

A Comprehensive Proof Of Hubble's Law Based On Aging Affected Wu's Spacetime Shrinkage Theory

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Abstract

Hubble's Law is an experimental result asserting a linear relationship between the recession velocity and proper distance of a star 5 billion light years away from earth. It indicates that the universe is moving apart with intrinsic expansion and acceleration. However, what the driving force (Dark Energy?) is and where it comes from remain a mystery. Although Hubble's Law can be derived by Acceleration Doppler Effect, it doesn't explain the intrinsic expansion and Dark Energy. To avoid these problems, several attempts to prove Hubble's Law were tried, but none of them are successful due to the insufficient mathematical models. In this paper, a revised model based on Principle of Parallelism has been applied successfully to prove Hubble's Law by Aging Affected Wu's Spacetime Shrinkage Theory. Not only the linear relationships between the redshift, recession velocity and proper distance of the star can be derived, but also the intrinsic expansion and the mysterious Dark Energy can be explained. As a result, the universe is not expanding, instead, earth is shrinking, and there is no such thing as Dark Energy after all.

Keywords: Hubble's Law, Hubble's constant, Universe Expansion, Cosmological Redshift, Intrinsic Expansion, Doppler Effect, Wu's Spacetime Shrinkage Theory, Wu's Spacetime Equation, General Relativity, Spacetime, Big Bang, Dark Energy, Yangton and Yington Theory, Wu Unit Length, Wu's Pairs, Principle of Parallelism, Vision of Object.

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I. Background

Hubble's Law is an experimental result asserting a linear relationship between the proper distance and recession velocity of a star 5 billion light years away from earth. It indicates that the universe is moving apart with intrinsic expansion and acceleration. Although Hubble's Law can be derived by Acceleration Doppler Effect [1], it is hard to believe that a star can move faster than light speed with an acceleration driven by a mysterious Dark Energy [2]. Also, it is difficult to understand the Intrinsic Expansion that all stars are moving away from earth consistently at the same time. To avoid these problems, several attempts to prove Hubble's Law were tried in the past few years [3][4][5][6][7][8], but none of them are successful due to the insufficient mathematical models. In this paper, a revised model based on Principle of Parallelism is applied to prove Hubble's Law by Aging Affected Wu's Spacetime Shrinkage Theory. A detailed result will be analyzed and discussed as follows.

II. Hubble's Law

The discovery of the linear relationship between Redshift and distance (Fig. 1) for stars at the same distance more than 5 billion years away, coupled with a supposed linear relation between recessional velocity and Redshift yields a straight forward mathematical expression for "Hubble's Law" [9] as follows:

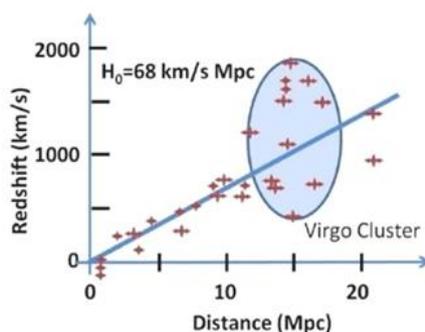


Fig. 1 Hubble's Law - the linear relationship between Redshift and distance.

Because

$$D/t \propto (\lambda_1 - \lambda)/\lambda$$

$$V \propto (\lambda_1 - \lambda)/\lambda$$

Therefore,

$$V = kD/t$$

Where k is a constant.

Given

$$H_0 = k/t$$

Therefore,

$$V = H_0 D$$

Where

- V is the recessional velocity caused by the expansion of space. It is theoretically possible for recession velocities to exceed the speed of light. (Usually in km/s).
- H_0 is Hubble constant and corresponds to the value of H (often termed the Hubble parameter a value that is time dependent and can be expressed in terms of the scale factor) in the Friedmann equations. (Roughly 70 km/s/Mpc)
- Taken at the time of observation denoted by the subscript "0". This value is the same throughout the universe for a given comoving time.
- D is the proper distance (which can change over time, unlike the comoving distance, which is constant) from the star (galaxy) to earth, measured in mega parsecs defined by given cosmological time.
- Recession velocity is the derivative of proper distance with respect to time $V = dD/dt$.

