# On the alternative interpretation of special relativity

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**Abstract:** A short outline of the alternative, Lorentzian version of special relativity is presented. It is shown that a simple principle of consistency of measurements, familiar and obvious to every experimentalist, when applied in the interpretation of experimental evidence about inertial motion, leads straightforward to the Lorentzian formulation of relativity which involves both the principle of relativity and Lorentz transformation and also a privileged state of motion and effects related to absolute motion.

## 1. Introduction

The discovery of the principle of relativity in the early 20th century was undoubtedly a historic event, which significantly influenced the further development of the whole of physics. Today it is generally accepted, and its undermining is rightly considered as unacceptable since it does not have any justification in the experimental material. However, if it comes to the overall picture of circumstances and implications of this principle, it is possible to clearly isolate two different strands. They clashed with each other in hot discussions at the beginning of the century and they still clash constantly, even though now it happens almost exclusively behind the scenes of today's mainstream physics. The first, a radical, formalistic stream was launched in 1905 by the extremely bold, revolutionary postulates of Einstein, which elevated the principle of relativity in one fell swoop to the rank of a central axiom, to which everything else should be subjected in an absolute way. The second stream, an evolutionary and constructive one, which used cautious deduction on the basis of then generally accepted principles, represented by the works of such physicists as Lorentz, Poincaré, Abraham, and Langevin, was the continuation of a lengthy and painstaking empirical and theoretical searching, lasting decades, during which the way to the acceptance of the principle of relativity and understanding its role was lengthy, gradual, with friction and reservations, while maintaining the classical conceptual apparatus and classical research methodology.

The radical trend won this battle in the sense that it was Einstein's works which have made the principle of relativity popular and caused a general fascination with this principle, and this happened at a time when supporters of the mainstream classical trend were still in the course of seeking the decisive final answers. Therefore, this principle has been commonly identified with the formulations of the Einstein's special relativity (SR), and because of this the Lorentzian formulation which appeared a little later became almost completely forgotten.

However, there is no doubt that supporters of the cautious constructive way soon reached their goal too, and if not earlier then for sure in 1910 already existed the Lorentzian interpretation of the phenomena associated with inertial motion in a complete, finished form. It is compatible with the principle of relativity and accepts this principle, but is free from any startling epistemological innovations which are characteristic for the approach of Einstein [1]. As a result of this fact, many if not most of those who participated in the tedious cognitive process or who watched it closely remained sceptical about the formulations of Einstein, inclining rather to relativity as formulated by Lorentz.

Later relativity as promoted by Einstein and Minkowski completely dominated the teaching of physics and the physical public opinion, never stopped however popping up more and more new followers of the Lorentzian relativity simply because keeping in the analysis of experimental facts classical concepts and methods, in a deductive process they arrived independently, often not even being aware of it, at the relativity in terms of Lorentz. Among later representatives of this trend one can mention such names as Ives [2], Builder, [3], Dingle [4], Prokhovnik [5], Jánossy, [6], Sjödin [7], Podlaha [8], Grøn [9]. In Poland the Lorentzian version of relativity was promoted among others by Frejlak [10] Grabińska [11], Czerniawski [12], and the author of this article [13].

Unfortunately, mutual contacts of the followers of both trends and their results, in any case, do not constitute a glorious chapter in the history of scientific research. Substantive discussions are extremely rare and even if they occur in those few cases, they end with a lack of any progress towards mutual understanding. They are often dominated by mutual allegations, virulent attacks or the attitude of self superiority and contempt for the opposing party. Perhaps the whole problem is due to the fact that physics, although it is considered to be an exact science, does not have its set of basic axioms. If like in mathematics or geometry such a basis would exist, the effects of the changes proposed by Einstein would be easily to trace exactly and this would probably bring to an end the long-standing fruitless disputes.

Observing the condition of things and following some discussions which took place in the past (in particular the famous duel Dingle-McCrea, to which numerous references can be found in the bibliographic work [14]), one can come to the conclusion that the cause of so a deep stalemate and the lack of a common language are the differences in a very fundamental, often not clearly enough defined assumptions, terms or concepts. The result of it is that starting points and ways of reasoning in both cases are so much different, that a constructive exchange of opinions becomes almost impossible. It follows from this that breaking the deadlock could possibly be reached by the clarification of these fundamental initial assumptions in order to locate the point of branching of the course of reasoning on two separate tracks, which although they take their origin in the same empirical basis and its mathematical description, arrive in a remote, almost opposing points when it comes to the final conclusions as to the nature of the inertial motion and how to interpret the observed phenomena associated with it.

This article is an attempt to present the Lorentzian version of relativity in such a way that it would be possible:

a) getting to know and understand the essential points of it,

b) to trace the main initial basic assumptions and how to proceed to the final result,

c) to take substantial discussion or a polemic by questioning the assumptions, specific circumstances, statements or conclusions.

In its first version this article was written in Polish at the turn of the years 1983 and 1984 and was directed to be published in the Polish journal “Postępy fizyki”. Unfortunately, as usual in such cases, the reviewer, a mainstream relativist, did not recommend its publication. Instead, he wrote his own article on the same subject [15], presenting therein an argument often used by relativists, that the standard interpretation of SR cannot be undermined and that there exist no alternative to it. In his article also some “cold war” accents against the “usurping improvers” of SR could be heard, the same with which one can meet very often in the opinions of relativists. It took more than three years of efforts, before we managed to post a short note [16], disproving some of his thesis.

There are, however. some signs of a gradual, slow climate change around the issues of the interpretation of SR. This subject is more often recently undertaken, albeit still less by physicists than by philosophers of science. This allows to hope that eventually the conviction will prevail that there exists here an interesting problem which demands a fair and thorough treatment, which has long been postulated by proponents of the alternative interpretation, and which until recently so persistently opposed the proponents of the standard approach.

However, in order not to waste time on fruitless breaking in open doors, it seems necessary to stress as strongly as possible:

a) We speak about a concept which involves the principle of relativity and the Lorentz transformation, and hence it is both empirically and mathematically indistinguishable from the standard, Einsteinian interpretation of SR. Therefore any references to some experiments which supposedly overthrew it, are misleading. The arguments of this type are usually referring to some short, temporary working hypotheses on the way to the final form of this interpretation, but in no case may relate to the latter.

b) It does not appear reasonable to argue with those who strongly insist that apart from the standard interpretation of SR no other concept able to explain all of the experimental facts exists, because such a claim may arise only out of ignorance or of dishonesty. It is true that the alternative Lorentzian concept is not widely known, however, this does not justify ignoring it.

c) In order to disprove the statements contained in this article it is not sufficient to argue that they are wrong because they are not compatible with the postulates of Einstein or other formulations of the standard interpretation of SR. This method of “disproving”, although widely used (this could be demonstrated on the basis of a rich material) is, however, for obvious reasons not acceptable when it comes to evaluating a concept, which is to be an alternative to the concept in question (although some supporters of the mainstream formalistic trend will probably find it very difficult to break away from such an approach to the matter).

## 2. Properties of physical objects and their descriptions

For the purpose of this article let us define physics as a science of the properties of physical objects and of the laws governing them. A physical object is any material body or a layout of material bodies, such as a rod, a clock, a Michelson interferometer, an atom, a laboratory, a human being, the solar system etc. Properties of a physical object are physical quantities which characterize this object, such as e. g. its length or some other size, the velocity of motion of individual parts of the object relative to each other, period of revolution, frequency of vibrations, time of flight of a body or a signal between different parts of the object, etc.

In order to get a description of a certain property of a physical object, measurements are necessary, based on certain assumptions. For example, if the object will be a rod, and if the property of the object to be measured is its length, then in order to describe this property one will need to introduce a unit of length. Hence the assumption will consist in the definition of a length standard and giving it a name.

After the adoption of the necessary assumptions the quantity in question can be measured, and the result is a description of the property in question. In our example, if the assumption is a definition of the meter, the measurement will consist in determining the ratio of the length of the rod to the length of the meter, and the description of the length $l$ of the rod will then be e.g.

$$l = 5 \text{ metres.} \tag{1}$$

Let us suppose now that two persons, *A* and *B*, are investigating independently of each other the lengths of two different rods *L* and *M*, and as a result they obtain the following descriptions:

$$l_{LA} = 5 \text{ metres}, \quad l_{MB} = 5 \text{ metres.} \tag{2}$$

The first of these descriptions is the description of the length of the rod *L* obtained by the person *A*, while the second one is a description of the length of the rod *M* obtained by the person *B*.

