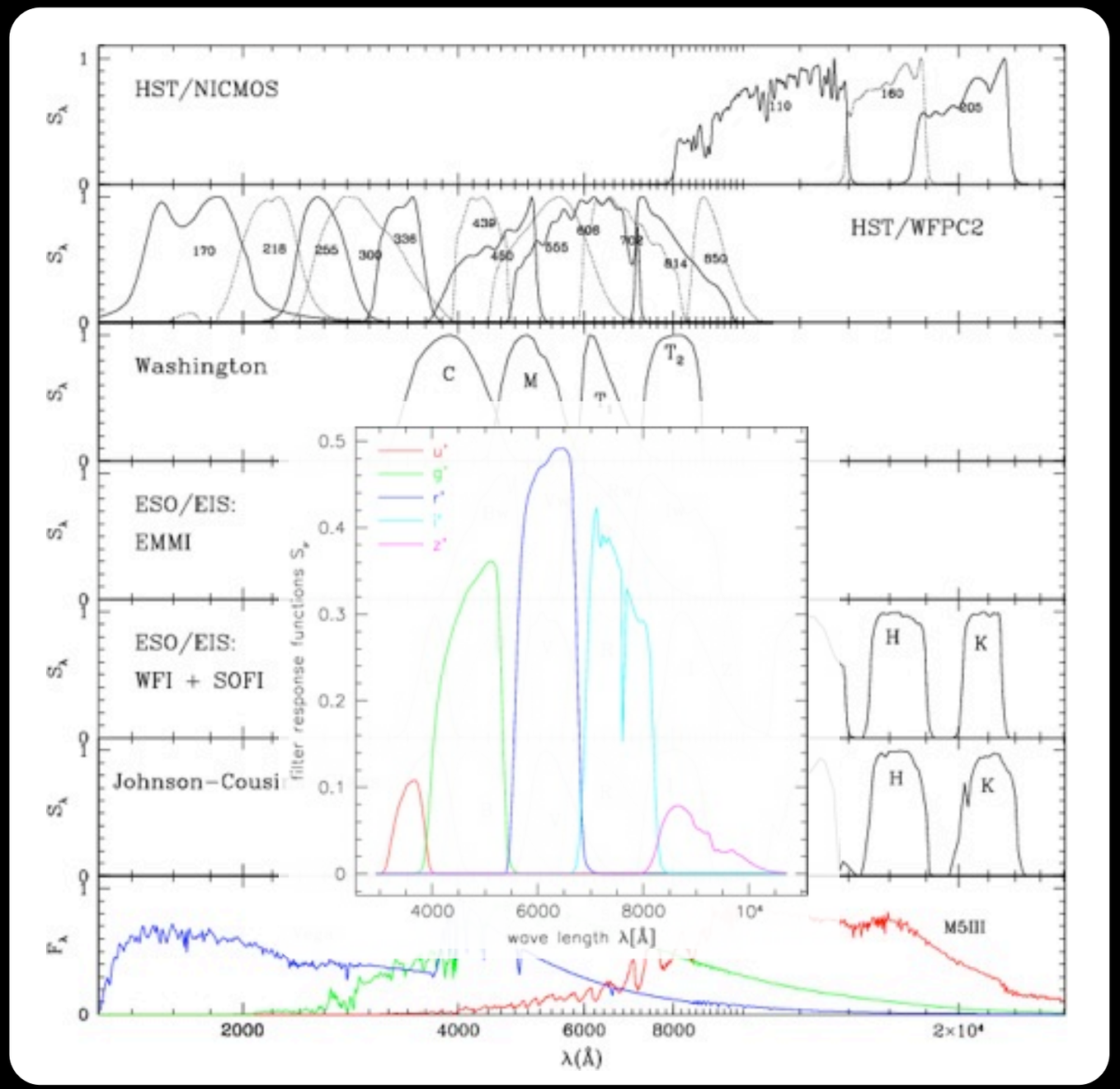

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Measuring Galaxy Luminosity

- Since galaxies are resolved, can measure surface brightness
- Surface brightness, μ, is the radiative flux per unit solid angle on an image

Centrally Concentrated
Ambiguous edges
deVaucouleurs profile:

$$I(R) = I_{\rm e} \exp\left\{-7.67\left[\left(\frac{R}{R_{\rm e}}\right)^{1/4} - 1\right]\right\}$$

More even brightness
Hard edges
Exponential profile:

$$I(R) = I_{\rm d} \exp(-R/R_{\rm d})$$

How to measure total luminosity?

1) Uniform Aperture 2) Isophote 3) Petrosian radius

$$\mathscr{R}_{\rm P}(r) \equiv \frac{\int_{\alpha_{\rm lo} r}^{\alpha_{\rm hi} r} dr' 2\pi r' I(r') / [\pi(\alpha_{\rm hi}^2 - \alpha_{\rm lo}^2) r^2]}{\int_0^r dr' 2\pi r' I(r') / (\pi r^2)}$$

