ISSN 0029-3865

CNPq

CBPF

CENTRO BRASILEIRO DE PESQUISAS FÍSICAS

Notas de Física

CBPF-NF-017/84

LORENTZ INVARIANCE AND THE ROTOR DOPPLER SHIFT EXPERIMENTS

by

W.A. Rodrigues Jr. and J. Tiomno

RIO DE JANEIRO
1984

ISSN 0029-3865

CBPF-NF-017/84

LORENTZ INVARIANCE AND THE ROTOR DOPPLER SHIFT EXPERIMENTS

by

W.A. Rodrigues Jr.* and J. Tiomno

Centro Brasileiro de Pesquisas Físicas - CNPq/CBPF
Rua Dr. Xavier Sigaud, 150
22290 - Rio de Janeiro, RJ - Brasil

*Instituto de Matemática, Estatística e Ciência da Computação
IMECC - UNICAMP
C.P. 1170
13100 - Campinas, SP - Brasil

ABSTRACT: It is shown that 'Rotor Doppler shift Experiments' provide a way to distinguish Einstein's Special Relativity (SR) from Lorentz's Aether Theory (LAT). Misconceptions in previous papers involving the Doppler shift experiments are examined. The theoretical and experimental data available on rotor Doppler shift experiments are analysed. Two models of SR violating theories are used to predict the output of a recently proposed experiment by Torr and Kolen. The first one corresponds to (strict) LAT and the other to an extended form of LAT. Contrary to the first, the second theory leads to results in agreement with the preliminary experimental data of Torr et al indicating a breakdown both of SR and strict LAT.

1. INTRODUCTION

There are a number of proposals and also experimental results in the literature concerning experiments involving the Doppler shift and aiming to distinguish Einstein's Special Relativity (SR) from Lorentz's Aether Theory (LAT).

The misconceptions found in the literature are remarkable. Indeed a brief "resumê" is as follows:

(i) Doppler shift experiments disprove LAT and confirm SR[1,2,3].

(ii) The predictions for Doppler shift experiments in LAT and SR are identical[4,5,6],

(iii) Kolen-Torr Doppler shift experiment[7] disproves SR, favoring LAT[8].

(i), (ii), (iii) are assertions found in the referred papers based on theoretical analysis and some experimental results. Since the above assertions are contradictory, what may we conclude?

To give an answer to the above question is the objective of this paper. We start by presenting in section 2 the structures of LAT and SR[9], and showing that at least in principle we can distinguish between the two theories. We then analyse the source of misconceptions involving the Doppler shift experiments. This is done without the lengthy calculations made in S_o, the absolute frame, in previous publications.

Indeed, for the rotor Doppler shift experiments, where absorber and emitter are attached to the ring of a rotating disk, all calculations are done in the inertial frame S where the disk has no translational motion. The coordinates used are the Einstein-Lorentz coordinate gauge (ELG) explicitly defined[9] in section 2.

In section 3 we discuss and clear out misconceptions found in the literature having to do with a class of experiments involving the Doppler shift and particularly those experiments where source and detector are attached to the ring of a rotating disk.

In section 4 we derive the general formula for the Doppler shift in ELG, with the approximations valid for application of the theory to the Torr at al experiment[8]. The advantage of calculations in this gauge is that it becomes obvious that a breakdown of Lorentz invariance can appear only if some non - Lorentz invariant phenomenon is explicitly postulated to exist.

Motivated by the results of Refs. (8,11) we investigate in section 5 the output of the rotor Doppler shift experiments under the assumption that the roto-translational motion of solid bodies (relative to S_o) break Lorentz invariance. The results obtained with different hypothesis are compared with the results of Torr at al[8] and we verify that one of them is able to explain all the aspects of the data, which disfavours both SR and LAT.

The theoretical results presented in this paper are new and we believe that together with the results of Ref.(9) [see also Ref.(10)] they shed a new light on the issue LAT ⊝ SR and Doppler shift experiments for detecting violation of SR. Our conclusions are presented in section 6.

