The Hubble Constant – Mathematical Proof

By Jayant Kapatker

EMAIL: JAYANT@STAMINTERACTIVE.COM TEL: 609 7509827

The Hubble Constant – Mathematical Proof

What is the Hubble Constant?

Does the universe expand? Science tells us the universe is expanding. Why is the universe expanding? How fast is the universe expanding? We are not very sure about the answers to these questions. Using powerful telescopes, scientists have watched the movement of different planets and galaxies and noticed the expansion is uneven. Some places the expansion is faster and at other places, it's slower. There's no explanation about this uneven expansion. Looking at far away planets and observing their rate of expansion, they have come up with a Hubble constant.

The Hubble constant states that the rate of expansion is about 72 kilometers per second per megaparsec. A megaparsec is a million parsecs, or about 3.3 million light-years. It means objects 3.3 million light years away are expanding at 72 kilometers per second. This is based on observation only. There is no mathematical proof of the Hubble Constant. If you understand the fundamentals of the expansion of the universe correctly, it is possible to calculate and prove the Hubble Constant. We calculate the Hubble Constant in this article and prove mathematically that what has been observed is indeed correct.

Fundamentals of the Spacetime Framework

So, what are the fundamentals of the expansion of the Universe? Understanding the spacetime framework is the key to understanding the expansion. So, how is the spacetime framework structured? This is where the confusion begins. Science teaches us that the spacetime framework started with the big bang about 13.7 billon years back. Does this mean that the starting point of the spacetime framework is the big bang? Yes, the beginning of the spacetime framework was the big bang, but that event was 13.7 billion years ago. Where is the start of the spacetime framework right 'now'? It is not the big bang; the big bang is now at the outer edge of the universe. The beginning or start must be at the other end. No one has observed the outer edge of the universe; therefore, how can you call the big bang is the start of the spacetime framework right 'now'? This incorrect understanding about the start of the spacetime framework is the underlying cause for the confusion about of space. This misunderstanding leads to the lack of proper knowledge about the construction of space, how fast it is expanding and why it expands at an uneven rate.

So, what is the starting point for the spacetime framework? The surprising answer is that I am, you are, we all are the beginning or starting point of the spacetime framework. The 'observer' within me, the 'observer' within you, the 'observer' within every living being is the starting point for the spacetime framework. We can call this starting point as t = 0 for the spacetime

framework. The 'observer' is the start of the spacetime framework, and this is therefore the t = 0 for the framework. To add more drama to this idea, the observer within you, the observer within me and the observer within everyone else is unique and independent of each other. This would imply that each observer or each living being will create their own independent spacetime framework. Each observer will have their own spacetime framework and the start or t = 0 for the framework is the observer.

There is no denying that this idea about the observer being the starting point for the spacetime framework is radical and is the opposite of what is being currently understood. This is totally different and contrary to current thinking. The question is, is there any way to support this idea with known scientific ideas or with proper reasoning? Fortunately, there is.

Let's analyze this issue from different angles to show our hypothesis is correct.

1. By Using Einstein's Theory of Special Relativity
2. By Using logical reasoning

1. By Using Einstein's Theory of Special Relativity

Einstein's theory of special relativity was a major discovery in science, a discovery of the connection between motion and time. The underlying principle behind the Theory of Special Relativity is that the speed of light is fixed at 186,000 miles per second, irrespective of the frame of reference. To understand this, let us say a person is traveling in a car at 40% of the speed of light and this person takes a measurement of light from the car. This person would expect that the speed of light is 60% of its original speed. This person will be surprised to learn that the speed of the light is still 186,000 miles per sec. How does this happen? The only way to explain this is that the 'time' of the person travelling in the car has slowed down. His clock will move slower as compared to people outside the car. His space or ruler will also be more compressed. Since time has slowed down and space has been compressed, his measurement of the speed of light will still be 186,000 miles per second. So, the main conclusion from this discovery is that if you have motion, any motion, time slows down. Even if you are walking or traveling at 40% of the speed of light, time slows down. How much time will slow down will depend on your speed or the speed of the travelling object. The higher the speed, the more time slows down. At the speed of light, time does not move, it remains stationary. The higher the speed of a moving object, space gets more compressed. We do not realize this, but the connection between motion and time has tremendous implications in our daily life. Do we see motion in this universe? Of course, there is motion everywhere. We see an ant crawling, we see a person walking and someone else is cycling or going in a car. Some are going faster while others are slower. If you apply the principles of Einstein's theory, it would mean that the time clock for each person is beating differently. The digital/atomic clocks created by human beings

