Project Set 2  
Due Thursday February 17

1. Seeing the Invisible

We’ve discussed several ways to see the “invisible” stellar substructure around the Milky Way, for example: Hess diagrams, applying color-magnitude selection to stars before looking at their spatial distribution, spatially smoothing distributions. For this problem, you will need the files imgunder.pro and Mystery3.dat, located in my home directory on both Hal and the Simpsons machines. The format of the data file is identical to that of the MW.dat files used in your first assignment.

a. Use Hess diagrams to reveal the presence of a Milky Way structure hidden in Mystery3.dat. I’ve made it easy for you and placed the Mystery Object in the center of this field [(Ra, Dec) = (0,0)]. (Please use the two Hess diagram tutorials (Tutorial 2 and 3) linked to our Class Tools pages. For some reason imgunder and plot haven’t been playing nicely together, so you may not be able to overplot axes onto your Hess diagrams after using imgunder. Thats OK.)

b. Based on your Hess diagrams, provide your best interpretation of the type of stellar population that this Mystery Object might be composed of, and the (very rough) distance that it might be at. The best, most complete answers to this question will include one or more figures.

c. (Extra Credit! Partial extra credit possible if you get partway there.) Use what you’ve learned to reveal the presence of this Mystery object in spatial coordinates. Make an argument for what type of object this is.
2. Chemical Evolution

Is this observation consistent with the predictions of the closed-box model of chemical evolution? If so, then be specific about how it is consistent. If not, then discuss one specific assumption of the closed box model that could be violated to produce this result.

b. Gas-rich galaxies are observed to have low effective yields. Although this is qualitatively consistent with the closed-box model of chemical evolution, the observed effective yields are lower than expected for a closed box model. Show that for gas-rich galaxies, outflow can reduce effective yield but infall cannot reduce effective yield. [Hint: Express the equation for effective yield in terms of only $M_Z(t)$, $M_{gas}(t)$, and $M_\bullet(t)$ and Taylor expand. Then, interpret your result].

3. Measuring the Mass of the Milky Way

Smith et al. (2007) used observations of high velocity stars observed in the RAVE survey to infer that the escape velocity from the Solar neighborhood is 544 km sec$^{-1}$.

a. Compare this empirically derived value for $v_{esc}$ to the escape velocity expected if all mass in the Galaxy is contained interior to the Solar circle. Relatively, how much mass is required outside of the Solar circle to account for the observed escape velocity?
b. Compare the amount of mass required outside of the Solar circle to explain $v_{\text{esc}}$ to the amount of light outside of the Solar circle and comment. (This question is similar to one on your second HW2 from Astr 206).

c. What is the truncation radius of an isothermal halo that would have an escape velocity of $544 \text{ km sec}^{-1}$? What total Galaxy mass would this correspond to?