A Special Physical Phenomenon — Innate Interconnection of Space-time Points

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Abstract: In the light of A. A. Friedman’s conceptual analysis of the World of events as a mathematical model of the physical reality in his book “The World as Space and Time”, a priori (innate) interconnection of events belonging to one and the same moment of time, which can condition the space-time metric, is considered with a summary review of its astronomical observations by N. A. Kozyrev’s method.

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1 Introduction

Ninety years ago, in 1923, fifteen years after famous lecture “Space and Time” by H. Minkowski, where the modern four-dimensional mathematical model of the physical reality (the ‘World of events’ or ‘space-time’) was proclaimed, A. A. Friedman’s book [1] came into the world. Its title was absolutely in the spirit of Minkowski — “The World as Space and Time”. There was a demonstrable analysis of the basic physical categories ‘space’ and ‘time’, too, that was appreciably deepening the Way declared by Minkowski.

Really, Friedman (1888 – 1925) was the only one among the contemporaries of the special relativity creators, who penetrated into analysis of the World of events as a mathematical model of the physical reality. Only Friedman was then going on the cause of Minkowski who had gone so early after his famous lecture — three and a half months later. Probably that is why physicists, with not many exceptions, perceived and assimilated the space-time just nominally, without recognition of its essence, only as certain mathematical formalism. Ipso facto A. Einstein’s position went unheeded: it is known that in his lectures on the essence of the theory of relativity in Princeton in 1921, Einstein has not only high estimated Minkowski’s contribution and its function in development of the relativity, but also clearly stated his opinion about the World of events as the physical reality. Unfortunately, up to date there is a diffused opinion about space-time as a convenient, but imaginary mathematical formalism.

That is why A. A. Logunov’s modern analysis of the special relativity, see [2], and A. A. Sazanov’s detailed examination of Minkowski’s four-dimensional World, see [3, 4], are very important. That is why this Friedman’s work is ever more actual. (The edition next to the third one [5] was announced by the publishing house Harri Deutsch Verlag (in German) in 2013.) This book distinguishes itself by dealing with the temporal aspect of the physical reality. In it the main questions relating to the time — the time as a core of the World of events, as an aspect of the physical reality — were considered. Firstly, Friedman showed that the core of the physical essence of the Lorentz transform just is in idea about time as an equal in rights coordinate of the frame of reference. In this status it does not differ from spatial coordinates. It means that the temporal coordinate is possessed of the physical reality as the spatial ones and the World of events is a mathematical model of the physical reality. Secondly, that is extra important, Friedman does not identify the temporal coordinate with the spatial ones, bearing in mind their functional difference in universe. In his analysis the time does not dissolve into a space many-dimensionality. That is why he is discussing special features of the temporal coordinate and consequently advances a new physical problem — the problem of reinstating time as exceptional physical entity associated with causality as the very important one and even immediately suggests the following approach to this problem.

Causality principle “must impose known restrictions:

1) on methods of arithmetization of the physical world at which invariance postulate takes place; of course, one can perform arithmetization ad libitum, but not for whatever arithmetization the invariance postulate will take place;

2) on properties of the geometrical four-dimensional space to whose interpretation the physical world corresponds;
3) on choice of that out of the physical world coordinates to which will be prescribe the time role (connected with causality principle) ” [1] see p. 68.

Unfortunately, this approach was not perfected—soon afterwards Friedman died prematurely.

The main aim of this paper is to show that Friedman’s approach to the space-time as a mathematical model of the physical reality and his analysis of the notion of time give a possibility to reveal a new fundamental phenomenon—a priory, i.e., innate interconnection in the World of events, that can condition space-time metric. To show, that really it is rather not all the same how we relate to the World of events essence.