Now we want to use these descriptions for comparing the lengths of both rods. Immediately one can see that both of these descriptions are the same. But does it mean automatically that both rods have the same length? In order to be able to derive from the descriptions such a conclusion, one still has to ensure that the term meter means for both persons the same thing, that is, that the two persons have used in their measurements and descriptions the same assumptions. If this would not be true, then despite the fact that the descriptions are formally equal, the two results would not be comparable and hence it would be impossible to draw from them a correct conclusion as to the mutual relationship of the lengths of both rods.

From the above elementary considerations the following general conclusions follow:

There exists a fundamental difference between a property of a physical object and a description of this property. A property of a physical object is an objective element of reality, independent of the observer and of the way of measurement or observation. On the other hand, a description of a property of a physical object contains both objective elements, as well as conventional elements which are in a sense, and to some extent subjective, dependent on the observer and on the way of measurement or observation, and originate from the assumptions adopted by him. A formal equality of the descriptions of properties is not a sufficient condition for a physical equality of those properties. Corresponding properties of two different physical objects are identical in a physical sense only if the same are their descriptions obtained as a result of measurements, carried out with the use of the same assumptions.

The adjective “formal” which occurs above will be used henceforth in this sense as “based on the same strings of numbers” or “giving numerically the same results” regardless of whether those numbers are in a physical sense comparable with each other or not.

This principle presented above let us call the principle of consistency of measurements or the principle of comparability of results of measurements. To put it briefly, it says that in order to obtain by measurements descriptions comparable with each other, one has to ensure that these descriptions are the results of measurements which are consistent with each other, and in order to obtain results of measurements consistent with each other, one has to ensure that these measurements are based on the same assumptions.

An important specific consequence resulting from this principle, which we will use in further considerations is that, if the measurements are compatible with each other (that is, if their assumptions are the same), then the descriptions resulting from them of the same objective reality (i.e. the same properties of the same object at the same physical conditions) must be the same. If two descriptions of the same objective reality (i.e. the same properties of the same object in the same physical conditions) are not the same, this is a clear evidence that the two measurements are not consistent with one another (i.e., there exist some differences in the assumptions made), and hence the descriptions (series of numbers) are incomparable.

What is the easiest way to check the mutual consistency of the measurements of both people *A*, *B*, who measured the lengths of the rods *L*, *M* ? Just let the person *A* carry out a measurement and make a description of the length of the rod *M* or let the person *B* carry out the measurement and make a description of the length of the rod *L*. If the results obtained by the two persons for the same rod, i.e. the two descriptions $l_{LA}$ and $l_{LB}$, or the two descriptions $l_{MA}$ and $l_{MB}$ would not be the same, it would be an evidence of mutual inconsistency of those two measurements due to some differences in the assumptions, and therefore it would be an evidence of the incomparability of those descriptions. If, on the other hand, a pair of descriptions made by two persons for the same rod are found to be equal, one can draw a conclusion that the corresponding measurements are consistent with one another, i.e. the assumptions of both people are the same, and one can conclude that the descriptions of those two persons are comparable. This means that the lengths of both rods are really the same:

$$l_L = l_M \,. \tag{3}$$

From what we have said is pretty obvious that in all physical investigations there exists an urgent need to distinguish thoroughly between the descriptions of physical properties and the properties themselves, as well as the need for careful selection and careful tracking of the assumptions underlying the measurements and descriptions. Without this it can easily happen that the elements of objective reality be mixed up with the conventional elements contained in the results of experiments. As a result of it one can draw incorrect conclusions about the objective properties of physical objects.

The above remarks look like taken out from a textbook of physics for elementary schools, however, it appears that even in important statements, regarded as a great achievements of modern physics, this elementary principle which is obvious for every experimenter tends to be neglected and badly violated.

In the course of further considerations, we shall see that the adoption of the above principle of consistency of measurements as the starting point for the analysis of the empirical base of SR (that is, of all what we know from the experiments about objects in the inertial motion) leads in a simple way to the Lorentzian interpretation of relativity, i. e. to the need to accept the existence of absolute rest and real changes of the properties of objects, related to the absolute motion.

### 3. The missing quantity

Studying and describing spatial properties of objects alone, such as length, does not cause any difficulties and requires only the definition of a length unit. Similarly simple is describing the time properties of objects only, such as the period of vibration, the time of rotation or circulation, etc., which can be achieved by comparing those times with the time unit, adopted as a standard. A specific difficulty appears when trying to investigate properties, in which both spatial and temporal elements exist. This difficulty lies at the very foundation of relativism and its realization is the key to understanding of many facts.

Let in our laboratory be at rest a rod of known length $l$ the ends of which are at the points $C$ and $D$, and two identical clocks, each at one end of the rod. From the point of $C$ let us push in the direction of the point $D$ in rectilinear uniform motion a ball at the moment when the clock in the point $C$ indicates the time $t_1$. We want to determine the velocity $v = l/t$ of the moving ball along the rod. To calculate it, one needs to know the time of flight $t$ of the ball from $C$ to $D$. It is equal to $t = t_2 – t_1$ , where $t_2$ is the moment of the arrival of the ball at the point $D$. At this moment on the clock in $D$ we read the time $t_3$ , which is equal to $t_3 = t_2 + T$, where $T$ is an unknown difference of the reading of both clocks. In order to determine $t_2$ , we need to know $T$. How can we measure this quantity? This problem would not exist if prior to the measurement of the velocity of the ball the synchronization of the two clocks would be carried out, because then it would be $T = 0$.

So let us try to synchronize those clocks. To do it let us send from $C$ to $D$ any signal which propagates with known velocity $v_s$ and let us set the reading of the clock at $D$ at the time of the arrival of this signal in $D$ to the value $t_{0D} = t_{0C} + l/v_s$ , where $t_{0C}$ is the reading of the clock in $C$ at the time of emission of this signal. But how can we determine the velocity $v_s$, since to measure any velocity it is necessary prior to synchronize the clocks? We have got a vicious circle. To synchronize, one needs to know some velocity, and to measure any velocity one needs synchronization. Any clock synchronization cannot be performed without a known velocity and no velocity can be measured without a synchronization of clocks.

It turns out that this difficulty is by no means trivial, but reflects a very fundamental feature of the construction of our world. It cannot be removed by any circumvention or any, even very complex experiments or theoretical considerations. It is not obvious at first glance and it is tempting to seek solutions to this problem, and many people spent a lot of time and effort trying, however, it proved to be futile.

What remains as a solution to this problem? We can only synchronize distant clocks conventionally, by definition. The definition of synchronization will also be a definition of a certain velocity, and a definition of simultaneity of distant events. This definition we need to include in the set of assumptions, needed to carry out measurements and to obtain descriptions of properties of physical objects. This assumption is of course an additional conventional element in the descriptions of the properties of objects. A definite form of this assumption we will discuss a little later but now we have only to stress the obvious fact that descriptions of the properties of an object depend on the form of this assumption. The adoption of different assumptions about the simultaneity of distant events will of course result in obtaining of different descriptions of the properties of the object, due to different values of velocities and a different order of distant events, although the very properties of a particular object, being a part of objective reality, are of course not influenced by changes of assumptions, they are independent of any changes of the assumptions made.

## 4. States of motion and frames of reference

Let us introduce a few concepts in order to facilitate the considerations related to the properties of physical objects in motion. We will only deal with inertial motions, i.e. rectilinear uniform (with constant velocity) motions of physical objects. These motions will always be relative, meaning motions of objects relative to one another, as the concept of motion for a single object is meaningless. Hence, the concept of velocity will always be the concept of relative velocity.

Let us introduce the term “state of inertial motion” (SIM) as a characteristic of the moving object. Two physical objects are in the same SIM if and only if they remain at rest relative to one another. However, if these objects move relative to one another at a finite velocity, we will say that they are in two different states of inertial motion (SIMs). Each physical object is, of course, at a certain moment, in one and only one SIM. Individual SIMs we will denote by means of the letter $S$ with the relevant indices.

