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The Light Doppler Effect Treated by Absolute Spacetime Theory

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We consider the light Doppler effect within the framework of our absolute spacetime theory, which proceeds from the aether conception for light propagation. We show that for the cases of "observer at rest, source moving" and "source at rest, observer moving" the formulas for the received frequency are the same, but the formulas for the wavelength are different. This is in a drastic contradiction with the formulas given by contemporary physics, which proceeds from the principle of relativity. Our recently performed "coupled-mirrors" experiments show that only our formulas can adequately describe physical reality. The experiment for the measurement of the transverse light Doppler effect proposed by us in another paper is reconsidered and we point out how it can be realized as a compensation experiment. The so-called "rotor" and "rotor–rotor" experiments are analyzed. We show why the rotor experiment carried out with the aim of establishing an aether drift has failed to give any positive result.

1. THEORETICAL CONSIDERATIONS

Following the performance of our deviative and interferometric "coupled-mirrors" experiments,[1,2] with whose help we measured the Earth's absolute velocity and disproved the principle of relativity, a description and explanation of all high-velocity phenomena in the light of the absolute spacetime conceptions is urgent. This paper is devoted to the light Doppler effect, which plays an important role in many physical phenomena. As will be shown, the interpretation of many aspects of this effect by conventional physics, based on Einstein's theory of relativity, does not correspond to physical reality.

The theory of the light Doppler effect will be elaborated using our "burst" model for photons, which is briefly described in Ref. 3, and the

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fundamental results of the absolute spacetime theory obtained in Ref. 4. Within effects of first order in v/c our model of light propagation, which we call the *Marinov aether* model, is the *same* as the conventional *Newton aether* model. However these two models differ in regard to effects of second order in v/c; the differences are considered by us in Ref. 5.

Let us recall that the light Doppler effect represents the frequency and wavelength shifts of photons, emitted from a source of radiation and received by an observer, due to the motion of source and observer with respect to absolute space.

1.1. Source and Observer at Rest

Let there be a source (emitter) of photons and an observer (receiver). The source can produce photons (an excited atom) or reflect them (a mirror). Let the source be at rest in absolute space. The *frequency* ν and the *wavelength* λ of any single photon, registered by an observer who is also at rest in absolute space, are connected with the proper energy[6] e_0 of the photon by the so-called de Broglie relations

$$\nu = e_0/h, \qquad \lambda = ch/e_0 \tag{1}$$

and thus

$$\nu\lambda = c \tag{2}$$

where h is the Planck constant and c the *absolute velocity of light*, i.e., the velocity of light with respect to absolute space, which is called briefly the *velocity of light*.

1.2. Source Moving, Observer at Rest

Suppose now (Fig. 1) that the observer is at rest in absolute space at the point O' and the light source moves with velocity v from the position S' where a photon is emitted to the position S where the source will be at the moment when the photon will be received by the observer. Suppose that the wavelength of the interchanged photon is much less than the distance between source and observer and, thus, the *emission* and *reception positions* of the source can be considered as points.

The distance between the emission and reception positions of the source is divided by the point S_m into two equal parts; thus the source will be at S_m at the midpoint in time between the moments of emission and reception. θ' is the emission angle, θ the reception angle, and θ_m the middle angle. We note that a certain freedom is inevitable when defining these angles, which leads to certain differences in the notations and in the formulas from those of our earlier papers.[7–9] Now, once and for all, we make the following

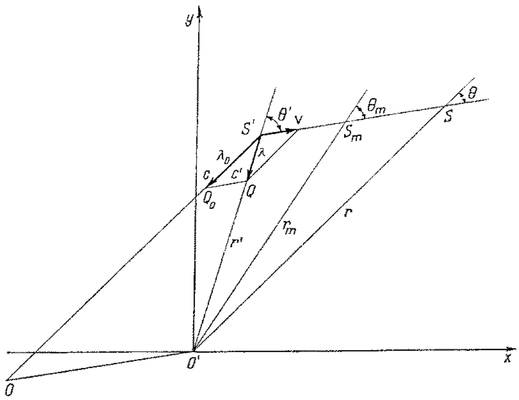

Fig. 1. Light Doppler effect in the case of a moving source (or of a moving observer).

stipulation: The *emission*, *reception*, and *middle angles* are subtended by the velocity of the moving object and the line connecting the object at rest with the moving object respectively at the emission, reception, and middle moments. We shall attach the subscript zero to the observed frequency and wavelength and *not* to the emitted ones, which will be written without any subscript. Primes will be attached to the initial (i.e., emission) distance, position, and angle, while the final (i.e., reception) distance, position, and angle will be written without any superscript.

