ASTR 102

B08

2016/03/14

5: How big is our galaxy?

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Objective/Purpose

The objective of the “How big is our galaxy?” lab is just as it sounds; to further understand the extent of the size of the Milky Way Galaxy. By estimating the mass of the galaxy and using Kepler’s law, we can get an idea of how big the galaxy really is.

Introduction/Theory

Most people don’t really ever stop to consider the vastness our galaxy. Can we even truly imagine the scale of the size of the Milky Way. In this lab we will determine the distance of several globular clusters (including M15) to then determine the weighted mean distance to the center of our galaxy, and finally use Kepler’s law to determine the approximate mass and therefore size of our galaxy. When we look up at the stars and see the Milky Way’s line of brightness in the sky, we don’t consider how many lightyears away those stars are, nor do we consider how many stars are not visible to the naked eye.

Equipment

The following is the equipment required to complete this lab:

- Computer (with peripherals)
- COG software

Procedure

The following steps will outline the required procedure to complete this lab.

1. We began by evaluating the approximate brightness of a specific star from a given map of M15.
2. We then calculated the average Magnitude of brightness for each of the marked stars.
3. Then calculated the distance in parsecs based on the magnitude of the star.
4. Using the average of the distances calculated we then opened up the COG software through XTERM.
5. With the COG software, we were able to “View & Measure” other entries to determine their approximate distance.
6. With all of these distances, COG gave us the Distance to the Galactic Centre.
7. Using the distance to the Galactic Centre, we were able to calculate the approximate circumference of the galaxy.
8. Knowing that the sun is moving at a certain speed, we are able to calculate the period at which the galaxy rotates and using Kepler’s law, we are able to calculate the approximate mass of the galaxy.

Observations

There were not very many observations for this lab as it was mostly data collection from pre-existing data. Some observations were made using the map of stars of M15 to collect initial magnitude measurements and then distance.

Tables/Measurements

Star B data:

Delta	Apparent Brightness	Time
468	15.7	0.228
470	16.4	0.279
475	15.3	0.381
477	15.3	0.409
481	15.6	0.478

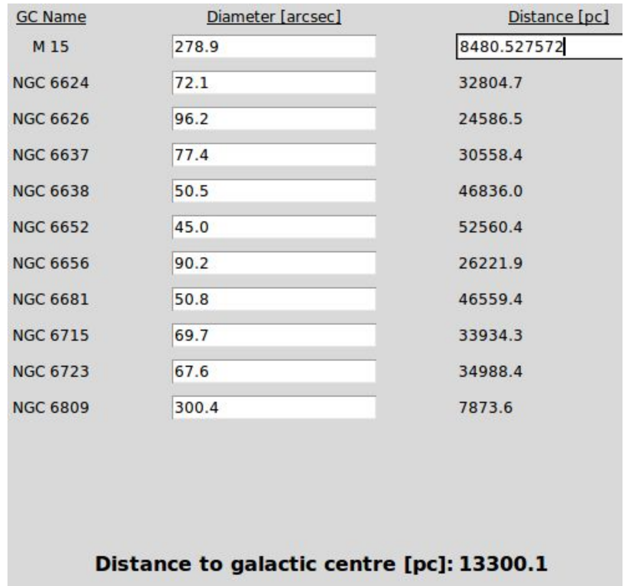
Average Magnitude: 15.66

For each star we calculated the distance using the average magnitude and the following eq:

$D = 10^{\frac{m-M+5}{5}}$ where M = 1.0

Star	Average Mags	Distance (parsecs)
A	15.59	8279.421637
B	15.66	8550.667129
C	15.58	8241.38115
D	15.7	8709.6359
E	15.64	8472.274141
F	15.68	8629.785478

AVG D = 8480.527572
MAX D = 8709.6359
DEV D (error) = +/- 229.1083271



GC Name	Diameter [arcsec]	Distance [pc]
M 15	278.9	8480.527572
NGC 6624	72.1	32804.7
NGC 6626	96.2	24586.5
NGC 6637	77.4	30558.4
NGC 6638	50.5	46836.0
NGC 6652	45.0	52560.4
NGC 6656	90.2	26221.9
NGC 6681	50.8	46559.4
NGC 6715	69.7	33934.3
NGC 6723	67.6	34988.4
NGC 6809	300.4	7873.6

Distance to galactic centre [pc]: 13300.1

Note that 3.26 LYR = 1 parsec, and there are 3x 10^7 seconds in a year
The sun's speed is approximately 220km/sec = 0.00021parsec/year

Graphs

The graph for this lab is attached at the end of the report. It graphs the data for Star B: the apparent brightness vs the time.

Calculations

The distance to the Galactic Centre (parsecs) is 13300.1, which is also the radius used in the circumference.

$$circumference = 2\pi r$$

The **circumference** then comes out to be a calculated **83566.92232 parsecs**

This means that the **period** of the galaxy comes out to **397937725.3 years**

Kepler's law is $Mass\ in\ solar\ Masses = 8.8 * 10^{15} * \frac{A^3}{Period^2}$

Using **Kepler's Law**, the mass of the galaxy comes out to **130,742,614,336.98 solar masses**.

I we were to **check out each star in the galaxy per second**, it would then take us **4358.087145 years.**

Results

The value for the approximate mass of the galaxy comes out to 130,742,614,336.98 solar masses. This allowed us to calculate an approximate time to view and examine each one of these stars (assuming it would only take us one second per star) of 4358.09 years.

Conclusion/Discussion

Something to consider when taking into account the time in which to examine each star is that we are making the assumption that the average size of stars in our galaxy is approximately 1 Solar Mass. If the average size of a star in the galaxy is 2 solar masses, then the time it would take for us to view (on average) all the stars in the galaxy would be half that of the calculated result. The value for the approximate mass of the galaxy if a very approximate number as it can change drastically if there is a miscalculation in the distances of the star clusters from the beginning exercises in the labs. Based on the collected data, we determined that there is a source of error of +/- 229.1083271 parsecs for the distances of each of the star clusters calculated. Other than possible inaccuracies in the map given to us, the other source of error would be when the “View and Measure” part was done in the COG application as the decisions on the approximate size of the clusters was very subjective.

References

No external information was required for the completion of this lab.

Evaluation

Like all of the labs so far in this course, we aren’t actually gathering any data that has not been pre-examined and tested. It would be much better of an experiment and exercise if we could actually measure and gather data from real sources and not pre-defined “textbook” locations that have reasonable data. If the data is skewed, that is something to be spoken about in the report, not a “failed lab”.