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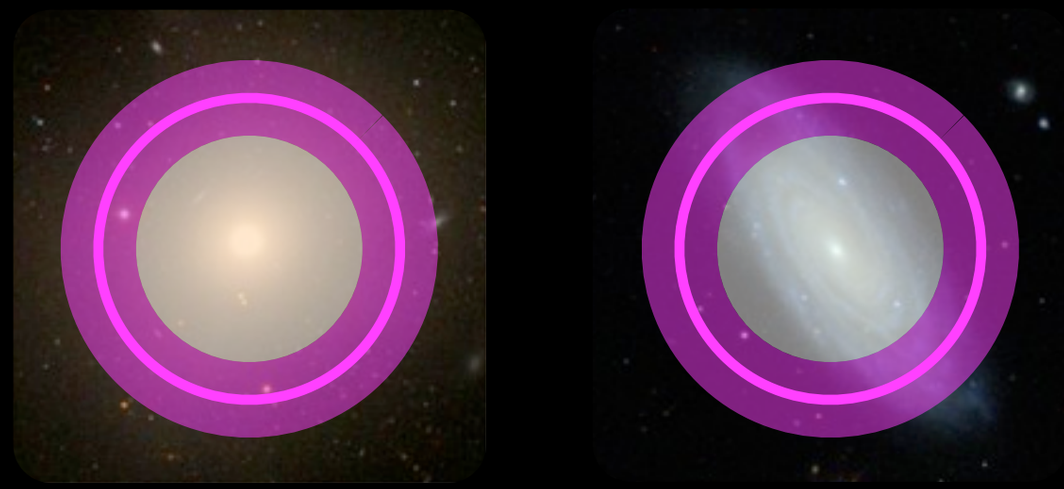

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The Luminosity Function

- The distribution of the luminosity of galaxies
- Normally expressed as Φ(L)
- Has some normalization

The paper uses: $\hat{\Phi}(M) = 0.4 \ln(10) \bar{n} L \Phi(L)$

For field galaxies, this distribution is fit by the Schechter function:

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

or

$$\hat{\Phi}(M) = 0.4 \ln(10) \phi_* 10^{-0.4(M-M_*)(\alpha+1)} \exp[-10^{-0.4(M-M_*)}]$$

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- The distribution of the luminosity of galaxies
- Normally expressed as Φ(L)
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The paper uses: $\hat{\Phi}(M) = 0.4 \ln(10) \bar{n} L \Phi(L)$

slope at faint end

For field galaxies, this distribution is fit by the Schechter function:

over-all density normalization

luminosity above which # of galaxies falls sharply

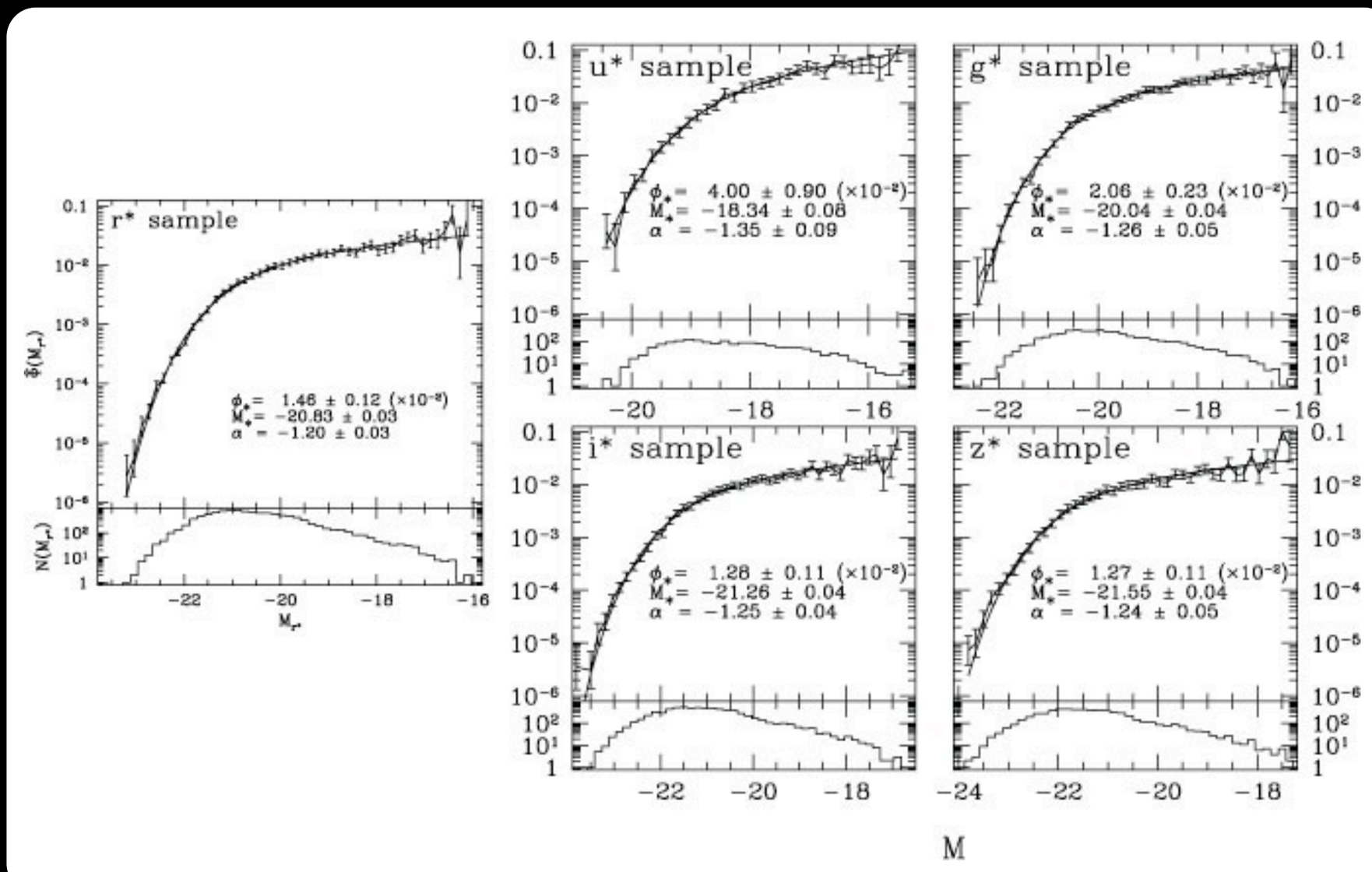
$$\hat{\Phi}(L) = \phi_* \left(\frac{L}{L_*}\right)^{\alpha} \exp(-L/L_*)$$