2. GENERAL CONSIDERATIONS

We first review the results of previous papers[9] were we investigated the status of SR as compared to a rival theory LAT explicitly defined through the following axioms:

(i) isotropic propagation of light in vacuum with velocity c (c = 1) in S_o (some absolute frame, where the aether is at rest) independently of the motion of the source,

(ii) time-dilation of moving clocks (time t) relative to local time t_a in S_o, where all clocks are synchronized, say, by light signals (Einstein's method), slow transportation of clocks, rotating shafts (Marinov's method)[10], etc. ... given by

$$dt = [1 - v^2(t_a)]^{1/2}\, dt_a \tag{1}$$

where $\vec{v}(t_a)$ is the velocity of the clock as measured in S_o. For constant velocity eq(1) reads

$$t(t_a) - t(0) = (1-v^2)^{1/2}\, t_a \tag{2}$$

(iii) Lorentz-FitzGerald contraction of a solid body in *translational uniform* motion, with velocity $\vec{v}$(relative to S_o), as compared to the length at rest in S_o

$$\begin{aligned} \delta x_{ao} &= (1-v^2)^{-1/2}\delta x_a \\ \delta y_{ao} &= \delta y_a \\ \delta z_{ao} &= \delta z_a \end{aligned} \tag{3}$$

In eq(3), $(\delta x_{ao}, \delta y_{ao}, \delta z_{ao})$ refer to the projections of the solid when at rest in S_o measured at time t_a ($\delta t_a = 0$). $(\delta x_a, \delta y_a, \delta z_a)$ refer to the projections of the solid when in motion with velocity $\vec{v}$ in S_o, also measured for $\delta t_a = 0$, for the same orientation of the body.

(i), (ii), (iii) characterize LAT with the underlying assumptions(*):

(iv) There *exists at least one* internal synchronization procedure by which distant clocks at rest in a frame S (moving with *constant* velocity $\vec{V} = V\hat{e}_x$ relative to S_o) obey:

(*) For dynamical problems, the following assumption is also needed: (vi) Increase of the mass of a point particle when in motion with velocity $\vec{v}$ relative to S_o, given by $m = (1-v^2)^{-1/2} m_o$ where m_o is the mass of the particle at rest in S_o.

(iv-L) $T(\vec{x}_1, t_a) = T(\vec{x}_2, t_a) = \gamma^{-1} t; \; \gamma^{-1} = (1 - v^2)^{1/2}$ (4)

for any two points with absolute coordinates $\vec{x}_1$ and $\vec{x}_2$, at time t_a.

This procedure may be provided by Marinov's rotating shaft *if Marinov's effect* [11] *is confirmed as a real phenomenon.* Other synchronization relations coexist, however, in LAT with (iv-L). Indeed (iv-L) cannot be achieved by Einstein's method, which gives instead of eq(4) the synchronization relation.

(iv-E) $T_E(\vec{x}_1, t_a) - T_E(\vec{x}_2, t_a) = -\gamma \vec{V} \cdot (\vec{x}_1 - \vec{x}_2)$ (5)

for the phase differences of physical clocks at rest in the moving frame S at different positions as seen at time t_a in $\vec{x}_1$ and $\vec{x}_2$ by S_o observers:

To complete the formulation of LAT we accept the following hypothesis[9]

(v) The angular velocity of a freely rotating body without translational motion in S (the moving frame) is constant either with respect to synchronization (iv-L) *or* to (iv-E), this velocity being constant for the freely rotating body at rest in S_o.

SR imposes besides (i), (ii), (iii) also (iv-E) for any internal synchronization procedure used in S(*). Thus SR is not compatible with Marinov's result[11]. Synchronization (iv-E) usually obtained by Einstein's method can also be obtained by slow transportation of clocks[12] and *can also be used in* LAT[9].

(*) In SR, S_o has no special significance, being any inertial frame in the class of all inertial frames.

Assumptions (i), (ii), (iii), (iv-E) correspond to the requirement in SR of invariance of all physical laws under Lorentz transformations. Thus, LAT considered as a predictive formalism is less restrictive than SR, leaving open the possibility of existence of *some* non-Lorentz invariant phenomenon in nature (*even if most of physics is Lorentz-invariant*). Such situations may have to do with experiments involving both electromagnetic radiation and the roto-translational motion of solid bodies relative to S_o[8,11], as shall be assumed in what follows.

We also investigated in Refs.(9) a few proposed experiments which claimed to distinguish between LAT and SR, showing that the majority of these proposals are not correct on first principles. We showed explicitly in Refs.(9) that the best system of space-time coordinates to calculate results *even of non-Lorentz-invariant phenomena* is the Einstein-Lorentz coordinate gauge (ELG) in the S-frame. Indeed as most of the laws of physics in this gauge are the same in S as in S_o we have only to find the precise definition of the non-Lorentz-invariant laws in this gauge in order to perform the calculations (this will be explicitly used in what follows).

