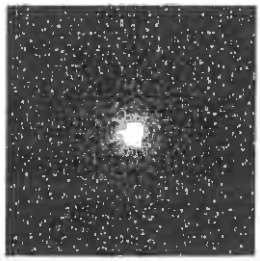
Chapter 30.3

Name _____ **Section** _____

Date _____



Distance to the Center of the Milky Way Galaxy

Objective

To determine the distance to the center of the Milky Way based upon observations of globular clusters.

Materials

Specialized polar graph sheet

Print out a copy of this graph paper and use a colored pencil or pen to mark the locations of the globular clusters. Alternatively, you may wish to get an original copy from your instructor.

Introduction

In the not-to-distant past, astronomers thought that the Sun was at the center of our galaxy, the Milky Way. Observations and determinations of distances were hampered by the lack of knowledge of interstellar dust, dust which is so prevalent that it blocks out visual starlight of many stars (including the exact center of our galaxy) and dims the light of many others. It was not until the distances to globular clusters were determined by using a type of variable stars called RR Lyrae stars that a more accurate picture of the size and shape of our galaxy was determined. By determining the distribution of the globular clusters, Harlow Shapley was able to determine the diameter of the Galaxy (from the diameter of the distribution) and the distance to the galactic center (from the distance to the center of the distribution).

In this exercise, we revisit Harlow Shapley's method.

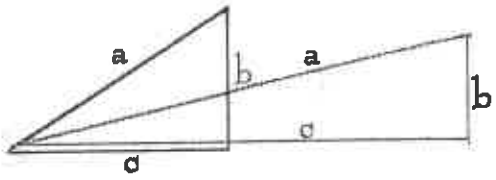
Procedure

Table 1 gives the distance data for about 60 globular clusters. The clusters are listed by NGC (New General Catalog) number. The galactic longitude (the longitude in a coordinate system using the plane of the Galaxy as the base plane) and projected distance are given for each cluster. Once this distribution is plotted, you should be able to determine the distance and direction to the galactic center.

This special polar graph sheet is to be used for the Distance-to-the-Center-of-the-Galaxy lab. The Sun (Earth) is at the very center. Each dark concentric circle represents 5 kpc (1 kiloparsec = 1,000 parsecs). The coordinates are galactic coordinates, with 0 degrees longitude meaning the "the center of the Galaxy".

The named constellations are those located in the general direction of the galactic longitude shown. For example, if a globular cluster were seen at 90 degrees, its projected direction lies in the constellation Cygnus (although, in reality, located well beyond the stars that make up that constellation).

distances are greater than those given here, but the effect of adjusting the data will average out. Because so many clusters are being used, your answer will not be significantly affected. In this figure, *a* is the actual distance, and *c* is the projected distance.



Exercise

1. Plot the data from Table 1 on the specialized polar graph paper. (Note: you do not need to label each point.) The Sun is at the very center of this polar graph.
2. Estimate the center of the distribution of globular clusters and mark it on the graph.
3. Determine the distance from the Sun to the center of the distribution:
   - Distance = _____ kpc
4. Determine the direction to the center of the distribution. This is considered to be the direction to the center of the Galaxy.
   - Longitude to center of the distribution = _____ degrees
5. In which constellation does the center of the Galaxy lie?
   - Constellation is: _____
6. At what time of year or season is this constellation most conspicuous? (Hint: check your planisphere.)
7. Why is the Milky Way Galaxy more prevalent in the summer than in the winter (ignore weather conditions)?
8. Describe the 2-dimensional space distribution of the globular clusters.
9. How do we know the Sun is not at the center of this distribution?

10. During their long orbit around the center of the Milky Way Galaxy, each globular cluster will cross through the plane of the disk of the Galaxy. Why is it, then, that we find most globular clusters far out in the halo? (Hint: Do Newton's Equations apply to globular clusters?)

11. Take a look at this set of selected images of globular clusters. Write a short paragraph giving your interpretation of what you see. Note any obvious similarities and differences in these images.

