A Simple Flat-Universe Model Recovering Mach Principle

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Abstract

Mach Principle presents the absolute universe. For example, when you stand on the ground and relaxed, your arms fall down naturally. However, if you rotate your body then your arms are lifted up as the rotation is faster and faster. Mach principle is that the matter of the whole universe can affect local dynamic systems. That is, the matter of the whole universe sets up the local absolute reference frames. However, both the theories of general relativity and Big Bang are against the absolute reference frames of Mach Principle. Here I present a simple model of flat universe which is consistent to most cosmic laws, and Mach Principle is recovered amazingly.
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1 The Absolute Reference Frame of the Universe

Human beings have many concepts. One of them is this: people are willing to put themselves as the center of the universe and thought that they did not belong to the nature and, instead, they were the spiritual existence independent of the nature. In fact, it is simple to verify that people are physically originated. If people could find one event which breaks causality, whether it is related to natural world or human beings itself, then the assumption of spiritual origin of human would have a solid foundation. We call such event ghost-event. Unfortunately, mankind has not found any ghost-event that contradicts causality.

Einstein's theory of relativity is mainly about high-speed motion of massless particle or the interaction of huge masses or energy. It is difficult to be directly verified. But it tends to be developed into some singular theories against causality. Time tunnel, time travel, black hole, wormhole, the Big Bang and so on are such theories which try to breach causality but are never verifiable.

If the entire universe forms the absolute reference frame then such ghost-events have no sound basis. This is because everything in the universe has the common standard of reference. Astronomical observations do suggest the existence of the absolute reference frame of the universe.

The universe is full of materials most of which are galaxies. Observations show that the materials are uniformly distributed at large scales. They move with respect to each other. Today's Big Bang cosmology is based on the assumption that the motion have no absolute reference. If there were no absolute reference then the universe would be unknowable and there would be no law in the observational data about the large-scale universe. However, several years after Einstein had proposed his general relativity and cosmology, Hubble discovered an important law about the universe, called the Hubble redshift law. It says that distant galaxies issue redshifted spectra which are proportional to their respective distances from earth. Big Bang cosmology assumes that galaxies ran away from us and the expansion led to the redshifts

as runaway trains give the static audience the sound waves of weaker frequencies. However, if there were no convergent movement among the distant galaxies then some galaxies would move towards the earth at fantastic speeds. The speeds would be so large that they would overwhelm the expansion and hit the earth directly. In that case, the galaxies would issue blueshifted spectra rather than redshifted ones. However, distant galaxies always present redshifted spectra and the redshifts are proportional to their distances from Earth.

Therefore, mainstream physicists and astrophysicists would admit that the materials in the universe have convergent movement and form the absolute reference frame. But they can not explain it. The existence of the absolute reference frame, however, is one of many consistent conclusions made by my simple model of the universe.

Recent astronomical observations show that the cosmic microwave background radiation has the privileged reference frame in which the radiation is isotropic. This privileged frame should be the absolute reference frame of the universe. Moreover, Earth moves with respect to the reference frame at the speed of several hundred kilometers per second.

We see very few people talking about the absolute reference frame because it is against the tenet of Einstein's general theory of relativity. In fact, the Big Bang cosmology is a kind of death universe without any meaning: no reference frame, no origin of changes, no origin of structures, no origin of time, no causality.

Einstein's general theory of relativity has no room for reference frames. I made a little modification of general relativity by adding the background reference frames to the theory. Such little modification, however, can explain the planetary distribution in the solar system [1] and suggest a very simple model of the universe.

2 The Grand Design of Universe

2.1 Expression of constant density

Ideal universe is constant. Constant density means that all objects have constant velocity (no change with time). Velocity is usually defined to be the variance rate of spatial distance with respect to time. The definition does not treat time t and space x equally. Actually we can introduce any parameter p, and calculate variance rate of time t and distance x with respect to the parameter p. We denote the rates T and X respectively. Careful readers will find in the following formulas that T is the variance rate of t multiplied by the speed of light c at current cosmological time. Therefore, the expression of constant density is:

$$L = XX - TT \tag{1}$$

The above expression is called Lagrange functional. The motion of any object can be solved according to the Lagrange functional. This method is known as the variational principle. Except human activities, nature always obeys the principle of optimization. According to the Lagrange functional of constant density, the reader can prove that all objects have constant velocities, and the maximum speed is the speed of light.