ELG give the natural space-time coordinates (*but not the necessary ones*) associated with postulates (i),(ii),(iii), (iv-E) above. The coordinates $(\vec{x},t)$ in this gauge (in S) are related to the coordinates $(\vec{x}_a,t_a)$ in S_o by usual Lorentz-transformations

$$x = \gamma(x_a - Vt_a) \; ; \; y = y_a \; ; \quad z = z_a$$
$$t = \gamma(t_a - Vx_a). \tag{6}$$

We recall that with postulates (i), (ii), (iii), (iv-L) in LAT it is natural (*but not necessary*) to use Ives-Marinov transformations (IMT) relating $(\vec{X},T)$ in S to $(\vec{x}_a,t_a)$ in S_o given by

$$X = \gamma(x_a - Vt_a) \;;\; Y = y_a \;;\; Z = z_a \qquad (7)$$
$$T = \gamma^{-1} t_a$$

and we call $(\vec{X},T)$ the Ives-Marinov coordinate gauge (IMG) in S. It is obvious, although not usual, that any coordinate system besides ELG and IMG (for instance, Newton-Galileu coordinates) can be used in LAT as in SR. Coordinates are labels, not physics! The IMG, for example can be implemented in SR using an *external synchronization* procedure. If non appropriate coordinates are used the laws of physics become more complicated with "fictcious" effects (inertial forces, aberrations, etc) appearing[9].

3. MISCONCEPTIONS ON THE THEORY AND INTERPRETATION OF PROPOSED ROTOR DOPPLER SHIFT EXPERIMENTS

As we said in section 1, using the method of Refs.(9), we investigate a class of experiments involving the Doppler shift between source and detector attached to the ring of a rotating disk, having in mind the computation of the Doppler shift experiment proposed by Kolen-Torr[7] and recently performed by Torr et al[8].

We must remember that Doppler shift experiments $(\Delta\nu/\nu)$ in rotating rings have been a source of a lot of misunderstandings. As correctly identified by Tyapkin[13] interest and much of confusion on the subject started with Møller[14] who in 1957 originated the discussion of a seemingly new possibility to test experimentally SR. He suggested comparing the Doppler shift of two-maser beams whose atoms move in opposite directions. His calculation of the Doppler shift on the basis of pre-relativistic physics (absolute Newton-aether theory, not to be confused with LAT), gave rise to the appearance of a term linearly dependent upon the velocity $\vec{V}$ of the *laboratory* system relative to the aether and the difference $(\vec{u}_e - \vec{u}_a)$ of the velocity of motion of emitter and that of the absorber atoms in S_0 (Møller's calculations are correct on the basis of his assumptions).

This experiment was made in 1958 and yielded a negative result[15]. In 1962 Møller[1] analysed the results of the experiment of Ref.(15) as well as the negative results of the rotor Doppler--shift experiment of Champeney and Moon[16], where source and detector are attached at the *opposite ends* of a diameter of a rotating disk concluding that these results prove SR and disprove the absolute Newton-aether theory. However one remark of him originated the incorrect idea that he concluded also for the disproof of LAT. Indeed Møller[1] said: "Apart from the increased accuracy, an experiment of this kind has the advantage over the Michelson-Morley experiments that a null result in this case cannot be explained by an *hypothesis of the Lorentz-FitzGerald type* (*), and it may therefore very well become the most direct and accurate test of the special principle of relativity".

It seems that Møller, as well as Champeney and Moon, were unaware of the fact that the rotor experiments had been proposed by Ruderfer[17] in 1960, who in 1961 discovered a mistake in his own calculations[18] thus exactly cancelling his prediction $\Delta\lambda \neq 0$, to the order considered, in LAT.

Møller's results are not valid in LAT for both the situations examined:

(a) For the original Møller's proposed experiment[14] a careful computation shows that the Doppler effect calculated in LAT is identical to the one calculated in SR. This has been proved by Lee and Ma[19] in 1962.

Actually in the lines of Refs.(9) we can state without computations, that $\Delta\nu = 0$ for this experiment, since only free motion of clocks (atoms) and radiation are involved. Indeed if no explicit non-Lorentz invariant motion is postulated for source and detector all results predicted by LAT and SR are identical.

(*) The italic is ours.

(b) For the rotor Doppler shift experiments the quoted Møller's conclusions are misleading in several aspects. Indeed, his Doppler-shift formula (valid in Newton-absolute aether theory reproduced in many text-books[2,3,22], is wrong(*) in LAT. Møller's formula for the Champeney and Moon[16] experiments reads (ωR being the velocity of emitter and absorber in the laboratory)

$$\frac{\Delta\lambda}{\lambda} = 2\omega\, R\, V\, \sin\omega t \tag{8}$$

which corresponds to Ruderfer's first calculation[17]. For the accuracy of the experiment, $\Delta\lambda/\lambda \sim 10^{-12}$, eq(7) implies the possibility of detecting an aether wind $V \sim 200$ m/s. Champeney and Moon[16] found $V \sim (1.6 \pm 2.8)$ m/s, about 1/2000 of the translation velocity of the Earth, thus considered a null result.

