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Was Einstein in need to impose the stability of the speed of light in the Theory of Special Relativity?

According to Einstein's first hypothesis only, it can be reached to transfer formats between reference frames in the special theory of relativity

Consider two observers A, B in both frames S_1, S_2

At first $T_1 = T_2 = 0$

: T_1 The time at frame S_1 and T_2 the time at frame S_2

Let A and B in the same place and at the same time, they each send a light signal

Let S_2 and (observer B) moving respect to S_1 and (observer A) with uniform Velocity $\vec{V}$

At the direction of the axis $\overrightarrow{ox}$

In this case the signal is spread as a spherical wave

<u>Measurements A:</u>

At the moment T_1 of his watch, the wave equation appears in the Formula:

$$X_1^{\,2} + Y_1^{\,2} + Z_1^{\,2} - C_1^{\,2} T_1^{\,2} = 0 \quad \text{-------------------------------} \quad (1)$$

C_1 Speed of light at fame S_1

<u>Measurements B:</u>

At moment T_2 of his watch, the wave equation appears in the Formula:

$$X_2^{\,2} + Y_2^{\,2} + Z_2^{\,2} - C_2^{\,2} T_2^{\,2} = 0 \quad \text{-------------------------------} \quad (2)$$

C_2 Speed of light at fame S_2

Notice $C_1 \neq C_2$

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Then

$X_1{}^2 + Y_1{}^2 + Z_1{}^2 - C_1{}^2 T_1{}^2 = X_2{}^2 + Y_2{}^2 + Z_2{}^2 - C_2{}^2 T_2{}^2$

-------------------------------- (3)

Let $Y_1 = Y_2$ and $Z_1 = Z_2$

So

$X_1{}^2 - C_1{}^2 T_1{}^2 = X_2{}^2 - C_2{}^2 T_2{}^2$ -------------------------------- (4)

Let

$X_2 = G_{11} X_1 + G_{14} T_1$ -------------------------------- (5)

$T_2 = G_{41} X_1 + G_{44} T_1$ -------------------------------- (6)

Where

G_{11} , G_{14}, G_{41}, G_{44} are constants

Consider the moving of origin point O_2 respect to S_1

(Ordinates O_2) is X_2=0

So from equation (5)

$0 = G_{11} X_1 + G_{14} T_1$

$G_{14} T_1 = -G_{11} X_1$

$G_{14} = -G_{11} \frac{X_1}{T_1}$ And $\frac{X_1}{T_1} = V$

So $G_{14} = -G_{11} V$ -------------------------------- (7)

Consider the moving of origin point O_1 respect to S_2

(Ordinates O_1) is X_1=0

So from equation (5)

$X_2 = 0 + G_{14}\, T_1$

$X_2 = G_{14}\, T_1$ -------------------------------- (8)

From equation (6)

$T_2 = G_{41}\, X_1 + G_{44}\, T_1$

$T_2 = 0 + G_{44}\, T_1$

$T_2 = G_{44}\, T_1$ -------------------------------- (9)

From equation (8) and (9)

$\frac{X_2}{T_2} = \frac{G_{14}\, T_1}{G_{44}\, T_1}$ And $\frac{X_2}{T_2} = -V$

So $\frac{G_{14}}{G_{44}} = -V$

From equation (7)

$\frac{-G_{11}\, V}{G_{44}} = -V$

G_{44}=G_{11} -------------------------------- (10)

From equations (5), (7)

$X_2 = G_{11}\, X_1 - G_{11}\, VT_1$

So

$X_2 = G_{11}\,(X_1 - VT_1)$ -------------------------------- (11)

From equations (6), (10)

$T_2 = G_{41}\, X_1 + G_{11}\, T_1$ -------------------------------- (12)

From equations (4), (11), (12)

