Determining Hubble's Constant for Distant and Local Universe

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I. Abstract

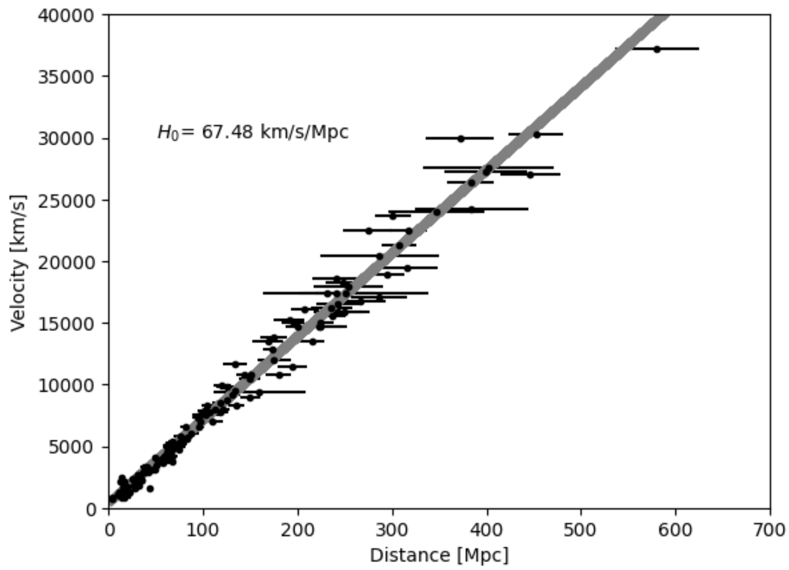
Scientists have been consistently trying to determine the age of the universe for many years. It has been an ongoing problem on determining whether the universe is expanding or shrinking, moving or stagnant, and speeding up or slowing down in growth. It wasn't until an astronomer named Edwin Hubble came on to the scene that we truly understood that our universe was in fact expanding and that there were other galaxies that were moving away from us. From this discovery, he used red shifting to create what is known as Hubble's Law. Using this law, I was able to plot the recessional velocity of the local and distant universe to determine Hubble's constant and discover the expansion history of the universe.

II. Motivation

During this project, my main goal was to determine the expansion history of the universe. I wanted to be able to determine the Hubble's constant for distant and local universe and learn how to compare those two to get a somewhat accurate reading on how the universe has changed over time. In order to compare these results, I needed to use date that was presented in the article Cosmological Results From High-z Supernovae (Tonry, 2003) to plot the supernovae and determine what the Hubble constant was for each section of the universe I was testing.

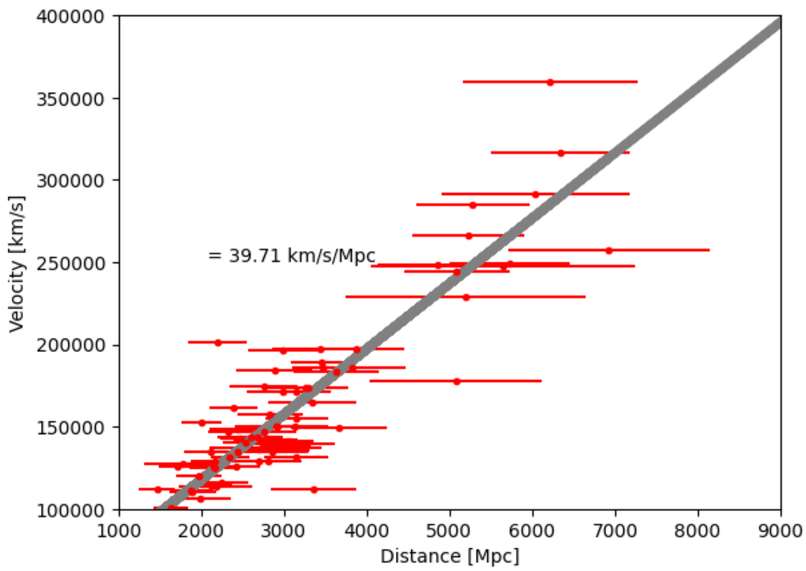
III. Methods

Before we compare the constants for the local and distant universe, I had to split the data in to two different sections. To learn what the Hubble's constant was for the local and distant universe, I had to plot the recessional velocities for the supernovae Ia that was detected in Tonry (2003). For the local universe, I used 0 Mpc to 700 Mpc for the x-axis and 0 km/s to 40,000 km/s for the y-axis. From there, we have to consider any error that was made while measuring the velocities for each supernovae by adding an error bar to each point. After this, I had to create a straight line that would intersect the data points to give us the average growth for the local universe. I then needed to replicate this process for the distant universe. For the distant universe I used 1,000 Mpc to 9,000 Mpc for the x-axis and 100,000 km/s to 400,000 km/s for the y-axis.



[Figure 1]

Figure 1 depicts the graphing of recessional velocities for the local universe. The dots each depict a supernovae Ia and the bars depict the error we calculate for any bias that can be seen when we were measuring the velocities. Lastly, the line is considered a line of best fit that helps us determine what the Hubble constant was for the local universe. In the upper left corner, we can see what the Hubble's constant is.



[Figure 2]

Figure 2 depicts the graphing of recessional velocities for the distant universe. The dots each depict a supernovae Ia and the bars depict the error we calculate for any bias that can be seen when we were measuring the velocities. Lastly, the line is considered a line of best fit that helps us determine what the Hubble constant was for the local universe. In the upper left corner, we can see what the Hubble's constant is.

IV. Results

From the lines of best fit for the velocities, we can see that the Hubble Constant for the local universe is 67.48 km/s/Mpc, as seen in Figure 1, and for the distant universe it is 39.71 km/s/Mpc, as seen in Figure 2. As we can see, the local universe has a higher slope or Hubble constant than the distant universe does. This tells us that the distant universe is expanding at a slower rate than the local universe is. Along with this, a larger Hubble constant can generally be characterized as a younger universe. From this, we can see that the local universe we were able to detect is younger than the distant universe showing us how the universe has expanded over time.

V. Conclusion

I concluded that the recessional velocities we plotted told the story of how the universe has expanded since the beginning. We can see that due to the lower Hubble's constant for the distant universe, the distant universe is therefore older than the local universe. The universe has been expanding for a long time and seeing how the distant universe is older shows us that the universe is still expanding. We can use these same techniques in the future to determine how much the distant universe is still expanding by comparing the Hubble constants we find at different times.

References

Tonry, J. L., Schmidt, B. P., Barris, B., Candia, P., Challis, P., Clocchiatti, A., Coil, A. L., Filippenko, A. V., Garnavich, P., Hogan, C., Holland, S. T., Jha, S., Kirshner, R. P., Krisciunas, K., Leibundgut, B., Li, W., Matheson, T., Phillips, M. M., Riess, A. G., … Suntzeff, N. B. (2003). Cosmological Results from High-zSupernovae. In The Astrophysical Journal (Vol. 594, Issue 1, pp. 1–24). American Astronomical Society. https://doi.org/10.1086/376865