When the source is moving, the observer at rest will *not* register the frequency ν and measure the wavelength λ that are registered and measured when the source is at rest, and which we call the *emitted frequency* and *wavelength*, but some other, in general different, quantities, ν_0, λ_0, which we call the *observed* (or *received*) *frequency* and *wavelength.*

If in Fig. 1 we represent the emitted wavelength λ by the segment $S'Q$, then, proceeding from our "burst" model,[3] we have to represent the observed wavelength λ_0 by the segment $S'Q_0$. Let us repeat that we consider only the case where the distance between source and observer is much larger than the wavelength of the interchanged photon, and on the figure we draw the wavelength so large only for the sake of clarity.

Since the photon moves in absolute space with velocity c, we shall have

$$\nu_0\lambda_0 = c \tag{3}$$

From (2) and (3) we obtain

$$\nu_0/\nu = \lambda/\lambda_0 \tag{4}$$

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The triangles $S'Q_0Q$ and $O'SS'$ are similar and thus

$$\lambda/\lambda_0 = r'/r \tag{5}$$

so that

$$\nu_0/\nu = r'/r \tag{6}$$

where r' is the *emission distance* $O'S'$ and r is the *reception distance* $O'S$.

According to formulas (4.21) of Ref. 4 (where we write $r_0 = r'$, $\theta_0 = \theta'$),

$$r = r' \frac{1 + v(\cos\theta')/c}{(1 - v^2/c^2)^{1/2}} = r' \frac{(1 - v^2/c^2)^{1/2}}{1 - v(\cos\theta)/c} \tag{7}$$

Substituting this into (6) and (5), one finds

$$\nu_0 = \nu \frac{(1 - v^2/c^2)^{1/2}}{1 + v(\cos\theta')/c} = \nu \frac{1 - v(\cos\theta)/c}{(1 - v^2/c^2)^{1/2}} \tag{8}$$

$$\lambda_0 = \lambda \frac{1 + v(\cos\theta')/c}{(1 - v^2/c^2)^{1/2}} = \lambda \frac{(1 - v^2/c^2)^{1/2}}{1 - v(\cos\theta)/c} \tag{9}$$

If we wish to have the dependence between the emitted and received frequencies and wavelengths on the middle angle θ_m, we have to insert in (6) and (5) the formula (4.25) of Ref. 4; and so we obtain

$$\nu_0 = \nu \left(\frac{1 - v(\cos\theta_m)/c}{1 + v(\cos\theta_m)/c}\right)^{1/2}, \qquad \lambda_0 = \lambda \left(\frac{1 + v(\cos\theta_m)/c}{1 - v(\cos\theta_m)/c}\right)^{1/2} \tag{10}$$

This one can obtain also by multiplying both formulas (8) and both formulas (9), writing $\cos\theta' = \cos\theta_m + a$ and $\cos\theta = \cos\theta_m - a$, where a is an algebraic quantity.

For $\theta' = \theta = \theta_m = 0$ (or π), we call the Doppler effect *longitudinal.*

For $\theta' = \pi/2$, $\theta = \pi/2 - v/c$, $\theta_m = \pi/2 - v/2c$, we call the Doppler effect *post-traverse.*

For $\theta = \pi/2$, $\theta' = \pi/2 + v/c$, $\theta_m = \pi/2 + v/2c$, we call the Doppler effect *ante-traverse.*

For $\theta_m = \pi/2$, $\theta' = \pi/2 + v/2c$, $\theta = \pi/2 - v/2c$, we call the Doppler effect *traverse.*

The post-traverse, ante-traverse, and traverse Doppler effects are designated collectively by the common term *transverse* Doppler effect.

