Properties and Dimensions of Space and Time

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Abstract: Based on materialist dialectics, both`time and space have the duality, namely absoluteness and relativity. If absolute time and absolute space cannot exist, then relative time and relative space cannot exist too; vice versa. However, they aren't equal. Absolute time and absolute space are more important, because they are the reference systems of relative time and relative space respectively. In addition, the absolute space is flat, while the relative space may be flat also may be curving. As for the dimensions of time and space, it is an extremely complicated question, we need to discuss the complicated time and the complicated space. The absolute space is three-dimensional, the absolute time is one-dimensional that is formed by the three-dimensional absolute time. For the relative space, it may have the multi-dimensional space, fractal dimensional space, plural dimensional space, variable dimensional space. For the relative time, it may have the multi-dimensional time, fractal dimensional time, plural dimensional time, variable dimensional time too, they are corresponding to the relative spaces. In other words, the relationship between space and time is the one by one corresponding relations. It is different to the general viewpoint that space is three-dimensional and time is one-dimensional, according to the viewpoints of self-similarity and similarity of fractal theory, three-dimensional time is derived. With the Lorentz transformation of Relativity, this paper presents the special form of three-dimensional time for a special case, which is also written as the form of variable dimension fractal. The examples given in this paper show that to establish the frames of multi-dimensional time, multi-dimensional space and the like, not only are possible but also necessary in some cases.

Key words: Absolute time, relative time, absolute space, relative space, fractal theory, variable dimension fractal, complicated time, complicated space

Introduction

The development of the theory of time and space has walked through a long and arduous road. Originally Newton established the theory of absolute space and absolute time. This viewpoint considered that space is a rigid frame, and time is glided uniformly. In addition, time and space are not subjected to the influence of any physical process. Later on, the concept of four-dimensional space-time continual region was established in the theory of relativity. Namely, any physical event corresponds to four digits: three of which represents the location of an event, another one represents the time of the event. Einstein thought that the overall of a large number events constitute a four-dimensional space-time continual region, the properties of space and time are related to the motions of objects, and containing the meaning that space and time are no longer absolute and they are independent each other. With the development of quantum theory, we can find another viewpoint that time and space are a kind of order between things.

Although the space-time theory is developing continuously, one viewpoint has not been changed, namely in general, space is three-dimensional, and time is one-dimensional.

Similar to the viewpoint of time is one-dimensional, Euclid's fifth postulate is as follows: through a point outside a straight line, there is only one line to parallel it. As is well known, the viewpoint that there is only one parallel line has been broken by non-Euclidean geometry. In that case, whether or not the viewpoint that time is one-dimensional should be broken?

As early as 1982, Zhang Shu-run discussed the seven-dimensional space-time in the journal of Potential Science, and proposed that time is four-dimensional. While the author proposed the viewpoints of three-dimensional time and multi-dimensional time in September 2002. On this basis we can also discuss fractal-dimensional time, plural-dimensional time and variable-dimensional time.

The dimensions of space also need to be reconsidered.

According to this situation, this paper presents the concepts of complicated time and complicated space, and the related issues are also discussed.

1 Absoluteness and relativity of time and space

According to the materialist dialectics, both`time and space have the duality, namely absoluteness and relativity. Relative time and relative space are conditional, temporary and limited; and absolute time and absolute space are unconditional, eternal, and infinite. Absoluteness and relativity are interdependent, both are necessary. Do not have absolute time and absolute space, relative time and relative space cannot exist, and vice versa. Do not have absolute time and absolute space, relative time and relative space cannot be defined. Now, if someone said that something only has the advantages without the disadvantages, no one will believe it. The reason that relative time and relative space cannot exist independently, is the same that something cannot have the advantages only without the disadvantages.

Similar to that absolute truth is existed in relative truths, absolute time and absolute space are only exist in relative times and relative spaces.

On the other hand, for absolute time and relative time, and for absolute space and relative space, their statuses are not equal. If absolute time and relative time are seen as the contradictory two aspects, so do absolute space and relative space, then for the contradictory two aspects, one aspect is main, and another aspect is non-main. Therefore we should say that absolute time and absolute space are more important, because they are the reference system of relative time and relative space. Of course, in another sense, we can also considered that relative time and relative space are more important, because the main aspect and non-main aspect may be interchangeable under certain conditions.