However in obtaining eq(8) in LAT these authors[2, 3, 16, 17] forgot the Lorentz factors (eq(1) and eq(2)). It should be noticed that although the angular velocity ω of the disk is implicitly taken as constant in S_o in order to use the galilean composition of the translational velocity ($\vec{v}$) and rotational velocities ($\vec{u}_a$, $\vec{u}_e$) in S_o, they explicitly state that ω is constant in S. We shall show that these assumptions are contradictory.

The correct formula, using the implicit hypothesis of Refs. (2,3,16,17), will be shown in section 4 to give no term proportional to $\omega RV \sin\omega t$. This has been found also by Ruderfer[18] and Tyapkin[13] who unfortunately did not solve completely the problem.

The Kolen-Torr proposed experiment[7] is in essence the Champeney and Moon[16] experiment for source and detector at small angular distance (and attached now to the rotating Earth). Kolen-Torr did not seem to be aware of Refs.(1,2,3,13,16,17,18). In Ref.(7) a theoretical analysis is made to predict the result of the experiment, but the calculations are misleading since, although the time dilation factor is taken into account, the

(*) It does not includes Lorentz time dilation.

Lorentz-contraction is not, and the wrong addition of velocities ($\vec{v}$ in S_o and $\vec{u}_e$ and $\vec{u}_a$ in the laboratory) is used[9]. In a note added in proof in Ref. (7) they state that they predict a formula for $\Delta\nu/\nu$ with a second harmonic variation. In Ref.(8) Dr. Torr informed that $\Delta\nu/\nu$, in their calculations, involves a second harmonic term for the small angular distance configuration and gives an equation that is half the value we shall find in section 5, but no details of the calculations. The preliminary results of Torr et al experiment[8], indicate the existence of this second harmonic term with $\Delta\lambda/\lambda \sim 10^{-16}$ in agreement with their prediction.

In sec. 4 we calculate the output of the rotor Doppler shift experiment (where source and detector are attached to the ring of rotating disk) according to the following possibilities:

(A) constant angular velocity of the disk relative to S in the ELG.

(B) constant angular velocity of the disk relative to S in IMG.

(C) constant angular velocity of the disk relative to S_o.

In all cases we assume for simplicity that a rotating disk remains circular in the S-frame (R = constant in ELG or IMG)*.

Case A corresponds to SR and case B to LAT as the angular velocity in the moving frame is referred respectively to Einstein and to Marinov time. Case C which do not belong to either LAT or SR is here considered as a situation which is wider than LAT (extended LAT).

As we shall see (B) and (C) imply a breakdown of Lorentz invariance and (C) seems to be in accord with the preliminary results of Ref.(8).

We mention here that the experiment proposed by dos Santos[20] which involve source (s) and detector (d) moving with equal and opposite velocities in S_o give null result ($\Delta\nu = 0$) not only in LAT (as stated in ref.(20)) but, contrary to ref.(20), also in SR. Indeed postulate (iv) is not used as photons are

---

* We assume, for simplicity that $\vec{V}$ lays in the plane of the disk.

exchanged for $\vec{r}_s = \vec{r}_d$ at 90º to the velocities in S_o, then LAT becomes identical to SR both giving null result if calculated in S_o.

The error of ref.(20) comes from the wrong assumption that SR must be used only in the rest frame of the detector. The calculation made in this system was wrong [21, 22*]

4. GENERAL FORMULA FOR THE DOPPLER EFFECT IN THE ELG (LABORATORY)

Taking advantage of the fact that the ELG can be used in both LAT and SR[9], in all inertial frames, and that Maxwell equations in S have the same form in this gauge both in S_o and S, we obtain in what follows a formula for the Doppler shift using the ELG.

