Appendix C. Long Range Action in a Gravitational Rotating World

> Probably, the relationship between gravitation and time is very deep, and a change in the physical properties of time can lead to a change in the gravitational forces between bodies.
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> *N.A. Kozyrev. Selected Works. Leningrad State University Publishing House, 1991, p. 334.*

In this section, special attention will be paid to a theoretical explanation of the possibility of long-range action, in particular, how the observed long-range action can be linked with the main provisions of the modern theory of space-time. In addition, here the issue of the possibility of observing the future position of the heavenly bodies is examined in detail. The starting point will be Kozyrev's interpretation of the results of his own observations. In the work described in the previous paragraph, he tells us which tool should be used to penetrate the essence of observations of various images of space objects. After all, it is completely obvious that these observations are simply a demonstration by Kozyrev to all of us of facts that are obvious to him, but still hidden to the vast majority of people. Both astronomical observations and many other experiments were only experimental confirmation of his concept of time as a substance that binds all the objects of the universe together. Therefore, for starters, just try using logic to go through a route that has already been illuminated for us by Kozyrev's consciousness.

First you need to pay attention to two facts and try to connect them together: 1) the past, the true and the future position of the star affects the resistor, and this effect will continue if the telescope lens (mirror) is closed by a lid; 2) the resistor is not affected by the light image, which should be shifted due to refraction, but that which the star would occupy if there were no atmosphere on the Earth. After all, refraction, or refraction of light rays, is due to the fact that starlight propagating in the space of the Universe, where the substance is extremely rarefied, when it enters the Earth's atmosphere goes out of its way, like a spoon in a glass of water looks broken. From here, Kozyrev concludes: *the effect on the resistor takes place over time and can be transmitted both instantly and at the speed of light*. This conclusion is fundamental, because it contains a fundamentally new concept of the geometric structure of the World: *the Universe is designed in such a way that the interaction between its objects can be carried out both instantly and at the speed of light*. What should be the geometry of such a Universe?

Kozyrev himself uses the four-dimensional flat space-time of the Special Theory of Relativity as the basic geometry of the Universe, called the Minkowski space. It was built as a basis for describing the motion of physical bodies moving with velocities comparable in magnitude with the speed of light c = 300,000 km/s (but not exceeding it), as well as for light-like particles, for example, photons. The speed of motion c, and, consequently, the speed of any interaction is in this space is limiting, that is, the Minkowski space allows only close interaction. Note that there is no place for such a phenomenon as gravity or gravity in this space — for its description, four-dimensional curved (Riemannian) space-time of the General Theory of Relativity is used [13]. The essence of Kozyrev's explanation of his own results is that the real World is a flat four-dimensional space-time (Minkowski space), in which all interaction occurs when the four-dimensional distance (interval) between bodies interacting vanishes. On the scale of the Universe, a star and an observer can be considered points, each of which has four coordinates — one temporal and three spatial. At the time of observation (interaction), the four-dimensional interval between these points vanishes. Kozyrev interprets his results in an inertial, that is, moving uniformly and rectilinearly reference frame in Minkowski space, where the four-dimensional interval (the square of the four-dimensional elementary distance between two points) has the simplest form

$$ds^2 = \mathrm{c}^2 dt^2 - dr^2 = c^2(dt^2 - u^2).$$

Here c^2dt^2 is the square of the time interval between two points (events), dr^2 is the square of the space interval between them, u^2 is the square of the speed of the reference system. Kozyrev claims that ds2 = 0 in three cases:

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

However, it can be seen from the previous formula that, if the first condition is satisfied, the three-dimensional interval dr between the points also vanishes, which is simply the usual three-dimensional distance between them. But these two points are the terrestrial observer and the cosmic object observed by him. It turns out that long-range interaction (instantaneous signal transmission) is only possible provided that the three-dimensional distance between the observer and the object is zero, i.e., the person and the star (or another galaxy) at the time of observation are at the same point in ordinary three-dimensional space. But we know that stars and galaxies are located at significant distances from us, measured in ordinary three-dimensional space. So, to explain the long-range action, another basic space-time is required. Which one? We will talk about this ahead, but for now let us turn to cases II and III.