There is a viewpoint to nagate absolute time and absolute space, that is absolute time and absolute space cannot exist in the real world.

While this viewpoint is clearly untenable in philosophy. As we already pointed out that, absolute time and absolute space can exist in relative times and relative spaces respectively.

In addition, what’s the meaning of existance? In a sense, absolute time and absolute space do not exist in the real world. But in an abstract world, namely for theoretical thinking in mathematics and physics, absolute time and absolute space can exist. In other words, things that do not exist in the real world do not mean that they cannot be defined, and cannot be applied.

For example, mathematical point cannot exist in the real world. But the concept of point can be defined mathematically, and it has a very wide range of applications. Another example is that, as discussing the celestial movements, the Earth and the Sun are becoming "point". It is convenient and the results are in line with the actual situations.

Einstein believed that it is not necessary to introduce a special "absolutely stationary space", but for the "static system" introduced by himself, in a sense, it is equivalent to the "absolutely stationary space".

How to determine the absolute space and absolute time?

The answer is as follows: according to different problems and different conditions, we can define or determine the absolute time and absolute space. For example, a certain point in the deep universe can be defined as the origin of absolute space, and its three axes can also be defined. Then place the world's most accurate atomic clock at the origin of the absolute space, thus the atomic clock can be used to measure the absolute time.

Of course, this manner will produce errors. But these errors can also be revised. For example, at present the timing system is accurate enough, but from time to time, it is also to be revised. Such as several years ago, according the related authorities of the world, that year's last-minute was 61 seconds instead of 60 seconds. This is the example to revise the timing system’s errors.

As to the problem of changing other coordinate system’s space and time into absolute space and absolute time, this is a topic that needs further study. However, to compare with the definition of absolute space’s origin, this should be relatively easy to solve. At present, we can use the formulas of the theory of relativity, until these formulas will be proved that they lead to the wrong results.

Now we discuss the space and time conversion problems between the different coordinate systems. For example, the conversion problems between a spaceship, the Earth and the Moon.

The space conversion problem has been solved in mathematics, here we will no longer discuss it.

As discussing the time conversion problem, two cases of absolute time and relative time should be considered respectively.

For absolute time, the absolute time in a spaceship is the same as the absolute time on the Earth and on the Moon, namely there is only one absolute time; as in Newton's view, absolute, true, and mathematical time, by its nature, it is independent of all external objects.

For relative time, in general the relative time in a spaceship is not the same as that on the Earth and on the Moon. According to the viewpoint of theory of relativity, for one person in a spaceship and for another person on the Earth, both of them will consider that the other side’s relative time is slower than that of himself, and the two slow degrees are the same; but for third side, for example from the viewpoint of the person on the Moon, the relative times in a spaceship and on the Earth, are all slower than that of the Moon, while the slow degrees are not the same. As to the specific conversion formulas, we can also use the ones given by theory of relativity temporarily.

The reason for that we can only use the formulas given by theory of relativity temporarily, is as follows.

Firstly we consider that whether or not the slow degree of time in a spaceship can be calculated with theory of relativity.

The answer is that it is impossible in some cases.

On this point, we can refer to the original version of Einstein. In the famous paper entitled "On the Electrodynamics of Moving Bodies" that presented the special relativity, only for the case of the route of spaceship is the arbitrary polyline, the calculation method for slow down time of a moving clock is given. Then Einstein assumed that the calculation method is still valid for the route is a continuous curve. In fact, this assumption may be incorrect for some continuous curves. The reason for this is that, the special relativity including Lorentz transformation is based on the principle of invariance of light speed and the principle of relativity, it does not take into account the cases of various continuous curves, so this calculation method is not guaranteed that it is correct for any continuous curve.

There are many more complex issues, such as the special twin paradox that two brothers' states of motion are quite same. If the elder brother and the younger brother all ride their respective high speed airships, facing the completely opposite directions to navigate from the identical time and the identical site on the Earth with the same speed along a straight line, after a long period they begin to decelerate simultaneously until static, then they turn around to navigate again along the same straight line with the manner of front to front, finally simultaneously return to the starting point. From the younger brother's viewpoint that, according to the theory of relativity, the elder brother should be much younger than the younger brother; Similarly, from the elder brother's viewpoint that, according to the theory of relativity, the younger brother should be much younger than the elder brother. Who is much younger to the end? Moreover, we can also suppose that from the beginning to the end, the two brothers are running along the complicated spiral curve s. How to solve these problems with the theory of relativity? Perhaps some scholars propose that this problem can be solved by taking the Earth as the reference system and using the theory of relativity. However, the Earth moves around the Sun, and the Sun moves around the Milky Way, considering these questions will cause the problems become extremely complex, or even impossible to be solved. Therefore, in order to solve these problems, finally we have to establish the theory beyond relativity that is based on absolute space and absolute time.

