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The Study of the Density of Physical Space and the Hubble Constant

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THESTUDYOFTHEDENSITYOFPHYSICALSPACEANDTHEHUBBLECONSTANT

Strictly as per the compliance and regulations of:

The Study of the Density of Physical Space and the Hubble Constant

Haitao Gao

Abstract- According to the description of physical space by general relativity and the principle of symmetry, this paper deduces the density property of physical space. On this basis, the author modified the metric tensor in Einstein's gravitational field equation, introduced the density factor of physical space into coordinate transformation, and deduced the gravitational field equation with a cosmological constant term. According to the equation, the cosmological constant term is the product of curvature and density factor of physical space, which is a negative increment of curvature, showing the property of repulsive force. This property could take the place of dark matter and dark energy. The author deduced the formula for calculating the Hubble redshift with space density term through Robertson-Walker metric and calculated the Hubble constant generated by space density according to the known material parameters of the universe. The calculated value is 74.6607Km ·s^{1} Mpc^{-1}, which is consistent with the observational results reported in the literature.

An experimental method to verify the density of physical space by using the fine structure of the Mossbauer spectrum of iron atoms is also presented, and a preliminary estimate of the accuracy of the experimental method is given.

Keywords: space density, metric tensor, gravitational field equation, Hubble constant, Hubble redshift, Mossbauer spectrum.

I. Preface

In 1929, The American astronomer Hubble published a classic paper on the expansion of the universe (Hubble, 1929):" A relation between distance and radial velocity among extra-galactic nebulae, "the main result of this paper is that "the distance of the galactic cloud is proportional to its redshift." Since then, scientists have observed the redshift of the river system using a variety of methods, In particular, after the Launch of the Hubble Space Telescope (HST), a team of researchers like W. Freedman used different methods to measure the Hubble constant H_0, The experimental results ranged from 68 ~ 82Km· S^{-1} · MPC^{-1} (Kirshner, 2004, Freedman et al. 2001, Freedman et al. 1999, Mould, 2002, Kennicutt et al. 1998, Sandage et al. 2006, Rims ,2009).

In March 2020, Chinese scholar Haitao Gao published an article entitled "The accelerated expansion of the universe may be an illusion of the observer "(Gao, 2020), In the paper, Haitao Gao calculated the Hubble constant with the density of physical space, and the results showed that the Hubble constant generated by the density of cosmic space was 114Km·s^{-1} MPC^{-1}.

Based on general relativity, this paper describes the difference between physical space and mathematical space and it discusses the relationship between the density of physical space and Einstein's equation of gravity or Robertson Walker's metric. By introducing the charge structure factor, the Hubble constant calculated by Haitao Gao in March 2020 is revised. Finally, the existence of physical space density is verified by the fine structure of the Mossbauer spectrum of γ-photon of iron atoms in liquid hydrogen as the medium.

II. The Theoretical basis of Hubble Redshift

In an isotropic universe, space can be described by the Robertson-Walker metric:

$$ds^2 = dt^2 - R^2(t)\left[\frac{dr^2}{1-kr^2} + r^2 \ (d\theta^2 + \sin^2\theta d\varphi^2)\right] \quad (1)$$

In the above equation, k is +1, -1, 0, respectively representing positive constant curvature space, negative constant curvature space and flat space. R (t) is the radius of constant curvature. Because of the uniform isotropy of space, it has no relation with three-dimensional space coordinates. It is a function of time t and has a dimension of length, also known as the cosmic scale factor.