The fulfillment of conditions II and III means that ds^2 vanishes if the signal in both cases is transmitted at a speed equal in magnitude to the speed of light, but opposite in sign for these conditions. A signal propagating at a positive speed of light comes from an image in the past, a signal propagating at a negative speed of light comes from an image in the future. Formally, both of these conditions can be realized in Minkowski space, but since there is no place for long-range action in it, but it has been found in experiment, we should look for another mathematical base in which coexistence of short-range and long-range interaction would be possible.

As the base space-time of the Universe, in which there is a place for both short-range and long-range action, we use four-dimensional Riemannian space. It is the basis of the General Theory of Relativity - a theory whose purpose was to explain gravitation (gravity), different from Newtonian. Newton attributed gravity to the fact that in nature, between any bodies, there are gravitational forces. Geometrically, the Newtonian Universe is a three-dimensional flat space — an infinitely large cube in which light and gravity propagate instantly, i.e., long-range interaction takes place. Time in the Newton’s Universe exists independently of space, that is, all the clocks in the Universe can be synchronized so that they will show the same thing at the same time [13]. In this model, time everywhere flows uniformly at the same speed, therefore, one watch is enough for the **whole world**.

Albert Einstein explained gravity by the presence of spacetime curvature. If space-time is flat, that is, there is no curvature, then it automatically goes into flat space-time of the Special Theory of Relativity (SRT) - Minkowski space. The General Theory of Relativity (GR) as a special case includes Newton's theory of gravitation. More precisely, Einstein's theory of gravity goes over into Newtonian theory when the speeds of gravitating bodies are small compared to the speed of light, and the gravitational fields themselves are weak. In curved GTR space-time, the rate of time flow at each point depends on the specific physical conditions existing in the vicinity of this point: on the magnitude of the gravitational field, on the speed of rotation of the space where this point is located. Now let's see what the interpretation of Kozyrev’s astronomical observations looks like in the framework of Riemannian (curved) space-time. In it, the space-time interval takes the form [13]

$$ds^2 = g_{\alpha\beta}dx^{\alpha}dx^{\beta},\ \alpha,\ \beta = 0, 1, 2, 3.$$

This form of recording means that summation is performed over spatio-temporal icons (indices), and the components of the tensor gαβ themselves — the four-dimensional potentials of the gravitational field — generally speaking, depend on all four coordinates. In this case, we are talking about measuring distances in four-dimensional curved space, or space-time. The quantity $g_{\alpha\beta}$ is a four-dimensional fundamental metric tensor, or, quite simply, a mathematical tool with which you can measure distances. Component g_{00} is purely temporary, gik is purely spatial, and components g_{0i}, which have one temporal icon and others are spatial, are nonzero only if the three-dimensional space of the observer rotates. In this case, it is called *nonholonomic* [14, 15]. So our planet is a non-holonomic space. In an inertial (moving uniformly and rectilinearly) frame of reference in the Minkowski space of the components of the metric tensor, only those for which both indices have the same values are different from zero: $g_{00} = -1$, $g_{11} = g_{22} = g_{33} = +1$, therefore, the expression for ds2 in the first formula has such a simple form, familiar to our consciousness, when the spatial and temporal characteristics are present in explicit form.

In order to be able to move from a generally covariant (independent of the choice of reference frame) writing of the expression $ds^2 = g_{\alpha\beta}dx^{\alpha}dx^{\beta}$ to a more familiar one written in the reference frame associated with a specific observer, one needs to use the theory of physical observables. The most elaborated theory is the theory of chronometric invariants — quantities whose values do not depend on which set of clocks we use in our measurements [14, 15]. In order to illustrate what has been said, it is appropriate to cite as an example time measurements carried out using two types of clocks - spring and pendulum. The readings of the pendulum clock depend on their location on the planet, since the period of oscillation of the pendulum depends on the curvature of the surface of the planet (the closer to the poles, the stronger the flattening of the planet’s body) and on the density of terrestrial rocks at the point of observation. Unlike a pendulum clock, a spring clock does not depend on the force of attraction and can be used in space, where the pendulum clock will not be able to work at all due to weightlessness. Obviously, the theory of observable quantities should be constructed in such a way that the measured effects do not depend on what clock we use in the measurements.