In order to be able to describe inertial motion and properties of physical objects, it is necessary to introduce an “inertial frame of reference” (IFR). To get the possibility to describe in numerical form the positions of objects or their parts and changes of those positions in time, it is necessary to define in the chosen IFR a system of coordinates, to introduce the standards of units of physical quantities, and to adopt the assumption about simultaneity of distant events. Then the obtained descriptions of velocities of objects will be descriptions of velocities in the chosen IFR, obtained using the adopted set of assumptions. The IFR can be chosen arbitrarily, and this choice is also one of the assumptions necessary to describe the properties of objects, and as such is also a conventional element of the descriptions. Individual IFRs we will denote by the letter $F$ with the relevant indexes.

The introduction of an IFR and making the other necessary assumptions, makes it possible, in particular, to unambiguously identify and keep records of SIMs. For the adopted IFR there is one and only one SIM such that objects being in this SIM are in this IFR at rest. Thus, the choice of an IFR consists in binding it with a definite, selected SIM. Other SIMs are then moving with constant velocities and are characterized by the description of their velocity vector. Each set of numeric values of the description of components of the velocity vector corresponds to a definite SIM, and vice versa.

The properties of physical objects in all SIMs can be and should be described using a common, the same set of assumptions. If this condition would not be fulfilled, then, as stated earlier, the descriptions of properties of a physical object would be incomparable among themselves. Changing the IFR and the other related assumptions is, of course, a change in the conventional elements in the descriptions, so, in general, this change can change the descriptions of the properties of an object, but there will be no change of the properties of this object themselves, because the object being tested and described is not subjected to any physical action, which could cause it to change.

On the other hand, changing the SIM of an object, i.e. moving this object from one SIM to another can only occur as a result of a physical action on the object: the application of force and giving it an acceleration, there can therefore not be ruled out in advance the possibility that in the course of this action some objective changes to the properties of the object occur.

Because of that, let us introduce one more concept, that of identical objects. Two objects are identical if placed parallel to one another in the same SIM, they have all their pairs of corresponding properties equal. If one then transfers those objects into different SIMs, they are still by definition identical, although their corresponding properties may not necessarily remain equal since they could be subject to some real physical changes as a result of this transfer.

The primary issue of physics of inertial motion is the question whether or not the corresponding properties of identical objects, after being transferred to different SIMs, remain equal.

## 5. The assumptions about the speed of light and units

Let us choose a definite SIM $S_A$, let us bind with it our IFR $F_A$ and let us define in this IFR the axes of the rectangular coordinates $x, y, z$. Now we need to introduce the necessary assumption on simultaneity, that is about the way of synchronization of distant clocks. Best suited for this purpose is the phenomenon of propagation of electromagnetic signals, or just light due to its specific characteristics and importance in nature. Its convenience lays in the fact that this is the fastest known, rectilinear uniform motion and unlike other motions the speed of light is easily reproducible because its time of flight between the point of emission and the point of absorption depends only on the distance of those points, but does depend neither on the SIM of the emitting object, nor on the SIM of the absorbing object.

The simplest form of the assumption about the speed of light is that in the chosen IFR $F_A$ the length of the vector of the speed of light does not depend on its direction, that is, that in $F_A$ the speed of propagation of electromagnetic signals is isotropic. This assumption we will denote by the symbol $I_A$.

Let us introduce now the assumptions about the units of length and time (others will not be needed here), using the well-known physical standards of a meter and a second. Because we are not yet sure whether the properties used in these definitions (vibration frequencies and the corresponding wavelengths of the krypton and cesium atoms) depend or not on the SIMs of these objects, we need to bind them to a particular SIM, in our case with the SIM $S_A$. These assumptions, concerning the units, let us denote by the symbol $U_A$.

The adopted assumptions $F_A$, $I_A$, $U_A$ present a set of assumptions which is both necessary and sufficient to carry out measurements and to make descriptions of properties of physical objects, located in any of the SIMs. Note in particular that the assumptions made define the simultaneity for any points of space and for any moments of time, and if in $S_A$ we put a clock and define its starting time, the introduced assumptions define in a unique way the description of the local time for each point of space and for each moment of time, synchronized by the assumptions made with the readings of the clock in $S_A$ .

It should be noted that the made assumption $I_A$ ensures only the isotropy of the description of the speed of light relative to objects in $S_A$ . This description $c_{AA}$ is expressed by the well-known numeric value $c$ , independent of the direction of motion of the light. The description of the speed of light $c_{XA}$ relative to objects in any other SIM $S_X$ , different from $S_A$ depends on the direction of motion of light and takes the values in the range between $c - v_{XA}$ and $c + v_{XA}$ , where $v_{XA}$ is the numeric value of the description of the velocity of motion of the SIM $S_X$ relative to the SIM $S_A$ obtained with the use of the set of assumptions $F_A$ , $I_A$ , $U_A$ .

## 6. Descriptions of an object in different states of motion

Let us introduce the following way of identification of descriptions: Let $D\,(R, S_A, F_A, I_A, U_A)$ means a description $D$ of a selected set of properties of a physical object $R$ in the SIM $S_A$ , obtained as a result of measurements carried out with the assumptions $F_A$ , $I_A$ , $U_A$ specified above. The description of a single, specific property will take the form of, for example:

$$L_x\,(R, S_A, F_A, I_A, U_A) = l\ , \tag{4}$$

where $L_x$ is the symbol of a given property, for example, the length of the object $R$ in the direction of the axis of $x$, and $l$ is a numeric value describing this property.

Let $S_A$ be the SIM of our laboratory equipped with standards of length and time, clocks, and other necessary devices, such as equipment for the emission and detection of light signals, for synchronizing clocks, etc. Using the assumptions $F_A$ , $I_A$ , $U_A$ let us build in $S_A$ two identical objects $P$, $R$, consisting of two mutually perpendicular arms of equal length, positioned along the $x$ and $y$ axes of the IFR $F_A$ , with equipments for the emission and detection of light signals at both ends of the arms, and a clock, and let all the parts of each of these objects be connected rigidly in one unit.

Into the set of properties of the objects $P$ and $R$ which are to be measured and described let us include: the lengths $L_x$, $L_y$ of both arms, the time intervals $T_x^+$, $T_x^-$, $T_y^+$, $T_y^-$ of light passing along the arms in one and the other direction, and the rate $s$ of the clock, which indicates by how much the reading of the clock advances during the time of one second.

Using the made assumptions and carrying out appropriate measurements and calculations, we will obtain the following description $D\,(P, S_A, F_A, I_A, U_A)$ of the properties of the object $P$:

$$\begin{aligned}
&L_x\,(P, S_A, F_A, I_A, U_A) = l,\\
&L_y\,(P, S_A, F_A, I_A, U_A) = l,\\
&T_x^+\,(P, S_A, F_A, I_A, U_A) = l/c,\\
&T_x^-\,(P, S_A, F_A, I_A, U_A) = l/c,\\
&T_y^+\,(P, S_A, F_A, I_A, U_A) = l/c,\\
&T_y^-\,(P, S_A, F_A, I_A, U_A) = l/c,\\
&s\,(P, S_A, F_A, I_A, U_A) = 1.
\end{aligned} \tag{5}$$

Because the objects $P$ and $R$ are identical, are placed parallel to each other in the same SIM $S_A$ and are described using the same set of assumptions $F_A$, $I_A$, $U_A$ , the descriptions of all their corresponding pairs of properties must be equal, that is, the description $D(R, S_A, F_A, I_A, U_A)$ will be exactly the same as the description $D(P, S_A, F_A, I_A, U_A)$ in eq. (5) with the identifying symbol of the object $R$ instead of $P$.