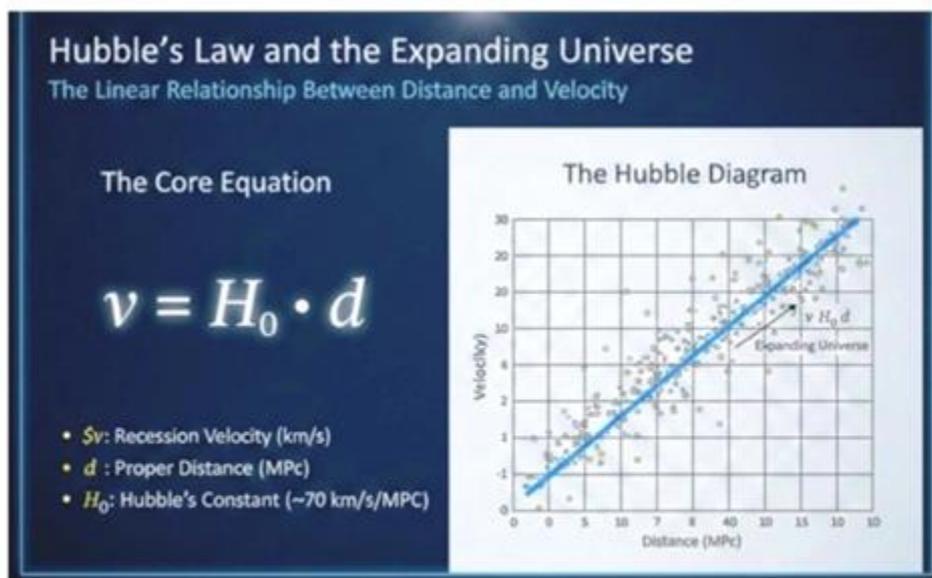


Fig. 2 Hubble's Law and the expanding universe – the linear relationship between recession velocity and proper distance.

As shown in Hubble's diagram (Fig. 2), the recession velocities of stars (galaxies) at 5 billion light years away is linearly related to their proper distances from earth. It indicates that the stars (galaxies) are uniformly moving apart from each others with accelerations. Also, space is under intrinsic expansion which looks the same from any galaxy, not just earth. Furthermore, the inverse of H_0 gives the approximate age of the universe $1/H_0 = 14.4$ billion years.

III. Hubble's Law And Acceleration Doppler Effect

Although Hubble's Law is an experimental result, it can derived by Acceleration Doppler Effect [1][10]. According to the mathematical model (Fig. 3) in the derivation of Redshift in Acceleration Doppler Effect, where a star is moving away from earth at a constant acceleration speed a, D is the distance from the star (light source) to earth, P is the distance from light origin to earth, S is the distance from light origin to the star (light source), and t is the time for the photon to reach earth. Then,

$$D = P - S = Ct + \frac{1}{2} at^2 = (C + \frac{1}{2} at) t$$

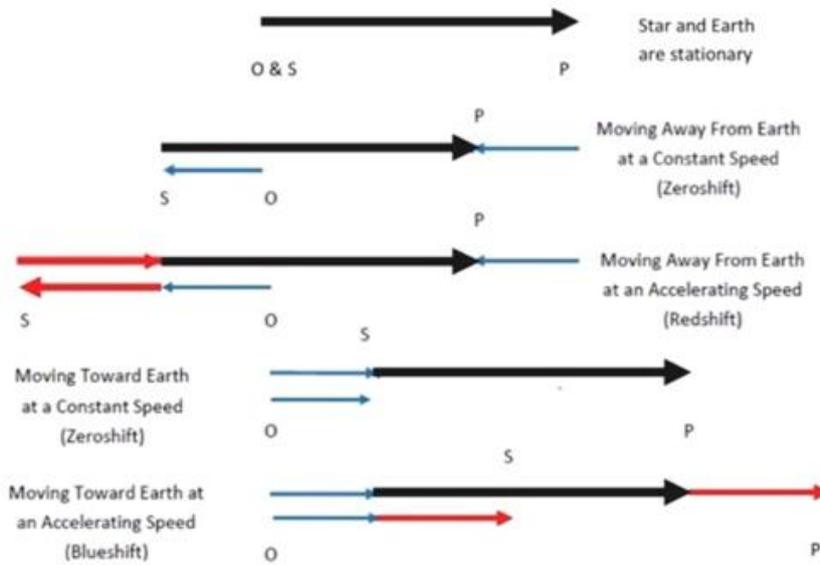


Fig. 3 Zeroshift, Redshift and Blueshift caused by Acceleration Doppler Effect.

