Astro 1221 Written Report #2:

Measuring the Age of the Universe using the Hubble Constant and Redshifting

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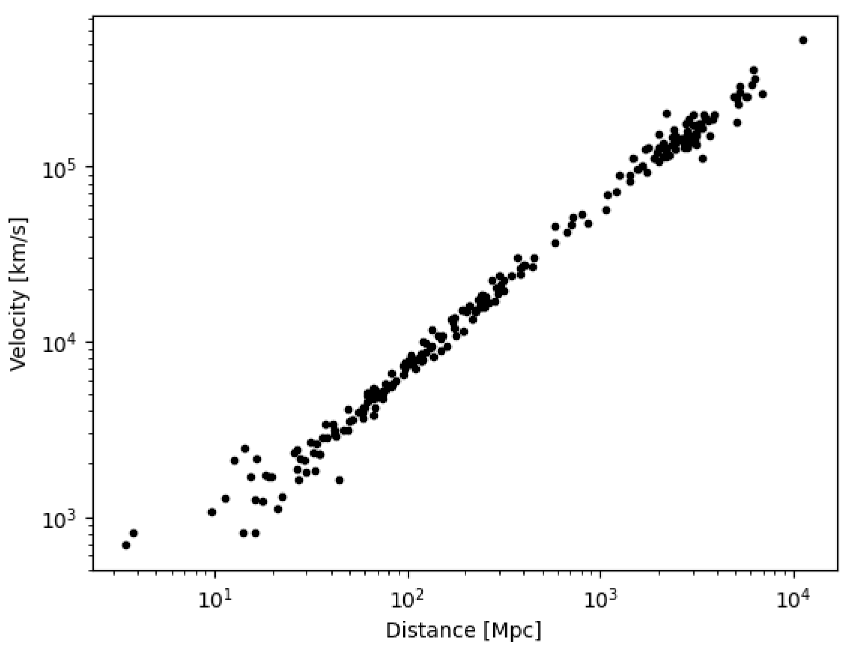
Motivations:

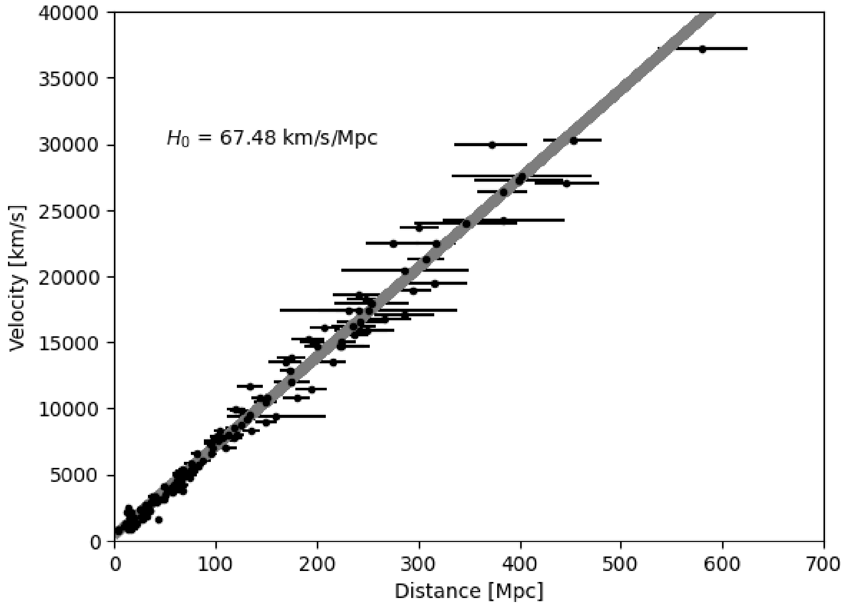
We built our model to show how we can use redshifting from type 1a supernova to measure how old the universe is. Redshifting is a phenomenon where light begins to shift towards the lower end of the light spectrum, making the light appear more red than it was originally. By measuring how far the light has shifted into the red-side of the visible spectrum, we can tell how long the light has been traveling, and thus we can find the expansion of the universe, and then extrapolate the age of the universe.

