ASTRONOMY 8400 – SPRING 2024
Homework Set 3, Due 4/2/24 at 10:30 AM

1. Suppose that you had a face-on disk galaxy at a distance of 10 Mpc that contains only solar-type stars (and no dust), with a uniform luminosity per area of 1 $L\odot$ pc^{-2}.
a) What is the surface brightness of this galaxy in the B band (μ_B) in mag $arcsec^{-2}$?
b) If there was an identical face-on galaxy behind it at a distance of 50 Mpc, what would the combined surface brightness (μ_B) be in the area of overlap?
c) What if the more distant galaxy was inclined to the line of sight by 60°? What would the combined surface brightness (μ_B) be in the area of overlap?
d) If the diameter of each galaxy in c) was 30 kpc, what would be their separate and combined B magnitudes?

2. Given the Schechter luminosity function for galaxies, what is the average luminosity density (in $L\odot$ Mpc^{-3}) of the present-day Universe? If the critical density for the present-day Universe is 2.8×10^{11} h^2 $M\odot$ Mpc^{-3}, what would the corresponding $\mathcal{M}$/L (mass-to-light ratio in solar units) be for a critical-density Universe?

3. Surface brightness profiles and luminosity:
a) Show that the deVaucouluer $R^{1/4}$ law results in a total luminosity of $7.22\ \pi\ R_e^2\ I(R_e)$.
b) Show that half of the above luminosity come from within a radius R_e.
c) Derive an expression for the total luminosity in a disk galaxy, where the surface brightness along the major axis is characterized by the exponential law.