Now let us transfer the object $R$ from the SIM $S_A$ to a new SIM $S_B$ different from $S_A$ and let for simplicity $S_B$ be defined in $F_A$ by the velocity vector directed along the axis of $x$. We want now to find the description of the object $R$ in this new SIM $S_B$, obtained using the same set of assumptions. The assumptions made and the measuring instruments used (which, however, must remain in the SIM $S_A$, because only there are by now specified their properties), allow us to perform all necessary measurements in order to obtain the description $D(R, S_B, F_A, I_A, U_A)$. On the basis of the known experimental facts we can foresee that this description will take the form:

$$\begin{aligned}
&L_x(R, S_B, F_A, I_A, U_A) = l/\gamma_{BA}, \\
&L_y(R, S_B, F_A, I_A, U_A) = l, \\
&T_x^+(R, S_B, F_A, I_A, U_A) = l/[\gamma_{BA} \cdot (c - v_{BA})], \\
&T_x^-(R, S_B, F_A, I_A, U_A) = l/[\gamma_{BA} \cdot (c + v_{BA})], \\
&T_y^+(R, S_B, F_A, I_A, U_A) = \gamma_{BA} \cdot l/c, \\
&T_y^-(R, S_B, F_A, I_A, U_A) = \gamma_{BA} \cdot l/c, \\
&s(R, S_B, F_A, I_A, U_A) = 1/\gamma_{BA}.
\end{aligned} \tag{6}$$

where

$$\gamma_{BA} = 1/\sqrt{(1 - v_{BA}^2/c^2)}, \tag{7}$$

and $v_{BA}$ is the numeric value of the description of the velocity of $S_B$ in the IFR $F_A$: $V(S_B, F_A, I_A, U_A) = v_{BA}$.

As one can see, the two descriptions $D(P, S_A, F_A, I_A, U_A)$ and $D(R, S_B, F_A, I_A, U_A)$ in the corresponding equations (5) and (6) are not equal. This result indicates that the descriptions of corresponding properties of two identical objects placed in two different SIMs, obtained by the use of the same set of assumptions, are generally not equal.

Since all the assumptions, that is, all conventional elements in both of the two above descriptions are the same, and yet these descriptions differ, the obvious conclusion is that the differences in those descriptions must be caused by some elements of objective reality, that is, that the corresponding properties of identical objects being in different SIMs, are generally not equal. Below we will get yet another confirmation of that conclusion.

## 7. Descriptions of an object in different frames of reference

All descriptions studied so far were based on the same set of assumptions. Now let us make a different set of assumptions and let us look at the descriptions obtained by applying them. Let us bind our new IFR with the SIM $S_B$. Let us assume the isotropy of the speed of light signal propagation in this new IFR $F_B$ and let us build in $S_B$ a set of necessary standards of units of length and time, using identical definitions of these units, but related now to the objects (atoms of krypton and cesium) being in the SIM $S_B$. Let us also build in $S_B$ the necessary measuring instruments, or let us transfer from $S_A$ to $S_B$ these measuring instruments, which previously we used in $S_A$ while carrying out measurements with the set of assumptions $F_A$, $I_A$, $U_A$. In this new IFR $F_B$ and applying this new set of assumptions $F_B$, $I_B$, $U_B$ let us carry out the necessary measurements in order to obtain the description $D(R, S_B, F_B, I_B, U_B)$ of the properties of the object $R$ in the SIM $S_B$ .

On the basis of the known experimental facts we can foresee that this description will take the form of:

$$\begin{aligned}
&L_x(R, S_B, F_B, I_B, U_B) = l,\\
&L_y(R, S_B, F_B, I_B, U_B) = l,\\
&T_x^{+}(R, S_B, F_B, I_B, U_B) = l/c,\\
&T_x^{-}(R, S_B, F_B, I_B, U_B) = l/c,\\
&T_y^{+}(R, S_B, F_B, I_B, U_B) = l/c,\\
&T_y^{-}(R, S_B, F_B, I_B, U_B) = l/c,\\
&s(R, S_B, F_B, I_B, U_B) = 1.
\end{aligned} \tag{8}$$

This new set of assumptions and the measuring tools being now in $S_B$ are also sufficient to carry out the measurements and obtaining a description of the properties of the object $P$, which remains still in the SIM $S_A$ . On the basis of the known experimental facts we can foresee that the description $D(P, S_A, F_B, I_B, U_B)$ will take the form of:

$$\begin{aligned}
&L_x(P, S_A, F_B, I_B, U_B) = l/\gamma_{AB},\\
&L_y(P, S_A, F_B, I_B, U_B) = l,\\
&T_x^{+}(P, S_A, F_B, I_B, U_B) = l/[\gamma_{AB} \cdot (c - v_{AB})],\\
&T_x^{-}(P, S_A, F_B, I_B, U_B) = l/[\gamma_{AB} \cdot (c + v_{AB})],\\
&T_y^{+}(P, S_A, F_B, I_B, U_B) = \gamma_{AB} \cdot l/c,\\
&T_y^{-}(P, S_A, F_B, I_B, U_B) = \gamma_{AB} \cdot l/c,\\
&s(P, S_A, F_B, I_B, U_B) = 1/\gamma_{AB}.
\end{aligned} \tag{9}$$

where

$$\gamma_{AB} = 1/\sqrt{(1 - v_{AB}^2/c^2)}, \tag{10}$$

and $v_{AB}$ is the numerical value of the description of the velocity of the SIM $S_A$ in the IFR $F_B$ : $V(S_A, F_B, I_B, U_B) = v_{AB}$ .

Note that the description $D(P, S_A, F_A, I_A, U_A)$ (in equations (5)) and the description $D(P, S_A, F_B, I_B, U_B)$ (in equations (9)) are two different descriptions of the same objective reality: the object $P$ in the SIM $S_A$ . Different are in them only the sets of assumptions, i.e. the conventional elements. Since these two descriptions are unequal, we can draw a conclusion that those two sets of assumptions are inconsistent with one another.

The same conclusion can be drawn from the non-equality of the descriptions $D(R, S_B, F_A, I_A, U_A)$ (in equations (6)) and $D(R, S_B, F_B, I_B, U_B)$ (in equations (8)), in which all the objective elements (the object $R$ in the SIM $S_B$) are the same.

Since both sets of assumptions $F_A, I_A, U_A$ and $F_B, I_B, U_B$ are not consistent with one another, the corresponding descriptions obtained while using them are incomparable. This result is not surprising at all. It was known in advance that both sets of assumptions are inconsistent, as they contain two differing definitions of simultaneity of distant events, which must lead to non-equality of obtained descriptions.

The sets of assumptions $F_A, I_A, U_A$ and $F_B, I_B, U_B$ are formally identical, based on the same rules and definitions, but one time related to the SIM $S_A$, and the second time to the SIM $S_B$, which, as one can see, does not ensure their compatibility. Formally identical assumptions are thus not equal if they relate to different states of motion.

### 8. Formal equivalence of the frames of reference

By comparing the description $D(P, S_A, F_A, I_A, U_A)$ (in equations (5)) with the description $D(R, S_B, F_B, I_B, U_B)$ (in equations (8)), we notice that they are formally equal. They relate to identical objects in different SIMs and were obtained using identical but not equal sets of assumptions. Formally equal will prove to be also the descriptions $D(R, S_B, F_A, I_A, U_A)$ (in equations (6)) and $D(P, S_A, F_B, I_B, U_B)$ (in equations (9)), if the numerical values $v_{AB}$ and $v_{BA}$, (and therefore also the values of $\gamma_{AB}$ and $\gamma_{BA}$) will be equal.

From known experimental facts we know that this equality of corresponding properties of identical objects in different SIMs, obtained by the use of identical but unequal assumptions, is valid for all IFRs and its name is the principle of relativity. In terms adopted by us here we can formulate it shortly as follows: The description $D(G, S_X, F_Y, I_Y, U_Y)$ of any property of any physical object $G$ in the SIM $S_X$ depends only on the description of the velocity $V(G, S_X, F_Y, I_Y, U_Y) = v_{XY}$ of the SIM $S_X$ in the IFR $F_Y$, and does not depend on the choice of the SIM $S_X$ nor the choice of the IFR $F_Y$. In a special form for $v_{XX} = 0$ this principle will have the form: The descriptions $D(G, S_X, F_X, I_X, U_X)$ for all SIMs and IFRs bound with them are equal.

In this sense, all IFRs are equivalent. Because this principle is about the equality of the descriptions of properties of physical objects, and not about the equality of those properties themselves, let us call this equivalence a formal equivalence.

The formal equivalence of IFRs means that an operationally preferred frame of reference does not exist. The descriptions of the properties of identical objects in all SIMs, obtained using identical sets of assumptions, but in each case related to this particular SIM, are equal. Hence, inertial motion is in this sense formally relative, since the descriptions of properties of identical physical objects in any IFR bound with the SIM of this object do not differ from the corresponding descriptions in other IFRs bound with the SIMs of those objects.

