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Research Article

Resolving the Hubble Tension: A Theoretical Approach Using Newton's Mechanics and Electromagnetic Wave Propagation

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ABSTRACT: Hubble tension problem is solved theoretically by applying Newton's gravitational and force laws and the laws of electromagnetic wave propagation. Theoretical predictions are verified by the experimental and observational data. It proposes a universe with a central core of dark matter and energy, showing accelerated expansion and supporting a cyclical cosmology. This proof implies that dark energy and dark matter exist at the center of the universe. The proof also proves the existence of center of the universe. The general theory of relativity has proved to be incorrect. Inflationary theory is proved in this paper. Theoretical predictions align with observational data, challenging general relativity and reinforcing the inflationary model. The universe is proved to be cyclical. The lifetime of the universe is calculated and the estimated value is at least in the range of 100 – 1000 billion years.

KEYWORDS: Hubble Tension, Modified Big Bang Theory, Dark Energy, Dark Matter, Electromagnetic Wave Propagation, Newton's Mechanics, Cyclical Universe, Inflationary Theory.

INTRODUCTION

Vesto Melvin Slipher performed the first measurements of radial velocity for galaxies. He was the first to discover that distance galaxies are redshifted, thus providing the first empirical basis for the expansion of the Universe [1-2]. He was also the first to relate these redshifts to velocity [3]. He stated that we are not at rest with respect to other galaxies on average. He deduced a mean velocity of 700km/s. In 1924, Lundmark established a linear distance-redshift relationship. However, the theoretical understanding of this relationship was not established [4]. He was the first one to estimate the value of the Hubble constant and the value estimated by him was 35 km/s/Mpc.

Alexander Friedman was the first to publish non-static solutions to Albert Einstein's field equations [5]. Lemaitre used the velocities of galaxies measured by Vesto Slipher and published by Stromberg [6-9] and distances to those galaxies determined by Hubble [10] to estimate the Hubble constant [11]. His estimated values were 575 km/s/Mpc and 625 km/s/Mpc. He was the first one to prove with observational evidence that the Universe is expanding. H.P. Robertson independently developed the concept of an expanding Universe [12] which implied that distant galaxies as seen from the Earth would be redshifted. In 1922 and 1924, C.W.Wirtz deduced with his data that galaxies that appeared smaller and dimmer had larger redshifts and thus that more distant galaxies recede faster from the observer [13-14].

In 1908, Henrietta Swan Leavitt, discovered a method for measuring vast distances to remote galaxies [15]. In 1929, Edwin Hubble combined Slipher's velocities with Leavitt's intergalactic distance calculations and methodology for calculating the expansion rate of the Universe [16]. Hubble's original estimate of the constant was 500 Kms/s/Mpc. This value is much higher than the currently accepted value due to errors in his distance calibrations.

Later on, Walter Baade found two distinct populations of stars in a galaxy which led to doubling the calculations made by Hubble [17]. For most of the second half of the 20th century, Hubble's constant value was estimated to be between 50 and 90 Kms/s/Mpc. In the late 1990s, the Lamda cold dark matter model (LCDM model) of Big Bang cosmology was introduced and this model is the standard model of cosmology. Using this model and measurements made in X-ray, optical and microwave frequencies gave a value of around 50-70 Kms/s/Mpc for Hubble's constant [18]. By the late 1990s advances in ideas and technology allowed higher precision measurements have converged on a value of approximately 73 Kms/s/Mpc for Hubble's constant. All these measurements were made in the late universe [19]. Since 2000, early universe techniques based on CMBR gave a value of approximately 67.7 Kms/s/Mpc [20]. This discrepancy between the two values is called Hubble tension [21]. This problem is not yet solved [22].

So, in this article, the Hubble tension problem is solved. In the first section, this problem is solved by interpreting the unit of the Hubble constant. The cosmological model used in this article is a modified Big Bang cosmological model [23]. In this model, the universe is assumed to be a spherical volume with a center. Dark energy and dark matter are assumed to be at the center of the universe. The field and the space are assumed to be different. Earlier, the author has validated such a model with observational and experimental evidence.

