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The question of orientability in Time

Abstract: In the article the Hawking and Ellis problem (the question of connectivity at orientability in Time) is considered. For this purpose, we introduce such concepts as: 1) current of Time j_i; 2) function T, in terms of Space-Time; 3) phase angel of Time Ψ_z. In the article the mechanism of correlation between the local currents of Time is described and the hypothesis about mathematical operator generating extrapolation of values of the phase angle to the local currents of Time is stated.

Key words: Time, Hawking, current, phase angle

1. Introduction

It follows from the postulate on local causality [4], that you can send a signal from one point r of the manifold M (we consider the manifold M connected as there is no information on disconnected parts accessible to us) to the other r' when and only when these points can be connected by not space-like geodesic curve. The concept of manifold responds directly to our ideas of Space-Time continuity. As a matter of fact, the structure of Space-Time is the manifold M

allotted with Lorentzian metric and affine connectivity determined by it. The question of orientability in Time is closely connected with the condition of local causality. Here and elsewhere we will write the terms Time, Future, Past and Present capitalized, where they are used with the meaning of real physical objects. Our attention is drawn to the work [1] in which the expanded definitions of the three last-mentioned temporal parameters are given from the point of view of their topological morphogenesis.

If we consider an region of Space-Time Y which is a subset of varieties M ($Y \subset M$), on which the "arrow" of Time [4] is strictly connected with the entropy increment of the quasi-isolated thermodynamic systems, then it may be expected that at each point of f_i , $f_i \in Y$ of this region there exists a priori a local "arrow" of Time specified not by an asymptote. For convenience of mathematical analysis of the problem raised in this article we will introduce instead of the term "arrow" of Time a new physical parameter: current of Time. We will denote it with a symbol: j_i . Then it is possible to formulate such definition

Definition 1

Current of Time j_i is a temporal current representing such period of time Δt, which is defined by stable Time of existence of the randomly chosen material body from the moment of its formation t' until the moment of its decay t''.

From this definition it follows logically that the current of Time j_i is equivalent to Δt, $j_i \sim \Delta t$ and, besides, the following fundamental conditions must be carried out at all times and in all places:

$$\begin{aligned} &\Delta t \in [\, t', t'' \,] \\ &\Delta t = [\, t'' - t' \,] \\ &t'' > t' \\ &\Delta t \neq 0 \end{aligned} \qquad (1)$$

So far, the mechanism of the established relationship between the currents of Time in various regions of Space-Time is not quite clear from the physical standpoint. Stephen W. Hawking and George F. R. Ellis have defined this problem

rather consistently. Hereafter we will refer to the initial problem as the Hawking and Ellis problem to simplify consideration. This problem is formulated as follows, hereafter according to text: "… It is not quite clear what the relationship is between this “arrow” and the other “arrows” defined by the expansion of the universe and by the direction of electrodynamic radiation… " [4].

2. Analysis of the Hawking and Ellis problem.

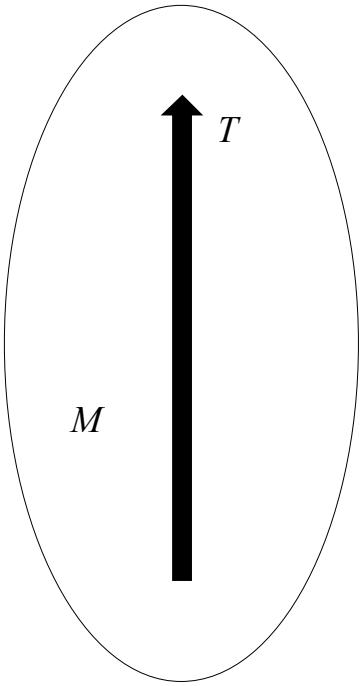
This solution of Hawking and Ellis problem will be constructed on the basis of several other conceptual suggestions rather than those presented in [4]. First of all we will consider the questions connected with temporal aspects.

The Universe, in general, can be considered as global thermodynamic system evolving, both in space and in time. As previously noted, the thermodynamic system of any kind is characterized by entropy, and thus by the strictly set direction in Time. Representing the Universe in the form of a complex multiply connected topological manifold M it is reasonable to suggest that the interior $int\ M$ of this structural formation is filled with the sum of events $\sum G_n$ of all material bodies. Any event G_n as a physical phenomenon is characterized by the fact that it is happening in Time. Consequent alternation of the set of events is also strictly determined by and complies with causal chronological postulates. Whereby the statement disclosed earlier in [4] is valid: in physically realistic judgements the condition of causality and the chronological condition are equivalent. In accordance with the abovementioned it seems physically reasonable to formulate such suggestion

Assumption 2.1

The beginning of inflation of the Universe [2] and its subsequent evolution in time is directly proportional to the function T acting as a transcendental type of Space-Time [1].

