Tutorial II Large Scale Structure

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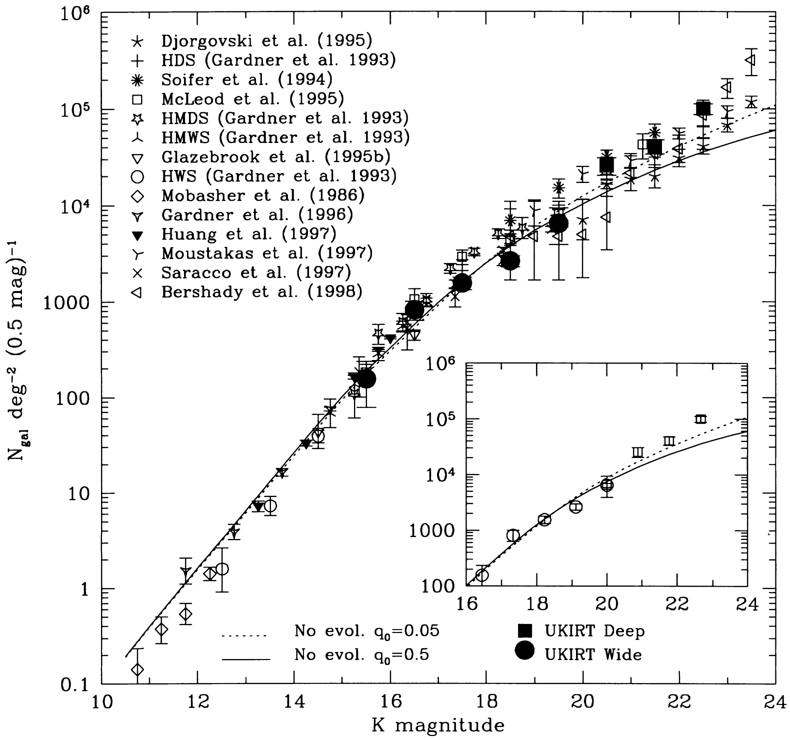
EXCERSIZE I, Observational Cosmology, Number Counts

Suppose you are counting galaxies up to a certain limiting apparent magnitude (i.e. flux limited) all over the sky. Assume that the galaxies are distributed homogeneously throughout space and that $n(L)$ is the galaxy luminosity distribution.



1. Give an expression for $N(S' > S|L)$, the number of L luminous galaxies with flux brighter than S. (Assume that galaxies are close)

2. Using

$$m = -2.5log_{10}S + const \quad (1)$$

$$\int n(L)dL = A \quad (2)$$

these relationships, show that $\frac{dlogN(m)}{dm} \propto 0.6m$.

3. As can be seen from the figure, this slope breaks downward for high magnitudes. Give at least two possible explanations for this fact.

EXCERSIZE II, Observational Cosmology, SuperNovae Ia

The (bolometric) flux, S, of a source is defined as:

$$S \equiv (dE/dt)/dA \tag{3}$$

As used above, the regular isotropic expression for the flux is:

$$S = \frac{L}{\mathrm{AreaofSphere}} \tag{4}$$

However for far away objects in in FRW cosmology this relationship does not hold. We now consider a standard candle with Luminosity L at a redshift z. (the present proper distance $d_p(t_0)$ equals r the comoving distance).

1. Show how an infitesimal dE transforms in a FRW cosmology, i.e. give a relationship between the observed energy and the emitted one.

2. Do the same for dt

$$ds^2 = -c^2dt^2 + a(t)^2[dr^2 + S_k(r)^2 d\Omega^2] \tag{5}$$

3. Using the metric, show that the Proper Area is given by: $A_p = 4\pi S_k(r)^2$

4. Give the cosmological flux equation.

5. For nearly flat universes and small redshifts ($z \ll 1$), the following relationship holds:

$$d_L \equiv S_k(r)^2(1+z) = \frac{c}{H_0} z \left(1 + \frac{1-q_0}{2} z\right) \tag{6}$$

   Explain how an observer who measures apparent magnitude and redshift can try to infer the Hubble constant H_0, and the deceleration parameter, q_0.