In the language of physical observables (chronometric invariants, abbreviated ch.i.) the space-time interval takes the form [14, 15]:

$$ds^2 = c^2d\tau^2 - d\sigma^2 = (c^2 - v^2)d\tau^2,\ i,\ k = 1, 2, 3.$$

Here $d\tau = (1 - w/c^2)c^2 - (1/c^2)v_idx^i$ is ch.i. interval of time, dt is interval of coordinate (flowing uniformly) time, w — 3-dimensional gravitational potential per unit mass v_i — ch.i. three-dimensional space speed, $d\sigma^2 = h_{ik}dx^idx^k$ — ch.i. three-dimensional space speed, $h_{ik} = - g_{ik} + (1/c^2)v_iv_k$ — ch.i. (observed) spatial metric tensor, g_{ik} — three-dimensional (coordinate) components of the four-dimensional metric tensor. From here you can easily see the difference between the observed and coordinate values. Coordinate time t is the ideal uniformly current time similar to the time in the Newtonian model of the Universe, and the observed time τ is the real time of the observer, the pace of which depends on the magnitude of the gravitational field and the speed of rotation of space at the place of observation. There are experiments confirming that the rate of proper time depends on the gravitational field and rotation of the observer's reference frame. Thus, the discrepancies in the readings of two ideal clocks — time standards, one of which is located on the Earth's surface and the other is raised in a balloon, are of the order of several nanoseconds (1 ns = 10^{-9} s). This is easily explained by the fact that gravity, therefore, the gravitational potential, decreases with distance from the Earth, which leads to a slowdown in the rate of proper time when moving away from the surface of the planet.

However, it can also be seen from the expression for the intrinsic time interval dτ that the rate τ also depends on the rotation speed vi of the observer's reference space, or, simply, the space in which he makes observations. A real observer is a person located in the space of a rotating planet, regardless of whether it is placed on its surface, under it, in water, in near-Earth space.A rotating body has a certain energy - this is easy to see if, for example, you begin to unwind an object tied to a rope. At a sufficiently high speed of rotation, the rope breaks, and the object flies forward along the movement in the direction tangent to the circle. If so, then any body moving along the direction of rotation of the planet must have additional energy due to the rotation of the planet, compared with a body that is stationary relative to it or moves along the meridian. Then a body moving in the opposite direction to the planet's rotation loses energy by an amount depending on the planet's rotation. Hafele and Keating, dealing with the problem of accurate time measurement, conducted an interesting experiment in October 1971: they placed one time standard (high-precision chronometer) on an airplane, and the other left exactly the same on the Earth's surface [16]. The plane flew twice around the globe along the equator: once in the direction of rotation of the planet, the other in the opposite. The readings of the resting and flying standards at the end of the flight gave a difference of 59 and 273 ns, depending on which direction the plane flew in relation to the direction of daily rotation of the planet [16].

So, gravitational acceleration and rotation of space affect the rate of observed time. The corrections to the readings of the moving standard with respect to the motionless one, caused by these two factors, are small in the considered conditions because the gravitational potential w and the rotation speed of the space vi are included in the expression for the interval of the observed time $d\tau$ divided by the square of the speed of light. However, if we write dτ in the form

$$d\tau - dt = - w/c^2 - (1/c^2)v_idx^i,$$

it is easy to notice that the difference between the observed time τ and ideal time t depends on the magnitude of the gravitational field (potential w), the duration of the observation dt, the linear speed of the reference frame vi and the remoteness of the object under observation about the observer dxi. Therefore, even in conditions of a weak gravitational field and low speed of rotation of space, the difference in the readings of spaced standards can be significant if they remain spaced in space for a long time or are spaced a great distance. Thus, a significant difference in the tempo of observed times at different points in space with respect to each other occurs in the following cases: 1) the gravitational field is strong; 2) the speed of rotation of space is comparable in magnitude with the speed of light; 3) observation is long enough; 4) the observer and the object of observation are far from each other.

Thus, a significant difference in the tempo of observed times at different points in space with respect to each other occurs in the following cases: 1) the gravitational field is strong; 2) the speed of rotation of space is comparable in magnitude with the speed of light; 3) observation is long enough; 4) the observer and the object of observation are far from each other.

