

# The original explanation of the Lorentz-Fitzgerald contraction phenomenon - photon pressure model

Roman Szostek<sup>1</sup>, Karol Szostek<sup>2</sup>

<sup>1</sup>*Rzeszow University of Technology, Department of Quantitative Methods, Rzeszow, Poland  
rszostek@prz.edu.pl*

<sup>2</sup>*Rzeszow University of Technology, Department of Aerospace and Space Engineering, Rzeszow, Poland  
kszostek@prz.edu.pl*

## Abstract:

The paper explains the Lorentz-Fitzgerald contraction phenomenon on the basis of Special Theory of Ether (STE). Presented explanation is based on the construction of innovative technical model of this phenomenon, and not only on his classical mathematical description.

The model explaining the reason of the Lorentz-Fitzgerald contraction is based on the photon pressure and the properties of the light clock, so we called it the photon pressure model. In this model, the dimensions of bodies result from the statistical equilibrium between the atoms that compose them, and this equilibrium is influenced by the photon pressure. In the Special Theory of Ether, physical bodies are contracted, not space-time. Therefore the model presented here combines the relativity theory with universal frame of reference (STE) and solid-state physics.

The model presented here shows how Michelson-Morley's experiment can be modified to be perhaps able to detect movement with respect to hypothetical ether.

The entire article includes only original research conducted by its authors.

**Key words:** Lorentz-Fitzgerald contraction, photon pressure, light clock, time dilation

## 1. Introduction

The content of this article is a continuation of the research on the light clock, therefore it is recommended to read the article [44] in advance, which discusses the light clock and time dilation, used in this article in the photon pressure model.

The Lorentz-Fitzgerald contraction [25] was proposed to explain the null result of the Michelson-Morley experiment [32].

The considerations in this article are made in the framework of the Special Theories of Ether (STE) [45]-[51].

There are infinitely many different Special Theories of Ether [48]-[49]. In STE, there is a universal frame of reference (ether, preferred frame of reference) in which light propagates. With reference to the universal frame of reference, the velocities of inertial systems can be measured. In STE the time elapse depends on the speed of moving in relation to universal frame of reference. This phenomenon is called time dilation. For example, in STE without transverse contraction, motionless clocks in relation to ether are measuring time the fastest. Clocks moving in relation to ether are measuring time slower. The faster clocks move, the slower they measure time. Time dilation is a natural property of a light clock and has been thoroughly studied in the article [44].

In each STE all observers evaluate the relative time elapse of any two processes in the same way, since in STE the simultaneity of events is absolute.

Each body emits photons, the amount and energy of which depends on the body temperature. The emitted photons are not homogeneous but have a Planck distribution. This phenomenon is also described by the laws of Wien and Stefan-Boltzmann. Bodies in a state of thermal equilibrium irradiate each other with photons with the same distribution. In this article we assume that bodies emit photons in their entire volume, not just on the surface. Photons emitted inside the body are absorbed by atoms and re-emitted, i.e. they move from atom to atom. Some of the photons go outside the body and are registered as electromagnetic radiation from the black body (thermal radiation).

## 2. Model of longitudinal contraction (Lorentz-Fitzgerald) and transverse contraction

This chapter proposes a model explaining the Lorentz-Fitzgerald contraction mechanism of bodies moving in relation to the universal frame of reference, in which light propagates. According to the explanation given, the contraction of bodies in motion is caused by the influence of this motion on the state of equilibrium of atoms in a solid body. We assume at least two opposite interactions affect atoms. The average distance of atoms results from the state of equilibrium between these interactions. One of these interactions is related to the light clock (photon pressure).

Figure 1 shows two atoms of a solid body that are in thermal equilibrium. The considered atoms are at average distance  $D$  and move in relation to the ether at velocity  $v$ . The distances between atoms are  $D$  for the observer from the ether and  $D'$  for the observer from the inertial system where the body is located. The angle between the direction determined by atoms and the direction of velocity  $v$  has a value  $\alpha$  (this is the angle measured in the ether system).

In the Special Theories of Ether between the values of  $D$  and  $D'$  there is a relationship derived in article [44]

$$D = \frac{D' \psi(v) \sqrt{1 - (v/c)^2}}{\sqrt{1 - (v/c)^2 \sin^2 \alpha}} \quad (1)$$

Each atom is under the influence of two interactions. One of them transmits momentum  $\Delta p_f$  to atoms and causes the atoms to repel each other. The other one acts on the atoms with force  $F_m$  and causes the atoms to attract each other. Figure 2 shows examples of the values of these interactions for a fixed value of speed  $v$ . The only stable distance – between the atoms is the  $D_s$  distance. If this distance increases slightly, then the attraction force is greater than the repulsive force. If this distance decreases, then the repulsive force is greater than the attraction force. If the distance of atoms increases above the distance  $D_n$ , then the intermolecular bond is permanently broken because the repulsive force becomes greater than the attraction force.

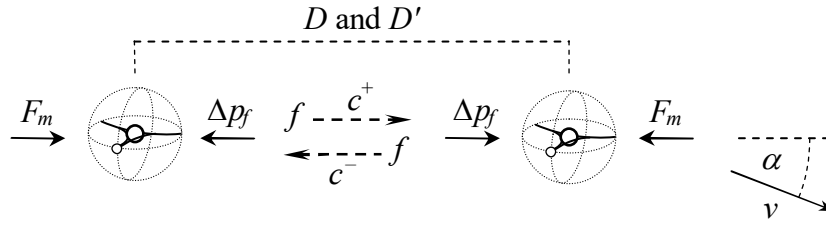


Fig. 1. There are two opposite interactions on atoms.  
 The average distance of atoms is the result of balance state between these interactions.

Now we will describe the repulsive effect. Atoms shown in Figure 1 emit and absorb photons with frequencies  $f$  that propagate in the ether. In the state of thermal equilibrium between atoms,  $n$  photons pass back and forth at time  $\Delta t(v)$ . So  $n$  is the number of photons that are in the space between the two atoms. For simplicity it is assumed that these photons reflect elastically from atoms. Atoms and photons that pass between them form a light clock. Each time when a photon reflects from an atom it transmits to it a momentum of the following value

$$\Delta p_f = 2 \frac{h}{\lambda} = 2 \frac{f h}{c} \quad (2)$$

where:  $\lambda$  is the wavelength attributed to the photon,  $f$  is the frequency of this wave,  $h$  is the Planck constant, while  $c$  is the speed of light in vacuum (average on the way back and forth).

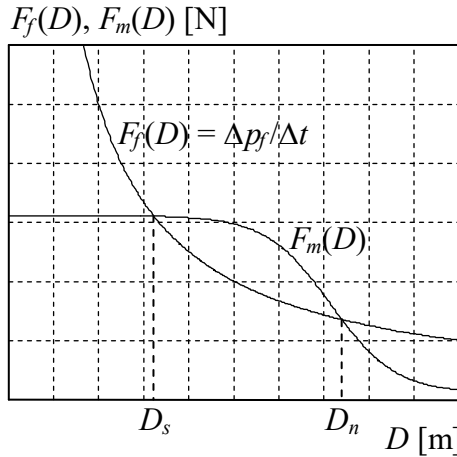


Fig. 2. Example of the values of interactions between atoms of solid body for a fixed value of speed  $v$ .  
 $F_f(D)$  is repulsive force,  $F_m(D)$  is an attraction force.