In addition, for many other properties of time and space, they must be considered with absoluteness and relativity respectively. For example, space is flat, or curving? Our view is as follows: absolute space is flat, while the relative space can be flat or curving. For these issues, we will discuss them in another paper.

2 Complicated time and complicated space

As discussing the dimensions of time and space, we must face a number of very complex situations, hence we need to introduce the concepts of complicated time and complicated space. In other words, for different situations, the dimensions of time and space are different.

In general, the dimension of time and the dimension of space have the corresponding relationship. This means that the dimension of time corresponds to the dimension of space.

Firstly we discuss the dimensions of absolute space and absolute time.

Absolute space is three-dimensional, this does not appear to be argued. Corresponding to the three-dimensional absolute space, there should be three-dimensional absolute time. However, absolute space is a rigid framework, the times for three coordinates are the same, so the absolute time is one-dimensional.

While dimensions of relative time and relative space are extremely complex.

If the description of moving body requires the use of three-dimensional space, and relative time is related to motion, so that in this case the relative time is three-dimensional too.

However, the three-dimensional space can only be used to determine the location of point, but cannot determine the rotation of point. If we consider point rotation around the three axes, it is necessary to add three-dimensional becoming a six-dimensional space. It is important to note, this six-dimensional space has been widely used in the ship engineering, architecture, and the like. Corresponding to this six-dimensional space, the time is six-dimensional too.

In other cases, we can also discuss multi-dimensional space, fractal dimensional space, plural dimensional space, variable dimensional space. As well as the corresponding multi-dimensional time, fractal dimensional time, plural dimensional time, variable dimensional time. In other words, the relationships between spaces and times are one-to-one correspondence.

Some specific issues are discussed below.

3 Implications of fractal theory and three-dimensional time

Fractal theory is introducted in 1967, although only a few decades passed, but it has been applied successfully in some areas, it is used to reveal the organizational structure deeply hidden in complex phenomena. Many scientists predict that, in the 21st century, whether in natural science or in social sciences, fractal methods will achieve significant results. The characteristic of fractal theory is introduced the concept of fractal dimension. In traditional geometry, dimension is a integer, for example, point is zero-dimensional, line is one-dimensional, plane is two-dimensional, and so on. While in fractal method, breaking the constraint of integer, the fractal dimension D can be taken as non-integer, such as the coastline fractal dimension D can be taken as 1.02,1.25 and so on. In the original fractal theory, the fractal dimension is constant, this fractal distribution is a straight line on a log-log coordinate.

One of the characteristics of organized structures revealed by fractal method is self-similarity. For example, the various photos, including the mountain photo taken from the plane, the photo of the rubble, and microscope photo of rough rocky surface, are very similar, sometimes we cannot distinguish them. As another example, putting together the original coastline photo, its enlarged 1 time photo, twice times photo, 5 times photo and the like, from the features of their twists and turns, they are also unable to be distinguished. In addition, for the same coastline, if using the rulers of 1m, 0.5m, 0.2m, 0.1m and the like to measure the length, the measurement results are not the same, the shorter the ruler, the longer the result. These self-similar phenomena, can be found in many areas, so they can be unified processing by using the fractal method.

It should be noted that, the conclusion concerning "self-similarity" in fractal theory can also produce the conclusion of "similarity". "Self-similarity" refers to the part and the global are similar. Since each part is similar to the global, then any part is similar to another part.

According to the revelation on "similarity between part and part" from fractal theory, if taking time and space as a global, taking time and space as two parts, then time and space should be similar. In that case, corresponding to the space is three-dimensional, the time should be three-dimensional too. Corresponding to the space of other dimensions, time should also be other dimensions.