are not that sensitive to register the differences in the clocks of people in motion. However small the difference, based on the theory of special relativity, the passage of time is different for people in motion. If two people are stationary, their clocks will beat at the same rate; the moment one of them starts walking, the clock of the person walking will slow down.

If the time clocks are different, space compression is also different for each person. This means that each person is creating their own spacetime framework. There is no other possible conclusion. Einstein's theory of relativity therefore supports the idea that the starting point or t = 0 for the spacetime framework is the observer within each person.

2. By Using Logical Reasoning

Let us study the external objects 'out there'. If we can see a faraway star, say 5 million light years away, light from that star will take 5 million years to reach us. Now, we see the sun, the light from the sun takes 8 min to reach us. We look at the moon; its light will take 3 seconds to reach us. We look at a plane flying in the sky, at 30,000 feet; its light will take about 300 milliseconds to reach us. As the distance to the object being viewed is reduced, the time taken for light to reach us is much smaller. This means the size of the spacetime is reducing and getting smaller. I now look at the tree outside the window; the time taken for light to reach me is 10 microseconds (10^{-6}). I am looking at the computer screen 1 ft away typing this article, light will take about 1 nanosecond (10^{-9}). As the distance reduces the time taken for light from the object being observed also reduces. If you extrapolate this backward, the only logical place for t to be equal to 0 is the observer, who is watching all these objects. This means that the observer within you is the starting point of the spacetime framework. This starting point of the spacetime framework is t = 0.

If you or anyone else looks at the universe with this understanding, they will reach the same conclusion. Everyone has their own t=0, which is within themselves. This will apply to every living being in the universe. It would seem; therefore, I have my own t=0, you have your own t=0 and every living being in the universe has their own t=0. The only way to understand this, is that every living being creates their own spacetime framework and this framework starts with t=0.

This logical reasoning also supports the idea the space of the universe is starting with the observer within you.

Now that we have established that the individual person's or the observer's location is the starting point for the spacetime framework, let us try and estimate the size and the rate of expansion of the universe.

Size and Expansion of the Universe

What is the possible maximum size of the spacetime framework? Science tells us that the age of the universe is 13.7 billion years old. This is the big bang moment. Light reaching us (or the observer) from the big bang moment would be the outer edge of the spacetime fabric. Light will take 13.7 billion light years to reach us from the big bang. This is the outer edge because there was no universe before the big bang. So, the size of the universe is 13.7 billion light years or 12.9×10^{25} meters. One light year is the distance light travels in one year, which is = 9.46×10^{15}meters.

Is this spacetime expanding? Definitely Yes. How much? Let us try and understand this. If you assume the universe is 13.7 billion years old 'right now'. After one second, the age of the universe will be 13.7 billion years + 1 sec. Light must now must travel an additional 186,000 miles to reach the observer, which means the size of the universe has grown by 186,000 miles. After 10 seconds, the size of the universe would increase by 186,000 x 10 = 1,860,000 miles. After one year from now, the size of the universe will increase by 1 light year. 1 light year is the distance light travels in one year.

From the above, we can conclude that the rate of expansion of the outer edge of the universe = 1 light year per year.

