

ASTRO 1050

The Structure of the Milky Way Galaxy

ABSTRACT

In this lab, you will learn that we live in the Milky Way Galaxy. There are one hundred billion stars in our Galaxy. We can see six thousand with the naked eye on a *very* clear, dark night. You will learn what the Milky Way looks like, how old it is, and our location (hint: we're not at the center!).

Materials

Google Sky, Protractor

Exercises

First pull-up Google Sky on your computers. We begin with viewing the Milky Way (via Google Sky) in the winter and the summer. Watch it circle the sky as you see the seasons change.

To find the Milky Way on Google Sky:
Zoom out by using the bar on the left side of the screen. Then click "Infrared" in the top righthand corner. **Remember we are currently *inside* the Milky Way Galaxy!**

To change the seasons on Google Sky:
As you move the cursor over the sky map, the bottom lefthand corner shows your right ascension coordinates. (ex. "9h 48m 02.3s")

September 21st has a right ascension of 0 hours at midnight.

December 21st has a right ascension of 6h at midnight.

March 21st has a right ascension of 12h at midnight.

June 21st has a right ascension of 18h at midnight.

1. Explain in a few sentences what the Milky Way looks like (be as detailed as you can; comment on the different structures you see, colors, etc.).

2. Our Milky Way Galaxy is made up of a disk, which you see as the band of the Milky Way in the night sky, a bulge, a large clump of stars surrounding the center, and a halo, a larger cloud of stars that surround the entire Galaxy. The halo is much larger than the bulge. Our Milky Way Galaxy is made up of mostly stars, gas and dust. The dust blocks out light from distant stars, and makes it difficult to see most of the Galaxy, especially the bulge and parts of the disk.

3. Now, we know that we live in a Galaxy that has a disk-like shape. But, where in the disk do we live? Are we at the center, or off on one side? In the early 1920s, an American astronomer named Harlow Shapley studied this question. He found that there were clusters of billions of old stars, called globular clusters, that were spread around the center of the Galaxy evenly in a spherical cloud in the halo. You can find a picture of a globular cluster below. Harlow Shapley realized that depending on where you are in the Galaxy, the pattern of globular clusters will look different. In reality, globular clusters are spread out in a spherical pattern, but we will study them only in two dimensions (so that we can draw a picture). The globular clusters will appear as a circle around the center of our Galaxy. Look at the diagrams on the last page.

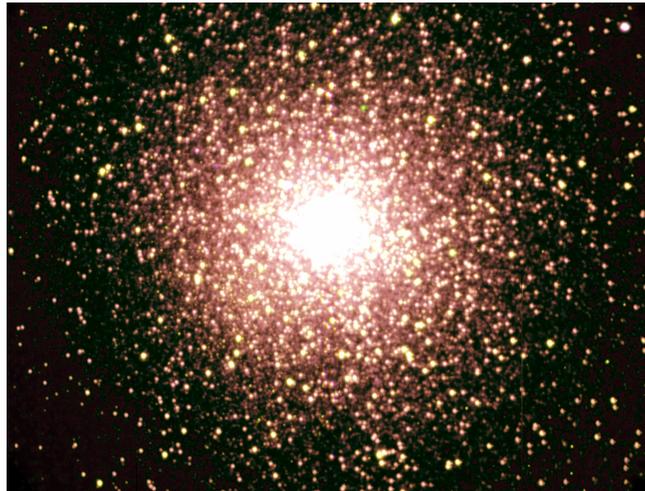


Fig. 1.—: Globular Cluster (Source: http://en.wikipedia.org/wiki/Globular_cluster)

A way to look at patterns in a set of data is a histogram. A histogram is a bar graph that shows the number of objects that have a certain property. A common type of histogram is the one that shows your grade compared to others in a class. Your instructor will show you how to make a histogram.

For cases A and B on the last page, measure the angle between the 0 degree line of the Sun and the line towards each globular cluster (make sure you place the center of your protractor on the Sun!). If, in the diagram, we are looking down on the Sun from the top of our Galaxy, then the angle you are measuring would be called “Galactic Longitude.” **(a)** Make a histogram of the angles that you find (there is plenty of empty space on the next page).

(b) Is there a difference between case A and case B in the histograms?

(c) If so, explain why clearly in your own words:

Case A | 0°-44° | 45°-89° | 90°-134° | 135°-179° | 180°-224° | 225°-269° | 270°-314° | 315°-360°

Case B | 0°-44° | 45°-89° | 90°-134° | 135°-179° | 180°-224° | 225°-269° | 270°-314° | 315°-360°

4. Now, here is some real data, taken randomly from a list of globular clusters.

Globular Cluster Name	Galactic Longitude (degrees)
47 Tuc	306
NGC 1466	288
M 79	227
Pal 3	240
Pal 4	203
M 68	300
AM 4	320
Pal 5	0
M 5	4
M 4	351
M 107	4
M 13	59
M 62	354
NGC 6304	356
M 92	68
M 9	6
Hp 4	356
NGC 6388	354
M 14	21
Ter 5	4
UKS 1	5
NGC 6517	19
M 69	2
M 70	3
M 54	6
M 71	57
M 2	53

(a) Using the globular cluster data above, make a histogram of the data, drawing the same type of graph that you used previously.

