Concentration of luminosity

Of Blanton's 4 quantities (luminosity, color, size, conc), this is the most directly related to dE/Sc morphology.

Sersic index provides a general measure:

\[ n = 1 \] low conc, exponential disk
\[ n = 4 \] high conc, \( R^{1/4} \) law

Special cases

Note that galaxies have a large range in:

- low concentration
- color

Red galaxies can have both high & low concentration
Fig. 1.— Distribution of broad-band galaxy properties in the SDSS. The diagonal panels show the distribution of four properties independently: absolute magnitude $M_r$, $g-r$ color, Sérsic index $n$, and half-light radius $r_{50}$. A bimodal distribution in $g-r$ is apparent. The off-diagonal panels show the bivariate distribution of each pair of properties, revealing the complex relationships among them. The greyscale and contours reflect the number of galaxies in each bin (darker means larger number).
Parameters from spectra

Dn (4000) or 4000 Å break gives a measure of age

Using stellar spectra, explain why

Stellar mass measured by fitting stellar population models (realistic combinations of stellar spectra) to spectrum to derive M/L plus galaxy luminosity

The age-stellar mass diagram resembles the luminosity-color diagram ... red and blue sequences

Strong correlation between metallicity of gas & galaxy mass

Why?
Fig. 2.— Distribution of spectroscopic galaxy properties in the SDSS (data courtesy Brinchmann et al. 2004; Tremonti et al. 2004). Greyscale and contours are similar to those in Figure 1. Upper left panel shows the distribution of stellar mass and $D_n(4000)$, a measure of the stellar population age. As in the color-magnitude diagram, the separation between old and young populations is apparent. Upper right panel shows for red galaxies the distribution of stellar mass and velocity dispersion, revealing the Faber-Jackson relation. Bottom left panel shows for star-forming galaxies the relationship between mass and gas-phase oxygen abundance, the “mass-metallicity” relation. Bottom right panel shows the Baldwin, Phillips & Terlevich (1981) relationship for emission-line galaxies. Shown are the divisions (based on Kauffmann et al. 2003a) among star-forming, Seyfert, and LINER galaxies.
THE GALAXY LUMINOSITY FUNCTION


Benson et al. AJ 110, 1507 (1995)


Let $\phi(L)$ be the number of galaxies per unit volume in the luminosity interval between $L$ and $L+dL$.

$$\phi(L) \propto L^{-\frac{3}{2}} e^{-L/L_*}$$  (Schechter)

*Note that some authors use luminosity function $\phi$ to describe the probability distribution for of galaxies, not the number density.*

Absolute magnitude $M_*$ corresponds to $L_*$

of order $M_* = M_{B_1} = -21$

$\alpha \approx -1.2$
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.
Figure 1  The LF of field galaxies (top) and Virgo cluster members (bottom). The zero point of log ϕ(M) is arbitrary. The LFs for individual galaxy types are shown. Extrapolations are marked by dashed lines. In addition to the LF of all spirals, the LFs of the subtypes Sa + Sb, Sc, and Sd + Sm are also shown as dotted curves. The LF of Irr galaxies comprises the Im and BCD galaxies; in the case of the Virgo cluster, the BCDs are also shown separately. The classes dS0 and “dE or Im” are not illustrated. They are, however, included in the total LF over all types (heavy line).
Problem

How would you go about measuring a galaxy LF, in a cluster & in the field?

Q
What would be possible biases in the field? In clusters?

Q
What effect might large-scale structure have on your results?
Luminosity function

Blanton et al. (2005) (SDSS data)

1. raw, $\mu_{50,r} < 24$
   $\alpha = -1.34 \pm 0.01$

2. corrected, $\mu_{50,r} < 24$
   $\alpha = -1.40 \pm 0.01$

3. "total"
   $\alpha = -1.52 \pm 0.01$

blue

red

low concentration

high concentration

low s.b.

high s.b.