Methods:

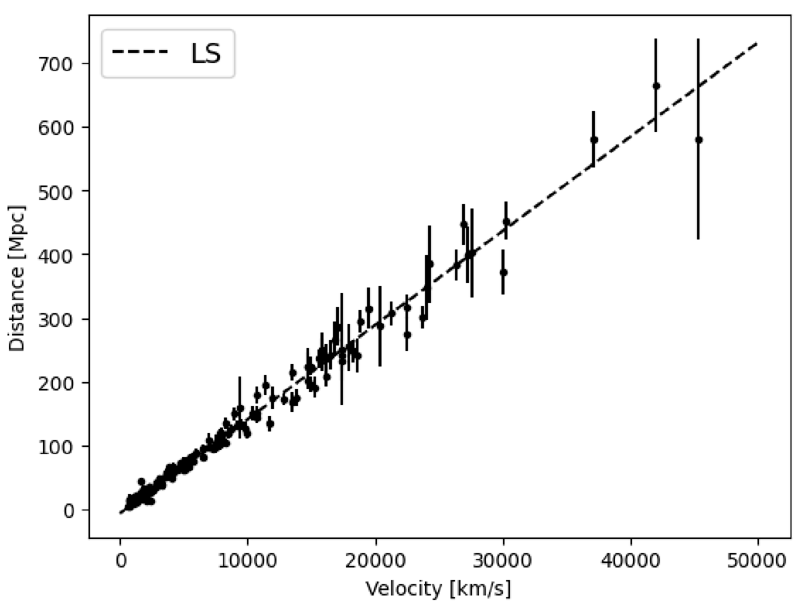
To build our model, a python program can be made based off of the above equation. To ease the process, the Python packages “astropy.constants”, “astropy.units”, “numpy”, and “matplotlib.pyplot” are imported. These tools allow us to use Astrophysical constants, units, numerical operations, and build plots, respectively.



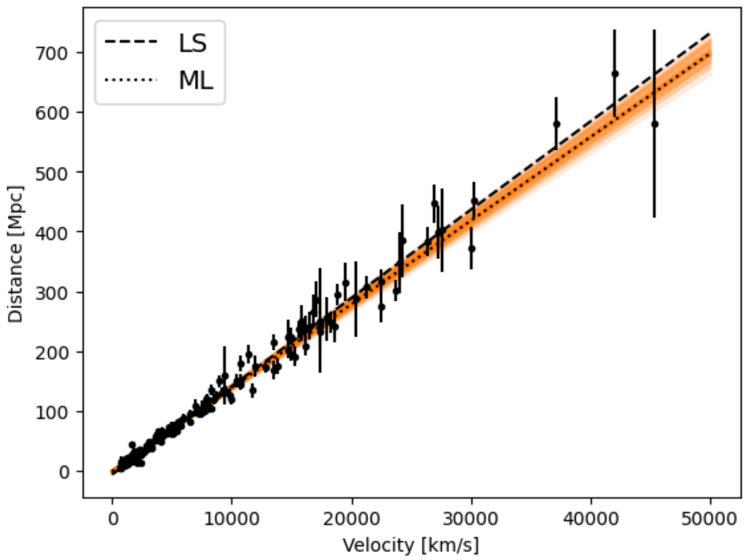
We then increase the x-axis and y-axis that way we are able to fit more data onto the graph. After that, we estimate the Hubble constant using a line of best fit.



We swap the x-axis and the y-axis to begin the process to find the actual Hubble Constant. The next thing we do is we add a least-square estimate to account for possible errors.



The next thing we do is add a most-likely estimate to the graph to have a line of best fit that we can use to calculate Hubble's Constant.



This graph shows us the line of best fit for the Hubble Constant, the orange parts of the graph show the margin of error for the constant.

Results:

```
Hubble = z[0] *u.km/u.s/u.Mpc# define Hubble constant
# convert Hubble constant to seconds by converting megaparsec to km
Hubble = Hubble / ((3.086 * (10**19))*u.km/u.Mpc)
age = 1 / Hubble # define variable for age of universe using age of universe equation
age = age / 60 / 60 / 24 / 365 * 1/u.s * u.yr# convert age to years
print(age) # print age
```

```
14501248926.094831 yr
```

Based on the data that was given to us, we calculated a Hubble Constant value of 67.48 km/s/Mpc. We then got rid of the distance units by canceling out kilometers and megaparsecs to get a unit of time in seconds. From there, we converted the seconds to years for which we got about 14.5 billion years.

Conclusions:

So based on the data given to us, we calculated the universe to be around 14.5 billion years old which is slightly different from what actual scientists have estimated. Scientists have estimated the universe to be around 13.8 billion years old, but other studies calculated by other researchers with other sets of data have gotten other values. The reason our value is different is because the value we calculated for the Hubble constant is slightly less than what's typically accepted for the Hubble constant as it ranges between 68 and 74 km/s/mpc. One issue with our data is that it only included data about a couple Type 1a supernovae when there are many more Type 1a supernovae than what was in the dataset. Also there are other events in space that occur which we can use to get a more accurate Hubble constant and thus a more accurate calculation of the age of the universe.

Contributions:

Owen Urban: Motivations
Jacob Mathew: Worked on Results and Conclusions

AI Statement:
For this project, we used Google's Gemini in order to help us write the code to generate the graphs of the orbital velocities of the different components in the galaxy.