Suppose that two points A and B in space are two points in the co-moving coordinate system,the distance when dt=0 is defined as the proper distance D_p, which does not change with the motion of the coordinate system.A and B choose coordinate system$\theta = \varphi$; at this point, the proper distance can be expressed as:

$$D_p = R(t)\int_0^{r_e}\frac{dr}{\sqrt{1-kr^2}} = \begin{cases} R(t)\sin^{-1} r_e & r=1 \\ R(t)r_e & r=0 \\ R(t)\,\mathrm{sh}^{-1} r_e & r=-1 \end{cases} \quad (2)$$

At A, r is 0, and at B, r is r_e, Definition: The natural velocity is the differential of the proper distance concerning time, we can get:

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$$v_p = \frac{dD_p}{dt} = \frac{d\ (R(t)\int_0^{r_e}\frac{dr}{\sqrt{1-kr^2}})}{dt} \cdot \frac{(R(t)\int_0^{r_e}\frac{dr}{\sqrt{1-kr^2}})}{(R(t)\int_0^{r_e}\frac{dr}{\sqrt{1-kr^2}})} = \frac{\dot{R}(t)}{R(t)}D_p \quad (3)$$

If $\frac{\dot{R}(t)}{R(t)} > 0$, we can conclude that the universe is expanding at an accelerating rate.

There is an assumption in the above derivation process; that is, the co-moving coordinate system is established. Therefore, the conclusion of the expansion of the universe is obtained under the assumption of the expansion of the universe, and formula two cannot be used as the theoretical proof of the accelerated expansion of the universe.

Since R(t) and D_p are difficult to observe directly, we can only verify the accelerating expansion of the universe by precise measurements of the optical signal.

Suppose that the light signal from the galaxy at t_e is received by earth at t_0. Also, another signal is sent at $t_e+\Delta t_e$ time galaxy, which is received at $t_0+\Delta t_0$ time on earth.We are interested in the relationship between Δt_0 and Δt_e, because if Δt_e is the period of an atomic clock, then Δt_0 is the corresponding value of that period at the receiving point,We can assume that galaxies and the Earth have the same θ and ψ values and take the radial coordinate of the earth as 0. The galaxy is located at r_e, then the light moves along the radial inward zero geodesics, and the equation of the light is:

$$dt^2 - R^2(t)\frac{dr^2}{1-kr^2} = 0 \cdots\cdots \quad (4)$$

For the two signals, we can derive:

$$\int_{t_e+\Delta t_e}^{t_e}\frac{dt}{R(t)} + \int_{t_0}^{t_0+\Delta t_0}\frac{dt}{R(t)} = 0 \quad (5)$$

When Δt_e and Δt_0 are both very small quantities, the mean value theorem can be applied to make the following approximation:

$$\frac{\Delta t_0}{R(t_0)} - \frac{\Delta t_e}{R(t_e)} = 0 \quad (6)$$

Δt_e and Δt_0 are the periods of emitting and receiving signals respectively. The period of optical signals can be defined as the frequency of light. After sorting out the above formula, it can be seen that:

$$\frac{v_0}{v_e} = \frac{\lambda_e}{\lambda_0} = \frac{R(t_e)}{R(t_0)}. \quad (7)$$

Spectral redshift is defined as:

$$z = \frac{\lambda_0 - \lambda_e}{\lambda_e} = \frac{v_e - v_0}{v_0} = \frac{R(t_0)}{R(t_e)} - 1 = \frac{R(t_0) - R(t_e)}{R(t_e)} \quad (8)$$

As can be seen from the above equation, if R (t_0),>R (t_e), the redshift is positive, the universe is expanding.

We found by the above method, under the assumptions that the expansion of the universe, we got the scale factor and the relationship between the spectrum redshift, as long as we can observe the spectrum redshift, so, the expansion of the universe is the inevitable result in fact we do observe the spectrum redshift, and redshift is proportional to the redshift of an extragalactic nebula, so we think that the expansion of the universe is accelerating.

III. Problem is Put Forward

Now, let's observe formula 7:

$$z = \frac{R(t_0) - R(t_e)}{R(t_e)}. \quad (9)$$

As long as the scale factor R (t_0) > R (t_e), spectrum redshift is positive.

We need to think about is, R (t_0) > R (t_e) must be produced by the expansion of the universe?

For space, we need to confirm the following questions:

1. What are the properties of physical space?
2. Is physical space the same as mathematical space when coordinates are transformed?