That is, photons passing between atoms push them and create internal pressure (we will call them the photons pressure).

Force is the momentum change in time. Therefore, the average force with which  $n$  photons act on one atom is (it is an action from one fixed side)

$$F_f = \frac{n \Delta p_f}{\Delta t(v)} = 2 \frac{n f h}{c \Delta t(v)} \quad (3)$$

It is assumed that the number of  $n$  photons does not depend on the distance of atoms  $D$ . The time  $\Delta t(v)$  that a photon needs to travel between atoms, back and forth is described by the two equations derived in the article [44] in the form

$$t = \frac{2D}{c} \frac{\sqrt{1 - (v/c)^2 \sin^2 \alpha}}{1 - (v/c)^2} \quad (4)$$

and in an equivalent form

$$t = \frac{2D'}{c} \frac{\psi(v)}{\sqrt{1-(v/c)^2}} \quad (5)$$

After substituting these equations to (3) the following is obtained

$$F_f = \frac{nfh}{D} \frac{1-(v/c)^2}{\sqrt{1-(v/c)^2} \sin^2 \alpha} \quad (6)$$

and in an equivalent form

$$F_f = \frac{nfh}{D'} \frac{\sqrt{1-(v/c)^2}}{\psi(v)} \quad (7)$$

The force  $F_f$  is a function of the speed  $v$  of the body with respect to the ether and the distance  $D$  or  $D'$  between the atoms, so we will sometimes denote it with the symbols  $F_f(v)$  and sometimes with the symbols  $F_f(D)$ . The repulsive force of atoms, written in the form (6), is inversely proportional to their distance  $D$  (measured in the ether reference frame), as shown in Figure 2. This force written in the form (7) is inversely proportional to their distance  $D'$  (measured in the body reference frame). This is due to the properties of light clock, which slows down the timing when the length of its arm increases [44]. Therefore, in Figure 2 the force  $F_f(D)$  is presented in the form of a hyperbola.

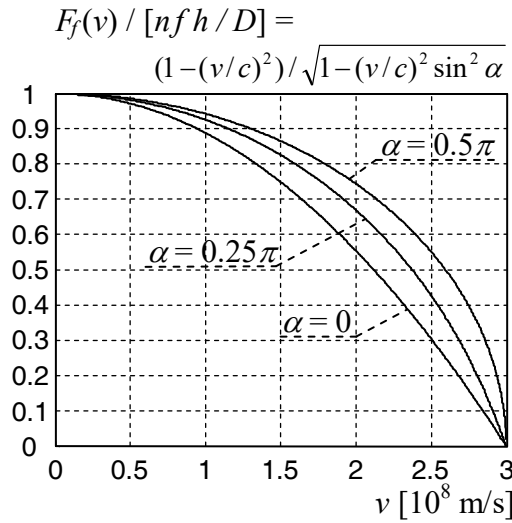


Fig. 3. Values of the repulsive force  $F_f(v)$  as a function of speed  $v$  for the angles  $\alpha = 0, 0.25\pi, 0.5\pi$  and fixed value of distance  $D$ .

Figure 3 shows the repulsive force  $F_f(v)$  as a function of speed  $v$ , resulting from formula (6). As the body increases its speed  $v$  with respect to ether, then the value of this force decreases. This means that the photon pressure that repels atoms is decreasing. Therefore, when the body moves with respect to the ether, the function  $F_f(D)$  shown in Figure 2 decreases and the equilibrium point  $D_s$  shifts to the left. The force  $F_f(v)$ , shown in Figure 3, decreases more when the arm formed by the atoms is inclined at a smaller angle  $\alpha$  to the velocity  $v$ . Therefore, bodies shorten more strongly in directions parallel to velocity  $v$ , than in directions perpendicular to velocity  $v$ .

Now we will describe the attraction effect. The atoms shown in Figure 1 are compressed by the intermolecular force  $F_m$ . In this paper we do not discuss the nature of this interaction. We want to select the values of force  $F_m$  so that the atoms remain in equilibrium when they are at a distance  $D_s$ .

Atoms will be in equilibrium at a distance of  $D_s$  if the equilibrium of attraction and repulsive forces occurs.

$$F_m(v, D_s, \alpha) = F_f(v, D_s, \alpha) \quad (8)$$

After substitution of the equation (6) the following is obtained

$$F_m(v, D_s, \alpha) = \frac{n f h}{D_s} \frac{1 - (v/c)^2}{\sqrt{1 - (v/c)^2 \sin^2 \alpha}} \quad (9)$$

Based on the relation (7), the equation for the attraction force  $F_m$  can be written in another form

$$F_m(v, D'_s) = \frac{n f h}{D'_s} \frac{\sqrt{1 - (v/c)^2}}{\psi(v)} \quad (10)$$

Equations (9) and (10) represent the value of intermolecular bond force only at the stable point  $D_s$  or  $D'_s$ , shown in Figure 2. For the remaining values  $D$ , the function  $F_m$  can have different values. This means that in general we can save the following dependencies on the function  $F_m$

$$\begin{cases} F_m(v, D, \alpha) = \frac{n f h}{D_s} \frac{1 - (v/c)^2}{\sqrt{1 - (v/c)^2 \sin^2 \alpha}} g_m(v, D, \alpha) \\ g_m(v, D_s, \alpha) = 1 \end{cases} \quad (11)$$

or

$$\begin{cases} F_m(v, D') = \frac{n f h}{D'_s} \frac{\sqrt{1 - (v/c)^2}}{\psi(v)} g_m(v, D') \\ g_m(v, D'_s) = 1 \end{cases} \quad (12)$$

The function  $g_m$  appearing in equations (11) and (12) is positive and continuous function that has to fulfill the conditions specified in (11) and (12). For a fixed value of speed  $v$  and angle  $\alpha$ , the values of this function depend only on the distance  $D$  or  $D'$  of atoms. It was the function  $g_m$  that decided about the exemplary shape of the force diagram  $F_m$  in Figure 2.

For such a forces  $F_f(v)$  and appropriate  $F_m$ , the dimensions of body will change if its speed in relation to the ether changes, as predicted by STE.

### 3. Another use of the photon pressure model

The model presented in this article can be used to interpret the known physical properties of bodies. For example, Figure 4 shows examples of differences between a hard body and a soft body. The harder is the body for which deformation of the distance  $D_s$  causes greater differences in values of forces  $F_m(D)$  and  $F_f(D)$  (i.e. for which the inclination of function  $F_f(D)$  is greater in point  $D_s$ ).