or

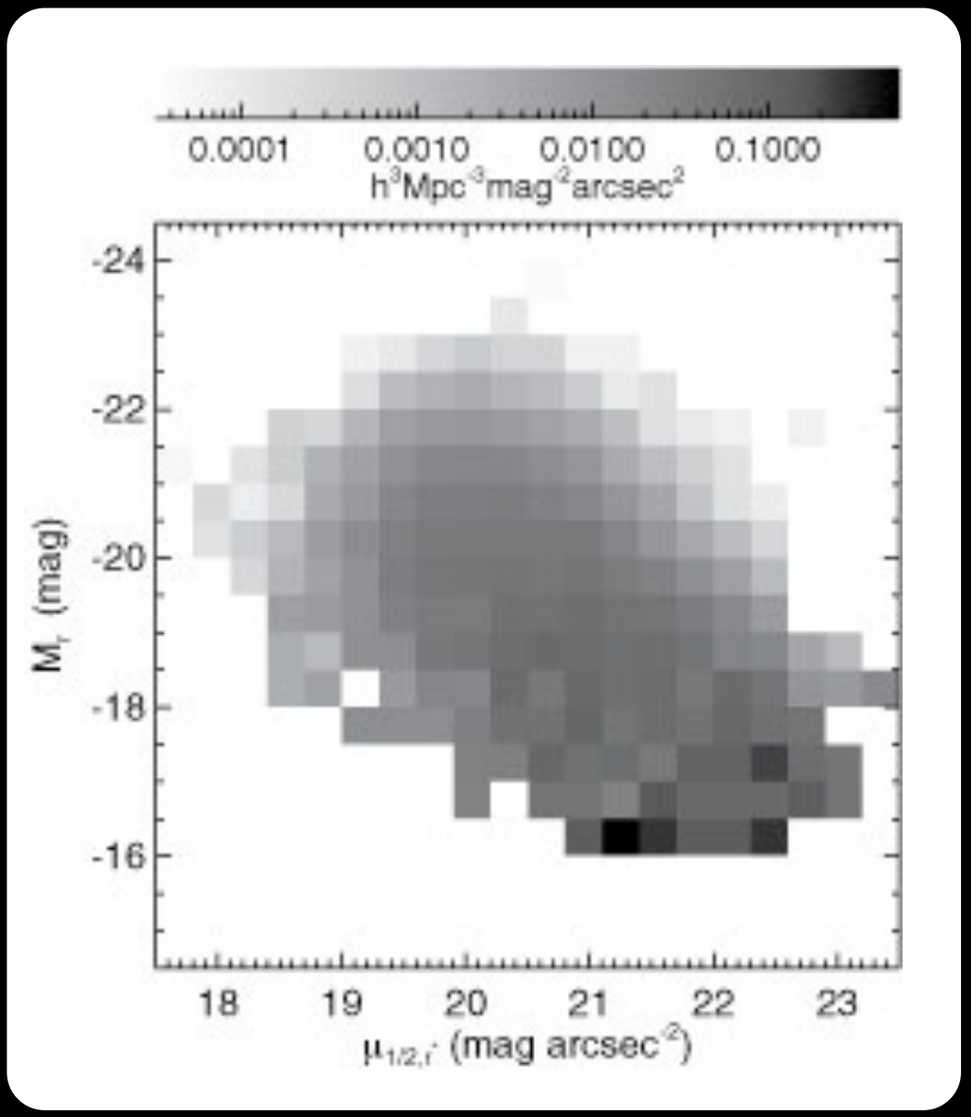
$$\hat{\Phi}(M) = 0.4 \ln(10) \phi_* 10^{-0.4(M-M_*)(\alpha+1)} \exp[-10^{-0.4(M-M_*)}]$$

Results!