The Doppler shift experiment is a comparison of the emitted and absorbed wave-lengths (or frequencies) of a monocromatic radiation. We have

$$\frac{\nu_e}{\nu_a} = \frac{\lambda_a}{\lambda_e} = \frac{\gamma_e}{\gamma_a}\,\frac{1 - \vec{k}\cdot\vec{v}_e}{1 - \vec{k}\cdot\vec{v}_a} = \frac{k_\mu \tilde{u}^\mu_e}{k_\mu u^\mu_a} \qquad (8)$$

In eq(8), the λ's are wave-lengths, ν_e and ν_a the frequencies as measured respectively in the emitter's rest frame and the absorber's rest frame, the k^μ is Maxwell's propagation 4-vector, and u^μ_e and u^μ_a are the 4-velocities of the emitter and absorber. $\gamma_{\binom{e}{a}}$ are Lorentz's factors associated with the respective velocities $\vec{v}_{\binom{e}{a}}$.

---

* One of us (W.A.R.) call attention to a misprint in ref.(21): In equ.(4) ν_a and ν_e should be exchanged.

Eq(8) identical to the relativistic expression is valid in any inertial frame for ELG as it involves only the Lorentz invariance of Maxwell's equation (in ELG) and the properties of point atoms. This equation is *valid* even if some non Lorentz-invariant phenomenon is also involved, which is this paper we restricted to the properties of the roto-translational motion of the solid body (the rotating disk) where source and detector are attached. Thus we do not consider here possible violations of Lorentz invariance in refractive media.

In the laboratory S eq(8) reads

$$\frac{\nu_a}{\nu_e} = \sqrt{\frac{1 - v_a^2(t+\delta t)}{1 - v_e^2(t)}} \cdot \frac{1 - \hat{k}\cdot\vec{v}_e(t)}{1 - \hat{k}\cdot\vec{v}_a(t+\delta t)} \tag{9}$$

In eq(9) t is the emission time and $t + \delta t$ the absorption time as measured in S in the ELG; $\vec{v}_{(\substack{e\\a})}$, like in eq(8) are the usual velocities and $\hat{k}$ is the unit vector in the direction of the radiation propagation between source at time t and detector at time $t + \delta t$ (Fig. 1).

We now approximate eq(9) for the situation of Kolen - Torr proposed experiment[7]. We have $\theta = \Delta\varphi = 10^{-4} \ll 1$ and $\cos\alpha \simeq 1$, where

$$\begin{aligned} \hat{k}\cdot\vec{v}_e &= v_e \cos\alpha_e \\ \hat{k}\cdot\vec{v}_a &= v_a \cos\alpha_a \\ \alpha_a &= \alpha_e = \alpha \end{aligned} \tag{10}$$

Writting

$$v_{(\substack{e\\a})}(t) = R\,\Omega_{(\substack{e\\a})}(t) \tag{11}$$

where R(const.) is the disk's radius and $\Omega\binom{e}{a}(t)$ is the angular velocity of source and detector at time t we have,

$$\Omega_a(t+\delta t) = \Omega_e(t) + \delta\omega \; ; \; \delta\omega << \Omega_e \tag{12}$$

from eq(9) we get for $\frac{\Delta\nu}{\nu} = \frac{\nu_a - \nu_e}{\nu_a}$

$$\begin{aligned} \frac{\Delta\nu}{\nu} &= - R\delta\omega \\ &= -R\Omega'\Delta\varphi \quad ; \quad \Omega' = d\Omega/d\varphi \end{aligned} \tag{13}$$

where $\theta = \Delta\varphi$ is the angular separation between emitter and absorber.

5. PREDICTIONS FOR THE DOPPLER SHIFT EXPERIMENT

CASE A

In this case, considering the rotating disk to have the geometry R = constant (in ELG or IMG in S) and $\Omega_e(t) = \Omega_a(t)$ = constant (in ELG in S) we have from eq(13)

$$\frac{\Delta\nu}{\nu} = 0 \tag{14}$$

a result that is general, i.e.,eq(9) also predicts the null result for any separation θ between source and detector.

CASE B

Here we assume again that the geometry of the rotating disk is R = constat in S (in ELG or IMG) and we now assume the rotation velocity to be uniform in the laboratory in Marinov's time, i.e., we write

$$\varphi_M - \bar{\varphi} = \omega T = \omega\gamma^{-1} t_a \tag{15}$$

This corresponds to LAT.

