Mathematical Description of Hubble's Experimental Law

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Abstract

Telescopes are always showing the acceleration of celestial objects, which is cosmic acceleration. These observations prove Hubble's experimental law, which shows that the farther away a galaxy is from Earth, the faster it moves away. In this paper, we have mathematically extracted Hubble's experimental law. By deriving this law, we proved that the universe has two motions: linear motion and rotational motion. The linear motion due to the expansion of the universe is due to the energy remaining from the Big Bang, and in rotational motion due to the absence of external force in the rotational motion, the angular velocity must also be constant. Since the angular velocity is constant, the only variable factor that affects the tangential velocity is the radius. This means that the linear motion increases the radius and in rotational motion at a constant angular velocity, the tangential velocity increases.

1.Introduction

Edwin Hubble, in 1929 found that all galaxies are moving away from us. In fact, he demonstrated that the universe with all galaxies was expanding and moving away from each other [1-6]. In June 2016, NASA and ESA scientists reported that the universe was found to be expanding 5% to 9% faster than thought earlier, based on studies using the Hubble Space Telescope [7-12]. Most of the galaxies, due to their structure, are moving away, and their speed will also increase. It should be noted that what drives them away is the initial energy that starts from the Big Bang moment and continues to this day and will continue to do so[13, 14]. In other words, the Big Bang energy caused a linear motion. However, this is the second step to explain the nature of the universe expansion. We supposed a rotational motion, with a constant angular velocity, for all celestial objects around the center of the universe and the Big Bang point, as a first step.

Finally, we compared the results of this theory and telescope detections. We have found it correct, as this theory, Saleh Theory, could derive the experimental law, Hubble law, mathematically.

2.Methods

After the huge explosion, the Big Bang, each particle of that compact globe expands at an extremely high velocity in n directions. If there was no rotational motion, these particles would never form the stars and galaxies. Therefore, the universe that existed was similar to a very large sphere of dust. Additionally, in our universe, there are many rotational motions, such as rotating of the Moon around itself and around the Earth, the Earth around itself and around the Sun, the Sun around itself and around the Milky Way and the Milky Way, which revolves around itself and could rotate around the hypothetical center of the universe. These two simple indications were the brainstorm.

Consequently, while the universe is rotating, all of its points are rotating together. Additionally, it expands from within. Therefore, each point has a linear motion plus a rotational motion in one plane, for example, in the x-y plane based on a Cartesian coordinate system. Therefore, we have two velocities, linear ($\vec{v}$) and tangential ($\vec{v'}$) and their resultant velocity ($\vec{V}$) [13, 14]. (Figure 1)

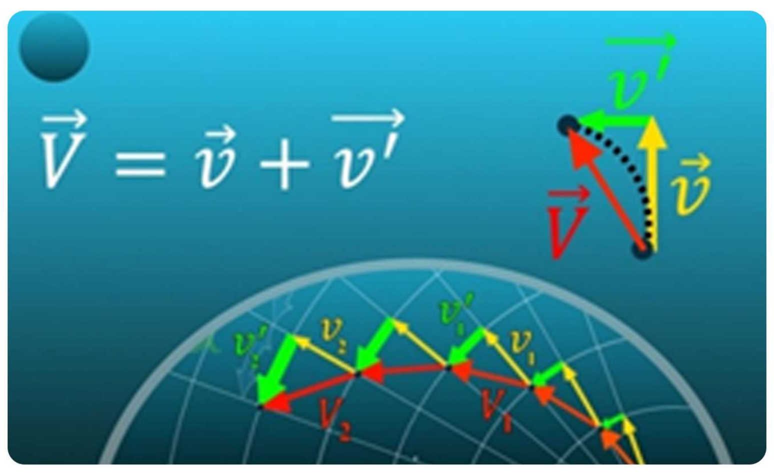

Figure 1.