In the second section, the theory of the first section is explained with mathematical tools. In this section, the same theory is developed by interpreting the definition of the Hubble constant and applying mathematics. In the third section, the Hubble constant is derived based on electromagnetic radiation and pressure. In the fourth section, the same theory is developed by applying Newton's gravitational and force laws. In the fifth section, the universe is proved to be inflationary. In the last section, the universe is proved to be cyclical and the lifetime of the present universe is estimated.

HUBBLE TENSION PROBLEM IS SOLVED

Hubble's law is considered the first observational basis for the expansion of the universe and is an important piece of evidence for supporting the Big Bang model of cosmology [24]. Hubble's constant is defined as the ratio of the velocity of a galaxy to its distance as per Hubble's law. In other words, the constant is not a constant, but a reciprocal of the age of the universe or Hubble's time. The approximate value of the Hubble constant is 70 Kms/s/Mpc. So, the Hubble time is 14.4 billion years. Hubble's constant could also be considered as a relative rate of expansion of the universe. In this form, the value of Hubble's constant is 7%/Gyr. This means, that at the current rate of expansion, it takes one billion years for an unbounded structure to grow by 7%.

The relative rate of expansion of the universe could also be defined as the ratio of difference between Hubble's constant value at present and its value at one billion years after the big bang to the value at one billion years after the big bang. From one billion years and for about 12.8 billion years, the universe has looked much as it does today and it will continue to appear very similar for many billions of years into the future. As we have seen in the previous paragraphs, the Hubble constant is inversely proportional to the time.

Two forces are acting on the observable Universe. One is the pressure from the radiation-dominated universe which is responsible for the expansion of the universe. Since the speed of energy is approximately equal to 3x108 m/s and the observable universe is a very small part of the whole universe, the speed of the matter-dominated world must be approximately constant. The second force acting on the observable universe is the gravitational force due to dark matter and dark energy. This gravitational force acts in the direction opposite to the direction of expansion of the universe. The speed due to this force decreases with time since the relative rate of expansion or Hubble’s parameter is inversely proportional to the time. So, the net speed and the relative rate of expansion of the universe are increasing with time.

So, the relative rate of expansion of the Universe at present is equal to the reciprocal of the age of the universe about the age of the universe when the first galaxies similar to the present-day galaxies were formed. This value is 7.8% and means that the Universe is expanding faster by 7.8% than it was one billion years after the big bang. As mentioned in the introduction, Hubble constant value in the current universe is 73 and the value in the early universe is 67.7. So, the Universe is expanding faster by 7.8% than it was one billion years after the big bang. This value calculated based on experimental and observational data agrees with the theoretically calculated value.

This proof also informs us that the remnant of the cosmic microwave radiation comes from when the universe was one billion years old. But cosmic microwaves were radiated when the universe was .38 million years old. So, the cosmic microwave radiated at about 0.38 million years ago were trapped and radiation from the remnant of cosmic microwave originated when the universe was one billion years old and transparent to the microwaves and light [25]. The newly formed (by recombination) hydrogen atoms radiated cosmic microwaves. But the neutral hydrogen atomic cloud blocked the radiation till the time of one billion years old.

Mathematical Theory I

As explained in the previous section, the Hubble constant H is equal to k/t where k is the proportionality constant and t is time. Let H_1 is Hubble constant when the age of the universe was one billion years. So,

$$H = k/t \text{ and } H_1 = k \quad \dots (1)$$

So, H decreases from k after one billion years with time. Let H_2 is Hubble constant when $t = t_2$ where t_2 is the current age of the universe. So,

$(H_2 – H_1)/H_1 = H_2/H_1 – 1 = t_1/t_2 – 1$ or $1 – H_2/H_1 = 1 – t_1/t_2$ and $1 – H/H_1 = 1 – 1/t$, where ‘t’ is in billion years … (2)

Equation (2) indicates that Hubble constant H increases with t for t > 1 and t2 = 12.8 billion years. So, H_2 is approximately 7.8% greater than H_1. This means the universe is expanding 7.8% faster than it was one billion years after the big bang. The equation (2) also indicates the action of two velocities in the opposite directions. One is constant and originates from the pressure due to the radiation-dominated universe. This is acting in the direction of expansion of the universe. The other one is acting in the opposite direction to the direction of expansion and originates from the gravitational force of the dark matter and the dark energy. This velocity declines with time. So, the net effect is the faster expansion of the universe than it was one billion years after the big bang.