1.3. Source at Rest, Observer Moving

Suppose now (see again Fig. 1) that the source is at rest in absolute space at the point S' and the observer moves with velocity v from the emission position O' to the reception position O. If in Fig. 1 we represent the velocity c of the photons with respect to absolute space by the segment $S'Q_0$, then, proceeding from our absolute spacetime conceptions,[4] we have to represent the observed velocity c', which is called the *relative velocity of light* and is measured with respect to the observer who moves in absolute space, by the segment $S'Q$. According to formula (4.30) of Ref. 4 (where we write $c_0 = c'$, $\theta_0 = \theta'$), it is given by

$$c' = c\,\frac{(1 - v^2/c^2)^{1/2}}{1 + v(\cos\theta')/c} = c\,\frac{1 - v(\cos\theta)/c}{(1 - v^2/c^2)^{1/2}} \tag{11}$$

where θ' is the angle between the direction of propagation of the photon and the velocity of the observer registered with respect to the observer, and θ is the same angle registered with respect to absolute space.

The relative light velocity c' is measured with the help of a clock at rest in absolute space, which reads *absolute time* and is called the *absolute clock*. If the relative light velocity is measured with the help of a clock attached to the moving observer, which reads *proper time* and is called the *proper clock*, we call it the *proper relative light velocity*; because of the absolute time dilation, it is given by

$$c_0' = \frac{c'}{(1 - v^2/c^2)^{1/2}} = \frac{c}{1 + v(\cos\theta')/c} = c\,\frac{1 - v(\cos\theta)/c}{1 - v^2/c^2} \tag{12}$$

If the absolute light velocity is measured in proper time, it is called the *proper absolute light velocity* (or, briefly, *proper light velocity*) and, because of the absolute time dilation, it is given by

$$c_0 = \frac{c}{(1 - v^2/c^2)^{1/2}} \tag{13}$$

Since the photon proceeds with respect to the moving observer with the relative velocity c', the relation between the observed frequency and wavelength will be

$$\nu_0\lambda_0 = c' \tag{14}$$

According to our "burst" model for photons, their wavelength can change only when the source moves with respect to absolute space. The motion of the observer with respect to absolute space leads only to a change in the velocity and frequency of the observed photons, but *not* to a change in their wavelengths. We have to emphasize that the wavelength is to be measured *always* with respect to absolute space, *even in the case of a moving observer*. The photon is a reality that exists *independently* of the observer, and the motion of the latter can exert *no* influence on the photon's wavelength, which is an immanent photon property. We have further to emphasize that a direct measurement of the wavelength cannot be performed. One can measure directly only the wavelength of standing waves, i.e., of "to and for" propagating photons, which interfere. All measurements of the wavelength of unidirectionally propagating photons are indirect. If one would accept that the motion of the observer leads to a change in the wavelength, then one is impelled to accept Einstein's dogma about the constancy of light velocity in any inertial frame, which, as we have experimentally shown, does not correspond to physical reality.

Thus, for the case of source at rest and a moving observer, we have

$$\lambda_0 = \lambda \tag{15}$$

From Eqs. (2), (14), and (15) we obtain

$$\nu_0/\nu = c'/c \tag{16}$$

Making use of formulas (11), we find

$$\nu_0 = \nu \frac{(1 - v^2/c^2)^{1/2}}{1 + v(\cos\theta')/c} = \nu \frac{1 - v(\cos\theta)/c}{(1 - v^2/c^2)^{1/2}} \tag{17}$$

Here again a formula analogous to (10) can be introduced, as well as the definitions for longitudinal and transverse Doppler effects.

1.4. Source and Observer Moving

Finally, suppose (Fig. 2) that the source moves with velocity v with respect to absolute space and the observer with velocity v_0, so that S' and O' are the emission positions of source and observer and S and O are their reception positions.

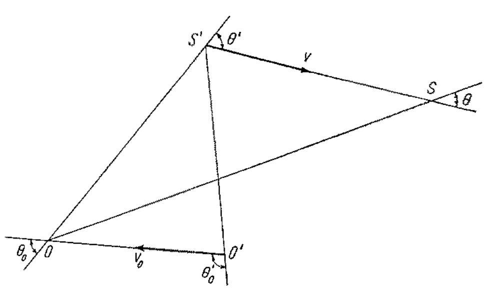

Fig. 2. Light Doppler effect in the case where both source and observer are moving.

