ASTRO 358: HOMEWORK 1

Assigned on Th Feb 14, 2012. Due at start of class on Tu Feb 21, 2012

Instructions: In order to get full credit, you must show the method that you used to derive the answer. The number of points for each question is indicated in brackets, and the total score is 100 points.

1. Show that for a Schechter luminosity function, as α tends to -1.0, the total number of galaxies per unit volume is infinite. (Hint: You may wish to consult some of the Handbooks/References for Mathematical Functions, listed on the class website). [**10 pts**]

2. Show that for a Schechter luminosity function with α = -1.0, the total luminosity per unit volume is finite . Express your answer in terms of Φ^* L^*. [**15 pts**]

3. Show that for a Schechter luminosity function with α = -1.5, a magnitude-limited survey will detect a sample of galaxies with the following demographics: only $\sim$ 5% of galaxies will have $L < 0.05L^*$, $\sim$ 50% of galaxies will have $L > 0.7L^*$, and only $\sim$ 5% of galaxies will have $L > 3L^*$. This exercise shows that *a magnitude-limited survey is essentially dominated by galaxies with* $L \sim L^*$. [**25 pts**]

4. You are provided with the following list of 5 galaxies: NGC 720, NGC 4772, NGC 5248, SMC, and M32. In this exercise, you will investigate the properties of these galaxies using the NASA Extragalactic Database (NED) web link, which is posted under the section "Extra Class Resources' on the course website (*http://www.as.utexas.edu/~sj/a358-sp12/*).

First view images of each galaxy as follows: Use the "By Name" link on the NED home page; enter the object name and submit the query. On the resulting page, scroll down to the section "INDEX for ...." and on the right hand side, click on the link "Images". This link will show you images at different wavelengths. Notice how the morphology of the galaxy changes from optical (e.g., B and R band images from 4360 to 6400 Å) to infrared (e.g., J, H, K images at 1.1, 1.65, and 2.2 μm) to radio (e.g., 20 cm or 21 cm maps).

For the 5 given galaxies, look up the properties listed below from the Third Reference Catalogue of Bright Galaxies (RC3; de Vaucouleurs et al. 1991) as follows: return to the section "INDEX for ...." and click on the link 'RC3 data' and you will see a set of RC3 data entries. The 'Help' button at the top of this page explains the data entries. Present your result as a table with the following columns (1) to (7). Note that your answer *must be in the units requested* to get credit.

(1) The galaxy name.

(2) The coded revised Hubble type from RC3. [**5x1=5 pts**]
(Example: For NGC 1300, this is ".SBT4")

(3) The revised Hubble type in standard format. [**5x3=15 pts**]
You can get this by decoding your answer in (2) using the conversion table in section 3.2 of the Second Reference Catalogue of Bright Galaxies (RC2, de Vaucouleurs G. et al. 1976). On the course website, under section "Extra Class Resources" I have posted a copy of this table, entitled "Orignal table from RC2", along with a simplified guideline on how to use it for converting the coded revised Hubble type in RC3 into standard format. (Example: For NGC 1300, ".SBT4" translates into SB(rs)bc)

(4) The major axis D_{25} in *arcminutes* from RC3. [**5x2=10 pts**]

D_{25} represents the diameter of the isophote where the galaxy surface brightness is 25 mag arcsec^{-2}. (Example: For NGC 1300, the value tabulated in RC3 is 1.79, which means that D_{25} is ($10^{1.79}\times 0.1$) or 6.1 arcminutes.)

(5) $(B\text{-}V)_{\rm T}$, the total B-V color index from RC3. **[5x1=5 pts]**
(Example: For NGC 1300, $(B\text{-}V)_{\rm T}$ is 0.68.)

(6) $V_{\rm GSR}$ in km s^{-1} from RC3. **[5x1=5 pts]**
This is the weighted mean of neutral hydrogen and optical velocities, reduced to the "Galactic standard of rest." (Example: For NGC 1300, $V_{\rm GSR}$ is 1496 km s^{-1}.)

(7) Distance D in Mpc, derived as below. **[5x2=10 pts]**
Derive D by applying Hubble's law and assuming that the recession speed is equal to the value in (6). For M32, why is this approach not valid? (Example: For NGC 1300, D is 21.4 Mpc.)

Values of physical constants

1 $M_\odot = 2 \times 10^{30}$ kg
Proton mass = 1.67×10^{-27} kg
Electron mass = 9.1×10^{-31} kg
1 parsec (pc) = 3×10^{16} m.
G = Gravitational constant = 6.7×10^{-11} N m^2 kg^{-2} = 4.5×10^{-3} (km s^{-1})^2 pc $M_\odot{}^{-1}$
Wien's constant $W = 2.9 \times 10^{-3}$ m K
c = Speed of light = 3×10^8 m s^{-1}
Planck's constant $h = 6.6 \times 10^{-34}$ J s;
Hubble's constant $H_0 = 75$ km s^{-1} Mpc^{-1}
σ = Stefan-Boltzmann constant = 5.7×10^{-8} J
$k_{\rm B}$ = Boltzmann constant = 1.38×10^{-23} J K^{-1}
1 Joule = 10^7 erg

END OF ASSIGNMENT