

# Astronomy 128: Galaxies and Galactic Structure

Week 2, Thursday, January 26

**Topic:** Meeting the neighbors: stellar content of the solar neighborhood

This week we'll look at what sorts of stars (and how many of each) we find in our part of the Galaxy, and what that might tell us about what kinds of stars are more likely to form, which stars have most of the mass, and which stars emit most of the light.

**Break:** Vernon

**Reading:**

- Sparke & Gallagher, Chapter 2 through section 2.2.

**Problems:**

1. Come to class with at least one *written* question on the reading.
2. Aside from the worked problems, there is a computer-based problem which you should get going on immediately. It involves using the Hipparcos database, which is available from the course webpage.

This problem involves getting to know the Hipparcos data. As SG mention, Hipparcos measured parallaxes of roughly 120,000 stars, so this dataset represents a good chance to learn something about the nearby stellar population in the Galaxy. This problem is a precursor to a more involved problem, so try to keep your program general in terms of what data you extract from the database.

- (a) Download the data from the course webpage or, if you are working on the Linux machines, you can access it directly:  
/home/httpd/html/astro128/hipparcos.fits (FITS binary format) or  
/home/httpd/html/astro128/hip\_main.dat (text format).

There is also a `ReadMe_hipparcos` file in the same directory that tells you the format of the data.<sup>1</sup>

- (b) Write an IDL (or whatever) program that, for each star in the database, computes the distance using parallax and then the absolute magnitude. Your program should only consider stars whose parallax error is not too large (I'll let you decide what is too large).
  - (c) Plot the apparent magnitude vs.  $B - V$  color and the absolute magnitude vs.  $B - V$  color. How do they compare? Label interesting features.
  - (d) Now try the color-color diagram. Plot  $B - V$  vs.  $V - I$ . Notice anything interesting? Try to explain the behavior of the plot.
3. SG problem 2.1.
4. SG problem 2.3. Having derived the expression for  $d_{\max}$ , calculate its value for main sequence stars of spectral type G0, K0, M0, and M6 to get a sense of how far out Hipparcos could see different types of stars.
5. (a) Argue that the present-day luminosity function  $\Phi_{MS}(M_V)$  is related to the initial luminosity function  $\Psi_{MS}(M_V)$  for stars for which  $\tau_{MS} < \tau_{\text{gal}}$  by:

$$\Psi_{MS}(M_V) = \Phi_{MS}(M_V) \frac{\int_0^{\tau_{\text{gal}}} R(t) dt}{\int_{\tau_{\text{gal}} - \tau_{MS}}^{\tau_{\text{gal}}} R(t) dt}$$

where  $R(t)$  is the stellar birthrate.

- (b) Assuming the birthrate is constant with time, derive equation (2.4) in Sparke and Gallagher.
- (c) Now do problem 2.4.

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<sup>1</sup>The `ReadMe_hipparcos` file describes the format of the `hip_main.dat` text file. The binary `.fits` file has the same fields, with the exception that that RA, Dec, proper motions, and parallax are all given in radian (or radian/yr for the motions) in the `.fits` file, while the coordinates are in degrees, the parallaxes are in milli-arcsec (mas), and the proper motions are in mas/yr in the `.dat` file. (Be careful, though: even in the `.fits` file, the proper motion and parallax *uncertainties* are in mas/yr and mas, respectively. If you're working in IDL, I recommend using the `.fits` file. It's in the form of a binary table, a compact way of storing tabular data in a compressed form. The IDL Astro library has a straightforward way of reading such files. Use `MRDFITS` to read each field into an IDL structure, e.g. `hip_struct = mrdfits('/home/httpd/html/astro128/hipparcos.fits', 1, header)`; then type `help, hip_struct, /structure` to see the different fields you've created. Let me know if you need some help working with structures, or dealing with IDL in general.

6. The expression SG give for the mass function is a little non-standard. It's more typical to write it as  $\xi(\mathcal{M}) = \xi_0(\mathcal{M}/\mathcal{M}_\odot)^{-2.35}$  so that the  $\xi$ 's have the same dimensions (which is stars per unit mass interval). Using this, do SG problem 2.5.
7. SG problem 2.7.
8. SG problem 2.11.