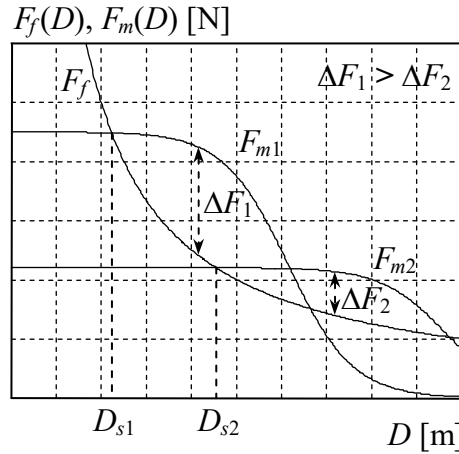


Fig. 4. Example of hard ( $F_{m1}$ ) and soft body ( $F_{m2}$ ).

Figure 5 shows examples of differences between a fragile body and a plastic body. The fragile body is the one for which smaller changes  $\Delta D$  cause permanent breaking of intermolecular bond, i.e. reaching the point  $D_n$ .

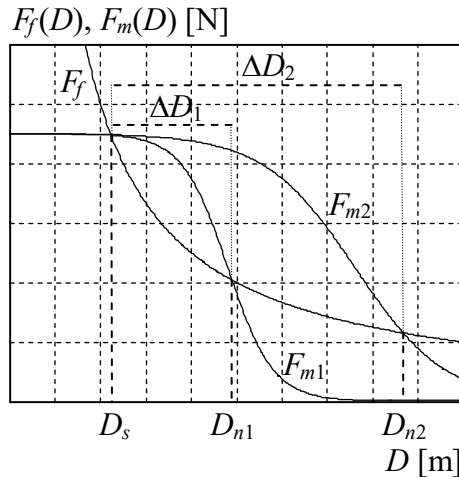


Fig. 5. Example of friable ( $F_{m1}$ ) and plastic body ( $F_{m2}$ ).

If the body temperature changes, the frequency  $f$  of photons causing the repulsive force changes (then it will be shown that their number  $n$  changes as well).

Figure 6 shows examples of differences between a cooler body and a warmer body. In a warmer body, the frequency of photons  $f$  is higher and the number  $n$  of photons is greater. This makes the repulsion force  $F_f(D)$  in the equations (6)-(7) is greater and the diagram of this repulsion force rises upwards. If the diagram  $F_f(D)$  is raised so that it no longer has any shared points with the diagram  $F_m$ , the body becomes liquid or gaseous. If the force diagrams  $F_f(D)$  and  $F_m(D)$  do not intersect, then there is no distance  $D_s$  of atoms for which the forces remain in equilibrium and form a rigid bond. Whether the body is liquid or gaseous depends on the external pressure and thus indirectly on the force of gravity. This is consistent with phase diagrams of equilibrium states.

The presented model also explains the mechanism of thermal expansion. For a warmer body, the graph of  $F_f(D)$  function moves upwards (Figures 6). Then the stability point  $D_s$  moves to the right, i.e. the distance between atoms and the dimensions of solid body increases. In the presented model, thermal expansion and Lorentz-Fitzgerald contraction are based on the same mechanism, i.e. change of photons pressure inside the solid body. In case of thermal expansion, the pressure changes due to a change in temperature, because then the number of photons and their momentum changes. In case of Lorentz-Fitzgerald contraction, the pressure changes due to a change in the

speed of body relative to the universal frame of reference, because then the frequency changes with which photons transmit the momentum to atoms of the solid body (frequency measured in the ether system).

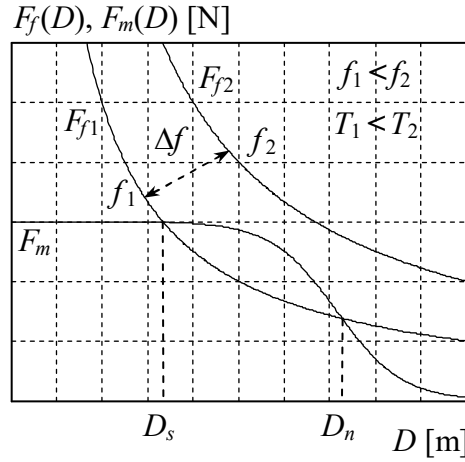


Fig. 6. Example of a body in solid state ( $F_{f1}$ ) and a body in liquid or gaseous state ( $F_{f2}$ ).

#### 4. Estimation of the number of photons of thermal radiation

In the presented model atoms emit and absorb photons (electromagnetic radiation). It is expected that part of photons oscillating between atoms escapes from the body area. Such prediction is in accordance with the fact that each body emits electromagnetic thermal radiation called the radiation of a black body. The distribution of black body radiation was described by Max Planck, who postulated that it originated from the vibrations of harmonic oscillators that emit and absorb this radiation. Therefore, the model presented here is consistent with the analysis based on which Max Planck derived an equation for the distribution of black body radiation.

We will now calculate the density and intensity of the photons of thermal radiation near the surface of the body emitting this radiation.

According to Wien's law, as body temperature increases, the main wavelength of thermal radiation emitted by the body decreases proportionally. Wien's law enables to calculate the frequency of photons for which the distribution of all photons in the black body radiation has a maximum value (mode in statistics). That is

$$f_{\text{mode}} = \frac{c}{\lambda_{\text{mode}}} = \frac{c}{b/T} = \frac{c}{b} T \quad [1/s] \quad (13)$$

The photon energy has a value of

$$E_f = f h \quad [J] \quad (14)$$

Symbol  $\rho_T [1/m^3]$  designates the photon density that is the number of photons of thermal radiation that are in a volume of  $1 \text{ m}^3$  (near the body surface and these are photons moving away from the body) at temperature  $T$ . These photons have different frequencies described in the Planck distribution. For the purpose of this paper, for simplicity it is assumed that the frequency of all photons has a value (13). Then the energy of all photons in a volume of  $1 \text{ m}^3$  is obtained after placing (13) to (14) and multiplying by  $\rho_T$ . Then the following is obtained

$$E_{m^3}(T) \approx \rho_T \frac{c}{b} T h \quad [J/m^3] \quad (15)$$

The energy of photons of thermal radiation, which escapes to the outside through its unit surface per second, is described by the law of Stefan-Boltzmann radiation in the form of

$$E_{m^2/s}(T) = \sigma T^4 \quad [\text{J}/(\text{s m}^2)] \quad (16)$$

Since photons move at an average speed of  $c$ , thus in the unit volume there are photons with the energy that is obtained by dividing (16) by  $c$

$$E_{m^3}(T) = \frac{E_{m^2/s}(T)}{c} = \frac{\sigma T^4}{c} \quad [\text{J}/\text{m}^3] \quad (17)$$

After comparing the equations (15) and (17), the following is obtained

$$\rho_T \frac{c}{b} T h \approx \frac{\sigma T^4}{c} \quad (18)$$

On this basis, an estimation of the photon density moving away from the body near the surface of a black body is obtained (the number of photons in the unit volume)

$$\rho_T = N_S T^3 \approx \frac{\sigma b}{h c^2} T^3 \quad [1/\text{m}^3] \quad (19)$$