It is needed to introduce function T and relate it to the Universe and therefore with the manifold M (Picture 1)



Picture 1 Space-Time T mapping onto manifold M

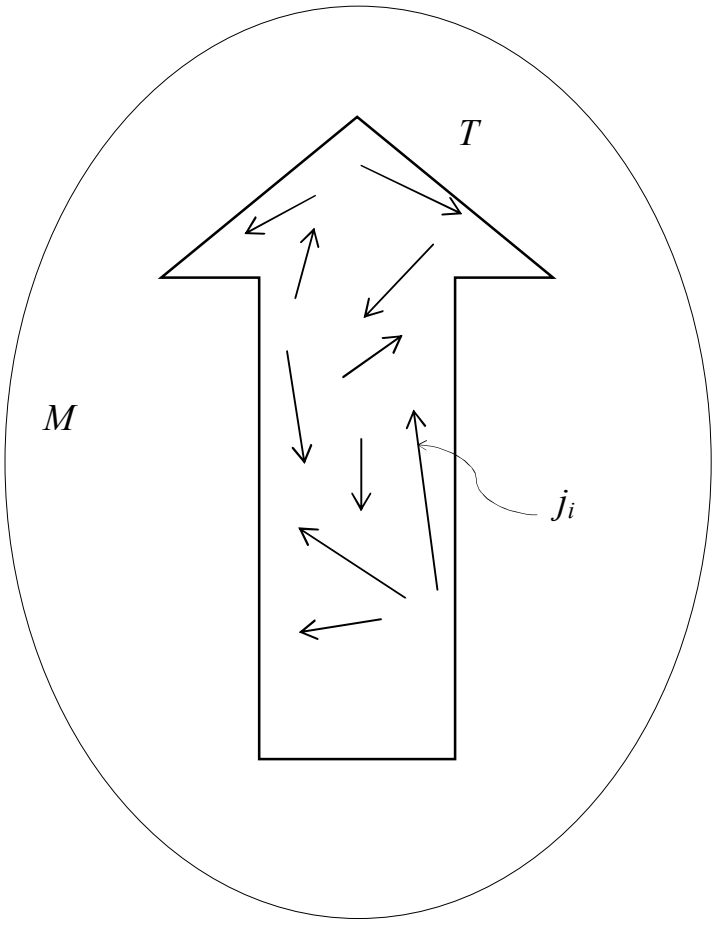
to it is necessary in order to fulfil the stable causality condition [4] that is written as follows: stable causality is identified everywhere in M if and only if the function T, the gradient of which is timelike everywhere, i.e. the metrics g is negative

$$X \in D_p \Rightarrow \exists g(X;X) < 0 \qquad (2)$$

where g is the Lorentzian metric, X is the non-vanishing vector, p is the element of M, where the non-vanishing vector X is timelike, $g(X;X)$ is the scalar square, D_p is space, representing the set of all directions in p, and which are identified as tangents to M vector spaces in p. The function T on the manifold M extrapolates as

the Space-Time of the Universe, in the sense that it ascends along each not spacelike curve directed to the Future, therewith $T \in M$ [4]. It is not difficult to notice that T reflects such current of Time of the Past to the Future at which all events G_n along the timelike curve h are determined according to the cause-and-effect relations. By curve h we mean the curve of non-zero extent, besides one point cannot be considered as a curve.

As noted above the interior of the Universe is predicted as a conglomerate of a vast number of material bodies, each of which can be compared to one-to-one correlation in the form of local timelike currents of Time j_i. This model lets us note that in the *int M* there is i number of bodies, for which the condition of bijection of *int M* is satisfied: $i \rightarrow j_i$. In this regard, it is not difficult to notice that from the physical standpoint the borders of Space-Time can be expanded continuously, i.e. now function T consists mainly of the integrated additive local currents of Time. It follows that an adequate local current of Time will be found to each material body in the Universe.



Picture 2. Distribution of local currents of Time j_i

as projection on to Space-Time T

Considering this criterion we can write down that the function T is nothing but sum of finite number of local currents of Time (Picture 2).

$$T = \bigcup_i j_i \qquad (3)$$

In the context of the axiomatic analysis it is clear that in case at a certain point of time we have two homogeneous systems, for example, two bodies, comparable by their nature (their physical, chemical, geometrical, etc. properties are identical), then they can have absolutely identical local currents of Time. Please note that such option can be realized only in ideal conditions. And, on the contrary, if two chosen material bodies completely differ according to all the physical characteristics, then their local currents of Time can't be identical. These days, when the Universe is in a dynamic state, it is very difficult to allocate two and more material bodies strictly equivalent to each other in all parameters. And this also causes that in the interior of Space-Time T there is no orientation between local currents of Time j_i that would be connected accurately and systematically. And this also causes that in the interior of Space-Time T there is no orientation between local currents of Time of j_i that would be connected accurately and systematically. It will be shown below that actually there is a certain physical mechanism that can distinguish descriptively the correlation between one single local current of Time and other local currents. As a matter of fact, one of probabilistic solutions of the Hawking-Ellis problem is formulated a priori.

