Relativity in Terms of Measurement and Ether

Lajos Jánosssy's Ether-Based Reformulation of Relativity Theory

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Abstract

In his monograph *Theory of Relativity Based on Physical Reality*, Hungarian physicist Lajos Jánossy develops the complete Einsteinian formalism of relativity theory by analysing the process of measurement, the systems of measures created in this process and experimental data expressed in terms of measures. He demonstrates that based on a simple principle (which he calls the Lorentz principle) and its generalization the whole formalism of the original theory may be developed in conformity with the notions of common sense without mathematizing physical reality, so that the new way of development is of the same heuristic power as the original one. His analysis makes it clear that the allegedly revolutionary new notions of space and time follows not from physical experiences but from Einstein's positivist philosophical commitments. Having established the place and role of a privileged (but not absolute) reference system, at the second level of his theory Jánossy connects this system to the carrier of electromagnetic phenomena which he also assumes to be the carrier of the gravitational and other physical fields. Although he uses the term 'ether', he explicitly rejects the old theories of this entity and attributes to it dynamic properties. In the last section of the paper Einstein's and Jánossy's ether concepts are compared and it is argued that despite the parallelism between the two concepts, from Jánossy's point of view Einstein's ether is too mathematical to cure the inverted relation between mathematics and physics characteristic for Einstein's relativity.

Key words: relativity, ether, propagation of light, privileged reference system, space-time, measurement, ideal solid rod, ideal clock, common sense in physics, mathematics in physics, physical reality, Einstein, Lorentz, Jánossy

1. Introduction

In *Physical Relativity*, a monograph published by Clarendon Press in 2005, Harvey Brown criticizes the received view of Einstein's theory and argues for a physical interpretation of relativistic phenomena. [Brown 2005] Both Brown's book and the regular conferences on the interpretations of relativity theory organized by Michel Duffy [Duffy 1988, 1990 ….2006] clearly indicate that the long tradition of considering the original, Einsteinian-Minkowskian notion of relativity theory too mathematical and claiming that it blurs (or even turns into its opposite) the epistemological relation between mathematics and physics is alive even today, more then 100 years after Einstein's famous paper.

In the introduction to his book Brown mentions the Hungarian physicist Lajos Jánossy as one of his forerunners inspiring his ideas. [Brown 2005, vii.] Jánossy was an important figure in the tradition of alternative interpretations of Einstein's theory, who (following Lorentz's ideas) elaborated a comprehensive alternative ("physical") relativity. He, along with American Herbert Ives (who belonged to a former generation of physicists) and Prokhovnik (a contemporary of Jánossy) may be considered as one of the classics of the field. However, while on the basis of personal communications it seems that his work on relativity theory was well known by those who did research in the topic in the last decades, he (in contrast with Ives and Prokhovnik) is only rarely cited in the literature. (M. Duffy mentions Jánossy's work in his recent paper [Duffy 2008] and Bell in his famous study *How Teach Relativity?* also expresses his appreciation for Jánossy's contribution to the topic [Bell 1976].)

The aim of this paper is to give a brief review of Jánossy's reformulation of relativity theory, which deserves more recognition than it has received until now.

2. Lajos Jánossy's career

Lajos Jánossy was born in Mátyásföld (then a village near Budapest, now part of the Hungarian capital) in 1912. His father Imre Jánossy was an astronomer who died relatively young in 1920. After the death of her husband, his mother, Gertrud Borstrieber (a mathematician belonging to the first generation of Hungarian women with a university degree) married the Hungarian philosopher George Lukács, who was considered by the French philosopher Lucian Goldman the first representative of the existentialist philosophy, but who later gave up his youthful enthusiasm for Kierkegaard and became a famous and highly controversial Marxist philosopher of the 20th century, oscillating permanently between communist movement discipline and sovereign philosophical thought and causing many a disturbance for the party leadership. After the fall of the Hungarian Soviet Republic in 1919 Lajos Jánossy's family moved to Austria and later to Berlin. Instead of following his stepfather in politics or philosophy, Jánossy became a physicist. He studies physics at the Humbold University in Berlin where he was a student of Edwin Schrödinger whose metatheoretical considerations on physics had a determinative influence on him. In the 1930s Jánossy became also a university professor and read physics (and especially relativity theory) at Manchester University (while his stepfather left Hitler's Berlin for Stalin's Moscow and lived there with his political and moral compromises). His main research field being cosmic radiations, he became an internationally respected scientist in the field, and his monograph on the topic belongs to the basic literature on the subject [Jánossy 1948, 1950].

After Word War Two George Lukács returned to Hungary and in 1950 Lajos Jánossy (then a professor at the Institute for Advanced Studies in Dublin and a colleague of his former professor, Schrödinger) followed him. While his stepfather was never a "pet" (or with the good German word a "Liebling") of the communist party, party leaders needed his international respect, as well as Lajos Jánossy's scientific knowledge. So the latter became head of the Central Institute for Physical Research, a grand new research institute established on a Soviet model.

It is generally held that Einstein's theory of relativity was deemed by the official Soviet ideologists as a bourgeois theory, so Jánossy's criticism of the Einsteinian notion of relativity may appear in this context as a version of the Soviet criticism of the theory, but it is not the case.

On the one hand, although several attempts were made in the Soviet Union to discredit relativity theory as a prototype of false, idealistic physics, and at the turn of the forties to the fifties of the last century a fierce campaign was waged against the theory, the attempts never resulted in its official denunciation. On the contrary, after the death of Stalin, Einstein's Soviet followers won the debate and Einstein's theory came to be glorified as a true dialectical theory, which as such fully corresponds to Marxism-Leninism. [See e.g. Graham 1972, 111-138; Székely 1987]

On the other hand, and quite importantly, Lajos Jánossy *had never taken part* in the antirelativistic campaign. The greater part of his critical considerations on relativity theory was published in a period when official Soviet ideology endorsed Einstein. Hence, beside the criticism his concept received from orthodox Einsteinian physicists, Jánossy's notion of the relativity theory also became a target of official philosophers of the Soviet block. Although the Hungarian Academy Press undertook the publication of his comprehensive work *„Theory of Relativity Based on Physical Reality"* [Jánossy 1971], in his last years he was considered by the orthodox Einsteinian physicists who were then dominating the Hungarian physics scene as an anti-relativist dinosaur and (while formally preserving his university position) he was gradually displaced from Hungarian scientific life. He died in 1978.

Whereas the ideological, political and sociological contexts of Lajos Jánossy's scientific work would also offer interesting topics, this contribution will be restricted to reviewing his concept of the theory of relativity only from the point of view of physics and the philosophy of science.

3. The metatheoretical foundation

3.1. The relation between mathematics and physics and the norm of common sense

As indicated in the title of his monograph, Lajos Jánossy characterizes his notion of relativity theory as a theory based on physical reality. This title expresses both a critical and a confirmative aspect. On the one hand, Jánossy argues that the Einsteinian theory is not based on physical reality: while it is an effective mathematical tool for handling the results of measurements and for making predictions, it does not provide an appropriate theory of physical reality. On the other hand, he affirms that the mathematical formulas of Einstein's theory are correct in the sense that they are in correspondence with observation and empirical data and are able to give correct predictions about the behaviour of physical reality.

Of course, Jánossy sees clearly that what Einstein offers us is not only mere mathematics but a definite physical theory. He insists, however, that Einstein turns the relation between mathematics and physics into its opposite: in his view the German physicist projects mathematical formulae into the physical world and in this way constructs physical reality by *hypostatisation* of mathematical ideas. Consequently in the context of his criticism the so called "spatialization of physics" which is often praised as a great achievement of relativity theory appears as a result of hypostatisation and Jánossy focuses his criticism on this element of the theory:

> "The theory of relativity in its original formulation is certainly not a mere attempt to describe phenomena by suitable mathematical expressions – the theory is a far reaching attempt to give a theory of space and time. Our criticism of the theory is just connected with this latter feature. We think that the theory reflects correctly certain general physical laws, but these laws – in our opinion – have nothing to do with the "general structure of space and time". Therefore our attempt is to give a physical interpretation of relativistic formulae, which is different from old one." [Jánossy 1971, 13]

But how do we know that the view Einstein offers of the physical world is inappropriate? An incorrect methodology does not necessarily imply the incorrectness of the theory. Does the theory have any independent, non-methodological features which might make it problematic?

