An Observer Traveling at the Speed of Light would Perceive the Universe as Being the Size of Planck Length

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Our universe is immensely big and it is expanding [9]. *However, because of the relativistic effects, an observer traveling on a photon of light would perceive the universe as being the size of Planck length* $L_p \approx 1.62 \times 10^{-35}$ *m.*

This finding makes it possible to calculate the speed quantum which is approximately equal to $\varepsilon_v \approx 2.34 \times 10^{-114}$ *m/s* [6].

KEY WORDS: Speed quantum, universe, speed of light, Planck

1. INTRODUCTION

In 1907, Einstein showed that relativity applied to time and space [7]. Indeed, our universe is made of four dimensions. By staying immobile on the spot, we travel only through time. It is also at this moment that the speed of movement in time is the fastest.

Inversely, when the observer moves towards a given direction, his movement speed through time decreases. If it moves in any direction, at the speed of light in a vacuum, its velocity in time tends to zero (in reality, this velocity tends to the speed quantum ε_v). Indeed, the time of Planck t_p becomes equal to the apparent age of the universe T_u. His perception of the dimensions of the universe becomes therefore quite different. What seemed to him a huge universe becomes for him a universe that takes the smallest dimension that is; Planck length L_p.

In the past, we calculated the quantum of speed ε_v, which is the smallest unit of speed. We obtained this result assuming that it was not possible to give a particle more energy than that contained in Planck's mass and that it was not possible to give to any object more energy than there is in the universe.

In this paper, we will show that the same value of the speed quantum ε_v can be obtained by a simple calculation in which we assume that an observer traveling at the speed of light in vacuum perceives the apparent radius of curvature of the universe as being equal to Planck length. We will also list other similar methods that can lead to the same result.

2. DEVELOPEMENT

2.1. Value of the physics parameters used

Let's outline all the basic physics parameters that we intend to use in this article. These values are all available in CODATA 2014 [1].

- Speed of light in vacuum $c \approx 299792458$ m/s
- Planck length $L_p \approx 1.616229(38) \times 10^{-35}$ m
- Planck time $t_p \approx 5.39116(13) \times 10^{-44}$ s
- Planck mass $m_p \approx 2.176\,470(51) \times 10^{-8}$ kg

2.2. How to get the speed quantum value

In 1907, Einstein showed that an object, which had a length L_0 at rest, is perceived by an observer at rest as having the length L' when traveling at speed v [7].

$$L' = L_0\sqrt{1-\frac{v^2}{c^2}} \tag{1}$$

This equation may suggest that L' can tend towards zero when the velocity v tends towards the speed of light in a vacuum c. The problem is that even light does not really travel at the speed c. In Lorentz factor, the constant c acts as a limit velocity that can not be reached by any object or information.

To make a comparison, suppose a horse race. At the beginning of the race, a vehicle that has a barrier welded to its rear bumper moves in front of the horses to force them to slow down. When all the horses are side by side, at a speed that seems equal, the vehicle starts to accelerate, leaving the horses behind. They then pick up speed and start the race. Before the vehicle accelerates, can we really say that the horses are going at the same speed as the vehicle? In appearance, yes. But in reality, the vehicle is slightly faster than the horses because it is in the lead and has the ability to accelerate as it pleases. This is not the case for horses. It is the same for light. Due to the fact that the universe is expanding, the speed limit increases over time [16]. The speed limit c precedes the actual speed of light v_L. The difference c-v_L is what we defined as being the speed quantum. Since this difference is of the order of 2.34×10^{-114} m/s, it is, for all practical purposes, nil and unmeasurable.

Suppose now two observers. The first is motionless at the center of mass of the universe. The second travels on a photon (which moves at the speed v_L which is very close to the speed limit c in vacuum, without equaling it) which starts from the center of mass of the universe while moving towards the periphery of the universe. For the first observer, the universe has an apparent radius of curvature equal to R_u (which is expanding) [4, 11 and 12].

$$R_u = \frac{c}{H_0} \approx 1.28 \times 10^{26} \text{ m} \tag{2}$$

In equation **(2)**, H0 represents the Hubble constant which is about 72.1 km/(s·MParsec) according to the Xiaofeng team [2] and according to our calculations [3].

