Loose comments on the topics of speed of light, generalized continuity and abductive reasoning in science

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7 March 2018

Abstract

The possible conclusions resulting from the huge speed of massless objects and certain remarks related to continuity in physics accompanying revolutionary changes are presented. We also show the relationship of the constant velocity of waves propagating in a vacuum with the principle of relativity. We also mention abduction reasoning (retroduction) in science.

Motto: *[Creativity is] t**he action of the infinite in the sphere of the finite** – that is, this meaning goes to infinite depths.˜* David Bohm, Unfolding Meaning: A Weekend of Dialogue with David Bohm

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1 Taming an infinity

In the paper we will accept that the speed of certain fields like gravitational or electromagnetic is very huge or even infinite, and that and the very large number of objects available for our observations like planes, rockes, meteorites move, relatively to those fields, slowly. For these objects the finite speed of light c will be a good approximation of infinity ∞:

$$c \cong_{local} \infty \tag{1}$$

Lower index - 'local' - means that approximate equality does not apply to the expansion of the Universe.

The purpose of this note is to draw attention to the fact that in the specjal relativity theory (SRT) in a sense, we have a combination of Newton's mechanical theory with Maxwell's field theory, but also an indication that this combination was possible due to the properties of infinite numbers roughly describing the enormous speed of light. To see this let us recall the strange properties of infinite quantities ('numbers') considered together with finite numbers denoted by 'a': it is assumed that:

$$\infty \pm a = \infty', \ for\ a < \infty \tag{2}$$

$$\infty + \infty' = \infty'' \tag{3}$$

$$\infty \cdot a = \infty', \ for\ a > 0\ and\ \infty \cdot a = -\infty, \ for\ a < 0 \tag{4}$$

but:

$$\infty - \infty' = ?! \tag{5}$$

The prime over the symbol ∞ is used to express, for example, that two infinite sets of even and odd numbers are different. Assuming the above properties for the symbol ∞, it is difficult to say that it has a specific numerical value. However, the above equations describe instead its qualitative features. A very interesting point of view on infinity and the paradoxes associated with it is presented in [8]. It is also necessary to notice the power of symbols, which introduced allow to give the concepts certain mathematical properties, and thus to define them more precisely.

From the above properties it follows that for reference frames related to slowly moving objects we can assume that the speed of light is approximately the same for them. By looking now at the transformations between coordinate systems moving in such a way that the speed of light in them is approximately or exactly constant we can find that the Lorentz transformations

$$x' = \gamma(x - vt), \tag{6}$$

$$y' = y \tag{7}$$

$$z' = z \tag{8}$$

$$t' = \gamma(t - \frac{v \cdot x}{c^2}) \tag{9}$$

where $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$ have such property. Indeed: if $c = \frac{x}{t}$ then

$$c' = x'/t' = \frac{x - vt}{t - vx/c^2} = \frac{ct - vt}{t - vct/c^2} = \frac{(c-v)t}{(1 - v/c)t} = c\spadesuit$$

In the cited formulas v can be interpreted as a velocity relative to a similar material object but not to the light. So could special RT (RT) be treated as a translation of intuitive property (2) of the infinity and Eq.(1) upon finite changes and movements? Of course, an important test of the above reasoning is the observation or experiment and the reasoning alone would not be possible without the genius of Albert Einstein and other giants. What is surprising in the above ramarks is the possibility of such direct influence of infinity on areas of human life.

We would also like to draw attention to the universal nature of Equality 2 in the sense that it also applies to concepts, for which it is sensible addition operations. If a rich man gets $ 10, his wealth, **relative** to its essential, will not change, which can be expressed with equality 2 :-).

Also wonders is the similarity between the property (2) and the illustration of the statement underlying SRT:

$$\{X_c\} + \{\vec{v}\} = \{X'_{c'}\};\ c = c' \tag{10}$$

that in any inertial system the light moves at the same velocity: the symbol $\{X_c\}$ is, for example, that in the coordinate system X the light moves at the speed $c = c'$ and the Eq.10 just means that one system is moving at the velocity $\vec{v}$ with respect to the other. A better explanation of a constant velocity of light in any inertial system is given in Sec.6.

Another approach to the constant speed of light than that represented in the presented work is the introduction of the two time coordinates, see: [6].