Calculation of the Hubble Constant

Imagine the spacetime fabric as an elastic rubber sheet, starting from t=0 (which means you) to the outer edge of the universe. The end at the observer's side is fixed. It is always t = 0, it does not change. The other end which is the outer edge of the universe is being pulled outwards. The outer edge of the elastic space time fabric is expanding by 186,000 miles every second. It is expanding at the speed of light every second, which is one light year every year. As time passes, the expansion of the spacetime fabric will continue at the speed of light.

It must be understood that only the outer edge of the universe is expanding at the speed of light, anything in between will not expand at the same speed, it will be proportional to the distance from the observer. Using the rubber sheet example, if you pull the outer edge by a certain distance, the inner parts will not be stretched by the same amount. The stretching will be more at the outer edges and it will be much less as you move inwards to the other side which is fixed. This idea can also be applied to the spacetime framework. This means that the rate of outward expansion of galaxies, stars etc., would really depend upon how far these galaxies are from the observer. The observer is t=0. Stars close by will expand more slowly, as compared to stars which are further away. This is because the space time for the stars nearby will "stretch" less as compared to the stars which are further away.

Based on this understanding of the "stretching" of the space time fabric, let us try and calculate Hubble Constant for objects which are 3.3 million light years (3.3×10^6 light years) away from us.

- The size of the universe is 13.7 billion light years (13.7×10^9 light years) and the outer edge expands by 1 light year every year
- The object 3.3 million light years away from us, it will expand proportionally by $3.3 \times 10^6 / 13.7 \times 10^9 = 0.240 \times 10^{-3}$ light year per year
- 1 light year = 9.46×10^{12} Km
- Therefore 0.240×10^{-3} light year per year x 9.46×10^{12} Km = 2.27×10^9 Km per year.
- 1 year = 3.15×10^7 sec
- 2.27×10^9 Km per year x 3.15×10^7 sec = 72 km /sec

The above calculation shows that the Hubble constant is indeed 72 km/sec. We have just calculated and proven what has been observed by science.

Spacetime and the Sun

In the same way, we can calculate the expansion of the of the sun, which is the closest star for us.

- The size of the universe is 13.7 billion light years and it expands by 1 light year every year
- The sun is 1.58×10^{-5} light years away from us, it will expand by $1.58 \times 10^{-5} / 1.37 \times 10^{10} = 1.15 \times 10^{-15}$ light year per year
- 1 light year = 9.46×10^{15} meters
- Therefore 1.15×10^{-15} light year per year x 9.46×10^{15} meters = 10.8 meters per year.

The outer edge of the universe is expanding at the speed of light, but the space time fabric around the sun is expanding only by 10.8 meters per year. I am not sure if observation has already been made of this expansion. If it has been made, I am confident the expansion rate will be as what we have calculated here. In fact, this model can be used to calculate the expansion rate for other stars and galaxies in the universe. I am positive this expansion model will be proved to be correct.

Since the calculation of the Hubble constant is accurate, it proves that the expansion model explained in this article is correct. This proves that the spacetime fabric starts with the observer within each person. Also, each person creates their own spacetime framework. Using this

unique idea, we have mathematically proved the Hubble Constant, which was, until now, only an observed fact. If we accept the concept of t=0 as the start of spacetime framework to be a universal and scientific truth, it will help solve many of science's unanswered questions. It is a revolutionary idea, but it is the only truth.

About the Author:

Jayant Kapatker
B.Tech from Indian Institute of Technology, Kanpur.
M.B.A. from Faculty of Management Studies, Delhi University.

My main passion these days is trying to assimilate the teaching of Vedanta in my daily life. For the past 15 years I have been attending Vedanta and Bhagavad Gita classes at the Arsha Bodha Ashram, New Jersey. Whatever I have learned in Vedanta has been due to my teacher Swami Tadatmananda. He is a teacher par excellence.

Having a scientific bent of mind, I have also been reading a lot about science and physics. The more I read, the more I find that there is a meeting ground between Science and Vedanta. Please visit www.vedantaandscience.com to read more articles and blogs.