The Luminosity Function



Luminosity & Surface Brightness Correlation



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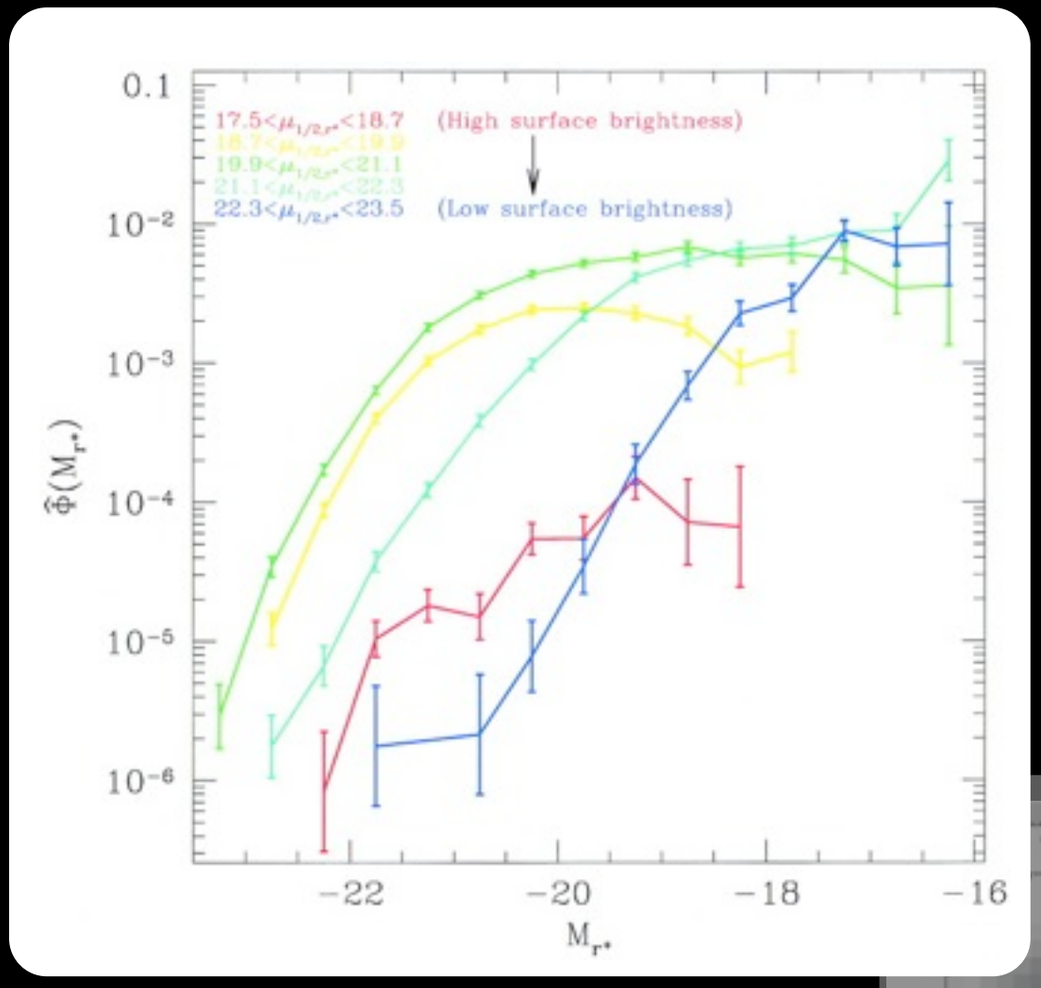
