Possibility of Experimental Study
of the Properties of Time

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Foreword of the Submitter: This article, an English translation from N. A. Kozyrev's book: *Causal or Unsymmetrical Mechanics in Linear Approximation*, Pulkovo Observatory, 1958 (in Russian), based on work done more than 50 years ago, is unique in the archives because it contains both theoretical and experimental results that bear on the causality principle. It is submitted for publication here to show some of the results that are similar to results from the previous article by J. C. Hafele: *Earth Flyby Anomalies Explained by a Time-Retarded Causal Version of Newtonian Gravitational Theory* (in this issue, pages 134–187). Kozyrev's experimental results are mostly based on measurements of the motions of various arrangements of an aircraft navigation gyroscope suspended from a torsion pendulum. Here are some reliable results from Kozyrev's article that are similar to results from Hafele's article: 1) on page 202, Kozyrev states that the effect on the motion of the pendulum: "is caused by the rotation of the Earth", 2) on page 203 he states: "the ratio of the horizontal force of the weight ... is 3.5×10^{-5}", 3) on page 207 he states: "it follows that $\Delta Q_{\mathrm{N}}/Q = 2.8 \times 10^{-5}$ at $\varphi = 48°$", 4) on page 209 he states: "For Pulkovo, $\Delta Q_{\mathrm{Z}}/Q = 2.8 \times 10^{-5}$", and 5) on page 212 he states: "To this deviation there corresponds the relative displacement $\Delta l/l = 0.85 \times 10^{-5}$". All of these ratios essentially equal the ratio of the time-retarded transverse component to the radial component of the Earth's gravitational field. The submitter does not endorse Kozyrev's metaphysical speculations.

Contents:

Part I.   Theoretical concepts

Time is the most important and most enigmatic property of nature. The concept of time surpasses our imagination. The recondite attempts to understand the nature of time by the philosophers of antiquity, the scholars in the Middle Ages, and the modern scientists, possessing a knowledge of sciences and the experience of their history, have proven fruitless. Probably this occurs because time involves the most profound and completely unknown properties of the world which can scarcely be envisaged by the bravest flight of human fancy. Past these properties of the world there passes the triumphal procession of modern science and technical progress. In reality, the exact sciences negate the existence in time of any other qualities other than the simplest quality of "duration" or time intervals, the measurement of which is realized in hours. This quality of time is similar to the spatial interval. The theory of relativity by Einstein made this analogy more profound, considering time intervals and space as components of a 4-dimensional interval of a Minkowski universe. Only the pseudo-Euclidian nature of the geometry of the Minkowski universe differentiates the time interval from the space interval. Under such a conception, time is scalar and quite passive. It only supplements the spatial arena, against which the events of the universe are played out. Owing to the scalarity of time, in the equations of theoretical mechanics the future is not separated from the past; hence, the causes are not separated from the results. In the result, classical mechanics brings to the universe a strictly deterministic, but deprived, causality. At the same time, causality comprises the most important quality of the real world.

The concept of causality is the basis of natural science. The natural scientist is convinced that the question "why" is a legitimate one, that a question can be found for it. However, the content of the exact sciences is much more impoverished. In the precise sciences, the legitimate question is only "how?": i. e., in what manner a given chain of occurrences takes place. Therefore, the precise sciences are descriptive. The description is made in a 4-dimensional world, which signifies the possibility of predicting events. This possibility of prediction is the key to the power of the precise sciences. The fascination of this power is so great that it often compels one to forget the basic, incomplete nature of their basis. It is therefore probable that the philosophical concept of Mach, derived strictly logically from the basis of the exact sciences, attracted great attention, in spite of its nonconformity to our knowledge concerning the universe and daily experience.

The natural desire arises to introduce into the exact science the principles of natural science. In other words, the tendency is to attempt to introduce into theoretical mechanics the principle of causality and directivity of time. Such a mechanics can be called "causal" or "asymmetrical" mechanics. In such mechanics, there should be realizable experience, indicating where the cause is and where the result is. It can be demonstrated that in statistical mechanics there is a directivity of time and that it satisfies our desires. In reality, statistical mechanics constructs a certain bridge between natural and theoretical mechanics. In the statistical grouping, an asymmetrical state in time can develop, owing to unlikely initial conditions caused by the direct intervention of a proponent of the system, the effect of which is causal. If, subsequently, the system will be isolated, in conformity with the second law of thermodynamics, its entropy will increase, and the directivity of time will be associated with this trend in the variation of entropy. As a result, the system will lead to the most likely condition; it will prove to be in equilibrium, but then the fluctuations in the entropy of various signs will be encountered with equal frequency. Therefore, even in the statistical mechanics of an isolated system, under the most probable condition, the directivity of time will not exist. It is quite natural that in statistical mechanics, based on the conventional mechanics of a point, the directivity of time does not appear as a quality of time itself but originates only as a property of the state of the system. If the directivity of time and other possible qualities are objective, they should enter the system of elementary mechanics of isolated processes. However, the statistical generalization of such mechanics can lead to a conclusion concerning the unattainability of equilibrium conditions. In reality, the directivity of time signifies a pattern continuously existing in time, which, acting upon the material system, can cause it to transfer to an equilibrium state. Under such a consideration, the events should occur not only in time, as in a certain arena, but also with the aid of time. Time becomes an active participant in the universe, eliminating the possibility of thermal death. Then, we can understand harmony of life and death, which we perceive as the essence of our world. Already, owing to these possibilities alone, one should carefully examine the question as to the manner in which the concept of the directivity of time or its pattern can be introduced into the mechanics of elementary processes.

