ASTR368
HW#4
February 9, 2024
Due February 16, 2024
2 points each part unless otherwise stated

1) a) Using Tables 25.1 and 25.2, and Appendix G, estimate the average spectral classification of main sequence stars in spiral galaxies of type Sa, Sb, Sc, Sd, and Im.

b) Compare the M/L ratios of these galaxy types to the M/L ratios of the typical stars derived above to say something about the relative amount of non-luminous matter (including dark matter+gas+dust).

2) I showed the Schechter luminosity function in class:

$$\phi(L)\,dL = \left(\frac{\phi^*}{L^*}\right)\left(\frac{L}{L^*}\right)^{\alpha} e^{-L/L^*} dL\,, \tag{1}$$

where the primes indicate typical values and α is a power law index at low luminosities. The units of ϕ are usually given in Mpc^{-3}, and this is the number density of galaxies that have luminosities between L and dL. Lets assume $\alpha = -1$, $\phi^* = 0.001\,\mathrm{Mpc}^{-3}$, and $L^* = L_{\mathrm{MW}}$, the luminosity of the Milky Way.

a) Derive an expression for the number density of galaxies that have luminosities greater than L. This may be an ugly final answer. That is ok.

b) Plug values into your answer for a) assuming $L = 0.5L_{\mathrm{MW}}$, L_{MW}, and $2L_{\mathrm{MW}}$. Based on your answers, what can you conclude about how the density of galaxies with a given L changes with L?

c) How would you compute the luminosity density of galaxies in $L\,\mathrm{Mpc}^{-3}$? Just write the integral, no need to solve it.

d) Derive the luminosity function in terms of absolute magnitudes $\phi(M)$ using

$$\phi(M)dM = \phi(L)d(-L)\,. \tag{2}$$

Show all work!