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RELATIVE EXISTENCE OF PHYSICALE OBJECTS

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Abstract. In this article we investigate the structure of the time and propose a new concepts of the local times with which is possible to work in physics. Novel concept of the local times allows parameterizations of the local times not only by the full real line but as well by the certain proper subsets of the real line. It is shown that local times for each point seen as the ordered set of moments can be compared one with another by their size or inclusion and it is demonstrated that the size of each local time depends on the observer. We elaborate how the existence of the physical objects depends on the observer and how it posses strictly relative character.

1. INTRODUCTION

Two notions determine our perception of time, its order and its flow. By the order of time we understand set of ordered moments T, with precisely defined ordering properties. The impression of the existence of the time flow is coming from our belief that the motion exists.

The standard theory of relativity introduces the concepts of time locality and the speed of the time flow (Einstein, 1955). Locality means that the time is strictly assigned to each point of space. It is assumed that each local time flows steadily with the certain flow rate that depends on the observer and that local times can be compared with respect to their "speed" of flow. Therefore, one can say that the Theory of Relativity is in fact theory of relativity of the speeds of the time flows.

Time, as the ordered set of moments, we believe, has all the properties of the ordered set R of the real numbers. That is the reason why we are used to parameterize the time by the real numbers. The order properties of the real numbers were precise by theorems of Dedekind and Cantor.[1] Each local time, as it has all the order properties of real numbers is linearly ordered, unbounded and complete with respect to order set of moments in which exist the ordered dense subset, linearly ordered with respect to induced order, unbounded and countable.

[1]See T. Jech, *Set theory*, Academic Press, New York, San Francisco, London 1978.

2. PARAMETRIZATION OF LOCAL TIMES

The same ordering properties as the set of all real numbers possess as well infinitely many its proper subsets. This can be seen from numerous examples.[2] In Ćirić and Ćirić (2012) we examine the possibility that local times related to each point of space can be parameterized not only by "full parametrization" R but by any proper subset of R that has all order properties as R as well. Here, each subset R^* of the set R, with induced order from R, such that there exists at least one ordering isomorphism $f : R \to R^*$ can be called parametrization of the local times.

Parametrization of the local time we relate to each point in space in the following manner. Lets suppose that $x \in X$ is any point in space X and ${R^*}_x \subset R$ its time parametrization. That the point $x \in X$, exists as material point, that has reality, it has to have extensionality in its space and its time. It has extensionality in space as $\{x\} \subset X$, and it has extensionality in time as $t \in {R^*}_x$. Point $x \in X$ does not have time extensionality in the set $R - {R^*}_x$, therefore it does not exists as the material point for the elements of that set. Size of the parametrization ${R^*}_x \subset R$ we determine by the size of the existence of the point x within the full time R. Thus, we can say that for the point $x \in X$ we have corresponding parametrization ${R^*}_x \subset R$ what means that the point $x \in X$ exists in the moments that are elements of the set ${R^*}_x$, and not exists in the "moments" that are elements of the set $R - {R^*}_x$.

The non-empty subsets of the real set that can be parameterizations of the local times are described in details in the Theorem 3., of Ćirić and Ćirić (2012). Namely, we saw that the following statement holds:

Theorem 1. (Characterization of the parameterizations of the local times.) Any non-empty subset R^* of the set R with respect to the order induced from R, is parametrization of local time if and only if the following conditions are fulfilled:

1. As the subset of the ordered set R, set R^* does not have minimal and maximal element in R.

2. It exists most countable family $\{X_i\}_{i \in I}$ of disjoint, finite or infinite intervals, such that:

$$R^* = \bigcup_{i \in I} X_i,$$

where the closed intervals, if they exist can be reduced to the point.

3. If X_i and X_j are two neighbouring intervals, such that X_i is before X_j, than either X_i is closed from the right and X_j open from the left or X_i open from the right and X_j is closed from the left side.

[2] See example 1., in Ćirić and Ćirić (2012).

3. MORE ABOUT THE PARAMETERIZATIONS OF THE LOCAL TIMES

From the definition of the parameterizations of the local times R^* one can see that there exists ordering isomorphism $f : R \to R^*$ that represents parametrization R^*. In the general case there can be infinitely many isomorphisms that represent the same parametrization. Each representation of the parameterizations of the local times on the set R^* defines order, algebraic structure and structure of the metric space. We saw from the Theorem 4., in Ćirić and Ćirić (2012) that all the representations define the same topological and order structure on the set R^* and up to isomorphism unique algebraic structure on that set. Each representation of parameterizations of the local times is isomorphism with respect to all mentioned structures.

