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# Concerning Santos' Experiment to Test Special Relativity

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*We show that the general light Doppler effect formula leads to an absolute null result in Santos' experiment. We point out that this experiment cannot be practically performed with the proposed Mössbauer effect technique. We emphasize that the relation between the emitted and received frequencies in the light Doppler effect is substantially different than the relation between the wavelengths.*

Let us have (Fig. 1) a light source moving at velocity $v$ (with respect to absolute space) which emits a photon at the position $S'$ when an observer moving at velocity $v_0$ is at the position $O'$. Let this photon be received when source and observer are, respectively, at the positions $S$ and $O$, supposing that the photon's wavelength is much shorter than the distance between source and observer. In Ref. 2, proceeding from our absolute spacetime

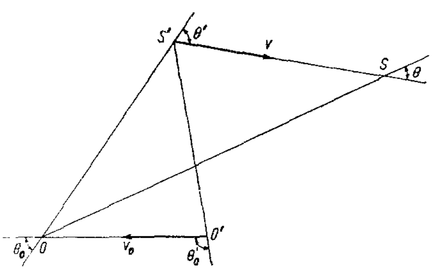


Fig. 1. Light Doppler effect for moving source and observer.

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theory, we have obtained the following relation between the emitted ($\nu$) and received ($\nu_0$) frequencies (the angles $\theta_0$ and $\theta'$ are shown in the figure):

$$\nu_0 = \nu \frac{1 - v_0 \cos \theta_0/c}{1 + v \cos \theta'/c} \left( \frac{1 - v^2/c^2}{1 - v_0^2/c^2} \right)^{1/2} \tag{1}$$

Now, proceeding from this formula, we shall predict the result of Santos' experiment.[1] For this reason we have to suppose that only those photons that are emitted by the source (a $\gamma$-ray emitter) in a direction perpendicular to $v$ can be received by the observer (a $\gamma$-ray absorber) when they travel along a direction perpendicular to $v_0$. Thus we have to put into (1) $\theta' = \pi/2$ and $\theta_0 = \pi/2$, obtaining, within an accuracy of second order in $v/c$,

$$\nu_0 = \nu[1 - (v^2 - v_0^2)/2c^2] \tag{2}$$

For $v = v_0$ we get $\nu_0 = \nu$.

It is very instructive to note that in this transverse Doppler effect experiment, where source and observer are moving with equal velocities, the result is the same at antiparallel and *parallel* directions of the velocities.

Now we shall show that, because of the *inevitable* appearance of first-order (in $v/c$) effects, Santos' experiment cannot be *practically* realized. Taking into account the transverse Doppler effect experiment considered by us in Refs. 2–4, we should suppose that between the disks of Santos rotating in opposite directions there is a shielding with length $d$ and aperture $b$, assuming, for simplicity's sake, the trajectories of emitter and absorber are rectilinear and the shielding exactly perpendicular to them. Since the emitter and absorber are not point objects, then for the different emitting and receiving atoms we shall have

$$\theta' = \pi/2 \pm b/d, \qquad \theta_0 = \pi/2 \pm b/d \tag{3}$$

Putting this into (1) and assuming $v_0 = v$, we obtain $\Delta\nu = \nu_0 - \nu = \pm 2\nu v b/cd$. On the assumption of the Einstein time dilation under the condition that the relative velocity between the antiparallel moving source and observer is $2v$, the effect which Santos expects to register must be $\Delta\nu = 2\nu v^2/c^2$. Thus the requirement $b/d < v/c$ is to be satisfied. Supposing $v = 300$ m/sec, $d = 10$ cm, we obtain $b < 10^{-5}$ cm. Obviously, such an experiment cannot be practically realized.

It should be especially noted that in all "rotor" experiments[5,6] there is no relative motion between source and observer and no effects first order in $v/c$ can appear.[2]

Let us emphasize that if the transverse Doppler effect experiment done with the help of electrically accelerated hydrogen ions[2–4] gives the result predicted by us, then Santos' experiment (considered as a thought experiment) must inevitably give a null result. Indeed, in our transverse Doppler effect experiment for any different velocity of the source we have to take another angle between the source–observer line and the velocity of the source if the same frequency $\nu$ (equal to the frequency emitted by the source at rest) is to be received by the observer. However, if at any different velocity of the source the observer will move with exactly the same, oppositely directed velocity, and the source–observer line is perpendicular to these two velocities, then the frequency received will always be the same. As a matter of fact, for moving source and observer at rest the Doppler effect will be post-traverse,[2–4] while for moving observer and source at rest the effect will be ante-traverse, so that for moving source and observer these two effects will cancel each other, producing a resultant null effect. Thus at certain position of the shielding, when the path of the photons interchanged between emitter and absorber will be exactly perpendicular to the trajectories of the latter, no change in the observed frequency can be registered at *any* velocity $v$ of emitter and absorber, as long as they are identical.

It is to be noted that in Santos' experiment the shielding plays a very important role. As noted, if this shielding is at rest in the laboratory (being perpendicular to the trajectories of emitter and absorber), then the experiment gives a null result. If the shielding is attached to the absorber, there will be a post-traverse Doppler effect, and, at $v = v_0$, one will get $\nu_0 = \nu(1 - 2v^2/c^2)$. If the shielding is attached to the emitter, there will be an ante-traverse Doppler effect, and thus $\nu_0 = \nu(1 + 2v^2/c^2)$.