We shall represent mechanics in the simplest form, as the classical mechanics of a point or a system of material points. Desiring to introduce thus into mechanics the principle of causality of natural science, we immediately encounter the difficulty that the idea of causality has not

been completely formulated in natural science. In the constant quests for causes, the naturalist is guided rather by his own intuition than by fixed procedures. We can state only that causality is linked in the closest way with the properties of time, specifically with the difference in the future and the past. Therefore, we will be guided by the following hypothesis:

   I. Time possesses a quality, creating a difference in causes from effects, which can be evoked by directivity or pattern. This property determines the difference in the past from the future.

The requirement for this hypothesis is indicated by the difficulties associated with the development of the Liebnitz idea concerning the definition of the directivity of time through the causal relationships. The profound studies by H. Reichenbach [1] and G. Withrow [2] indicate that one can never advance this idea strictly, without tautology. Causality provides us with a concept of the existence of the directivity of time and concerning certain properties of this directivity; at the same time, it does not constitute the essence of this phenomenon, but only its result.

Let us now attempt, utilizing the simplest properties of causality, to provide a quantitative expression of hypothesis I. Proceeding from those circumstances in which: (1) cause is always outside of the body in which the result is realized and (2) the result sets in after the cause; we can formulate the next two axioms:

  II. Causes and results are always separated by space. Therefore, between them there exists an arbitrarily small, but not equaling zero, spatial difference δx.

 III Causes and results are separated in time. Therefore, between their appearance there exists an arbitrarily small, but not equaling zero, time difference δt of a fixed sign.

Axiom II forms the basis of classical Newtonian mechanics. It is contained in a third law, according to which a variation in a quantity of motion cannot occur under the effect of external forces. In other words, in a body there cannot develop an external force without the participation of another body. Hence, based on the impenetrability of matter, $\delta x \neq 0$. However, on the basis of the complete reversibility of time, axiom III is lacking in the Newtonian mechanics: $\delta t = 0$.

In atomic mechanics, just the opposite takes place. In it, the principle of impenetrability loses its value and, based on the possibility of the superposition of fields, it is obviously assumed that $\delta x = 0$. However, in atomic mechanics there is a temporal irreversibility, which did not exist in Newtonian mechanics; the influence upon the system of a

macroscopic body, according to theorists, introduces a difference between the future and the past, because the future proves predictable, while the past is not. Therefore, in the temporal environs of the experiment, $\delta t \neq 0$, although it can be arbitrarily small. In this manner, classical mechanics and atomic mechanics enter into our axiomatics as two extreme systems. This circumstance becomes especially clear if we introduce the relationship:

$$\frac{\delta x}{\delta t} = c_2 \, . \tag{1}$$

In a real world, c_2 most likely constitutes a finite value. However, in classical mechanics, $\delta x \neq 0$, $\delta t = 0$, and hence $c_2 = \infty$. In atomic mechanics, $\delta x = 0$, $\delta t \neq 0$, and therefore $c_2 = 0$.

Let us now discuss the concept of the symbols δx and δt introduced by us. In a long chain of causal-resultant transformations, we are considering only that elementary chain wherein the cause produces the result. According to the usual physical viewpoints, this chain comprises a spatial time point, not subject to further analysis. However, on the bases of our axioms of causality, this elementary causal-resultant chain should have a structure caused by the impossibility of spatial-time superimposition of causes and effects. The condition of non-superimposition in the case of the critical approach is stipulated by the symbols δx and δt. Hence, these symbols signify the limit of the infinitely-small values under the condition that they never revert to 0. These symbols determine the point distances or dimensions of an "empty" point, situated between the material points, with which the causes and effects are linked. However, in the calculation of the intervals of the entire causal-resultant chain, they should be considered equal to 0 with any degree of accuracy. However, if they have infinitely low values of one order, their ratio c_2 can be a finite value and can express a qualitatively physical property of the causal-resultant relationship. This physical property is included in the pattern of time, formulated qualitatively by hypothesis I.

In reality, according to definition (I), the value c_2 has the dimensionality of velocity and yields a value to the rate of the transition of the cause to the effect. This transition is accomplished through the "empty" point, where there are no material bodies and there is only space and time. Hence, the value c_2 can be associated only with the properties of time and space, not with the properties of bodies. Therefore, c_2 should be a universal constant, typifying the pattern of time in our world. The conversion of the cause to an effect requires the overcoming of the "empty" point in space. This point is an abyss, through which the transition can be realized only with the aid of the time pattern.

From this, there follows directly the active participation of time in the processes of the material systems.