In answering this question, Lajos Jánossy represents a view which is typical in the criticism of Einstein's relativity and which can be characterized as "common sense criticism".

> "I got acquainted with the theory of relativity at a comparatively early age – I read the famous popular book written by Einstein. Reading the latter I had difficulties with some of Einstein's concepts: however, having been young and enthusiastic, I convinced myself in the end that I could understand those concepts – to prove this I tried to explain the theory to everybody who was interested. In the course of such attempts I learned the 'language of relativity' and I gradually 'got used' to the theory.
> …. Many years later I read several years in succession a course of physics at the university of Manchester. My course contained also the special theory of relativity. As the years went on I developed a technique of presenting the subject so that in the end I could convince my students that they really understood the theory. However, as my technique presenting the theory improved, my own belief in the adequateness of the concepts vanished. In the end I became convinced that from the philosophical point of view the concepts had to be changed. Since about 1950 I have struggled with the problem of the reformulation of the theory and the results of my deliberations are found in this volume." [Jánossy 1971, 14]

As Descartes's narrative about his schools and education in his *Discours de la Methode* (*Discourse on the Method)* expresses a radical criticism of the philosophical views of the epoch and his personal style functions as endorsement and authentication of the criticism, here, in Jánossy's reminiscence we also encounter a radical philosophical criticism. Jánossy challenges the generally received view that relativity theory requires us to give up our common sense terms. We should not be mislead, he argues, but recognize that there is really something disturbing in Einstein's theory and the correct attitude is not to suppress this disturbing factor by blaming our common sense for incapacity to grasp physical reality but to face and eliminate it by reformulating the theory.

In other writings he is more sanguine and characterizes the received attitude of modern physics to common sense as a cult of irrationality, in the context of which contradiction with common sense becomes a virtue and the scientific character of a theoretical claim is measured by the extent of its absurdity. Rejecting this approach, he insists that "[a] scientific way of thinking cannot be but the refinement, deepening and further development of everyday thought" and that "the whole complex of the theory of relativity can be built up by means of natural methods in conformity with everyday thought". [Jánossy and Elek 1963, 9, the original is in Hungarian] (Jánossy, influenced by the philosophy of his stepfather, prefers the term "everyday thought" to "common sense" but in his argument the former functionally corresponds to the latter.)

To summarize, the metatheoretical foundation of the criticism and reformulation of relativity theory by Jánossy consists of two interlaced moments, namely, the priority of physics regarding the mathematical formalism and the conscious acceptance of the terms of common sense as a norm for theory construction. Whereas these moments are common to criticisms of Einstein's theory, the metatheoretical foundation of the criticism is only seldom formulated so explicitly and definitely as in his case, and this is especially true regarding the role of common sense. The requirement of conformity with the basic notions of common sense as a norm for theory construction emphasized so resolutely by Jánossy may be regarded as *Jánossy's thesis* and considered as one of the most important metatheoretical theses concerning modern physics. [Székely 1987; Székely 1988]

3.2. Measures, measurement and relativity theory

Metatheoretical norms and principles, however excellent, cannot have any significance if one cannot find the way of their correct application in concrete theories. Jánossy's main achievement regarding relativity theory is not simply the formulation of the metatheoretical foundation of the criticism but *a complete and consistent reformulation of the theory in physical and mathematical terms.*

In the following parts of our paper Jánossy's version of relativity theory will be often contrasted with the Einsteinian one. To avoid misunderstandings, it is important to emphasize that in doing so we will always use the terms „Einstein's theory" or "Einsteinian relativity" in the sense of the version of the theory as it was presented in Einstein's original (physical) papers and as it is generally taught at universities and presented in textbooks. That is, in our usage the term „Einstein's theory" will not include any of the metatheoretical and physical reflections made by the German physicist after the publication of the theory. The relation of Jánossy's notion of relativity theory to Einstein's subsequent, out-of-theory reflections (which cast a new light on his original formulation of the theory and leave room for a reading which might suggest its reformulation in the direction represented by Jánossy) will be considered at the end of this paper.

As a consequence of the heated ideological debates, late in his scientific career Jánossy abandoned philosophical categories regarding relativity theory. Thus in his comprehensive monograph *"Theory of Relativity Based on Physical Relativity"* published in 1971 we cannot find even such ideologically neutral categories as "common sense" or "everyday thought". Instead of using philosophical categories he identifies the indicated disturbing aspect of Einstein's theory in terms of measurement theory. According to him,

> " [i]n our approach of physics in general and the theory of relativity in particular we think it very important always to remember that we are dealing with objective physical quantities

> and that we attempt to describe the latter in terms of measures." [Jánossy 1971, 15]

Furthermore,

> " [a]n objective physical process develops according to its own laws and it can be described in arbitrary measures." [Jánossy 1971, 14]

Distinguishing measures from things measured, Jánossy definitely commits himself to the traditional concept of physical reality, according to which there exists something „out there" with its own laws and thus he rejects the positivist approach. But emphasizing the arbitrariness of the measures used by physics, he also opposes naive, metaphysical realism which maintains that the investigated objects and the theoretical entities directly correspond to each other (or – in a weaker version – considers the latter the approximations or conceptual pictures of the formers). In his concept physical quantities as characteristics of physical entities are outside of physical theories, while measures (and theoretical construction, so coordinate systems built up of these measures) are the *representations* of these quantities which physicists can chose arbitrarily. [Jánossy 1971, 72]

Consequently, in Jánossy's interpretation space and time coordinates, as well as their transformations lose the mystical character conferred them by relativity theory:

> "We may write x=r,t for a four-coordinate of an event. Changing from one system of reference to another we can introduce transformed coordinates x'=f(x) (1) where f(x) is some reversible four-function of its variable x. If the coordinates x are suitable to describe events, then the transformed coordinates are also suitable. Introducing particular measures x or x' for events we give some kind of names to the events with the help of which we recognize them. … The fact that a transformation type (1) mixes the measures of time and space coordinates does not seem to be of particular importance and it does not imply any properties of space and time." [Jánossy 1971, 14]

This view of physical quantities and their measures is open to contention. However, it is based on acceptable and justified metatheoretical postulates well established in the history of physics which may serve as a foundation for physical theories. Furthermore, it is clear that these postulates contradict the Machian-positivist philosophical background of Einstein's notion of relativity and thus their definite formulation by Jánossy makes it evident that that notion is not neutral from the point of view of physics: it does not follow from the nature of the physical world but rather is a consequence of Einstein's metatheoretical commitments.

But if measures are only names or signs arbitrarily chosen by physicists, how is it possible to know anything about physical reality that is supposed to exist outside physics, a system of human theories?

Lajos Jánossy answers this problem by introducing the concept of distinguished measures. While a physical quantity can be described by an infinite number of systems of measures, the majority of the possible descriptions do not contain any information about the quantity in question. Distinguished measures are particular classes of measures which "reflect clearly certain properties of quantities" [Jánossy 1971, 72] Therefore, one of the most important tasks of theoretical research is to find distinguished measures for the quantities under scrutiny, that is, to attempt to find for the description of particular quantities numbers which reflect adequately certain physical properties. [ibid.]

