Astro 530: Galaxies

Problem Set #3
Due February 12, 2009

5. **Surface Brightness:** Suppose a galactic disk viewed face-on (with no dust) has a surface brightness equivalent to one solar-type star per pc^2. Show that its surface brightness in magnitude units is 27.05 B-mag per $arcsec^2$. Thus, for arbitrary disk surface brightness I_B in solar units per pc^2:

$$\mu_B = 27.05 - 2.5\log(I_B)$$

Use the fact that the B-band absolute magnitude of the Sun is $M_B = 5.48$ mag. Note that the number 27.0 mag is good to remember as it quickly allows you to convert from galaxy surface brightness to volume star density, assume some thickness of the object you are looking at.

6. **Rotation Curve of Milky Way:** [adapted from S. Faber] From the figure attached derive the northern and southern hemisphere rotation curves of the Milky Way from 2.5 kpc outward to the solar circle. Assume that $v_r = 220$ km/s at the Sun and $R_{sun} = 8$ kpc. First measure the terminal velocities, v_t, at various longitudes and compare your results to Figure 9.16 BM. Do you find more or less North-South asymmetry than plotted in BM? The tricky part of measuring the terminal velocities is making allowance for the turbulent broadening. Note that if you don't do this, you won't recover the rotation speed of 220 km/s at the Sun. Plot your final rotation speeds similar to BM 9.17 (but with a more zoomed-in y-axis) and comment on any differences. Re-plot assuming $v_r = 180$ km/s for the Sun and note the effect that this has on the average slope of the rotation curve. Based on the two values, 220 and 180, which gives the flattest overall rotation curve?

7. **Modeling the Milky Way Foreground:** Because we live in the Milky Way, any extragalactic study must address the issue of contamination from foreground stars in the Milky Way. This problem uses a model of star counts in the Milky Way bulge, thin/thick disk, and halo to predict the amount of foreground stars expected in various applications.

We will use the Besancon model of the Milky Way model which is located at:

http://model.obs-besancon.fr/

First, briefly describe the Milky Way components which go into this model.

a) Extragalactic survey: You are designing a ground-based, deep imaging survey to image galaxies using the CFHTLS filters (ugri) to a limiting magnitude in $r = 26$ mag. You have the choice of imaging one of the two fields below:

	RA(2000)	DEC(2000)
Field 1	03:32:39	-27:47:29
Field 2	16:31:00	+12:47:30

Plot the expected number of foreground Milky Way stars per square degree as a function of *r*-magnitude in each field, using the Besancon MW model above. In the model input page, I suggest using the 'small field' option which requires inputing the coordinates in Galactic latitude/longitude. You will need to convert the above Ra/Dec, first into decimal degrees and then into *l/b* coordinates. I have placed an IDL script on the class webpage which quickly converts between these systems. Please list the input Galactic coordinates of the two fields above.

Based on your star count plots which of the two fields above would you chose to conduct a deep, wide-field galaxy imaging survey? Why?

b) The Hubble Ultra Deep Field (Field 1 above) is one of the deepest exposures of the sky, covering 11 sq arcmin to a depth of $i = 29$. How many foreground stars do you predict in this field? Does this compare to the number observed (e.g. see Pirzkal et al. 2005)?