Data | $0^\circ\text{-}44^\circ$ | $45^\circ\text{-}89^\circ$ | $90^\circ\text{-}134^\circ$ | $135^\circ\text{-}179^\circ$ | $180^\circ\text{-}224^\circ$ | $225^\circ\text{-}269^\circ$ | $270^\circ\text{-}314^\circ$ | $315^\circ\text{-}360^\circ$

(b) Does the Galaxy's globular cluster system look more like case A (Sun in center) or case B (Sun on one side)? (c) If you believe it is case B, can you give an estimate which direction the center of the Galaxy is, in degrees? (d) Explain your reasoning!

5. Globular clusters have another important use to astronomers. Like the Pleiades, an H-R diagram can be used to determine the approximate ages of the stars in the globular cluster, by finding where the main sequence turns off, as you learned in the last lab. Below is an H-R diagram of M55, a globular cluster.

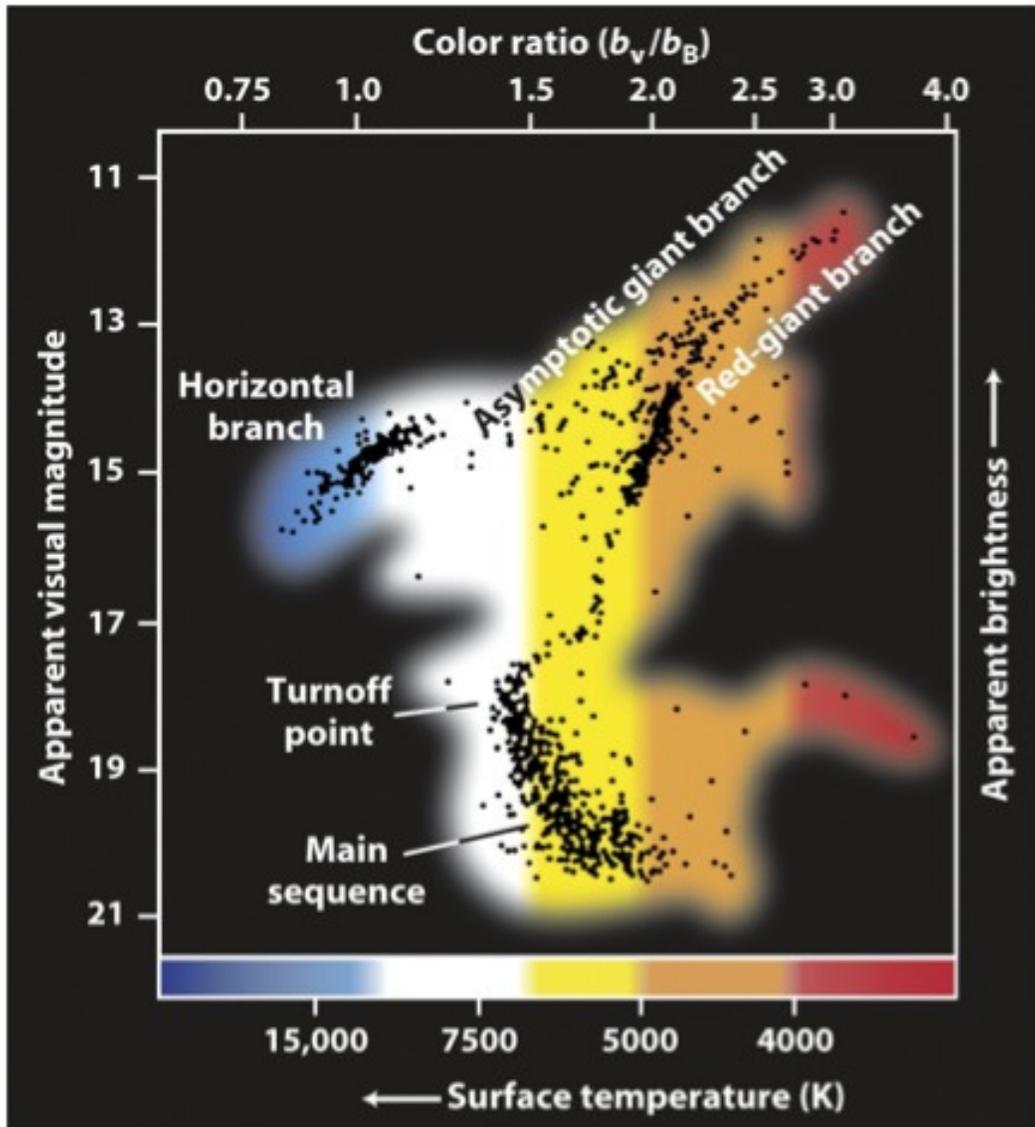


Figure 20-3
Universe, Eighth Edition
© 2008 W. H. Freeman and Company

Fig. 2.—: H-R Diagram, M55

(a) Do you notice anything different about this H-R diagram, compared to the one you made in the Pleiades lab? Be as complete as possible!