We introduce two pairs of emission and reception angles: θ_0' and θ_0 are the emission and reception angles if the source is at rest at its emission position, while θ' and θ are the emission and reception angles if the observer is at rest at its reception position. For certain problems it is convenient to use the angles θ', θ_0, for others the angles θ_0', θ.

To find the relation between the emitted and received frequencies and wavelengths we proceed as follows: Suppose that the real source emits a photon and an imaginary observer is at rest at point O (the reception position of the real observer). The frequency and wavelength registered by this observer, called an intermediary, will be [use formulas (8) and (9)]

$$\nu_{\text{int}} = \nu \frac{(1 - v^2/c^2)^{1/2}}{1 + v(\cos\theta')/c} = \nu \frac{1 - v(\cos\theta)/c}{(1 - v^2/c^2)^{1/2}} \tag{18}$$

and

$$\lambda_{\text{int}} = \lambda \frac{1 + v(\cos\theta')/c}{(1 - v^2/c^2)^{1/2}} = \lambda \frac{(1 - v^2/c^2)^{1/2}}{1 - v(\cos\theta)/c} \tag{19}$$

If now an imaginary source is at rest at point S' (the emission position of the real source) and emits a photon with frequency ν_{int} and wavelength λ_{int}, then the frequency and wavelength registered by the real observer when he crosses point O will be [use formulas (17) and (15)]

$$\nu_0 = \nu_{\text{int}} \frac{(1 - v_0^2/c^2)^{1/2}}{1 + v_0(\cos\theta_0')/c} = \nu_{\text{int}} \frac{1 - v_0(\cos\theta_0)/c}{(1 - v_0^2/c^2)^{1/2}} \tag{20}$$

$$\lambda_0 = \lambda_{\text{int}} \tag{21}$$

Substituting (18) and (19) into (20) and (21), we obtain

$$\begin{aligned}\nu_0 &= \nu \frac{1 - v_0(\cos\theta_0)/c}{1 + v(\cos\theta')/c} \left(\frac{1 - v^2/c^2}{1 - v_0^2/c^2}\right)^{1/2} \\ &= \frac{1 - v(\cos\theta)/c}{1 + v_0(\cos\theta_0')/c} \left(\frac{1 - v_0^2/c^2}{1 - v^2/c^2}\right)^{1/2}\end{aligned} \tag{22}$$

$$\lambda_0 = \lambda \frac{1 + v(\cos\theta')/c}{(1 - v^2/c^2)^{1/2}} = \lambda \frac{(1 - v^2/c^2)^{1/2}}{1 - v(\cos\theta)/c} \tag{23}$$

When $\mathrm{v}_0 = \mathrm{v}$, it means $\theta_0 = \pi - \theta'$, $\theta_0' = \pi - \theta$, and Eq. (22) reduces to

$$\nu_0 = \nu \tag{24}$$

while formulas (23) remain the same, so that

$$\nu_0 \lambda_0 = c' \tag{25}$$

c' being the relative light velocity with respect to source and observer. In this case θ is the angle between the direction opposite to that of light propagation and the velocity of source and observer registered with respect to both of them, while θ' is the same angle registered with respect to absolute space.

If the relative light velocity is measured in the proper time of the moving observer, it becomes

$$\nu_0 \lambda_0 = c_0' \tag{26}$$

and formula (24) remains the same, while formulas (23) must be replaced by the following ones:

$$\lambda_0 = \lambda \frac{1 + v(\cos \theta')/c}{1 - v^2/c^2} = \frac{\lambda}{1 - v(\cos \theta)/c} \tag{27}$$

Equation (24) shows that if an observer moves with the same velocity as the light source, then the measurement of the received frequency can *never* give information about their absolute velocity. However, formula (27) shows that the measurement of the wavelength *can* give such information. These conclusions are of extreme importance. Let us note that according to contemporary physics, which proceeds from the principle of relativity, a Doppler effect appears only when source and observer move with respect to one another. By contrast, we have shown that a Doppler effect appears also when source and observer move with the same velocity, to wit, the received wavelength is different from that which would be measured if source and observer were at rest in absolute space.

2. THE TRANSVERSE "CANAL RAY" EXPERIMENT

Let us now turn our attention to the experimental situation.