${X_1}^2 - {C_1}^2{T_1}^2 = {X_2}^2 - {C_2}^2{T_2}^2$

${X_1}^2 - {C_1}^2{T_1}^2 = {G_{11}}^2(X_1 - VT_1)^2 - {C_2}^2(G_{41}\, X_1 + G_{11}\, T_1)^2$

------------------------------- (13)

Compare the coefficient of $X_1{}^2$

$$1 = G_{11}{}^2 - C_2{}^2(G_{41})^2$$

$$G_{11}{}^2 = 1 + C_2{}^2(G_{41})^2$$

------------------------------- (14)

Compare the coefficient of X_1T_1

$$0 = -2VG_{11}{}^2 - 2C_2{}^2(G_{41}\,G_{11})$$

$$0 = VG_{11}{}^2 + C_2{}^2(G_{41}\,G_{11})$$

$$VG_{11}{}^2 = -C_2{}^2(G_{41}\,G_{11})$$

$$VG_{11} = -C_2{}^2(G_{41})$$

$$G_{11} = \frac{-C_2{}^2}{V}(G_{41})$$

$$G_{41} = \frac{-V}{C_2{}^2}(G_{11})$$

------------------------------- (15)

From equation (15) in (12)

$$T_2 = \frac{-V}{C_2{}^2}(G_{11})X_1 + G_{11}\,T_1$$

$T_2 = G_{11}\,(T_1 - \frac{V}{C_2{}^2}X_1)$ ------------------------------- (16)

From equation (14) , (15)

$$G_{11}{}^2 = 1 + C_2{}^2(\frac{-V}{C_2{}^2}(G_{11}))^2$$

$$G_{11}{}^{2} = 1 + \frac{V^2}{C_2{}^2}(G_{11})^2$$

$$G_{11}{}^{2} - \frac{V^2}{C_2{}^2}(G_{11})^2 = 1$$

$$G_{11}{}^{2}(1 - \frac{V^2}{C_2{}^2}) = 1$$

$$G_{11}{}^{2} = \frac{1}{(1 - \frac{V^2}{C_2{}^2})}$$

-------------------------------- (17)

Compare the coefficient of $T_1{}^2$

$$-C_1{}^2 = G_{11}{}^{2}(-V)^2 - C_2{}^2(G_{11})^2$$

$$-C_1{}^2 = G_{11}{}^{2}(V^2 - C_2{}^2)$$

$$G_{11}{}^{2} = \frac{-C_1{}^2}{(V^2 - C_2{}^2)}$$

-------------------------------- (18)

Equation 17 = 18

$$\frac{-C_1{}^2}{(V^2 - C_2{}^2)} = \frac{1}{(1 - \frac{V^2}{C_2{}^2})}$$

$$(V^2 - C_2{}^2) = -C_1{}^2(1 - \frac{V^2}{C_2{}^2})$$

$$(\frac{C_2{}^2}{C_1{}^2} - \frac{V^2}{C_1{}^2}) = (1 - \frac{V^2}{C_2{}^2})$$

Compare the coefficient

$Then\ \ C_1{}^2 = C_2{}^2$

So

$C_1 = \pm C_2$

Einstein was not to need to impose the stability of the speed of light in the Theory of Special Relativity

Then

$$G_{11}{}^2 = \frac{-C_1{}^2}{(V^2 - C_1{}^2)}$$

$$G_{11} = \sqrt{\frac{-C_1{}^2}{(V^2 - C_1{}^2)}}$$

$$G_{11} = \sqrt{\frac{1}{1 - \frac{(V^2}{C_1{}^2})}}$$

---------------------------- (19)

So transformation is

$X_2 = G_{11}\,(X_1 - VT_1)$ ---------------------------- (11)

$T_2 = G_{11}\,(T_1 - \frac{V}{C_2{}^2} X_1)$ ---------------------------- (16)

$G_{11} = \sqrt{\frac{1}{1 - \frac{(V^2}{C_1{}^2})}}$ ---------------------------- (19)