IV. Discussion on the Properties of Physical Space and the Equations of the Gravitational Field

General relativity holds that physical space can be bent and physical space can expand. Therefore, according to the principle of symmetry, we infer that physical space can be compressed and physical space has density, which is a reasonable inference.

Therefore, physical space has density, which is one of the properties of physical space.

Mathematical space is a hypothetical space, there's no density convention, so we can determine that when we transform coordinates, the properties of mathematical space and physical space are different. We should consider the density of physical space.

In general relativity, the metric tensor of mathematical space is used to describe the properties of space. The metric tensor is defined as follows:

$$g_{\mu\nu} = \boldsymbol{e_\mu} \cdot \boldsymbol{e_\nu} = \frac{\partial y^k}{\partial x_\mu}\frac{\partial y^k}{\partial v}. \quad (10)$$

Among them, the e_μ and e_υ is the basal vector coordinate system, in a Euclidean space, e_μ and $e_\upsilon$is different vector.

Now, we define a scalar B, which represents the density of space. By multiplying both sides of equation nine by the density of space, we can get:

$$b_\mu b_\upsilon g_{\mu\upsilon} = (b_\mu \boldsymbol{e_\mu}) \cdot (b_\upsilon \boldsymbol{e_\upsilon}) = \frac{\partial y^k}{\partial x_\mu}\frac{\partial y^k}{\partial \upsilon} \qquad (11)$$

According to cosmological principles, our universe is isotropic on large scales, and therefore b_μ and $b_\upsilon$can be considered as constants.

In Equation 8, R (t_0) is the scale factor of physical space, and R (t_e) is the scale factor of mathematical space. Because physical space has density, physical space has spatial increment compared with mathematical space, which can be expressed as follows:

$$R(t_0) = \left(1 + b_0 + a\right) R(t_e) \qquad (12)$$

In formula eight available:

$$z = \frac{R(t_0) - R(t_e)}{R(t_e)} = b_0 + a \qquad (13)$$

b_0 is the spectral redshift caused by the density of physical space, while a is the spectral redshift caused by the expansion of the universe.

It can be seen from Formula 11 that the density of physical space can also generate spectral redshift. As long as the spectral redshift is observed and compared with the spectral redshift calculated by using the known physical space density, the information of the universe can be obtained.

Physical spatial density has the following physical meanings:

A unit geometric measure (mathematical space), the amount of space contained (physical space).

When the base unit of geometric measurement of mathematical space is set as 1, let:

$$b_\mu b_\upsilon g_{\mu\upsilon} = \left(1 + c\right) g_{\mu\upsilon} \qquad (14)$$

Einstein's equation of gravitational field can be written as:

$$R_{\mu\upsilon} - \frac{1}{2}\left(1 + c\right) g_{\mu\upsilon} R = 8\pi G T_{\mu\upsilon} \qquad (15)$$

Make: $-\frac{1}{2}cR = \Lambda$ available:

$$R_{\mu\upsilon} - \frac{1}{2} g_{\mu\upsilon} R + \Lambda g_{\mu\upsilon} = 8\pi G T_{\mu\upsilon} \qquad (16)$$

Equation 12 is the gravitation equation with the cosmic factor. It can be seen that the physical meaning of the cosmic factor is the product of space density and space curvature scalar. For our universe on large scales can be thought of as isotropic constant curvature space, hence $\Lambda = -\frac{1}{2}cR$ is negative constant, is the representative of a negative increment of the curvature of the universe, the nature of the performance is the repulsion.

V. Calculate the Hubble Red Shift and Hubble Constant from the Density of Physical Space

In March 2020, Gao Haitao published a paper in which he calculated the Hubble redshift and The Hubble constant through the space density of protons in the universe, and derived the relationship between the linear density of protons in the universe and the Hubble constant. The expression is as follows:

$$z = 5.8571144 \cdot 10^{-12} NDP \qquad (17)$$

N ~ the number of protons per unit length in the observation path, in units: 1 /m.

D ~ the spatial distance between the observed object and the observer, unit: m.

P ~ the probability that light meets a proton per unit length.