The longitudinal light Doppler effect of second order was measured by three groups.[10–12] According to the reports of all investigators, experiment well confirmed formula (8). However, as was shown by Kantor,[13] the accuracy of all these experiments is seriously in doubt.

In our opinion, with the present technical state of the art, we have to take the experiment proposed by us in Ref. 7 and reconsidered in Ref. 8 as a reliable experiment capable of establishing beyond doubt the existence of a light Doppler effect of second order when an *inertial* motion of the source is observed.

It is interesting to note that if one considers the state of experimental technique in the period prior to World War I, the conclusion can be drawn that the experiment proposed by us in 1970 could have been performed even at that time. Indeed (see the experimental arrangement in Fig. 3 and its description below), Stark,[14] who investigated the light Doppler effect in 1906, used accelerating voltages of about 10 kV, but, as he wrote, voltages as high as 60 kV could have been supplied. As a spectroscopic apparatus he used a Rowland grating with dispersion 1.64 nm on 1 mm for $\lambda = 500$ nm. Experimental equipment with optimal capabilities of the same order have been used by all investigators of the visible light Doppler effect of second order mentioned above. However, the realization of the longitudinal Doppler effect is very complicated, requiring measurements of distances between spectral lines with very high precision and additional calculations. We share the opinion of Kantor[13] that the available reports on the measurements of the longitudinal Doppler effect of second order must be viewed with considerable reservation.

Now we shall show that the experiment for the measurement of the transverse Doppler effect proposed by us can reliably be carried out, because it can be realized as a compensation experiment. Indeed, keeping in mind Refs. 7 and 8, we can perform this experiment as follows:

As a moving light source one should use ions in a canal-ray tube of the Dempster type according to Fig. 3. The ions are produced in the arc between the heater H and the perforated electrodes E and E'. Between E and E' the ions are accelerated by an electric field, thus forming the beam S. They proceed with a constant velocity and represent the moving source. The photons emitted by the excited ions, passing through the large slit Q, illuminate the narrow slit O, behind which there is a spectroscopic apparatus that gives a response only when photons are incident with frequency equal to the frequency ν emitted by the ions at rest. Let us emphasize that *any* indi-

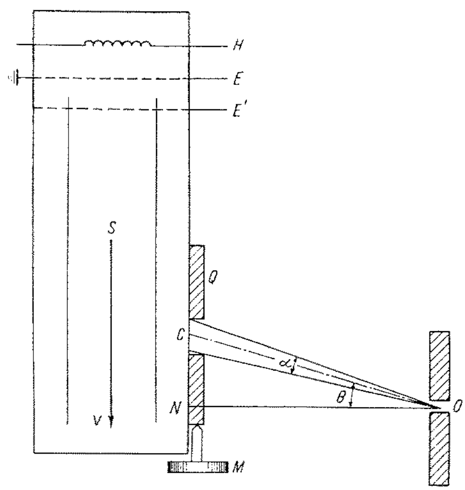

Fig. 3. The transverse canal ray experiment.

cator that registers light radiation is affected by the received frequency and *not* by the wavelength.

From Fig. 3 and from the formula (8) we see that photons will fall on the indicator with frequency

$$\nu_0 = \nu \frac{(1 - v^2/c^2)^{1/2}}{1 + (v/c)\cos(\frac{1}{2}\pi + \theta \pm \frac{1}{2}\alpha)} = \nu \left[1 + \frac{v}{c}\left(\theta \pm \frac{\alpha}{2}\right) - \frac{v^2}{2c^2}\right] \quad (28)$$

where θ is the angle between the perpendicular ON to the ionic beam and the line OC connecting slit O with the center of slit Q; α is the angle under which slit Q is to be seen from point O. If we choose $\alpha \ll \theta$, then we see that photons with frequency ν will fall on the indicator only when

$$\theta = \tfrac{1}{2}v/c \quad (29)$$

Hence the experiment is to be performed as follows: For any voltage applied to the electrodes, i.e., for any velocity v of the ions, we search for the position of slit Q at which the indicator will show the presence of photons with frequency ν. Then the theory will be proved right if a plot of $2\theta c$ vs. v gives a straight line of slope unity.