In Equation (1), the symbol δt has a definite meaning. It can be established by the standard condition: the future minus the past comprises a positive value. However, the sign of the value for δx is quite arbitrary, since space is isotropic and in it there is no principal direction. At the same time, the sign of c_2 should be definite, because logically we should have a possibility of conceiving of the world with an opposite time pattern: i. e., of another sign. A difficulty arises, which at first glance seems insurmountable, disrupting the entire structure formulated until now. However, owing to just this difficulty, it becomes possible to make an unequivocal conclusion: c_2 is not a scalar value but a pseudo-scalar value: i. e., a scalar changing sign in the case of the mirror image or inversion of the coordinate system. In order to be convinced of this, let us rewrite Equation (1) in a vector form, having signified by i the unit vector of the direction of the causal-resultant relationship:

$$c_2 \left(i\delta t \right) = \delta x \,. \tag{1a}$$

If c_2 is pseudo-scalar, $i\delta t$ should be a critical of a pseudo-vector collinear with the critical vector δx. The pseudo-vector nature of $i\delta t$ signifies that in the plane (yz) of a perpendicular to the x-axis there occurs a certain turning, the sign of which can be determined by the sign of δt. This means that with the aid of δt, we can orient the plane perpendicular to the x-axis: i. e., we can allocate the arrangement of the y and z axes. Let us now alter in Equation (1) the sign of δx, retaining the sign of δt and signifying the retention of the orientation of the plane (yz). Then the constant c_2 changes its sign, as it should, since our operation is tantamount to a mirror image. However, if we change the sign not only of δx but also of δt, the constant c_2 based on Equation (1) does not change sign. This should be the case, because in the given instance we effected only a turning of the coordinate system. Finally, changing the sign of δt only, we once again obtain a mirror (specular) image of the coordinate system under which the sign of the pseudo-scalar should change. This proof of the pseudo-scalar property of the time pattern can be explained by the following simple discussion. The time pattern should be determined in relation to a certain invariant. Such an invariant, independent of the properties of matter, can be only space. The absolute value of the time pattern is obtained when the absolute difference in the future and the past will be linked with the absolute difference between right and left, although these concepts per se are quite tentative. Therefore, the time pattern also should be

established by a value having the sense of a linear velocity of turning (rotation). From this it follows that c_2 cannot equal the speed of light, c_1, comprising the conventional scalar.

From the pseudo-scalar properties of the time pattern, there immediately follows the basic theorem of causal mechanics: **a world with an opposite time pattern is equivalent to our world, reflected in a mirror**.

In a world reflected in a mirror, causality is completely retained. Therefore, in a world with an opposite time pattern the events should develop just as regularly as in our world. It is erroneous to think that, having run a movie film of our world in a reverse direction, we would obtain a pattern of the world of an opposite time direction. We can in no way formally change the sign in the time intervals. This leads to a disruption of causality: i.e., to an absurdity, to a world which cannot exist. In a variation of the directivity of time, the influences that the time pattern exerts upon the material system should appear as modified. Therefore, the world reflected in a mirror should differ in its physical properties from our world. Up until modern times, this identity was assumed in atomic mechanics and was said to be the law of the preservation of parity. However, studies by Lie and Young of the nuclear processes during weak interactions led to experiments that demonstrated the erroneous position of this law. This result is quite natural under the actual existence of time directivity, which is confirmed by direct experiments to be described later. At the same time, one can never make the opposite conclusion. Numerous investigations of the observed phenomena of the nonpreservation of parity have demonstrated the possibility of other interpretations. It is necessary to conclude that further experiments in the field of nuclear physics will narrow the scope of possible interpretations to such an extent that the existence of time directivity in the elementary processes will become quite obvious.

The difference in the world from the mirror image is graphically indicated especially by biology. The morphology of animals and plants provides many examples of asymmetry, distinguishing right from left, independently of which hemisphere of the Earth the organism is living in. Asymmetry of organisms is manifested not only in their morphology. The chemical asymmetry of protoplasm discovered by Louis Pasteur demonstrates that the asymmetry constitutes a basic property of life. The persistent asymmetry of organisms being transmitted to their descendants cannot be random. This asymmetry cannot only be a passive result of the laws of nature, reflecting the time directivity. Most likely, under a definite asymmetry, corresponding to the given time pattern,

an organism acquires an additional viability: i.e., it can use it for the reinforcement of life processes. Then, on the basis of our fundamental theorem, we can conclude that in a world with an opposite time pattern, the heart in the vertebrates would be located on the right, the shells of mollusks would be mainly turned leftward, and in protoplasm there would be observed an opposite qualitative inequality of the right and left molecules. It is possible that specially formulated biological experiments will be able to prove directly that life actually uses the time pattern as an additional source of energy.

Let us now comment on yet another important circumstance, connected with the determination of the time pattern by Equation (1). Each causal-resultant relationship has a certain spatial direction, the base vector of which is signified by i. Therefore, in an actual causal relationship, the pseudo-scalar ic_2 will be oriented by the time pattern. Let us prove that at one point the values for — the cause — and at another point — the result — should be in opposite directions. In reality, the result in the future will be situated in relation to the cause, while the cause in the past will be situated in relation to the result. This means that at the points cause and effect, δt should have opposite signs, meaning that there should also be an opposite orientation of the plane perpendicular to i. Then, at a definite i-value we have a change in the type of the coordinate system, and the expression ic_2 will have a different sign. However, if during the transition from the cause to the effect we have a change in the sign of i, the sign of c_2 will remain unchanged; and, hence, ic_2 will change sign in this case also. This means that the time pattern is characterized by the values $\pm ic_2$ and constitutes a physical process, the model of which can be the relative rotation of a certain ideal top (gyroscope).