To elucidate the concept in more detail, in Chapter III of his monograph Jánossy analyses the measurement of electric charges and then (taking into account that relativity theory is strongly connected to the so called space and time coordinates) in Chapter IV he works out distinguished measures for space and time. According to his analysis distinguished measures are characterized by the fact that in general both their sum and product (or in certain special cases at least their sum) express significant physical quantities, that is, their sum and product also appear in our measurements and/or in the established physical laws. For example, the sum of the usual measures of two electric charges *E1* and *E2* (say measures *e1* and *e2*) will be equal to the measure we receive measuring the joint charge, while the product of *e1* and *e2* appears in Columb's Law. (In fact, Jánossy designates physical quantities with Gothic letters while their measures with Roman letters, so he designates a physical charge with a Gothic *e* while its measures with a Roman *e*. For technical reasons we do not follow his notation here.) A physicist used to the usual notation and language of physics may find this terminology rather curious, since physical texts do not usually distinguish the charge and its measure but designate both by the same symbol (say *e*). However, in the metatheoretical context established by Jánossy it is clear that the charges as objective physical entities do not determine directly the measures to be constructed in the process of measurement and hence it is not at all evident that the measure of joint charges should be the sum of the measures of the two original ones. In Jánossy's words,

> "[i]n practice there seems to be no point in introducing non-additive scales for quantities if there is a possibility of introducing also additive representations. It must be emphasized, however, that it is not trivial that for certain quantities additive measures can be introduced. Whether or not such measures can

> be introduced in a particular case is a question which can be decided experimentally…." [Jánossy 1971, 78]

Of course, the question of measurement is a very complex topic and in his monograph on relativity theory Jánossy could only briefly outline his respective ideas. A more detailed presentation can be found in his earlier monograph *Theory and Practice of Evaluation of Measurements* which contains a comprehensive presentation of his theory of measurement. That book should be consulted by those interested in this aspect of Jánossy's theory. [Jánossy 1965]

What follows is a brief sketch of Jánossy's reformulation of relativity theory based on the metatheoretical commitments outlined above. We will attempt to reproduce the logic and the conceptual structure of his theory and will set aside the technical-mathematical details that are essentially the same as the well known textbook formulation of Maxwellian electrodynamics, the formulae of Lorentz transformation and the Einsteinian formalism of the special and general theory of relativity.

3.2. Measures and relativity

3.2.1. Measures of space and time based on rigid rods and physical laws. The definition of ideal clocks.

While in his famous paper Einstein firstly introduces a scale of length with the help of rigid rods and then "*defines time*" (ie, in Jánossy's terms, "*introduces distinguished temporal measures*") with the help of clocks and light signals and so he establishes a "hybrid" scale of space and time, Jánossy separates the rigid rod method from the light signal method and introduces two independent systems of measures: one based on rigid rods, another on light signals.

As we have seen, for Jánossy it is not at all trivial that additive length measures can be introduced. The use of additive length scales in everyday practice is based on the fact that with the help of rods considered in every day life as "solid" additive length measures can be obtained. According to Jánossy, science can introduce the term of ideal solid rods only because we are given this experience and he defines a rod to be an ideal solid rod if with its help an additive scale of length can be obtained. [Jánossy 1971, 79]

On the other hand, Jánossy emphasizes that with the help of periodical processes (such as mechanical clocks, planetary motions etc) we can complete our system of length measures to set up *a combined system of length and temporal measures in terms of which physical phenomena obey certain rules*. As measures in general, temporal measures in particular can be obtained in several ways and there is no a priori guarantee that these ways will all result in the same measures (or that measures arrived at in different ways will coincide). However, considering that the aim of physics is to discover rules in the behaviour of the physical world and formulate them as physical laws, from the point of view of science it is rational to attempt to complete our length scale with a temporal scale in such a way that certain fundamental and in the practice well confirmed laws, for example, Newton's first law be fulfilled.

At first sight, perhaps, this approach may seem to be logically circular, since physical rules may appear only if we have already a joint scale of length and time, while Jánossy want to complete the length scale with a temporal scale with the help of already known laws. Is this not a vicious circle?

Taking a closer look at the issue reveals that the approach is correct. In the history of physics we are given physical rules (for example, Newton's first law) which seem to work if we use our everyday length and time measures or measures established in the history of physics. These rules appear in terms of measures, which are intuitive and without reflection (or are based on metaphysical commitments as for example in Newton's case) and therefore it cannot be excluded that they are to a certain extent consequences of our choice of measures. To enlighten the nature of these rules we need an a priory analysis of the applied measures and in this analysis (while suspending the validity of the concerned rules regarding physical reality) we may introduce a hypothetical world in which these rules are assumed to be fulfilled, and Jánossy follows this methodology.

Thus we may assume a region where Newton's first law is valid in terms of a given (but yet unknown) system of measures. Provided that we already have a length scale, in such a region we no longer need Einstein's radar method to synchronize clocks: it will suffice to observe the motion of free particles and to adjust the local measures of time showed on the local clocks in such a way that Newton's first law be fulfilled. (To observe the path of a particle we need not use light signals: every observer can measure with the help of his own clock and make a note of the time when his own position is crossed by a moving particle and then the notes can be collected and analysed in order to synchronize the clocks.) Exploiting this a priory possibility, Jánossy introduces the term of „ideal clock". According to his definition *a clock is ideal when it gives immediately (without correction) the distinguished temporal measures based on Newton's first law.* [Jánossy 1971, 95-96] The rate of an ideal clock is by definition constant and our physical practice definitely shows that there are regions in the real world which allow us to introduce good approximations of a system of measures based on ideal solids and ideal clocks. (Otherwise Newton's first law would not be applicable in practice.)

Similarly, we may introduce temporal measures using planetary motions or the rotation of the Earth around its axis and assuming the validity of the law of gravitation and it is also possible to use atoms as clocks and taking into account the physical theories of atoms. Of course, it is not evident that all these scales will correspond to the first, mechanical or 'ideal' temporal scale; neither is it evident that the non-mechanical (planetary, sideric or atomic) scales will be adjustable to each other. In this respect Jánossy's definition of ideal clocks is a metatheoretical norm requesting a physical explanation in any case when an applied time scale deviates from the ideal one. (Incidentally, since Newton's first law is deducible from Leibnitz's principle of sufficient reason, Jánossy's definition of ideal clocks may be deduced from this fundamental Leibnitzian thesis. On the other hand, it can be also shown that the Einsteinian version of special relativity does not fulfil the Leibnitzian principle. Thus Jánossy's version of relativity theory - despite its empirical orientation - can be seen as a reformulation of the original Einsteinian theory, with the aim of satisfying Leibnitz's principle. Furthermore, Jánossy's method of definitions of ideal solid rods and ideal clocks, a beautiful example of the application of everyday experiences in physics, follows – unconsciously – the logic of the so called "hermeneutic circle" emphasized by Heideggers' philosophy and indicates how promising a possible Heideggerian metatheory of physics may be.)

3.2.2. Measures by radar method without rods

Jánossy also shows that it is possible to attempt to introduce length and time scales using only light signals, provided that we assume that light is propagated isotropically and with a constant velocity relative to a given reference system, say K. It is clear that similarly to the rigid rod scale, we do not have any a priory guarantee of success in this case either. It is a matter of practice whether a coherent system of space and time coordinates can be constructed in such a way and if we succeed and a system of coordinates introduced by this method passes the test of coherence, then this fact „can be taken to support the hypothesis about the mode of propagation of light in K". [Jánossy 1971, 99] The introduction of such a scale follows the same logic as the rod scale without the radar method: first an ideal region is assumed where light is propagated isotropically and the measures are defined for this ideal region, then, as the second step, experience will show whether these measures can or cannot be applied in the real world.

4. Lorentz transformations and Jánossy's theorem

4.1. Lorentz trasformations as transformations of measures

Applying the conceptual basis introduced above, Jánossy demonstrates that:

if there is a system of coherent measures M of length and time in terms of which light appears to be propagated isotropically and with the velocity c relative to a reference system S,

then there exists a group of mathematical transformations of that system of measures with the following characteristic:

- each members of the group transforms the system of measures M into another system of measures M' in whose terms light appears to be propagated isotropically and with the velocity c relative to another reference system S' which is in rectilinear and even motion relative to the original reference system S;

- vice versa, for any reference system S' in rectilinear and even motion relative to the original reference system S there exist a member of the group of transformation above, which transforms the system of measures M into a system of measures M' so that in the reference system S' light will appear to be propagated isotropically in terms of M'. [Jánossy 1971, 100-105]

Anyone familiar with relativity theory will see that the group of transformations which Jánossy found is the well known group of the Lorentz transformations. That is, he did not discover transformation of a new kind but deduced the famous ones in a new way different from both the Einsteinian and the Lorentzian deductions. However, what is important for us is not simply the new deduction but the new meaning of the transformations. Whereas in Einstein Lorentz transformations are deduced as transformations which connects inertial reference systems so that Einstein's two axioms be satisfied, in Jánossy they emerge in an investigation of the propagation of light in terms of various systems of measures without referring to the concept of inertia and their existence are stated in the form of an a piori, mathematical theorem.

