Name____________________ Homework #2 Due February 15

1) Integrate the Salpeter mass function between a lower mass limit of M_l and an upper limit of $M_u > M_l$.
   a) Find the number of stars formed within 100pc of the Sun assuming the stellar density is uniform within this radius.
   b) Find expressions for the total stellar mass and the total luminosity. As shown in figure 2.3 show that the total stellar mass is sensitive to M_l and that the total luminosity depends on M_u.
   c) Given that $M_l = 0.3$ M and $M_u >> 5M_\odot$, what fraction of stars have $M> 5M_\odot$. What fraction have $M>M_\odot$.
2) Using the model for the radial distribution of stars in the disk (eqn 2.8)
   a) show that at a radius R that the surface density of stars of type S is $\Sigma(R,S) = 2n(0,0,S)h_z(S)e^{-R/h_R(S)}$.
   b) If each type has a luminosity of L(S), the surface brightness I(R,S) = L(S)Σ(R,S). Assuming that $h_z = h_R$ for all types of stars, show that the total luminosity of the disk is $L_D = 2\pi I(R=0)h_R^{\ 2}$.
   c) For the Milkyway $L_D = 1.5 \times 10^{10} L_\odot$ in the V band and h_R is 3kpc , show that the disk's surface brightness at the solar radius (8 kpc) is $\sim 18\ L_\odot\ pc^{-2}$.
3) Use the data in figure 2.2 as representative of stars in the local disk and use the data in figure 2.13 as representative of halo stars.
   a) What is the absolute magnitude M_v of a disk star at B-V = 0.4? Note: B-V = 0.65. If it has an apparent magnitude of $m_v = 20$, what is its distance? The bluest stars in M30 that are still on the main sequence have B-V $\approx$ 0.4. Using figure 2.13 find M_R and M_V for these stars. Show that an apparent magnitude of $m_v = 20$ corresponds to a distance of about 20 kpc.
   b) What absolute magnitude could a disk star have if it has B – V = 1.5? What would its distance be if $m_v = 20$. In M30 a star with B – V $\approx$1.5 corresponds to B – R $\approx$ 2. What values could M_V have? How distant would these stars be if $m_v = 20$?
   c) In figure 2.15 explain why the reddest stars are likely to belong to the disk and the bluest stars to the halo.
4) For a simple model of the Galaxy with V(R) = 220 km/s everywhere,
   a) find V_r(l) for gas in circular orbits at R = 4, 6, 10, and 12 kpc. Do this by varying the azimuth ϕ around each ring, find d for each (ϕ,R), and thus the longitude l and V_r .
   b) Make a plot similar to figure 2.18 showing the gas on each of these rings.
   c) Using figure 2.18 explain where the gas lies that corresponds to longitude $l \sim 50^\circ$,V > 0; $l \sim 50^\circ$,V < 0; $l \sim 120^\circ$,V < 0; $l \sim 240^\circ$,V > 0; $l \sim 300^\circ$,V > 0; $l \sim 300^\circ$,V < 0. Where is the gas at $l \sim 120^\circ$,V > 0?

5) Use equation 2.18 to find the mass within a sphere of radius R_0 about the Galactic center.

   a) What is the average density of the spherical region in units of $M_\odot$ pc^{-3}? How much greater is this than the critical density of the Universe given in eqn 1.24?

   b) The HI disk in our galaxy extends to about 2.5 R_0. Show that the mass in this component is $M(R<2.5\ R_0) \approx 2 \times 10^{11}\ M_\odot$. Using an estimate of the Galaxy's luminosity from table 4.1 show that the mass-to-light ratio is $M/L_V \geq 10$. How does this compare to the results in section 2.1 for the solar neighborhood? What can you infer from this?