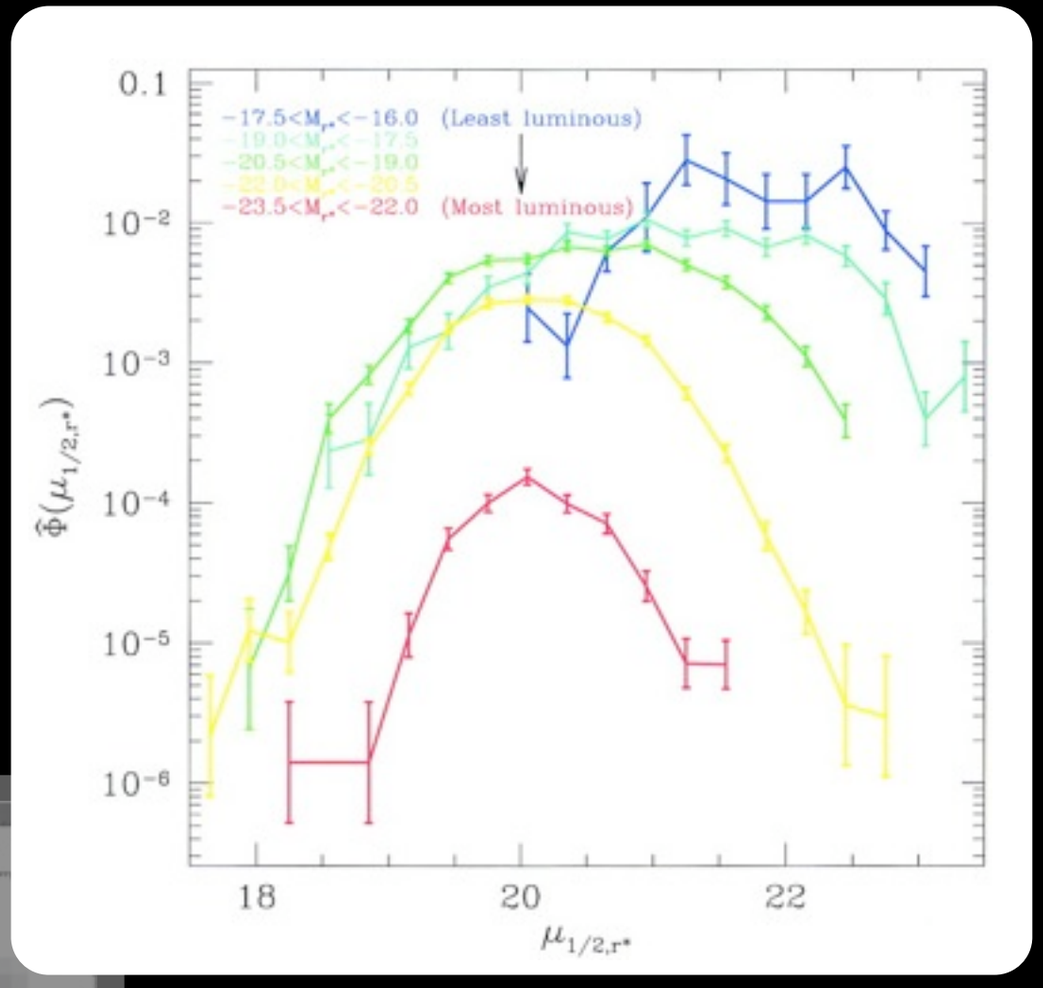
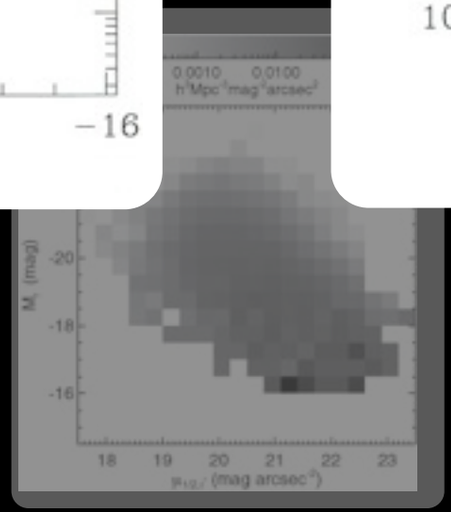
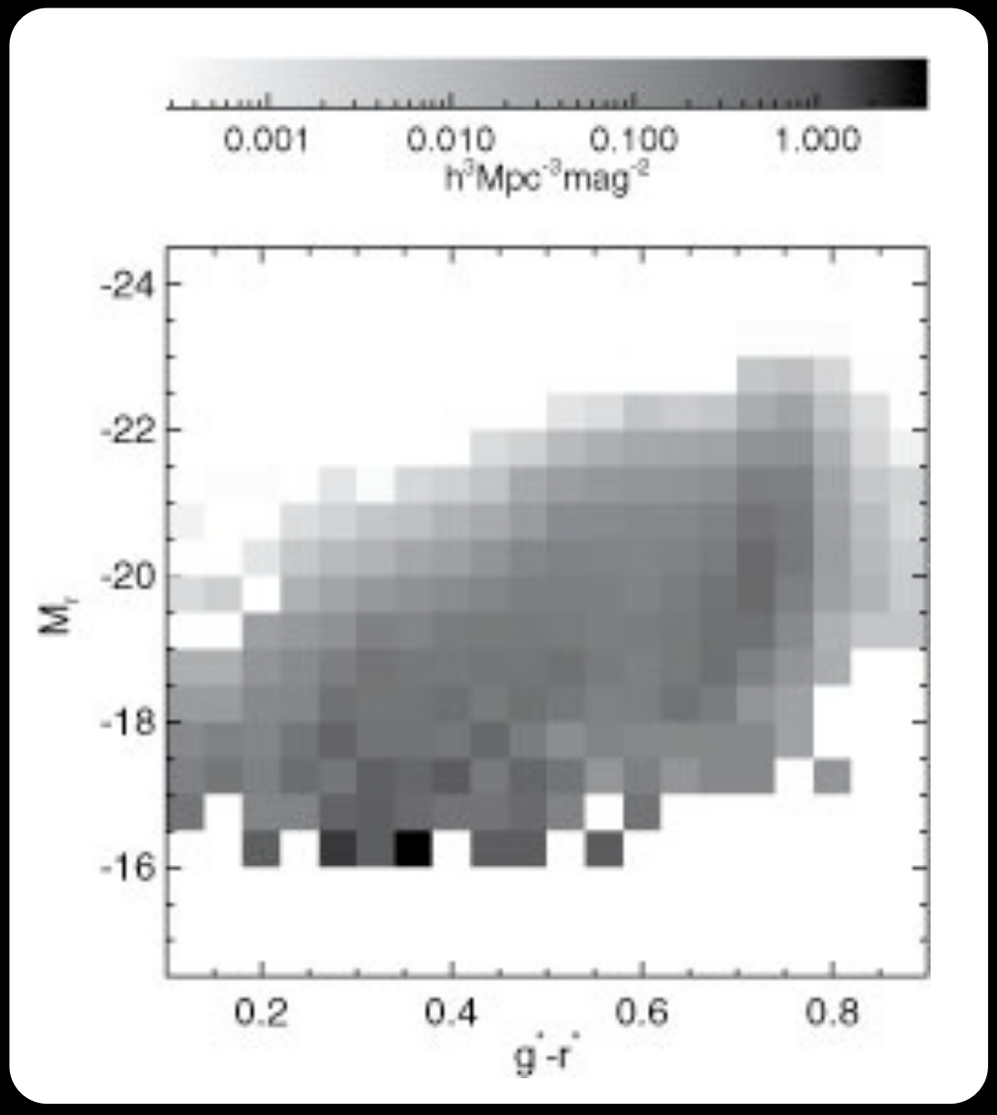