### 9. Physical non-equivalence of the states of motion

We stated earlier that the primary issue of physics of inertial motion is the question of whether the corresponding properties of identical objects, transferred into different SIMs, remain equal. If it were so, all SIMs would be equivalent in a physical sense, and therefore inertial motion would be relative not only formally but also physically.

It would be not justified to conclude that the equality of the descriptions $D(R, S_A, F_A, I_A, U_A)$ and $D(R, S_B, U_B, I_B, J_B)$ is a proof that the properties of the object $R$ in $S_A$ and of the same object $R$ in $S_B$ are equal. Such a conclusion would contradict the fact of the non-equality of the descriptions $D(R, S_B, F_B, I_B, U_B)$ and $D(R, S_B, F_A, I_A, U_A)$ as well as the fact of non-equality of the descriptions $D(R, S_A, F_A, I_A, U_A)$ and $D(R, S_A, F_B, I_B, U_B)$ since these facts indicate that the sets of assumptions $F_A, I_A, U_A$ and $F_B, I_B, U_B$ are inconsistent with one another and thus render mutually incomparable descriptions. Furthermore, such a conclusion would also contradict the fact of the non-equality of the descriptions $D(R, S_B, F_B, I_B, U_B)$ and $D(R, S_A,$

$F_B$, $I_B$, $U_B$) as well as the fact of non-equality of the descriptions $D(R, S_A, F_A, I_A, U_A)$ and $D(R, S_B, F_A, I_A, U_A)$ since in those pairs of descriptions the sets of assumptions are the same, and hence the non-equality of those descriptions is a direct proof that the corresponding properties of the object $R$ in $S_A$ and the same object $R$ in $S_B$ are not equal.

By the way, the non-equality of the corresponding properties of identical physical objects in different SIMs can be demonstrated even in a more straightforward way. Let us recall the difficulties with the synchronization of distant clocks mentioned earlier. If the corresponding properties of an object $P$ in a SIM $S_A$ and an identical object in $S_B$ were equal indeed, then the synchronization of two distant clocks in $S_A$ could be performed in many different ways and it would not be necessary to resort for this purpose to a convention or an agreement.

For example, if the lengths of the arms $L_X(P, S_A)$ and $L_X(R, S_B)$ were indeed equal (we omit here the identifiers of the conventional elements, i.e. the assumptions because we do not speak here anymore about the descriptions of properties but about the properties themselves), then the two ends of both of the arms shifting aside one another would have to meet at the same time, which could be the way of determining the simultaneity for two distant points.

Similarly, if the rates $s(P, S_A)$, and $s(R, S_B)$ of the clocks were indeed equal, then the clock in $S_B$ could be used to synchronize two distant clocks in $S_A$ regardless of the relative velocity $v_{AB}$ of those two SIMs. From the known experimental facts, as well as from the mathematical formalism of SR it is well known that synchronizing distant clocks by this method produces inconsistent results which depend on the velocity $v_{AB}$, and this is a further direct proof that the corresponding properties of identical objects in different SIMs are generally not equal.

And hence, on the basis of many well-known experimental facts and the arguments presented above we can accept with certainty the conclusion that despite of the formal relativity of different IFRs (i.e. the formal equality of descriptions of corresponding properties of identical objects in different SIMs), different SIMs are in general not physically equivalent, i.e. the corresponding properties of identical objects in them are generally not equal. This means that the relativity of inertial motion is not a physical relativity. Physical object when transferred from one SIM to another one undergo objective, physical changes of some of their properties. These changes, however, are undetectable, if these properties are measured and their descriptions are made each time by the use of a different IFR and a different set of assumptions, associated each time with a different SIM.

It is not difficult at all to understand why this is so. If when transferred to a new SIM the length of an object changes, then the length of a transferred standard length unit will change in the same way as well. The changed length measured by a changed length unit will give an unchanged result, i.e. the changes in lengths will remain undetected. Similarly, when transferred to a new SIM the rate of a clock changes, then the rate of a transferred standard clock will change in the same way as well. The changed clock rate measured by a changed standard clock rate will give an unchanged result, i.e. the changes in the clock rates will remain undetected. This simple consideration indicates that to draw a conclusion that the properties $W(P, S_A)$ and $W(R, S_B)$ are equal on the basis of the equality of the corresponding descriptions $D(P, S_A, F_A, I_A, U_A)$ and $D(R, S_B, F_B, I_B, U_B)$ is not justified.

## 10. Formal reason of the differences of descriptions

Why descriptions $D(P, S_X, F_Y, I_Y, U_Y)$ depend on the description of the velocity of the SIM $S_X$ relative to the IFR $F_Y$ : $V(S_X, F_Y, I_Y, U_Y) = v_{XY}$ ? It is unnecessary to assume that it is a mysterious property of space-time which causes that the magnitude of changes of individual properties of objects seems to be dependent on the relative velocity of the object relative to the observer. Instead, it is the description of the velocity of the SIM $S_X$ relative to the SIM $S_Y$ for which the assumption about the isotropic propagation of the speed of the light signals has been made. This isotropy is invalid for other SIMs, different from $S_Y$ , and the magnitude of the anisotropy is proportional to the description of the velocity $v_{XY}$ . This value is therefore a measure of the assumed anisotropy of the speed of propagation of electromagnetic waves relative to the SIM $S_X$ . Hence, the magnitude of the "relativistic" effects, i.e. the magnitude of changes of the descriptions of the properties of the object $D(P, S_X, F_Y, I_Y, U_Y)$ in comparison to the descriptions $D(P, S_Y, F_Y, I_Y, U_Y)$ depends on the assumed anisotropy of the speed of light with respect to the SIM $S_X$, the value of which is $v_{XY}$ . Thus, the "relativistic" effects which appear in the descriptions, have an objective reason, and this reason is the assumed magnitude of the anisotropy of the speed of light with respect to the object which is being investigated and described.

## 11. Physical reason of the differences of properties

From earlier considerations it follows that the properties of physical objects, transferred to different SIMs, undergo real, physical changes, so it begs the question, what are these properties and what are the regularities of their changes. Because we obtain different descriptions of the properties of objects depending on the adopted set of assumptions, i.e. on the conventional elements in those descriptions, in order to draw correct conclusions about the properties of objects themselves we have to take into account all of those different descriptions. It seems logical to conclude that the objective data about the properties of the objects themselves will be the data that result from all descriptions, i.e. from all the sets of assumptions.

The first and fundamental fact which meets this requirement, is that the speed of propagation of electromagnetic signals can be isotropic with respect to one and only one SIM, while with respect to all other SIMs the speed of light is not isotropic. This follows from each set of assumptions. There does not exist any set of sound and logically coherent assumptions for measurements and descriptions of the properties of objects in various SIMs, according to which the speed of light would be isotropic with respect to more than one SIM.

The acceptance of this fact gives immediately a transparent picture of properties of physical objects and their changes under the influence of motion. In accordance with this image, there is one and only one privileged SIM $S_0$ such that the speed of light relative to objects in this SIM is constant, independent of direction. The true description of any object $Q$ in the SIM $S_0$ is the description $D(Q, S_0, F_0, I_0, U_0)$. A true description of the object $Q$ after its transfer to any other SIM $S_X$ is the description $D(Q, S_X, F_0, I_0, U_0)$, in which the velocity $v_{X0}$ of this object relative to the SIM $S_0$ plays its role. The true description of this velocity is the description $V(S_X, F_0, I_0, U_0) = v_{X0}$ . Objects moving relative to the SIM $S_0$ undergo objective, real, physical changes of their properties (i.e. they are subject to the "relativistic" effects, in particular length contraction in the direction of motion and slowing-down of all physical processes), whose magnitude depends on the velocity $v_{X0}$, which determines the true anisotropy of the speed of light relative to the given SIM $S_X$ .

Due to the formal equivalence of IFRs, i.e. due to the formal relativity, the SIM $S_0$ cannot be experimentally identified, and as a result of it true descriptions of the properties of the objects cannot be selected from the infinite number of all possible descriptions.