For constant values

$$\begin{aligned} \sigma &= 5,670400 \cdot 10^{-8} \quad [\text{J}/(\text{s m}^2 \text{K}^4)] \\ b &= 2,897768 \cdot 10^{-3} \quad [\text{mK}] \\ h &= 6,6260693 \cdot 10^{-34} \quad [\text{Js}] \\ c &= 2,99792458 \cdot 10^8 \quad [\text{m/s}] \end{aligned} \quad (20)$$

we can calculate the value of the constant  $N_S$ . Equation (19) takes the form of

$$\rho_T = N_S T^3 \approx 2\,759\,179 \cdot T^3 \quad [1/\text{m}^3] \quad (21)$$

For example, at room temperature (293 K) near the surface of the body, the density of thermal radiation photons is

$$\rho_{T=293K} \approx 6,9404 \cdot 10^{13} \quad [1/\text{m}^3] \quad (22)$$

The intensity of thermal radiation photons, i.e. the number of photons passing per unit time through  $1 \text{ m}^2$  of a black body surface, is obtained by multiplying the formula (19) by the speed of light  $c$

$$I_T = c N_S T^3 \approx \frac{\sigma b}{h c} T^3 = 8,2718 \cdot 10^{14} \cdot T^3 \quad [1/(\text{s m}^2)] \quad (23)$$

$$I_{T=1K} \approx 8,2718 \cdot 10^{14} \quad [1/(\text{s m}^2)] \quad (24)$$

$$I_{T=293K} \approx 2,0807 \cdot 10^{22} \quad [1/(\text{s m}^2)] \quad (25)$$

## 5. Estimation of the photon pressure value

We will calculate the photon pressure inside bodies, assuming that the density of photons inside the bodies is the same as the density of the photons of thermal radiation, i.e. outside the bodies. The photon density (21) only takes into account photons moving away from the body in one



of the six directions. Therefore, the number of photons moving back and forth is twice as high. Therefore, the number of  $n$  photons creating the force (6) in a volume of  $1 \text{ m}^3$  is  $2\rho_T$ .

According to the formula (6) the photon pressure is ( $S = D^2$  is the surface occupied by the atom)

$$p_T = \frac{F_f}{S} = \frac{n}{SD} f h \frac{1-(v/c)^2}{\sqrt{1-(v/c)^2 \sin^2 \alpha}} = 2\rho_T f h \frac{1-(v/c)^2}{\sqrt{1-(v/c)^2 \sin^2 \alpha}} \quad (26)$$

After taking into account the equation (13) we obtain

$$p_T \approx 2\rho_T f_{\text{mode}} h \frac{1-(v/c)^2}{\sqrt{1-(v/c)^2 \sin^2 \alpha}} = 2\rho_T \frac{hc}{b} T \frac{1-(v/c)^2}{\sqrt{1-(v/c)^2 \sin^2 \alpha}} \quad (27)$$

On the basis of (22) we obtain

$$p_{T=293K} \approx 2\rho_{T=293K} \frac{hc}{b} T \frac{1-(v/c)^2}{\sqrt{1-(v/c)^2 \sin^2 \alpha}} \quad (28)$$

$$p_{T=293K} \approx 2,78802 \cdot 10^{-6} \frac{1-(v/c)^2}{\sqrt{1-(v/c)^2 \sin^2 \alpha}} \quad [\text{Pa}] \quad (29)$$

Graphs of the fraction occurring in formula (29) are shown in Figure 3. The photon pressure does not depend on the type of body, but depends on its temperature  $T$ , the speed  $v$  of moving with respect to the ether and the angle  $\alpha$  of the inclination of the direction of this pressure with respect to the velocity  $v$ .

The obtained value of the photon pressure (29) is very small in relation to the pressure necessary to crush the solid, which, for example, for steel is 200-1000 MPa, depending on the type of steel. Therefore, in order for the photon pressure model to fit the real data, it must be supplemented with an additional repulsive force of atoms. This additional repulsive force may have a value depending on the type of body. Its value is much greater than the photon pressure force. Its value does not have to depend on the movement of the body relative to the ether.

When the body is crushed, it is counteracted by photon pressure and this additional, much bigger, repulsive force. The movement of the body in relation to the ether affects the photon pressure, which is one of the forces that repels atoms, therefore the moving body deforms (Lorentz-Fitzgerald contraction).

It is also possible that the photons of photon pressure are something like a catalyst that activates the ability of atoms to repel, i.e. the photon pressure contributes to this additional repulsive force. In such a model, as the photon pressure decreases, then this additional force also decreases.

## 6. Proposals for experiments that can detect motion against the ether

If, in fact, change in body dimensions in motion relative to the ether is due to stresses in solid bodies, it is very likely that different substances will contract slightly in a different way. It may be that each substance has its own individual function  $\psi(v)$ . If both arms of the interferometer in the Michelson-Morley experiment are made of the same material, they will shorten proportionally as it described in the Special Theories of Ether [44], [48], [49]. This makes the experiment unable to detect motion relative to the ether. But if the arms are made of different substances, then perhaps the Michelson-Morley's experiment will be able to detect motion relative to the hypothetical universal frame of reference in which light propagates.

Therefore, Michelson-Morley's experiment should be carried out, in which each arm is made of a different material. It is necessary to investigate which materials give the greatest effect [54].

According to the Lorentz transformation and some STE transformations, the dimensions of bodies accelerated to speed  $c$  will be zero. It is to be expected that in reality this will not be the case. Each theory acts only to some limited extent. Theoretical predictions for inertial systems unavailable for experiments are the outcome of extrapolation results obtained in experiments in inertial systems available for experiment. In a body moving at high speeds relative to the ether, the photon pressure is very small. In such a body, the second repulsive force, which was mentioned in the previous chapter, becomes dominant. Further increasing the speed of the body will not result in a greater Lorentz-Fitzgerald contraction. Sufficiently densely packed atoms will not come close together even if the photons pressure does not act on them. However, in modern physics it is common that the results of extrapolation are treated literally and, for example, it is claimed that the Lorentz transformation shows that in the real world bodies accelerated to speed  $c$  will shorten to zero dimensions. We consider such a claim to be incorrect.

According to equations (15) and (21), the energy and number of photons forming photons pressure decreases to zero when the body temperature drops to absolute zero. This means that in bodies cooled to low temperatures, the photon pressure stops functioning. However, it is known that the dimensions of such bodies do not decrease to zero. It follows that at low temperatures, when the atoms are already close enough, another mechanism is revealed which does not allow the atoms to come any closer. This is the same mechanism as that referred to in the previous paragraph, that is, the second repulsive force. This conclusion from the presented model can be very useful in planning an experiment that would enable to detect our motion in relation to the hypothetical ether [54]. That is, the arms of interferometer should be cooled down to low temperatures (Figure 7). Perhaps the temperature of liquid nitrogen will be sufficient. At low temperatures, the interferometer arms should not undergo the Lorentz-Fitzgerald contractions, which compensated for the differences in time dilatation of the classical light clock, referred to in [44]. If there is indeed ether in which light propagates, such an experiment with the interferometer (figure 7) should give a positive result. Perhaps the better effect will be obtained when one arm of the interferometer is cooled to low temperatures and the other is not cooled to freely undergo contractions.

