GGT Transforms and the Gagnon Paper

1. Experimental setup

The Gagnon paper makes clever use of the Earth's revolution around the Sun and of the Earth's diurnal rotation.

Let v represent the revolution speed.

Let S' represent a reference frame centered in the Sun.

Let S represent the reference frame of the lab at 0 AM (fig 1). The axis of S and S' are aligned. Two waveguides, **A** and **B** of different cutoff frequencies are aligned with the x-axis. A certain difference of phase $\Delta\phi_1$ is observed between the two waveguides.

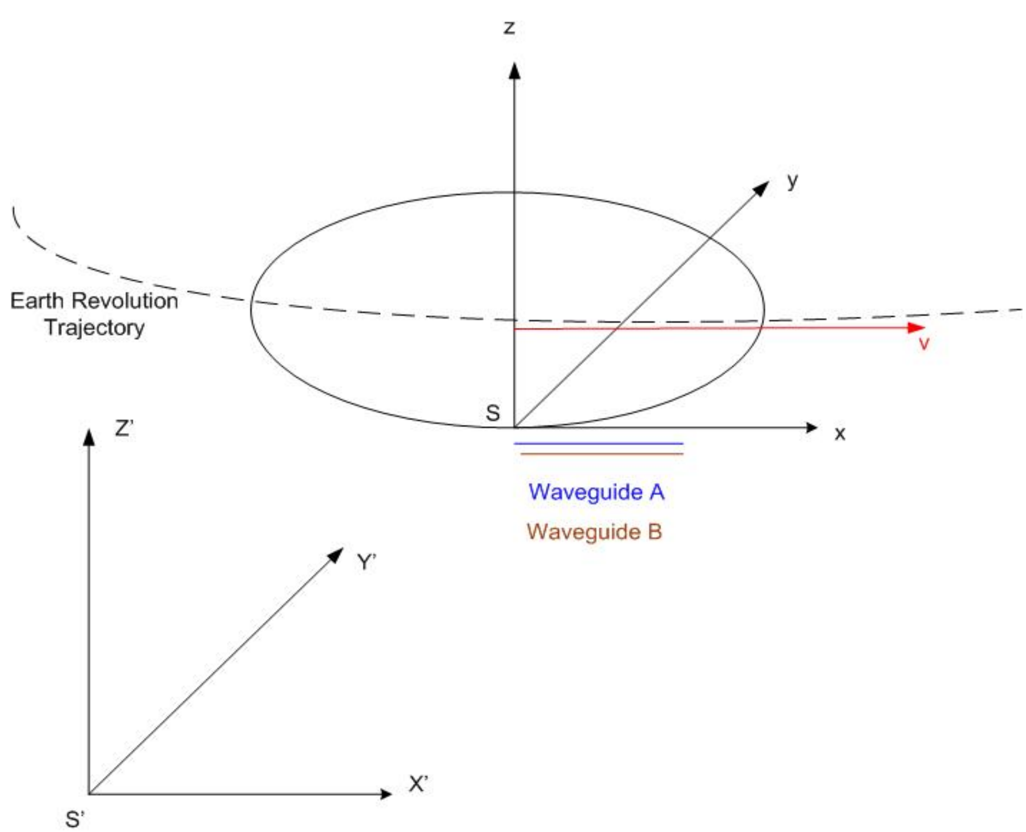

Fig. 1 The lab frame at 0 AM

At 6 AM the lab has rotated by 90^0 around the z-axis, let s be the reference frame resulting from the rotation. Because the speed v is now perpendicular to the waveguides a different phase difference $\Delta\phi_2$ is observed between the two waveguides. The total non-null difference in S':

$$\Delta\phi = \Delta\phi_2 - \Delta\phi_1 \quad (1.1)$$

is predicted by equation (9) of the Gagnon paper under the assumption that a GGT (non-Lorentz) set of transforms apply. The theoretical expression for the difference is derived by solving the partial differential equation given by (5) in the Gagnon paper:

$$div\vec{E} + 2\langle \frac{\vec{v}}{c^2}, grad\frac{\partial E}{\partial t}\rangle - [1-\frac{v^2}{c^2}]\frac{1}{c^2}\frac{\partial^2 E}{\partial t^2} = 0 \quad (1.2)$$