Santos claims that special relativity predicts a non-null result for his experiment, and thus it can serve as an *experimentum crucis* in favor of the Einstein or Lorentz conceptions. Rodrigues and Buonomano[7] have shown that, proceeding from the Lorentz transformations, a null result also is to be obtained. The analysis of these two authors is reasonable, and there is nothing strange in their absolute (null) result, since, as we have shown in Ref. 8, the Lorentz transformation can be (and is to be!) treated on the presumption of absolute space and time.

However, Rodrigues and Buonomano cite the following formula for the Doppler frequency shift in the case of moving source and observer, which is not true[7,9]:

$$\nu_0 = \nu_s \frac{1 - v_0 \cos\theta_a/c}{1 - v_s \cos\theta_a/c} \left(\frac{1 - v_s^2/c^2}{1 - v_0^2/c^2}\right)^{1/2} \tag{4}$$

where $\nu_s$ and $\nu_0$ are the emitted and received frequencies, $v_s$ and $v_0$ are the velocities of source and observer, and $\theta_a$ (in Ref. 9 denoted by $\theta_p$) is "the angle relative to the absolute frame."

According to our formula (1), the angles in the numerator and denominator of (4) are, in general, *not* equal. In the numerator is the angle between the direction of propagation of the photon and the velocity of the observer at the moment of reception (see our angle $\theta_0$), while in the denominator is the angle between the direction of propagation of the photon and the velocity of the source at the moment of emission (see our angle $\pi - \theta'$). Let us note that formula (1) was first given by Lee and Ma.[10]

In formula (8) of Ref. 7, where the relation between the emitted and received wavelengths is given, the angles in the numerator and denominator are different (as they must be!). However, from the point of view of our absolute spacetime theory (which is to be considered in many aspects as a Lorentzian theory), the relation between the wavelengths is *completely different* from the relation between the frequencies. As we show in Ref. 2, the relation between the emitted ($\lambda$) and received ($\lambda_0$) wavelengths for the case shown in Fig. 1 is the following:

$$\lambda_0 = \lambda \frac{1 + v \cos \theta'/c}{(1 - v^2/c^2)^{1/2}} = \lambda \frac{(1 - v^2/c^2)^{1/2}}{1 - v \cos \theta/c} \tag{5}$$

Thus there is a change in the wavelength only if $v \neq 0$, i.e., only if the emitter moves with respect to absolute space. The motion of the receiver ($v_0 \neq 0$) does not lead to a change of the wavelength.

Formula (5) given by our absolute spacetime theory is of an *enormous theoretical and experimental significance*. Since our "coupled-mirrors" experiment[11] has shown that the velocity of light in a moving frame is anisotropic, then the motion of the observer cannot lead to a change of the wavelength, which is to be registered *always* with respect to absolute space.

In a paper that for two years we have been submitting (in vain) to different journals, we discuss the significance of formula (5), analyzing many performed (such as Bömmel's[12]) or proposed (such as Carnahan's[13]) experiments. Our analysis shows that formula (5) is adequate to describe physical reality. Instead of (5), special relativity posits a formula which can be obtained from (1) after replacing $\nu$ by $c/\lambda$ and $\nu_0$ by $c/\lambda_0$. Anyone who proceeds from the assumption of absolute space and time (as Rodrigues and Buonomano do) has to defend our formula (5) and not the Einsteinian one. This is an important problem, and if the spacetime specialists ignore it, the light Doppler effect will remain in darkness.

Final remark: The assertion of Rodrigues and Buonomano[7] that the result in Santos' experiment is null only when the distance between emitter and absorber is small (as they write, "when the distance between emission and absorption is small compared to the time of flight of the photon") is odd. According to formula (1), at any distance between emitter and absorber the result in Santos' experiment must be null.

## NOTE ADDED IN PROOF

In Ref. 2, in parallel with formula (5), we also introduce the following relation between the emitted and received wavelengths

$$\lambda_0 = \lambda \frac{1 + \cos \theta'/c}{1 \div v\,(v^2/c^2)} = \frac{\lambda}{1 - (v \cos \theta/c)} \tag{6}$$

The difference between formulas (5) and (6) is the following: In (5) it is not taken into account that when a periodic system (the source emitting photons) is set in motion with velocity $v$ its period $T$ increases according to the relation[8] $T_0 = T(1 - v^2/c^2)^{-1/2}$, while in formula (6) this absolute, *really existing,* time dilation is taken into account.

The difference between these two formulas becomes clear if we consider a light source and a mirror placed in front of it, which produce standing waves with length $\lambda$ when at rest in absolute space. If setting the system in motion with velocity $v$, the length of the standing waves *remains the same,* as it can immediately be obtained from formula (6) for the "transverse" case, $\theta = \pi/2$, $\theta' = \pi/2 + v/c$, while this length becomes equal to $\lambda(1 - v^2/c^2)^{1/2}$, if working with formula (5). For the frequencies such difficulties do not appear, because the received frequency depends on the velocities both of source and observer, while the received wavelength depends only on the velocity of the source. Let us further note that *all* optical apparatus register frequencies; wavelengths can be measured *directly* only in a pattern of standing waves produced from the interference of coherent incident and reflected photons, whose wavelengths are different when the system moves in absolute space.

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