Probably, it is fascinating to continue theoretically to design the universe by means of own usual mathematical resources and suppose that the physical reality has only one aspect—the spatial one and that the space-time is a product of the space evolution in time. But this implies to stay in Newtonian notions about the physical reality, which were adequate for his problems: they correspond to the unstructured bodies having the same internal state, without evolution phenomena. Thereby in fact we confine ourselves especially to the stationary universe. This circumstance attracted J. L. Synge’s attention and he stated: “Steeped as we are in Newtonian ideas, it is necessary to emphasize, even ad nauseam, that space-time cannot, in general, be split onto space and time in any invariant way” [3 see p. 154]. We ought to take into consideration that we have the semantic extravagance if, on the one hand, we observe and admit the universe evolution and, on the other hand, try to simulate the universe by means of theoretical foundation adequate only for the stationary universe.

Generally speaking, we can see fruit of the physical reality temporal aspect ignoring, looking at the general picture that gave us the centennial use of space-time. It was interpreted in detail in A. K. Guts’s review “Hundred years of Minkowski’s absolute World of events” [7]. Volens nolens, this picture illuminates essentially the mathematical idea brilliance and poverty of the concrete physical achievements, if one is in fact founded on Newtonian ideas related to the stationary physical reality and blindly ignores the principles, fundamental impossibility of the ‘space-time’ separation into ‘space’ and ‘time’.

That is why Friedman’s conceptual analysis of the spatial aspect of the physical reality, including the space arithmetization and the space metric, is important at present, because it leads to the following conclusion:

“Thus, we cannot perfectly generate the physical actions necessary for the experimental identification of the physical geometry in three-dimensional space; for us these actions are as impossible as for us is impossible the physical actions in two-dimensional space, where it is impossible to locate our devices and where we ourselves cannot locate. The cause of these difficulties is time, without which there is no space and which is conditioning not the physical three-dimensional space, but the physical four-dimensional space — the World” [11 see p. 47–48].

If we comprehend that the World of events is the objective physical reality, then immediately a new field of action is opened for our investigations. (By the way, Minkowski said in the very beginning of his lecture about them: about a strength of the views for space and time in question and about their radical tendency.) Really, entire terra incognita is opened—the new aspect of objective reality for physics. According to the logic of things, two organically connected inter-promotional aspects of the physical reality, the spatial and temporal, must play different parts in universe. The temporal aspect does not copy the spatial one, it has its functional purpose and consequently its specific properties. So, it is interesting and necessary to investigate them. Really, Friedman directed to such investigations, suggesting the problem of reinstating time as exceptional physical entity associated with the very fundamental, key property of universe—with causality.

The Minkowski–Friedman cause was continued after 30 years by N. A. Kozyrev in his theoretical and experimental investigations of physical properties of time as an aspect of the physical reality (see [8]). Actually, these investigations are returning to the time in physics its exceptional position connected with causality. Note that Kozyrev’s study always begins with experience and terminates in it. So, his attention to time was called by his analysis and synthesis of numerous astronomical observational data in search of ways of tackling the fundamental astronomical problem of the stellar energy nature [8 see p. 71–154] (the detailed conceptual analysis of this fundamental work and criticism of positions of its adversaries (D. A. Frank-Kamenetsky and A. G. Masevich) are in the book [9]; note that in 2005 the English translation [10] was published). This theoretical investigation has led him to a conclusion that it was necessary to consider ‘space’ and ‘time’ as two organically, inherently interconnected aspects of the reality, but which had essentially different purposes. He supposed that space acted a passive part whereas time did an active one. Later the capital books by J. L. Synge [8], G. J. Whitrow [11], I. Prigogine [12] were evidence of great importance of the temporal aspect for natural sciences. Synge proposed that the word ‘chronometry’ ought to be used for denotement of “that part of science which deals with the concept of time, with the same wide scope which we have learned to give to the word ‘geometry’” [13 see p. 410]. Synge felt strongly that “Euclid put us on the wrong track, so that we put space first and time second—a very poor second indeed, for a child’s study of chronometry hardly goes beyond learning to read the face of the clock” [13 p. 411].