Dependence of Luminosity on Color



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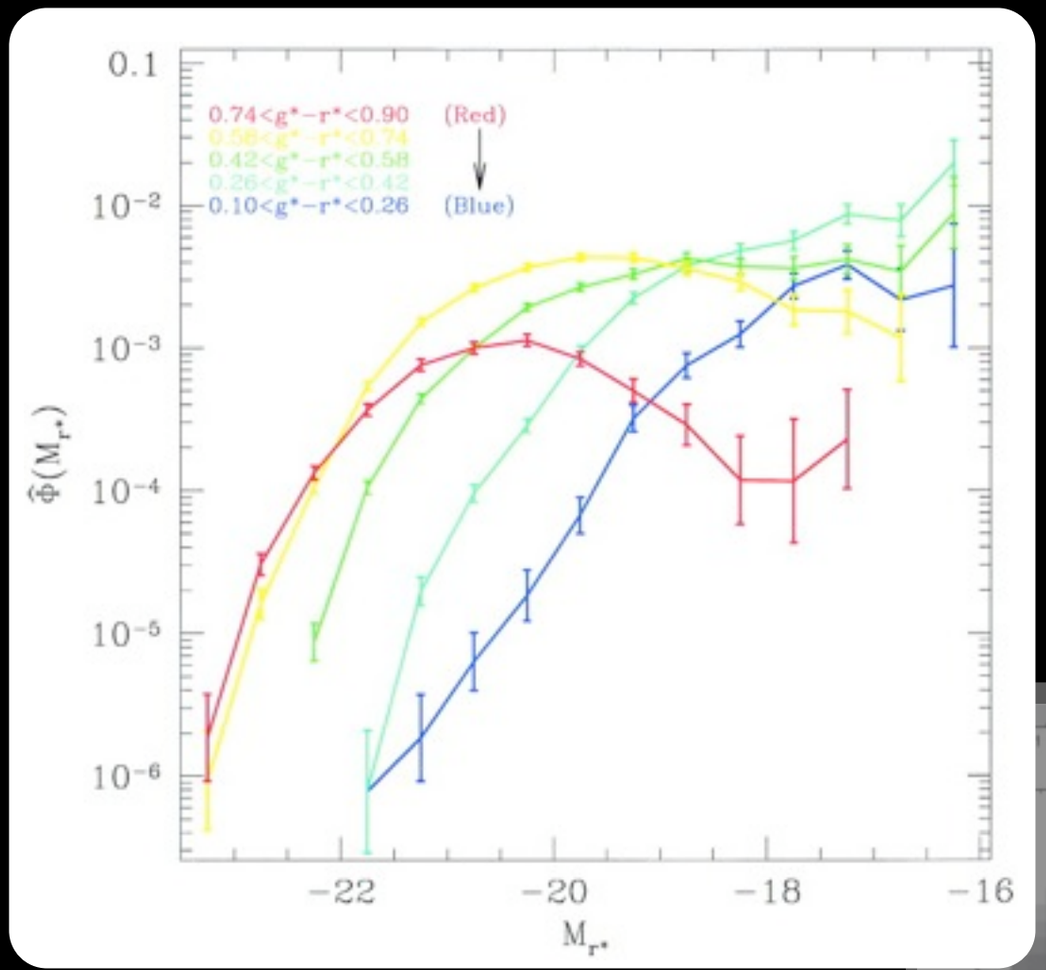