For stars at a distance more than 5 billion light years away from earth, the acceleration $\frac{1}{2}$ at of the star at present time becomes much bigger than C ($t = 5$ billion years since photon emitted from the star 5 billion years ago). Therefore,

$$\frac{1}{2} at \gg C$$

$$D/t = \frac{1}{2} at$$

Because

$$\lambda_1 = D/vt = (Ct + \frac{1}{2} at^2)/vt = (C + \frac{1}{2} at)/v = \lambda + \frac{1}{2} at/v$$

$$(\lambda_1 - \lambda)/\lambda = (\frac{1}{2} at)/C$$

$$(\lambda_1 - \lambda)/\lambda \propto at$$

Therefore,

$$D/t \propto (\lambda_1 - \lambda)/\lambda$$

Also,

$$V = V_0 + at$$

$$at \gg V_0$$

$$V = at$$

Therefore,

$$V \propto (\lambda_1 - \lambda)/\lambda$$

Where λ_1 is the wavelength of the photon emitted from the star observed on earth and λ is the wavelength of the photon on earth, $(\lambda_1 - \lambda)/\lambda$ is the Redshift, V is the velocity of the star moving away from earth and D/t is the proper distance.

Because both V and D/t are proportional to $(\lambda_1 - \lambda)/\lambda$

Therefore,

$$V = kD/t$$

Given

$$H_0 = k/t$$

Then

$$V = H_0 D$$

Where k is a constant and H_0 is Hubble Constant (a time-dependent constant).

As a result, based on Acceleration Doppler Effect, Redshift $(\lambda_1 - \lambda)/\lambda$ are proportional to both proper distance D and recession velocity V . Also, Hubble's Law can be successfully derived with a linear relationship between proper distance and recession velocity for the stars at the same cosmological time 5 billion light years away from earth.

For those stars (galaxies) at the same cosmological time 5 billion light years away from earth, both t (from the initial time to present time) and $H_0 = k/t$ are constants, and V - D curve becomes a straight line. For those stars having the same cosmological time earlier than 5 billion years ago, t is bigger, $1/t$ is smaller and H_0 is smaller, such that V - D curve becomes flatter with a smaller slope [11]. Furthermore, for those stars (galaxies)

at the same cosmological time close to Big Bang Explosion, t becomes extremely bigger and $1/t$ becomes extremely smaller, such that eventually $1/t$ converges to a constant, as is H_0 .

Although Acceleration Doppler Effect can be used to derive Hubble's Law and explains that universe is expanding and also accelerating. However, it has two downsides: (1) what is the driving force (Dark Energy) for the acceleration? And (2) how to explain the intrinsic expansion of the universe?

IV. Wu's Spacetime Shrinkage Theory

According to Yangton and Yington Theory [12], Wu's Pairs are the building blocks of the universe. Therefore, Wu Unit Length l_{yy} (dimension) and Wu Unit Time t_{yy} (duration) are the dominant factors of all the properties of an object or event. In other words, any interference that can affect either Wu Unit Length or Wu Unit Time can change the properties of the object or event [13][14].

Under massive graviton bombardment [15](or at a large gravitational field in a stationary single parent object system), based on Graviton Radiation and Contact Interaction Theory [16], the speed of Yangton and Yington circulation is slower which can make Wu Unit Length and Wu Unit Time bigger (Wu's Spacetime Equation $t_{yy} = \gamma l_{yy}^{3/2}$) [17]. This phenomenon is named "Gravity Affected Wu's Spacetime Shrinkage Theory" [17]. Furthermore, in compliance with Wu's Spacetime Transformation [18] (in accordance to Principle of Parallelism [19] and Wu's Spacetime Equation [17]), the dimension and duration of an object or event should be bigger while velocity and acceleration should be smaller, also wavelength should be bigger and light speed should be slower.

In case of static graviton flux [20], the dimension, duration, velocity and acceleration of an object or event, as well as wavelength and light speed are all dependent on the static gravitational field generated by the static graviton flux between two stationary objects, such as Gravitational Redshift [21], Altitude Time Dilation [22], Deflection of Light [23] and Perihelion Precession of Mercury [23]. On the other hand, in case of dynamic graviton flux [20], all these properties are dependent on the dynamic gravitational field generated by the dynamic graviton flux dependent on the relative velocity and direction between the moving object and stationary parent object, such as Air Bound flight [24], Pendulum Swing Time Dilation [25] and Anisotropic Light Speed [26].