The fact that it is impossible to identify the SIM $S_0$ experimentally is not contrary to the conclusion of its existence, nor does it undermine that conclusion since the existence of this SIM is a consequence of the physical non-equivalence of SIMs which can be derived without doubt from the existing and observed differences of the properties of identical objects in different SIMs.

The necessity of the existence of the privileged SIM $S_0$ follows also from a pretty elementary consideration. If light moves rectilinearly with a constant speed and its speed is reproducible and does depend neither on the SIM of the emitting object nor the SIM of the absorbing object, which is generally accepted without reservation, then it must exist another SIM with respect to which this speed is determined, i.e. the SIM $S_0$.

## 12. The reason of formal relativity

If there exists a privileged SIM $S_0$ and if the properties of the objects depend on their velocity relative to this SIM, then how can we explain the impossibility to identify this SIM, i.e. the formal relativity, i.e. the formal equivalence of IFRs, i.e. the formal equality of the descriptions of the properties of objects $D\,(Q, S_X, F_X, I_X, U_X)$ for all $S_X$ and $F_X$ attached to them?

There is a formal answer to this question as well as a physical one. Formally taking it is due to the fact that the Lorentz transformation which correctly describes reality, has such a specific mathematical form. This transformation is a valid recipe for transforming descriptions of properties of objects, obtained by the use of one set of assumptions, into descriptions of those properties obtained by the use of a different set of assumptions, and more specifically: a recipe for transforming the descriptions obtained while assuming the anisotropy of the speed of light relative to the object described into the descriptions obtained while assuming the isotropy of that speed. The mathematical form of this transformation is such that after assuming the isotropy of the speed of light relative to the object, the description of the properties of the object turns out to be independent of the SIM of the object.

This form of transformation is of course not accidental, but it is imposed by the physical laws which are in force. So why in spite of the anisotropy of the speed of light relative to the object, and despite that the magnitude of this anisotropy determines the properties of the object, after making the assumption of the isotropy of the speed of light the descriptions of these properties appear to be exactly what are the properties of the same object in a SIM without anisotropy of the speed of light, that is $S_0$ ?

This fact, i.e. the formal relativity, is undoubtedly a fundamental fact and an explanation of its reason is important for understanding the logic of construction of our world. In the standard interpretation of SR formal relativity is being explained in geometric terms as a result of the symmetry of space-time, but here we need a visual, physical explanation.

It is not difficult to formulate such an explanation. The speed of light is not only the speed of transmission of electromagnetic signals, but, what is more important, also the speed of transmission of electromagnetic force interactions in vacuum, and most probably also of all other interactions. Individual elements of the physical object $Q$ in a SIM $S_0$, described correctly by the description $D(Q, S_0, F_0, I_0, U_0)$, interact with each other by forces, the speed of propagation of which is independent of direction. Each element of an object is at any time in a dynamic equilibrium in the field of forces from all other elements of this object.

Let us suppose that an object would be transferred from the SIM $S_0$ to another SIM $S_X$ with non-isotropic speed distribution of forces without changing the properties of it, and in particular with unchanged mutual distances of each of its elements. The result of such a transfer would be, of course, the imbalance of individual elements due to changes in intensity and delays of the forces acting on them by all the other elements. Because of that such a transfer of an object from $S_0$ to $S_X$ without any changes of its properties is impossible.

Instead of that, individual elements of the object being transferred remain in dynamic equilibrium due to the fact that the appearing imbalance caused by the appearing of the anisotropy of forces is continuously compensated by changes of mutual positions of the individual elements of this object under the influence of those forces. Hence, dynamic equilibrium inside the object is continually being restored and after the transfer of the object into the new SIM $S_X$ each element takes a shape and takes such a position, which does not feel any changes occurring, i.e. where all the other elements act on this particular element in a way exactly identical as in $S_0$.

Indeed, the description $D(Q, S_X, F_X, I_X, U_X)$ is an exact analogy of the description $D(Q, S_0, F_0, I_0, U_0)$ in the new physical conditions, and as a result of that an observer moving with the object and investigating it will not be able to detect any changes of this object. But to each element of an object can be ascribed the role of an observer of all other elements, with the implication that each element despite the physical changes which took place in the object remains in a state of equilibrium which cannot be distinguished from the previous one, i.e. which is exactly identical as in the SIM $S_0$.

Formal relativity is thus in this interpretation the result of exact adjusting of the properties of the object to the new configuration of forces acting on this object, and its existence is not only understandable but also necessary, because without such changes, which restore the equilibrium inside the object, it could not exist in the new conditions.

In this context, it is worth noting that the “relativistic” effects such as shortening of lengths (contraction), slowing-down of physical processes (time dilation), growth of the mass, etc. are not independent phenomena whose existence it would be necessary to postulate in order to get a good agreement with experimental results (as the followers of the geometric interpretation of SR argue — see, for example. [15]), but they remain in close connection with each other. For example, in the so-called optical clock (where the time unit is derived from the time of flight of a light signal on a closed path) time dilation appears automatically as a result of length contraction. Similarly, the length contraction of electric charges leads automatically to the increase of mass (i.e. potential energy).

Let's look yet at formal relativity from the historical point of view. The basic problem of the period before the formulation of SR was the failure of attempts to detect the motion of the Earth relative to the ether (i.e. the privileged SIM). The standard interpretation of SR resolves this problem saying that there is no such SIM (the ether). On the other hand, the Lorentzian interpretation not only permits but also requires the existence of such a SIM, and the impossibility to observe the motion relative to this SIM it explains as a result of changes of properties of objects under the influence of this motion. In experiments carried out before the year 1905 and even later physicists attempted to detect the anisotropy of the speed of light (called the wind of the ether) assuming the equality of corresponding properties of identical objects in different SIMs. If one reinterprets the results of this experiments, taking into account the changes to the objects under the influence of this motion, it turns out that these experiments are insensitive to the velocity relative to the privileged SIM, so they cannot render any information about this motion (more exactly speaking, their results are compatible with any speed of this motion, less than *c*) .

### 13. The physical meaning of the Lorentz transformation

Let us consider the relationship of two different descriptions of an object $Q$ in a SIM $S_B$ : $D(Q, S_B, F_B, I_B, U_B)$ and $D(Q, S_B, F_A, I_A, U_A)$, expressed respectively by the coordinates of $x', y', z', t'$, and $x, y, z, t$ . The transformation which transforms the description $D(Q, S_B, F_A, I_A, U_A)$ into the description $D(Q, S_B, F_B, I_B, U_B)$ is called the Lorentz transformation $L$ . In a simplified form (if the axes $x$, $x'$ are in one line with the vector of the relative velocity of these two SIMs) it can be expressed as follows:

$$x' = \gamma \cdot (x - v \cdot t), \ y' = y, \ z' = z, \ t' = \gamma \cdot (t - v \cdot z/c^2). \tag{11}$$

The Lorentz transformation can be divided into two parts: the Galilean transformation ($G$) of the form:

$$x'' = x - v \cdot t, \ y'' = y, \ z'' = z, \ t'' = t \tag{12}$$

that converts the description of $D(Q, S_B, F_A, I_A, U_A)$ into the description of $D(Q, S_B, F_B, I_A, U_A)$, and the supplementary transformation ($L–G$):

$$x' = \gamma \cdot x'', \ y' = y'', \ z' = z'', \ t' = t''/\gamma - \gamma \cdot v \cdot x''/c^2 \tag{13}$$

that converts the description of $D(Q, S_B, F_B, I_A, U_A)$ into the description of $D(Q, S_B, F_B, I_B, U_B)$ .

The physical meaning of the Galilean transformation ($G$) is that it only takes into account the change of the IFR $F_A$ into $F_B$, but it does not take into account the changes of the remaining assumptions (about the units and the definition of simultaneity). As a result of it this transformation changes only those descriptions of the properties of the object that characterize it in its external relations, without changing the descriptions of the other (internal) properties of the object.

Note in particular that the description $D(Q, S_B, F_B, I_A, U_A)$ is a description of an object in an IFR in which the object is at rest, and despite of that in this description continue to appear all the “relativistic” effects, i.e. shortening of the lengths and slowing-down of clock rates (as this description is equal to the description $D(Q, S_B, F_A, I_A, U_A)$, given in equations (6)). Thus it can be clearly seen that these effects are not associated with the motion of the object relative to the observer, but with the accepted assumption about how light propagates in the SIM, in which the object is at rest. In our case, because of the assumptions $I_A$, $U_A$, in the IFR $F_B$ the speed of light is not isotropic.