From these positions, any theoretical constructions which disregard time’s own mission at the very beginning shall be simply inadequate in essence. This statement relies on the experimental facts relating to the peculiar physical properties of the temporal aspect [9]. That is why in the two next sections we give our brief review of such an experience knowledge: in the first the relation representing mathematically the World of events physical reality is discussed, this relation lets to talk about a priory (innate) interconnection of events relating to one and the same moment of time, which can condition space-time metric; in the second are considered astronomical evidences of the World of events phys-
2 The innate events

As it is well-known, for measurement of temporal interval between moments of time (duration) we use special objects—processes (motions) continuing in time. Friedman defines that motion as the ‘base’. Suppose, as a base process, some physical process $\lambda$ is used in our clock engine and, as a tentative duration measure, the change of its key property $\tau_\lambda$ is taken. (Such property has to change monotonously from the past to the future.)

It means that if to the moment of an event $i$ corresponds its value $\tau(i)$ and to the moment of a subsequent event $j$ ($i < j$) corresponds its value $\tau(j)$,

$$\tau(i) - \tau(j) \equiv \tau_\lambda(i, j) \quad \forall i < j$$

is the measure of the temporal interval between events $i$ and $j$ (the sign ‘$<$’ denotes ‘is preceding’).

J. L. Synge [3] right assumes that such duration measure makes no important physical sense and the concept of time will acquire greater concrete sense if we imply an existence of the ‘standard clock’, e.g., the atomic one. So that the concept of duration is founded on the existence of special, ‘standard’ processes, and immediately arises the question about the objective choice of that standard clock.

The problem of the standard clock choice was resolved by G. J. Whitrow [11] see Ch. III, § 8]. Analysing of the standard clock problem, he pointed out an important moment of the time measurement: the measure of a duration which consists of two successive durations has to be equal to the arithmetical sum of theirs. That is because of the time additivity

$$t(i, j) + t(j, k) = t(i, k) \quad \forall i < j < k,$$

(1) where $t(a, b)$ is the actual measure of the duration between an event $b$ and an event $a$ preceding it.

G. J. Whitrow started from one apparent fact that by using some tentative measure $\tau_\lambda$ we can find out that

$$\tau(i, j) + \tau(j, k) \neq \tau(i, k) \quad \forall i < j < k.$$

(2) (For example, the process $\lambda$ is the radioactive decay and $\tau_\lambda$ is the part of decayed atoms [11] see Ch. III, § 8]). In order to make clear what differs the nonstandard process from the standard one, G. J. Whitrow suggests for the tentative measure for that occurs [2] to consider the possibility of introduction of the temporal sum $\oplus$ which shall satisfy the condition (1):

$$\tau(i, j) \oplus \tau(j, k) = \tau(i, k) \quad \forall i < j < k.$$ 

(3)

G. J. Whitrow has analytically obtained that the temporal sum (3) is determined by formula

$$\tau(i, j) + \tau(j, k) = \varphi_\lambda^{-1}\{\varphi_\lambda(\tau(i, j)) + \varphi_\lambda(\tau(j, k))\}$$

(4)

where $\varphi_\lambda$ is the definite monotonous function corresponding to the process $\lambda$, $\varphi_\lambda^{-1}$ is the inverse one. In order to obtain the (4), he used only the well known properties of the temporal intervals: their commutativity, i.e.,

$$\tau(i, j) + \tau(j, k) = \tau(j, k) + \tau(i, j) \quad \forall i < j < k,$$

and their associativity, i.e.,

$$\tau(i, j) + (\tau(j, l) + \tau(l, k)) = (\tau(i, j) + \tau(j, l)) + \tau(l, k) \quad \forall i < j < k < l.$$ 

The (3) indicates that every base process $\lambda$ may be used in principle as a standard one with the aid of the measure

$$t(i, j) = \varphi_\lambda(\tau(i, j))$$

that satisfies the condition (1), i.e., it is the actual measure of the duration between an event $i$ and an event $j$ because of its uniqueness (within a scale factor), i.e., generally [11] Ch. III, § 8]

$$t(i, j) = C_\lambda \cdot \varphi_\lambda(\tau(i, j)).$$

(5)

where $C_\lambda$ is the scale factor for the base process $\lambda$. Thereby G. J. Whitrow resolved the standard clock problem: the standard clock is a clock with the additive scale; it is clear, if a tentative measure $\tau_\lambda$ corresponding to the given process $\lambda$, does not satisfy the condition (1), we can always unambiguously (within a scale factor) image it by means of the function $\varphi_\lambda$ on the additive measure (3).