The calculated Hubble constant is:

$$H_0 = v \approx zC = 114.02793 Km \cdot s^{-1} \cdot Mpc^{-1} \qquad (18)$$

The above results do not consider the shape factor of electron charge and proton charge but consider the proton charge as a sphere.

Since the charges in the universe are paired, each positive charge must have a negative charge, the effect of the electron's charge on the density of space needs to be taken into account.

According to the description of the material space theory (Gao, 2018), the gravitational mass of a proton is: $1.6726216378 \cdot 10^{-27}$Kg, Radius: $8.4087 \cdot 10^{-16}$m, the shape is a four-dimensional sphere; A proton is closely bound to a positive charge, and the charge of the positive charge is: $1.140152226 \cdot 10^{-15} m^3 s^1$ ($1.602176462 \cdot 10^{-19}$Coulomp). The structure of positive charge is: the cylindrical spiral with a radius of $8.4117893 \cdot 10^{-16}$m and a height of $2.0873379 \cdot 10^{-15}$m surrounds the cylindrical space. The spatial shape of the proton is shown in the figure below:

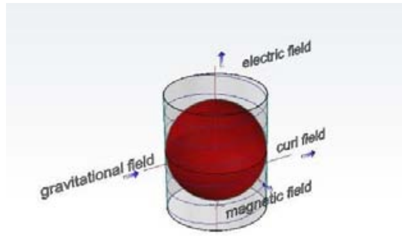

Figure 1: Spatial structure of a proton

The gravitational mass of an electron is: $9.10938215 \cdot 10^{-31}$Kg, Radius: $6.8693998 \cdot 10^{-17}$m, the shape is a four-dimensional sphere; An electron is closely bound to a negative charge, and the charge of the negative charge is: $1.140152226 \cdot 10^{-15} m^3 s^{-1}$ ($1.602176462 \cdot 10^{-19}$Coulomp). The structure of negative charge is: the cylindrical spiral with a radius of $8.4117893 \cdot 10^{-16}$m and a height of $2.0873379 \cdot 10^{-15}$m surrounds the cylindrical space. The spatial shape of the electron is shown in the figure below:

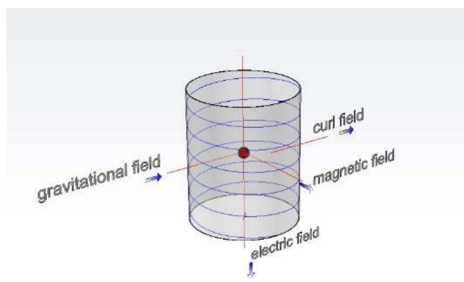

Figure 2: Spatial structure of electron

Considering the shape factor of charge (Gao, 2019), protons and light will scatter with the gravitational mass when they meet in the axial direction of the spiral space of charge, therefore, light can only pass through the charge space in the radial direction of the helical space without meeting the gravitational mass. Therefore, the effective coefficient of light passing through the proton charge space is:

$$A_P = \frac{S_1}{S_0} = \frac{2\pi R(H - H_1)}{2\pi RH + 2\pi R^2} \tag{19}$$

Where R is the radius of the cylinder, H is the height of the cylinder, and H_1 is the height of the cylinder occupied by the gravitational mass.
For protons in the free state, it can be calculated as follows:

$$A_P = \frac{2\pi 8.4118 * 10^{-16}(2.0873 * 10^{-15} - 8.4118 * 10^{-16})}{2\pi 2.0873 * 10^{-15} \times 8.4118 * 10^{-16} + 2\pi \ (8.4118 * 10^{-16})^{\ 2}} = \frac{34.0662}{175.5822} = 42.553\% \tag{20}$$

According to the description of the material space theory, the electron charge of hydrogen atom is coaxial with that of the proton. Therefore, in the hydrogen atom, the light rays passing through the cylindrical electron charge in the direction of the cylinder axis will be scattered by the gravitational mass of the proton. This part of light is invalid. Therefore, the effective coefficient of light passing through the electronic space structure is:

$$A_e = \frac{S_1}{S_0} = \frac{2\pi RH}{2\pi RH + 2\pi R^2} \tag{21}$$

For the electrons in hydrogen atom, it can be calculated as follows:

$$A_e = \frac{2\pi 8.4118 * 10^{-16} \times 2.0873 * 10^{-15}}{2\pi 2.0873 * 10^{-15} \times 8.4118 * 10^{-16} + 2\pi \ (8.4118 * 10^{-16})^{\ 2}} = 71.277\% \tag{22}$$

Ignoring the volume of the gravitational mass of the electron, the effective coefficient of the spatial structure of the free electron is $A_F=1$.