The transformation ($L$–$G$) is a transformation without a change of the IFR, and it takes into account only the change of assumptions (about the units and simultaneity), which causes a change of descriptions. The transformation ($L$–$G$) accounts for the change from the assumption about anisotropic speed of light (relative to the SIM $S_B$) to the assumption about isotropic propagation of light (relative to this SIM) while at the same time replacing the units defined in $F_A$ by the units defined in $F_B$. This can be seen clearly from the equation for the time variable $t'$, in which there are two components: a "dilational" part, associated with a change in the clock rate, and a "synchronisational" part, dependent on $x''$, associated with a change of the assumption about the propagation of light.

As a result of this transformation (as a result of changes of assumptions) disappear, of course, all the "relativistic" effects in the object described, which is completely understandable, because the individual quantities are now expressed in units derived from standards which are subject to the same changes as the objects studied and described.

The Lorentz transformation is thus a composition of two transformations of various physical meaning: the Galilean change of the frame of reference (which is invariant with respect to the assumptions about units and simultaneity, and thereby is not affecting the descriptions of the "internal" properties of objects), and a change of metric (due to the introduction of the new assumptions about the units and simultaneity, and more specifically, due to the adjustment of these assumptions to the current properties of the objects described, and as a result changing the descriptions of the properties of the objects).

## 14. The Lorentzian image of the world

The described alternative to the standard interpretation of the "relativistic" phenomena can be visually presented in the velocity space. If we attach our IFR $F_A$ to a chosen SIM $S_A$, we can introduce a Cartesian system of rectangular coordinates, on the axes of which we will put the numerical values of the components of the description of velocities $V_x(S_X, F_A, I_A, U_A) = v_{AXx}$, $V_y(S_X, F_A, I_A, U_A) = v_{AXy}$, $V_z(S_X, F_A, I_A, U_A) = v_{AXz}$. Note that in the velocity space defined in such a way each point corresponds to one and only one definite SIM and vice versa. The SIM $S_A$, of course, is represented in it by a point in the origin of the system of coordinates: $v_{AAx} = v_{AAy} = v_{AAz} = 0$. With increasing distance of the point ($v_{AXx}$, $v_{AXy}$, $v_{AXz}$) which represents the SIM $S_X$, from the origin of the system of coordinates (0, 0, 0) which represents the SIM $S_A$, the magnitude of the observed "relativistic" effects increases (i.e. the numeric values of the descriptions of lengths in the direction of the vector describing velocity decrease, the numeric values of the descriptions of clock rates decrease, the numerical values of the descriptions of the masses of objects increase, etc.).

From the experimental evidence we know that objects with non-zero rest mass can move at velocities smaller than the speed of light, i.e. at subluminal velocities. This means that such objects can occupy SIMs the descriptions of the velocity components of which satisfy the condition:

$$v_{XA} = \sqrt{(v_{AXx}{}^2 + v_{AXy}{}^2 + v_{AXz}{}^2)} < c \,. \tag{14}$$

In our velocity space they correspond to points inside the sphere $C$ with a radius of $c$ with the centre in the origin of the coordinate system. Whenever and wherever a light signal is being emitted, it always is in a SIM $S_X$ the description of the velocity of which has the numerical value of $c$. Thus, all the SIMs which can contain light signals correspond to points on the surface of the sphere $C$ and the description of their distance from the origin of the system of coordinates is always $c$ . The surface of the sphere $C$ is thus the geometric place of all the SIMs pertinent to light. On the other hand, all SIMs described by velocities $v_{AX} > c$ can only contain supraluminal objects and thus can not contain any of the known kinds of objects, unless the existence of tachyons would be confirmed. All points which correspond to this supraluminal class of objects lie outside of the sphere $C$ .

In this representation the qualitative non-equivalence of SIMs is evident. There exist three of their distinct classes corresponding to three distinct classes of physical objects.

Let us now look how this picture will change if we apply the Lorentz transformation, i.e. if we change the set of assumptions used in the descriptions. If we replace the assumptions $F_A$, $I_A$, $U_A$ by a new set of assumptions $F_B$, $I_B$, $U_B$, then the SIM $S_B$ will be in the center of the sphere $C$ , while the SIM $S_A$ will be at some distance from the center of the sphere and will be described by the non-zero components of the description of its velocity:

$$\begin{aligned} V\,'_x\,(S_A, F_B, I_B, U_B) &= v\,'_{ABx} \,, \\ V\,'_y\,(S_A, F_B, I_B, U_B) &= v\,'_{ABy} \,, \\ V\,'_z\,(S_A, F_B, I_B, U_B) &= v\,'_{ABz} \,. \end{aligned} \tag{15}$$

As a result of this, in the descriptions of the properties of objects being in that SIM the "relativistic" effects will be present.

Generally speaking, as a result of this transformation there will be a displacement of the points (that is, the SIMs) in the new coordinate system $v'_{BXx}$ , $v'_{BXy}$ , $v'_{BXz}$ relative to their positions in the previous coordinate system $v_{AXx}$ , $v_{AXy}$ , $v_{AXz}$ . There will also be changes in the descriptions of the properties of objects in $S_X$ . But these changes are only conventional, caused by the change of the assumptions, not related to any physical change, because these objects remain as previously in the SIM $S_X$ .

It is important that these displacements being the result of the transformation, i.e. the change of assumptions, do not affect the three distinct classes of SIMs. The reason of it is, which can be easily checked, that the surface of the sphere $C$, described by the formula $v_{AXx}{}^2 + v_{AXy}{}^2 + v_{AXz}{}^2 = c^2$, transforms into the surface of the sphere $C'$, described by the formula $v'_{BXx}{}^2 + v'_{BXy}{}^2 + v'_{BXz}{}^2 = c'^2$ , which means that this sphere transforms into itself since $c = c'$ . Hence, no SIM can as a result of the Lorentz transformations leave the surface of the sphere $C$ , or go through the surface of the sphere from the outside to the inside, or vice versa. As a result of the transformation there is a displacement of the points (SIMs) inside the sphere, on the surface of it, and outside of it. However, the distinction of SIMs into the three classes is not affected. Hence, this distinction is Lorentz invariant.

Thus, regardless of the SIM adopted as a basis of the set of assumptions, the image of the empirical reality remains the same. There is always one and only one SIM which is in the centre of the sphere $C$ (with an isotropic description of the speed of light distribution relative to this SIM) and always with increasing velocity relative to this SIM there is an increase of the anisotropy of the speed of light and there is an increase of the magnitude of the "relativistic" effects.

Conclusions as to the objective reality (that is no longer as to the descriptions of the properties of objects, but as to properties of these objects themselves) which follow from all these images together, are straightforward. Everything becomes clear and transparent, if one accepts the existence of a privileged SIM $S_0$ , which is the true centre of the sphere $C$ and the existence of real, objective, physical changes of the properties of physical objects, dependent on their velocity relative to this SIM $S_0$ Due to the form of the Lorentz transformation we cannot identify or indicate the SIM $S_0$ , but the conclusion about its existence follows from the obvious argument that since there exists a sphere, there must exist also its center.

A literal understanding of the Einstein's postulate of the constant speed of light (i.e. as a statement about the speed itself and not about the descriptions of it) would be equivalent to the statement that each point inside the sphere $C$ is its center. The absurdity vanishes, however, when we take into account that the Einstein's postulate is not a statement about the speed itself but about the descriptions of it, obtained while applying dissimilar sets of assumptions, with the result that these descriptions are not comparable with each other.

Hence, every point inside the sphere $C$ may by an appropriate choice of assumptions become its center, but always (i.e. for any set of assumptions) there will be one and only one such point, whereas all other points will fill the space between the center and the surface of the sphere. Thus, one and only one SIM is characterized by the isotropic speed of light, and in all the rest of the SIMs light propagates with an anisotropic speed, and this anisotropy is for individual SIMs of different magnitude and different direction.

Objective, physical changes of the properties of objects, caused by the motion of those objects relative to the privileged SIM $S_0$ (i.e. their absolute motion) we observe in measurements with the use of any set of assumptions (in particular any IFR), but because these assumptions are arbitrary, we get different, incomparable descriptions of those properties and their changes.