We will refer to this theorem as "Jánossy's theorem" and (following his terminology) call the reference systems relative to which light appears to be propagated isotropically in terms of a particular system of measures "Lorentz systems". Notice, that Jánossy's theorem is not about inertial systems: it is valid independently of whether Lorentz systems are inertial or not.

4.2. The analysis of Jánossy's theorem

Jánossy's theorem imposes two a priory constraints upon physical reality.

A) On the one hand, *if rods and clocks are never deformed when in motion with respect to any Lorentz system* (that is they preserve their shape and pace), then

i) (on simple geometrical grounds) there will be only one Lorentz system in which the system's own Lorentz measures (that is, the measures in terms of which light appears to be propagated isotropically relative to the system) and measures based on rods and clocks without light signals will coincide; consequently

ii) the relative velocity of any other Lorentz system with respect to this special system will be determinable with the help of rods and clocks and light signals, since in terms of measures established with the help of these rods and clocks light will not appear to be propagated isotropically relative to these systems. (This simply follows from the fact that Lorentz measures are connected with Lorentz transformations which change the measures of length and time, while the unchanged rods and clocks will establish the same system of measures independently of their motion relative to any Lorentz system.)

B) On the other hand, if we observe that Lorentz measures and measures based on rods and clocks co-moving with the systems will always coincide, then this observation will indicate that

i) there is a definite Lorentz system in physical reality which may be called as the basic system, and

ii) rods and clocks moving relatively to this basic system suffer deformation according to the formulae of the Lorentz transformations.

The observed relativistic effects (that is, the relativistic contraction of lengths and the slowing down of physical processes according to Lorentz's formulae) show that in physical reality the second possibility is the case, thus on the basis of Jánossy's theorem as an a priory theorem these effects necessarily imply the existence of a basic physical system in which rods and clocks at rest are not deformed, while in motion relative to this system they suffer deformation according to Lorentz's formulae.

4.3. The hidden epistemological and logical background of Einstein's special theory

The a priory analysis of Jánossy's theorem makes clear that Einstein's special theory of relativity is based on two mathematical "boundary-conditions". On the one hand, special relativity is only possible because Jánossy's theorem is valid, that is, Lorentz transformations exist and they transform a system of measures in term of which light appears to be propagated isotropically into another system of measures with the same characteristic. On the other hand, the Einsteinian version of the theory, that is, the version in which – in contrast to the implication of Jánossy's theorem –, the existence of any privileged systems is rejected, can only escape logical contradiction because Einstein implicitly rejects that the spatial relations of the physical entities of a given region form a definite, consistent spatial configuration.

To enlighten the latter moment of Einstein's theory, let us recall that the claim about the isotropic propagation of light in any inertial system is perhaps the most paradoxical ingredient of the Einsteinian theory of special relativity. Namely, if a physical effect is propagated in a given reference system isotropically, then it cannot (on geometrical grounds) be propagated in a similar way in other systems moving rectilinearly and evenly with respect to the former. How is it possible that Einstein succeeded in working out a consistent theory incorporating this geometrically impossible characteristic of the propagation of light?

Jánossy's theorem helps to explore the hidden conceptual background which makes possible for Einstein to avoid the contradiction.

Namely, geometry excludes the simultaneous isotropic propagation of light relative two different (physical) reference systems in motion at a constant velocity relative to each other only if the following two premises are fulfilled:

i) the space and time relations of the physical entities of the concerned region define a common, definite space in which the investigated systems move

and

ii) length and time are measured in both systems with the same measures.

Consequently, we can construct a consistent physical theory in which light appears to be propagated isotropocilly with respect to two different reference systems in motion relative to each other only if we reject at least one of these premises.

Now, Jánossy explains relativistic phenomena with the help of the assumption that rods and clocks in motion relative to the basic system are deformed according to Lorentz's formulae. Consequently, in the case of two Lorentz systems in motion at different rate relative to the basic system these measuring tools will suffer different deformations and so the systems of measures introduced with their help will be also different. Thus in Jánossy's conceptual framework it is premise ii) that is not fulfilled, and the function of the assumed deformations of rods and clocks are exactly to give an explanation of the change of measures that takes place despite the use of the same rods and clocks when we change the systems. Of course this explanation – as any Lorentzian kind approach – breaks the ontological symmetry of the relativistic effects: in its context the contraction of rods observed from a system moving faster relative to the basic system than the observed rods is only an apparent phenomenon since the latter suffer smaller contraction than the measuring rod of the observer and hence in reality they are longer than the observer's rod.

Since Einstein's theory excludes the existence of any basic system and assumes relativistic effects to be symmetric that does not allow to speak about real, physical deformations of measuring tools, his theory can be consistent only if the first premise is rejected. However, if we assume that physical entities are definite entities with definite spatial relations, then these relations will form a definite physical space in which these entities exist and move. So the rejection of premise i) amounts to rejecting that physical entities have definite spatial relations independently of the applied measures and in Einstein's special relativity this really is the case. Due to Einstein's neopositivist attitude, in his theory physical entities exist and move not in a common physical space but inside relative co-ordinate spaces, that is, (using Jánossy's term) inside spaces of different systems of measures and it can't be introduced any common system of spatial relations that could be independent of our measures. Put differently, Einstein's axiom of special relativity by exclusion of the existence of any privileged reference system also excludes the possibility of any definite physical configuration formed by the spatial relations of the physical entities, and so, in the words of Hungarian philosopher Melchior Palágyi, it fragments physical reality into an infinite number of reference systems. [Palágyi 1914, 59-60; see also: Székely 1996]

5. Ether and Lorentz principle

5.1. Ether and Lorentz deformations

Jánossy calls the deformations of clocks and rods in motion relative to the basic system "Lorentz deformations". Taking into account that these deformations emerge when rods and clocks are in motion with respect to the basic system, it is natural to assume that the basic system is connected to some physical entity (such as a background physical field) and the deformation is somehow caused by this entity. Furthermore, considering that the classical concepts of the ether have a function similar to that of this entity, the latter can be called "ether" without any commitment to the notions of the classical ether theories. However, it is not necessary to use this term. What is important is only that if one distinguishes measures as representations from the measured things as parts of physical reality, then the observed relativistic phenomena discussed in the special theory of relativity will imply the existence of such a background entity as well as the Lorentz deformations of clocks and rods in motion relative to it.

Now Jánossy identifies this background entity with the electromagnetic ether which he introduces on common sense grounds. According to him

> "From Maxwell's theory it follows that light in particular and all electromagnetic action in general is propagated with a velocity c= c', where c' is the critical velocity. …. The question cannot be avoided relative to what are electromagnetic waves propagated with velocity c?…. A simple answer to this question could be obtained claiming that light is propagated with the velocity c relative to its source. The latter assumption contradicts, however, the well established theory of Maxwell and seems also to be contradicted directly by experiments…. Electromagnetic perturbation once it has left its source is propagated thus with a velocity c independently of how the perturbation comes about. The only reasonable interpretation of this is to assume that the perturbation moves with a velocity c relative to its carrier. The carries may be denoted using Maxwell's terminology, ether. We shall in accord with the ideas of Maxwell also assume that light is propagated with a velocity c relative to the ether." [Jánossy 1971, 48]

That is, for him the existence of a basic system is granted in advance, independently of the Lorentz transformation and an analysis of relativistic phenomena, on the basis of Maxwell's theory. So the logic of his presentation does not follow strictly our a priori analysis above. We have made a small change in the presentation of his ideas and deduced the existence of a basic system from the observed relativistic phenomena with the help of his theorem just to indicate the heuristic power of his approach.