4 Formulas of three-dimensional time in a special case

Selecting two different reference frames S and S', their coordinates are x, y, z, and x', y', z'. At the beginning, S and S' are coincident, in frame S there is a line r through its origin O, the angles between r and x, y, z are α, β, γ respectively. In frame S' the corresponding line is r'. Then the origin O' of S' is moving along the line r with constant speed V, and x', y', z' are always parellel to x, y, z. Supposing that in frame S, the times along x, y, z and r directions are t_x, t_y, t_z and t_r respectively, and in frame S', the times along x', y', z' and r' directions are $t'_{x'}$, $t'_{y'}$, $t'_{z'}$ and $t'_{r'}$ respectively.

Assuming that the reference frame S is absolutely static, then we have

$$t_x = t_y = t_z = t_r = t \qquad (1)$$

According to the Lorentz transformation in the theory of relativity, if frame S' is moving along x direction, it gives the time transformation formula as follows

$$t' = \frac{t - (V/c^2)x}{(1 - V^2/c^2)^{1/2}} \qquad (2)$$

Accordingly, if frame S' is moving along r direction, it gives the time transformation formula along r' direction as follows

$$t'_{r'} = \frac{t - (V/c^2)r}{(1 - V^2/c^2)^{1/2}} \qquad (3)$$

Projecting it to x', y', z' directions respectively, in frame S' it gives the times of $t'_{x'}$, $t'_{y'}$, $t'_{z'}$ along x', y', z' directions as follows

$$t'_{x'} = t'_{r'} \cos\alpha \qquad (4)$$

$$t'_{y'} = t'_{r'} \cos\beta \qquad (5)$$

$$t'_{z'} = t'_{r'} \cos\gamma \qquad (6)$$

At this point, in frame S' we derive the formulas of three-dimensional time in a special case.

5 Variable dimension fractal formulas of three-dimensional time

Fractal distribution can be defined as follows[1]

$$N = \frac{C}{r^D} \qquad (7)$$

where: r is the characteristic scale, such as length and the like; N is a quantity related to r, such as time, temperature, force and the like; C is an undetermined constant; D is the fractal dimension.

In the present application of fractal method, D is a constant, this kind of fractal is known as constant dimension fractal. It is a straight line on a log-log coordinate. But for non-linear functional relationship, the constant dimension fractal cannot be used. In order to overcome this difficulty, in reference [2]~[4] we introduce the concept of variable dimension fractal and fractal dimension D is the function of characteristic scale r.

The expression of D is as follows

$$D = g(r) \qquad (8)$$

Now we illustrate that any functional relationship N = f(r) can be converted into the form of variable dimension fractal, for this purpose it gives

$$f(r) = \frac{C}{r^D} \qquad (9)$$

The value of D can be solved as follows

$$D = \frac{\ln C - \ln f(r)}{\ln r} \qquad (10)$$

Namely the function f(r) is converted into the form of variable dimension fractal.

For Eq.(3) to Eq.(6), only Eq.(3) is required to be converted into the form of variable dimension fractal. For the sake of convenience, supposing C=1, then we have

$$t'_{r'} = \frac{1}{r^D} \qquad (11)$$

From Eq.(3) and Eq.(11), we can get

$$D = -\frac{\ln K}{\ln r} \qquad (12)$$

where: $K = \frac{t - (V/c^2)r}{(1 - V^2/c^2)^{1/2}}$

It should be noted that, here the time is still three-dimensional, but it is rewritten into the form of variable dimension fractal.

6 Multi-dimensional time and the related examples

In reference [5], in order to overcome the difficulties encountered by certain issues, Stephen Hawking introduced "imaginary time", thus the "imaginary time" and the “real time” can be seen as an example of multi-dimensional (two-dimensional) time.

Now we present an example that the multi-dimensional time must be applied.

Firstly assuming that within a certain period, one stock’s price P can be written as a function of time

$$P = F(t) \qquad (13)$$

Secondly assuming that the concrete strength Q_A located at position A can be written as a function of time

$$Q_A=G_A(t) \quad (14)$$

Thirdly assuming that the concrete strength Q_B located at position B can be written as another function of time

$$Q_B=G_B(t) \quad (15)$$

Similarly, more functions can be defined.

