Henrietta Leavitt: Modern Astronomy’s Unsung Heroine

Background

Henrietta Leavitt was born on the Fourth of July of 1868 in Lancaster, Massachusetts. She studied at Radcliffe College in 1888 at the age of 20. She was very dedicated to her studies and her church duties. Her education at Radcliffe was rigorous and eclectic: she studied philosophy, fine arts, analytical geometry, and differential equations but it was her Astronomy classes that really piqued her interests. After graduating in 1892 at the age of 23 with her Bachelor of Arts degree, she volunteered at the Harvard College Observatory while working on an advanced degree in Astronomy.

Given her educational background, her passion for astronomy, and her meticulous attention to detail, she should’ve been a shoe-in for an astronomer position. But since she was a woman, her talent was grossly underestimated and she was given the position of “computer” which was a position almost exclusively filled by women and involved a lot of manual calculations that the male astronomers didn’t want to do.

Important Questions

Before I dive into Leavitt’s accomplishments and discoveries, here are some important questions about the scale of the universe I want you guys to keep in mind:

- How do we measure the distances of stars?
- How large is the Milky Way?
- How do we know that there are other galaxies in the universe?

Parallax Method

So how do we measure the distance of stars? When we look up at the night sky, we see a flat 2-dimensional view. Enter parallax. In order to demonstrate parallax, I’d like you to hold out your thumb and close your right eye. Now open your right eye and close your left eye. You should notice that your thumb changed position relative to the background when you changed which eye you were looking through. This is because each of your eyes is at a slightly different position and thus you are seeing two different images. The distance to your thumb is directly correlated with the distance it had appeared two move horizontally from the two images from each eye. This is how distances in space are measured: photos are taken of a stellar object at one side of Earth's orbit and the second image is taken 6 months later, and the images are studied for any differences in the backgrounds of the images.

However, the Parallax Method is only effective for stars that are within 3,300 light years of Earth.

Leavitt's Law: Period-luminosity Relation

Edward Charles Pickering, the director of the Harvard College Observatory at the time, had assigned Leavitt with studying pulsating variable stars, which are stars whose brightness as seen from Earth fluctuates due to their changing diameters, in the small and large Magellanic clouds. Her task was to measure and catalogue the brightness of these stars. Her work required meticulous attention to detail. She identified 1,777 variable stars – 969 in the small cloud and 808 in the large cloud. She noticed that the variable stars which were brighter had longer periods. She published these results in the *Annals of the Astronomical Observatory of Harvard College* in 1908.

Leavitt had successfully published a thorough and important paper in Harvard's astronomical journal but she wasn't done yet. She continued her painstaking and meticulous research and in 1912, she published her breakthrough paper in which she plotted the brightness and the periods of 25 Cepheid variable stars in the Small Magellanic Cloud.

She noticed that how fast they pulsed is directly related to how bright they are. So if you could measure how bright they *appear* in the sky, you then know how distant they are. Cepheid variable stars became the first *standard candles* of the universe which help us determine large distances since we know their absolute brightness. On the chart above, the horizontal axes represent the period of the cepheid star and the vertical axes represent the apparent brightness. The Figure on the right has the modification that the horizontal axis is actually the log of the period of the cepheid star so we can more easily see the relationship between the period of the star and its apparent brightness.

Think about it this way: if you had a candle next to you, you know how bright it *actually* is. This is called its absolute brightness. If you left the candle in place and started to move away from it, its *apparent* brightness would decrease and because of the inverse square law, you could then deduce how far away that candle is.

This meant that we could finally accurately calculate the distances to things in the universe. And so every single distance measurement we now make in the universe is all calibrated on these nearby distance estimates using Leavitt's law of pulse period is related to brightness.

Impact

Leavitt's discovery meant that astronomers were now able to measure distances of stars up to about 20 million light years, which was a total game changer and has led to a new paradigm for measuring distances in space.

Additionally, Leavitt's discovery was pivotal to many other important advancements in astronomy. In 1917, Harlow Shapley used Leavitt's law to determine the size of the Milky Way galaxy at about 100,000 light years and put the sun at 30,000 light years away from its center. This was the first model of the Milky Way that didn't have the sun at the center. In 1926, Edwin Hubble used Leavitt's law to determine that the distance to the Andromeda Galaxy - which was at the time considered a nebula - to be much larger than the size of the Milky Way, establishing that there are in fact *other* galaxies in the universe.

Death

Leavitt's career was often interrupted with illness; she died in 1921 at the age of 53 from stomach cancer. Her death was seen as a tragedy. Her colleague, Solon I. Bailey, at the Harvard College Observatory wrote in her obituary, "she had the happy, joyful, faculty of appreciating all that was worthy and lovable in others, and was possessed of a nature so full of sunshine that, to her, all of life became beautiful and full of meaning."

Legacy

The Period-luminosity Relation is only *sometimes* called Leavitt's Law. This is made even more disappointing since her work had gone mostly unnoticed during her lifetime and only in recent history has it gained more recognition.

She does have a crater on the moon and an asteroid named after her but I feel like that's not enough recognition for her. She deserves more.

Interestingly, I found out that Swedish Mathematician Gösta Mittag-Leffler had attempted to nominate her for the Nobel Prize in Physics in 1925, only to later learn that she had died of cancer three years earlier. She was not able to be nominated since the rules of the Nobel Prize state that the prize cannot be awarded posthumously.