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THREE DIMENSIONAL SPACE-TIME

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ABSTRACT: *The space-time description in Physics was composed of 3D space and the 1D time which was independent of 3D space before the proposal of the 3D space-time. Therefore, space-time was regarded as 4-dimensional. With the metrical method, the author finds out that time and space can be quantified by the same quantity value which can be described by three numbers (coordinate values) if the metric for the space distance is selected as the time wave length. Hence, space-time can be regarded as not only the observable quantity but also 3 dimensional.*

KEYWORDS: Space Time; Metric; Space; Distance; Time

INTRODUCTION

Physical phenomenon is composed of various events among which each event is described by space and time. Then, is the space-time composed of both space and time 3 dimensional or 4 dimensional? The description of space-time in the past physics was composed of the 3D space continuum and the 1D time continuum which is independent of space. Hence, space-time is considered as 4 dimensional [1−3]. Since the structures of time and space are considered as independent of each other, it is difficult to quantify them with the same quantity value, which makes it hard to derive the space-time quantity value relationship. However, it could provide a new thinking for the physical concept of space and time if the metric for space distance is selected as the time wave length based on the metric method.

Space time Structure

In Physics in the case of measuring the length of a distance, the reference point of a location is needed according to the physical explanation of distance. Then, the distance quantity value from the reference point to the given point can be determined with the metrical method. The simplest way is to use geometrical principle to connect two points with a straight line. The unit measuring gauge is used to measure the distance between the reference point and the given point. The numbers of the unit measuring gauge thereby is the distance quantity value, while the unit measuring gauge is the metric for this distance, which can be metre, centimetre, or millimetre, etc. This law can be expressed by the following equation: Set o as the reference point, p as the given point, ρ as the unit measuring gauge, the metric for the distance quantity value from p to o. As shown in Fig. 1, the relative distance from p to o is:

$$r_p = n(\rho)\cdots\cdots\cdots(1)$$

In Eq. (1), n is the quantity value for the relative distance from p to o measured by the unit measuring gauge ρ .

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If the metric for the relative distance from p to o is selected as the time wavelength λ ($\lambda < \rho$), such setting can be expressed in the following equation based on the following consideration. Set a clock on the reference point o (static), as shown in Fig. 2, the relative distance from p to o can be adapted from Eq. (1) to:

$$r_p = N(\lambda) \cdots\cdots\cdots (2)$$

Meanwhile, as the time velocity of clock v is a characteristic constant, let $T = \lambda/v$, $t_p = r_p / v$, Eq. (2) divided by v on both sides is:

$$t_p = N(T) \cdots\cdots\cdots (3)$$

In Eq. (2) and Eq. (3), N is not only the distance quantity value using the time wave length λ to measure the relative distance from p to o, but also the time quantity value using the time period T to measure the relative time from p to o. Therefore, such space and time quantified by the same quantity value N is called the relative space-time from p to o.

The location of the space is described by three numbers (coordinate values). Set o as the reference point, $p(x, y, z)$ as the coordinate for the location of any given point, and $x^2 + y^2 + z^2 = r_p^2$. If the metric for the quantity value of the relative space distance from p to o is the unit measuring gauge ρ, as shown in Fig. 3, the relative space distance from p to o is:

$$x^2 + y^2 + z^2 = [n(\rho)]^2 \cdots\cdots\cdots (4)$$

In Eq. (4), n is the quantity value of the relative space distance from p to o measured by the unit measuring gauge ρ.

If the metric for the quantity value of the relative space distance is selected as the time wave length λ ($\lambda < \rho$), such setting can be expressed in the following expression: Set a clock on the reference point o (static), as shown in Fig. 4, Eq. (4) can be adapted as:

$$x^2 + y^2 + z^2 = [N(\lambda)]^2 \cdots\cdots\cdots (5)$$

Meanwhile, as the time velocity of clock v is a characteristic constant, let $t_x = x / v$, $t_y = y / v$, $t_z = z / v$, $T = \lambda/v$, Eq. (5) divided by v^2 on both sides is:

$$t_x^{\ 2} + t_y^{\ 2} + t_z^{\ 2} = [N(T)]^2 \cdots\cdots\cdots (6)$$

In Eq. (5) and (6), N is the space-time which can be described by three numbers (coordinate values).

The following equation can be obtained by comparing the relationship between space and time from Eq. (1) and Eq. (2) or from (4) and (5):

$$\frac{N}{n} \cdot \frac{(\lambda)}{(\rho)} = 1$$

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Let $\eta = \lambda/\rho$, then

$$n = \eta N$$

Where the ratio between the time wavelength λ and the unit measuring gauge ρ is called space-time coefficient η. When $\eta = 1$, then $N = n$, i.e. space-time is equal to space; when $\eta < 1$, then $N > n$, i.e. space-time contracts relative to space; when $\eta > 1$, then $N < n$, i.e. space-time expands relative to space.