That every representation induces same topology on the set R^* one sees from the following statement.

Proposition 1. Let R^* be parametrization of local times and $f, g : R \to R^*$ ordering isomorphisms that represents that parametrization. If d_f and d_g are metrics on set R^* defined as:

$$\forall y, \forall z, y, z \in R^*, d_f(y, z) = d(f^{-1}(y), f^{-1}(z)),$$

or:

$$\forall y, \forall z, y, z \in R^*, d_g(y, z) = d(g^{-1}(y), g^{-1}(z)),$$

than topologies induced on R^* are the same. Here d is the usual metrics on R.

Proof. If $y_0 \in R^*$ is arbitrary point and set

$$K_f(y_0, \epsilon) = \{y \mid d_f(y, y_0) < \epsilon\} =$$

$$= \{y \mid d(f^{-1}(y), f^{-1}(y_0)) < \epsilon\} = \{y \mid x_0 - \epsilon < f^{-1}(y) < x_0 + \epsilon\}$$

open ball in metrics d_f sa $x_0 = f^{-1}(y_0)$. There exist numbers u and v such that $x_0 - \epsilon < u < x_0$ and $x_0 < v < x_0 + \epsilon$ $g((u, v)) \subset K_f(y_0, \epsilon)$. As g is homeomorphism, (u, v) open subset of R, than $g((u, v))$ is open subset as well in metric space (R^*, d_g) which than with each its point, and the point y_0 contains at least one d_g- open ball $K_g(y_0, \eta)$. Therefore, it holds:

$$y_0 \in K_g(y_0, \eta) \subset g((u, v)) \subset K_f(y_0, \epsilon).$$

Each open set in metric space (R^*, d_f) that with each point in the set contains d_f open ball, with each point contains and at least one d_g open ball, so it is open in the metric space (R^*, d_g). Similarly can be proved that each open set in metric space (R^*, d_g), is open in the metric space (R^*, d_f), what makes proposition proved.

Proposition 2. If R^* is parametrization of local times and $f : R \to R^*$ arbitrary ordering isomorphism, topology induced by the metrics d_f is interval topology on R^*.

The proof is obvious.

Proposition 3. If $f : R \to R^*$, is ordering isomorphism, and if there exists at least one $y \in R - R^*$ such that $L_y = (-\infty, y] \cap R^*$ and $D_y = [y, +\infty) \cap R^*$ are non-empty, then, (and only then) there exists the point $x_0 \in R$ in which function f seen as function $R \to R$, does not have limit.

The proof is obvious.

We saw that one can state the existence of the time flow with a certain flow rate. If the local time of the point $x \in X$ is parameterized by the set R^* its time flow is driven by the whole R but the existence and materiality of the point $x \in X$ is restricted when time flows over the set R^*. Finally, that local time flows, and that flow has certain speed now means that point $x \in X$ moves towards its future through full time R with certain speed but exist only in the moments that belong to the set ${R^*}_x \subset R$, and it does not exist as a material point, as reality in the "moments" that are elements of the set $R - {R^*}_x$.

Set R is parametrization of the local times and it can be represented not only by identical function, but as well with another isomorphism that keeps order structure $f : R \to R$. Each such isomorphism is derivable function on R and its derivative f' shows change of the speed of flow of the local time R. *The choice of the representation of the local times means choice of the configuration of the speed of the time flow.* For example, requirement *that local time R flows steadily* is equivalent to the requirement that speed of flow is the same in each moment or that function f that represents local time R is of the form $f(x) = \alpha x + \beta$, where $\alpha > 0$.

It can be proved that *the set $R^* \subset R$ is unbounded parametrization of the local time in R if and only if for each isomorphism that keeps order $f : R \to R$, function:*

$$f^*(x) = \begin{cases} f(x) + \mu([x, 0] \cap (R - R^*)), & x < 0 \\ f(x) - \mu([0, x] \cap (R - R^*)), & x \geq 0 \end{cases}$$

is isomorphism that keeps order of the set R^* in the set R. As the inversion function of the function f^* is representation of the parametrization of the local time, that means that every and therefore linear function as well $f(x) = \alpha x + \beta$, where $\alpha > 0$, induces an arc by arc linear representation of the set R^* that has derivative $\frac{1}{\alpha}$ in all except the mostly countable points. Therefore, we have the following situation. We suppose that "full time" R is prominent parametrization with steady flow and the speed of flow that is taken as the unity in analyzing speeds of flows of other local times. Unbounded local time R^* we see inside "full time" R and its flow as the part of the flow of "full time" that contains it. The existence of the function ${f^*}^{-1}$ that represents parametrization R^* whose derivative where is defined is $\frac{1}{\alpha}$, means that time through set R flows with speed $\frac{1}{\alpha}$. Therefore, one can compare the speed of the flow of certain local time with speed of the flow of the "full time" for which we assume that has unity of speed flow.