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

Outwardly, this formula and Kozyrev's formula are very similar, but the difference between them is fundamental, and their fundamental differences are in condition I. In a flat Minkowski space, condition I takes the form $dt = 0$, i.e., it is understood that at the moment of observation of the true position of the object, the signal from it is instantly transmitted to the observer, and the concept instantly refers to the ideal time t.

However, simple experiments with the transportation of standards indicate that even on one planet the tempo of time depends on the place (depending on altitude) and on movement in relation to the daily rotation of the planet. What can we say about the observation of the distant galactic and extragalactic inhabitants of the Universe moving at their own speeds in gravitational fields of different intensities. Therefore, the replacement of ideal time with real will be the next step in approaching, with which new horizons will open up in the endless process of understanding the World where we live. At other times, people will appreciate this situation with a new look, and we will only continue the path begun by Kozyrev. The condition $d\tau = [1 - w/c^2 - (1/c^2)v_i dx^i]dt = 0$, meaning that at the time of observation the signal from the object to the observer propagates instantly in real time, can be rewritten in the form

$$w + v_i u^i = c^2,$$

where $u^i = dx^i/d\tau$ is three-dimensional coordinate velocity of the observed object.

The mathematical justification of the possibility of long-range action given here, as well as concepts such as null space and null particles, have been published in several of our scientific articles (together with D. D. Rabunsky), as well as in our monographs [17], published since 1997–1999 several editions in English, French and Russian. It follows from this formula that long-range interaction is possible provided that the gravitational potential per unit mass and the scalar product of the object's speed and the speed of rotation of space add up to the square of the speed of light. The value of the scalar product of two vectors is equal to the product of the lengths (absolute values, or modules) of these vectors by the cosine of the angle between them

$$v_i u^i = |v_i||u^i|\cos(v_i; u^i).$$

This shows that the scalar product, which, simply put, is the result of projecting one multiplied vector onto another, vanishes if the vectors are mutually orthogonal (perpendicular to each other) and have maximum value when they are located along one direction. Moreover, depending on whether these vectors are codirectional or opposite, the magnitude of the scalar product has a positive or negative sign.

From the same formula it follows that if there is no rotation or if the movement occurs in a direction orthogonal to the direction of the rotation speed (for example, movement along the meridian of a planet rotating around an axis), then this condition takes the form: $w = c^2$. If this condition is met, space-time collapses, that is, it becomes a black hole — an object whose gravitational field is so strong that even photons cannot escape from it. Astronomers believe that the state of a black hole is the final stage in the life of massive stars. The fact is that for the star's stable living conditions it is necessary that there be a dynamic equilibrium between the gravitational attraction, which tends to compress it, and the radiant pressure acting in the opposite direction. According to calculations, with the age of stars whose masses are more than 3 times the mass of the Sun, this equilibrium is violated, since the processes that cause combustion inside the star, due to which it emits light, decay. Correspondingly, the role of gravitation is growing, which collapses the star into a small very dense object — a black hole. Thus, in the absence of rotation (or if it does not manifest itself due to the orthogonal arrangement of the directions of rotational and translational motion), then long-range interaction is possible only through a state of matter that meets the conditions in black holes.

If there is no gravitational field ($w = 0$), then long-range action is possible through the state of matter, which is a rotating space, consisting of particles moving in such a way that the scalar product of the velocity vector of each of the particles by the space velocity vector is equal to c^2. Since the cosine of the angle is in the range from –1 to +1, the desired value is obtained provided that the space rotates at the speed of light, and its constituent particles move in the direction of rotation with the speed of light along parallels, i.e., perpendicular to the axis of rotation. If $w \neq 0$, then long-range action is also possible in the case when the speeds of rotation of space and particles are less than the speed of light. Moreover, the stronger the gravitational hollow, the lower the rotation speed is achieved the possibility of long-range.