Let us assume that in some (already mentioned above) region of Space-Time Y, there are two material bodies U and V, chosen so that they would interact with each other in a certain way. These bodies are chosen so that they don't belong to the same type. It is understood that their physical properties and parameters are

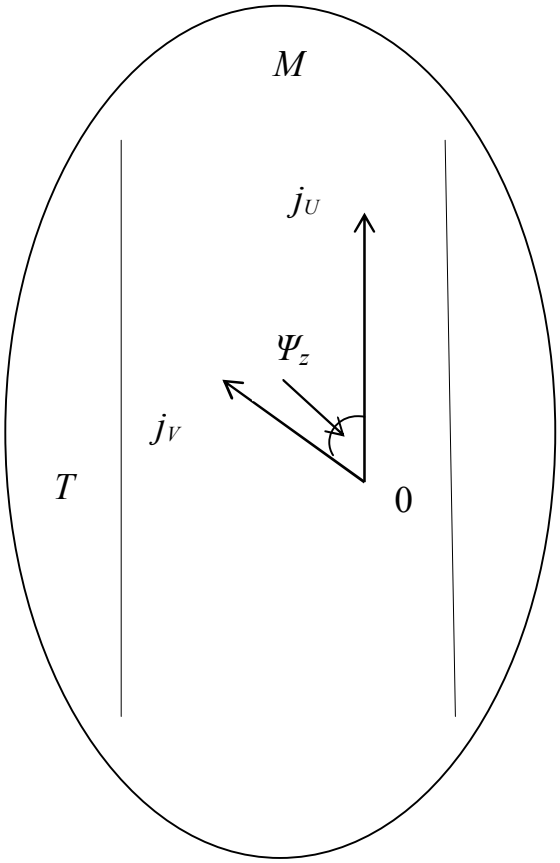
heterogeneous. Due to the fact that these bodies influence each other, despite different orientation of their local currents of Time j_U and j_V, functional and physical connection between them still remains. The question is in finding this connection, i.e. it is required to reveal such calibration parameter that would allow establishing correlation between initial local currents of Time.

For solution of this problem it is appropriate to carry out the following mathematical transformations:

1) local currents of Time j_U and j_V are situated relative to each other in such a way that their reference points coincide in point – 0. Theoretically this point represents a pole, such that

$$\{0 \in j_U \cap j_V\} \leftrightarrow \{0 \in j_U\} \wedge \{0 \in j_V\} \qquad (4)$$

2) let us assume that one of the local currents of Time, for example j_U, is set parallel to Space-Time T, $j_U \parallel T$. Then, local current of Time j_V of the material body V will be oriented in relation to j_U at a certain angle (Picture 3)



Picture 3 Relative positioning of local currents of Time

in a segment of Space-Time with the allocated phase angle of Time

From gnoseological standpoint this is a very important conclusion. Indeed, according to paragraphs 1) and 2) the oriented mapping of local current of Time j_V onto local current j_U can be carried out by means of angular parameter. Let us designate this parameter as *phase angle of Time* and denote it with Ψ_z; then we can write down the following:

$$\Psi_z : j_V \longrightarrow j_U$$

(5) where Ψ_z is mapping j_V at $\Psi_z(j_V) \longrightarrow j_U$.

Index z is needed to allocate this angle from the class of basic geometrical angles. First assumption of possible existence of phase angle of Time has been stated in the article [3].

Assumption 2.2

Phase angle of Time Ψ_z is the angle between local currents of Time j_i (brought to one pole) that identifies connectivity at orientability in the interior of Space-Time T.

It is clear conceptually that numerical borders of the phase angle of Time Ψ_z have variational values. Indeed, basing on the analysis methods applied in mathematical morphology, we define that for a particular configuration of two specific local currents of Time the value Ψ_z is strictly individual and is characterized only by the local currents of reference.

Let us adapt the techniques of mathematical induction to the analysis of system, in which i - number of local currents of Time accumulates. For this purpose let us take as the frame of reference any of Time currents, and provided that we use the phase angle of Time, it is elementary to determine functional connection (orientability) between the local current of Time of reference and other

local currents. Thus, clear probability of understanding of the proceeding processes in Space-Time T with due account for orientation of local currents of Time j_i relative to each other is generated.

Summarizing all the above-mentioned we can draw the following conclusion: Hawking and Ellis problem is solved sufficiently precise in case it is summed up to finding values of phase angle of Time. As angles are measured in degrees or radiant, specific numerical interpolation of these angles is high-priority. it should be also remembered that the algorithm of getting a nonabstract number included in value of the variable Ψ_z correlates with existence of a certain mathematical operator explicitly. The issue of this operator is the key aspect and it also need to be worked out, however doing that within this article is to soon. Further analysis will be made in the subsequent researches. The top priority is verification of the hypothesis of local currents of Time offered in this article.

3. Conclusion

The case considered in this article demonstrates that for solution of the question of connectivity at orientability in Time, it is necessary and sufficient to define the angular characteristic distinguished as a phase angle of Time Ψ_z. The imperative of such mathematical operation is due to the fact that in the inflation Universe it is functional to connect certain temporal regions to each other.

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