Recently a very reliable transverse light Doppler effect experiment has been performed.(15) In this experiment light was incident normally to a rapidly rotating mirror and the frequency of the reflected photons was compared with the frequency of the incident photons with the help of a Michelson interferometer. The authors registered no change in the frequency of the reflected photons. This result can immediately be explained by our theory. Indeed, for the photons received by the rotating mirror there is an ante-traverse Doppler effect, while for the photons "emitted" (i.e., reflected) by the rotating mirror and received by the observer (the Michelson interferometer) there is a post-traverse Doppler effect. The apparatus measures the resultant effect, which is null, because the ante and post-traverse Doppler effects cancel one another. Let us mention that the authors give the same explanation for the null final effect. Thus this experiment *cannot* be considered as showing directly the existence of a transverse Doppler effect.

3. THE ROTOR EXPERIMENT

The so-called "rotor" experiment was carried out first by Hay *et al.*(16) and then repeated many times by other investigators.

The scheme of this experiment, where the Mössbauer effect is used, is shown in Fig. 4. Radioactive ^{57}Co representing the source was put on a rotating wheel at a distance R from the center of rotation C. A thin ^{57}Fe

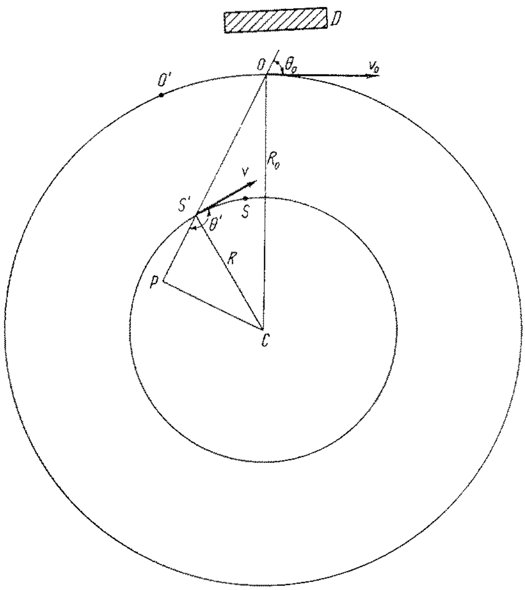

Fig. 4. The rotor experiment.

absorber representing the observer was put on the circumference of the rotating wheel at a distance R_0 from the center of rotation. A detector D at rest was used to measure the rate of passage through the absorber of photons emitted by the source. The transmission of the absorber was measured for various angular velocities. It was found to increase as the angular velocity increased, indicating a shift in the characteristic frequency of the absorber.

Since the line shape of the absorber at rest was known experimentally, the magnitude of the frequency could be established, and it was found to agree with the frequency shift calculated according to formula (22).

Indeed, from the triangles OPC and $S'PC$ in Fig. 4 it follows that

$$R_0 \cos \theta_0 = -R \cos \theta' \tag{30}$$

Taking into account that

$$v = \Omega R, \qquad v_0 = \Omega R_0 \tag{31}$$

where Ω is the angular velocity of rotation, substituting relations (31) into (22), and keeping in mind (30), we obtain the relation

$$\nu_0 = \nu \left(\frac{1 - v^2/c^2}{1 - v_0{}^2/c^2}\right)^{1/2} \tag{32}$$

This was also the relation established experimentally.

Let us emphasize that formula (32) is valid for any position of source and observer on the circumferences with radii R and R_0.

4. THE ROTOR-ROTOR EXPERIMENT

Now we shall describe a modification of the rotor experiment, which we call the "rotor–rotor" experiment (Fig. 5). It can be realized when the center of the rotor just considered (which we shall call the small rotor) rotates at an angular velocity Ω and linear velocity v_0 with respect to some center, thus making another, "large rotor." The radii of the small and large rotors are denoted by r and R; the angular velocity of rotation of the small rotor about its own center is denoted by ω. We shall suppose that the source is placed at the tip of the small rotor and the observer is at its center. The linear velocity of rotation of the source is denoted by v_r and its absolute velocity by v. Thus we have

$$\mathbf{v} = \mathbf{v}_r + \mathbf{v}_0 \tag{33}$$

The angle between $\mathbf{v}_r$ and $\mathbf{v}$ is denoted by ψ and that between $\mathbf{R}$ and $\mathbf{r}$ by φ. The small angle between the observer's radii at the emission and reception moments is denoted by α, and the small angle under which the emission