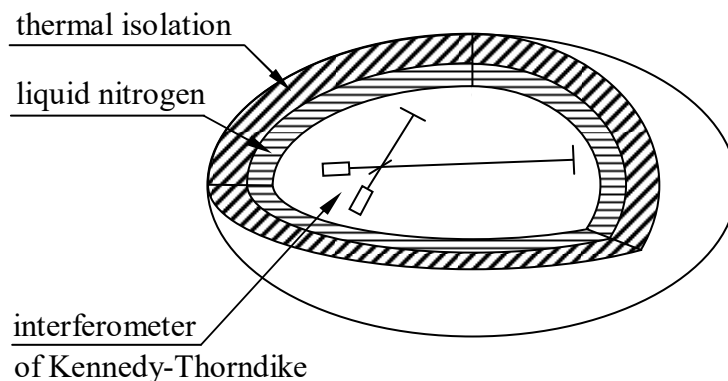


Fig. 7. A proposal for an experiment whose aim is to measure our velocity relative to the ether. If the interferometer is cooled to low temperatures, then there is no photon pressure in its arms, which depends on the speed relative to the ether. The cooled arms will not be subject to Lorentz-Fitzgerald contraction, therefore a cooled interferometer may show a positive result of measurement of our velocity relative to the ether.

## 7. Final conclusions

The paper proposes a photon pressure model to explain the phenomenon of longitudinal contraction (Lorentz-Fitzgerald contraction) and transverse contraction (transverse contraction may occur in a Special Theory of Ether).

In the presented model, Lorentz-Fitzgerald contraction is a physical property of solid body, not a property of space-time, as it is today interpreted within the Special Theory of Relativity. It is the bodies that contract, not the space.

Contractions of bodies in motion are caused by a change in the electromagnetic interaction between atoms of a solid body (the photon pressure). In the presented model the balance of position between atoms is affected by the speed at which the body moves in relation to the ether. Therefore, the dimensions of solids depend on their velocity and are closely related to time dilation. The model presented here combines the properties of relativity theory with universal frame of reference (STE) and physics of a solid body.

Presented analysis shows that one of the ways to measure the movement in relation to the ether may be to conduct Michelson-Morley experiment using an interferometer, the arms of which are made of two different substances, or an interferometer which arms (or one arm) are cooled to low temperatures (perhaps liquid nitrogen temperature will be appropriate) [54]. The frozen arms of the interferometer are almost devoid of thermal photons creating photon pressure, therefore they will not be subject to Lorentz-Fitzgerald contraction.

The article [44] explains what time is in physical theories. It's about time that physical theories use, not what time is in the real world. The article [44] shows that because in the Special Theory of Relativity and Special Theory of Ether kinematics a light signal is used to synchronize the clocks, a light clock is automatically introduced in these theories as a time standard. In other words, STR and STE are theories in which time is measured by the light clock. These are theories that describe the aspects of using such clocks. Therefore, in these theories there is a time dilation phenomenon which is a natural property of the light clock. This article [44] also presents a proof that the mathematics of kinematics of the Special Theory of Relativity does not indicate that the speed of light in a vacuum is the maximum speed in nature. The notion that the speed of light in a vacuum is an impassable speed results from the over interpretation of the mathematics on which the kinematics of STR is based.

Predictions of the Special Theory of Ether and Special Theory of Relativity are very similar. However, there are differences which may allow for experimental falsification of these theories in the future. In STR, all inertial systems are equivalent, i.e. there is no universal frame of reference. For this reason, according to STR, it is not possible to measure absolute speed using local measurement. This means that for each observer the space is completely isotropic (the same properties in each direction). However, according to STE, the observer can use local measurements to determine the direction of its movement in relation to ether. This means that for observers moving in relation to ether, the space is not isotropic (has different properties in different directions). Confirmation of this by experiment is not easy due to the low speed of the Solar System relative to ether. For a small speed, the effects of non-isotropic space are very slight. This is the most important difference between the Special Theory of Ether and Special Theory of Relativity [47]. The proposal of a mechanical measuring system for falsification of the Special Theory of Ether and the Special Theory of Relativity is presented in the article [50].

In the Special Theory of Ether, the cosmic microwave background can be electromagnetic thermal radiation of ether (black body radiation). Such a hypothesis was proposed for the first time in article [45]. This concept is consistent with the fact that the microwave background radiation has a Planck distribution, i.e. a distribution of thermal blackbody radiation [43]. Moreover, this radiation is very uniform, just like the hypothetical ether that would be the source of this radiation. If the microwave background radiation is the thermal radiation of ether, it is produced at all times,

throughout the space, including in our immediate vicinity. Therefore, in this radiation, the distribution of galaxies is very poorly visible. So it did not arise in the early universe as is commonly believed today. If the universe is homogeneous and filled with homogeneous ether, this filling it cosmic microwave background should be homogeneous in the ether system. Numerous measurements have shown that in our frame of reference the microwave background radiation is very homogeneous, but has the dipole anisotropy [43]. The dipolar anisotropy of this radiation as measured in our reference frame is caused by the Doppler Effect that results from the movement of the Solar System relative to ether.

In this way, on the basis of Special Theory of Ether, it is possible in a natural way to explain the dipole anisotropy of cosmic microwave background. This enables to determine the velocity at which the Solar System moves in relation to universal frame of reference, i.e.  $369.3 \text{ km/s} = 0.0012 c$ . This was presents in works [46] and [48].

A huge breakthrough in physics would occur if our velocity relative to the ether, measured by a frozen interferometer [54], matched the velocity resulting from the dipole anisotropy of the microwave background radiation [48]. It would require extremely bad will to ignore such evidence of the existence of the luminiferous ether.

The work [48] shows that there is infinite number of theories with ether that correctly explain zero result of the Michelson-Morley's and Kennedy-Thorndike's experiments. Even the theory with ether is possible, in which time is absolute.

In the article [49] it was shown that Lorentz transformations should be assigned a different interpretation than that adopted in the Special Theory of Relativity. It has been shown that the commonly adopted interpretation of STR mathematics is incorrect as it is a theory with desynchronized clocks that cause the unreal time to elapse measurements in inertial systems moving in relation to the observer. Incorrectly calibrated clocks are the cause of numerous paradoxes of STR.

The problem that mathematical formulas can be assigned different physical interpretations is not just about the Lorentz transformation. For example, in article [53], it was shown that gravitational waves should be interpreted as an ordinary modulation of gravitational field intensities. The modulation resulting from the General Theory of Relativity is a property of a system of rotating bodies, not a property of the gravitational interaction, as is commonly believed today.

For each kinematics it is possible to derive many dynamics. The examples for Special Theory of Relativity were derived in the article [52]. One of the new dynamics for STR was shown in [39].

