

# Distance Measurement of Globular Clusters, Using Cepheid Variable Star.

Bootsarakam Namyuda  
Hoksibpansawittayakom Ubonratchathani School,  
148 Mu 8, Tambol Nong-Bok, Amphoe Laosuakok, Ubonratchathani 34000, Thailand  
E-mail: bootsarakam@gmail.com

## Abstract

The main focus of the study is to measure the distance of the earth to globular clusters using Cepheid variable stars. The globular clusters in Southern Hemisphere named NGC7089 and NGC5139 were selected.

The distance calculation was done by using the apparent magnitude and absolute magnitude data from the light curve analysis. The result of the study showed that the distance of Cepheid variable star in NGC7089 and NGC5139 were approximately 36,000 light-years and 20,000 light-years respectively.

## Introduction

Globular clusters are spherical cluster of stars held together by gravity. Cepheid Variable Star is a star which the brightness vary regularly, where the relationship between period and luminosity is known. It has a clear illumination, therefore, astronomers determined that Cepheid Variable Stars are standard candles which can be used to measure the distance of the Earth from other objects in space, for instance, galaxies and cluster stars etc.

The objective of this project is to measure the distance to globular clusters using Cepheid Variable.

The Cepheid variable stars called V1 and V29 were selected as standard candles in order to measure the distance from the globular clusters NGC7089 and NGC5139. PROMPT5 telescope in CTIO, Chile were used to obtain images in filter V.

## Method

1. Selected the Cepheid variable star in globular cluster from Vizier database and selected reference star type star from SIMBAD database.

2. Took globular cluster photos in filter V by PROMPT5 telescope and the exposure time were set at 40 seconds for NGC7089 V1 and 45 seconds for NGC5139 V29 respectively.

3. Perform photometric analysis and create a light curve using the equation:

$$m_1 - m_2 = -2.5 \log (f_1 / f_2).$$

4. Determine the period (P) of the variability by JD last of period – JD start of period.

5. Determine the average apparent magnitude (m), by taking an everyday magnitude from the light curve to find out an average.

6. Determine the absolute magnitude (M) from the period using the equation:

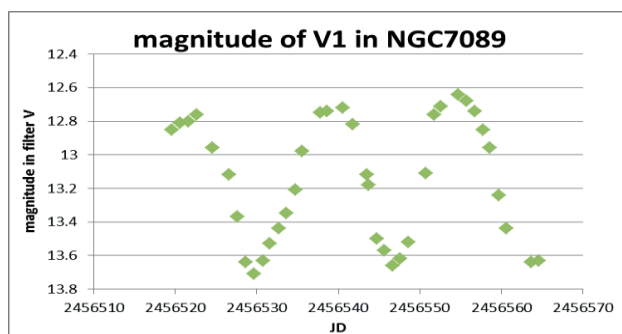
$$M_V = -1.64 \log P + 0.05. \quad [1]$$

7. Measure the distance between the earth and the two globular clusters by the equation:

$$m - M = 5 \log (d) - 5.$$

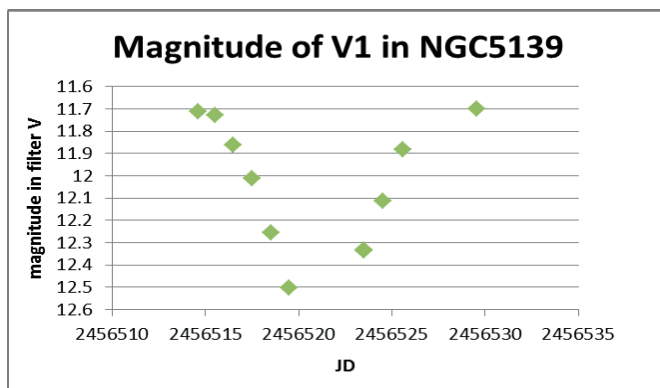
## Results and Discussion

From the figure we see that the X-axis is the date using the Julian Day (JD), whereas Y-axis is the magnitude of Cepheid variable star.



The NGC7089 V1 figure shows that during the study the luminosity of star increased and then it decreased. The variability period of V1 is 16.85 days and the average apparent magnitude is 13.24.

*This figure showed the apparent magnitude of V1 compared with 3 referent stars.*



The NGC5139 V29 figure shows that, during the study the luminosity of star reduced and then it increased, the period variability of V29 is 14.97 days, and the average apparent magnitude is 12.04.

*This figure showed the apparent magnitude of V29 compared with 3 referent stars.*

The absolute magnitude of V1 and V29 could be calculated from the period of the stars by using the equation:  $M_V = -1.64 \log P + 0.05$ . When  $M_V$  is an absolute magnitude in filter V, while P is a period variability of stars, the absolute magnitude of V1 is -1.96 and V29 is -1.88. Then the measurement of the distance was done by using modulus of distance in the equation:  $m - M = 5 \log (d) - 5$ . When m is an apparent magnitude, M is absolute magnitude and d is distance of the earth to the globular cluster which has a parsec unit.

So, the distance between the earth and V1 star in NGC7089 is 11,000 parsec or 36,000 light-years and the distance between the earth and V29 star in NGC5139 is 6,100 parsec or 20,000 light-years.

### Conclusion

Based on the observation of Cepheid variable and using the Period-Luminosity relation, we have found that:

The distance between the earth and Cepheid variable star in the NGC7089 globular cluster is 11,000 parsec or 36,000 light-years.

The distance between the earth and Cepheid variable star in the NGC5139 globular cluster is 6,100 parsec or 20,000 light-years.

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### References

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