ASSIGNMENT 3, due date Feb 15th

1. For a simple model of the Galaxy with $V(R) = const = 220km/s$, plot the graph for the line-of sight recess velocity $V_r(l)$ of the gas at several radii, $R = 4, 6, 10, 12kpc$. Make a graph with axes similar to figure 2.20 of the textbook (2.18 in the first edition). Explain where the gas lies that corresponds to

   (a) $l \sim 50, V_r > 0$
   (b) $l \sim 50, V_r < 0$
   (c) $l \sim 120, V_r > 0$
   (d) $l \sim 120, V_r < 0$
   (e) $l \sim 300, V_r > 0$
   (f) $l \sim 300, V_r < 0$

2. Oorts constants A,B: Show that if the rotation curve is flat $V(R) = V_0 = const$, then $A + B = 0$ and $A - B = V_0/R_0$. The observed values $A = 14.8 \pm 0.8km/s/kpc$ and $B = -12.4 \pm 0.6km/s/kpc$ do not sum to zero exactly. Does this value correspond to the rising or to the falling galactic rotation curve $V(R)$?

3. From the value of the rotational velocity V_0 at the position of the Sun, find

   (a) the mass of the Galaxy, contained within the sphere of solar orbit radius, $M(< R_0)$.
   (b) The average mass density inside this sphere.

   The Galaxy's HI disk extends to about $2.5R_0$, where there is already almost no star light. Show that if the rotation curve remains flat to such distances, then $M(< 2.5R_0) \sim 2.5 \times 10^{11} M_\odot$. Using the data from the textbook on the total luminosity of our Galaxy, show that the mass-to-light ratio for our galaxy $M/L_V \geq 10$. Compare this value with what was quoted for the mass in stars only (say, near the sun). What conclusion can be made ?

4. Let us have a look at two Figures the links for which are given separately. The first Figure gives HR diagram for stars in the vicinity of the Sun, which we extrapolate to be valid to all stars in the galactic disk. The other is HR diagram for stars in globular clusters. Note, that these diagrams are given in "observers" coordinates - magnitude versus color. Be careful (and this is one point of the assignment) - the bands chosen are different. In the first Figure we plot M_V (V band) versus $B - V$ colour, while in the second (upper panels) we plot *apparent* m_R (R band) versus $B - R$ colour.

   Under important assumption that stars in the disk and $M30$ globular cluster are similar, answer the following questions:

   (a) What is the absolute magnitude M_V of a disk star at $B - V = 0.4$? How far away must it be to have apparent magnitude $m_V = 20$? Express your answer both as distance modulus and in parsecs.
   (b) Using the results from the previous question, estimate the distance to the globular cluster $M30$ using *upper-right* panel of Figure 2. Here is a piece of additional information needed - assume that *the bluest stars still on main sequence* in $M30$ have $B - V = 0.4$ (let us say we have additional measurements of $B - V$ colour for $M30$). Again, the main sequence stars in disk and in $M30$ are assumed similar in all respects (mainly - metallicity, which can affect colours).

       For this question *lower* panels of the second Figure may provide a check, but you need to get an answer only from upper, apparent magnitude, data.

(c) How bright could a disk star be if it has $B - V = 1.5$? How far away would it be at $m_v = 20$? Let us say that in M30 a star with $B - V \approx 1.5$ corresponds to $B - R \approx 2$. What are the possible values for M_V ? Is there a whole possible range ? How distant are those stars if $m_v = 20$?