12. These images were all taken on the same telescope under similar observing conditions. If we assume that these globular clusters are all the same physical size, why do some look so big while others look very small in these images?

13. Take a look at the images of NGC 6838 and NGC 6266. These globular clusters are of similar angular size and therefore of similar distances from us. Which one are we viewing through the plane of the Milky Way? Which one would be easier to observe in detail and why?

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URL: http://www.astro.washington.edu/astro101u/labs/ctrgal/cog.html

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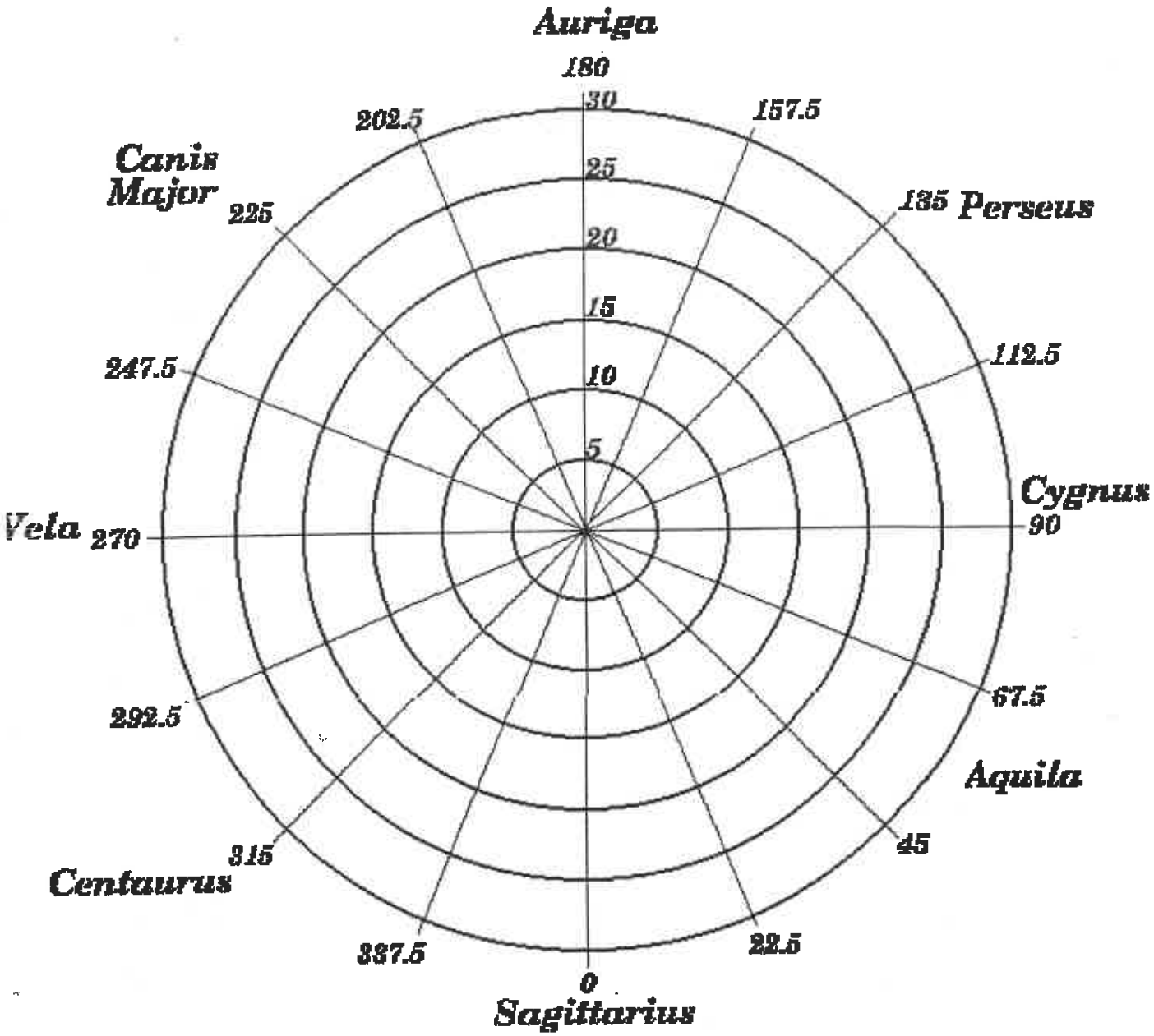
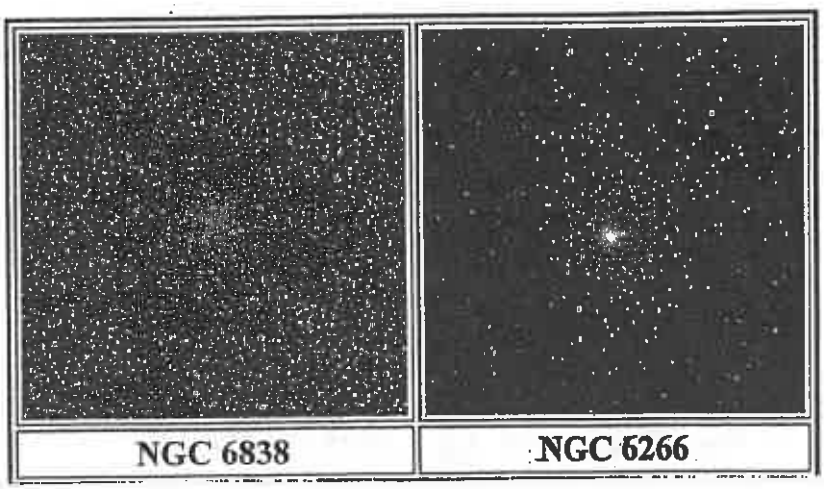
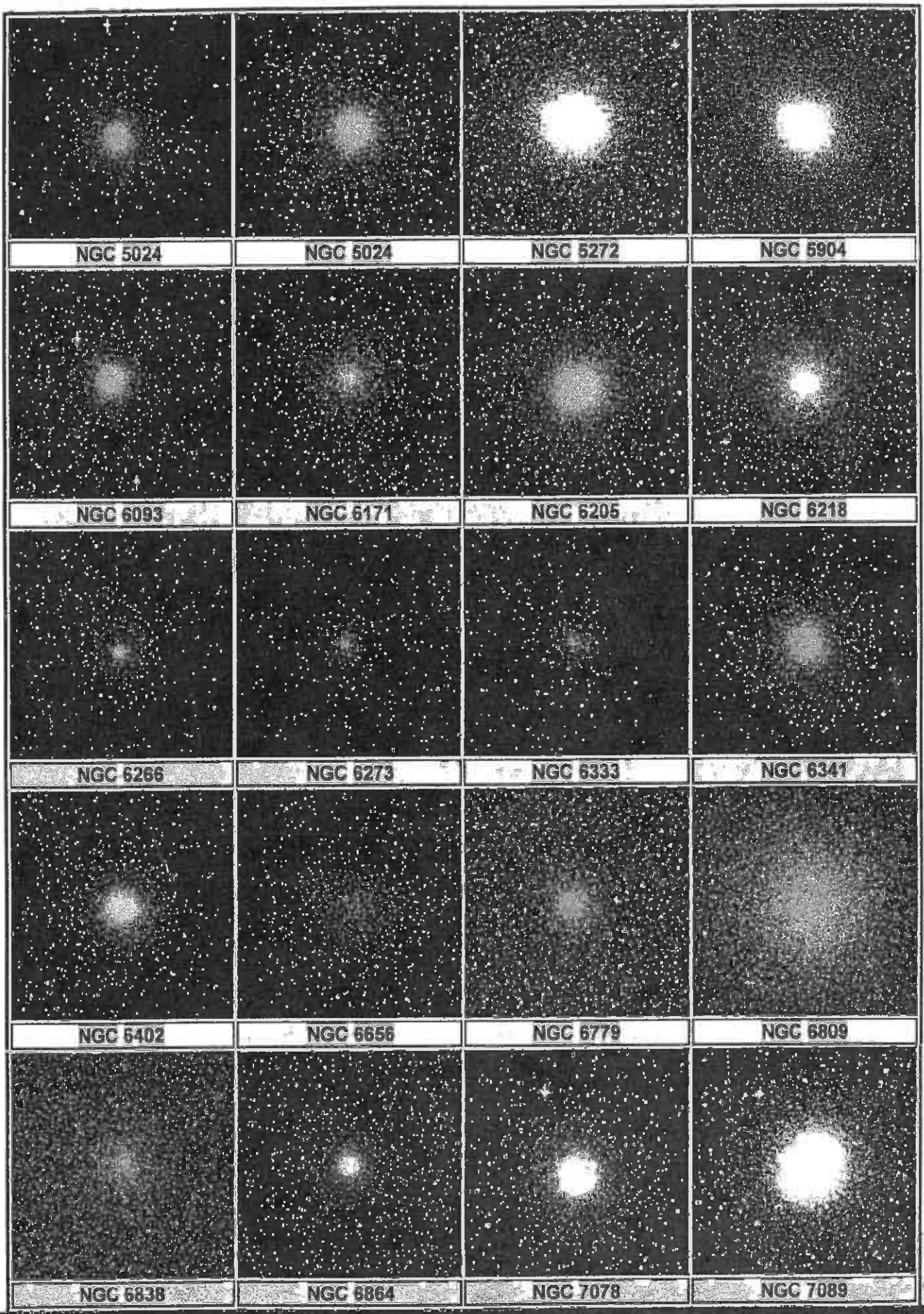
Table 1 -- Globular Cluster Data