6. You found in the Pleiades lab the age of the Pleiades. The Pleiades is a star cluster in the disk of our Galaxy. Now, we will find the approximate age of M55, which is in the halo of our Galaxy.

The approximate total time that a star spends on the main sequence, in terms of spectral type, that you might need are:

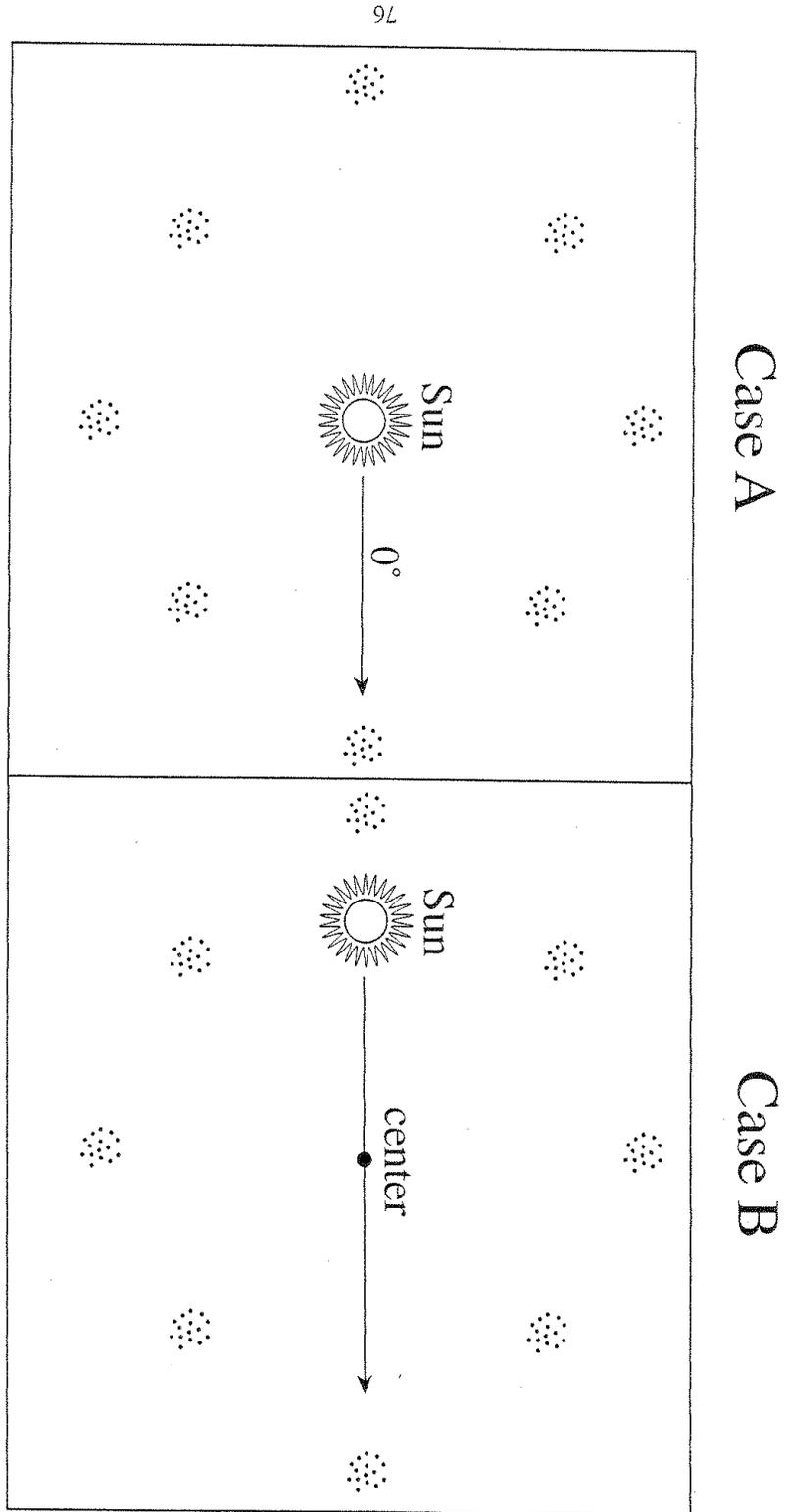
- F0 (7,350 K) is 3 billion years
- F5 (6,700 K) is 7 billion years
- G0 (5,930 K) is 11 billion years
- G5 (5,660 K) is 18 billion years.

Again, intermediate stars have intermediate ages.

Using the information given, determine the age of the globular cluster. Explain your answer!

7. Now if we assume that the entire Universe has a finite age, the Universe has to be at least as old as M55, and is probably older. Lets assume that M55 formed about a billion years after the Universe formed.

From the information given, what is your estimate for the age of the Universe? Does this number make sense to you? Does it fit with the estimated age of the Earth (which is 4.56 billion years)?



76

Fig. 3.—: Cluster Diagram (Source Unknown)