5.2. The Lorentz principle

Relying on the null results of the experiments aiming to determine the translation velocity of the Earth relative to the ether (such as the Michelson-Morley and the Kennedy-Thorndike experiments) and on the observation of the perpendicular Doppler effect, Jánossy finds it reasonable to introduce the following general principle which he calls "the Lorentz principle":

> *"The law of nature is such that provided S is a real physical system, then the Lorentz deformed systems S* are possible systems obeying the same laws as S."* [Jánossy 1971, 120]

It is evident that this is a reformulation of Einstein's principle of special relativity in physical terms, implying the same observational predictions and the same modifications of classical physics as Einstein's principle does. It is a frequently repeated argument against Lorentzian-type interpretations that they are ad hoc in contrast to Einstein's beautiful axiomatic theory. Now Jánossy has definitely showed that this is not the case. On the one hand, the Lorentz transformation can be deduced in a train of thought of simple considerations about measurements and measures. On the other hand, the Lorentz principle as a simple idea based on observational data completely substitutes Einstein's axiom of the equivalence of inertial systems and predicts the relativistic phenomena in a similarly simple and coherent way as Einstein's axiom does. Furthermore, if we want to compare the two approaches using the term "ad hoc", we must conclude that it is Einstein's theory and not Jánossy's reformulation that is ad hoc in the particular sense that it states the equivalence of inertial systems as an unexplainable and non-deducible axiom, while Jánossy's Lorentz principle and the concept of Lorentz deformations are based on an analysis of physical measurement and measures, a problem that Einstein's positivist attitude prevents even to address.

6. Jánossy's general relativity

Jánossy does not stop at the reformulation of the special theory of relativity, but also reconsiders the general one. His notion of general relativity is based on two ideas:

i) the concept of measures applied in the reformulation of the special theory and the term of rigid bodies defined with the help of these measures;

ii) the generalization of the Lorentz principle originally introduced by him in the context of the special theory.

6.1. Ideal solid rods and the exclusion of the space-time metaphysics of general relativity

As we have seen, Jánossy defines ideal solid rods as rods with the help of which a consistent additive length scale may be obtained. In a further step Jánossy introduces a system of space co-ordinate vectors (that is, the usual space coordinate system) with the help of measures determined by rigid measuring rods and defines the distance of two points in this co-ordinate space by the formula $(R_i\text{-}R_k)G(R_i\text{-}R_k)=R_{ik}^2$ (formula *F*) where *Ri* and *Rk* are the coordinate vectors of points *Pi* and *Pk*, *G* is a positive definite symmetric matrix, and *Rik* is the distance. It is clear that according to this definition for any *N+1* points *P0, P1 ….. P(N+1)* we are given *N(N+1)/2* equations for the 3xN components of the co-ordinate vectors, thus we will have an overdetermined system of equations which does not have necessary solutions. Jánossy applies this fact to an extended definition of ideal solid rods: if in a system of space co-ordinates which has been established by measuring rods the distance formula above will work for any number of points (that is, the system of equations defined by the formula *F* for any points *P0, P1…Pk …..Pn* will have solutions), then we may consider our rods to behave as ideal solid rods. [Jánossy 1971, 81] Consequently, if we observe that the system of equations according to the formula *F* does not have a solution at any set of points, then this fact will indicate that the rods we have used in the construction of our co-ordinate system have been deformed in the process of measurement (that is, they are not ideal solid rods).

It is clear that this extended notion of ideal solid rods introduced by Jánossy aims to exclude any word usage about non-Euclidean physical spaces and is in full agreement with Poincare's idea of the relation of physics to geometry. Our hypothesis is neither on geometry nor on physics in itself but on geometry and physics together, Poincaré emphasizes, and Jánossy commits himself to a connection of physics and geometry in which the structure of space (at least in the Einstenian sense) loses its meaning. If formula *F* does not work consistently (that is, our co-ordinate space is not Euclidean), that will only inform us about the behaviour of measuring rods but will have nothing to do with the "structure of physical space":

> "The above statements can also be formulated in another way. If the measured distances r_{ik} between the points of a set can be expressed by a quadratic form (*F*), then one might conclude the space in which the points are situated is 'Euclidean'. Or if no

consistent co-ordinate measures can be obtained one might conclude that the space is 'non- Euclidean'.
We do not think, however, that such a conclusion has any meaning. The fact that the overdetermined system (*F*) poses solutions R_k *k=0,1, 2 …… n* seems to us *to reflect upon the method of measurement of the distances* r_{ik} *and in particular upon the measuring rods used.* Roughly speaking one may conclude from the consistency of measures that the measuring rods made use of are behaving like rigid bodies, i.e. if the measuring rods are turned or shifted they do not change their length." [Jánossy 1971, 86. Italics mine: Sz. L.]

It is to be noted that this conceptual scheme (whereas it radically opposes Einstein's view of the relation between geometry and experience presented in his paper of 1921 [Einstein, 1921]) is more than a clever trick to prevent any talk about non-Euclidean physical spaces. On the contrary, it is based on a correct epistemological presentation of the practice of physics and the relations among measures, the measured characteristics of physical entities and measuring tools. Jánossy's concept of the ideal solid rod makes it once again clear *that non-Euclidean spaces in Einstein's theory are only implications of Einstein's positivist philosophical commitment which neglects that measures and theoretical spaces built up of them are only human constructs which do not correspond directly to physical entities or their characteristics.*

On the other hand, this positivist washing away of the difference between physical reality and human representations may turn into its opposite and result in a metaphysics of space-time if (as is the general case in the university teaching of relativity theory) we assume that the metric of space-time appearing in the general theory is the cause of the gravitational phenomena. Namely, in this interpretation the structures and characteristics of co-ordinate spaces will appear as objective properties of the physical world and thus Einstein's positivist starting point will results in a theory of "objective" curvature of space-time which determines the behaviour of physical phenomena. If we have a feeling that in Einstein the cart is put before the horses [see: Balashov and Jansen 2003, 340; Brown 2005,133-134]), then Jánossy's analysis will explain the reason for this feeling. Measures as human constructions are numbers, so co-ordinate systems, coordinate spaces etc. constructed with their help are necessarily of a mathematical-geometrical nature. Washing away the difference between these human constructions and physical reality necessarily transforms physical reality into mathematics.

6.2. The extension of the Lorentz principle from homogeneous regions to inhomogeneous ones

On the face of it Jánossy's notion of general relativity may seem disturbing. While Einstein introduces the principle of special relativity as the equivalence of inertial systems and arrives at the general theory by extending that principle to arbitrary systems, in Jánossy's reformulation the special theory deals with the propagation of light and not with inertial systems. However, this apparent difference can be easily resolved, since (as Jánossy shows) *the Lorentz principle implies that Lorentz systems are inertial systems and vice versa*. This implication is eventually equivalent to the claim that the two independent systems of measures introduced by Jánossy (that is, the system of measures based on rods without light signals and that established with the help of light signals by means of the radar method) are equivalent. So Jánossy would also be able to introduce the general theory as the extension of the special theory from inertial to arbitrary systems.

Nevertheless, he does not follow this path, but continues to investigate the problem in terms of measures and the propagation of light. While he demonstrates that Lorentz systems and inertial systems coincide and thus a Lorentz system can be identified with the help of inertial phenomena, in his approach inertia remains only a *secondary* characteristic of these systems. The primer characteristic of a Lorentz system is for him the existence of a special system of measures in whose terms light appears to be propagated isotropically and with constant velocity relative to the system itself. Since such systems can only exist in physical regions where light appears to be propagated homogeneously, Lorentz systems are connected to such regions and Jánossy formulates the problems of general relativity with the help of this fact:

> "In the special theory of relativity only such regions are considered in which light is propagated homogeneously. The laws governing the motion of physical systems inside such regions obey symmetries which can be expressed by the Lorentz principle. In reality light can nowhere be assumed to be propagated strictly homogeneously, as we have reason to believe that the propagation of light is affected by gravitation and regions entirely free of gravitation do not exist. The Lorentz principle can be therefore taken to be valid only to such an approximation as gravitational effects can be neglected. The question arises, how the Lorentz principle should be generalized so as to apply to regions containing not negligible gravitational fields." [Jánossy 1971, 214]

Although his terminology considerably differs from that of Einstein's, Jánossy's train of thought is mathematically parallel to the consideration of the German physicist. So he shows that the sufficient and necessary condition of the homogeneous propagation of light in a given physical region is the existence of a straight (that is Euclidean) representation of the region established with the help of light signals, a criterion which is mathematically equivalent to the criterion that the Riemann-Christoffel tensor formed of the propagation tensor of light expressed in any measures of coordinate is equal to zero. [Jánossy 1971, 218-220]