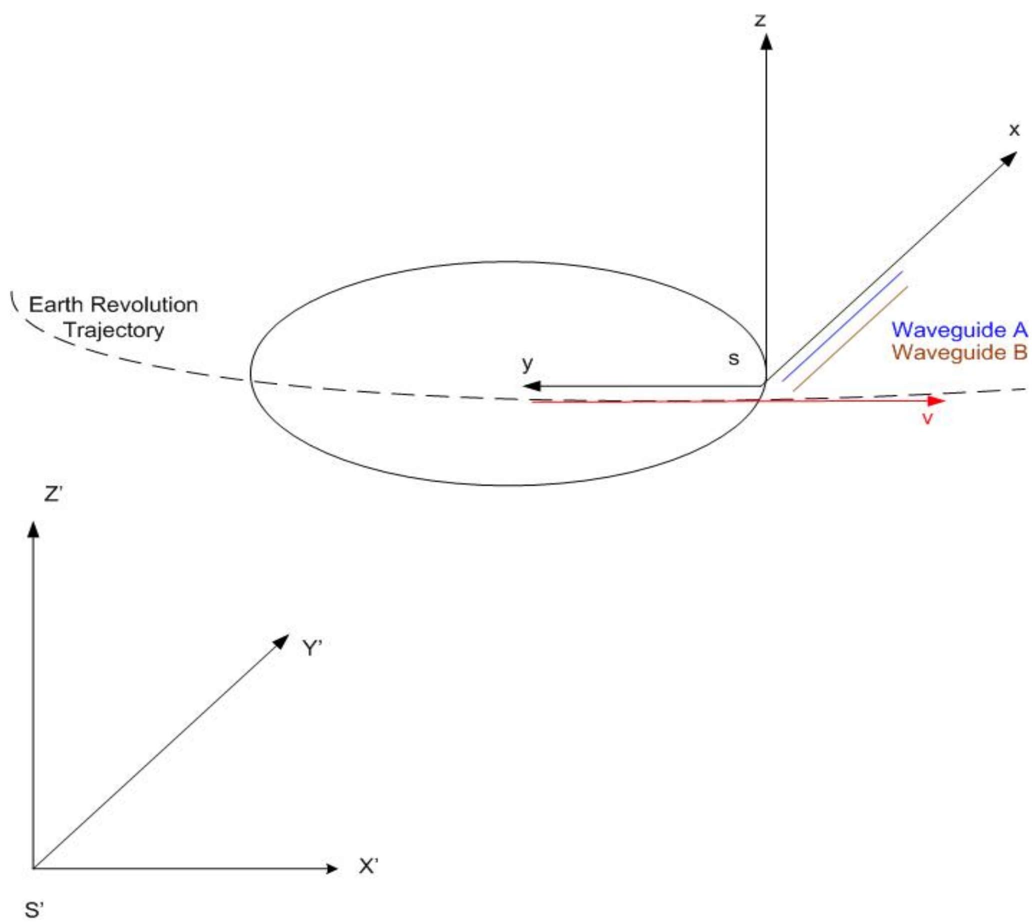

Fig. 2 The lab at 6 AM

There are two ways of dealing with equation (5):

a. Solve it in systems S and s and transform the solution into S' in order to do the comparison of phase differences. The initial conditions are expressed in S and s respectively.

b. Transform equation (5) into S', together with its initial conditions and solve it for the two cases: 0 AM and 6 AM.

The authors have selected the second approach. A charge has been made by User: gregory_ that the authors have neglected to execute the proper transformation of the initial conditions. We will prove this charge to be false.

2. The GGT transforms

$$x' = \frac{x - vt}{a} \tag{2.1}$$

$y'=y$

$z'=z$

$$t' = \frac{t}{a}$$

where $\beta=v/c$, $a=\sqrt{1-\beta^2}$

3. Relativistic electrodynamics

Let P be a non time varying point in the inertial frame S. Then:

$$\partial E_x/\partial t=\partial E_x/\partial x'*\partial x'/\partial t+\partial E_x/\partial y'*\partial y'/\partial t+\partial E_x/\partial z'*\partial z'/\partial t+ +\partial E_x/\partial t'*\partial t'/\partial t \tag{3.1}$$

From (2.1) we get :

$\partial t'/\partial t=1/a$

$\partial x'/\partial t=-v/a$

$\partial y'/\partial t=0$, $\partial y/\partial t=0$, $\partial z'/\partial t=0$, $\partial z/\partial t=0$

$$a*\partial E_x/\partial t= \partial E_x/\partial t'-v*\partial E_x/\partial x' \tag{3.2}$$

Let's calculate the partial derivative :

