Appendix B. Kozyrev on the Geometry of Space-Time

> The main drawback of the scheme of theoretical mechanics and physics is the extremely simplified idea of time. For the exact sciences, time has only a geometric property. It complements the spatial arena in which events of the World are played out. At the same time, physical properties can exist in time, such as, for example, the direction of its flow and density.
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> *N.A. Kozyrev. Selected Works. Leningrad State University Publishing House, 1991, p. 409.*

Article N.A. Kozyrev's "Astronomical proof of the reality of four-dimensional Minkowski geometry" [2], is especially interesting in that the author gives her own theoretical explanation of the results. The main idea of this work is that "... the reality of geometry, that is, its correspondence with the properties of our World, can be established only by observations and experience, and not by a logical conclusion". The concept of geometry Kozyrev relates not only to the spatial characteristics of the World, but also to time. "In the same way, in order to study the geometric properties of time, existing either independently of space or forming a four-dimensional manifold with it, it is necessary to introduce some physical properties into the time intervals measured by the clock, due to which the effect of time on matter is possible. The existence of physical properties at the time was proved by a number of laboratory experiments and astronomical observations" [2]. The results of astronomical observations were described in detail in Appendix A. Here we will talk about a theoretical explanation of the essence of the phenomenon by the author himself.

"The effect of time on matter per second can be a measure of the amount of time in this unit, or its density. The density of time in a given place in space depends on the processes taking place in the vicinity of this place. Processes in which there is an increase in entropy increase the density of time, and they, therefore, radiate time. This means that the density of time increases when a substance loses an organization. Already from this circumstance, we can conclude that time carries an organization, or negentropy, which can be transferred to another substance — a sensor. Near such processes, for example, the ordering of the crystal lattice increases, and therefore, in particular, the electrical conductivity of the resistor with a positive temperature coefficient should increase" [2]. Then Kozyrev gives in general terms a geometric picture of the Universe, which can be built on the basis of astronomical data, which were discussed in Appendix A. According to his reasoning, the availability of observational data allows us to conclude that the mathematical model of our Universe should not be based on a concept Newton, where time does not depend on space, but on the assumption that our World is a four-dimensional manifold that includes time.

The results of astronomical observations of distant space objects allow us to conclude that the detected effect propagates in the Universe both instantly and at the speed of light. Instantaneous action, or long-range action, fits into the framework of Newtonian ideas about the Universe, where gravitational action and light propagate instantly. However, the experimentally detected effect by Kozyrev, propagating with a finite speed (short range) equal to the speed of light, suggests that it is necessary to turn to such a picture of the Universe, within the framework of which coexistence of two types of interactions - short range and long range interaction. Kozyrev was not built such a theory, but he managed to formulate the main ideas that can serve as the cornerstone in the basis of new ideas about the relationship of space and time, where time is not just a geometric characteristic, but a directed flow of energy that creates everything that is in the Universe including herself.

The fundamental idea of Kozyrev was an attempt to apply as a basis for the mathematical explanation of the results of his observations a four-dimensional flat space-time, constructed by mathematician German Minkowski [13]. The fact is that in Minkowski space-time, the spatial distance between any two points and the time interval separating them, measured in different reference frames, have different values depending on how fast these reference frames move relative to each other, i.e. are not *invariants*. An invariant is a quantity that has the same value in any reference frame. Minkowski space-time is used as the basis for the Special Theory of Relativity (relativistic physics) in contrast to Newton's three-dimensional space with its absolute time used in classical (nonrelativistic) physics, where the distance between points in space does not depend on which reference frame (moving or resting) to measure it.

"In the theory of relativity, the time intervals dt and the spaces dr are not invariant, but depend on the relative speed of the coordinate systems. The invariant is some value ds formed from them.

$$ds^2 = cdt^2 - dr^2.$$

The invariance of this expression can have a geometric interpretation as the invariance of the interval of a four-dimensional manifold with coordinates *ict, x, y, z*, where i is the imaginary unit. This four-dimensional Minkowski world can be the real world in which we live, or it can only be an abstract construction invented for the simple derivation of Lorentz transformations. In terms of the reality of such a world, everything that can happen already exists in the future and continues to exist in the past. Moving along the time axis, we only encounter events in our present" [2]. It must be clarified that invariance, that is, independence from the choice of the reference frame of the reduced expression, which is the spatio-temporal "distance" between any two points, actually has a deep philosophical meaning.It consists in the fact that at the beginning of the twentieth century, the consciousness of mankind overcame the isolation of the three-dimensional world and entered the fourth dimension — time. This expansion of consciousness was manifested, in particular, in the fact that physicists began to build cosmological models of the Universe on the basis of a four-dimensional manifold, which is an inextricable unity of space and time.