Using again eq(12) and the fact that $\varphi_M = \varphi$ (where φ is the angle measured in ELG) we have

$$\Omega(t) = \frac{d\varphi}{dt} = \omega/(1+\omega r V \sin\varphi(t)) \tag{16}$$

For $V << 1$ we approximate eq(16) as

$$\Omega(t) \simeq \omega - \omega^2\, r V \sin\varphi \tag{17}$$

As $v_{(e_a)} = R\Omega_{(e_a)}$ eq(16) shows that $v_{(e_a)}$ depends on the angular coordinate $\varphi_{(e_a)}$. For the experiment of Ref(8) we then get, from eq(13) and eq(17), using $\Delta\varphi \simeq d(1+\omega R)/R$, where d is the distance between source and detector

$$\Delta\nu/\nu \simeq \frac{d}{R}(\omega^2 R^2) V \cos\varphi \tag{18}$$

Notice that eq(16) for Ω/ω is in agreement with Theorem I of Ref.(9a) as it tends to 1 in the limit $\omega \to 0$, as in SR. Also from equ.(18) $\frac{\Delta\nu}{\omega} \to 0$ for $\omega \to 0$ as in SR.

CASE C

Here again the rotating disk has the geometry $R = \text{constant}$ (in the ELG in S), but now we assume that the angular velocity of the disk is constant in the S_o-frame. Notice that we are not anymore in LAT, but in a more general situation (extended LAT). We have

$$\gamma^{-1} t_a = t + \vec{V}\cdot\vec{x} \tag{19}$$

for the transformation that gives the relation between the time in $S_o(t_a)$ and the time of the clocks in S (in ELG).

According to our hypothesis we can write

$$\varphi_a = \omega t_a + \tilde{\varphi}\ ; \quad \tilde{\varphi} = \text{constant} \tag{20}$$

The relation between φ and φ_a follows immediately from the Lorentz contraction and reads

$$\tan\varphi(t) = (1 - V^2)^{1/2} \tan\varphi_a(t_a) \tag{21}$$

Using eqs(19) and (20) in eq(21) we obtain, putting $\Omega(t) = d\varphi/dt$, and remembering that $\vec{V}\cdot\vec{x} = Vr\cos\varphi$

$$\Omega(t) = \omega/[(\gamma^2 - \gamma^2V^2\cos^2\varphi)^{-1} + \omega r V \sin\varphi] \tag{22}$$

For $V << 1$ and $\omega r << 1$ we get *

$$\Omega(t) = \omega(1 - V^2\sin^2\varphi(t) - \omega r V \sin\varphi(t)) \tag{23}$$

As before $v_{\binom{e}{a}} = R\Omega_{\binom{e}{a}}$, eq(22) shows that the velocity of the emitter and absorber depends on its localization on the disk's ring. Notice however that contrary to case B, $\Omega \neq \omega$ and $\Delta\nu/\omega \neq 0$ in the limit $\omega \to 0$. This shows again that this theory is not LAT as otherwise it would contradict Theorem I of Ref(9a).

For the explicit case of the Torr et al experiment[8] we have for $R\delta\omega$ (where $\delta\omega$ is defined in eq(12))

$$R\delta\omega = -\omega R V^2 \sin 2\varphi\Delta\varphi - \omega^2R^2V\cos\varphi\Delta\varphi \tag{24}$$

Substituting eq(24) in eq(13) gives

$$\frac{\Delta\nu}{\nu} = \omega R V^2 \sin 2\varphi\Delta\varphi + \omega^2R^2V\cos\varphi\,\Delta\varphi \tag{25}$$

or remembering again that $\Delta\varphi = d(1+\omega R)/R$, we have

$$\frac{\Delta\nu}{\nu} = \frac{d}{R}(\omega RV^2 \sin 2\varphi + \omega^2R^2V\cos\varphi) \tag{26}$$

higher order terms being neglected. For the experiment of Ref.

(*) Conversily we obtain a similar expression of a time dependent angular velocity in S_0 if it is constant in S in ELG.

(8) we have $d/R \sim 10^{-4}$, $\omega R \sim 10^{-6}$, $V \sim 10^{-3}$ (*). Then, the first term in eq(22) gives a contribution of order 10^{-16} with a second *second harmonic variation*, while the second term gives a contribution of order 10^{-19} with a *first harmonic variation*. This can be compared with eq(18) which gives $\Delta\nu/\nu \sim 10^{-19}$ with a first harmonic variation, a presently non detectable effect.

6. CONCLUSIONS

Following the lines of Refs. (9) we have shown that a number of errors exist in previous papers analysing rotor Doppler shift experiments and that the conclusion usually accepted that the experimental results prove Lorentz Aether Theory to be wrong as compared to Special Relativity is non-sequitur. We show that mistakes have resulted from neglecting effects that exist in both theories when calculations are done in the absolute frame S_o. Even in papers where misconceptions of this type are examined[7], some of them being eliminated, mistakes resulting form further misconceptions remain[9].