In fact, space is three-dimensional while time is always one-dimensional. Therefore, the above-said functional should be: $L = XX + YY + ZZ - TT$. However, for simplicity, we choose to ignore the additional Y and Z terms.

2.2 Real universe: changing density with time

A universe of constant density with time is not real. It is a dead one without vitality. Realistic one is that the distribution of materials is spatially homogeneous at large-scales but the density changes with time (aging). This changing universe presents the force which has the similar effect as fluid pressure: It exerts at any point in all directions. It is this pressure that indicates an starting point of the universe. The universe itself has a beginning like human life.

We will know that the simple assumption of aging density is able to explain most basic astronomic observations.

2.3 The Lagrange functional of the real universe

For the motion of objects in the real universe, the corresponding Lagrangian functional is different from the above one by two factors, $A(t)$ and $B(t)$:

$$L = A(t)XX - B(t)TT \tag{2}$$

These two factors are independent of spatial variables because the density of materials at the large-scales is spatially uniform. Therefore, my model of the universe contains only two variables A and B. You can find the formulas of particle motion based on the Lagrange functional of real universe.

2.4 Cosmological redshift and Hubble redshift law

Astronomical observations show that stars in distant galaxies present atomic spectrum whose frequency is weaker than the one observed on Earth. This resembles the phenomenon that the siren frequency from moving-away train is weaker than the one from the still train. This is called Kepler redshift of motion. However, do you really believe that galaxies in the universe move away from us? The universe is vast and the light traveling from one end of our galaxy to the other end takes tens of thousands of years. As for the distant galaxies, we simply can not observe their single stars, not to mention the star motion on the sky.

The redshift of the universe is actually the symbol of aging universe. Big Bang cosmology has no reference frame but real universe has the absolute reference frame. The spatial variables in the above formula (2) are the ones defined in the absolute reference frame while the aging universe defines the time variable. For simplicity, we take the universe's current aging process to be the standard time. The variational principle proves that the observation of atomic frequency spectrum depends only on the coefficient $B(t)$ and the redshift of the spectrum requires $B(t)$ increases with time t.

Hubble discovered an important law known as the Hubble redshift law: the distance of a galaxy from the earth is proportional to the corresponding redshift of the galaxy. The proportion constant is called the Hubble constant. Calculation of the distance involves the factor $A(t)$ in the formula (2). Therefore, Hubble redshift law requires that the factor $A(t)$ be dependent on the other factor $B(t)$.

My model of the universe contains only two variables $A(t)$ and $B(t)$. Cosmological Redshift requires that $B(t)$ increase with time while the Hubble redshift law requires that $A(t)$ depend on $B(t)$. It looks that my model of the universe would fail. Only one variable is left and its direction of monotonous change with time is identified, however, we still have a lot of astronomical observations to be explained by the model.

2.5 "Accelerating expansion" of the universe

Astronomical observation shows that the Hubble constant is not a constant, but an increasing variable with time.

Big Bang cosmology is based on the general theory of relativity, and general relativity is based on Newton's gravity. Gravity means that objects move more and more closer. Therefore, Big Bang cosmology predicts that the expansion of the universe should be slower and slower due to gravitation. That is, Big Bang cosmology assumes that the universe should be expanding and the expansion should slow down. However Observations show that the universe is at "accelerating expansion". The mainstream scientists assume that the main component of the universe is the never observable dark material which has negative energy, called dark energy. The negative energy presents repulsive force so that the universe had "accelerating expansion". Anyway, the assumption wants to make Einstein right.

But my model of aging universe directly indicates that the Hubble constant is an increasing function with time if $B(t)$ is an increasing function with time.

2.6 The speed of light is not constant, but decreases with time

Big Bang cosmology is based on the general theory of relativity and general relativity assumes that the laws of physics (including physical constants) are the same at any time and any where. However, astronomical observations show that the fine structure constant of atomic physics changes with the evolution of the universe.