In order to learn more about the properties of the space in which long-range interaction is realized, let us return to the four-dimensional interval recorded through physical observables ($ds^2 = c^2d\tau^2 - d\sigma^2$). In the case of a long-range action, the conditions must be met simultaneously: $ds^2 = 0$ and $d\tau = 0$. From here automatically follows the vanishing of the square of the three-dimensional physically observable spatial interval, or, simply, the distance $d\sigma^2 = 0$. However, there is also a difference between the physically observed distance and the usual (ideal) three-dimensional distance dr^2 in the real world, as well as between the ideal time t and the observed time τ. Indeed, where do we get such a long ruler, many times curved and sometimes turned inside out like a Mobius strip, with which it was possible to measure distances to stars, and even more so, to other galaxies and their clusters? And bends and inversions are inevitable, since all objects of the Universe move along complex spiral routes, with each coil of a spiral, on the one hand, being wound onto a section representing a fragment of another spiral of a larger scale, and, on the other hand, it consists of spirals of spirals smaller scale. Therefore, the "direct" method of measuring distances to the nearest stars using the parallax method is an idealized method of measurement using an ideal straight ruler stretched from the observer to the object. We can say that we, being in the maze, stretch the ruler directly, reaching it to its branches that are not too distant. And indirect measurement methods, when the distances to distant objects are either calculated or determined using any characteristics (for example, measuring distances using Cepheids), can be compared with the mental extension of the ch.i. 3-dimensional metric tensor $h_{ik} = -g_{ik} + v_iv_k/c^2$ — tool for measuring distances in real three-dimensional space — is the sum of the ideal (coordinate) three-dimensional tensor g_{ik} and the quantity v_iv_k/c^2, (the ratio of the product of the components of the speed of rotation of space to the square of the speed of light).Therefore, the measurements of distances in real and ideal space differ from each other in that in real space an additional contribution to the result is made by the rotation of space. Moreover, the greater the speed of rotation of space compared with the speed of light, the more the ideal and real distances differ.

In view of the foregoing, let us see what space-time should be so that long-range action can be realized in it, i.e., instantaneous signal transmission. Obviously, this requires the simultaneous fulfillment of two conditions $d\tau = 0$ and $d\sigma^2 = h_{ik}dx^idx^k = 0$. Substituting in $d\sigma^2$ expression for h_{ik}, we get the formula for the perfect metric dr^2

$$dr^2 = g_{ik}dx^idx^k = (1 - w/c^2)^2c^2dt^2.$$

This shows that the ideal distance between the object of observation and the observer is not equal to zero, which is consistent with our ideas about the remoteness of stars and other objects of the Universe. It vanishes only under the condition that the observer and the object observed by him are in the same black hole, which has absorbed the observed part of the Universe together with the Earth. But the end of the universe is still very, very far away ...

Now let's try to figure out what it means to vanish the observed distance $d\sigma^2$ between the object of observation and the observer, which takes place when registering the true positions of stars and other inhabitants of the Universe. The fact is that the joint fulfillment of the conditions $ds^2 = 0$ and $d\tau = 0$ leads to the fact that both metric forms — four-dimensional ds^2 and three-dimensional $d\sigma^2$ — are both equal to zero. This means that the distance between two points, measured by these tensors, is indefinite, in contrast to the Riemannian metric, where the distance between any two points is invariant, i.e., it has the same value in any reference frame. According to the concepts of space-time formulated in GR, the real world is described precisely by Riemannian geometry, one of the requirements of which is the non-degeneracy of the quadratic form ds^2, i.e., the condition $g = \det\|g_{\alpha\beta}\| \neq 0$, where $\|g_{\alpha\beta}\|$ is matrix determinant of $g_{\alpha\beta}$. Thus, the question of the possibility of instantaneous signal transmission in the framework of the most widely accepted theory currently describing space-time-gravity — the General Theory of Relativity — is solved as follows: long-range action is possible only in the case of expanding the base space-time of GR by introducing a generalized space that allows degeneracy metrics, a special case of which are Riemannian space-time of general relativity.

So, the model of the Universe, within the framework of which coexistence of near- and long-range interaction is possible, can be built on the basis of a generalized space-time, which includes, as a special case, Riemannian space-time GTR, in which matter exists in the form of matter - particles moving with sublight speed, and fields propagating at the speed of light. We can say that our ordinary world, filled with matter and fields, is an integral part of the World in which its inhabitants can establish instant communication with each other regardless of the distance that separates them. And Kozyrev's registration of radiation of a non-electromagnetic type emitted by its inhabitants invisible to us indicates that humanity is already on the verge of discovering a matter of a fundamentally new type, which means that over time it will be possible to talk about the development of energy of a new type. This energy spreads instantly and has a restoring (negentropic) effect on the structure of matter — living (colony of bacteria) and non-living (metal).