Linear ($\vec{v}$), Tangential ($\vec{v'}$) and Resultant Velocity ($\vec{V}$)

a) The linear motion:

Suppose there is a celestial object with initial speed (v_0) in the x-direction and that its coordinate in t=0 is (r_0 ,0 ,0). So we have:

$$x(t) = \frac{1}{2}at^2 + v_0 t + r_0 \qquad (1)$$

$$y(t) = 0\,, \quad z(t) = 0 \qquad (2)$$

Where "a" is the acceleration due to projectile motion because of Big Bang and" r_0" is the distance of the celestial object from the center of the Big Bang at the Big Bang moment.

b) The rotational motion:

Suppose there is a rotating motion around the center of Big Bang too. Therefore, the sphere of the universe had a rotational motion around itself, with angular velocity($\vec{\omega}$). It should be noted that since there is no external force ($\vec{F_E}$), the angular velocity ($\vec{\omega}$) is always constant:

$$\vec{F_E} = 0 \qquad (3)$$

$$\vec{\tau} = \vec{r} \times \vec{F_E} = 0 \qquad (4)$$

$$\vec{\tau} = I\vec{\alpha} = 0 \qquad (5)$$

$$I \neq 0 \Rightarrow \vec{\alpha} = \frac{d\vec{\omega}}{dt} = 0 \qquad (6)$$

$$d\vec{\omega} = 0 \Rightarrow \omega = constant \qquad (7)$$

where $\vec{\tau}$ is torque, $\vec{\alpha}$ is angular acceleration and I is the moment of inertia of celestial objects. The angular velocity is constant, and on the other hand, we have:

$$\vec{v'} = \vec{\omega} \times \vec{r} \qquad (8)$$

Thus, as the angular velocity (ω) is always constant, our tangential velocity ($\vec{v'}$) depends on the variable $\vec{r}$. This means that a larger radius ($\vec{r}$) causes a higher tangential velocity ($\vec{v'}$). Now suppose there is a rotating celestial object around the center, that its coordinate in t=0 is (r_0 ,0 ,0) and that it has a constant angular velocity (ω) in the x-y coordinate plane. So we have:

$$\omega = \frac{v'}{r} \qquad (9)$$

$$x(t) = r\,\cos\omega t\,,\ \ y(t) = r\,\sin\omega t\,,\ \ z(t) = 0 \qquad (10)$$

c) Linear and rotational motion simultaneously (spiral):

Now, we combine these two motions: a linear motion and a rotational motion with a constant angular velocity (ω) [17]. So we have:

$$x(t) = \left(\frac{1}{2}at^2 + v_0 t + r_0\right)\cos\omega t\,,\quad y(t) = \left(\frac{1}{2}at^2 + v_0 t + r_0\right)\sin\omega t\,,\quad z(t) = 0 \qquad (11)$$

As this motion is in the x-y coordinate plane and z(t) is always zero, we do not write that more. So:

$$\dot{x}(t) = (at + v_0)\cos\omega t - \omega\left(\frac{1}{2}at^2 + v_0 t + r_0\right)\sin\omega t \qquad (12)$$

$$\dot{y}(t) = (at + v_0)\sin\omega t + \omega\left(\frac{1}{2}at^2 + v_0 t + r_0\right)\cos\omega t \qquad (13)$$

$$\ddot{x}(t) = a\cos\omega t - 2\,(at + v_0)\omega\,\sin\omega t - \omega^2\left(\frac{1}{2}at^2 + v_0 t + r_0\right)\cos\omega t \qquad (14)$$

$$\ddot{y}(t) = a\sin\omega t + 2(at + v_0)\omega\,\cos\omega t - \omega^2\left(\frac{1}{2}at^2 + v_0 t + r_0\right)\sin\omega t \qquad (15)$$

where v_0 is a initial linear velocity (m/s), ω is a constant angular velocity (rad/s), v' is tangential velocity (m/s), v_x ($\dot{x}$) is the velocity in the x-direction, v_y ($\dot{y}$) is the velocity in the y-direction, a_x ($\ddot{x}$) is the acceleration in the x-direction, a_y ($\ddot{y}$) is the acceleration in the y-direction and t is time (s). In polar coordinate system:

$$\vec{R}(t) = \left(\frac{1}{2}at^2 + v_0 t + r_0\right)\widehat{e_r} + \omega t\,\widehat{e_\theta} \qquad (16)$$