In particular, the fact that physical processes are being slowed-down in objects moving with large velocities relative to the true center of the sphere $C$ is not only a known fact, but in addition a fact with a significant practical use. We are able in our laboratories to increase substantially, even hundreds of times the lifetimes of unstable mesons and muons by locating and keeping them on closed orbits inside the sphere $C$ near its surface (that is, in SIMs in which the physical processes run much slower).

It would be incompatible with the statement that "time passes in all inertial systems equally" if we would understand this statement verbally as "the rates of identical clocks in all SIMs are equal", that is, if we would assume that this statement refers to the properties of objects themselves (in particular to the clock rates). This contradiction disappears, however, if we take in mind that this statement is about the descriptions of clock rates, obtained by the use of dissimilar sets of assumptions, and that as a result these descriptions are not comparable with each other.

We have yet to dispel false hopes that the SIM $S_0$ could be identified by sending in space in various directions identical clocks, leaving them there long enough and then comparing their readings. It seems that the one who would be put close to the center of the sphere $C$ , should be after some time "older" than the one sent in the opposite direction, closer to the surface of this sphere. It is so indeed according to the interpretation presented here, (by the way exactly as according to the standard interpretation of SR), however, in order to be able to compare the readings we need to bring the clocks to the same point (in the distance space), and this requires to put them for a sufficiently long period of time in a SIM opposite to the previous one (in the velocity space) where the change in the clock rate will be opposite too. As a result the two opposing effects will almost entirely compensate one another and only a small "relativistic" effect will remain, independent of the direction and always of the same sign (the returning object is always "younger").

## 15. Summary

This article is not the place of a polemic with the traditional, generally accepted interpretation of special relativity. However, presenting the alternative interpretation, we have to mention what are some of the objections of followers of this alternative interpretation to the formulations of the standard interpretation. They are convinced that the standard formulations are inaccurate and ambiguous, which leads to misleading conclusions, in which it comes to the distortion of the image of objective reality. The reasons of it are, in particular, the following:

a) The lack of distinction between the descriptions of the properties of physical objects and those properties themselves, and, consequently, a certain mix-up of the subjective, conventional elements with the absolute, objective ones, both in interpreting the results of measurements, and, as a consequence also in the definitions and formulations of final conclusions;
b) The lack of distinction between the states of inertial motion in which the objects are and the inertial frames of reference in which the descriptions are being made, which leads to uncertainty and ambiguity of wording and statements;
c) The lack of distinction between formal equality of descriptions of the properties of physical objects and the physical equality of those properties which leads to the lack of distinction between the formal equivalence of the inertial frames of reference and the physical equivalence of the states of inertial motion (that is, between formal and physical relativity);
d) Mixing-up the physical concepts with the geometric ones, in particular the introduction of variable metrics, depending on the physical properties of objects, which makes impossible the comparison of the descriptions of the properties of objects in different states of inertial motion and causes that the conclusions about the properties of those objects and about their changes under the influence of motion drawn from experiments are incorrect.

The alternative interpretation of relativity, which includes the notion of a privileged state of inertial motion, whose elements are outlined here, is in the opinion of its adherents more rich in its physical content than the standard interpretation of special relativity due to the fact that it reaches deeper into the real essence of the phenomena being investigated and described. It is not satisfied with just the logical consistency of the formulations and with the agreement of its predictions with experimental results, but also is searching after deeper comprehension of the fundamental physical phenomena which govern our universe. In particular, the following advantages of it can be mentioned:

a) It retains the classical concepts of space and time. The observed “relativistic” effects are being explained not as the result of another construction of space-time than formerly accepted, but as a result of another behavior of physical objects than formerly accepted: the changes of properties of objects under the influence of absolute motion;
b) It retains the classical, visual nature of the propagation of light; the alleged independence of its speed from the reference system it explains as an seeming phenomenon, resulting from the introduced assumptions, that is from the accepted conventional elements of the descriptions (in particular from the way of synchronizing of remote clocks in which the assumption of the isotropy of the speed of light is already contained);
c) It retains the classical spatial transformation (in the form of the Galilean transformation) on the condition that in all descriptions (i.e. in all frames of reference) the same set of assumptions is being used; The Lorentz transformation is being explained as a simultaneous change of the frame of reference and of the set of assumptions made (the adjustment of the metrics to the changed properties of objects);
d) It retains the classical, visual method of adding the velocities of objects on the condition that all the descriptions of velocities to be added are comparable, i.e. that all the descriptions were made by the use of the same set of assumptions; the non-additive formula for “adding velocities” is being explained as a recipe for combining mutually incomparable descriptions of velocities obtained by using unequal assumptions;
e) It retains full consistency and comparability of experimental results carried out on objects in any state of inertial motion, using measuring instruments and standards of any frame of reference on the condition that in all experiments and descriptions the same set of assumptions is being used; “relativity” of the results of experiments is being explained as a result of obtaining descriptions which are incomparable with each other due to the application of different assumptions;
f) It explains visually the so called “relativistic” phenomena (in particular the length contraction and time dilation) as real, physical changes of the properties of objects under the influence of their absolute motion;
g) It explains the physical reason of the “relativistic” phenomena as a result of the adaptation of the properties of physical objects to the changing anisotropy of the speed of propagation of the forces acting on those objects;
h) It explains the principle of relativity, that is the equivalence of the frames of reference, as being only formal, apparent, based on the formal equality of descriptions of properties which are incomparable with each other; as a result of it from this formal relativity it does not follow physical relativity.
i) It can be derived from the existing experimental evidence by the use of very elementary and obvious assumptions (in particular of the principle of consistency of measurements, i.e. of the comparability of experimental results) which are the basic, intuitive weapons of every experimental physicist; in the standard interpretation such a derivation is lacking; it is based, as known on postulates accepted ad hoc and in order to maintain them it is necessary to reject such basic, intuitive assumptions (in particular, the principle of consistency of measurements) and the empirical consequences which follow from them.

Generally speaking, special relativity in its Lorentzian version gives very clear, beautiful picture of facts, devoid of any puzzles or paradoxes, fully compatible with a common, intuitive perception of the world. It should be pointed out that this is achieved without losing anything of value and without any risks, of which seem to be so much afraid the adherents of the Einstein's interpretation of relativity. Because the formalism of the relativity principle remains intact, there is no need to change anything in the SR itself, there is also no fear of having to revise anything in other physical theories, constructed on the basis of SR. The difference is mainly in the language, by which we describe all known facts. But this is not irrelevant, if the alternative is characterized by greater transparency and easier comprehension, allowing a better understanding of the facts and see new details.

According to the adherents of the standard interpretation, to explain the "relativistic" effects as reflecting real changes under the influence of absolute motion is "a complicated explanation of a simple phenomenon" (see, for example. [17]). From the point of view of the interpretation of Lorentz the opposite is true. It is in the standard interpretation where a simple phenomenon (the influence of absolute motion on the properties of moving bodies) is being explained in a rather complicated way (by means of destruction of the fundamental concepts of space and time, the introduction of variable metric and the "relativization" of everything except the quantities which are Lorentz invariant) only in order to make the principle of relativity a fundamental axiom. The existence of the alternative interpretation of Lorentz refutes the belief that "this profound revolution in the way of thinking" was imposed by experimental evidence. In the light of this alternative, it appears rather as unnecessary.

Finally, however, we have to stress that it would be a mistake to expect that discussions about those two interpretations could lead to the victory of one, and the overthrow of the other. In view of the equality of their empirical predictions it would be both aimless and impossible. It would also make no sense to pursue efforts in order to gain supporters for one interpretation at the expense of the other. What, however, is urgently needed is a thorough, insightful analysis of both interpretations, in particular their conceptual apparatus and the assumptions taken in them (often tacitly or even subconsciously) as it can both enrich our knowledge of the fundamental laws governing matter, as well as improve our scientific methodology. So there is no point in quarrelling but it is worth to analyze this specific kind of dualism which for so long was generally out of attention. If this work manages to contribute to this, it will meet its goal.

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The original version in Polish was written in 1983/1984. In 1993 it appeared in a revised version as a preprint of the Institute of Nuclear Physics, Cracow, No. 1625/PL.
The English translation is published here for the first time.