By an ideal gyroscope, we connote a body, the entire mass of which is located at a certain single distance from the axis. This top can have an effect on another body through a material axis of rotation and material relationships with this axis, the masses of which can be disregarded. Therefore, the mechanical property of an ideal gyroscope will be equivalent to the properties of a material point having the mass of the gyroscope and its rotation. Let us assume that the point with which the top interacts is situated along the direction of its axis. Let us signify by j the base vector of this direction and consider it to be a standard vector. We can tentatively, independent of the type of the coordinate system, place it in another point: for example, in the direction from which the rotation of the top appears to be originating — in this case, in a clockwise direction. The rotation of the top can be described by

the approximate pseudo-scalar ju, where u equals the linear velocity of rotation. With such a description and the direction selected by us, u should be a pseudo-scalar, positive in the left-hand system of coordinates. Let us now consider the motion of a point upon which the gyroscope axis is acting from the position of the point of its rim. Since the distance of this point from the plane of the rim is arbitrarily small, its velocity, computed from the position of the rim in respect to the radius and the period, will be the same value for u. We can draw on a sheet of paper the motion of the points of the rim relative to the center and to the motion of the center from the position of the rim points. The motion is obtained in one direction if we examine the paper from the same side: e. g., from above. However, the infinitely small emergence of a stationary point from the plane of the rim compels us to examine the rotation from another position: i. e., to examine the paper from beneath. We obtain a rotation in the opposite direction, as a result of which we should compare with the gyroscope the approximate pseudo-scalar: i. e., ju. This signifies that the time pattern being determined by the values $\pm ic_2$ actually has an affinity with the relative rotation, which is determined by the values $\pm ju$ of the same type. Understandably, this formal analogy does not fully explain the essence of a time pattern. However, it opens up the remarkable possibility of an experimental study of the properties of time.

In reality, if into the causal relationship there enters a rotating body, we can expect that in a system with rotation, the time pattern will change instead of $\pm ic_2$: it becomes equal to $\pm(ic_2 + ju)$. Let us now attempt to explain which variations from this can occur in a mechanical system. For this, it is necessary to refine the concept of cause and effect in mechanics.

The forces are the causes altering the mutual arrangement of bodies and their quantity of motion. The change in the arrangement of bodies can lead to the appearance of new forces, and according to the d'Alembert principle, the variation of a quantity of motion for unit time, taken with an opposite sign, can be regarded as the force of inertia. Therefore, in mechanics the forces are comprised of the causes and all possible effects. However, in the movement of a body (1) under the effect of force F, the force of inertia, $-dp/dt$, does not constitute a result. Both of these forces originate at one point. According to axiom II, owing to this there cannot be a causal-resultant relationship between them, and they are identical concepts. Therefore, as Kirchhoff operated in his mechanics, the force of inertia can serve as a determination of the force F. The force F, applied to point (1), can evoke an effect only in

another point (2). Let us call this force of the result the effect Φ_0 of the first point upon the second:

$$\Phi_0 = F - \frac{dp_1}{dt} = \frac{dp_2}{dt} \, . \tag{2}$$

For the first point, however, it comprises the lost d'Alembert force:

$$\frac{dp_1}{dt} = F - \frac{dp_2}{dt} \, .$$

In conformity with these expressions, we can consider that for one time, dt, point (1) loses the pulse dp_2 which is transmitted to point (2). In the case for which there is a causal relationship between point (1) and (2), $\delta t \neq 0$, and between them there exists the approximate difference $\delta p_2 \neq 0$. When the cause is situated at point (1), the transition of dp_2 from point (1) to point (2) corresponds to an increase in the time. Therefore:

$$\frac{\delta p_2}{\delta t} = \frac{dp_2}{dt} = \Phi_0 \, . \tag{3}$$

Let us signify by i the unit vector of effect Φ_0. Then, according to (3):

$$\Phi_0 = i\,|\Phi_0| = i\frac{\delta p_2}{\delta t} = i\left|\frac{\delta p_2}{\delta x}\right|\frac{|\delta x|}{\delta t} \, .$$

According to (1), the value $|\delta x|/\delta t$ can be replaced by c_2 if we tentatively utilize that system of coordinates in which c_2 is positive.

Under this condition:

$$\Phi_0 = ic_2\left|\frac{\delta p_2}{\delta x}\right| . \tag{4}$$

The factor ic_2 comprises a value independent of a time pattern: i.e., a force invariant. In reality, during any pattern of time not only the spatial intervals but also the time intervals should be measured by the unchanging scales (weights). Therefore, the velocity and, consequently, also the pulses should not depend on the pattern (course) of time. As was demonstrated above, in case of the existence of a time pattern ic_2 in point (2), there must be in point (1) the time pattern $-ic_2$. This means that during the effect upon point (2), there must be a counter effect or a reaction force R_0 in point (1):

$$R_0 = -ic_2\left|\frac{\delta p_2}{\delta x}\right| . \tag{5}$$

Thus, the third Newtonian law proves to be the direct result of the properties of causality and pattern of time. The effect and the counter

effect comprise two facets of the identical phenomenon, and between them a time discontinuity cannot exist. In this manner, the law of the conservation of a pulse is one of the most fundamental laws of nature.