$$\vec{V}(t) = (at + v_0)\,\widehat{e_r} + \left(\frac{1}{2}at^2 + v_0 t + r_0\right)\omega\,\widehat{e_\theta} \qquad (17)$$

$$\vec{a}(t) = \left\{a - \left(\frac{1}{2}at^2 + v_0 t + r_0\right)\omega^2\right\}\widehat{e_r} + 2(at + v_0)\,\widehat{e_\theta} \qquad (18)$$

where $\vec{R}$ is the position vector (m), $\vec{V}$ is the total velocity vector (m/s) and $\vec{a}$ is the total acceleration vector (m/s²). To prove this theory, Saleh Theory, we have derived the experimental law (Hubble's law) based on these equations of motion for a specific situation.

d) The proof of Hubble's law based on Saleh Theory:

In 1929, Edwin Hubble found that the velocity of a galaxy can be expressed mathematically as:

$$V_H = H \times D_H \qquad (19)$$

where V_H is the galaxy's outward velocity, D_H is the galaxy's distance from Earth, and *H* is the Hubble constant.

1.The physical dimension of Hubble constant

Although the exact value of the Hubble constant is still somewhat uncertain, the physical dimension of the Hubble constant in SI is s^{-1} certainly.

2.The speed and distance in Hubble's law

Based on Saleh Theory, our universe has two types of motion: linear and rotational. Of course, our telescopes will detect the resultant velocity ($\vec{V}$) of these two types [13, 14]. Therefore, the speed in Hubble's law is the resultant velocity but relative velocity. This means that we detect the relative resultant velocity between a celestial object and the Earth. Hubble's law gives us this relative resultant velocity. So:

$$\vec{V_H} = \vec{V_c} - \vec{V_e} \qquad (20)$$

$$V_H = \left|\vec{V_c} - \vec{V_e}\right| = \Delta V \qquad (21)$$

where V_H is the speed in Hubble's law, V_c and V_e are the resultant velocities of a celestial object and Earth, respectively, and ΔV is their relative velocity. On the other hand, D_H in Hubble's law is the difference between the position vector of Earth and that celestial object:

$$\vec{D_H} = \vec{R_c} - \vec{R_e} \qquad (22)$$

$$D_H = \left|\vec{R_c} - \vec{R_e}\right| = \Delta R \qquad (23)$$

where $\vec{R_c}$ and $\vec{R_e}$ are the position vectors of a celestial object and Earth from the center, respectively, and ΔR is their relative position. We put the origin, the center of the coordinate system (where the lines intersect), in the center of the universe, where the Big Bang occurred. Therefore, according to (19), (21) and (23), the Hubble constant (H) is:

$$H = \frac{V_H}{D_H} = \frac{\left|\vec{V_c} - \vec{V_e}\right|}{\left|\vec{R_c} - \vec{R_e}\right|} = \frac{\Delta V}{\Delta R} \qquad (24)$$

3.Deriving the Hubble's law from Saleh Theory

Now suppose the position of a celestial object, the same as the Earth, in $t=t_1$ is on the x-axis. Therefore, in the polar coordinate system, they have the same angular coordinates but different radial coordinates (figure2). According to (27) we have:

$$\vec{R_c}(t_1) = \left(\frac{1}{2}at_1{}^2 + v_0 t_1 + r_{0_c}\right)\widehat{e_r} + \omega t_1\,\widehat{e_\theta} \qquad (25)$$

where $\vec{R_c}(t_1)$ is the position vector of the celestial object, v_0 is the constant linear speed, r_{0_c} is the distance of the celestial object from the center of the Big Bang at the Big Bang moment and ω is the constant angular velocity (figure 3). Also for the Earth we have:

$$\vec{R_e}(t_1) = \left(\frac{1}{2}at_1{}^2 + v_0 t_1 + r_{0_e}\right)\widehat{e_r} + \omega t_1\,\widehat{e_\theta} \qquad (26)$$

where $\vec{R_e}(t_1)$ is the position vector of the Earth, v_0 is the constant linear speed, r_{0_e} is the distance of the Earth from the center of the Big Bang at the Big Bang moment and ω is the constant angular velocity (figure 3).