The universe must have a violent start. In order to achieve the uniform distribution of materials in the later time we have to assume that the speed of light was close to infinity at the starting point of the universe and then decreases. In other words, the speed of light decreases with time. According to my model of aging universe, the decreasing speed of light is consistent with the requirement that $B(t)$ increase with time. What a miracle!

To overcome the above-said issue, Big Bang theory assumes that the starting explosion of the universe should be immediately followed by a process of inflation. This process is not testable which was made by some scientists to "resolve" the big problem and "save" the big bang theory.

2.7 The absolute reference frame of the universe

If there were no absolute reference frame of the universe then cosmological law of the universe would not exist. However, the universe is observable and it has laws. The first observed cosmological law of the universe is the Hubble redshift law. It is the fundamental evidence that the universe has the absolute reference frame.

According to my model, the universe is aging and the objects in the universe (galaxies, for example) tend to be static with respect to each other. That is, the motion with respect to each other slows down and approaches the ultimate mutual stationary positions. This mutual static process forms the universe's absolute reference frame. With respect to the absolute reference frame, the speed of any body in the universe is a decreasing function over time. This is consistent with the requirement that $B(t)$ increase with time. What a miracle too!

2.8 Structure formation of the universe

Our universe is composed of stars. Stars are constantly burning: turning massive particles into massless photons in order to illuminate the universe's structure (including humans). As a result, the mass density of the universe is decreasing. My model of the universe and quantum gravity [1] point out that mass density of the universe at large scale does decrease with time, a fact consistent with the increasing function $B(t)$. This is really the miracle of miracles.

Full mathematical details of the above cosmological model are given in the following Section.

3 A Flat-Universe Model Based on Simple Principles

(i) A set of simple and basic principles about the large-scale universe. Our current knowledge of the universe is very limited and all models of the universe are mainly based on some assumptions. A correct model of the universe must be based on some absolute inertial frame (the flat background spacetime). The existence of such a frame is shown to be true from the following three basic principles: (1) The universe has an isotropic but temporally changing "gravitational field"; (2) The gravity is described by a Lagrangian which is the generalization to the proper distance of special relativity (a similar metric form to Big Bang theory); (3) Hubble law is approximately true. These lead to varying light speed with time and give account of galactic redshifts and Hubble law (including 'accelerated expansion') as demonstrated in the following.

(ii) Lagrangian, Lagrange's equation and its solution. The above set of principles uniquely determine the following Lagrangian which describes the isotropic "gravitational field" in the universe,

$$\begin{array}{ll} \frac{1}{2}\dot{s}^2 & = L(x^0, x^i, \dot{x}^0, \dot{x}^i) \\ & = \frac{1}{2}B(\tilde{t})(\dot{x}^0)^2 - \frac{1}{2}A(\tilde{t})\sum_{i=1}^{3}(\dot{x}^i)^2 \\ & = \frac{1}{2}g_{\alpha\beta}\frac{dx^\alpha}{dp}\frac{dx^\beta}{dp} \end{array} \tag{3}$$

where

$$\dot{x}^i = \frac{dx^i}{dp}, \text{ etc.},$$

p is the path parameter as explained in Section 2.1, ($x^0 = ct = \tilde{t}, x^1 = x, x^2 = y, x^3 = z$), and

$$g_{00} = B(\tilde{t})(> 0), g_{11} = g_{22} = g_{33} = -A(\tilde{t})(< 0),\ g_{\alpha\beta} = 0(\alpha \neq \beta). \tag{4}$$

The canonical momentums conjugate to time $\tilde{t}$ and space coordinates x^i are respectively,

$$\begin{array}{l} P_0 = \frac{\partial}{\partial \dot{x}^0}L = B\frac{d\tilde{t}}{dp} \\ P_i = \frac{\partial}{\partial \dot{x}^i}L = -A\frac{dx^i}{dp},\ i = 1, 2, 3. \end{array} \tag{5}$$