Let us now assume that the time pattern has varied and, instead of $\pm ic_2$ it has become equal to $\pm(ic_2 + ju)$. Then, based on Eqs. (4) and (5), the following transformation of forces should occur:

$$\Phi = (ic_2 + ju)\left|\frac{\delta p_2}{\delta x}\right|, \qquad R = -(ic_2 + ju)\left|\frac{\delta p_2}{\delta x}\right|.$$

The additional forces are obtained:

$$\Delta\Phi = \Phi - \Phi_0 = +j\,\frac{u}{c_2}\,|\Phi_0|\,,$$

$$\Delta R = R - R_0 = -j\,\frac{u}{c_2}\,|\Phi_0|\,. \tag{6}$$

Thus, in the causal relationship with a spinning top (gyroscope), we can expect the appearance of additional forces (6) acting along the axis of rotation of the top. The proper experiments described in detail in the following section indicate that, in reality, during the rotation, forces develop acting upon the axis and depending on the time direction. The measured value of the additional forces permits us to determine, based on (6), the value of c_2 of the time pattern not only in magnitude but also in sign: i. e., to indicate the type of the coordinate system in which c_2 is positive. **It turns out that the time pattern of our world is positive in a laevorotary system of coordinates.** From this, we are afforded the possibility of an objective determination of left and right; the left-hand system of coordinates is said to be that system in which the time progress is positive, while the right-hand system is one in which it is negative. In this manner, the time progress linking all of the bodies in the world, even during their complete isolation, plays the role of that material bridge concerning the need, of which Gauss [3] has already spoken, for the coordination of the concepts of left and right.

The appearance of additional forces can perhaps be graphically represented in the following manner: Time enters a system through the cause to the effect. The rotation alters the possibility of this inflow, and, as a result, the time pattern can create additional stresses in the system. These variations produce the time pattern. From this it follows that **time has energy**. Since the additional forces are directed oppositely, the pulse of the system does not vary. This signifies that time does not have a pulse, although it possesses energy.

In Newtonian mechanics, $c_2 = \infty$. The additional forces according to

(6) disappear, as should occur in this mechanics. This is natural because the infinite pattern of time can in no way be altered. Therefore, time proves to be an imparted fate and invincible force. However, **the actual time has a finite pattern and can be effective**, and this signifies that **the principle of time can be reversible**. How, in reality, these effects can be accomplished should be demonstrated by experiments studying the properties of time.

In atomic mechanics, $c_2 = 0$. Equations (6), obtained by a certain refinement of the principles of Newtonian mechanics, are approximate and do not give the critical transition at $c_2 = 0$. They only indicate that the additional effects not envisaged by Newtonian mechanics will play the predominant part. The causality becomes completely intertwined (confused), and the occurrences of nature will remain to be explained statistically.

The Newtonian mechanics corresponds to a world with infinitely stable causal relationships, while atomic mechanics represents another critical state of a world with infinitely weak causal relationships. Equations (6) indicate that the mechanics corresponding to the principles of causality of natural science should be developed from the aspect of Newtonian mechanics, and not from the viewpoint of atomic mechanics. In this connection, there can appear features typical for atomic mechanics. For instance, we can expect the appearance of quantum effects in macroscopic mechanics.

The theoretical concepts expounded here are basically necessary only in order to know how to undertake the experiments on the study of the properties of time. Time represents an entire world of enigmatic phenomena, and they can in no way be pursued by logical deliberations. The properties of time must be gradually explained by physical experiment.

For the formulation of experiments, it is important to have a foreknowledge of the value of the expected effects, which depend upon the value $c_2 = 0$. We can attempt to estimate the numerical value of $c_2 = 0$, by using the atomic mechanics and proceeding from dimensionality concepts. The single universal constant which can have the meaning of a pseudo-scalar is the Planck constant, h. In reality, this constant has the dimensionality of a moment of a quantity of motion and determines the spin of elementary particles. Now, utilizing the Planck constant in any scalar universal constant, it is necessary to obtain a value having the dimensionality of velocity. It is easy to establish that the expression

$$c_2 = \frac{\alpha e^2}{h} = \alpha \times 350 \,\text{km/sec} \tag{7}$$

comprises a unique combination of this type. Here e equals the charge of an elementary particle and α equals a certain dimensionless factor. Then, based on (6), at $u = 100\,\mathrm{m/sec}$, the additional forces will be of the order of 10^{-4} or 10^{-5} (at a considerable α-value) from the applied forces. At such a value for c_2, the forces of the time pattern can easily be revealed in the simplest experiments not requiring high accuracy of measurements.

Part II. Experiments on studying the properties of time, and basic findings

The experimental verification of the above-developed theoretical concepts was started as early as the winter of 1951–1952. From that time, these studies have been carried on continuously over the course of a number of years with the active participation by graduate student V. G. Labeysh. At the present time, they are underway at the laboratory of the Pulkovo Observatory with engineer V. V. Nasonov. The work performed by Nasonov imparted a high degree of reliability to the experiments. During the time of these investigations, we accumulated numerous and diversified data, permitting us to form a number of conclusions concerning the properties of time. We did not succeed in interpreting all of the material, and not all of the material has a uniform degree of reliability. Here we will discuss only those data which were subjected to a recurrent checking and which, from our viewpoint, are completely reliable. We will also strive to form conclusions from these data.