It turns out that there are generalized Lorentz transformations that maintain a constant speed of light, [10]. They also fit in the above scheme, in which the enormous speed of light combines coordinate systems moving at moderate speeds. It should be noted here that the linking of the mechanical world with the diametrically different world, namely the electromagnetic world, can also be only a symptom of an endless genius that is unmistakably associated with Transcendence! On the other hand, through SRT, Einstein introduced a human element, namely a measurement element to Classical Mechanics. Similarly, it happened in Quantum Mechanics, but other people did it. In both theories, infinity plays a significant role. In the first case, almost infinite speed of light

propagation, interaction propagation. In the second case, Hilbert's infinitely dimensional space.

2 Taming an infinity is continued

From the foregoing considerations it follows that the same velocity of light (its invariance) in 'slow' motion of inertial systems is due to the huge speed of light which can be regarded as the physical approximation of the infinity - marked by the symbol ∞.

Einstein and probably his wife Mileva were credited for deriving formulas (6-9) using the **same speed** of light in various inertial systems. In the paper we show that not only the invariance of light velocity but also its magnitude have physical consequences.

The great merit of A. Einstein was to use the properties of light to describe the properties of space-time. The finite, but huge value of its velocity, partly reflected in the Eq.1, leads, however, to a series of cosmic conseqences, where certain phenomena characterized by huge scales at higher velocities then c are allowed. In fact, the subscibe 'local' in Eq.1 means that an 'infinite velocity of light' can be realized for small spacetime scales like in the experiments with unstable particles which take place in atmosphere or in particle accelerators. The inverted commas in the last sentence mean in fact that we are referring to the properties expressed in the Eq.2. I see here surprising similarities to the case when the measure of a flat surface (universe) with "arbitrary" boundary is approximated by the sum of the measures of simpler figures, eg rectangles (a local part of the universe) with vanishing two oposite sides.

Yet such a remark: **taming an infinity** can rely on its use to avoid parados and also on the use of some of its properties in the description of certain physical phenomena, such as the same speed of light in various inertial systems, see also [8].

It is also worth remembering that the infinite speed of light has been well motivated for a long time, which is well illustrated by the experimental 'evidence' vividly described in the book by Jerzy Przystawa: "Discover the taste of physics" , see [7].

I would also like to add the often quoted David Bohm's sentence about the meanings:

*For the present we can say that creativity is not only the fresh perception of new meanings, and the ultimate enfoldment of this perception within the manifest and the somatic, but I would say that it is ultimately [Creativity is] t**he action of the infinite in the sphere of the finite** – that is, this meaning goes to infinite depths.*

˜ David Bohm, Unfolding Meaning: A Weekend of Dialogue with David Bohm

3 About time and space coordinates and their restrictions from mathematical and physical reasons

From the foregoing considerations it follows that the treatment of light velocity as an approximation of infinity makes alike the time variable to the spatial variables. We say that time is the fourth dimension that together with space variables form space-time with, e.g., Minkowski's geometric interpretation. However, there is another situation in which the time variabe t is treated in a simmilar way as the space variables. This is when we use the field concept: $\varphi_\mu(t,\vec{x}) \equiv \varphi(\tilde{x})$. This is especially true when we consider the **tensor products** of the field φ: $\varphi(\tilde{x}_1)\cdots\varphi(\tilde{x}_n)$ which should be considered when the initial and/ or boundary conditions of the fields, denoted by α, are random quantities. In this case we have to consider correlation functions, or more generally, n-point information:

$$< \varphi(\tilde{x}_1)\cdots\varphi(\tilde{x}_n) >= \int \delta\alpha P[\alpha]\varphi[\tilde{x}_1;\alpha]\cdots\varphi[\tilde{x}_n;\alpha] \tag{11}$$

where $\int \delta\alpha$ means the functional integration, P is e.g. some probability density functional and $\varphi[\tilde{x};\alpha] \equiv \varphi(\tilde{x})$ and n=1,2,3,...

The benefits of uniform treatment of the time-space variables are particularly evident when considering equations for correlation functions, see e.g. author's works: [1], [2] and literatures given there. It is worth noting that to justify a constant speed of light the discrete space-time is used, see [12]. It is also worth noting also that the discreteness of variables does not lead to divergences that accompany continuous variables when the products of the delta function appear.

