Calculating the Age of the Universe

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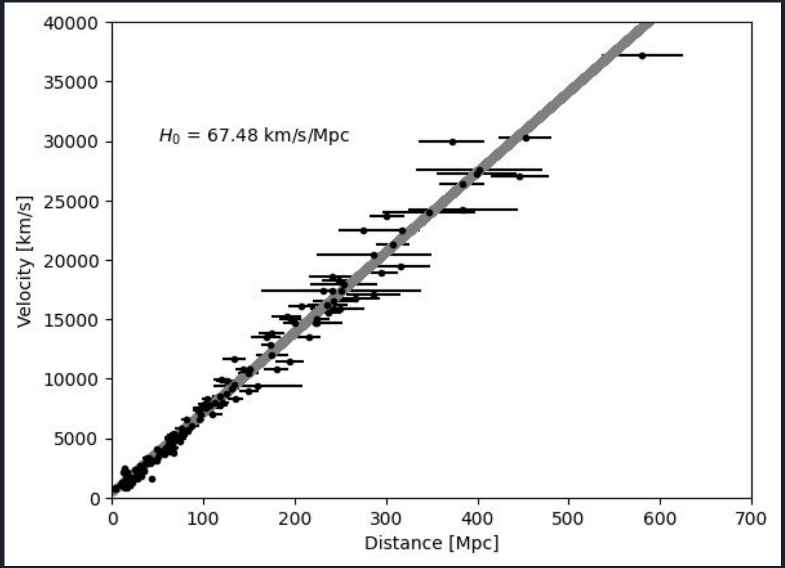
Motivations - Why we made this model

We built our model to show how we can use redshifting from type 1a supernova to measure how old the universe is. A supernova refers to when a star explodes due to reaching the end of its life. A type 1a supernova is a specific type of supernova where the star that explodes is a white dwarf. Redshifting in this case is a phenomenon where light from the supernova begins to shift towards the lower end of the light spectrum, making the light appear more red than it was originally. As light becomes more red, it’s wavelengths are stretched out more and this is due to the expansion of the universe.

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 extrapolate the age of the universe by calculating the Hubble constant which is our goal for this project.

Methods - Equations We Used

- Hubble's Law states V = d*H0 where d is the distance of the supernova from us and V is the velocity that the light travels at from the supernova
- H0 represents Hubble's constant which basically represents the rate at which the universe is expanding
- So for our project, we were given data about multiple type 1a supernovae like the distance and the velocity of the light from the supernovae
- By graphing this all of the data on a graph where the x-axis represents the distance from the supernova and the y-axis represents the velocity that the light was traveling at, we could make a linear line of best fit for the data where the slope would represent the Hubble constant



Methods - Calculating age of universe

- The equation for the age of the universe is d/v as dividing the distance by the velocity gives us a time value, but we know from Hubble's law that v = H0 *d so if we substitute that into the age equation, we get that the age of the universe is 1/H0
- So if we substitute the Hubble constant value we got from the previous slide and convert the value to seconds by getting rid of the km and mpc units, we can get a value in seconds which we then convert to years

```python
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
```

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 which we then used to calculate the age of the universe for which we got about 14.5 billion years.

Conclusion:

Scientists typically estimate the universe to be about 13.8 billion years old but our calculations estimate it to be 14.5 billion years old. This difference is due to our calculation for the Hubble constant as we estimated that it was 67.48 km/s/Mpc. While it may seem far off, there isn't one concrete answer for the Hubble constant and the age of the universe. Also, this was calculated only using type 1a supernova and there are other events in the universe that allow us to calculate the age of the universe meaning there is a margin of error with the most accepted estimate.

AI Statement:

- For this project, we used Google's Gemini in order to help us write the code to generate the graphs for the supernova velocities and distances along with the line of best fit