In addition, when the universe becomes older, due to the attraction between Yangton and Yington particles caused by Force of Creation [12] in Wu's Pairs, the speed of Yangton and Yington circulation becomes faster while the circulation orbit becomes smaller. In other words, both Wu Unit Length and Wu Unit Time become smaller. This phenomenon is named "Aging Affected Wu's Spacetime Shrinkage Theory" [17]. Furthermore, in compliance with Wu's Spacetime Transformation (in accordance to Principle of Parallelism and Wu's Spacetime Equation), as Wu Unit Length and Wu Unit Time become smaller, the dimension and duration of the object or event become smaller while velocity and acceleration get larger, also wavelength becomes smaller and light speed becomes faster. As a result, the shrinkage of the dimension of an object and the wavelength of a photon due to aging of the universe is the main reason to cause Cosmological Redshift [17], Hubble's Law [7], Intrinsic Expansion [7] and Universe Expansion [1][7].

V. Cosmological Redshift And Universe Reverse Expansion Theory

According to Aging Affected Wu's Spacetime Shrinkage Theory, the diameter of Wu's Pairs l_{yy} (Wu Unit Length) and the period of the Wu's Pairs t_{yy} (Wu Unit Time) on the present earth are smaller than that on the stars 5 billion years ago. Therefore, the photon emitted from a star a few billion years ago, has a larger wavelength (slower light speed and less frequency) than that on the present earth. These preserved ancient properties such as longer wavelength can be observed when the photon emitted from ancient star quenches onto earth. This is known as Cosmological Redshift.

In addition, based on Principle of Parallelism, normal unit length (meter) and normal unit time (second) are also smaller on the present earth than that in the past. Therefore, even the universe doesn't change, the distance between star and earth seems to grow bigger (expansion) with time, while measured by the shrinking normal unit length (yardstick) on the present earth. This is named "Universe Reverse Expansion Theory" (or "Earth Shrinkage Theory" and "Wu's Spacetime Reverse Expansion Theory") to distinguish from "Universe Expansion Theory" [8].

VI. Hubble's Law And Universe Reverse Expansion Theory

Although Hubble's Law can be derived successfully from Acceleration Doppler Effect [1], it is hard to believe that a star can move faster than light speed with an acceleration driven by a mysterious Dark Energy. Also, it is difficult to understand the Intrinsic Expansion based on Einstein's Spacetime Theory that all stars are moving away from earth consistently at the same time. To avoid these problems, Wu's Spacetime Shrinkage Theory and Principle of Parallelism are proposed to interpret Hubble's Law (more accurately Reverse Hubble's Law) and universe expansion theory [7](more accurately universe reverse expansion theory).

According to Aging Affected Wu's Spacetime Shrinkage Theory, when the universe gets older, both the circulation period (t_{yy}) and orbital diameter (l_{yy}) of Wu's Pairs become smaller, as is the normal unit length and wavelength. Consequently, a photon emitted from a star more than 5 billion years ago has larger wavelength than that on the present earth. This is the reason to cause Cosmological Redshift and Hubble's Law.

VII. Hubble's Law Derived By Aging Affected Wu's Spacetime Shrinkage Theory

Fig. 4 shows the mechanism of Universe Reverse Expansion Theory based on Aging Affected Wu's Spacetime Shrinkage Theory. Revised from my previous works [3][4][5][6][7][8], a new mathematical model is proposed as follows:

1. A photon emitted from a star 5 billion years ago at time t_i (cosmological time since Big Bang Explosion) and distance X (5 billion light years away from earth dependent on the light speed and wavelength). It reaches earth at present time t_f (cosmological time $t_f = t_i + 5$ billion years) with the freezing original wavelength of the photon λ which is dependent on the aging of the universe of the star at time t_i (cosmological time of the star t_i since Big Bang Explosion).
2. The distance X between the star and earth is fixed. It doesn't change with time. However, according to Aging Affected Wu's Spacetime Shrinkage Theory and Wu's Spacetime Transformation (in compliance with Principle of Parallelism and Wu's Spacetime Equation), both Wu Unit Length (diameter of Wu's Pair l_{yy}) and the normal unit length (L), (such as meter on a yardstick) on earth are shrinking with time. Because $X = M_i L_i = M_f L_f$, where L_i is the normal unit length and M_i is the amount of normal unit length measured for X at t_i on earth. Also, L_f is the normal unit length and M_f is the amount of normal unit length measured for X at t_f on earth (present time). Therefore, the amount of normal unit length is increasing with time such as $L_i > L_f$ and $M_i < M_f$.
3. D is the aging affected vision of the star (Aging Affected Vision of Object [27]) from time t_i to t_f observed on the shrinking earth under aging of the universe. Therefore, the proper distance can be represented by $D = M_f L_f - M_i L_i$ and the average recession velocity can be calculated by $V = Dk/t = (M_f L_f - M_i L_i)k/t$, (where k is a time dependent constant and $t = t_f - t_i = 5$ billion years) observed at time t_f on present earth.

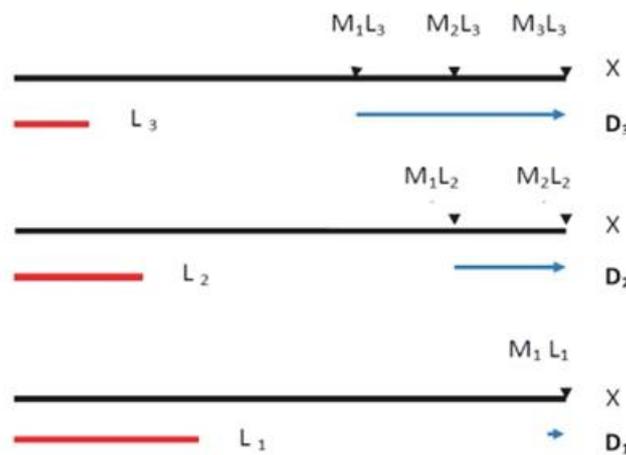


Fig. 4 The distance of a star measured by a shrinking ruler on earth.

Fig. 4 shows a schematic diagram of the aging affected vision of the star (Aging Affected Vision of Object) from time t_i to time t_f observed on earth at different stages of aging of the universe.

Because

$$X = M_i L_i = M_f L_f = \lambda vt$$

$$\lambda = W_i L_i = W_f L_f$$

Therefore,

$$M_f/M_i = W_f/W_i = L_i/L_f$$

Where λ is the original wavelength of the photon emitted from the star, dependent on the aging of the universe of the star at time t_i (cosmological time of the star t_i since Big Bang Explosion). W_i is the amount of normal unit length measured by the normal unit length L_i on earth for λ , and W_f is the amount of normal unit length measured by the normal unit length L_f on earth for λ . M_i is the amount of normal unit length measured by the normal unit length L_i on earth for X , and M_f is the amount of normal unit length measured by the normal unit length L_f on earth for X .

Also,

$$D = M_f L_f - M_i L_f$$

$$D = (M_f L_f / M_i L_f - 1) M_i L_f = (W_f L_f / W_i L_f - 1) M_i L_f$$

Assuming at 5 billion years ago, the wavelength of the photon is about the same on both the star and earth, then

$$W_i L_i = W_0 L_i$$

$$W_i = W_0$$

$$W_i L_f = W_0 L_f = \lambda_0$$

$$W_f L_f = \lambda_1$$

Therefore,

$$D = ((\lambda_1 - \lambda_0) / \lambda_0) M_i L_f$$

Where D is the aging affected vision of the star from time t_i to t_f observed on the shrinking earth under aging of the universe. W_0 is the amount of normal unit length L_0 measured for the wavelength of the corresponding identical photons at the same gravitational field and aging of the universe. λ_1 is wavelength of the photon emitted from the star 5 billion years ago observed on present earth and λ_0 is the wavelength of the same photon emitted and observed on present earth.

Also,

$$M_f L_f \gg M_i L_f$$

$$X = M_f L_f \approx D$$

Therefore,

$$X = ((\lambda_1 - \lambda_0) / \lambda_0) M_i L_f$$

Also,

$$V = Dk/t$$

$$V = ((\lambda_1 - \lambda_0) / \lambda_0) M_i L_f k/t$$

Therefore,

$$V = Dk/t$$

Given

$$H_0 = k/t$$

Then

$$V = H_0 D$$

Where V is the recession velocity and D is the proper distance of the star observed on the present earth. H_0 is Hubble constant dependent on the traveling time t of the photon from star to earth.