It should be mentioned that there are publications which show that the Michelson-Morley experiment gives a positive result, although it is much weaker than originally predicted from the kinematics of Galileo Galilei with a luminiferous ether. If this were the case, it would mean that even the average velocity of light flowing in a vacuum along a closed trajectory is not constant. These results, however, have not been sufficiently confirmed, and the articles that present them are ignored by official physics [31], [33]. These studies are a significant argument in favor of the Special Theory of Ether, which can be very easily modified to be consistent with the non-zero result of the Michelson-Morley experiment.

There are numerous articles on the subject of relativistic mechanics with significant theoretical results. The article [21] presents the original definition of acceleration in Special Theory of Relativity. The articles [2], [18], [34] and [35] relate to important insights on time dilation in relativity, while articles [4], [36], [37] and [59] presents alternative ideas for relativity. There are also published papers showing the paradoxes of the Special Theory of Relativity concerning rotating frames of reference [12]. Numerous works discuss the zero result of the Michelson-Morley experiment, from which the Lorentz-Fitzgerald contraction results [26], [46]. The article [27] discusses the problem that Newtonian mechanics has with the description of certain physical phenomena. There are publications in which tachyons are analyzed [5], [6] and papers, in which

various relativistic aspects of gravity are analyzed [9], [10], [13], [16], [29]. In article [28] there is a discussion of the relativistic Doppler effect and the gravitational effect of the light. Articles [14], [15] present research on the Special Theory of Relativity on De-Broglie wavelength of a particle and on electric permittivity and magnetic permeability of electromagnetic wave. Research is being conducted on the practical aspects of relativistics. The article [1] examines cosmological models that include some considerations about gravitational energy density and pressure. In paper [30] obtained analytically the bound state solution for the relativistic modified Klein-Gordon equation. Using the method of retarded potentials, approximate formulae are obtained that describe the electromagnetic field outside the relativistic uniform system [7]. A original derivation of the Lorentz transformation is developed in papers [19], [20], [58]. In article [56] in the course of a research study on Lorentz transformation the fundamentals of the relativistic concepts of space and time were studied. The work [11] discuss the possibility to classify relativity in accordance with the classification of second order partial differential equations, while the articles [17], [55] examines various aspects of the Special Theory of Relativity. The article [38] discusses the invariance of the components of the electromagnetic field vectors with respect to the Lorentz transformation. Research is also being conducted on various aspects of ether [57]. The article [41] presents an analysis of the speed of light in materials in the model of the Special Theory of Relativity. Future research on the Special Theory of Ether should also concern issues related to electrodynamics, i.e. should be able to model issues such as those discussed in articles [3], [8], [22], [23], [24], [42], [40].

## Bibliography

- [1] Altayeva G. S., Razina O. V., Tsyba P.Yu., *Cosmography in the multifield cosmological model*, Bulletin of the Karaganda University. Physics series, No 2(106), 37-48, 2022.
- [2] Arneth Borros, *Hafele and Keating revisited: A novel interpretation of the results of the Hafele-Keating experiment*, Physics Essays, Volume 37, Number 2, 150-152, 2024.
- [3] Bartman Jacek Bartman, Kwater Tadeusz, Kwiatkowski Bogdan, Mazur Damian, *Analysis of the coherence of parameters of electricity receivers in the context of non-invasive device identification*, Przegląd Elektrotechniczny, 98 (11), 265-268, 2022.
- [4] Borros Arneth, *Hafele and Keating revisited: A novel interpretation of the results of the Hafele-Keating experiment*, Physics Essays, Volume 37, Number 2, 150-152, 2024.
- [5] Brown Jesse Timron, Demiroglu Necati, *Forms of Time: Fields and Particles*, Applied Science and Innovative Research, Vol. 3, No. 3, 106-109, 2019.
- [6] Demiroglu Necati, Yalcin Orhan, Ozum Songul, *A Simple Methodology for Quantum Mechanical Theory of Tardyons and Tachyons*, International Journal of Scientific and Technological Research, Vol. 1, No. 6, 31-37, 2015.
- [7] Fedosin Sergey G., *The Electromagnetic Field outside the Steadily Rotating Relativistic Uniform System*, Jordan Journal of Physics, 14 (5), 379-408, 2021.
- [8] Gołbiowski Marek, Gołbiowski Lesław, Smolen Andrzej, Mazur Damian, *Direct Consideration of Eddy Current Losses in Laminated Magnetic Cores in Finite Element Method (FEM) Calculations Using the Laplace Transform*, Energies, 13 (5), 1174, 1-16, 2020.
- [9] Heald Graeme, *Are Black Holes Actually Quark Stars?*, Physics Essays, Volume 31 (4), 449-461, 2018.
- [10] Heald Graeme, *Relativistic jets and event horizons for a kinetic spiral solution*, Physics Essays, Volume 31 (4), 387-396, 2018.
- [11] Ho Vu B., *Classification of Relativity*, Journal of Modern Physics, 11, 535-564, 2020.

- [12] Javanshiry Mohammad, *The Mechanical Behavior of a Multispring System Revealing Absurdity in the Relativistic Force Transformation*, International Journal of Mathematics and Mathematical Sciences, Volume 2021, ID 2706705, 1-8, 2021.
- [13] Karn Santosh Kumar, Demiroglu Necati, *A Study of the Behavior of Mass of a Particle (Matter) under Gravitational Interaction with Another Particle in Relativistic Motion and the Mathematical Model*, Open Access Library Journal, Volume 10, e9741, 2023.
- [14] Khadka Chandra Bahadur, *Redefinition of De-Broglie Wavelength Associated with Material Particle*, Indian Journal of Advanced Physics (IJAP), Volume 2, Issue 1, 14-16, 2022.
- [15] Khadka Chandra Bahadur, *Relative Nature of Electric Permittivity and Magnetic Permeability of Electromagnetic Wave*, Indian Journal of Advanced Physics (IJAP), Volume 2, Issue 1, 17-25, 2022.
- [16] Khadka Chandra Bahadur, *Determination of Variation of Mass with Gravity*, Journal of Nepal Physical Society, Vol. 9, No. 1, 2023.
- [17] Khadka Chandra Bahadur, *Derivation of the Lorentz transformation for determination of space contraction*, St. Petersburg State Polytechnical University Journal. Physics and Mathematics, Vol. 16. No. 3, 2023.
- [18] Khadka Chandra Bahadur, *Transformation of Special Relativity into Differential Equation by Means of Power Series Method*, International Journal of Basic Sciences and Applied Computing (IJBSAC), Vol. 10 (1), 10-15, 2023, ISSN: 2394-367X.
- [19] Khadka Chandra Bahadur, *Formulation of the Lorentz Transformation Equations in the Three Dimensions of Space*, St. Petersburg State Polytechnical University Journal. Physics and Mathematics, Vol. 17. No. 2, 160-173, 2024.
- [20] Khadka Chandra Bahadur, *Geometrical Interpretation of Space Contraction in Two-dimensional Lorentz Transformation*, Bibechana, Vol. 21, No. 2, 103-112, 2024, ISSN: 2091-0762.
- [21] Koczan Grzegorz Marcin, *New definitions of 3D acceleration and inertial mass not violating  $F=MA$  in the Special Relativity*, Results in Physics, Volume 24, 104121, 2021.
- [22] Kühn Steffen, *Experimental investigation of an unusual induction effect and its interpretation as a necessary consequence of Weber electrodynamics*, Journal of Electrical Engineering, 72 (O6), 366-373, 2021.
- [23] Kühn Steffen, *Analysis of a Stochastic Emission Theory Regarding Its Ability to Explain the Effects of Special Relativity*, Journal of Electromagnetic Analysis and Applications, 12, 169-187, 2020.
- [24] Kühn Steffen, *General Analytic Solution of the Telegrapher's Equations and the Resulting Consequences for Electrically Short Transmission Lines*, Journal of Electromagnetic Analysis and Applications, 12, 71-87, 2020.
- [25] Lorentz Hendrik Antoon, *The Michelson-Morley Experiment and the Dimensions of Moving Bodies*, Nature, Volume 106, 793-795, 1921.
- [26] Louiz Akram, *The correct formulas of Michelson-Morley experiment*, Maghrebian Journal of Pure and Applied Science, Volume 6, No 2, 60-64, 2020.
- [27] Louiz Akram, *A thesis about Newtonian mechanics rotations and about differential operators*, Maghrebian Journal of Pure and Applied Science, 6 (1), 26-50, 2020.
- [28] Louiz Akram, *Physics letter: Cosmical observations and experiments against the relativistic explanations of the Doppler effect and the Gravitational effect of the light*, Maghrebian Journal of Pure and Applied Science, 8 (2), 106-110, 2022.