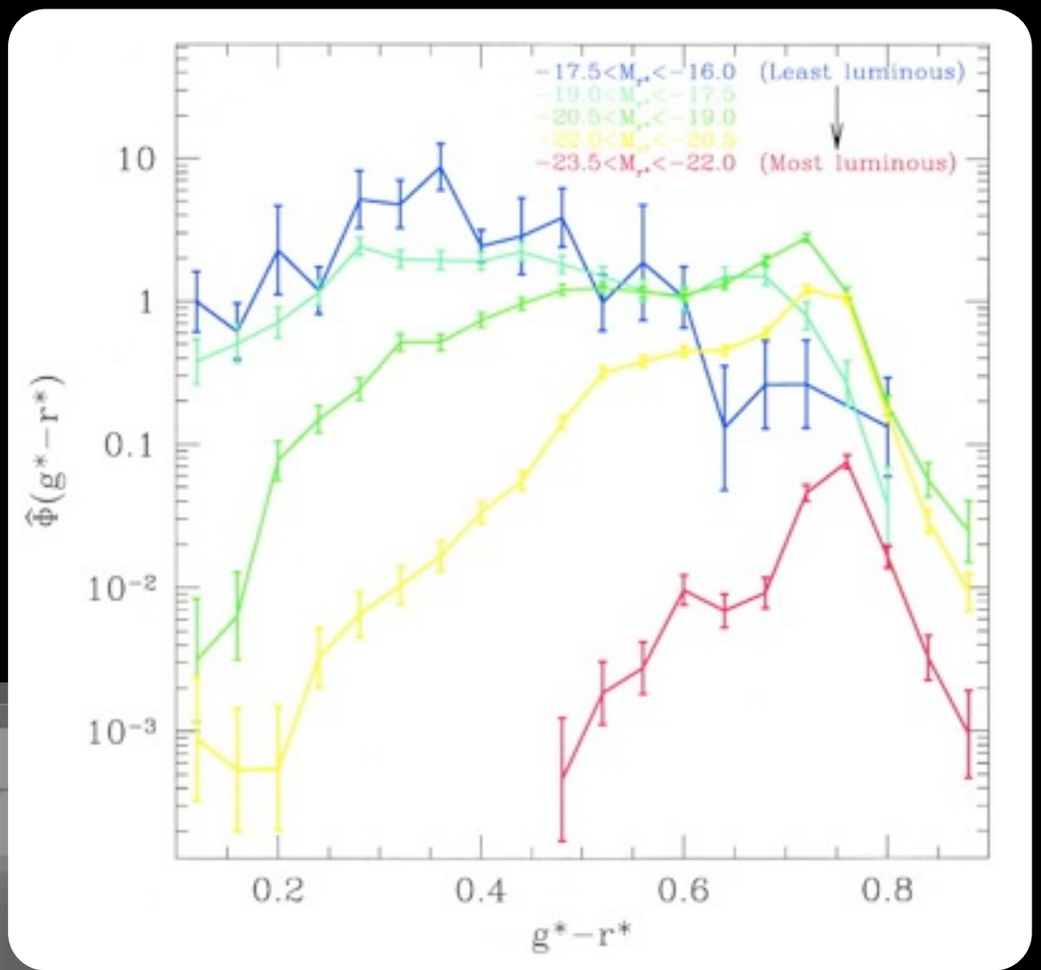
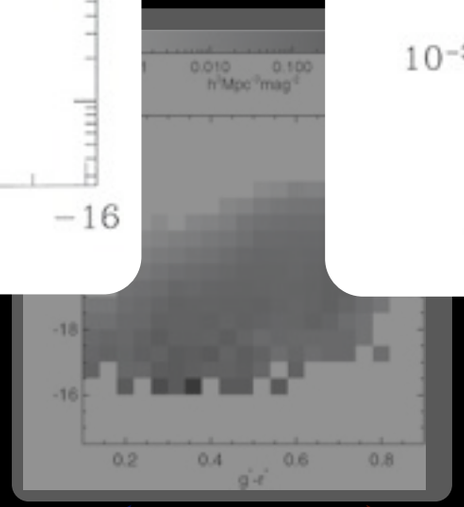
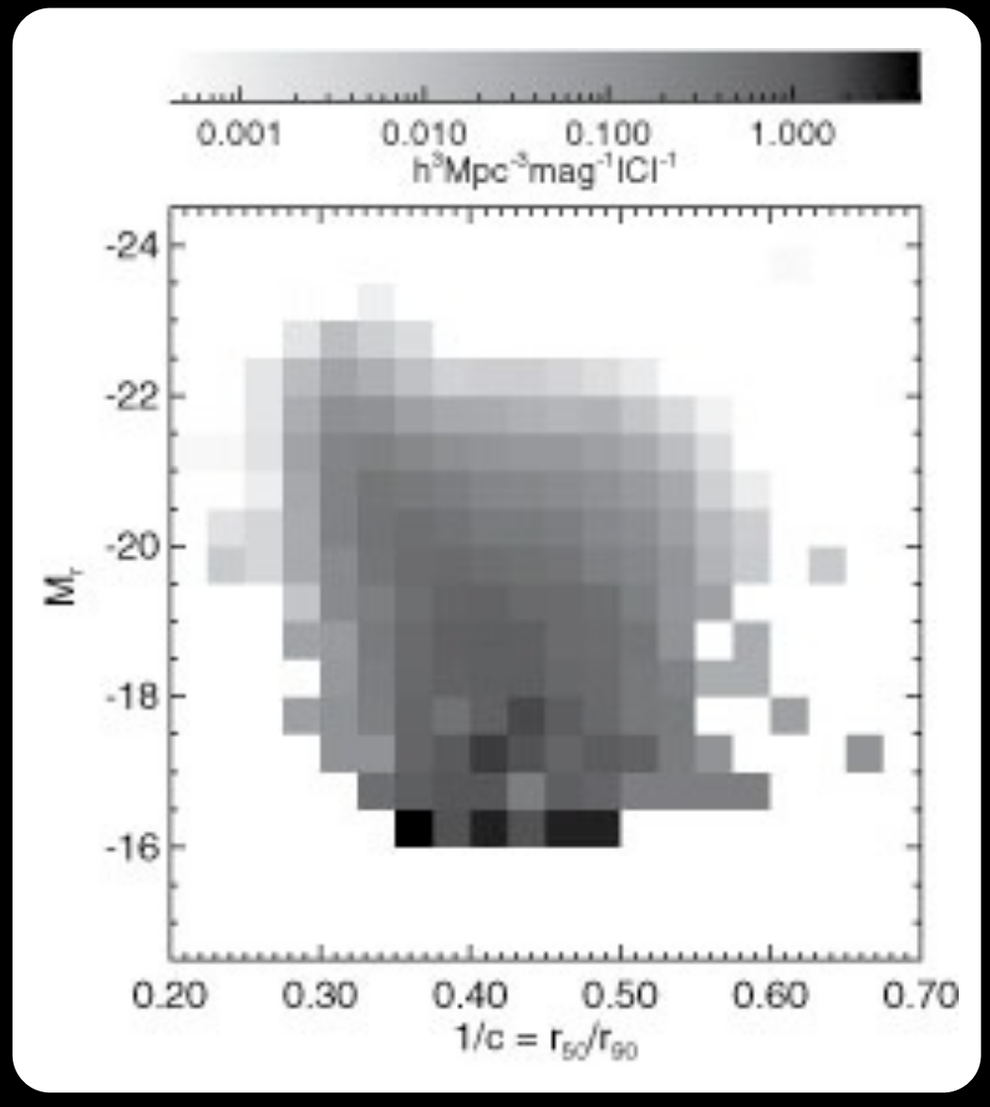