Contrary to what equation **(1)** may suggest, the second observer will not perceive the universe with zero length. He will rather perceive the universe as having an apparent radius of curvature of Planck length dimension L_p. Indeed, in quantum physics, because of the Heisenberg principle, the smallest "existing" length is Planck length L_p. Below this length, it is zero (for a "nonexistent" object).

The second observer will thus have the impression that the apparent radius of curvature of the universe R_u narrows to become equal to Planck length L_p:

$$L_p = R_u \sqrt{1 - \frac{v_L^2}{c^2}} \approx 1.62 \times 10^{-35} \text{ m} \tag{3}$$

Let's isolate v_L:

$$v_L = c \cdot \sqrt{1 - \frac{L_p^2}{R_u^2}} \tag{4}$$

From Weyl-Eddington equation [13], it can be shown that the large number N is equal to the ratio between the square of the apparent radius of curvature R_u of the universe and the square of Planck length L_p:

$$N = \frac{R_u^2}{L_p^2} \approx 6.30 \times 10^{121} \tag{5}$$

In equation **(5)**, *N* represents the maximum number of lower energy photons (having a wavelength $\lambda = 2\pi \cdot R_u$) that may exist in the universe. This value derives from Dirac large number hypothesis [9]. In previous work, we state more than a hundred ways [10] to obtain the large number *N*.

Using equation **(5)** in equation **(4)**, we obtain:

$$v_L = c \cdot \sqrt{1 - \frac{1}{N}} \tag{6}$$

Equation **(6)** can be approximated as follows:

$$v_L \approx c - \frac{c}{2N} \tag{7}$$

In the past, we have defined the term ε_v as being the "speed quantum":

$$\varepsilon_v = \frac{c}{2N} \approx 2.34 \times 10^{-114} \text{ m/s} \tag{8}$$

As we should expect, the speed v_L is, for practical purposes, equal to *c* but does not equal it:

$$v_L \approx c - \varepsilon_v \approx c - 2.34 \times 10^{-114} \text{ m/s} \approx \text{c} \tag{9}$$

This equation was obtained by assuming that an observer traveling on a photon sees the apparent radius of curvature of the universe R_u narrowing, by relativistic effects, to become equal to Planck length L_p.

Without demonstrating it here, we leave to the reader the pleasure to verify that it would be possible to obtain the same result by saying that for an observer who travels on a light photon, time contracts to the point of seeing the apparent age of the universe, which is $T_u \approx 13.56$ billion years [5], becomes equal to Planck time $t_p \approx 5.39 \times 10^{-44}$ s. We would then start from the following equation:

$$t_p = T_u \sqrt{1 - \frac{v_L^2}{c^2}} \tag{10}$$

In the same way, always without demonstrating it, it would be possible to obtain the same result by saying that for an observer who travels on a light photon, the apparent mass of the universe [14, 15] $m_u \approx 1.73 \times 10^{53}$ kg would be reduced to equal Planck mass $m_p \approx 2.18 \times 10^{-8}$ kg with the following equation:

$$m_p = m_u \sqrt{1 - \frac{v_L^2}{c^2}} \tag{11}$$

3. CONCLUSION

Thanks to this article, we find that there are several different (but similar) ways to obtain the speed quantum ε_v.

We also find that this number is extremely small and unmeasurable. This is why the actual displacement speed of light has long been confused with the speed limit c. These two speeds are, for all practical purposes, identical.

By knowing the value of the quantum of speed, we are able to use the equations of relativity more appropriately. To name just this example, using the speed quantum, it becomes impossible to give more energy to a mass than there is energy contained in the entire universe...

4. REFERENCES

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