- [29] Łukaszyk Szymon, *Black Hole Horizons as Patternless Binary Messages and Markers of Dimensionality (Chapter 15 in book: Future Relativity, Gravitation, Cosmology)*, Nova Science Publishers, 2023, ISBN 979-8-88697-455-3.
- [30] Maireche Abdelmajid, *The Relativistic and Nonrelativistic Solutions for the Modified Unequal Mixture of Scalar and Time-Like Vector Cornell Potentials in the Symmetries of Noncommutative Quantum Mechanics*, Jordan Journal of Physics, 14 (1), 59-70, 2021.
- [31] Maurice Allais, *The Experiments of Dayton C. Miller (1925-1926) And the Theory of Relativity*, 21st century - Science & Technology, Spring, 26-32, 1998.
- [32] Michelson Albert A., Morley Edward W., *On the relative motion of the earth and the luminiferous ether*, American Journal of Science, 34, 333-345, 1887.
- [33] Miller Dayton C., *The Ether-Drift Experiment and the Determination of the Absolute Motion of the Earth*, Reviews of Modern Physics, Vol. 5, 203-242, 1933.
- [34] Nawrot Witold, *The Hafele and Keating Paradox*, Physics Essays, 17 (4), 518-520, 2004.
- [35] Nawrot Witold, *The Hafele-Keating paradox - Serious problems of the special theory of relativity?*, Physics Essays, 27 (4), 598-600, 2014.
- [36] Nawrot Witold, *Alternative Idea of Relativity*, International Journal of Theoretical and Mathematical Physics 7 (5), 95-112, 2017.
- [37] Nawrot Witold, *Theory of Relativity – Biggest Mistake of the 20th Century?*, International Journal of Theoretical and Mathematical Physics 11 (1), 1-14, 2021.
- [38] Olszewski Stanisław, *Lorentz Transformation Leads to Invariance of the Difference between the Electric and Magnetic Field Intensity*, Journal of Modern Physics, 13, 1212-1215, 2022.
- [39] Osiak Zbigniew, *Energy in Special Relativity*, Theoretical Physics, Isaac Scientific Publishing, Vol. 4, No. 1, 22-25, 2019, ISSN 2519-9625.
- [40] Rozowicz Sebastian, Zawadzki Andrzej, Włodarczyk Maciej, Rozowicz Antoni, Mazur Damian, *Assessment of the Impact of Per Unit Parameters Errors on Wave and Output Parameters in a Transmission Line*, Energies, 14 (21), 1-19, 2021.
- [41] Saito Shinichi, *Special theory of relativity for a graded index fibre*, Frontiers in Physics, Vol. 11, 1225387, 1-13, 2023.
- [42] Shchur Ihor, Mazur Damian, Makarchuk Olekcandr, at others, *Improved Matlab/Simulink model of dual three-phase fractional slot and concentrated winding PM motor for EV applied brushless DC drive*, Archives of Control Sciences, 32 (4), 677-707, 2022.
- [43] Smoot George F., Nobel Lecture: *Cosmic microwave background radiation anisotropies: Their discovery and utilization* (in English), Reviews of Modern Physics, Volume 79, 1349-1379, 2007, <https://journals.aps.org/rmp/abstract/10.1103/RevModPhys.79.1349>.  
Smoot George F., *Anizotropie kosmicznego mikrofalowego promieniowania tła: ich odkrycie i wykorzystanie* (in Polish), Postępy Fizyki, Tom 59, Zeszyt 2, 52-79, 2008, <https://pf.ptf.net.pl/PF-2008-2/docs/PF-2008-2.pdf>  
Смут Джордж Ф., *Анизотропия реликтового излучения: открытие и научное значение* (in Russian), Успехи Физических Наук, Том 177, № 12, 1294-1317, 2007, <https://ufn.ru/ru/articles/2007/12/d>.
- [44] Szostek Roman, *Explanation of what time in kinematics is and dispelling myths allegedly stemming from the Special Theory of Relativity* (in English), Applied Sciences, Vol. 12 (12), 6272, 2022, 01-19, ISSN 2076-3417, <https://www.mdpi.com/2076-3417/12/12/6272/htm>.  
Szostek Roman, *Wyjaśnienie czym jest czas w kinematykach oraz obalenie mitów rzekomo wynikających ze Szczególnej Teorii Względności* (in Polish), viXra 2019, [www.vixra.org/abs/1910.0339](http://www.vixra.org/abs/1910.0339).