Making the computations in the comoving inertial frame S attached to the centre of the disk and using a coordinate gauge (ELG) in which radiation propagates in vacuum isotropically with constant velocity in S we have different laws in S and S_o only for the phenomena violating Lorentz invariance. We show that for two kinds of such situations the violation of SR is detectable.

First we consider the possibility of free roto-translanting disks with angular velocity constant neither in S_o nor in S for ELG but in S for IMG. This obeys LAT but implies a

(*) This is approximately the velocity of the Earth in relation to the system where the cosmic blackbody background radiation is isotropic.

violation of SR since now the angular velocity of the disk in S in ELG is

$$\Omega(t) = \omega/(1 + \omega r V \sin\varphi(t)) \qquad (16')$$

thus implying a distinction between S_o and S when ELG is used. As a consequence $\Delta\nu/\nu \neq 0$.

We assumed then a freely rotating and translating disk has constant angular velocity in S_o. As a consequence the angular velocity in S is not constant for a given point in the disk as observed in the laboratory using ELG (or even in IMG) thus leading to a distinction of S and S_o which violates SR (and LAT). In this case we find in ELG

$$\Omega(t) = \omega/[(\gamma^2 - \gamma^2 V^2 \cos^2\varphi(t))^{-1} + \omega r V \sin\varphi(t)] \qquad (22')$$

Here also $\Delta\nu/\nu \neq 0$.

These results show that conclusions[4,5,6] that the fact that Doppler shift experiments with free emitters and absorbers lead necessarily to exactly null result both in LAT and SR should imply that also Doppler shift experiments with emitter and absorber attached to a rigid body (in roto-translational motion) have to give a null result are wrong. Also it shows how dangegerous it is to work with a not well defined problem or mixing quantities defined in one coordinate system (S_o) with other defined in another (S).

Finally we notice that the situation described by eq (26) agree with the experimental results of the Doppler shift experiment of Ref(8). If the experimental results of Torr et al are correct and this is the only explanation of these results it follows that both LAT and SR are violated! It should be stressed that, as Torr et al[8] obtain for $\Delta\nu/\nu$ one half of the dominant term in (26), it seems that really they, as Torr and Kolen[7], may have used model C, although Ref.[7] do not define precisely the theory used. Thus their wrong result may be due to neglecting Lorentz contraction of the disk[9].

A much larger effect can be obtained with Mössbauer experiment in a rotating table like Ref.(16) but with the Torr-Kolen[7]. arrangement. Indeed for $d/R \sim 10^{-1}$, $\omega R \sim 10^{-6}$, $V \sim 10^{-3}$ we find[24]

$$\frac{\Delta\nu}{\nu} = 10^{-16} \text{ for theory B}$$

$$= 10^{-13} \text{ for theory C}$$

Therefore now theory B (strict LAT) gives a presently detectable effect while theory C gives a result which could have been detected already by Champeney-Moon[16] in 1960. Other arrangements give even larger result[24].

To conclude we like to stress that, as the strongest evidence of violation of SR comes from Marinov work[11] it should be very important to have an independent and more precise experimental confirmation (or disproof?) of his results.

ACKNOWLEDGEMENTS

We are grateful to Prof.E.Recami and Dr.A.K.Maciel for useful comments. One of us (W.A.R.) is grateful to CNPq for a research grant.

REFERENCES

1. C. MØLLER, Proc. Roy. Soc. A270, 306 (1962).

2. J.D. JACKSON, Classical Electrodynamics, J. Willey, N. York (1975).

3. M.A. TONNELAT, Histoire du Principe de Relativité, Flammarun Ed., Paris (1971)

4. L. JANOSSY, The Theory of Relativity Based on Physical Reality, Akademiai Kiado, Budapest (1971).

5. V. BUONOMANO and J.E. MOORE, Am. J. Phys. 42, 1021 (1974).

6. S.J. PROKHOVNIK, Found. of Phys. 10, 197 (1980).

7. D.G. TORR and P. KOLEN, Found of Phys. 12, 265 (1982).

8. D.G. TORR, private communication (to be published).

9(a).W.A. RODRIGUES Jr. and J. TIOMNO, Rev. Bras. de Física in press; (b) Found. of Phys. (submitted).

10. W.A. RODRIGUES Jr., Submitted Hadronic Journal (1984).

11. S. MARINOV, Czech. J. Phys. B24, 965 (1974); Gen. Rel.Grav. 12, 57 (1980).

12. W.A. RODRIGUES Jr. and J. TIOMNO, Proc. Int. Conference on Space-Time Absolutness, pp. 147-150, edited by S. Marinov and J.P.Wesley,East-West Publ.Company,Graz,Austria (1982).

