

## No Tachyons

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Abstract :

In this work, we discuss the existence of tachyons and obtain a negative result.

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Einstein's variance of mass with velocity equation is given by

$$m = \frac{m_0}{(1-n)^{1/2}} \quad (1)$$

$$m(1-n)^{1/2} = m_0 \quad (2)$$

Where  $m$  is moving mass,  $m_0$  is rest mass,  $n=v^2/c^2$ ,  $v$  is the velocity of the object and  $c$  is light velocity per second.

$$\text{Squaring (2), } m^2(1-n) = m_0^2 \quad (3)$$

In 1962, Sudarshan and his co-workers proposed a hypothesis that particles whose rest mass is imaginary, can travel by birth faster than light.

[(2), (3) and (4)]

Assuming  $m_0=i$  and replacing  $i^2$  by  $-1$

$$m^2 (1-n) = -1$$

$$\text{ie } m^2 (n-1) = 1 \quad (4)$$

$$\text{Also } m^2 n = m^2 + 1 \quad (5)$$

$$\text{Squaring (5), } m^4 n^2 = m^4 + 1 + 2m^2$$

Replacing  $m^2 + 1$  by  $m^2 n$  [see (5)] we get

$$m^2 n^2 - m^2 - 1 - n = 0 \quad (6)$$

Eqn. (6) is quadratic in  $n$

$$n = \frac{1 \pm (1 + 4 m^4 + 4 m^2)^{1/2}}{2 m^2}$$

$$n = \frac{1 + [(2m^2 + 1)^2]^{1/2}}{2m^2} \quad (7)$$

Since (6) is quadratic in n, we are free from all mathematical fetters to assume negative value

So, Choosing -ve value in (7) we obtain

$$n = \frac{1-1-2m^2}{2m^2}$$

$$n = -1 \quad (8)$$

Since eqn (6) is an extension of eqn (4) and eqn (6) can be deduced to eqn (4), we can replace n by -1 in (4). So, putting n= -1 in (4) we get that

$$m^2 = -\frac{1}{2} \quad (9)$$

Applying n = -1 in (6), the eqn, satisfies. Putting n = -1 and m<sup>2</sup> = - 1/2 in (6), the eqn satisfies. So, n = -1 and m<sup>2</sup> = - 1/2 are consistent.

According to the laws of quadratic eqn if α and β are the roots, then

$$\alpha + \beta = -B/A \quad (10)$$

and  $\alpha \beta = C/A \quad (11)$

$$(10) + (11) \text{ gives } \alpha + \beta + \alpha \beta = \frac{C-B}{A} \quad (12)$$

So, applying (12) in (6),  $\alpha + \beta + \alpha \beta = \frac{C-B}{A} = \frac{-m^2-1+1}{m^2} = -1$

i.e.  $\alpha + \beta + \alpha \beta + 1 = 0$

i.e.  $(\alpha + 1)(\beta + 1) = 0$

$\alpha = -1 \quad (13)$

Let us find out the value of β.

In (6),  $\alpha + \beta = \frac{-B}{A} = \frac{1}{m^2} \quad (14)$

Replacing α by -1 and m<sup>2</sup> by - 1/2 [see eqns (13) and (9) we have,

$$\beta - 1 = \frac{1}{-1/2} = -2 \quad (15)$$

i.e.  $\beta = -1$

i.e. in (6), the roots of n are distinct.

According to the theory of quadratic eqns. the roots are distinct if  $B^2 - 4AC = 0$ .

In (6),  $B^2 = 1$

$$4AC = -4m^4 - 4m^2$$

So, making  $B^2 - 4AC = 0$  we get that,

$$1 + 4m^4 + 4m^2 = 0 \quad (16)$$

From (4), we get that  $m^2 = 1/n - 1$ . Putting this in (16) we get that

$$1 + \frac{4}{(n-1)^2} + \frac{4}{n-1} = 0$$

Multiplying throughout by  $(n-1)^2$ ,

$$n^2 + 1 - 2n + 4 + 4n - 4 = 0$$

$$\text{i.e. } (n+1)^2 = 0$$

$$\text{i.e. } n = -1 \quad (17)$$

So, we get that  $n = -1$  is the only solution for eqn (6)

Since  $n = v^2/c^2$ , we obtain that  $v^2 = -c^2$

$$\text{Taking root, } v = ic \quad (18)$$

Needless to say, eqn (18) is a contradiction. Consequently this shows that our assumption that  $m_0 = i$  in (2) is NOT acceptable. This makes us to make a resurvey of Sudarshan's tachyon hypothesis.

