Astronomy 830, Autumn 2004, Problem Set 4

Due Friday, Nov 1 in class

Problem 1: The Data Scavenger Hunt, Part II: Galaxies

This problem is designed to acquaint you with how to look up basic information on galaxies. You can ask me for hints on where to look, but otherwise please work on your own. For every answer please state where you got the data. And, well, let's just cut to the chase, shall we. Some of you have already discovered NED, the NASA/IPAC Extragalactic Database (http://nedwww.ipac.caltech.edu). NED is awesome and getting better all the time. In fact, it makes this exercise hardly sporting any more. As such, while most of the answers will be in NED, not all of them are there (despite how much it *does* have) though it may provide valuable clues Where given (or appropriate), quote the measured uncertainties of any quantities you are asked to find (if none are given, please say so).

a) Find RA and DEC coordinates (equinox J2000.0), accurate to ~1", of Markarian 573?

b) What kind of object is VV 234? What does VV stand for?

c) Find a recent Hα rotation curve of NGC 4303?

d) What is the Zwicky photographic magnitude of NGC 5739?

e) What is the *cluster* redshift of the galaxy cluster Abell 1367?

f) Find a distance for NGC 4414 that was *not* derived from its redshift.

g) Gather spectrophotometric data for Messier 106 over all wavelengths and plot a spectral energy distribution for this galaxy.

h) Find an image of the Cetus dwarf galaxy (a member of the Local Group). Make a hardcopy, indicating scale and orientation on the sky.

i) What is the Galactic dust extinction in the V and K bands towards the Circinus Galaxy? Are there any issues with these estimates one should be aware of before using them?

j) Find a spectrum of a Z>5 quasar that was *not* discovered by the Sloan Digital Sky Survey.

Problem 2:

On the class webpage under Problem Set 4, you will find the ASCII text file "lgirwin.txt" which contains a table of the 41 currently recognized members of the Local Group compiled by Mike Irwin at Cambridge University. The purpose of this exercise is to derive the luminosity function for the Local Group and compare it with the Schechter luminosity function fit to nearby field galaxies by Efstathiou, Ellis, and Peterson (1998, henceforth EEP). To facilitate this comparison (and keep you from getting bogged down computing numerical solutions of incomplete gamma functions for a case not covered by *Numerical Recipes*) I have used the best-fit parameters of EEP to compute the total number of galaxies brighter than a

given luminosity, N(>L), and the fraction of the total luminosity contributed by all galaxies brighter than a given luminosity, f(>L), as a function of L/L^*. This table is available on the webpage via the link to eepflfv.txt. This table uses a faint-end power law slope of $\alpha = -1.07$ following EEP. Note also that their best-fit value of L^* corresponds to $M_V^* \approx -21.35$.

a) Gather the M_V data for the Local Group into 1^{mag} bins centered on whole-number magnitudes (e.g., -21 ± 0.5^{mag}, -20 ± 0.5^{mag}, etc.) and plot the luminosity function $\log \phi(M_V)$ vs. M_V (ignoring the volume in Mpc^3, it comes out in the normalization). Rather than using a histogram-style "step" plot, plot your data as points, using x-axis error bars to indicate the bin width (a common practice). Estimate the uncertainty in $\log \phi(M_V)$ as $0.4343/N^{1/2}$ where N is the number of galaxies in each bin (i.e., assuming simple counting error – an approximation sufficient for our purposes).

b) Using the values of M_V^* and α for the EEP field-galaxy luminosity function, compute and plot the expected $\log\phi(M_V)$ using the formula given in the book (Eqn 4.2). You will need to estimate by-eye the normalization factor ϕ^* that best matches the observed number of galaxies in the Local Group (i.e., you cannot use EEP's value of ϕ^* as quoted in the book).

c) What is the result if instead you adopt a faint-end slope of $\alpha = -1.27$ like that found by Sandage et al. (1986) for the Virgo Cluster but keeping M_V^* the same? Is this a better or worse representation of the data (note this not a formal fit, just a by-eye estimation)?

d) The small number of Local Group galaxies (41) makes the binned luminosity function look very noisy. An alternative method of plotting the luminosity function that does not require binning is to plot the cumulative number of galaxies, $\log N(<M_V)$, as a function of M_V. Using the data in eepflfv.txt, normalize the EEP cumulative galaxy counts N(>L) and plot the predicted $\log N(<M_V)$ through the data.

e) Based on your results, how do the luminosity functions of the field and the Local Group compare?