The theoretical concepts indicate that the tests on the study of causal relationships and the pattern of time need to be conducted with rotating bodies: namely, gyroscopes. The first tests were made in order to verify that the law of the conservation of a pulse is always fulfilled, and independently of the condition of rotation of bodies. These tests were conducted on lever-type weights (scales). At a deceleration of the gyroscope, rotating by inertia, its moment of rotation should be imparted to the weights (scales), causing an inevitable torsion of the suspensions. In order to avert the suspension difficulties associate with this, the rotation of the gyroscope should be held constant. Therefore, we utilized gyroscopes from aviation automation, the velocity of which was controlled by a variable 3-phase current with a frequency of the order of $500\,\mathrm{cps}$. The gyroscope's rotor turned with this same frequency. It appeared possible, without decreasing significantly the suspension precision, to supply current to the gyroscope suspended on weights (scales) with the

aid of three very thin uninsulated conductors. During the suspension the gyroscope was installed in a hermetically sealed box, which excluded completely the effect of air currents. The accuracy of this suspension was of the order of 0.1–0.2 mg. With a vertical arrangement of the axis and various rotation velocities, the readings of the weights (scales) remained unchanged. For example, proceeding from the data for one of the gyroscopes (average diameter D of rotor equals 4.2 cm: rotor weight Q equals 250 gm), we can conclude that with a linear rotational velocity, $u = 70$ m/sec, the effective force upon the weights (scales) will remain unchanged, with a precision higher than up to the sixth place. In these experiments, we also introduced the following interesting theoretical complication: The box with the gyroscope was suspended from an iron plate, which attracted the electromagnets fastened together with a certain mass. This entire system was suspended on weights (scales) by means of an elastic band. The current was supplied to the electromagnets with the aid of two very thin conductors. The system for breaking the current was accomplished separately from the weights (scales). At the breaking of the circuit, the box with the gyroscope fell to a clipper fastened to the electromagnets. The amplitude of these drops and the subsequent rise could reach 2 mm. The test was conducted for various directions of suspension and rotation masses of the gyroscope, at different amplitudes, and at an oscillation frequency ranging from units to hundreds of cps. For a rotating gyroscope, just as for a stationary one, the readings of the weights (scales) remained unchanged. We can consider that the experiments described substantiate fairly well the theoretical conclusion concerning the conservation of a pulse in causal mechanics.

In spite of their theoretical interest, the previous experiments did not yield any new effects capable of confirming the role of causality in mechanics. However, in their fulfillment it was noted that in the transmission of the vibrations from the gyroscope to the support of the weights (scales), variations in the readings of the weights (scales) can appear, depending on the velocity and direction of rotation of the gyroscopes. When the vibrations of the weights (scales) themselves begin, the box with the gyroscope discontinues being strictly a closed system. However, the weights (scales) can go out of equilibrium if the additional effect of the gyroscope developing from rotation proves to be transferred from the shaft of the gyroscopes to the weights' [scales'] support. From these observations, we developed a series of tests with these gyroscopes.

In the first type, the vibrations were due to the energy of the rotor

and its pounding in the bearings, depending on the clearance in them. It is understandable that the vibrations interfere with accurate suspension. Therefore, it was necessary to abandon the precision weights (scales) of the analytical type and convert to engineering weights (scales), in which the ribs of the prisms contact small areas having the form of caps. Nevertheless, in this connection we managed to maintain an accuracy of the order of 1 mg in the differential measurements. The support areas in the form of caps are also convenient by virtue of the fact that with them we can conduct the suspension of gyroscopes rotating by inertia.

A gyroscope suspended on a rigid support can transmit through a yoke its vibrations to the support of the weights (scales). With a certain type of vibration, which was chosen completely by feel, there occurred a considerable decrease in the effect of the gyroscope upon the weights (scales) during its rotation in a counterclockwise direction, if we examined it from above. During the rotation in a clockwise direction, under the same conditions, the readings of the weights (scales) remained practically unchanged. Measurements conducted with gyroscopes of varying weight and rotor radius, at various angular velocities, indicated that a **reduction of the weight, in conformity with (6), is actually proportional to the weight and to the linear rate of rotation**. For example, at a rotation of the gyroscope ($D = 4.6$ cm, $Q = 90$ gm, $u = 25$ m/sec), we obtained the weight difference of -8 mg. With rotation in a clockwise direction, it always turned out that (the weight difference) $= 0$. However, with a horizontal arrangement of the axis, in azimuth, we found the average value $= -4$ mg. From this, we can conclude that any vibrating body under the conditions of this experiment should indicate a reduction in weight. Further studies demonstrated that **this effect is caused by the rotation of the Earth**, which will be discussed in detail later.

Presently, the only fact of importance to us is that during the vibration there develops a new zero reading relative to which **with a rotation in a counterclockwise direction, we obtain a weight reduction, while during a rotation in a clockwise direction we obtain a completely uniform increase in weight** ($+4$ mg). In this manner, (6) is given a complete, experimental confirmation.

