Distance Analysis of Supernova Type Ia SN2024unx

Miss Pinyaphat Rungruang (Grade 10), Miss Prim Krisanamis (Grade 10)
[Varee Chiangmai School, Chiang Mai Province, Thailand]

Abstract

The 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. Images were captured daily using an R filter. The apparent magnitude was measured from the flux using AstroImageJ, and the light curve was constructed from daily observations. The absolute magnitude was calculated as -19.037. Applying the distance modulus formula, the distance to SN2024unx was determined to be 246.831 Mpc.

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. Therefore, they are referred to as "standard candles."

Methodology

Firstly, Supernova Type Ia SN2024unx were observed using the NARIT Thai Robotic Telescope. The observational data were obtained from the Sierra Remote Observatory in California, USA, with images captured continuously daily. Second, the images were analyzed using AstroImageJ to determine the apparent magnitude of the supernova Type Ia from The Pogson logarithmic magnitude relation. The apparent magnitude of the SN2024unx, recorded daily, was plotted as a graph showing the relationship between apparent magnitude and Julian date. Third, the brightest absolute magnitude was calculated from the peak of this light curve using Phillips relation for Type Ia supernovae. Next, the distance to the SN2024unx was calculated using the information above, based on Distance Modulus Equation.

Results and Discussion

The SN2024unx (RA 02:27:55.070, Dec +37:26:51.83) [1] was observed using the Thai Robotic Telescope. The R filter was used during the imaging process, with an exposure time of 200 seconds (see Figure 1). The collected images were subsequently analyzed using AstroImageJ to determine the apparent magnitude of the supernova. Figure 2 shows the relationship between the apparent magnitude and Julian date, derived from the measured flux.

The brightest absolute magnitude and apparent magnitude of SN2024unx are -19.037 and 17.925. The apparent magnitude was taken from the peak of the graph shown in Figure 2 Use the brightest absolute magnitude and apparent magnitude to calculate the distance of SN2024unx and the distance derived from the redshift value show in Table 1. From Table 1, the parameters of SN2024unx were obtained from the relationship between apparent magnitude and Julian date. These parameters were used to calculate the distance to SN2024unx, resulting in a value of 246.831 Mpc. This distance was then compared to the distance calculated from the redshift value, which was 192.723 Mpc. From this comparison, the percentage difference was found to be 24.616%.
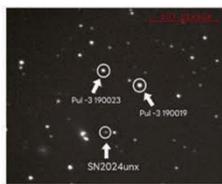

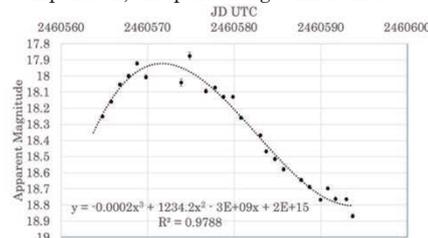Figure 1: showing SN2024unx and its reference star.

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

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 Absolute magnitude, M_{max}	-19.037
Distance from light curve, d (Mpc)	246.831
Redshift, z	0.045
Distance from redshift, d_z (Mpc)	192.723

Conclusion

The analysis of the light curve of the SN2024unx successfully demonstrated the use of the Δm_{15} method to estimate its distance. The apparent magnitude at peak brightness was measured to be 17.925, and the brightest absolute magnitude was calculated to be -19.037 using empirical constants. Applying the distance modulus formula, the resulting distance was 246.831 Mpc. This value was then compared to the distance derived from the redshift (z = 0.045), which yielded a value of 192.723 Mpc. The percentage difference between the two distance estimations was found to be 24.616%.

Reference
[1] Supernova working group. SN2024unx. Retrieved from https://www.wis-tns.org/object/2024unx