The Lorentz transformation of Feynman

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1 Feynman Original

FEYNMAN wrote in the lectures II 21-6 *"The potentials for a charge moving with constant velocity; the Lorentz formula" [2]:*

"Suppose we have a charge moving along the x-axis with the speed v. We want the potentials at the point $P(x, y, z)$, as shown in Fig. 21-7. If $t = 0$ is the moment when the charge is at the origin, at the time t the charge is at $x = vt$, $y = z = 0$. What we need to know, however, is its position at the retarded time

$$t\acute{} = t - \frac{r\acute{}}{c}, \qquad (21.35)$$

where $r\acute{}$ is the distance to the point P from the charge *at the retarded time*. At the earlier time $t\acute{}$, the charge was at $x = vt\acute{}$, so

$$r\acute{} = \sqrt{(x - vt\acute{})^2 + y^2 + z^2}. \qquad (21.36)$$

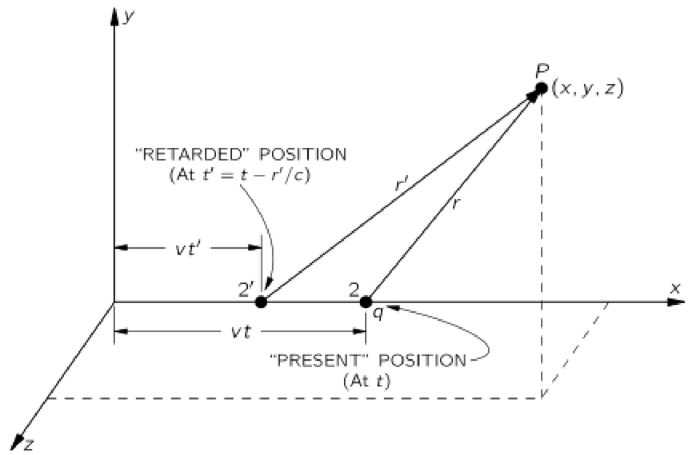

Abbildung 1: Fig. 21–7. Finding the potential at P of a charge moving with uniform velocity along the x-axis.

To find $r\acute{}$ or $t\acute{}$ we have to combine this equation with Eq. (21.35). First, we eliminate $r\acute{}$ by solving Eq. (21.35) for $r\acute{}$ and substituting in Eq. (21.36). Then, squaring both sides, we get

$$c^2(t - t\acute{})^2 = (x - vt\acute{})^2 + y^2 + z^2,$$

which is a quadratic equation in $t\acute{}$. Expanding the squared binomials and collecting like terms in $t\acute{}$, we get

$$(v^2 - c^2)t\acute{}^2 - 2(xv - c^2 t)t\acute{} + x^2 + y^2 + z^2 - (ct)^2 = 0.$$

Solving for $t\acute{}$,

$$(1 - \frac{v^2}{c^2})t\acute{} = t - \frac{vx}{c^2} - \frac{1}{c}\sqrt{(x - vt)^2 + (1 - \frac{v^2}{c^2})(y^2 + z^2)}. \qquad (21.37)"$$

FEYNMAN wrote also:

"We are seeing it in a moving coordinate system, and it appears that the coordinates should be transformed by

$$x \to \frac{x - vt}{\sqrt{1 - v^2/c^2}},$$
$$y \to y,$$
$$z \to z.$$

That is just the Lorentz transformation, and what we have done is essentially the way Lorentz discovered it."

2 My view

The equation is the same as

$$(1-\frac{v^2}{c^2})ct\,' = ct-\frac{v}{c}x-\sqrt{(x-\frac{v}{c}ct)^2+(1-\frac{v^2}{c^2})(y^2+z^2)}$$

or

$$(ct-\overline{v}x)-(1-\overline{v}^2)ct\,' = \sqrt{(x-\overline{v}ct)^2+(1-\overline{v}^2)(y^2+z^2)}$$

or

$$\frac{ct-\overline{v}x}{\sqrt{1-\overline{v}^2}}-\sqrt{1-\overline{v}^2})ct\,' = \sqrt{\left(\frac{x-\overline{v}ct}{\sqrt{1-\overline{v}^2}}\right)^2+y^2+z^2},$$

$$c\,(\tau-\tau')=\sqrt{\xi^2+\eta^2+\zeta^2}$$

but is not correct, because

$$\left\{c\,(\tau-\tau')=\sqrt{\xi^2+\eta^2+\zeta^2}\right\}\neq\left\{c^2(t-t\,')^2=(x-vt\,')^2+y^2+z^2\right\}.$$