Furthermore, for stars at a distance more than 5 billion light years away, because L_f is a constant and M_i is close to a constant, such that $M_i L_f$ is also close to a constant. Therefore, as it is claimed by Hubble's Law, both X and V are proportional to $(\lambda_1 - \lambda_0) / \lambda_0$.

$$X \propto (\lambda_1 - \lambda_0) / \lambda_0$$

$$V \propto (\lambda_1 - \lambda_0) / \lambda_0$$

Hubble's Law can be successfully proved by Aging Affected Wu's Spacetime Shrinkage Theory. Not only the linear relationships between the redshift, recession velocity and proper distance of the star can be derived, but also the intrinsic expansion and the mysterious Dark Energy can be very well explained. As a result, the universe is not expanding, instead, earth is shrinking, and there is no such thing as Dark Energy after all.

It is believed that after the inflation and formation of the stars in the universe, until about 5 billion years ago, a shrinking process happened across the whole universe due to the attraction generated by Force of Creation in Wu's Pairs, which causes the shrinkage of wavelengths as well as the dimensions of all objects in the universe in compliance with Aging Affected Wu's Spacetime Shrinkage Theory. As a consequence, all the photons coming down to earth emitted from ancient stars 5 billion years ago have maintained a larger wavelength than that on the present earth, which results in cosmological redshift, universe expansion and acceleration, as well as intrinsic expansion.

The proof of Hubble's Law by Aging Affected Wu's Spacetime Shrinkage Theory also gives an indirect proof to Aging Affected Wu's Spacetime Shrinkage Theory itself that for all objects and events, dimensions are larger, durations are longer, wavelengths are bigger and light speeds (Absolute Light Speed) are slower at the early age of the universe.

VIII. Wu's Spacetime Shrinkage Rate

The correlation between the visual acceleration rate and Wu Unit Length shrinkage rate observed on earth (Fig. 3) can be calculated as follows:

$$D = M_f L_f - M_i L_f = X - M_i L_f$$

$$dD = dX - M_i dL$$

X and M_i are constants,

Therefore,

$$dD = -M_i dL$$

In addition, according to Principle of Parallelism,

$$L \propto l_{yy}$$

$$dL = k_1 dl_{yy}$$

Where k_1 is a constant, L is the normal unit length of a corresponding identical standard object or event and l_{yy} is the Wu Unit Length of a designated corresponding identical elementary subatomic particle (such as up quark) at the same gravitational field and aging of the universe, no matter of the gravitational field and aging of the universe.

Therefore,

$$dD = -M_i dL = -M_i k_1 dl_{yy}$$

$$dD/dt = k_2 (-dl_{yy}/dt)$$

$$V \propto -S$$

Where D is the aging affected vision of the star (Aging Affected Vision of Object) from time t_i to t_f ($t_f = t_i + 5$ billion years) observed on the shrinking earth under aging of the universe. D is the proper distance ($D = M_f L_f - M_i L_i$) and V is the recession velocity ($V = Dk/t = (M_f L_f - M_i L_i)k/t$) of the star observed on earth. k_1 and k_2 are constants and k is a time dependent constant. t is time. $S = dl_{yy}/dt$ is the shrinkage rate of Wu Unit Length l_{yy} of Wu's Pairs in the reference elementary subatomic particle (such as up quark) on earth.

Because the star is visually moving away from earth in an acceleration speed ($dV/dt > 0$) observed by the normal unit length on earth, therefore Wu Unit Length shrinkage rate is getting smaller ($dS/dt < 0$). However, people can't tell the differences because everything on earth is shrinking proportionally at the same time [7].

In theory, Wu's Spacetime shall shrink to a critical size before Yangton and Yington can recombine and destroy each other. Then, the whole universe will become None – no space, time, energy and matter. Although we know Wu Unit Length is shrinking with acceleration, but we don't know how far it can go before Wu's Pairs collapse to end the whole universe. One possible answer can be found in Singularity where the critical density can trigger the destruction of everything in the black hole. It is believed that the recombination and Annihilation between Yangton and Yington in Wu's Pairs can also happen as the critical density reaches.

IX. Einstein's General Relativity And Spacetime Versus Universe Expansion

Both Einstein's General Relativity [28] and Gravity Affected Wu's Spacetime Shrinkage Theory [29] agree that under a massive gravitational field, the dimension and duration of an object or event are bigger, while velocity and acceleration are smaller, also wavelength is bigger and light speed is slower. As a consequence, photon generated from a massive star has larger wavelength than that on earth which results in Gravitational Redshift.