However, for now, we will follow Kozyrev's thought, that is, we will look at the results of amazing astronomical observations with his eyes. "The formula for the interval can be rewritten as follows:

$$ds^2=dt^2(c^2 - u^2),$$

where $u = dr/dt$ represents the speed of the object relative to this coordinate system. For $u = 0$, $ds = cdt$. Therefore, the interval is the intrinsic time of the system, which rests the clock at rest. Being an invariant, the interval is the concept that replaces the space-independent time of classical physics. The change in the physical properties of the interval should be perceived by our sensors. Moments of proper time, as material threads, connect the center of action with objects perceiving this action. Transfer is possible through the same thread, that is, through the same moment. Thus, communication through time is possible only under the condition

$$ds = 0.$$

In the Minkowski world, as can be seen from the formula for the interval, this condition will be fulfilled in three cases ..." [2]:

$$\text{I) } dt = 0,\ \text{II) } u = +c,\ \text{III) } u = -c.$$

Kozyrev identifies case I with the instantaneous propagation of the signal from the true image of the object, and cases II and III with the propagation of the signal from past and future images, respectively. Strictly speaking, the question of the possibility of long-range action in the framework of the Special Theory of Relativity requires further consideration, which will be done in Appendix D. Here we confine ourselves to Kozyrev's opinion on this subject: "... the possibility of instant communication over time does not contradict the geometric properties of the Minkowski world — a world that fully reproduces all the conclusions of the theory of relativity. At the same time, the theory of relativity was created by Einstein from physical considerations based on the postulate of the impossibility of long-range action, i.e., the impossibility of instant communication. Our observations showed that long-range action is carried out in nature. Therefore, a rigorous justification of the theory of relativity is not given by Einstein's argument, but by the geometry of the four-dimensional Minkowski world. However, it would hardly have been possible to find this geometry without the conclusions Einstein received" [2].

Then the article is followed by Kozyrev's very interesting conclusions regarding observational astronomy of a fundamentally new type — terrestrial refractive-free astronomy. The fact is that a ray of light undergoes refraction upon transition from one medium to another, i.e., it descends from the previous trajectory and propagates at a different angle of inclination. So, a ray of light flying from a star or any other celestial body to the Earth in an extremely rarefied space is refracted when it enters the dense layers of the atmosphere, due to which, when a star is observed through a telescope, its visible image shifts relative to the position that it would occupy if there was no atmosphere on Earth. This phenomenon of displacement, called refraction, is taken into account by astronomers using specially introduced corrections. In addition, due to the fact that there are various air currents in the planet's atmosphere, the image of stars in the telescope experiences trembling, which, of course, makes it difficult to obtain high-quality images. Therefore, observatories are usually built in places where the atmosphere is as calm as possible, the air is clean, and the sky is often clear. However, images of celestial bodies created by the "rays of time" are free from refraction and from trembling, since the rays of time freely pass through the atmosphere of the planet. But the aberration of the “rays of time” should be the same as the rays of light, since it is associated only with the transition from the reference system associated with the Sun (heliocentric) to the reference system associated with the Earth (geocentric). The validity of this statement by Kozyrev is confirmed by the fact that the observed displacement of the true position of the celestial body with respect to the apparent one coincides with a good degree of accuracy with this displacement calculated taking into account the aberration correction. The observations also confirmed Kozyrev’s conclusion that for the future image, the aberration has a sign opposite to that for the past image. This means that the image in the future is created from the reflected “rays of time”, propagating at a speed equal to the speed of light, but opposite in sign.

Kozyrev writes that “... of course, such a fundamental conclusion as the possibility of observing a star or something else in the future, as a real existing phenomenon, and not as a forecast, and required special and careful observations to be made ... For each of the six observed stars, three positions were noted at which the action on the resistor occurred, with the same distance between them equal to the calculated value $\Delta 1\alpha$. But the observations of the Andromeda nebula (M31) and the globular cluster M2 in Aquarius were especially convincing” [2]. Then Kozyrev writes: “Minkowski’s world turned out to be not a mathematical scheme, but the real geometry of our World. In this world, the future already exists and therefore it is not surprising that it can be observed now” [2].

Now, after a detailed acquaintance with these amazing works by Kozyrev, it becomes clear that they are talking about things that are completely unusual for our consciousness. However, time itself will be the judge of these works. And only it is able to decide whether humanity is ready to accept them or whether the moment of awareness is ahead along the galactic route of our planet.