The nature of the speed of electromagnetic waves

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Henok Tadesse, Electrical Engineer, B.Sc

Ethiopia

e-mail: *entkidmt@yahoo.com* or wchmar@gmail.com

Abstract

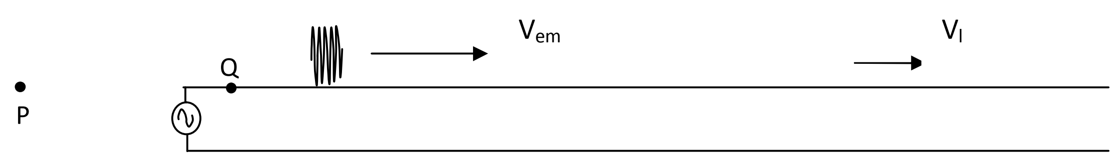
An electromagnetic wave travelling on a transmission line which itself is moving relative to an observer will be investigated to show the contradictions arising from the assumption of the source independent speed of electromagnetic waves (light) and to invalidate the postulate that the speed of light is the highest possible speed.

Introduction

The speed of light (C) has been postulated to be independent of the speed of its source and to be the highest possible speed, in special relativity theory. In this paper, we will investigate an electromagnetic wave travelling on a transmission line to determine what speed two observers will measure: an observer at rest relative to the transmission line and an observer in relative motion with the transmission line.

Discussions

Consider an electromagnetic wave travelling forward on a transmission line with speed V_{em} as shown in Fig.1.



Suppose the transmission line itself is moving in space forward at a speed V_l relative to an observer P and another observer Q is moving forward with the same speed V_l (i.e. he/she is at rest relative to the transmission line).

Let us determine at first what speed of the EM wave the observer Q will measure (V_{em}).

The speed of an EM wave on a transmission line is given by (as measured by observer Q):

$$V_{em} = \frac{1}{\sqrt{LC}}$$

Therefore the speed V_{em} depends on the inductance and capacitance per unit length of the line. For an air dielectric this speed is typically 0.95C, where C is the speed of light in vacuum (300,000 Km/s).

Now we will present and discuss the contradictions regarding the speed of the EM wave as observed (measured) by observer P, by applying relativity theory (1 and 2) and present the explanation (3) considered to be correct in this paper.

1. According to special relativity [1],

$$V'em = \frac{Vem - Vl}{1 - Vl\frac{Vem}{C^2}}$$

Where V'_{em} is the speed of the EM wave as measured by observer P and Vem is the speed measured by observer Q. Here we are assuming that the EM wave is 'detached' from its source (the line), as postulated in relativity theory. (actually it is obvious that it is 'attached' to the line)

If V_{em} =0.95 C , V_l = 0.05 C are substituted in the above equation, V'_{em} will be :

V'_{em} = 0.94488C

Therefore, the two observers are measuring different speeds of the same EM wave, whereas it is postulated in the theory of relativity that the speed of EM waves (light) is the same constant for all observers. So the theory of special relativity contradicts itself in this case. This analysis is not correct also because of the assumption that the EM wave is 'detached' from the line, when it is obviously not.

2. If one argues that observer P should measure the same speed of the EM wave as observer Q (i. e $V'_{em} = V_{em}$), this contradicts relativity theory because only the speed C is the same to all observers and no other speed.

3. Therefore, the most straightforward determination of the speed of the EM wave as measured by observer P is as follows. We know that the EM wave is 'attached' to the transmission line. Therefore, in addition to its velocity V_{em} with respect to the transmission line, it will have an additional forward velocity V_l. Therefore,

$V'_{em} = V_{em} + V_l$

In this case, the two observers P and Q will measure different speeds of the same EM waves. Therefore we conclude that the speed of EM waves is defined and is constant only relative to their source.

This analysis is perhaps the only one acceptable of the three even to a proponent of relativity theory, because it is obvious that the wave is 'attached' to the line. In this case we can see that the speed of the EM wave in space (V'_{em}) as measured by observer P can be greater than the speed of light, if V_l is greater than 0.05 C in the above example.

$$V'_{em} = V_{em} + V_l = 0.95C + V_l$$

$$V'_{em} > C \quad \Rightarrow \quad 0.95C + V_l > C \quad \Rightarrow \quad V_l > 0.05C$$

This invalidates the postulate of special relativity that nothing moves at a speed greater than the speed of light. The EM wave can have a speed greater than C relative to observer P.

Whether an EM wave is propagating in space or on a transmission line, the fundamental nature of the speed of EM waves is the same. Therefore, since the speed of an EM wave on a transmission line is defined with respect to the source (and the transmission line), the speed of an EM waves (light) in space is also defined with respect to its source.

Conclusion

The fundamental nature of EM waves is the same whether they are travelling in space or on a transmission line. It doesn't also depend on the frequency of the EM wave (whether it is light or an EM wave propagating on a transmission line). Therefore, since EM waves travelling on a transmission line are defined with respect to and 'attached' to the line, the speed of light should also depend on the speed of its source.

References

1. *Introduction to the Basic Concept of Modern Physics*, Carlo Maria Becchi, Massimo D'Elid, April 2007, page 6