> "We see thus that using signals of light only we are in a position to examine whether or not light is propagated homogeneously in the region we are investigating, and if the propagation of light proves to be homogeneous, we are in a position to construct a straight system of reference with the help of the signals of light." [Jánossy 1971, 222]

The Lorentz principle implies that homogeneous regions obey the same physical laws even if a system is Lorentz deformed, so physical laws of homogeneous regions are Lorentz invariant. Jánossy generalizes this fact along the following train of thoughts:

i) From a mathematical point of view the laws valid for homogeneous regions may have several generalizations for inhomogeneous regions even if

a) we restrict the possibilities of generalizations by requiring that the Lorentz principle originally valid for homogenous regions should also be valid for sufficiently small inhomogeneous regions [Jánossy 1971, 230], and

b) we prescribe that the laws of homogenous regions should be contained as limiting cases by the generalized laws. [Ibid 264]

ii) Since i) allows an unlimited number of possibilities for generalization, we ought to seek further restrictions and it seems that the most rational and heuristically most fruitful restriction is to seek only generalizations that can be expressed in tensors and covariant operators.

Jánossy introduces the latter requirement as the extended (that is, generalized) Lorentz principle. [Ibid.] Thus in contrast to Einstein's general principle of relativity which forms a definite claim on the nature of physical reality, his general theory of relativity is based on a methodological principle involving only a vague ontological element: namely the conjecture, that physical reality is such that this principle can be successfully applied to it.

There is no place and perhaps it is not even necessary to give a more detailed presentation of Jánossy's development of the general theory, since it is easy to see that it mathematically corresponds to Einstein's considerations. What is important for us is the physical meaning of his presentation which considerably differs from Einstein's.

a) Firstly, in Jánossy's notion *general relativity primarily is about the propagation of light*. As a consequence, in his presentation the metric tensor of the general theory primarily appears as the propagation tensor of light. It emerges only in a later phase of the development of the theory that this tensor coincides with the metric tensor of the gravitation field [Jánossy 1971, 242-256, 266] (a coincidence which requires an explanation since the extended Lorentz principle as a heuristic principle cannot explain anything). Similarly, the equivalence of the gravitational and inertial masses (on which Einstein's theory is based) loses its fundamental role and appears only as a secondary implication of the theory [241, 263].

b) Secondly, since the generalized Lorentz principle is for Jánossy only a *heuristic* principle, it is not at all granted that laws constructed with its help really are natural laws:

> "Sometimes suggestions are made to the effect as if the generalizations of the laws of nature which lead to the forms of the laws in gravitational fields could be obtained in a priori considerations. According to this view the laws thus obtained are logically more or less the only possible ones …. Such considerations are at fault; we shall show in the following that relativistic laws are based on well-defined physical hypotheses concerning the structure of matter and gravitation. It is a question of fact as to what extent these hypotheses give a correct description of real nature. " [Jánossy 1971, 213-214]
>
> "So as to find the form of various physical laws in inhomogeneous regions it is useful to see how the mathematical form of such laws, valid in homogeneous regions, can be generalized. It is a question of experiment to find out whether or not the generalizations which suggest themselves are in accord with experiment." [Jánossy 1971, 235]
>
> In any particular case it remains thus to be decided by experiment which of the generalized form of the physical law describes correctly the observed phenomenon. However, we have to go further: *it is also a question to be decided by experiment whether or not the law describing a particular phenomenon correctly is an invariant one?*" [Jánossy 1971, 264]

(Notice that in Jánossy's terminology a law is characterized as 'invariant' if it can be expressed in terms of tensors and covariant operators.)

c) Thirdly, while non-Euclidean spaces appear in both Einstein's and Jánossy's theory, Jánossy argues that they are only spaces of measures, that is, theoretical spaces constructed by human beings to represent physical reality. The primary physical terms for Jánossy are homogeneous and inhomogeneous regions of the propagation of light, of which the first can but the second cannot be represented with straight coordinates. As a consequence, with Jánossy *straight coordinates always* *indicate homogeneous regions* and so regarding such regions they should be considered as *privileged representations* which directly characterize the regions, while in Einstein there are no privileged representations.

d) Lastly, in Jánossy the four dimensional space-time is only a construction built up of measures, that is of representations constructed by human beings. So the interpretation that real physical bodies move on their geodetic paths in the four dimensional space-time is meaningless.

> "… it seems to us that it is a play with words if we suppose the geodetic line to be a 'straight line in four dimensions'. ….. the solutions [of Einstein's field equations]…. include among others Kepler's ellipses along which planets move. – If we call those orbits 'straight' then we lose completely the meaning of what is usually called straight." [Jánossy 1971, 241]

7. The nature of Jánossy's ether.

7.1. The antenna problem. The erroneous claim on the simplicity of Einstein's theory

Jánossy's reformulation of relativity theory in terms of measurement arrives at a mathematical formalism equivalent to that of Einstein's theory. Jánossy might as well stop at this point since his version of the theory does everything that the original version does. However, as he considers the term „structure of space-time" devoid of physical meaning, he is firmly opposed to using it to explain relativistic phenomena. In his interpretation it is not the metric of space-time that determines the behaviour of other physical entities but the latter imply the former: the relations and rules of the physical world are such as to permit theoretical representation with the help of this term. As a consequence, in Jánossy's conceptual framework the original version of relativity theory appears as a merely phenomenological theory, while the ether-based interpretation of its mathematical formalism serves as its completion with a second, explanatory level.

And at this point we arrive at the heart of any ether-based issue: *what is the nature of the ether and what is the mechanism by which it impacts physical phenomena?*

It is often argued in favour of Einstein that his theory needs no such mechanism and so it is incomparably simpler and more elegant as any ether-based approach. A common counterargument (present also in Jánossy) is that simplicity and elegance are no criteria of truth since nature does not have to respect these human qualifications.

As a matter of fact, even this counterargument is unnecessary since Einstein does not give us any explanation of how the assumed mathematical properties of space-time can influence physical phenomena or, put differently, how it is possible that physical entities follow geodetic lines. Is there an influence, a constraint exercised by the space-time (or the ether) on physical entities determining their behaviour or do the latter have an innate inclination to follow geodesics? Here we face the so called “antenna problem” well known in the literature. [Nerlich 1976, 264; DiSalle 1994; Brown 2005, 24-25] The main point is not, however, the problem, but the fact that the classical formulation of Einstein’s theory does not even attempt to answer the problem. Now, a theory that ignores and fails to address a crucial point of its subject and is, in this respect, incomplete, is highly likely to be simpler than another theory, which not only deals with the issues addressed by the first theory but also confronts problems ignored by the other one. The claim that Einstein’s theory is simpler and more elegant than the ether-based approaches is mere tautology. (Put ironically, the null theory is the simplest theory as it sees no problem and thus only declares that there is nothing to be solved.) Consequently, the ether-based explanation of relativistic phenomena is not an unnecessary and clumsy alternative to the original, Einsteinian explanation but, on the contrary, is a completion of the latter proposing a physical-causal explanation of the phenomena described mathematically by the original one.

7.2. The nature of Jánossy’s ether and Jánossy’s hypothesis on the mechanism of the Lorentz deformation

Turning to Jánossy’s views on the physical nature of the ether, it should be emphasized that the main objective of Jánossy’s monograph on relativity theory is to reformulate Einstein’s theory on correct epistemological and physical grounds and to elucidate the logical and physical place of a privileged physical system in the context of a theory of relativistic phenomena. As such, the work does not aim at a complete theory of the ether. It lays down only the basic principles and outlines a few provisional hypotheses in order to assist and orientate further work on the topic.