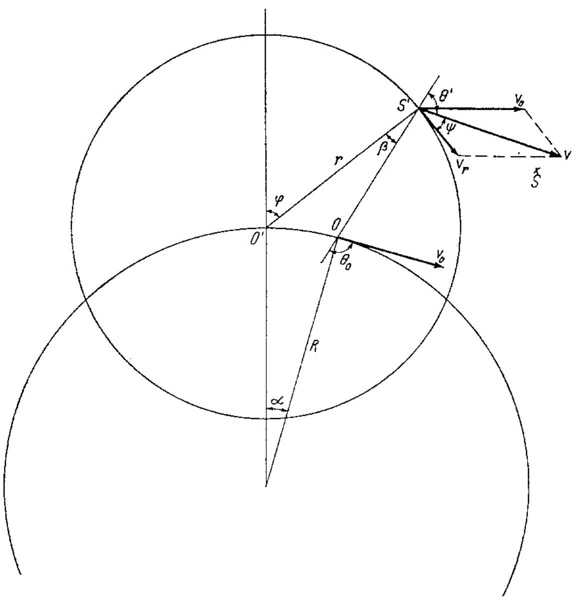

Fig. 5. The rotor–rotor experiment.

and reception positions of the observer are seen from the emission position of the source is denoted by β.

We have from Fig. 5 (see also Fig. 2)

$$\theta' = \pi/2 - \psi + \beta, \qquad \theta_0 = \pi/2 + \varphi - \alpha - \beta \tag{34}$$

with

$$\alpha = v_0 r/cR, \qquad \beta = (v_0/c)\cos\varphi \tag{35}$$

Substituting (35) into (34) and taking into account that α and β are small quantities, we can write

$$\cos\theta' = \sin\psi\cos\beta - \cos\psi\sin\beta = \sin\psi - (v_0/c)\cos\varphi\cos\psi \tag{36}$$

$$\begin{aligned}\cos\theta_0 &= -\sin\varphi\cos(\alpha+\beta) + \cos\varphi\sin(\alpha+\beta)\\ &= -\sin\varphi + (v_0/c)[(r/R) + \cos\varphi]\cos\varphi\end{aligned} \tag{37}$$

From the figure we have further

$$\sin\psi = v_0(\sin\varphi)/v, \qquad \cos\psi = (v_r + v_0\cos\varphi)/v \tag{38}$$

from which we get

$$v^2 = v_0{}^2 + v_r{}^2 + 2v_0 v_r\cos\varphi \tag{39}$$

Using the last four formulas in (22) and working within an accuracy of the second order in $1/c$, we obtain the relation

$$\nu_0 = \nu\left(1 - \frac{v_r{}^2}{2c^2} - \frac{v_0{}^2}{c^2}\frac{r}{R}\cos\varphi\right) \tag{40}$$

Taking into account that

$$r\omega/v_r = R\Omega/v_0 \tag{41}$$

one can write (40) in the form

$$\nu_0 = \nu\left(1 - \frac{v_r{}^2}{2c^2} - \frac{v_r v_0}{c^2}\frac{\Omega}{\omega}\cos\varphi\right) \tag{42}$$

This result can be confirmed by the "rotor–rotor" experiment proposed by us for the verification of the absolute formula (22).

However, we can show that formula (42) is already checked to a certain degree by experiment. Indeed, if we suppose $\Omega \ll \omega$, then Eq. (42) shows that with the help of the rotor experiment one cannot measure the absolute translational velocity v. Hence the suggestion of Ruderfer,[17] who predicts for such a case the same formula but without the factor Ω/ω (however, see Ref. 18) is based on an incorrect treatment of the light Doppler effect. Champeney *et al.*[19] and Turner and Hill[20] have performed experiments to check (42) written without the factor Ω/ω. The aim of Champeney *et al.* was to measure the Earth's rotational velocity (which is 310 m/sec on the 45° parallel). Experiment has shown that v_0 must be less than 1.6 ± 2.8 m/sec, and this result was treated as a new and better verification of the Einstein principle of relativity (with respect to the accuracy of the historical Michelson-Morley experiment).