From Eq.(14) we can reach the value of t as follows

$$t=H_A(Q_A) \quad (16)$$

Substituting it into Eq.(13), we can get

$$P=F(H_A(Q_A)) \quad (17)$$

Namely we get a ridiculous conclusion: one stock's price P is a function of the concrete strength Q_A located at position A.

Of course, if this problem is procesing by the human brain, this conclusion cannot be reached. But procesing by the computer, this conclusion may be reached. In order to fundamentally prevent such errors, we must use different time coordinates. Such as the stock time coordinate can be recorded as t_0, at position A the time coordinate can be recorded as t_A, and so on. And we stipulate that the different time coordinates cannot be interchanged. If multidi-mensional time is not introduced in this example, we will have not the reason to make the non-interchangeable provisions.

Finally, it is worth to mention such a historical fact: facing many people's blame, the founder of non-Euclidean geometry said, the viewpoint is correct logicaly that through a point outside a straight line, there are more than one lines to parallel it.

Similarly, the concepts of multidi-mensional time, fractal dimensional time, plural dimensional time, and variable dimension fractal time, are all correct logicaly.

Based on the same reason, the various dimensions of space can also be introduced, but we do not intend to discuss them in this paper.

7 Fractal dimensional time, plural dimensional time, and variable dimensional time

From the previous discussions we can find that the dimensions of time and space are related to the problems we discussed and the methods we applied.

In references [6-8], fractal dimension, plural dimension fractal, and variable dimension fractal have been used to deal with some problems in physics and the like.

By using fractal dimension, plural dimension fractal and variable dimension fractal, and the like to discuss the problems of time, we can reach fractal dimensional time, plural dimensional time, and variable dimensional time.

Firstly let us look back on the application of general fractal formula Eq. (7) to deal with coastline length, and reach the dimension of coastline. For the same coastline, if using the rulers of 1m, 0.5m, 0.2m, 0.1m, and the like to measure the length, the measurement results are not the same. Drawing these results on a log-log coordinate, if the data points are located at the same straight line, then the slope of the straight line is the dimension of the coastline. If the data points are not located at the same line, we can use the least squares method and the like to calculate the slope of the fitting straight line, and take it as the dimension of the coastline. If the coastline is a straight line, its dimension is equal to the integer 1; if the coastline is a complex curve, its dimension D may be a fraction, such as 1.02,1.25, and so on.

Similar methods can be used to find the dimensions of time in some cases.

Assuming that for a certain route, several counters in the spaceship will be used to measure the times. In advance, these counters were calibrated on the Earth, thus the counters' intervals of "tick-tock" are 1s, 0.5s, 0.2s, and the like respectively. For each counter, measuring result should be drawing on a log-log coordinate, if all the data points given by the different counters located at the same straight line, the slope of the straight line is the dimension of time. If all the data points are not located at the same straight line, we can use the least squares method and the like to calculate the dimension of time. If the spaceship's route is a straight line and its speed is lower, the dimension of time is equal to the integer 1, and the time is one-dimensional, thus the result is consistent with the traditional viewpoint; if the route is a complex curve and the speed is very fast and changable, then the dimension may be a fraction, and the example for fractal dimensional time is given.

In addition, after the above mentioned data are drawing on a log-log coordinate, if the distribution of these data is the form of a curve, instead of close to a straight line, thus we cannot apply least square method and the like to fit these data with a straight line. In this case, the variable dimension fractal method should be used to fit these data with a curve, namely the fractal dimension of time is variable, and the variable dimensional time is reached.

Moreover, supposing that we consider two spaceships simultaneously, these two spaceships' routes are two complex curves and their speeds are very fast and changable, and these two measuring results with counters are drawing on two log-log coordinates respectively. If we want to process these two measuring results with a unified way, then the plural dimension fractal method should be used, namely the dimension of time is a plurality, and the plural dimensional time is reached.

7 Conclusions

According to the viewpoint of materialist dialectics, we can discuss the absoluteness and relativity of time and space. As studying the dimensions of time and space, we can introduce the concepts of complicated time and complicated space. The absolute space is three-dimensional, and the absolute time is one-dimensional. The relative spaces may be multi-dimensional, fractal dimensional, plural dimensional, and variable dimensional. The relative times may be corresponding to the relative spaces, and they may also be multi-dimensional, fractal dimensional, plural dimensional, and variable dimensional. The above mentioned results are correct logically and supported by many examples.

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