13. A.A. TYAPKIN, Lett. Nuovo Cimento, 7, 760 (1973).

14. C. MØLLER, Suppl. Nuovo Cimento, 6, 381 (1957).

15. J.P. CEDARHOLM, G.F. BLAND, B.L. HAVENS and C.H. TOWNES, Phys. Rev. Letters, 1, 342 (1958).

16. D.C.CHAMPANEY and P.B. MOON, Proc.Phys.Soc. 77, 350 (1960).

17. M. RUDERFER, Phys. Rev. Letters, 5, 191 (1960).

18. M. RUDERFER, Phys. Rev. Letters, 7, 361 (1961).

19. E.T.P. LEE and S.T. Ma, Proc. Soc. 79, 446 (1962).

20. A.N. SANTOS, Nuovo Cimento B32, 519 (1976).

21. W.A. RODRIGUES Jr. and V. BUONOMANO, Nuovo Cimento B34, 240 (1976).

22. D.G.ASHWORTH and DAVIES, Nuovo Cimento B36, (1976).

23. A.MILLER, Albert Einstein's Special Theory of Relativity Reading, Mass, J. Wesley (1981).

24. A.K.MACIEL and J.TIOMNO, to be published.

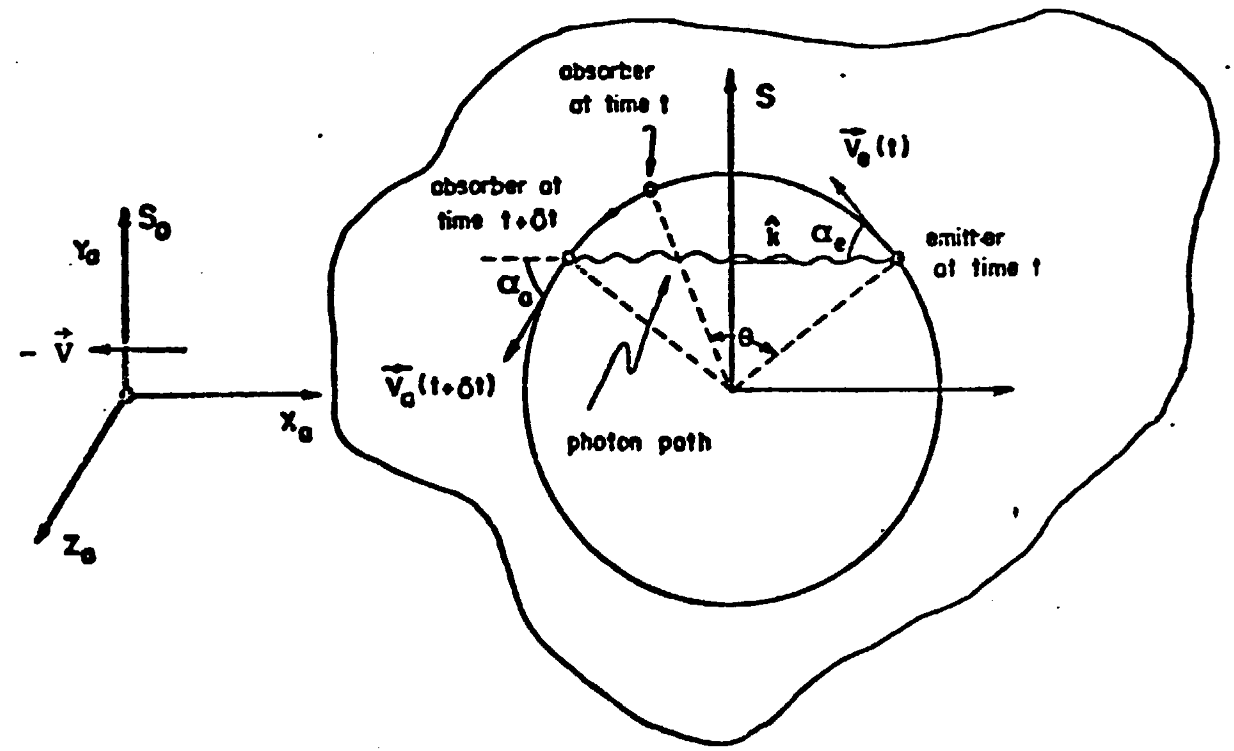

Fig. 1 The rotor Doppler shift experiment as seen in the moving frame S in the E.L.G. The absolute frame S_o has velocity $-\vec{V}$.