It is clear that this conclusion is untenable. When we analyze Champeney's experiment with the help of (42), then we see that if $\Omega = 1.15 \times 10^{-5}$ rad/sec (the Earth's diurnal angular velocity), $\omega = 1.15 \times 10^3$ rad/sec (the rotor angular velocity), and $v_0 = 310$ m/sec, then $v_0\Omega/\omega = 3.1 \times 10^{-6}$ m/sec. This result is six orders lower than the accuracy of Champeney's experiment, and thus the diurnal velocity of the Earth cannot be detected by the Mössbauer technique of the rotor experiment. Since in nature all kinds of motions of celestial bodies are rotational, we can detect (at least theoretically!) any such motion, using the rotor, i.e., the rotor–rotor experiment, where the large rotor represents the rotation of the celestial body (about its rotational axis, about the primary, or about the galactic center).

A more detailed analysis of the rotor–rotor experiment gives us enough certainty to assert that absolute space does exist. We proceed to show this.

Let us suppose that in the discussed rotor–rotor experiment $r \ll R$. The unique difference from the case considered above is that now $\alpha = 0$, and we can successfully use Fig. 5. Substituting this zero value for α and the second formula of (35) into (36) and (37), we get

$$\cos\theta' = \sin\psi - (v_0/c)\cos\varphi\cos\psi \tag{43}$$

$$\cos\theta_0 = -\sin\varphi + (v_0/c)\cos^2\varphi \tag{44}$$

After the substitution of these two formulas and of formulas (38) into (22), we obtain

$$\nu_0 = \nu\left(\frac{1 - v^2/c^2}{1 - v_0^2/c^2}\right)^{1/2}\left(1 + \frac{v_r v_0}{c^2}\cos\varphi\right) \tag{45}$$

Substituting (39), we find within an accuracy of second order in $1/c$

$$\nu_0 = \nu\left(1 - \frac{v_r^2}{2c^2}\right) \tag{46}$$

If we attach two clocks respectively to the source and to the observer, then the relation between their reading t and t_0 for a *short enough* absolute time interval (in which we can assume that the source's absolute velocity v does not change substantially its direction and hence also magnitude) will be[4,21]

$$t = t_0 \left(\frac{1 - v^2/c^2}{1 - v_0^2/c^2}\right)^{1/2} \tag{47}$$

When the relation between the emitted and received frequencies is given by formula (32), then ν and ν_0 are exactly inversely proportional to the rates of the clocks attached respectively to the source and observer. Formula (32) shows that there is a post-traverse Doppler effect for the source and an ante-traverse effect for the observer. For its part, formula (45) shows that, besides the post- and ante-traverse effects (which are of second order in $1/c$), there is in the rotor–rotor experiment also a longitudinal effect (it is of first order in $1/c$, but since the angle involved is small, it becomes of second order in $1/c$). It is just this longitudinal effect that leads to the result that in the rotor–rotor experiment at $r \ll R$ the emitted and observed frequencies are not inversely proportional to the rates of the clocks attached, respectively, to source and observer. The frequencies ν and ν_0 are inversely proportional to these rates only when $\mathbf{v}$ and $\mathbf{v}_0$ are perpendicular to the line $S'O$ (the line connecting the emission position of the source with the reception position of the observer), or when the components of the source and observer velocities, respectively, at the emission and reception moments on the line $S'O$ are equal, i.e., when

$$v_0 \cos \theta_0 = -v \cos \theta' \tag{48}$$

As can be seen immediately from Fig. 5 (assuming there $\alpha \approx 0$), in the rotor–rotor experiment at $r \ll R$ the components of $\mathbf{v}$ and $\mathbf{v}_0$ on the line $S'O$ are not equal ($\mathbf{v}_r$ is not perpendicular to $S'O$, except for the case where $\mathbf{v}_r$ is perpendicular to $\mathbf{v}_0$).

These considerations give us the assurance to assert that in the rotor–rotor experiment at $r \ll R$ (i.e., when the small rotor moves inertially at velocity v with respect to absolute space) the clocks attached to the source and to the observer show (for a given short enough time interval) readings which are related as in Eq. (47).

Hence the existence of absolute space, which was experimentally established by our "coupled-mirrors" experiments,[1,2] can be anticipated when analyzing the rotor–rotor experiment.

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