Whitrow’s approach to the standard clock problem gave us the possibility to find out a priory (innate) interconnection of events relating to one and the same moment of time [17]. Really, consider the series of standard processes $\lambda, \mu, \nu, \ldots$ and their actual duration measures

$$C_\lambda \varphi_\lambda(\tau_\lambda), \quad C_\mu \varphi_\mu(\tau_\mu), \quad C_\nu \varphi_\nu(\tau_\nu), \quad \ldots,$$

where $C_\lambda, C_\mu, C_\nu, \ldots$ are scale factors corresponding to the base processes $\lambda, \mu, \nu, \ldots$.

According to the physical reality of the temporal aspect, if we measure the temporal interval between events $i$ and $j$ by means of these standard clocks with various engines $\lambda, \mu, \nu, \ldots$ (of course, in one and the same frame of reference), results of these measurements have not to depend on the engines $\lambda, \mu, \nu, \ldots$, and the following relation must hold true:

$$C_\lambda \varphi_\lambda(\tau_\lambda(i, j)) = C_\mu \varphi_\mu(\tau_\mu(i, j)) = C_\nu \varphi_\nu(\tau_\nu(i, j)) = \ldots.$$ 

(6)

The relation (6) indicates that all base processes $\lambda, \mu, \nu, \ldots$, which look like independent ones, proceed not independently, but interactively — there is an innate interconnection of their key characteristics $\tau_\lambda, \tau_\mu, \tau_\nu, \ldots$, which is not connected with phenomenon of “propagation action” in space, but conditional by their common existence in time. In other words, the relation (6) mathematically represents the space-time physical reality.
An example of the similar innate interconnection one can see in the physical interconnection which is hiding behind an action of Pauli exclusion principle.

This interconnection is representing the common, one-piece realization (“course”) of base processes in the temporal aspect, the same is associated in philosophy with the concept about one-piece worldwide process. The given interconnection relates to the temporal aspect and covers events relating to one and the same moment of time. In other words, it is an instantaneous action, a distance-type action. Just such interconnection is able to create the space-time metric. We are obtaining the physical solution of Riemann’s question about space metric as to space-time — about the intrinsic cause of appearance of space-time metric; in his paper, A. D. Aleksandrov has given only philosophical solution, see [16].

Naturally immediately arises a question: How can we detect such innate interconnection in our experiment? In principle, quite simply. We ought to pay attention to irreversible processes whereas they relate to the base ones, to the external irreversible processes and complex systems (i.e., structured systems that can be in various internal states). In such a system there are appropriate internal processes. That is why certain nonpower influence on the complex system state must be observed from an external irreversible process (of course, under definite conditions connecting with special properties of interconnection in question). Consider one demonstrable example: look at the behaviour of a complex biological system — the cells of Escherichia coly microorganisms under some external irreversible process, to which they are indifferent accordingly to the conventional viewpoint. The state of the given system is determined by means of a standard test that uses the cells ability to form colonies on a hard agarized medium: the viability of the cells is studied (by the number of cells capable of reproducing), and also their state is studied by determining the spontaneous mutation background.

As an external irreversible process to which this biological system is indifferent accordingly to the conventional viewpoint was taken the process associated with liquid nitrogen at room temperature. Observations were made in special camera (it has ellipsoidal form, the distance between focuses equals 40 cm, the ellipsoid surface was covered by means of aluminum foil) in order (1) to ensure a good stability of temperature in focus where was the biological system (in other focus was the process) and (2) to concentrate action of the process. The open container with liquid nitrogen was located at the bottom focus, the closed retort with the cells suspension was located at top one. It is necessary to emphasize that temperature of cells suspension was keeping equal (22.0 ± 0.3°C during the experiment and there is not any known action upon the cells being in anabiosis.