There is, however, an important problem to address: how to take into account, in the more algebraic approach, an **impact of interactions on the movement of clocks in e.g. the Minkowski space!**? This sentence is reffering to my paper [2] in which Poincare's convensionalism is advocated together with gauge symmetry, which seems to ensure the overlap of LPEI (Laplace Principle of Equal Ignorance) as a fundamental law of nature, see [9]. An additional complementary element in the construction of the theory combining classical and quantum demands, and therefore quantum gravity, is the introduction of FFS (Free Fock Space), see [1], [2]. In this space, in which the equations for n-pi (n-point information) are written by right- and / or left invertible reversible operators, there is a place for boson-fermion symmetry and description of equations of general relativity in a more simpler way, see [1] and other papers:-).

4 Quantitative and qualitative information

From Wikipedia 26 June 2017, at 14:29:

"*Quantitative* information or data is based on quantities obtained using a quantifiable measurement process. In contrast, *qualitative* information records

qualities that are descriptive, subjective or difficult to measure."

Based on these definitions, I would classify a function with some difficulty to a qualitative concept, and its domain to a quantitative concept. But they are really vague concepts and they need a lot of self-denial to eg describe the pot qualitatively, and the material filling it quantitatively :-)

5 About continuity in science and amazing durability of some qualitative properties

Following closely the successive revolutions in physics, it is evident that certain elements, structures remain preserved despite fundamental conceptual changes in subsequent stages. In this sense, we can talk about a certain continuity of change, see [3], page 18. The simple example of continuity is supplied by the Lorentz's transformations (6-9) in which if $c \to \infty$ we get the Gelileo's transformations.

Our analysis shows that in the transition from classical to relativistic mechanics, continuity also has a **qualitative** dimension: the infinite velocity of the interaction propagation in Newton's mechanics (spooky interaction) is replaced by the finite velocity in Einstein's mechanics, but the fundamental property of infinity expressed by Eq.2 is preserved by the constant velocity of light in an arbitrary slow inertial reference frame. If you believe in the superiority of **qualitative** properties over quantitative in evolutionary processes of matter, see [4], page 11, then transferring Lorentz transformation at greater velocity is a matter of pure extrapolation.

Quantum mechanics as is saying is a radical changed of classical mechanics however we can say about continuity in the sense that certain properties are presserved, e.g., the dynamic equations of both theories have an identical form when quantum mechanics is written in Heisenberg's representation. Similar remark applies to Poisson brackets.

You can place a very basic question here: what it makes that certain **qualitative** concepts worked out on one scale are maintained without any change in another scale? In this place I strongly recommend reading S. Weinberg's article about a revolution in science that did not occur in which the author discusses Kuhn's approach and his own to history of science, [5]. In this context, radical criticism of Aristotle's **qualitative** physics from the point of view of quantitative modern physics is not fully justified. The argument behind this statement is not the recent development of Quality Physics, but the observation of the role played by some **qualitative features of classic concepts** in modern science. A fascinating example of this phenomenon is the retention of only the qualitative property expressed by Eq.2 in a **spooky action** at a dystance what is expressed by Eq.10. In other words, gravitational or other interaction are not infinitely fast, but the **qualitative** property of ∞ expressed by Eq.2 survives in Einstein's modified theory, see Eq.10. Once again, some **qualitative properties** of notions of inferior theory can survive in better theory. **But in advance**

it is not known which should remain and by what content they should be filled!

6 Generalized continuity is continued

Based on the ideas contained in the book "Science, Order, and Creativity", [2], and the modest illustrations of some of them in the submitted work, one can conclude, in opposition to Kuhn's philosophy, that continuity in the development of science both in terms of its **uninformed infrastructure** and openly publicized often revolutionary ideas is likely to be an important tool in making new discoveries. It does not have to be continuity based on the convergance of new parameters to certain values, but can be based on preserving some of the features of the **pre-revolutionary** theory. In a word, they are based on the concept or concepts of **generalized continuity**. An extreme example of continuity in physics is the general theory of relativity in which all movements, changes, are described by the geodesics, and thus the generalizing principle of Galileo relativity. dare say that continuity manifests itself not only in exact sciences. For example, it occurs when we say that it is not possible to interpret individual sentences of a given text without looking at it completely, or when the law states the inviolability of acquired rights. That's how we look at the bible or the constitution. **Moving away from democracy is accompanied by a lack of continuity in law!**