- [45] Szostek Karol, Szostek Roman, *The existence of a universal frame of reference, in which it propagates light, is still an unresolved problem of physics* (in English), *Jordan Journal of Physics*, Vol. 15, № 5, 2022, 457-467, ISSN 1994-7607, <https://journals.yu.edu.eg/jpp/JPIIssues/Vol15No5pdf2022/3.html>.  
Szostek Karol, Szostek Roman, *Istnienie uniwersalnego układu odniesienia, w którym propaguje światło, jest ciągle nierozstrzygniętym problemem fizyki* (in Polish), *viXra* 2021, [www.vixra.org/abs/2106.0152](http://www.vixra.org/abs/2106.0152).
- [46] Szostek Karol, Szostek Roman, *The explanation of the Michelson-Morley experiment results by means universal frame of reference* (in English), *Journal of Modern Physics*, Vol. 8, No. 11, 1868-1883, 2017, ISSN 2153-1196, <https://doi.org/10.4236/jmp.2017.811110>.  
Szostek Karol, Szostek Roman, *Wyjaśnienie wyników eksperymentu Michelsona-Morleya przy pomocy teorii z eterem* (in Polish), *viXra* 2017, [www.vixra.org/abs/1704.0302](http://www.vixra.org/abs/1704.0302).  
Szostek Karol, Szostek Roman, *Объяснение результатов эксперимента Майкельсона-Морли при помощи универсальной системы отсчета* (in Russian), *viXra* 2018, [www.vixra.org/abs/1801.0170](http://www.vixra.org/abs/1801.0170).
- [47] Szostek Karol, Szostek Roman, *Kinematics in the Special Theory of Ether* (in English), *Moscow University Physics Bulletin*, Vol. 73, № 4, 413-421, 2018, ISSN 0027-1349, <https://rdcu.be/bSJP3> (open access) or <https://doi.org/10.3103/S0027134918040136>.  
Szostek Karol, Szostek Roman, *Kinematyka w Szczególnej Teorii Eteru* (in Polish), *viXra* 2019, [www.vixra.org/abs/1904.0195](http://www.vixra.org/abs/1904.0195).  
Szostek Karol, Szostek Roman, *Кинематика в Специальной Теории Эфира* (in Russian), *Вестник Московского Университета. Серия 3. Физика и Астрономия*, № 4, 70-79, 2018, ISSN 0579-9392, <http://vmu.phys.msu.ru/abstract/2018/4/18-4-070>.
- [48] Szostek Karol, Szostek Roman, *The derivation of the general form of kinematics with the universal reference system* (in English), *Results in Physics*, Volume 8, 429-437, 2018, ISSN 2211-3797, <https://doi.org/10.1016/j.rinp.2017.12.053>.  
Szostek Karol, Szostek Roman, *Wyprowadzenie ogólnej postaci kinematyki z uniwersalnym układem odniesienia* (in Polish), *viXra* 2017, [www.vixra.org/abs/1704.0104](http://www.vixra.org/abs/1704.0104).  
Szostek Karol, Szostek Roman, *Вывод общего вида кинематики с универсальной системой отсчета* (in Russian), *viXra* 2018, [www.vixra.org/abs/1806.0198](http://www.vixra.org/abs/1806.0198).
- [49] Szostek Roman, *Derivation of all linear transformations that meet the results of Michelson-Morley's experiment and discussion of the relativity basics* (in English), *Moscow University Physics Bulletin*, Vol. 75, № 6, 684-704, 2020, ISSN 0027-1349, [www.vixra.org/abs/1904.0339](http://www.vixra.org/abs/1904.0339) (open access) or <https://doi.org/10.3103/S0027134920060181>.  
Szostek Roman, *Wyprowadzenie wszystkich transformacji liniowych spełniających wyniki eksperymentu Michelsona-Morleya oraz dyskusja o podstawach relatywistyki* (in Polish), *viXra* 2021, [www.vixra.org/abs/2101.0037](http://www.vixra.org/abs/2101.0037).  
Szostek Roman, *Вывод всех линейных преобразований, удовлетворяющих эксперименту Майкельсона-Морли, и обсуждение основ релятивизма* (in Russian), *Вестник Московского Университета, Серия 3. Физика и Астрономия*, № 6, 142-161, 2020, ISSN 0579-9392, <http://vmu.phys.msu.ru/abstract/2020/6/20-6-142>.
- [50] Szostek Karol, Szostek Roman, *The concept of a mechanical system for measuring the one-way speed of light* (in English), *Technical Transactions*, Tom 120, No. 2023/003, e2023003, 1-9, 2023, ISSN 2353-737X, <https://sciendo.com/pl/article/10.37705/TechTrans/e2023003>.  
Szostek Karol, Szostek Roman, *Koncepcja mechanicznego układu do pomiaru jednokierunkowej prędkości światła* (in Polish), *viXra* 2013, <https://vixra.org/abs/2302.0141>.



- [51] Szostek Roman, *The original method of deriving transformations for kinematics with a universal reference system* (in English), *Jurnal Fizik Malaysia* 43 (1), 10244-10263, 2022, ISSN 0128-0333, <https://ifm.org.my/viewpublication/637edcf8ef0a867aa5a22b39>.  
Szostek Roman, *Oryginalna metoda wyprowadzania transformacji dla kinematyk z uniwersalnym układem odniesienia* (in Polish), *viXra* 2017, [www.vixra.org/abs/1710.0103](http://www.vixra.org/abs/1710.0103).
- [52] Szostek Roman, *Derivation method of numerous dynamics in the Special Theory of Relativity* (in English), *Open Physics*, Vol. 17, 153-166, 2019, ISSN 2391-5471, <https://doi.org/10.1515/phys-2019-0016>.  
Szostek Roman, *Metoda wyprowadzania licznych dynamik w Szczególnej Teorii Względności* (in Polish), *viXra* 2017, [www.vixra.org/abs/1712.0387](http://www.vixra.org/abs/1712.0387).  
Szostek Roman, *Метод вывода многочисленных динамик в Специальной Теории Относительности* (in Russian), *viXra* 2018, [www.vixra.org/abs/1801.0169](http://www.vixra.org/abs/1801.0169).
- [53] Szostek Roman, Góralski Paweł, Szostek Kamil, *Gravitational waves in Newton's gravitation and criticism of gravitational waves resulting from the General Theory of Relativity (LIGO)* (in English), *Bulletin of the Karaganda University. Physics series*, No. 4 (96), 39-56, 2019, ISSN 2518-7198, <https://physics-vestnik.ksu.kz/apart/2019-96-4/5.pdf>.  
Szostek Roman, Góralski Paweł, Szostek Kamil, *Fale grawitacyjne w grawitacji Newtona oraz krytyka fal grawitacyjnych wynikających z Ogólnej Teorii Względności (LIGO)* (in Polish), *viXra* 2018, [www.vixra.org/abs/1802.0012](http://www.vixra.org/abs/1802.0012).
- [54] Szostek Roman, Szostek Karol, *Device for testing the properties of light and method for testing the properties of light*, (in Polish: *Urządzenie do badania własności światła oraz sposób badania własności światła*) Polish Patent Office, application number P.449065, of 28.06.2024.
- [55] Tatum Eugene Terry, *Relativity Isoframes – A Useful and Potentially Unifying Conceptual Framework*, *Journal of Modern Physics*, 12, 731-738, 2021.
- [56] Tehrani Fleur T., *On Lorentz Transformations and the Theory of Relativity*, *Journal of Modern Physics*, 13, 1341-1347, 2022.
- [57] Wu Jingshown, Tsao Hen-Wai, Huang Yen-Ru, *Reviewing Michelson Interferometer Experiment and Measuring the Speed of Starlight*, *Journal of Modern Physics*, 10, 539-547, 2019.
- [58] Zhao Jianzhong, *Lorentz Transformation Derived from Relativity of Time*, *Journal of Modern Physics*, 13, 851-857, 2022.
- [59] Zheng Wenhui, *A Euclidean geometric model that has a maximum speed  $c$* , *Physics Essays*, 36 (1), 117-122, 2023.