### Case 2.

Einstein's variance of mass with velocity eqn. is given by

$$m = m_0 (1 - v^2/c^2)^{-1/2} \quad (1)$$

Squaring,  $m^2 ((1-v^2/c^2) = m_0^2$   
i.e  $m^2 (c^2 - v^2) = m_0^2 c^2$

I Assuming  $m_0=i$  and  $v= c+a$  [ i.e Sudershan's hypothesis ] where  $a$  is a constant in (1a) we get that,

$$m^2 (-a^2- 2ca) = i^2 c^2$$

$$\text{Replacing } i^2 \text{ by } -1, m^2 (a^2 + 2ca) = c^2 \quad (1b)$$

$$\text{Squaring, } m^2 (a^2 + 2ca)^2 = c^4 \quad (1c)$$

$$(1b) + (1c) \text{ give, } m^4 (a^2 + 2ca)^2 + m^2 (a^2 + 2ca) - c^4 - c^2 = 0 \quad (2)$$

Eqn. (2) is quadratic in  $a^2 + 2ca$

$$\begin{aligned} a^2 + 2ca &= \frac{-m^2 \pm (m^4 + 4m^4c^4 + 4m^4c^2)^{1/2}}{2m^4} \\ &= \frac{-m^2 \pm [(m^2 + 2m^2c^2)^2]^{1/2}}{2m^4} \\ a^2 + 2ca &= \frac{-m^2 \pm (m^2 + 2m^2c^2)}{2m^4} \end{aligned}$$

Needless to say we are free from all mathematical fetters according to the laws of quadratic equations to assume both negative and positive values in the above relation.

$$\text{Choosing - Ve value , } a^2 + 2ca = \frac{-m^2 - m^2 - 2m^2c^2}{2m^4}$$

$$\text{i.e. } a^2 + aca = -1/m^2 - c^2/m^2$$

$$\text{i.e. } m^2 (a^2 + 2a) + c^2 + 1 = 0$$

Assuming (1b) in the first factor we obtain that ,

$$2c^2 + 1 = 0$$

Needless to say eqn (3) is a contradiction. This establishes that our assumption that  $m_0 = i$  and  $v = c + a$  in (1a) is not acceptable. Consequently this makes us to resurvey Sudarshan's Tachyon Hypothesis.

## **Discussion**

### **Tachyons**

Hypothetical subatomic particle whose velocity is always greater than that of light. Its existence appears consistent with the theory of relativity. Just as an ordinary particle such as an electron can exist only at speeds less than that of light, a tachyon can exist only at speeds greater than that of light. At such speeds, its mass would be real and positive. On losing energy, a tachyon accelerates; the faster it travels, the less energy it has. The existence of tachyons has not been established experimentally.

According to the theory of relativity, the speed of light is the limiting velocity for all ordinary material particles. Particles having nonzero rest mass can approach, but not reach, the speed of light, since their mass would become infinite at that speed. On the other hand, particles with zero rest mass, such as the photon, must always travel at the speed of light; they cannot be brought to rest or even slowed down. Theorists have argued that since nothing in principle prohibits the existence of a third class of particles that travel only at speeds exceeding that of light, such particles, called tachyons [Gr. *tachys*, =swift] may exist although no

evidence for them has been found. In the terminology of the theory, the particles that travel only at the speed of light are called luxons, and those that travel at lesser speeds are called tardyons. Like the original theory of relativity, the theory of tachyons has several aspects that appear to contradict common sense but that are fully self-consistent. For example, a tachyon must have an imaginary (in the mathematical sense) rest mass, or proper mass, and it must travel faster rather than slow down when it loses energy.

. The first description of tachyons is attributed to German physicist Arnold Sommerfeld; however, it was George Sudarshan, Olexa-Myron Bilaniuk Vijay Deshpande and Gerald Feinberg (who originally coined the term in the 1960s) that advanced a theoretical framework for their study. Tachyonic fields have appeared theoretically in a variety of contexts, such as the Bosonic string theory. In the language of special relativity, a tachyon is a particle with space-like four-momentum and imaginary proper time. A tachyon is constrained to the space-like portion of the energy-momentum graph. Therefore, it cannot slow down to subluminal speeds. Even if tachyons were conventional, localisable particles, they would still preserve the basic tenets of causality in special relativity and not allow transmission of information faster than light, contrary to what has been written in many works of science fiction.

Today, in the framework of quantum field theory, tachyons are best understood as signifying an instability of the system and treated using tachyon condensation, rather than as real faster-than-light particles, and such instabilities are described by tachyonic fields. According to the contemporary and widely accepted understanding of the concept of a particle, tachyon particles are too unstable to be treated as existing. By that theory, faster than light information transmission and causality violation with tachyons are impossible on both grounds: they are non-existent in the first place (by tachyon condensation) and even if they existed (by Feinberg's analysis) they wouldn't be able to transmit information (also by Feinberg's analysis). Despite the theoretical arguments against the existence of tachyon particles, experimental searches have been conducted to test the assumption against their existence; however, no experimental evidence for or against the existence of tachyon particles has been found. So,our results in Cses (1) & (2) demonstrate once and for all that there are NO chances for the existence of tachyons

## **References**

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