To find the Lagrange's equation, we need

$$\begin{array}{l} \frac{\partial}{\partial x^0}L = \frac{1}{2}B'\left(\frac{d\tilde{t}}{dp}\right)^2 - \frac{1}{2}A'\sum_{i=1}^{3}\left(\frac{dx^i}{dp}\right)^2, \\ \frac{\partial}{\partial x^i}L = 0,\ i = 1, 2, 3, \\ \frac{d}{dp}\left(\frac{\partial}{\partial \dot{\tilde{t}}}L\right) = B'\left(\frac{d\tilde{t}}{dp}\right)^2 + B\frac{d^2\tilde{t}}{dp^2} \end{array} \tag{6}$$

where A' and B' are derivatives with time $\tilde{t}$:

$$A' = \frac{dA(\tilde{t})}{d\tilde{t}},\ B' = \frac{dB(\tilde{t})}{d\tilde{t}}. \tag{7}$$

The middle equation in (6) indicates that $x^i, i = 1, 2, 3$ are cyclic coordinates. Therefore, the spatial components of the Lagrange's equation are

$$P_i = \text{constant} = -A(\tilde{t})\frac{dx^i}{dp},\ i = 1, 2, 3. \tag{8}$$

The temporal component is

$$\frac{d}{dp}\left(\frac{\partial}{\partial \dot{\tilde{t}}}L\right) - \frac{\partial}{\partial \tilde{t}}L = B\frac{d^2\tilde{t}}{dp^2} + \frac{1}{2}B'\left(\frac{d\tilde{t}}{dp}\right)^2 + \frac{1}{2}A'\sum_{i=1}^{3}\left(\frac{dx^i}{dp}\right)^2 = 0. \tag{9}$$

Combination with (8) gives

$$B\frac{d^2\tilde{t}}{dp^2} + \frac{1}{2}B'\left(\frac{d\tilde{t}}{dp}\right)^2 + \frac{A'}{2A^2}((P_1)^2 + (P_2)^2 + (P_3)^2) = 0. \tag{10}$$

We define the constant (conservative) spatial momentum P of the particle (e. g., a galaxy or a light crest from a galaxy),

$$P^2 = (P_1)^2 + (P_2)^2 + (P_3)^2. \tag{11}$$

Finally the solution of the equation (10) is

$$\frac{dp}{d\tilde{t}} = \sqrt{\frac{A(\tilde{t})B(\tilde{t})}{P^2 + WA(\tilde{t})}}. \tag{12}$$

where W is another constant. Substitution of the solution to the spatial ones (8) we finally have the particle's motion in our universe

$$\frac{dx^i}{d\tilde{t}} = -P_i\sqrt{\frac{B(\tilde{t})}{(P^2 + WA(\tilde{t}))A(\tilde{t})}}. \tag{13}$$

However, this is not the full story. Since our Lagrangian is proportional to the effective distance $(d\bar{s}/dp)^2$ and we deal with causal motion only, we always have $d\bar{s}^2 \geq 0$. Substitution of all our solutions into (3) gives

$$\frac{1}{2}\left(\frac{d\bar{s}}{dp}\right)^2 = L = \frac{1}{2}W = \text{constant}. \tag{14}$$

This supports a geometric assertion

$$\bar{s} \propto p. \tag{15}$$

Causal motion implies that we always have

$$W \geq 0. \tag{16}$$

(iii) Varying light speed in the gravitational field of the universe. Because light has the maximum speed ($d\bar{s}^2 = 0$), we have $W = 0$ for the motion of light. In its propagation direction we have

$$\frac{dx}{d\tilde{t}} = \sqrt{\frac{B(\tilde{t})}{A(\tilde{t})}}. \tag{17}$$

Currently the universe is at the time of

$$\tilde{t} = \tilde{t}_1 = ct_1. \tag{18}$$

The current light speed is $c \simeq 3 \times 10^8 \mathrm{m\,s^{-1}}$ which is used in the definition of $\tilde{t}$: $\tilde{t} = ct$. It is not wrong that we choose other light speed for the definition.