So the Hungarian physicist emphasizes that using the term “ether” he does not want to commit himself to any traditional theory:

> “ [...] as to avoid misconceptions we wish to emphasize that we regard the ether merely as the carrier of electromagnetic waves and possibly the waves associated with other fields and of elementary particles.” [Jánossy 1971, 48]

He also rejects the macroscopic-mechanical models of the ether and its notion as a reference frame at absolute rest:

> “Einstein’s polemic against the ether concerned mainly the assumption that the ether is at ‘absolute rest’. Thus Einstein denied the existence of a system K_0 which is at ‘absolute rest’. ” [Jánossy 1971, 49]

> “We think that the assumption that electromagnetic waves possess a carrier has nothing to do with the question of absolute rest. The concept of ‘absolute rest’ is a metaphysical concept which must be rejected. However, the concept of the ether as the carrier of electromagnetic and other phenomena is quite a different one….. Whether or not the ether, i.e. the carrier of electromagnetic waves, is at rest or at ‘absolute rest’ is a question which does not arise here and certainly has no significance in relation to our problems…. For our consideration it is also immaterial whether or not various parts of the ether move relative to each other. It seems quite plausible that considered on a cosmic scale distant parts of the ether are streaming with various velocities ….” [Jánossy 1971, 49-50]

On the other hand, as an affirmative feature of his concept, besides being primarily the carrier of electromagnetic interactions, the ether also appears as an entity causing the Lorentz deformations. Jánossy assumes that the deformation emerge when physical entities accelerate relative to the ether. If the acceleration is slow enough and proceeds step by step, then the accelerated physical system will have time after all consecutive phases to settle down into newer and newer configurations. However, if the acceleration is continuous, the system will lag behind the configuration corresponding to the achieved velocity, and it will settle down into the latter only after a certain small temporal interval following the acceleration. So in the latter case the process of the deformation is (at least theoretically) observable, since there is a minor temporal interval during which the deformation has not yet taken place and thus the states of measuring tools do not coincide with the states expected according to the Lorentz transformation. [Jánossy, 127-128]

Jánossy illustrates this hypothesis with the help of a practically solid rod. A rod is a configuration of its atoms and these latter are in a state of dynamic equilibrium. The forces causing the acceleration disturb this state, but after the acceleration has ceased, the atoms - now moving relatively to the ether - will establish a new equilibrium [Ibid, 127]. (Of course, in the case of deceleration inverse processes occur.)

These hypothetical processes also constitute a physical explanation for the Lorentz principle. Whereas the principle declares the form of possible physical systems, the mechanism of deformations caused by the acceleration relative to the ether explains how and when such systems come to exist. To express the connection between these processes and the Lorentz principle, Jánossy formulates a dynamic version of the principle, which he considers to be one “compatible with the originally formulated Lorentz principle and […] an addition to it” [Jánossy 1971, 126]:

> “*If a connected physical system is carefully accelerated* [with respect to the ether] *then, as a result of the acceleration, it suffers a Lorentz deformation.”* [Ibid.]

In contrast with Jánossy, Harvey Brown opines that this principle is only a simple implication of the original formulation of the Lorentz principle [Brown 123-124]. However, the original formulation leaves open the question about the concrete physical cause of the Lorentz deformations, since from an a priori point of view it is not necessary to connect these deformations to the acceleration. So one may assume that the deformations are caused by permanent pressure of the ether during the rectilinear and even motion. By connecting the Lorentz deformations to the process of acceleration the dynamic principle excludes the alternative explanations and hence it really contains an additional element with respect to the original formulation.

In the context of the general theory Jánossy assigns other characteristics to the ether. So it may have different physical states, it contains inhomogeneous structures, strains, etc. and functions as the seat of different physical fields (such as the field of gravitation). While Einstein explains the phenomena of the general theory with the help of the metric of space-time, for Jánossy the clue is the state of the ether which is represented with the metric tensor:

> “*G* (the metric tensor) represents some physical field which appears when observing very different physical phenomena – the propagation of light is only one of many such phenomena. The usually accepted interpretation of *G* is that it represents the ‘metric of the space-time continuum’. We do not think the latter interpretation to be a fortunate one. We would rather suggest that *G* represents the state of the ether which is the carrier of all physical fields.” [Jánossy 1971, 266]

Before closing this section, we would like to make two brief remarks.

The first concerns the above citation which shows some ambiguity. Namely, Jánossy speaks here about the tensor *G* as a representation but uses a Gothic *G* rather than a Roman *G* to denote it, which seems to run contrary to the convention introduced earlier in his book, according to which representations are notated by Roman *G*s. However, from the context it is clear, that the word “representation” here does not mean the representation in our theories but a characterization of the state of the ether by physical quantities as, for example, the quantities of volume, temperature, pressure etc. “represent” – that is characterize – the state of a gas cloud.

Jánossy's refers here with the term „metric tensor" to a complex of physical quantities (or briefly to a "tensor quantity") which is not a mathematical entity and, therefore, does not consist of numerical values or mathematical functions but may be considered as a "tensor" only in the sense that we need mathematical tensors to represent it. Consequently, its notation by a Gothic *G* is correct and the ambiguity of Jánossy's text follows not from the notation but from the fact that he uses the word "represent" in two different senses.

Our second remark is about a critical reflection by Harvey Brown on the relation between Jánossy's Lorentz principle and the Lorentz covariance of the laws of physics.

> "[The] ambiguity in the formulation of the principle would be removed if Jánossy just equated it with the Lorentz covariance of the fundamental laws of physics, and it is hard to see why he didn't. It is almost as if Jánossy intends the Lorentz principle to stand over Lorentz covariance. At the start of the mentioned discussion of Maxwell's equations, he announces that 'Physically new statements are obtained if we apply the Lorentz principle to Maxwell's equations'. But of course what emerges in the discussion is simply the Lorentz covariance of these equations." [Brown 2005, 123]

Brown is formally right. Lorentz covariance really may substitute Jánossy's Lorentz principle. However, the requirement of Lorentz covariance in itself is only a formal requirement which allows different physical interpretations. Whereas in the original Einsteinian theory Lorentz convariance relates to our representations depending of the chosen reference system and later is connected to the'structure of space-time', in Jánossy the term 'structure of space-time' is without physical meaning and Lorentz covariance is rather connected to physical deformations emerging independent of our representations. The function of Jánossy's Lorentz principle is to exclude the Einsteinian interpretation and to give a physical interpretation to the relativistic phenomena; a function that cannot be served by the formal requirement of the Lorentz covariance of physical laws. (May be I am wrong but it seems to me that Brown overlooks this important moment of Jánossy's notion of relativity theory since he ignores the measurement theory aspect of Jánossy's investigations.)

7.3. The emergence of gravitation forces

Jánossy closes his reformulation of general relativity with an interesting hypothesis on the emergence of gravitational forces. According to his hypothesis closed physical systems are kept together by internal forces which are propagated with the velocity of light in the ether. When a gravitation field is present, it disturbs the homogeneous propagation of these forces (as it also disturbs the propagation of light). Due to this disturbance a new force emerges which tends to accelerate the system just like the Newtonian gravitational force is expected to do. Consequently,

> "[t]he gravitational force observed phenomenologically is equal to the self force with which a closed system acts upon itself, if the propagation of the internal forces is made inhomogeneous by the gravitational field." [Jánossy 1971, 263]

In this context we also receive an physical explanation of the equivalence of inertial and free gravitational motion, which forms a basis pillar of Einstein's general relativity:

> "in a free falling particle the propagation of inner forces is nearly homogeneous relative to the particle itself, therefore in the free fall no resultant self force is present." [Ibid.]

Jánossy illustrates the applicability of his hypothesis on the example of an electric charge, but he unfortunately does not proceed further in this direction. However, the author of the present paper think that his hypothesis is of heuristic value and worth for further consideration even in this preliminary form and even if one agrees with Brown that several aspects of Jánossy's idea of the ether are too traditional. If one feels similar to Brown then one must be aware of that we face a problem here characteristic for any ether-based approach. Namely, it is not so easy to find how to satisfy all the requirements we expect from a modern theory of the ether without turning it into a *'mathematical ghost'* as Walter Ritz had characterized yet not the Einsteinian but the Lorentzian ether 100 years ago [Ritz 1908], which, in turn, was considered by Einstein several years later as still too mechanical.