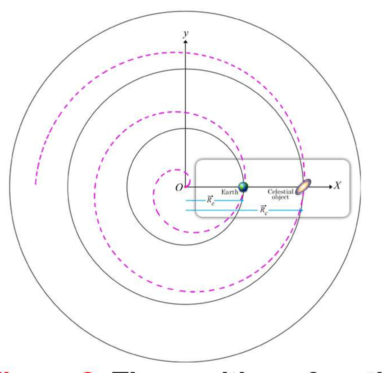

Figure 2. The position of earth and a celestial object in the Universe.

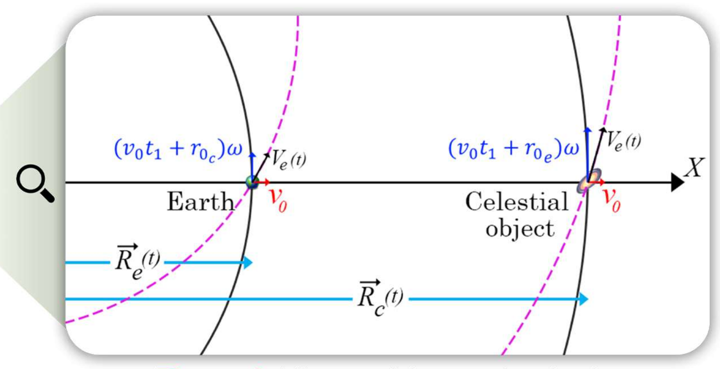

Figure 3. The position and velocity vector of earth and a celestial object.

$$\vec{\Delta R} = \vec{R_c}(t_1) - \vec{R_e}(t_1) = (r_{0_c} - r_{0_e})\widehat{e_r} \qquad (27)$$

$$\Delta R = \left|\vec{R_c}(t_1) - \vec{R_e}(t_1)\right| = r_{0_c} - r_{0_e} \qquad (28)$$

So, the relative position and velocity are:

$$\vec{V_c}(t_1) = (at_1 + v_0)\,\widehat{e_r} + \left(\frac{1}{2}at_1{}^2 + v_0 t_1 + r_{0_c}\right)\omega\,\widehat{e_\theta} \qquad (29)$$

$$\vec{V_e}(t_1) = (at_1 + v_0)\,\widehat{e_r} + \left(\frac{1}{2}at_1{}^2 + v_0 t_1 + r_{0_e}\right)\omega\,\widehat{e_\theta} \qquad (30)$$

$$\vec{\Delta V} = \vec{V_c}(t_1) - \vec{V_e}(t_1) = (r_{0_c} - r_{0_e})\omega\,\widehat{e_\theta} \qquad (31)$$

$$\Delta V = \left|\vec{V_c}(t_1) - \vec{V_e}(t_1)\right| = (r_{0_c} - r_{0_e})\omega \qquad (32)$$

$$\frac{\Delta V}{\Delta R} = \frac{\left|\vec{V_c}(t_1) - \vec{V_e}(t_1)\right|}{\left|\vec{R_c}(t_1) - \vec{R_e}(t_1)\right|} = \frac{(r_{0_c} - r_{0_e})\omega}{r_{0_c} - r_{0_e}} = \omega \qquad (33)$$

$$\Delta V = \omega \times \Delta R \qquad (34)$$

where $\vec{V_c}(t_1)$ and $\vec{V_e}(t_1)$ are the velocities of the celestial object and the Earth, respectively, ΔV and ΔR are the total relative velocity and the relative position of a celestial object and Earth, and they are the same as V_H and D_H .Therefore:

$$V_H = \omega \times D_H \qquad (35)$$

And if we put the H instead of ω then we have:

$$V_H = H \times D_H \qquad (36)$$

And this is the Hubble's law. So, we have proven that Hubble's law is a specific mode of general definition. If we use the equations of motion based on the Saleh Theory and simplify them for a specific situation, we have Hubble's law. Additionally, we must note that the physical dimension of angular velocity (ω) is radians per second, and we know that we could say it in s^{-1}, the same as the physical dimension of the Hubble constant.