Let's say that 10% of the hydrogen atoms in the universe exist in a fully ionized state, where the light passes through the space between the charge of the free proton and the charge of the free electron, The remaining hydrogen atoms are bound plasma, Moreover, light cannot pass through the charge space of both electrons and protons in hydrogen, Suppose that the charge of the electron and the charge of the proton each account for 50% when the light passes through the space of the hydrogen atoms. Therefore, the coefficient of the actual light passing through the space of charge in the universe is:

$$A = 0.1A_F + 0.1A_P + 0.5(0.9A_e + 0.9A_P) = 0.6548 \quad (23)$$

Through the above calculation, equation 13 can be amended to:

$$z = 5.8571144 * 10^{-12} NDPA\cdot \quad (24)$$

The Hubble constant corresponding to the redshift can be calculated by plugging in all parameters:

$$v \approx zC = 74.6607 Km \cdot s^{-1} \cdot \mathrm{Mpc}^{-1} \quad (25)$$

The results show that the spectral redshift generated by the density of physical space corresponds to the observed Hubble constant, and the redshift of the expansion of the universe in Equation 11 May not exist, so our universe may not be expanding.

VI. Suggestions for Verification Experiments on Physical Space Density

The core content of this paper is the corollary of the density of physical space. Although it is a reasonable corollary of the density of physical space from the symmetry principle, we need to prove the existence of the density of physical space through experiments.

In 1960, Pound R.V used the Mossbauer spectrum of iron atoms (Pound, Rebka. 1959), in his experiments to verify the gravitational redshift, and measured the gravitational redshift of the earth's surface as $2.46{\cdot}10^{-15}$(Pound, Rebka, 1960, Pound, Snider, 1964) with gamma photons within 1% accuracy. Therefore, we can design experiments according to the experimental principle of gravitational redshift to verify the redshift generated by the material space density of the earth environment.

According to Formula 14, the relevant parameters are substituted in (where: $A = 0.5(A_e + A_P) = 0.569147$), and the following equation can be obtained:

$$z = 2.8041 \cdot 10^{-27} ND\cdot \quad (26)$$

Liquid hydrogen is selected as the medium to measure the spatial density at low temperatures. According to the properties of liquid hydrogen, the atomic line density of liquid hydrogen is: $N=3.4935{\cdot}10^9$/ m, therefore:

$$z = 0.9732 \cdot 10^{-17} D \quad (27)$$

Liquid hydrogen is injected into a horizontal pipe with a Fe^{57} γ-photon scattering source at one end and a γ-photon detection device at the other end when the experimental length of liquid hydrogen pipeline is 100 meters, the results can be obtained within the error range of 1% according to the experimental accuracy of gravitational redshift. If you take 10 meters of liquid hydrogen, you get a 10% error. Therefore, the existence of the density of physical space can be verified by experiments on earth, of course, to complete this experiment, also need to be detailed design and planning by professionals of photoelectric measurement.

VII. Conclusion

The density of physical space is derived from the description of physical space by general relativity and the properties of physical space inferred from the principle of symmetry. This property shows the difference between physical space and mathematical space, and in particular, physical space should take the density of space into account when carrying out coordinate transformation.

When considering the density of physical space, Einstein's equations of gravitational field would produce cosmological constants with repulsive forces that would replace dark matter and dark energy. In cases where the existence of dark matter and dark energy cannot be directly proved, it is necessary to conduct experiments to confirm the existence of physical space density.

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