It follows from the adduced data that $c_2 = 550$ km/sec. According to this condition, the vector j is oriented in that direction in which the rotation appears to be originating in a clockwise direction. This means that during the rotation of the gyroscope in a clockwise direction it is directed downward. With such a rotation, the gyroscope becomes lighter, meaning that its additional effect upon the support of the weights is di-

rected downward: i.e., in respect to the base vector j. This will obtain
in the case in which u and c_2 have the same signs. Under our condi-
tion relative to the direction of the base vector j, the pseudo-scalar u
is positive in a left-hand system of coordinates. Consequently, a time
pattern of our world is also positive in a left-hand system. Therefore,
subsequently we will always utilize a left-hand system of coordinates.
The aggregation of the tests conducted then permitted us to refine the
value of c_2:

$$c_2 = +700 \pm 50 \quad \text{km/sec in a left-hand system.} \tag{8}$$

This value always makes probable the relationship of the time pat-
tern with other universal constants based on (7) at $\alpha = 2$. Then, the
dimensionless constant of the thin Sommerfield structure becomes sim-
ply a ratio of the two velocities c_2/c_1, each of which occur in nature.

The tests conducted on weight (scales) with vibrations of a gyroscope
also yield a new basic result. It appears that the additional force of effect
and counter effect can be situated at different points in the system: i.e.,
on the support of the weights (scales) and on the gyroscope. We derive
a pair of forces rotating the balance arm of the weights (scales). Hence,
**time possesses not only energy but also a rotation moment
which it can transmit to a system**.

A basic checking of the results obtained with the weights (scales)
yields a pendulum in which the body constitutes a vibrating gyroscope
with a horizontal axis suspended on a long fine thread. As in the tests
conducted with the weights (scales), during the rotation of a gyroscope
under quiescent conditions nothing took place and this filament (thread)
did not deflect from the perpendicular. However, at a certain stage of
the vibrations in the gyroscope the filament deflected from the perpen-
dicular, always at the same amount (with a given u-value) and in the
direction from which the gyroscope's rotation occurred in a counter-
clockwise direction. With a filament length $l = 2\,\text{m}$ and $u = 25\,\text{m/sec}$,
the deflection amounted to $0.07\,\text{mm}$, which yields, for the ratio of the
horizontal force of the weight, the value 3.5×10^{-5}, sufficiently close to
the results of this suspension.

A significant disadvantage of the tests described is the impossibility
of a simple control over the conditions of vibration. Therefore, it is
desirable to proceed to tests in which the vibrations are developed not
by the rotor but by the stationary parts of the system.

In the weights, the support of the balance arm was gripped by a spe-
cial clamp, which was connected by a flexible cable with a long metal
plate. One end of this plate rested on a ball-bearing, fitted eccentrically

to the shaft of an electric motor, and was connected by a rubber clamp with the bearing. The other end of the plate was fastened by a horizontal shaft. Changing the speed of the electric motor and the position of the cable on the plate, we were able to obtain harmonic oscillations from the balance arm support of the weights (scales) at any frequency and amplitude. The guiding devices for raising the balance arm support during a stopping of the weights eliminated the possibility of horizontal swaying. For the suspension of the gyroscope, it was necessary to find the optimal conditions under which the vibration was transmitted to the rotor and, at the same time, maintain that one end of the balance arm remain quasi-free relative to the other end, to which the balancing load was rigidly suspended. Under such conditions, the balance arm can vibrate freely, rotating around its end, fastened by a weight to a rigid suspension. Oscillations of this type could be obtained by suspending the gyroscope on a steel wire 0.15 mm in diameter and with a length of the order of 1–1.5 m. With this arrangement, we observed the variation in the weight of the gyroscope during its rotation around the vertical axis. It was remarkable that, in comparison with the previous tests, the effect proved to be of the opposite sign. During the turning of the gyroscope counterclockwise, we found, not a lightening, but a considerable weight increase. This means that in this case there operates on the gyroscope an additional force, oriented in a direction from which the rotation appears to be originating in a clockwise direction. This result signifies that the causality in the system and the time pattern introduced a vibration and that the source of the vibration established the position of the cause. In these tests, a source of vibration is the non-rotating part of the system, while in the initial model of the tests, a rotor constituted a source. Transposing in places the cause and the effect, we alter in respect to them the direction of rotation: i.e., the sense of base vector j. From this, based on (6), there originates the change in the sign of the additional forces. In conventional mechanics all of the forces do not depend entirely on what comprises the source of the vibration, but also on what is the effect. However, in causal mechanics, observing the direction of the additional forces, we can immediately state where the cause of the vibrations is located. This means that in reality it is possible to have a mechanical experiment distinguishing the cause from the effects.