7 The principle relativity conclusion for waves propagating in vacuum

Let us consider waves propagating in some medium: then RP would mean that in all **accessible** frames of reference they would propagate in the same way if the medium in which waves are propagating is moving in the same way in every considered frame of reference. Taking, for example, a given point of the wave front, we can write:

$$v_w = v_m + v_0 \tag{12}$$

where v_0 is the velocity of waves in the medium which depens on the medium, v_m is a velocity of the medium in a given reference frame. The principle of relativity shows that in every accessible reference frame, e.g., inertial, we have a similar formula. In the case of waves, which do not need a medium for their propagation, e.g. electromagnetic waves, such waves propagate at the same speed which depends on the vacuum! Other waves about this property are gravitational waves! See also the last section of this chapter.

Again, in the case of possibility of moving waves in a **vacuum** (lack of a medium),

$$v_w = v_0 \tag{13}$$

which can be interpreted as the same velocity of wave front in a vacuum in any accessible (e.g. inertial) reference frame.

Is this not an example of generalized continuity in science?

From Wikipedia:

"**Absolute space,** in its own nature, without regard to anything external, remains always similar and immovable. **Relative space** is some movable dimension or measure of the absolute spaces; which our senses determine by its position to bodies: and which is vulgarly taken for immovable space ... Absolute motion is the translation of a body from one absolute place into another: and relative motion, the translation from one relative place into another ... — **Isaac Newton**

These notions imply that absolute space and time do not depend upon physical events, but are a backdrop or stage setting within which physical phenomena occur. Thus, every object has an absolute state of motion relative to absolute space, so that an object must be either in a state of absolute rest, or moving at some absolute speed.[5] To support his views, Newton provided some empirical examples: according to Newton, a solitary rotating sphere can be inferred to rotate about its axis relative to absolute space by observing the bulging of its equator, and a solitary pair of spheres tied by a rope can be inferred to be in absolute rotation about their center of gravity (barycenter) by observing the tension in the rope.

Absolute time and space continue to be used in classical mechanics, but modern formulations by authors such as Walter Noll and Clifford Truesdell go beyond the linear algebra of elastic moduli to use topology and functional analysis for non-linear field theories".

At the end I would like to add observations clearly illustrating the generalized continuity in science: just the gravitational waves and light resulting from the collision of two neutreron stars travelled 130 million years and arrived at virtually the same time (with 2 sec difference). It looks like one more confirmation of Galileo's experiments on the leaning tower in Pisa !?

8 Abductive reasoning (retroduction) in my understanding

In 1903 the *abductive reasoning* (inference) Peirce described as follows:

1. The **surprising** fact, C, is observed,
2. But if A were true, C would be a matter of course,
3. Hence, there is reason to **suspect** that A is true.

The key to understanding abductive reasoning is the word 'suspect', which admits any 'truths' in the sense of possibility. In the case of *inductive reasoning* achievable through numerous experiments, many 'truths' can not be excluded, but in general one of them is distinguished by a degree of certainty (probability close to unity). This is generally not the case for abduction reasoning. There may be several different A. Choosing one among them may not be easy or

possible, if the criteria of simplicity, generality or some others do not work. This is often the case in both micro and microstructure, when Laplace Priciple of Equal ignorance (LPEI) takes place, [11, 2].

As an example of abductive reasoning in physics, I would treat the constant speed of light in various reference systems as the surprising fact marked by C - while Lorentz transformations with their interpretation that observers moving at different velocities may measure different distances and elapsed times but always such that the speed of light is the same in all inertial reference frames as - A. Hence, there is reason to suspect that A is true! And what's more, this suspicion is confirmed under certain conditions by numerous observations.

Our reflections on the speed of light show that A can be filled with various contents with different as yet practical values:-(

It seems likely that the more surprising fact C is, the more likely it is its explanation A!?

In the case of gradually appearing other explanations (other A) to distinguish them scientists are usually guided by such criteria as the principle of simplicity, generality, authority or fashion:-)

It seems to me that **abductive reasoning** should include especially those that are not supported by **direct experience**. For this reason, they should include explanations in cosmology based on dark matter and energy or theories based on the "God particle" (Higgs particle) before its final detection (2013). Other areas of human activity such as courts, police, geology, etc. are vividly based on this type of reasoning.

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