Determination of the Large Magellanic Cloud's distance using the Cepheid variable star

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Abstract

This work determines the Large Magellanic Cloud's distance using the period-luminosity relation of the Cepheid variable star. I acquired data from the PROMT 5 telescope and used the catalog of Cepheid from the OGLE database to locate the Cepheid variable star. I measured light curve of one Cepheid variable star which is in the Large Magellanic Cloud, then took the magnitude and the period-luminosity relation, to calculate the distance. I found the distance of the Cepheid variable star to be about 158,000 light-years.

1. Introduction

There are many methods to determine the distance of celestial objects. These include using radar, parallax, redshift or type Ia supernovae for galaxies, and the Cepheid variable stars. Each method is suitable for different celestial objects for example parallax can be use to find the distance of nearby stars but type Ia supernovae for galaxies can be used for more distant stars. This method also needs an Ia Supernova to occur but the Cepheid variable stars don't have this qualification. In this research, I determined the Large Magellanic Cloud's distance by using the period-luminosity relation of the Cepheid variable star. This is the same method used by Edwin Hubble to discover galaxies other than the Milky Way.

The Cepheid variable star can be used to determine the distance of a galaxy or a cluster from earth. The period of Cepheid variable star is related to the luminosity of the star, which can be used as standard candle. Distance can then be calculated using the distance modulus.

The purpose of this research was to determine the distance of the Large Magellanic Cloud using Cepheid variable star. I used the variable data of one Cepheid variable star which is in the Large Magellanic Cloud and used data from the PROMT 5 telescope in Chile.

2. Method

I acquired data about the Cepheid variable star from PROMT 5 telescope at the Cerro Tololo Interamerican Observatory (CTIO) and used the catalog of Cepheid from the Optical Gravitational Lensing Experiment (OGLE) to locate Cepheid variables in our data. I performed photometric analysis of one Cepheid with one reference star, and got the magnitude of the reference star from the USNO-A2.0 database.

When I located the variable star and the reference star, then I took the image to photometry and got the apparent magnitude of the variable star to compare with the magnitude of the reference star. Then I took the average magnitude of the variable to plot a light curve of the variable star. Graphs of the variable star reveal the period magnitude of Cepheid variable star. I took the period magnitude of the variable star to determine the absolute magnitude from the equation: $M = -2.80 \log P - 1.43$, which is given by the graph showing the apparent magnitude and period of Cepheid variable star. Because apparent magnitude is related to the absolute magnitude from

the equation <m> - <M> = -5 log d -5, absolute magnitude is directly related to the average luminosity of the star too. Therefore, a correlation between the period of Cepheid variable star and the average luminosity is log $\frac{<L>}{L_{\odot}}$ = 1.15 log P + 2.47, when $L_{\odot}$ is luminosity of the sun. It can be written in terms of the absolute magnitude: M = -2.80 log P -1.43.

Finally I calculated the distance from the equation of absolute magnitude and apparent magnitude: m - M = 5 log d -5

3. Results

I took the data to phometry and create X, Y graphs. The X-axis is the time in Julian Date and the Y-axis is the magnitude of the stars. From the graph, the data is not contiguous because some information is missing, but the periods of variable star can clearly be seen and they reveal light curves of the variable star because the magnitude of the variable star moves up and down over time.

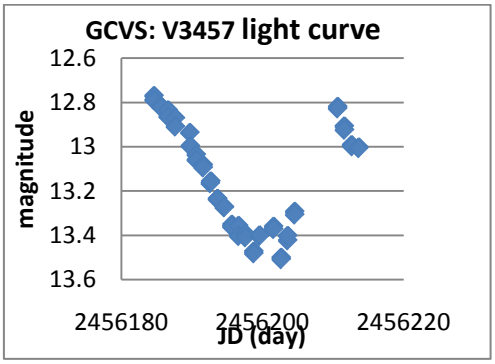

Figure1: Light Curve of GCVS: V3457 variable stars

Figure 1 reveals that the period magnitude of GCVS: V3457 variable star is 23.5 days and the average apparent magnitude is 13.2.

4. Discussion

I found the absolute magnitude from the period of the variable star. By equation: M = -2.80 log P -1.43, when M is absolute magnitude and P is the period of variable star. So the absolute magnitude is -5.27.

Then I substituted the average apparent magnitude (m) and the absolute magnitude of GCVS: V3457 variable stars (M) in equation: m - M = 5 log d -5. I solved the equation above to obtain the distance (d) of 48,300 parsec or 158,000 light years.

5. Conclusion

This determination of the Large Magellanic Cloud's distance used the period-luminosity relation of the Cepheid variable star. I found the distance of Large Magellanic Cloud about 48,300 parsec or 158,000 light years.

6. Acknowledgement

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