Mathematical theory II

The theory in this section is based on the electromagnetic wave radiation and propagation of the early universe. As per the modified big bang theory of cosmology, the energy of the universe originated suddenly in the beginning of the universe from the absolute space or vacuum. The energy was very hot (very high temperature) and dense. This energy cooled down and the wavelength was reduced. Then the energy was converted into matter particles. Matter particles evolved from the photons. Then the hydrogen clouds, stars and galaxies originated. So, the constant pressure of the radiation-dominated universe drives the matter-dominated universe and to expand. The gravitational force of the central dark matter and the dark energy reduces the speed of the expansion. So, the net result is expansion with increased speed with the growth of time. Let us represent the four-dimensional spherical space-time structure of the universe in the two-dimensional polar coordinate system. Let r be the radial distance of any point and θ be the angle in radians of the radial line from the reference radial line. Let l be the arc length from the point of intersection of the circle of radius r with the reference radial line of length r to the point of intersection of the circle and the radial line with the angle θ.

$$\text{So, } l = \theta.r \ldots (3)$$

$$\text{So, Hubble constant } H = dl/dt/l = dr/dt/r \text{ for any particular value of } \theta \ldots (4)$$

In the above equation, H is independent of θ. Let the velocity $dr/dt = v = k - ce^{-at}$ where $c = 3\times10^{8}$ m/s, a is a very large attenuation constant and k is the constant velocity of expansion due to the radiation pressure … (5)

Since the hot and dense energy cools down exponentially as per Newton's law of cooling and energy propagates as per the laws of electromagnetic wave propagation and building the matter particles by converting the energy, speed v is assumed to be declining exponentially from the value of c. If we integrate the equation (5), we get the following equation (6)

$$r = kt + ce^{-at}/a \ldots (6)$$

$$\text{At } t = 0,\ r \approx 0 \text{ because } a >> c \ldots (7)$$

By expanding e^{-at}, we get the following equation,

$$e^{-at} = 1 - at + \ldots (8)$$

$$e^{-at} \approx 1 - at \ldots (9)$$

By substituting the equation (9) in the equation (6), we get,

$$r \approx (k - c)t + c/a \ldots (10)$$

Since a >> c, the equation (10) could be written as the following,

$$r \approx (k - c)t \ldots (11)$$

$$\text{So, } dr/dt = v \approx k - c \ldots (12)$$

Dividing the equation (12) by the equation (11), we get,

$$v/r = H \approx 1/t \ldots (13)$$

Equation (1) and equation (13) are very much similar and so, the universe is expanding faster by 7.8 % now than it was one billion years ago after the big bang.

Mathematical theory III

The theory of this section is based on Newton's gravitational force and Newton's laws of force. As explained in the previous section, the speed of expansion of the universe v is due to radiation pressure acting in the direction of expansion (k) and the gravitational force of the central dark matter and dark energy (dr/dt). So,

$$v = k – dr/dt \ldots (14)$$

As per the Newton's gravitational force and general force laws,

$d^2r/dt^2 \approx – G.M/r^2$ where G is gravitational constant and M is the mass of the universe … (15)

By integrating the equation (15) we get,

$dr/dt = – 3GMt/r^3 + k$ where k is constant of integration and equal to constant velocity due to radiation pressure if equations (14) and (15) are compared … (16)