This experiment found out a negative reaction of the cells viability upon the presence of liquid nitrogen at the bottom focus. Figure 1 shows the results of this biological system testing. As we can see in Figure 1A, under processes in question accruing inactivation is observed — cells are losing their viability. About the cells viability attests the estimation their ability to reproduction: $K$ is the number of cells formed colonies in the sample, $t$ is the continuance of influence. In Figure 1B we see the data showing the efficiency of processes in question as certain mutagenic agent. The population resistance with respect to the two antibiotics (nalidixic acid and rifampicin) was studied: $K$ is the number of cells formed colonies in the sample, $K_{oc}$ is the same number in control, $K_M$ is the number of cells which are immune to the action of these antibiotics, $K_{oM}$ is the same number in control. We see, the number of viable cells as compared with control decreases, but a part of viable cells which are immune to the action of these antibiotics as compared with control, on the contrary, increases.

In order to estimate the action in question as a mutagenic agent, the control experiments with the known mutagens were actualized: with the chemical and radiative one (ultraviolet). Results of this study we are giving in Figure 1B by means of circles with dots inside — the action in question, as a mutagenic agent, does not surrender to the ultraviolet.

Thus, this experiment indicated that an external irreversible process (to which the given biological system, accordingly to the conventional viewpoint, is indifferent) influences in truth upon its state. Of course, one may imagine that there is certain unknown property of known physical interactions of which the carrier is liquid nitrogen and which can cause the observed cells inactivation. That is why we ought directly to say that, when it became known that telescope (reflector) may be used for observation of the stellar processes influence upon the states of terrestrial complex systems, manifold special astronomical observations were implemented [18].
3 Astronomical evidences

In the astronomical observations it was unexpectedly revealed that the used sensors react also upon the projections onto celestial sphere of the two space-time points, $C_-$ and $C_+$ (see Figure 2), that relate to the observed stellar object and lie on the corresponding light cone. Remember that we are discussing the interconnection of events belonging to one and the same moment of time and on the light cone lie just such. In Figure 2 $O$ is the observer on the Earth, $C$ is the world-line of the stellar object, $C_-$ is the event “Apparent stellar object”, its projection onto the celestial sphere is away from the apparent stellar object at a distance equal to the value of refraction for this object at the moment of observations, $C^*$ is the event “True stellar one”, its projection onto the celestial sphere coincides with this stellar object at the moment of observations, $C_+$ is the event “Symmetric stellar one”, its projection onto the celestial sphere coincides with the position of given object for the future, when a light signal sent from the Earth at the moment of observations would reach it.

Sensor’s reaction on the projects on the celestial sphere of events $C_-$ and $C_+$ testifies to the truth of the space-time physical reality, see above, in introduction, cited Einstein’s statement about it. In addition adequacy of Minkowski’s World is confirmed. That is why it is necessary to note the following.

1. Minkowski’s World of events is in the base for Vlasov–Logunov–Mestvirishvili relativistic theory of gravitation [19].

2. Gerber’s formula for Mercury’s residual precession, that in due time ensured the greatest triumph of Einstein’s general relativistic theory, can be interpreted due to the cogravitational field produced by the apparent motion of the Sun around Mercury giving exactly the same estimate as derived from the Schwarzschild metric in general relativity theory [20]. These authors used the generalized theory of gravitation of O. D. Jefimenko [21], there Newton’s theory of gravitation was developed for moving and time-dependent gravitational systems. Generally speaking, O. D. Jefimenko’s theory revealed an impassable vulnerability of Einstein’s version of Gerber’s formula for Mercury’s residual precession. The significant ontological, semantic difficulty of the general relativity was visualized: the mass current produced by a moving mass distribution of density $\rho$ is $J = 4\rho v$ rather than $J = \rho v$ as would be expected on the basis of general considerations of the mass-current concept. Then owing to the velocity of light, as a physical quantity, is first introduced in the general relativity when the theory, in its limiting case, is made compatible with Poisson’s equation of the Newtonian theory of gravitation, at which time Einstein’s gravitational field equation is finally obtained, on the one hand, and through the additional factor in formula for the current $J$, on the other hand, one gets rather different, contradictory values for the velocity of gravitation in the different methods of linearization of Einstein’s equation, see [21, Ch. 20].