As the speed of the flow of each unbounded in R local time R^*, with the speed of the flow of full time, we can compare speeds of unbounded local times one with another as well. *Thus, for the class of unbounded parameterizations of local times the Theory of Relativity is possible.*

We have to stress that *there are local times that could not flow steadily.*

Although parameterizations of the local times are bounded in R, and do not have linear representation, *it is possible to compare the speeds of local time flows of the same or different parameterizations of in many cases.* For example, if set R^* is bounded parametrization of local times, and $f : R^* \to R$ is isomorphism that keeps order, than the function $\alpha f : R^* \to R$ for $\alpha \neq 1$ is also isomorphism with respect to order. Let local times of the points x and y be parameterized by the set R^* which is in the point x represented by the function f^{-1}, and in the point y by the function $(\alpha f)^{-1}$, we can say that the speeds of flow of local times in the points x and y are comparable and that time in the point y flows with the factor $\frac{1}{\alpha}$ with respect to the speed of flow of the time in the point x.

4. PHYSICAL OBJECTS AND RELATIVITY OF THEIR EXISTENCE

Every set of points, as the subset of the space, has extensionality in space. That set of the points has reality, or existence, it has to have extensionality in time as well. Only the objects that have extensionality in space and time can be seen as the material objects or the objects that exist in reality. *Therefore, one can ask the following question: how to select physical objects from the material objects.*

Physics is not formal theory, and it does not have its formal language. However, we can extend the language of the standard mathematics, or the language of Theory of Sets, by proper relations relevant for physics and obtain *the language of physics* with which we can formulate *physical properties.* The objects that are considered in physics or *the physical objects are therefore, among the sets of the points, subsets of the space, determined by the totality of their physical properties.*[3] We allow as well that physical objects as mathematical can be determined by its elements and by some physical property that collect elements of the physical objects in that concrete physical object.

Primer properties of all physical objects are their material existence, their reality and extensionality in space and time. The fact that the physical objects are some subsets of the space X means their extensionality in space. Let $\Re = \{x|\varphi(x)\}$ be any physical object whose elements x have physical property φ. Each element $x \in \Re$ is the point in which local time is defined with parametrization ${R^*}_x \subset R$. Each local time ${R^*}_x \subset R$ except its size in the "full time" R has its flow, and the speed of flow. Flow of the local time R^* in the point we see as the flow of "full time" R that contains it, so that the point exist while its time passes over the set R^*, and does not exist on the set $R - R^*$. That $\Re$ presents physical object it has to have extensionality in time as well, and obviously it has to be the set $\bigcap_{x\in\Re} {R^*}_x \neq \emptyset$. Also, in order to define time flow of the object and its speed of flow, all the elements that make constitutes object $\Re$ need to have local times that flow steadily and whose time flows are of the equal speed. This means that parametrization of local times of the points

[3] It is known that sets or objects that mathematics treats are determined by totality of their collectivizing properties and due to Axiom of extensionality in Set Theory by their elements as well, which are collected in some set by some of the collectivizing mathematical property.

that make physical object $\Re$ need to be unbounded in R. Hence, the non-empty set $T_{\Re} = \bigcap_{x \in \Re} R^*{}_x$ will be *the time of physical object* $\Re$*, or time in which the physical object exists.*

We can therefore say (see Ćirić and Ćirić, 2012) that *each non-empty set* $\Re$ *of the space* X *whose elements are collected via certain physical property is physical object, if all local times of its points flow steadily, with the same speed, and if the time in which the object* $\Re$*,* $T_{\Re} = \bigcap_{x \in \Re} R^*{}_x$ *exists as a non-empty set.*

We define physical object $\Re$, as non-empty subset of the space determined with corresponding physical property. Here one precise and size of the object $\Re$ in the time. Namely, on the non-empty set $T_{\Re} \subset R$ the object exists, and on the set $R - T_{\Re}$, it does not exist. While it exists, the object $\Re$ has reality and materiality.