If we integrate the equation (15) with the limits r = 0 to r and t = 0 to t, we get,

$$dr/dt = 3MGt/r^3 \ldots (17)$$

If the equation (17) is integrated with the limits r = 0 to r and t = 0 to t … (18)

$$r^4 = 6MGt^2 \ldots (19)$$

From the equation (19), we get,

$$r^3 = (6MG)^{3/4} \times t^{3/2} \ldots (20)$$

From the above equation, we get,

$$r = (6MG)^{1/4} \times t^{1/2} \ldots (21)$$

By substituting the equation (20) into equation (16), we get,

$$dr/dt = k(1-A/t^{1/2}) = v; \text{ where } A = (3MG)^{1/4}/k \ldots (22)$$

Dividing the equation (22) by the equation (21), we get,

$$v/r = (1 – A/t^{1/2})/t(1- 2A/t^{1/2}) \ldots (23)$$

Since A is a very small quantity, $v/r = H \approx 1/t$ … (24)

Equations (1), (13) and (24) are very much similar and so, the universe is expanding faster by 7.8 % now than it was one billion years ago after the big bang.

Expansion rate of the universe: The earliest galaxy found so far is 290 million years old after the big bang [26]. Let the Hubble constant at that time be H_1 and the Hubble constant at later times be H.

Since $H = 1/t$, $H/H_1 = t_1/t$ where $H_1 = 1/t_1$ and $t_1 = 0.29$ billion years. So, $H/H_1 = 0.29/t$; where $t > 0.29$ … (25)

$$1 – H/H1 = 1 – 0.29/t \ldots (26)$$

So, equation (26) gives the increase in the expansion rate of the universe at time t with reference to the expansion rate at time t_1. So, at one billion years after the big bang, the expansion rate was 29% faster than it was 0.29 billion years ago after the big bang. So, the inflationary theory of the universe is proved [27].

Life Time of the Universe: The unit of Hubble's constant is s – 1 and so, the Hubble's constant could be considered as a number of cycles per second. In other words, unit of the constant could be considered as Hertz and the constant could be the frequency of the universe. Reciprocal of the frequency is the time period of a cycle of the universe. This means the universe is a cyclical one. As per the first law of thermodynamics which states that energy can't be created, nor destroyed, but can be transformed from one form into another form, the universe must be cyclical. So, the Hubble constant or parameter proves that the universe is cyclical and agrees with the first law of thermodynamics.

From the equation (2), $1 – H/H_1 = 1 – 1/t$ where t is in billion years. This equation indicates that the rate of expansion is zero when the time t is very large as compared with 1 billion years. ($t >> 1$). This means expansion is stopped. So, this expansion stops when $t = T/2$ where T is the lifetime of the current universe. After the time T/2, the universe will enter into the compression phase from the expansion phase.

As mentioned earlier, $H_1 \approx 0.07/\text{b.yrs}$ … (27)

So, when $t = T/2$, $H = 2.H_1/T$ … (28)

So, if $T >> 2H_1 = 0.14$, the expansion stops at $t = T/2$ … (29)

Since the current age of the universe is 13.8 billion years, $T/2 > 13.8$ or $T > 27.6$. So, T is at least in the range of about $100 < T < 1000$ b.yrs.

CONCLUSION

The universe known to us consists of energy, matter, and electric and magnetic charges. From the laws of electric and magnetic fields (Coulomb and Biot Savart's laws), the charge can be defined as a field of very high density. Energy is stored in the fields. So, charges are particles with very high energy density. As per the energy and matter relationship of Albert Einstein, all matter in the universe could be equated to energy. So, the universe must have originated from the energy. Particle physics also confirms that the universe originated from energy. This energy must have originated from the absolute space or vacuum at a point that is the center of the universe. These are the basic principles of the modified Big Bang theory of cosmology [23]. In the modified Big Bang theory of cosmology, space and field are assumed to be independent. This theory satisfies the cosmological principle, Hubble's law and CMBR and was verified by the observational evidence. In this article, the Hubble tension problem is solved by three different methods. Then inflationary theory of the universe is proved. All these proofs and verifications confirm the validity of the modified Big Bang theory of cosmology.

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