Now let's talk in more detail about what properties a degenerate space has and what particles fill it. So far, we have only established that these particles are long-range carriers and propagate along trajectories whose observed three-dimensional length is $d\sigma = 0$. Therefore, they can be called null particles, and the degenerate space in which they propagate is null space. But in an ideal (coordinate) three-dimensional space, their velocity of propagation is equal in magnitude

$$u = (c - w/c).$$

It can be seen from this that in an ideal space, null particles propagate at a speed the magnitude of which does not exceed the speed of light. Moreover, the stronger the gravitational field, the lower their propagation velocity. In the limiting case, $w = c^2$, i.e., when the null space collapses, the null particles stop.

Here it is appropriate to draw an analogy with light-like particles, for example, photons, in four-dimensional space-time: they move in it along special lines, the four-dimensional distance along which is zero. Such lines are called isotropic. It turns out that along these trajectories, i.e., in space-time, photons propagate instantly. Meanwhile, the speed of their propagation in three-dimensional space is equal to the speed of light s. Particles propagating with velocity c are elementary carriers (quanta) of a field. For example, photons are quanta of an electromagnetic field. They have a non-zero relativistic mass (energy), or mass (energy) of motion, and their rest mass is zero. Unlike particles (quanta) of the field, particles of a substance always move with sublight velocities V and have a non-zero rest mass m0 and a relativistic mass

$$m = m_0/(1 - V^2/c^2)^{1/2}.$$

In this case, the relativistic mass increases as the particle velocity of the substance increases. In the extreme case. i.e., when the particle velocity tends to c, the relativistic mass tends to infinity. This means that a particle of matter cannot reach the speed of light.

Zero particles have zero relativistic mass and zero rest mass. But for them the quantity that is appropriate to call the gravitational-rotational mass M is different from zero, since its value depends on the magnitude of the gravitational field and the speed of rotation of zero space. Comparing the propagation of light and null particles, we can say this: light moves in the observed space with velocity c, i.e., it is a moving wave, while the zero-stream in the observed space is stationary, i.e., it is a standing wave.

Now back to Kozyrev's observations of the past, present and future of distant objects. It was experimentally established that the true image of the object is in the middle between its past and future images, and all of them are not electromagnetic and equally affect the receiving device. Obviously, each specific observed material object is present in the Universe in a single copy, and its past and future images are phantoms created by reflections of the true image. At the same time, the location of the previous image of the object coincides with its electromagnetic phantom — the visible image. The mathematical interpretation of the results, successively carried out within the framework of one concept - spatio-temporal representations of general relativity - led to the conclusion that an explanation of the phenomenon is possible if we assume the existence of a certain space, of which the ordinary, or physical world, consisting of matter and fields, is a part. It is possible that the laws of the physical world are a manifestation of the laws of another world, of which our material Universe is an integral part. Now back to our stars.

All three images of the star (past, present and future) have the same effect on the sensor, therefore, these effects are caused by the same source, namely, the stream of null particles emitted in a true way. And past and future images are null phantoms. Moreover, as experience shows, the propagation of null particles in null space obeys the same law that obeys the propagation of light in the world of physical bodies and fields, namely: the angle of incidence is equal to the angle of reflection. Therefore, past and future images are simply reflections of a stream of null particles emitted by a star at the time of observation. Exactly the same reflections, only created by particles of the electromagnetic field — photons — we see in the set every night in the sky: these are stars, clusters, nebulae, etc. Yes, and during the day when we look at the Sun we see its electromagnetic phantom, and the true Sun is ahead along its route at a distance that it managed to go in those 8 minutes, until the light emitted by it reached the Earth.

It is interesting to note that electromagnetic radiation is reflected only in one direction in time, namely, only to the past, while null radiation is reflected both in the past and in the future. This can be explained by the fact that electromagnetic radiation, like ourselves, is a prisoner of the so-called ordinary world, consisting of matter and fields, therefore its reflection into the future (and it must exist) is hidden for us. And the null particles belong to the world that encloses our physical world together with all matter and fields, including electromagnetic fields, which is why we can observe both reflected images **— past** and **future**.