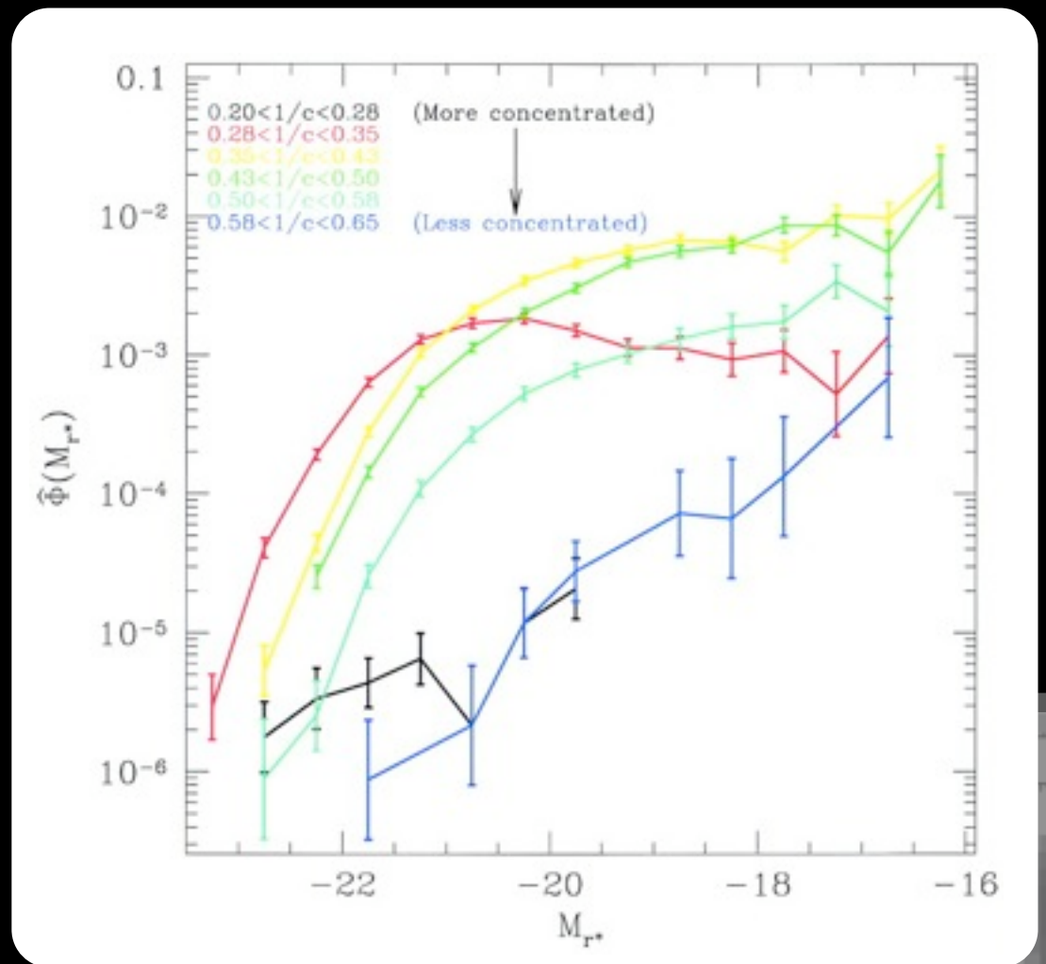


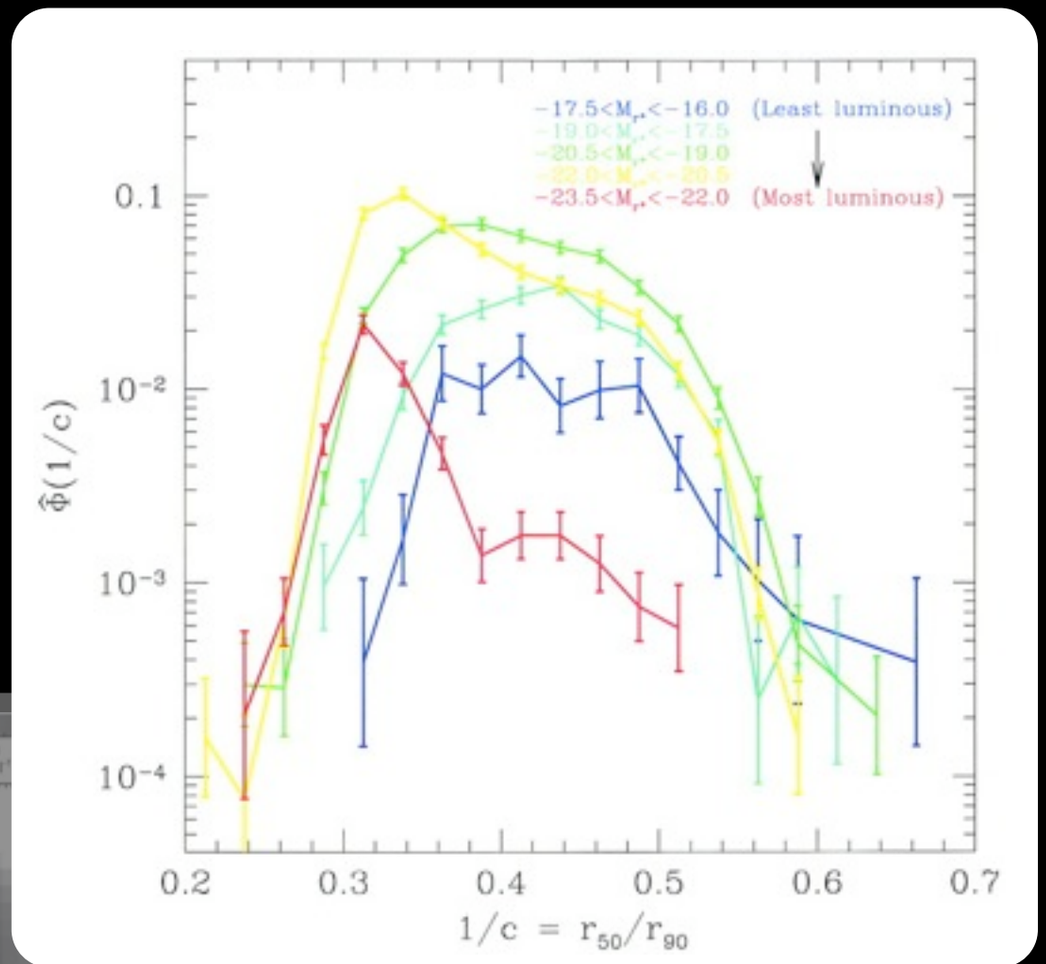
Dependence of Luminosity on Morphology

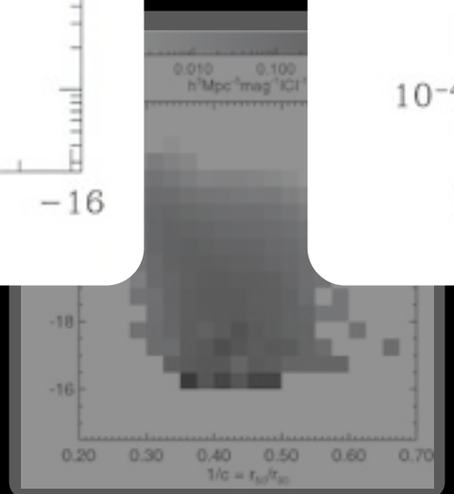


Concentration

Dependence of Luminosity on Morphology







Concentration

Conclusions

- The limited sample of early SDSS galaxies are already a useful data set, characterizing galaxy relationships such as:
  - Surface brightness and luminosity correlation
  - Dependence of luminosity on color
  - Dependence of luminosity on morphology
- SDSS has found significantly more luminosity density than prior surveys due to improved measurement techniques