4.Result

We have derived the Hubble's law to prove that celestial objects have a linear motion outwards from the Big Bang center and a rotational motion around the Big Bang center with constant angular velocity. The residual energy of the Big Bang expands the universe. Therefore, the radius of the universe, the radius of rotation ($\vec{r}$), is always increasing, and consequently, our tangential velocity ($\vec{v'}$) is always increasing. This means that the residual energy increases $\vec{r}$ and that $\vec{r}$ increases the tangential velocity ($\vec{v'}$) [13, 14]. Therefore, without any external force, the resultant velocity ($\vec{V}$) always increases.

5.Conclusion

From 20 years ago, our detection by telescope shows the acceleration of the universal expansion according to Hubble's law. But up to know there is not any acceptable finding. They always tried to find dark energy by finding new things but not a new method. Of course, this article has used a new method and we have proven that the dark energy was unknown because we had a mistake about the total motions in the Big Bang, and it is a usual effect of combination motion of linear and rotating motion and have derived Hubble's law for the first time to prove the theory and for the next steps, we should focus on finding the other effects of that rotational motion.

6.References

[1] Battersby S 2016 Dark energy: Staring into darkness Nature 537 S201-S4
[2] Mannheim P D 2019 Is dark matter fact or fantasy?—Clues from the data International Journal of Modern Physics D 28 1944022
[3] Roberts M S and Whitehurst R N 1975 The rotation curve and geometry of M31 at large galactocentric distances The Astrophysical Journal 201 327-46
[4] Rubin V C, Ford Jr W K and Thonnard N 1980 Rotational properties of 21 SC galaxies with a large range of luminosities and radii, from NGC 4605/R= 4kpc/to UGC 2885/R= 122 kpc The Astrophysical Journal 238 471-87
[5] Schaf J 2015 The Nature of Dark Matter and of Dark Energy Journal of Modern Physics 6 224
[6] Team N W S Tests of Big Bang: Expansion. National Aeronautics and Space Administration)
[7] Vimal R L P 2019 Dark Energy for expanding universe and Dark Matter for large rotational velocities of stars: extended Dual-Aspect Monism framework
[8] Hartle J B, Hawking S and Hertog T 2008 No-boundary measure of the universe Physical review letters 100 201301
[9] Saleh Gh, Faraji M J, Alizadeh R and Dalili A 2018 A New Explanation for the Color Variety of Photons MATEC Web of Conferences 186 01003
[10] Saleh Gh, Faraji M J, Alizadeh R and Dalili A 2018 THE SUPERSTRING THEORY AND THE SHAPE OF PROTONS AND ELECTRONS MATTER: International Journal of Science and Technology 4
[11] Saleh Gh, Alizadeh R and Dalili A 2020 WHY THE ELECTRON IS NEGATIVELY CHARGED AND THE PROTON POSITIVELY? MATTER: International Journal of Science and Technology 6
[12] Saleh Gh, Alizadeh R and Dalili A 2020 Presenting a New Theory about the Feasibility of Existence of Speed Faster than Light in Several Ways Bulletin of the American Physical Society
[13] Saleh Gh, Alizadeh Dahdahli R and Dalili A 2020 A New Theory to Explain the Dark Energy. p 342.02
[14] Saleh Gh, Alizadeh Dahdahli R and Dalili A 2020 A New Theory to Explain the Dark Energy. In: American Astronomical Society Meeting Abstracts# 236, p 342.02
[15] Halliday D, Resnick R and Walker J 2013 Fundamentals of physics: John Wiley & Sons)
[16] Fowles G R and Cassiday G L 2005 Analytical mechanics: Belmont, CA: Thomson Brooks/Cole)
[17] contributors W 2021 Archimedean spiral. Wikipedia, The Free Encyclopedia.)
[18] Saleh Gh, Alizadeh R, Khezri M R and Kaboli K 2020 A New Theory to Explain the Dark Matter Bulletin of the American Physical Society
[19] Saleh Gh and Faraji M 2021 New Justification and Proof for the Accelerated Movement of the Universe. In: APS Texas Sections Spring Meeting Abstracts, p C05. 005