Numerous, simple properties of physical object are proved in Ćirić and Ćirić (2012). Here we will analyze the existence of the physical objects.

Let $(\Re_1, T_{\Re_1})$ and $(\Re_2, T_{\Re_2})$ be two different physical objects in material space X. Lets imagine that we placed the observers A and B, in the objects $\Re_1$ and $\Re_2$ respectively.

Lets suppose that the time of the object $\Re_1$ is proper subset of the set R, so that $T_{\Re_1} \neq R$. In the moments $t \in T_{\Re_1}$ the observer A exists, and does not exist as physical object on the set $R - T_{\Re_1}$, as on that set at least one of its point has not reality, and has not extensionality in its local time. Taking into account that on set $R - T_{\Re_1}$ the observer A does not exist, there is no way for the observer A to detect the discontinuities in its time flow. Time $T_{\Re_1}$ in which the observer A exists, the observer A sees as one, continuous interval, subset of the "full time" R. Its proper time $T_{\Re_1}$, the observer A sees with all order properties of interval that is subset of the ordered set R of the real numbers.

For the observer A the time flow exists, this is the time flow of all elements of the physical object $\Re_1$, reduced on its time $T_{\Re_1}$. The observer A does not exist on the set $R - T_{\Re_1}$, it exist while its time passes through the set $T_{\Re_1}$. Time flow of the $T_{\Re_1} \subset R^*_x$ for every $x \in \Re_1$ is steady and it has a speed of flow that is equal to speeds of flow of all its points.

On the set $T_{\Re_1}$ we have induced order, topological and algebraic structure. The observer A sees structures on $T_{\Re_1}$ like they are induced from R.

All what we said for the observer A we can say for the observer B.

Existence of the observer A is reducing to the existence of the observer A in its time $T_{\Re_1}$. The observer A exists in its local reality. Naturally one ask the question *when for the observer* A *exists the observer* B.

Lets suppose here *that the object* $\Re_2$ *is near enough to the object* $\Re_1$ *that the information transfer about the existence of the object* $\Re_2$ *to the object* $\Re_1$ *is almost instantaneous and that relativistic effects are negligible.*

In that case if $T_{\Re_1}$ and $T_{\Re_2}$ are times in which the objects $\Re_1$ and $\Re_2$ exist, it can be $T_{\Re_1} \cap T_{\Re_2} \neq \emptyset$ or not.

If $T_{\Re_1} \cap T_{\Re_2} = \emptyset$ *in reaity of the observer* A *the observer* B *can never exist.*

If $T_{\Re_1} \cap T_{\Re_2} \neq \emptyset$ for the observer A the observer B exists in the time $T_{\Re_1} \cap T_{\Re_2} \subset T_{\Re_1}$. In the time $T_{\Re_1} \cap (R - T_{\Re_2})$, of the observer A, the observer B does not exists. The observer A can detect, that the local time $T_{\Re_2}$ is proper subset of the R, but it does not have to be the case if $R - T_{\Re_2} \subset R - T_{\Re_1}$. If the observer A in certain moments of its time $T_{\Re_1}$, sees disappearance of the object $\Re_2$, and equally after some time interval it sees reappearance of the object $\Re_2$ on the place and characteristics as it has been never disappeared, the observer A can state that it is about the same object $\Re_2$. *Therefore, the observer* A *can state that the time* $T_{\Re_2}$ *of the object* $\Re_2$ *has discontinuities, as it sees the discontinuities in the existence of the object* $\Re_2$*.*

The following question arises, is it possible for the observer A to detect the discontinuities in its local time, and if it can how it can do it? We saw that this is impossible within its proper time. Let now the observer B with respect to the observer A moves on arbitrary trajectory with variable speed with neglecting relativistic effects again. It could happen than that in the reality of the observer A that the object $\Re_2$ abruptly change the place in space. By assuming that there is no abrupt change in space, the observer A can only conclude that there was interruption in its own existence. The reason is simple, namely in the interval of the interruption of the existence of the object $\Re_1$, or the observer A the object $\Re_2$ existed as the physical object in its own time and it has change the place in the space meanwhile. The observer A does not see the discontinuities in its own existence and therefore for him the displacement of the object $\Re_2$ is instantaneous. Here, of course it is about the abrupt displacement or change of any physical characteristics.

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