7.4. Einstein's and Jánossy's ether

It is well known that after publishing his general theory of relativity, Einstein made several metatheoretical assertions which shed new light on the problem of relativity. So he reintroduced the concept of the ether in the interpretation of the metric field of the general theory, and (as a more far reaching change with respect to his early ideas) he also indicated that his special theory needed a completion concerning the dynamical mechanism of the deformation of rods and clocks. These assertions clearly indicated that after the publication of his theory Einstein had a feeling that it was not sufficiently complete but needed a second, physical level. That is, in contrast to many current representatives of Einstein's theory at universities and research institutes (who are more Einsteinian in this respect than the German physicists himself was) Einstein did not consider the published version of his theory to be necessarily final and did not exclude an ether-based interpretation of relativistic phenomena and a physical-dynamical theory of the deformation of rods and clocks. [See e.g. Einstein 1920; 1921, 127; 1924; 1949, 22-23; Kostro 2000; 2008; Brown 2005, 113-114]

So it is not at all an unfounded reference to Einstein's authority when at the beginning of Chapter II of his discussed book Jánossy cites an important fragment of Einstein on the ether and insists that his reformulation of the relativity theory is based on similar ideas as the ideas expressed there by the German physicist. The key assertion of the citation runs as follows:

> "Dass es in der allgemeinen Relativitaetstheorie keine bevorzugten, mit der Metrik eindeutig verknüpften raumzeitlichen Koordinaten gibt, ist mehr für die matematischen Form dieser Theorie als für ihren physikalishen Gehalt charakteristisch."[Jánossy 1971, 49; the original: Einstein 1924, 90-91]

In Jánossy's translation:

> "The fact, that in the framework of the general theory of relativity, there are no distinguished space-time representations connected in an unambiguous manner with metric - is rather a characteristic of the mathematical methods of the theory than a characteristic of its physical contents." [Ibid.]

Although this study deals with Jánossy and not with Einstein, it seems necessary to emphasize that this is a very serious statement, which seems to withdraw the principle of general relativity, or more adequately, to degrade it to a mere consequence of the applied methodology. If taken seriously, the assertion will imply that there is a definite, privileged (bevorzugt) metric structure of physical reality (the structure carried by the ether) while the metric structures of a given system of "raumzeitlichen Koordinaten" (and so the "relativity" of the possible systems of co-ordinates) are only an implication of the "matematischen Form" of the theory. Now it is easy to see that Jánossy translates Einstein's German terms into his own English terminology (so "bevorzugten … Koordinaten" into "distinguished .. representations") but even in the absence of his tendentious translation the German original allows us to perceive a definite parallelism between Einstein's view expressed here and Jánossy's ether based notion of relativity. If both the original Einsteinian formulation and the received view of the relativity theory may be characterized by a washing away of the difference between the theoretical-mathematical representation as a human product and the represented physical reality, then here, in this discussion of the problem of the ether Einstein recaptures this difference and represents a view similar to that of Jánossy. So despite the contrast between the original formulation of relativity theory and Jánossy's reformulation, Einstein's out-of-theory reflections seem to be near to Jánossy's view.

However, at a closer look it will be also clear that the parallelism between Einstein and Jánossy is limited.

Firstly, whereas Jánossy's ether is the carrier both of the electromagnetic waves and the gravitational field, for Einstein the ether is only the "gravitational ether". [See for example: Kostro 2008. 52-53]

Secondly, for Jánossy the united space-time or the space-time continuum is only a human construction, a human representation of physical reality. Consequently, he opposes the view according to which the difference between space and time is a mere appearance due to the shortcomings of our senses, as it is claimed in Minkowski's paper introducing the concept of the four dimensional space-time [Minkowsky 1909] and then many times endorsed by Einstein. Whereas Einstein claims that the separation of space and time is without 'objective meaning' [i.e. Einstein 1949, 22; 1949a, 99-100; Kostro 2008, 57] for Jánossy it is an evident and "objective" physical fact appearing in the radical difference between the measuring tools of length and time. As a consequence, Jánossy's ether is definitely a three dimensional spatial entity, while in the case of Einstein it is hard to see how his ether could be imagined otherwise than a mystical four dimensional space-time continuum.

It also can be easily seen that the problem of four dimensional space-time is closely connected to Jánossy's thesis on the importance of common sense regarding physical theories. Taking seriously the ontological priority of the Einsteinian-Minkowskian space-time, a temporal interval, for example, that between the birth and the death of a person will appear of the same nature as the spatial distance between, say, Budapest and London, and the difference between translational motion and aging will disappear. Considering these consequences we may see that Jánossy's thesis on the role of common sense is considerably more than a naive insistence on our accustomed everyday habits and judgments; it concerns our most ultimate ontological experiences, such as our experience of life and death. But these consequences also show that Einstein's claim on the ontological, "objective" priority of the four dimensional space-time has significant metaphysical implications and transforms Einstein's positivist starting point into a metaphysics of a four dimensional space time.

Lastly, whereas Einstein verbally acknowledges that the ether has physical properties and speaks only about its deprivation of "mechanical" characteristics, it is clear that with the term "mechanical" he refers to all traditional physical properties including pressure, strain, density etc. In contrast with Einstein, Jánossy characterizes the state of the ether with the help of these terms. Of course, in doing so he is using the latter only in a metaphorical sense and he does not mean to claim that the ether has exactly the same properties as macroscopic entities. However, the application of these terms definitely indicates that in his view the ontological nature of the ether is basically similar to the macroscopic physical entities. The difference between Einstein's and Jánossy's notions of the ether cannot be reduced even if we assume that in the context of physics Einstein also uses the term "geometry of space-time" metaphorically. The metaphorical use does not change the fact that Jánossy's terms come from physics and they attribute to the ether physical characteristics even if they are used metaphorically, while Einstein's term is transferred into physics from mathematics and hence its application necessarily results in a mathematization of physical reality. Therefore the conversion of the German physicist to the concept of the ether does not cure the epistemologically inverted relation between mathematics and physics characterizing his theory.

In this respect it is often argued that the Einsteinian turn of physics brought about not only a theory change but also transformed the conceptual framework of physics and, as part of this transformation, it gave a new meaning to the word "physical". The properties of Einstein's ether are not "physical" if we use the old meaning of the word but in the new conceptual framework they become definitely physical. However, this argument is invalid since the point is exactly whether one accepts or refuses the conceptual change. The new meaning of "physical" is a consequence of the mathematization of physics by the Einsteinian version of relativity theory, the main target of Jánossy's reformulation of the theory. Dubbing mathematical terms and properties as physical will not change their real nature. On the contrary, physical reality should first be attributed a mathematical nature in order to characterize such properties as physical. And conversely, if we really think that the latter are truly "physical", then this will amount to transforming the nature of physical reality from physical to mathematical.

Or is it possible that the mathematization of physical reality, criticized so vehemently by Lajos Jánossy (and more recently by H. Brown) regarding the theory of relativity, but also present in quantum mechanics, is more than a pure consequence of a methodological mistake? Is it possible that in its ultimate ontology the world around us is not of a physical but a mathematical nature? Maybe the cart is put before the horses not only by the received interpretation of relativity theory but also in physical reality? These are far reaching metaphysical questions that surely do not belong to relativity theory, and especially not to the topic of the present review of Jánossy's interpretation of relativity theory, but still concern so intensively the whole interpretational problem of the theory that they must be raised at the close of this paper.

8. Summary

We have seen that Jánossy's theory of relativity consists of two levels. At the first level he reformulates Einstein's theory in terms of measurement, while at the second level he outlines an ether-based explanation of relativistic effects. His reformulation of the relativity theory not only elucidates the relation between the mathematical formalism of the theory and physical reality and establishes an ether-based interpretation of relativistic phenomena, but also gives a deep insight into the hidden conceptual background of the Einsteinian version of the theory. In our days when the relation between physics and mathematics in relativity theory has become a topical issue again, Jánossy's analysis of the relativistic phenomena and his deduction of the formalism of the theory in terms of measurement are especially significant both from a physical and a philosophical point of view. We have seen furthermore that his consideration about the role of the ether in the explanation of relativistic phenomena as well as his hypotheses about the nature of this entity are of high heuristic value and may give significant stimulation for further research in the direction of a dynamical theory of the ether.

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