$\partial E_x/\partial x' = \partial E_x/\partial x * \partial x/\partial x' + \partial E_x/\partial y * \partial y/\partial x' + \partial E_x/\partial z * \partial z/\partial x' + \partial E_x/\partial t * \partial t/\partial x'$

$= 1/a * \partial E_x/\partial x$ (3.3)

Substituting (3.3) in (3.2) we obtain:

$\partial E_x/\partial t = 1/a * \partial E_x/\partial t' - v/a^2 * \partial E_x/\partial x$ (3.4)

From Maxwell's laws:

$0 = \partial E_x/\partial x + \partial E_y/\partial y + \partial E_z/\partial z$ i.e. $\partial E_x/\partial x = -(\partial E_y/\partial y + \partial E_z/\partial z)$

Substituting in (3.4) we get:

$\partial E_x/\partial t = 1/a * \partial E_x/\partial t' + v/a^2 * (\partial E_y/\partial y + \partial E_z/\partial z)$

Also from Maxwell's laws:

$\partial H_z/\partial y - \partial H_y/\partial z = \varepsilon_0 * \partial Ex/\partial t = \varepsilon_0/a * \partial E_x/\partial t' + \varepsilon_0 v/a^2 * (\partial E_y/\partial y + \partial E_z/\partial z)$

$\varepsilon_0/a * \partial E_x/\partial t' = \partial/\partial y(H_z - \varepsilon_0 v/a^2 E_y) - \partial/\partial z(H_y + \varepsilon_0 v/a^2 E_z)$

$\varepsilon_0 * \partial E_x/\partial t' = \partial/\partial y'(aH_z - \varepsilon_0 v/aE_y) - \partial/\partial z(aH_y + \varepsilon_0 v/aE_z)$ (3.5)

The law $\partial H_z/\partial y - \partial H_y/\partial z = \varepsilon_0 * \partial E_x/\partial t$ as written in S must be rewritten in system S' as:

$\partial H'_z/\partial y' - \partial H'_y/\partial z' = \varepsilon_0 * \partial E'_x/\partial t'$ (3.6)

where **H'**,**E'** are the vectors in S' while **H**,**E** are the vectors in S.

Comparing (3.6) with (3.5) we conclude that:

$E'_x = E_x$

$H'_z = aH_z - \varepsilon_0 v/aE_y$

$H'_y = aH_y + \varepsilon_0 v/aE_z$ (3.7)

$H'_x = H_x$

$E'_z = aE_z + \upsilon_0 v/aH_y$

$E'_y = aE_y - \upsilon_0 v/aH_z$

The TE waveguide mode[1] used in Gagnon means $E_x=0$ at 0AM when the wave guide is aligned with the x,x'-axis:

$E'_x = E_x = 0$ (3.8)

The initial condition of the partial differential equation as expressed in S' is conserved.

At 6AM, after a rotation of 90^0 x exchanges roles with y and y exchanges roles with –x (see fig 2):

$E'_y = e_y$

$H'_z = ah_z + \varepsilon_0 v/ae_x$

etc (3.9)

Now **h**,**e** are the vectors in s. Since now $e_y=0$, it follows that $E'_y=0$ i.e the initial condition of the partial differential equation as expressed in S' is conserved (while the equations are different).It is highly likely that Gagnon et al. proved the above in the earlier versions of their paper and removed it at some later time since it is trivial.

User:gregory_ makes some calculations that show that the Lorentz force does not conserve when passing from S to S'. From this he incorrectly extrapolates that the initial conditions at boundaries do not conserve, something that we have just proven wrong.

4. Conclusion

There is no error in the Gagnon paper[2], the initial conditions are conserved between frames. The correctness of the Gagnon paper, in conjunction with the correctness of the Krisher paper[3] answer the Mansouri-Sexl paper[4] about the second order effects. The Gagnon paper represents the very higher precision Kennedy-Thorndike experiment that Mansouri and Sexl are asking for in[4]. So is the Krisher experiment as well.

5. References

1. Fundamentals of Electromagnetics with Engineering Applications – Stuart M. Wentworth (p338-355)

2. Gagnon, Torr, Kolen, and Chang, Phys. Rev. **A38** no. 4 (1988), p1767

3. Krisher et al., Phys. Rev. D, **42**, No. 2, pp. 731-734, (1990)

4. Mansouri-Sexl General Relativity and Gravitation, Vol **8**, No 10 (1977) (p809-814)