DISCUSSION

We can imagine an event of a man knocked down by a car when crossing the street. What is needed for the happening of this event is that this man and that car must appear in the same place and at the same time. Otherwise, it would not happen. Therefore, events in the real world are composed of spatial point and the time upon this point. Physically, to describe the space-time structure of an event, we must explain on which point in space and at which time the object of this event is. The space-time of this event, in essence, can be regarded as the observable quantity. The space-time description in physics was composed of 3D space and the 1D time which was independent of 3D space before the proposal of the 3D space-time. Therefore, space-time was regarded as 4-dimensional [1−3]. However, any measurement is carried out by comparing the metrics and then the times of metrics respectively in physics. The metric is some basic quantity chosen to derive the relationships of other physical quantities, which is the precondition of physics using mathematical methods by inference. It can be seen with metrical methods that time and space can be quantified by the same quantity value described by three numbers (coordinate values) if the time wave length is selected as the metric for the space distance quantity value. Hence, space-time can be regarded not only as observable quantity, but also 3 dimensional.

In the past studies, space is a 3D continuum, namely the location of any point in space can be described by 3D coordinate values (x, y, z), the unit measuring gauge of space being taken as the metric to measure these three values. In addition, there are infinite numbers of points near this point, which can be described by such spatial coordinate values as x_1, y_1, z_1 and the values of which can be as close to the spatial coordinate values x, y, z of the first point as possible. Thus, the space of this area is 3D continuum because of the latter feature. Similarly, the event of any point in space-time is also described by 3D coordinate values (x, y, z). What is different is that the time wavelength is taken as the metric to measure these three values. As to each space-time point, the "adjacent" space-time point can be selected infinitely, with an infinitesimal quantity from the coordinate values x_1, y_1, z_1 of the "adjacent" space-time point to those x, y, z of the initially considered point. Thus, 3D space-time is also a continuum like 3D space. Space-time equals to space when the time wavelength equals to the unit measuring gauge of space ; space-time contracts relative to space when the time wavelength is less than the unit measuring gauge of space; space-time expands relative to space when the time wavelength is greater than the unit measuring gauge of space.

The above mentioned space-time structure is only a certain clear concept limited to the relatively static state without which 3D space-time in the relative motion state could not be founded.

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It can be seen that with the metrical methods, the space-time which could be quantified by the same quantity value can be regarded as observable quantity if the time wave length is selected as the metric for the space distance quantity value. It is difficult to regard the 4D space-time as observable quantity, which is hard to accept for the measurement of physics. Rethinking the space-time structure could help find out that space and time are covariant in 3D space-time. Such space-time could not only determine the time that the event happens by the location of the spatial point of the real event, but also determine the location of the spatial point of that event by the time of the real event. What is more important is that the relationship of the quantity values could be derived since the 3D space-time is regarded as observable quantity. Thus, it is easy to judge whether two events happened at different time are on the same location in space. Just like the table tennis springing in situ on the train, the observer can judge whether the table tennis of different time is on the same location in space. Therefore, it is the nature that space and time are mutually independent in structure in 4D space-time that has made people feel that this convention which regards time unrelated to space lacks support, which in turn makes it hard to help people directly judge the location and time that the natural event happens. It is a pity that physics does not realize that 4D space-time in essence is difficult to be regarded as observable quantity. Consequently, space-time is taken as the physical entity, differing from other physical quantity. This is the reason why there are different descriptions of space-time for the physical event.

Thus, rethinking the space-time structure could help us rethink the physical concept for space-time instead of thinking only about mathematical deductions.

CONCLUSION

Space-time could not only be regarded as observable quantity, but also 3 dimensional if the time wave length is selected as the metric for the space distance quantity value.

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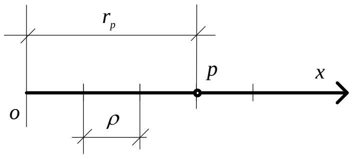

Fig. 1 1D Space

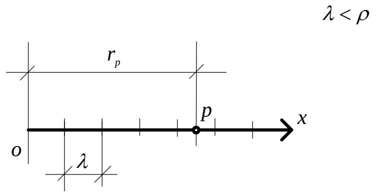

Fig. 2 1D Space-time

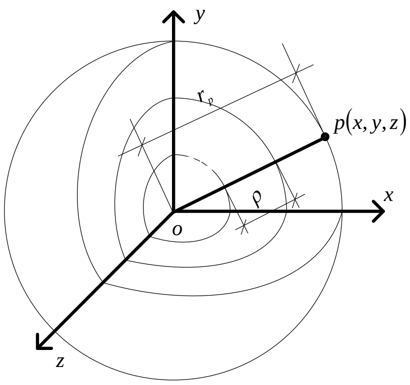

Fig. 3 3D Space

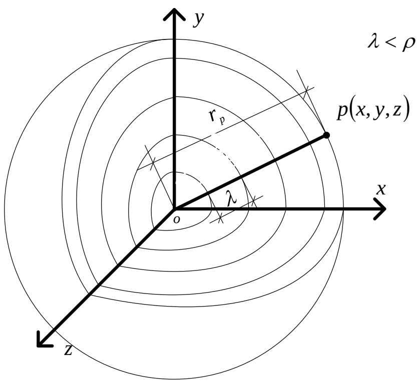

Fig. 4 3D Space-time

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