A form invariance is not a total invariance of the inside terms. The quadratic equation

$$(v^2-c^2)t\,'^2-2(xv-c^2t)t\,'+x^2+y^2+z^2-(ct)^2=0$$

is a quadratic form

$$f=x^2-2\overline{v}xct\,'+(\overline{v}ct\,')^2+y^2+z^2-(ct)^2+2ctct'-(ct\,')^2=0,$$

$$f=\begin{pmatrix} x & y & z & ct' & ct \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 & -\overline{v} & 0\\ 0 & 1 & 0 & 0 & 0\\ 0 & 0 & 1 & 0 & 0\\ -\overline{v} & 0 & 0 & -1+(\overline{v})^2 & 1\\ 0 & 0 & 0 & 1 & -1 \end{pmatrix}\begin{pmatrix} x\\ y\\ z\\ ct'\\ ct \end{pmatrix}=0,$$

and for $ct=ct'$

$$f=\begin{pmatrix} x & y & z & ct' \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 & -\overline{v}\\ 0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0\\ -\overline{v} & 0 & 0 & -\left(1-(\overline{v})^2\right) \end{pmatrix}\begin{pmatrix} x\\ y\\ z\\ ct' \end{pmatrix}=0.$$

In this is

$$\begin{pmatrix} 1 & 0 & 0 & -\overline{v}\\ 0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0\\ -\overline{v} & 0 & 0 & -1+(\overline{v})^2 \end{pmatrix}=\begin{pmatrix} 1 & 0 & 0 & 0\\ 0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0\\ -\overline{v} & 0 & 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 & 0\\ 0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0\\ 0 & 0 & 0 & -1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 & -\overline{v}\\ 0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 1 \end{pmatrix}$$

or with EINSTEIN [1]

$$f=x_\nu\Gamma^\nu_\sigma G^\sigma_\tau\Gamma^\tau_\mu x^\mu=0.$$

Herein are x_ν and x^μ two four vektors Γ^ν_σ and Γ^τ_μ two transponed GALILEAN tensors and G^σ_τ the fundamental tensor. When we divide

$$\frac{1}{\sqrt{1-\overline{v}^2}}\begin{pmatrix} 1 & 0 & 0 & -\overline{v}\\ 0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0\\ -\overline{v} & 0 & 0 & -1+\overline{v}^2 \end{pmatrix},$$

then we will have the LORENTZ-transformation, but this are two GALILEAN transformations. In other words:

> *The* LORENTZ-*Transformation is a matrix transformation of the fundamental tensor with the Galilean tensor like*
>
> $$\Lambda=\Gamma G\Gamma^T$$
>
> *and*
>
> $$f=\mathbf{x}\Lambda\mathbf{x}^T=\mathbf{x}\left(\Lambda\mathbf{x}^T\right)=\left(\mathbf{x}\Lambda\right)\mathbf{x}^T=0.$$
>
> *In this wave equation one vektor will be transfomed only with the* LORENTZ *tensor.*
>
> *The* LORENTZ *transformation is not a vektor transformation, but it is a classical matrix transformation.*

3 Conclusion

The LORENTZ transformation is a bad transformation, and with the FEYNMAN solution can the ligt rather be then c and the lighting sources can move in the world, what the EINSTEINEANs not like (e.g. SCHMUTZER [3]). I think, that this transformation is obsolete. In this way once can complete the quadratic form for moving sources and receivers with

$$c^2(t-t')^2 - \left(r_{Pt}^2 - r_{Qt'}^2\right) = 0,$$

$$r_{Pt}^2 = \left(x_{P0} + w_x t\right)^2 + \left(y_{P0} + w_y t\right)^2 + \left(z_{P0} + w_z t\right)^2,$$

$$r_{Qt'}^2 = \left(x_{Q0} + v_x t'\right)^2 + \left(y_{Q0} + v_y t'\right)^2 + \left(z_{Q0} + v_z t'\right)^2.$$

Literatur

[1] A. Einstein. Die grundlage der allgemeinen relativitätstheorie. *Annalen der Physik*, 49:769–822, 1916.

[2] Richard P. Feynman. *Vorlesungen über Physik II.* Oldenbourg, 3. ausgabe edition, 2001.

[3] Ernst Schmutzer. *Grundlagen der Theoretischen Physik*, volume I u. II. WILEY-VCH, 2005.