Determination of the Hubble Constant using Supernova Ia

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Abstract

Supernova Type Ia is considered a standard candle because the absolute magnitude can be approximated. Supernovae that are included in this research is SN2012fr and SN2020hvf which the photos that are taken will be analyzed by AstroImageJ. The output of the program is the apparent magnitude which can be used to calculate the distance and combine it with the recessional velocity in order to determine the Hubble Constant.

Introduction

Big bang theory is all about how the universe started. It is the most reliable theory that scientists rely on in the present. This is because it has lots of evidence such as Supernovae type Ia. It is considered a standard candle because the absolute magnitude can be approximated which is about -19.3 mag. The absolute magnitude of it can be used to calculate the distance which leads to the Hubble constant.

Material and methods

First, supernova type Ia were taken by NARIT Thai Robotic Telescope (PROMPT8, 0.6 meter robotic telescope at Cerro Tololo Inter-American observatory (CTIO) and 0.7 meter, Gao Me Gu in kumming china). The photos were taken every day continuously. Second, the photos were analyzed by AstroImageJ to find the apparent magnitude of the supernova type Ia from the flux as shown as: $m - m_{ref} = -2.5\log(\frac{F}{F_{ref}})$ The apparent magnitude of supernova Ia that were taken each day will be created as a graph of the relationship of apparent magnitude and Julian date. Third, the exact absolute magnitude was calculated by the peak of the relationship of apparent magnitude and Julian date with: $M_{max} = a + b[\Delta m_{15} - 1.1]$ Next, the distance of supernova Ia can be calculated from the information above by: $m - M_{max} = 5\log(d) - 5$ After that, The Open Supernova Catalog database was used to find the recessional velocity [4]. Finally, the Hubble Constant was calculated by the relationship of recessional velocity and distance

Result and Discussion

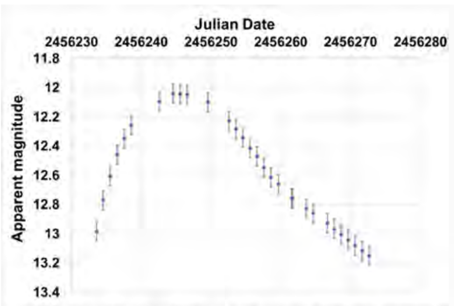

Fig 1. Showing the relationship of the apparent magnitude and Julian date of SN2012fr

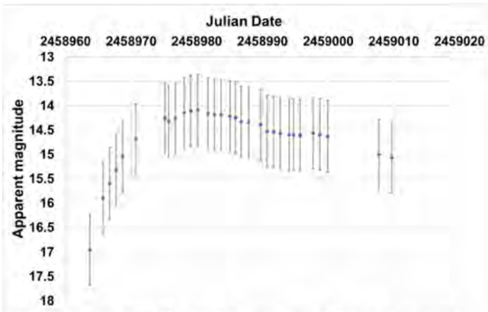

Fig 2. Showing the relationship of the apparent magnitude and Julian date of SN2020hvf

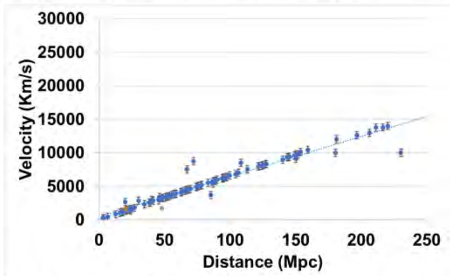

Fig 3:Relationship of velocity and distance

The photos were taken and analyzed each day which is shown in figure 1 and 2. The peak of the graphs were used to calculate the maximum absolute, which is -19.18 mag and -19.08 mag for SN2012fr and SN2020hvf respectively. The distance that was calculated was 17.52 Mpc and 1750.19 Mpc for SN2012fr and SN2020hvf respectively. The Hubble constant that was determine by the slope of figure 3 was 59.935 km/s/Mpc.

Conclusion

The Hubble constant that was determined is 59.935 km/s/Mpc. According to NASA, the present Hubble constant is 73.8 km/s/Mpc so it's an 18.79% error.

Acknowledgement

I would like to express my deepest appreciation to NARIT. I would like to thank my advisor Sarawut Pudmale, Mr. Jessada Keeratibharat and Ms Pranita Sappankum who helped me make this project possible

Reference

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