Globular Cluster (NGC)	Galactic Longitude (degrees)	Projected Distance (kpc)	Globular Cluster (NGC)	Galactic Longitude (degrees)	Projected Distance (kpc)
104	306	3.5	6273	357	7
288	147	0.3	6284	358	16.1
362	302	6.6	6287	0	16.6
1904	228	14.4	6293	357	9.7
2808	283	8.9	6333	5	12.6
Pal 4	202	30.9	6341	68	6.5
4147	251	4.2	6356	7	18.8
4590	299	11.2	6366	18	16.7
5024	333	3.4	6397	339	2.8
5053	335	3.1	6402	21	14.1
5139	309	5	6535	27	15.3
5272	42	2.2	6656	9	3
5634	342	17.6	6712	27	5.7
5694	331	27.4	6717	13	14.4
Pal 5	1	24.8	6723	0	7
5897	343	12.6	6752	337	4.8
5904	4	5.5	6760	36	8.4
6093	353	11.9	6779	62	10.4
6121	351	4.1	Pal 10	53	8.3
6541	349	3.9	6809	9	5.5
O 1276	22	25	Pal 11	32	27.2
6626	7	4.8	6838	56	2.6
6638	8	15.1	6864	20	31.5
6144	352	16.3	6934	52	17.3
6171	3	15.7	6981	35	17.7
6205	59	4.8	7078	65	9.4
6218	15	6.7	7089	54	9.9
6229	73	18.9	7099	27	9.1
6235	359	18.9	Pal 12	31	25.4
6254	15	5.7	7492	53	15.8
6266	353	11.6			





NGC 6838 | NGC 6266


NGC 5024
NGC 5024
NGC 5272
NGC 5904
NGC 6093
NGC 6171
NGC 6205
NGC 6218
NGC 6266
NGC 6273
NGC 6333
NGC 6341
NGC 6402
NGC 6656
NGC 6779
NGC 6809
NGC 6838
NGC 6864
NGC 7078
NGC 7089