3. The modern experimental investigations with the aid of coherent excitation of relativistic nuclei in a crystal (the Japanese research teams supervised by K. Komaki, Y. Yamazaki, and T. Azuma) [22, 23], which fine-resolution confirmed the conclusion of the special relativity concerning the relativistic time dilation of relativistic “clock”, actually brought in guilty for the general relativity, as far as the corresponding energy-level changes of relativistic nuclei undergoing tremendous accelerations inside of a crystal target were not registered in these high-precision experiments. The results of the Andromeda Nebula (M 31) observations [24] (see also [9, see p. 160–166] and [17]) give us a shining example:

- the three sensor’s reactions to the projections of the lengthy events “Apparent M 31”, “True M 31”, and “Symmetric M 31” (the events “Apparent stellar object”, “True one”, and “Symmetric one” are defined above);

- at the time of this observation, simultaneous visual control by sighting device does not single out any celestial object which would be projected on the sensor during the profile of the projection of the events “True M 31” and “Symmetric M 31”;

- the size of them along right ascension and along declination corresponds to the one of the Andromeda Nebula;
the angular distances both between the projections of the events “Apparent M 31” and “True M 31” and between the projections of events “True M 31” and “Symmetric M 31” were $(188 \pm 2)^\prime$ along right ascension and $(34 \pm 2)^\prime$ along declination that corresponds to the accepted data set on this galaxy;

the angular distance between the projection of the event “Apparent M 31” and the apparent M 31 was of the order of $23^\prime$ along declination that corresponds to the value of the refraction of the apparent position for that celestial object at the moment of observation — that value was equal to $23.6^\prime$;

finally, structure of all these profiles has one and the same peculiarity — in the center of the galaxy takes place a decrease of the sensor’s reaction, it corresponds to the neutral hydrogen distribution map in the Andromeda nebula obtained by means of the observation data [25], that is similar to a giant doughnut with a hole in its center instead of the expected well known disk-shaped distribution of stars in that galaxy.

4 Conclusion

Thus, we have the repeated astronomical observations data (of different authors [13]) that demonstrate the physical reality of the Minkowski’s World of events — we can observe the definite points of four-dimensional World projects on celestial sphere as images of celestial bodies. The physical reality of World of events demands to face the facts of the absolute space-time as Minkowski at the very beginning accentuated in his famous lecture and that sequentially, step by step, explained and expounded Friedman in the two first chapters of [11], unveiling the role (function) of time as the temporal aspect of the physical reality.

In conclusion let us put the rhetorical question: “Do we have to know about the World of events physical reality”? Undoubtedly, it is necessary. Because only then may arise the understanding of that circumstance that it is senseless to develop “theories of the universe” as-suming that the physical reality has one sole aspect — the spatial — and ignoring the temporal and its exceptional properties, if we wish really to know how our universe was constructed. Remember Einstein’s words from his famous Herbert Spencer Lecture at Oxford (1933): “Pure logical thinking can give us no knowledge whatsoever of the world of experience: all knowledge about reality begins with experience and terminates in it. Conclusions obtained by purely rational processes are, so far as Reality is concerned, entirely empty... Experience of course remains the sole criterion of the serviceability of mathematical construction for physics”, see [20] p. 164, 167. Friedman turned his attention to that 90 years ago, apart from Friedman, 65 years ago, to such conclusion — about urgency of temporal aspect investigations — came Kozyrev in consequence of his study of the stellar energy nature [10]. Physical properties of the temporal aspect revealed by him afforded an effective possibility to find out a priory (innate) interconnection in the World of events considered in this paper. Recently the properties of that phenomenon and observable effects connected with it have been represented in detail in our monographs [13] and [27].

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