(iv) Galactic redshift and Hubble law. Galactic redshift is the formula

$$z = \frac{\nu_1}{\nu_2} - 1 = \frac{\sqrt{g_{00}(\tilde{t}_1)}}{\sqrt{g_{00}(\tilde{t}_2)}} - 1 = \frac{\sqrt{B(\tilde{t}_1)}}{\sqrt{B(\tilde{t}_2)}} - 1. \tag{19}$$

We see that $B(\tilde{t})$ must be a monotonously increasing function with time for us to have galactic redshifts rather than blueshifts,

$$B(\tilde{t}) \uparrow . \tag{20}$$

The distance D between the two galaxies 1 (Milky Way) and 2 is given by the integral of the light travel formula (17)

$$D = \int_{\tilde{t}_2}^{\tilde{t}_1} \frac{dx}{d\tilde{t}} d\tilde{t} = \int_{\tilde{t}_2}^{\tilde{t}_1} \sqrt{\frac{B(\tilde{t})}{A(\tilde{t})}} d\tilde{t}. \tag{21}$$

The distance formula must have a redshift factor to give the Hubble law. This indicates that $A(\tilde{t})$ depends on $B(\tilde{t})$. A simple and general model of the dependence is

$$A(\tilde{t}) = \frac{B^{m+1}(\tilde{t})}{N^2 B'^2(\tilde{t})} \tag{22}$$

where m is a constant and $N(> 0)$ is another constant whose unit is length. Finally we have Hubble law,

$$\begin{aligned} D &= \tfrac{2N}{m-2} \left(\tfrac{1}{\sqrt{B(\tilde{t}_2)}^{m-2}} - \tfrac{1}{\sqrt{B(\tilde{t}_1)}^{m-2}} \right) \\ &= \tfrac{2N}{m-2} \left(\tfrac{1}{\sqrt{B(\tilde{t}_2)}} - \tfrac{1}{\sqrt{B(\tilde{t}_1)}} \right) \left(\tfrac{1}{\sqrt{B(\tilde{t}_2)}^{m-3}} + \dots \right) \\ &= \tfrac{2Nz}{(m-2)\sqrt{B(\tilde{t}_1)}} \left(\tfrac{1}{\sqrt{B(\tilde{t}_2)}^{m-3}} + \dots \right) \\ &= \tfrac{cz}{H_0(\tilde{t}_2, \tilde{t}_1)} \end{aligned} \tag{23}$$

where the Hubble constant H_0 is

$$H_0 = \frac{c(m-2)\sqrt{B(\tilde{t}_1)}}{2N} \Big/ \left(\frac{1}{\sqrt{B(\tilde{t}_2)}^{m-3}} + \dots \right). \tag{24}$$

As a summary, I note that the redshift requires $B(\tilde{t})$ be a monotonously increasing function of time and Hubble law requires A be determined by the function B (see (22)). Therefore, the only one degree of freedom left is the function form of $B(\tilde{t})$.

(v) 'Accelerated Expanding' Universe. If H_0 depended only on $\tilde{t}_1$, the current time, then Hubble law would be perfectly true. However, it depends on the past time of the galaxy we observe,

$$H_0 = H_0(\tilde{t}_2, \tilde{t}_1). \tag{25}$$

If we assume

$$m > 3$$

then Hubble constant H_0 is not constant and increases with the past time $\tilde{t}_2$, of which the galaxy is observed. This increase with time of H_0 is explained as the 'accelerating expansion' of the universe. However, in my model, spacetime is flat (no expansion of curved spacetime) and the redshift is gravitational one which results from the evolution of the universe (mass density varies with time). Because redshift requires increasing $B(\tilde{t})$, we see that 'accelerating expansion' is consistent to galactic redshift.

(vi) Infinite Light Speed and the Birth of the Universe. Positive and increasing quantity $B(\tilde{t})$ indicates a time $\tilde{t}_0$, when $B(\tilde{t}_0) = 0$. This is the starting time of the universe. We can choose $\tilde{t}_0 = 0$ to be the time of cosmic birth. Currently we do not know the exact physics at the hot birth. One thing is sure that light speed at the time must be infinite. Only infinite speed of communication could result in a later spatially homogeneous mass distribution in the infinite flat universe. This resolves the horizon and flatness problems due to a birth in Big Bang theory. Infinite initial light speed indicates a decrease of light speed with time. Observation during the last decade does support the result of decreasing light-speed with time. The formula of light speed is (17). Therefore, decreasing light speed imposes further condition on the evolving factor $B(\tilde{t})$,

$$2BB'' \leq mB'^2. \tag{26}$$

(vii) Light Speed Constancy and the Death of the Universe. However, there is strong evidence that light speed is approximately constant during mature stage of the universe. Constant light speed with time means that $A(\tilde{t})$ and $B(\tilde{t})$ are the same

