

Calculation of Galaxy's Distance with Supernova Ia

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Abstract

This research calculates the distance from the Earth to the Supernova Ia CSS121008. CSS121008 was detected at RA 1h 42m 44, Dec +21 39' 28.4'' on 8 October 2012 and was classified as Supernova Ia. The distance is calculated from photos taken in V filter by PROMT 5 telescope at Chile between 12 and 25 October 2012 and magnitudes were measured by comparing with a reference star, with the maximum brightness determined to be 16.9. Using this magnitude, the distance to the supernova CSS121008 and the parent galaxy is measured at 550 ± 10 million light years.

1. Introduction

There are many galaxies in the universe and there are many procedures that can calculate distance from the Earth to the galaxies. For the galaxies that are not far from the Earth, astronomers can calculate the distance by many theories such as parallax, period of binary star, radial velocity of galaxy, rotate velocity of galaxy, etc but the distance with these theories are incorrect for the galaxies that are so far from the Earth. For those galaxies, astronomers calculate by observation with Supernova type Ia because there is less deviation than another procedure.

A Type Ia Supernova typically results from the violent explosion of the White Dwarf Star in a close binary star system. There are Red Giant Star and the White Dwarf Star in the system. The Red Giant's masses are transferred to the White Dwarf. When mass of the White Dwarf is more than 1.38 solar mass, the White Dwarf will violently burst called Supernova Type Ia. The minimum absolute magnitude is -19.3.

The relation between absolute magnitude and apparent magnitude can be used to calculate distance with equation $m - M = 5 \log d - 5$ where m is apparent magnitude, M is absolute magnitude and d is the distance in parsec.

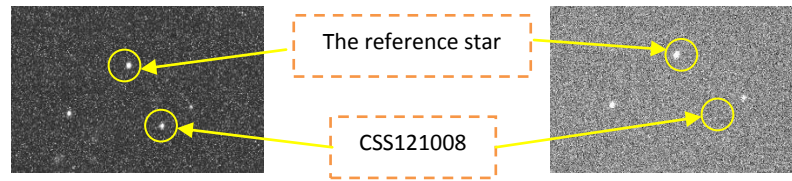
This research calculated the distance from the Earth to the Supernova Ia CSS121008. The data used for calculation are the photographs of CSS121008 taken by Prompt 5 telescope at Chile.

2. Method

The data about Supernova Type Ia is from www.cbat.eps.harvard.edu/lists/RecentSupernovae.html. When a new Supernova Type Ia was discovered, its image would be taken remotely via PROMPT 5 telescope at the Cerro Tololo Inter-American Observatory (CTIO). Five exposures were taken each day with each exposure lasting 150 seconds. The photos used in this research were taken between 12 and 25 October 2012. The Supernova type Ia was studied in this research is CSS121008 at RA 1h 42m 44.8s DEC +21 39' 28.4''.

After five exposures were combined, the flux of CSS121008 and a reference star was measured by aperture photometry tool, the magnitude was calculated three times from two different reference stars. The average flux will be used to calculate apparent magnitude.

Obtain apparent magnitude of the reference star (RA 1h 41m 38.8s DEC +21 38' 46.7") in V filter from catalog GSC 2.3. The reference star's apparent magnitude is 16.51.



Substitute apparent magnitude of the reference star, flux of the reference star and flux of CSS121008 into the equation to calculate CSS121008's apparent magnitude

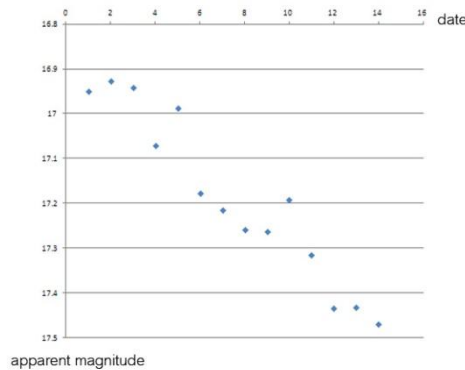
$$m_1 - m_2 = -2.5 \log(f_1 / f_2)$$

Plot graph between apparent magnitude of CSS121008 and time for calculating maximum brightness of CSS121008.

Substitute the minimum apparent magnitude into the equation $m - M = 5 \log d - 5$ (M is absolute magnitude, $M = -19.3$) in order to calculate the distance from the Earth to CSS121008.

3. Results

The figure below shows the light curve between apparent magnitude of CSS121008 and time.



4. Discussion

From the light curve, the maximum brightness of CSS121008 is 16.9 magnitude. Substitute the magnitude into the equation $m - M = 5 \log d - 5$, $M = -19.3$. The distance from the Earth to CSS121008 is 170 ± 4 million parsecs or 550 ± 10 million light years.

The error in the photometry process in this measurement is estimated by repeating the photometry with a different reference star. The error in the magnitude measurement is estimated to be about 0.1, which translated into about 10 million light years.

5. Conclusion

The calculation of the distance between the Earth and the Supernova Type Ia CSS121008 at RA 1h 42m 44.8s Dec +21 39' 28.4" is 550 ± 10 million light years. Since supernova occurs in a star inside a galaxy, this means that the distance to the host galaxy is also 550 ± 10 million light years.

6. Acknowledgement

This work made use of the PROMPT robotic telescopes at the Cerro Tololo Inter-American Observatory (CTIO). The PROMPT access for Thai students is made available through a collaboration between the University of North Carolina at Chapel Hill and the National Astronomical Research Institute of Thailand (NARIT).