

Astronomy Homework #5

Name _____

DUE: **March 30** (at the start of class)

This homework is worth 30 points, so don't wait to do it until the last minute!

Your homework grade depends not only upon your getting the correct answer but also grammar, spelling and punctuation, particularly in questions that require explanations. Numerical answers to questions do not need to be written in complete sentences and you should show your work where ever it is appropriate. Partial credit may be given for showing your work even if your result is incorrect. You will also be graded on the use of significant figures, proper units of measure and proper scientific notation. You may work with others in determining the answers to the questions, but what you write should be in your own words – any homework assignments that look too similar to that of other students will receive no credit. Unless otherwise noted, all questions are worth 1 point.

1 (10 points) At the course website there is an application which plots up stars in globular clusters and displays various *isochrones*. These are lines that correspond to where stars in a cluster would be located on an H-R diagram as they evolve over time. They show only the location of the Main Sequence and stars heading toward the Red Giant region.

a. If all cluster stars formed at the same time, which of those stars would leave the Main Sequence first (or put another way, which stars die first)?

b. If you look at the clusters displayed at the website you'll see that the Main Sequence is a short stubby tail that seems to cut off abruptly at the bottom in most of the graphs. Why doesn't it extend very far down? (Hint: globular clusters tend to be thousands of parsecs away)

c. In most of the clusters, the number of stars shown in the Main Sequence is greater than in the other areas of the H-R diagram. Why is this the case?

There are three sets of isochrones displayed each corresponding to a different measure of the amount of metals (Z). A value of $Z=0.008$ indicates that the isochrones stars have about $\frac{1}{2}$ the amount of metals compared to the Sun, while $Z=0.0017$ is about $\frac{1}{10}$ and $Z=0.00017$ is about $\frac{1}{100}$ of the Sun's. Your job will be to determine which set of isochrones "fits" the data the best. As you'll see, there are few perfect fits, but you'll want to concentrate on the area where there are the most stars – the main sequence and those that are heading towards the red giant area. You can move the isochrones graphs around by clicking on it with your mouse and dragging it.

d. (4 points) Put the best fitting Z value into the blanks below (only one value per blank).

Arp 2 _____	NGC 5272 _____
M 68 _____	NGC 5286 _____
NGC 104 _____	NGC 6809 _____
NGC 1904 _____	NGC 7492 _____

e. Each set of isochrones corresponds to a different age for the star cluster, with the oldest line (colored blue) corresponding to 14.1 billion years and the youngest line (colored yellow) corresponding to 5.6 billion years. Does the data for the clusters in general fit best with the youngest or oldest isochrones?

f. (2 points) The isochrone data is based upon computer models of many stars that have been produced over the years. How would you describe the quality with which the isochrones "fit" with the observed data? Make sure you provide specific examples illustrating the quality of the fit.

2. (10 points) **Galaxy Classification.** At the website there is a link to images of 20 galaxies. Take a look at the galaxies and determine their type. Your options are Spiral, Barred Spiral, Elliptical and Irregular. Put only one type down for each galaxy.

Galaxy 1

Galaxy 2

Galaxy 3

Galaxy 4

Galaxy 5

Galaxy 6

Galaxy 7

Galaxy 8

Galaxy 9

Galaxy 10

Galaxy 11

Galaxy 12

Galaxy 13

Galaxy 14

Galaxy 15

Galaxy 16

Galaxy 17

Galaxy 18

Galaxy 19

Galaxy 20

3. (10 points). On the last homework assignment you looked up the most recent supernova which occurred (actually which we observed in the Universe). Supernovae are often used to determine distances to remote galaxies.

a. Which type of supernova would be the best ones to determine distances? Justify your answer.

We can use supernovae to determine distance and also measure how different parts of the Universe are moving. We know that the Universe has mass, which means that it has gravity which causes all parts of it to pull upon all other parts. The Universe is also expanding, so parts are observed to be moving away from one another.

b. What would eventually happen to the Universe if the gravity is stronger than the expansion motion?

c. What would eventually happen to the Universe if the gravity is much weaker than the expansion motion?

At the course website there is a link to a calculator that displays data from distant supernovae along with some parameters we can use to describe the characteristics of the Universe. You can plot up two sets of data, distant and nearby supernovae. The galaxy distances are indicated by the value of DM (which actually stands for Distance Modulus), while their velocities away from us are shown by the value of z , which measures their redshifts. So this is really just a Hubble Diagram. There is a line drawn through the data that depends upon the value of the Hubble Constant and other parameters that are described below the graph. All of these values can be adjusted to change the location of the curve. Normally the line in a Hubble diagram is usually drawn as straight, but due to the units of measure used here, it actually ends up as a curved line.

d. With only the NEARBY supernovae plotted, is it possible to determine a likely value for Omega as well as Lambda without any uncertainty? Explain your answer.

e. Display both the nearby and distant supernovae and adjust the values of Omega and the Hubble constant (don't adjust Lambda, leave it at 0). Can you get the line to go through the central distribution of the data? If so, what values of Omega and the Hubble Constant work best?

f. Again, with both the nearby and distant supernovae displayed adjust the values of Lambda and the Hubble Constant to place the line through the data in the best possible manner. In this case, keep the value of Omega=0. For your best fit to the data, what values of Lambda and the Hubble Constant did you end up with?

g. Which situation had the best fit to the data, the one you found for part "e" or the one you found for part "f"? What does this tell us about the nature of the Universe?

h. The latest results place the value of the Hubble Constant at 70 km/s/Mpc, and the value for Omega at about 0.27. Make sure those values are set, and adjust the value of Lambda to get the curve going through as many of the data points as possible. What range of values for Lambda fit the data well (give a range here, not just one value)?

i. If $\Lambda + \Omega = 1$, then the curvature of the Universe is "Flat". Is that a possibility based upon your result from part "h"?

j. What do you think will eventually happen to the Universe? You can base your answer upon your results here, or upon other scientific results that you are aware of.