$$A(\tilde{t}) \equiv B(\tilde{t}).$$

They serve as the scaling factor. Perfect Hubble redshift-distance linear law completely determines the scaling factor,

$$\frac{1}{B(\tilde{t})} \equiv \frac{1}{A(\tilde{t})} = \frac{1}{B_0} - M(\tilde{t} - \tilde{t}_0) \tag{27}$$

where M is a constant and $B_0 = B(\tilde{t}_0)$. This formula indicates a finite time $\tilde{t}_1$ when $M(\tilde{t}_1 - \tilde{t}_0) = 1/B_0$. This is the ending time of the universe because the scaling factor reaches infinity. The possibility of a rebirth needs further investigation.

(viii) The Absolute Inertial Frame of the Universe. Our calculation and results are reference-frames depended. For example, photon frequency is dependent on reference frames. Our results are meaningful only when single preferred inertial frame of the universe exists and the results are calculated with respect to the frame. The absolute frame is meaningful only when all components (e.g., galaxies) of the universe have convergent motion with respect to the frame. That is, all components slow down their speed of motion with respect to the frame. Since the nineteenth century, scientists have proposed many theories of the absolute reference frame and the report on its evidences has never been stopped. Because of light speed constancy we have $A(\tilde{t}) \equiv B(\tilde{t})$ in the formula (13). We can see that the absolute speed of material particles (galaxies) does decrease with time, slowing-down motion with respect to the absolute inertial frame (Note that $W > 0$ for material particles). Here we see that the existence of absolute inertial frame is once again the direct result of galactic redshift.

(viiii) The Variance with Time of Matter Distribution in the Universe. Our Lagrangian is defined on flat spacetime and can be quantized according to the classical and covariant quantization procedure [1]. Because the spatial distribution of matter in the universe is homogeneous,

the resulting amplitude of the wave function must be proportional to the density of the distribution. Astronomical observation suggests that the density decreases with time especially during early universe. We can see that the amplitude does decrease with time if $B(\tilde{t})$ increases with time. That is, the astronomic observation is once again consistent to the result of galactic redshift.

4 All are the Change of Materials

You have known my model of the universe. The essence of my model is that everything is the physical change of materials (maybe including human body).

The nature of time is also the change of materials. When in 2007 I learned from the internet that British physicist Julian Barbour had the idea of "there is no time but change", I had a sudden wake up in my life! In fact, Julian Barber put forward the idea in more than 40 years ago when he was a doctoral student in physics. But the concept of time had been demonized as an independent existence (the object with dynamic energy) instead of the fact that time stands for the change of real materials. In order to continue his exploration of truth, Julian Barbour, after graduation, bought a house in the country and raised his family by translating into English the Russian physics journals in the former Soviet Union. What a pity!

Space is also the change of materials. According to my model of the universe, there is no imagined space. Instead space is the real existence of material: there are infinite materials in position. Do not imagine a boundary of the universe. There is no border, there is only materials. The universe is the unmeasurable vast. However, the relative motion between materials slows down gradually and eventually all the materials will be static with respect to each other. Such a process towards the final static states defines the absolute reference frame of the universe. Because the large-scale distribution of materials is always uniform, this frame is the global flat inertial reference frame. The universe is stable which can be relied upon. The universe sets the standard for the measuring of human life. Anyone who recognizes this is modest. Only those arrogant people try to overcome the vast.

You have seen the old clocks, but they are the change of materials: the change of spring. You have seen the atomic clocks, but they are the change of materials: atomic radiation. You have seen the natural clocks on farmlands, but they are the change of materials: sunrise and sunset. You have seen the age, but it is the change of materials: faces.

You have seen the scale, but it is real: wood. You have seen the microscopic world, but it is real: protons and electrons. You have seen the macroscopic world, but it is real: forests and stars.

All are the change of materials: the orderly changes. When you face your wife, you may think of beauty, but have not thought of that she is the orderly and rational change. When you face your husband, you may think of able man, but have not thought of that he is the orderly and rational change. You may have missed appreciation of the most important things in life.

References

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