Einstein's Spacetime [30][31] is the potential energy (a property) of an object or event [32]. According to Wu's Spacetime Shrinkage Theory and Wu's Spacetime Transformation (in accordance to Principle of Parallelism and Wu's Spacetime Equation), Einstein's Spacetime (potential energy) like any other property is dependent on the local gravitational field. It can reflect the distribution of gravitational field, as is the acceleration and the curvature of spacetime.

Because only large wavelength (redshift) and small acceleration (small spacetime curvature) are found with the incident photons emitted from all the stars 5 billion years ago onto present earth. Therefore, is this means that all those stars have small spacetime curvatures? It doesn't make any sense. On the other hand, because Gravitational Redshift [21] can be generated from massive stars, therefore is this means that all those stars emitted photons 5 billion years ago onto present earth are massive stars? It doesn't make any sense either.

In addition, can Einstein's Spacetime be used to explain Intrinsic Expansion of the universe? Several questions need to be answered here: Does the Spacetime (potential energy) Expansion cause the Intrinsic Expansion? What is the driving force and energy (Dark Energy)? And where is it coming from? We don't have any clue for these answers.

As a result, both Einstein's General Relativity and Spacetime Theory cannot explain Hubble's Law (universe expansion and acceleration) neither the intrinsic expansion of the universe.

Furthermore, because the photon generated 5 billion years ago from a massive star has a bigger wavelength than that on earth at the same time, therefore unlike Cosmological Redshift in which all wavelengths are assumed equal at the time of photon emission from the ancient star 5 billion years ago, such that Hubble's Law can be successfully derived. Gravitational Redshift cannot be used for the derivation of Hubble's Law.

In fact, Cosmological Redshift, Hubble's Law and Intrinsic Expansion, as well as Universe Expansion (Universe Reverse Expansion or Earth Shrinkage) can all be explained by Aging Affected Wu's Spacetime Shrinkage Theory. In which, as the universe becomes older, due to the attraction between Yangton and Yington

particles caused by Force of Creation in Wu's Pairs, the speed of Yangton and Yington circulation becomes faster while the circulation orbit becomes smaller. In other words, both Wu Unit Length and Wu Unit Time become smaller. Furthermore, according to Wu's Spacetime Transformation, as Wu Unit Length and Wu Unit Time become smaller, the dimension and duration of the object or event become smaller while velocity and acceleration get larger, also wavelength becomes smaller and light speed becomes faster.

In conclusion, the shrinkage of wavelength due to aging of the universe is the main reason to cause Cosmological Redshift, as well as (Reverse) Hubble's Law, Intrinsic Expansion and Universe (Reverse) Expansion.

X. Dark Energy Doesn't Exist

During aging of the universe, according to Aging Affected Wu's Spacetime Shrinkage Theory, the potential energy of Yangton and Yington circulation can be converted to the kinetic energy of Wu's Pairs, such that the circulation speed is getting faster and Wu Unit Length is getting smaller, while the distance between the star and earth remains unchanged. Since there is no need of any external energy (Dark Energy) in this process, it is believed that Dark Energy never really exist. As a consequence, the universe is never expanding, instead, earth is shrinking at all times, and there is no such thing as Dark Energy after all [8].

XI. Conclusion

Hubble's Law is an experimental result asserting a linear relationship between the recession velocity and proper distance of a star 5 billion light years away from earth. It indicates that the universe is moving apart with intrinsic expansion and acceleration. However, what the driving force (Dark Energy?) is and where it comes from remain a mystery. Although Hubble's Law can be derived by Acceleration Doppler Effect, it doesn't explain the intrinsic expansion and Dark Energy. To avoid these problems, several attempts to prove Hubble's Law were tried, but none of them are successful due to the insufficient mathematical models. In this paper, a revised model based on Principle of Parallelism has been applied successfully to prove Hubble's Law by Aging Affected Wu's Spacetime Shrinkage Theory. Not only the linear relationships between the redshift, recession velocity and proper distance of the star can be derived, but also the intrinsic expansion and the mysterious Dark Energy can be explained. As a result, the universe is not expanding, instead, earth is shrinking, and there is no such thing as Dark Energy after all.

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