43T

Distance Analysis of Supernova Type Ia SN2024unx

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Abstract

This project investigates the light curve of the Supernova Type Ia SN2024unx to determine its distance using the Δm_{15} method and to compare the result with the distance derived from its redshift. Observational data were obtained using the Thai Robotic Telescope from the Sierra Remote Observatory in California, USA. Images were captured daily using an R filter with an exposure time of 200 seconds. The apparent magnitude was measured from the flux using AstroImageJ, and the light curve was constructed from daily observations.The peak apparent magnitude was estimated to be 17.925, and the decline rate Δm_{15} was 0.650. the absolute magnitude was calculated as -19.037. Applying the distance modulus formula, the distance to SN2024unx was determined to be 246.831 Mpc. In comparison, the distance derived from the redshift value was 192.723 Mpc, with a percentage difference of 24.616%.

Keyword : Supernova Type Ia

Introduction

A supernova is a powerful stellar explosion that can occur through different physical mechanisms. One important class is the Type Ia supernova, which originates from a white dwarf in a binary system. This project focuses on Type Ia supernovae because they exhibit a well-defined and nearly uniform peak luminosity, making them highly suitable for calculating cosmic distances [1]. Therefore, they are referred to as “standard candles.”

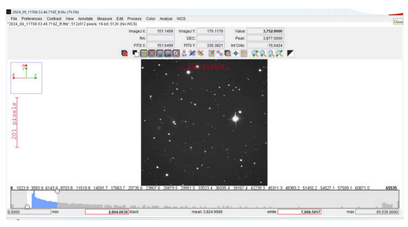
Methodology

step 1

Finding supernova type Ia and capture images

step 2

Photometry images and measure the flux of the supernova Ia and reference star



step 3

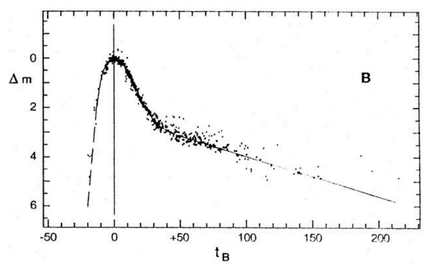
$$m - m_{ref} = -2.5log(\frac{F}{F_{ref}})$$

Calculate the apparent magnitude of the supernova type Ia [2] and using the database to find the apparent magnitude of the Reference star

m : apparent magnitude of Supernova Ia
m_{ref} : apparent magnitude of the reference star
F : fluxes of the Supernova Ia
F_{ref} : fluxes of reference star

step 4

The apparent magnitude of the supernova was recorded daily and plotted on a graph to show the relationship between apparent magnitude and Julian date



step 5

$$M_{max} = a + b\,(\Delta m_{15} - 1.1)$$

Calculate the maximum absolute magnitude

M_{max} : Maximum absolute magnitude
a , b : filter-dependent constants
Δm15 : Decline rate

step 6

$$m - M_{max} = 5log(d) - 5$$

Calculate the distance from the light curve

M_{max}: Maximum absolute magnitude
m : Maximum apparent magnitude
d : Distance from light curve

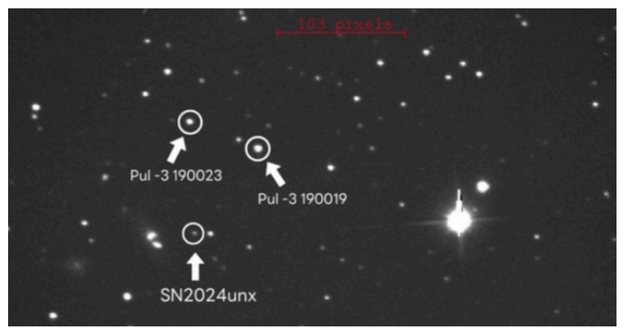
step 7

Calculate the distance from the redshift value

$$d = \frac{Z \cdot c}{Ho}$$

d : Distance from redshift
Z : Redshift
C : Speed of light
Ho : Hubble Constant

Results and discussion

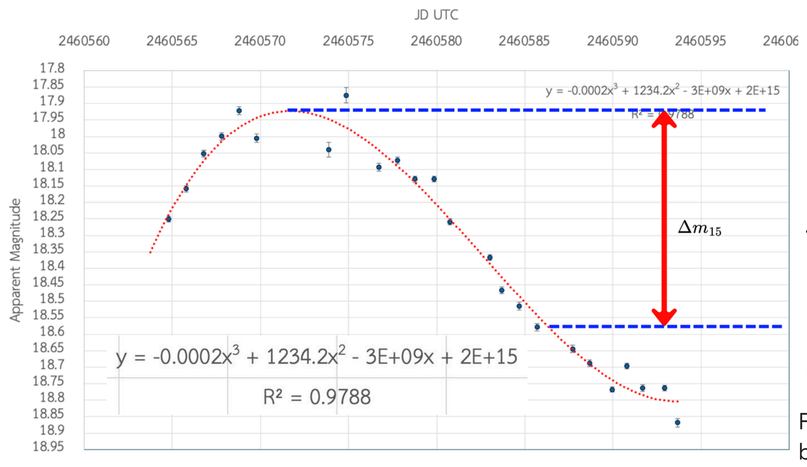


Observed using Thai Robotic Telescope from Sierra Remote Observatory in California, USA

The R filter

Exposure time of 200 seconds

Figure 1: showing SN2024unx and its reference star.



The maximum absolute magnitude and apparent magnitude of SN2024unx is -19.037 and 17.925. The maximum apparent magnitude was taken from the peak of the graph shown in Figure 2

Figure 2: showing the relationship between the apparent magnitude and Julian date of SN2024unx

Use the maximum absolute magnitude and maximum apparent magnitude to calculate the distance of supernova Ia SN2024unx and the distance derived from the redshift value is shown in Table 1

Distance from light curve
246.831 Mpc.

Distance calculated from the redshift 192.723 Mpc

The percentage difference
24.616%

Table 1 : showing parameter of SN2024unx

Parameter	Value
Apparent magnitude, *m*	17.925
Decline rate, $\Delta m15$	0.650
Constant *a*	-18.920
Constant *b*	0.260
Maximum bsolute magnitude, M_{max}	-19.037
Distance from light curve, *d* (Mpc)	246.831
Redshift, *z*	0.045
Distance from redshift, *dz* (Mpc)	192.723

Conclusion

-The graph represents a third-degree polynomial

-The distance estimated from the light curve is 246.831 Mpc, while the distance derived from the redshift is 192.723 Mpc, resulting in a discrepancy of approximately 24.6%

-The discrepancy may have been caused by gaps in the observations, as data could not be collected during the supernova’s peak brightness. Nevertheless, the Δm_{15} method remains an effective and reliable tool for determining the distance to Type Ia supernovae.

Acknowledgement

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Reference

[1] Christopher R. Burn. (2011). The carnegie of Supernova project: Light curve fitting. (Astronomy). America. Observatories of the Carnegie Institute for science.
[2] Matipon Tangmatitham. (2561). Practical guide to astronomy. 4th ed. Chiang Mai:NARIT.