The tests with the pendulum provided the same result. A gyroscope suspended on a fine wire, during the vibration of a point of this suspension, deflected in a direction from which its rotation transpired in a clockwise direction. The vibration of the suspension was accomplished

with the aid of an electromagnetic device. To the iron plate of a relay installed horizontally, we soldered a flexible metal rod, on which the pendulum wire was fastened. Owing to the rod, the oscillations became more harmonic. The position of the relay was regulated in such a way that there would not be any horizontal displacements of the suspension point. For monitoring the control, we connected a direct current, with which the electromagnet attracted the plate and raised the suspension point. The position of the filament (thread) was observed with a laboratory tube having a scale with divisions of 0.14 mm for the object under observation. Estimating by eye the fractions of this wide division, we could, during repeated measurements, obtain a result with an accuracy up to 0.01 mm. At a pendulum length $l = 3.30$ m and a rotation velocity $u = 40$ m/sec, the deflection of the gyroscope Δl was obtained as equaling 0.12 mm. In order to obtain a value of the additional force ΔQ in relation to the weight of the rotor ($Q = 250$ gm), it is necessary to introduce a correction for the weight of the gyroscope mounting $a = 150$ gm: i. e., to multiply $\Delta l/l$ by $(Q+a)/Q$. From this, we derive just that value of c_2 which is represented above (8). In these tests it turned out that to obtain the effect of deflection of the filament, the end of the gyroscope shaft, from which the rotation appears to be originating in a clockwise direction, must be raised somewhat. Hence, in this direction there should exist a certain projection of force, raising the gyroscope during the vibrations. In reality, the effect of the deflection turns out to be even less when we have accomplished a parametric resonance of the thread with oscillations, the plane of which passed through the gyroscope axis. Evidently, the existence of forces acting in the direction ju intensifies the similarity of ju with the time pattern and facilitates the transformation $\pm c_2$ by $\pm (ic_2 + ju)$. It is also necessary to comment that the gyroscope axis needs to be located in the plane of the first vertical. With a perpendicular arrangement of the axis — i. e., in the plane of the meridian — a certain additional displacement develops. Obviously, this displacement is created by the force evoked by the Earth's rotation, which we mentioned in describing the first experiments of the vibrations on weights. Let us now return to an explanation of these forces.

Let us signify by u the linear velocity of the rotation of a point situated on the Earth's surface. This point is situated in gravitational interaction with all other points of the Earth's volume. Their effect is equivalent to the effect of the entire mass of the Earth at a certain average velocity $\bar{u}$, the value of which is located between zero and u at the equator. Therefore, in the presence of a causal relationship there

can originate additional forces, directed along the axis of the Earth, and similar forces acting upon the gyroscope during its rotation with the velocity $(u - \bar{u})$ relative to the mounting. If the causal occurrences of the cosmic life of the Earth are associated with the outer layers, these forces should act upon the surface in the direction from which the rotation appears to be originating counterclockwise: i. e., toward the north. Thus, in this case on the Earth's surface there should operate the forces of the time pattern:

$$\Delta Q = \frac{-j\,(u - \bar{u})}{c_2}\,|Q|\,, \qquad (9)$$

where j is the Earth's orthonormal vector directed at south, while Q is the force of weight. In the interior of the Earth, forces act in the opposite direction, and according to the law of conservation of momentum, the Earth's center does not become displaced. In the polar regions $u < \bar{u}$, and therefore in both hemispheres ΔQ will be directed southward. Hence, in each hemisphere there is found a typical parallel where $\Delta Q = 0$. Under the effect of such forces, the Earth will acquire the shape of a cardioid, extending to the south. One of the parameters characterizing a cardioid is the coefficient of asymmetry η:

$$\eta = \frac{b_{\mathrm{S}} - b_{\mathrm{N}}}{2\,a}\,, \qquad (10)$$

where a equals the major semi-axis and b_{S} and b_{N} are the distances of the poles to the equatorial plane.

On Jupiter and Saturn the equatorial velocity u is around $10\,\mathrm{km/sec}$. Therefore, on planets with a rapid rotation the factor can be very high and reach nonconformity with expressions (8) and (9) by several units of the third place. Careful measurements of photographs of Jupiter made by the author and D. O. Mokhnach [4] showed that on Jupiter the southern hemisphere is more extended and $\eta = +\,3{\times}10^{-3} \pm 0.6{\times}10^{-3}$. A similar result, only with less accuracy, was also obtained for Saturn: $\eta = 7{\times}10^{-3} \pm 3{\times}10^{-3}$.

The measurements of the force of gravity of the surface of the Earth and the motion of artificial Earth satellites indicate that there exists a certain difference of accelerations of gravity in the northern and southern hemispheres: $\Delta g = b_{\mathrm{N}} - b_{\mathrm{S}} > 0$, $\Delta g/g = 3{\times}10^{-5}$. For a homogenous planet this should also be the case for an extended southern hemisphere, because the points of this hemisphere are located farther from the center of gravity. The factor η should be of the order of $\Delta g/g$. It is necessary to stress that the conclusion is in direct contradiction with the adopted

interpretation of the above-presented data concerning the acceleration of gravity. The gist of this difference consists in the fact that without allowance for the forces of the time pattern, the increase in gravity in the northern hemisphere can be explained only by the presence there of denser rocks. In this case, the leveled surface of the same value should regress farther. Identifying the level surface with the surface of the Earth, it will remain to be inferred that the northern hemisphere is more extended. However, the sign of η obtained directly for Jupiter and Saturn provide evidence against this interpretation, containing in itself a further contradictory assumption concerning the disequilibrium distribution of the rocks within the Earth.

The sign obtained for the asymmetry of the shapes of planets leads to the paradoxical conclusion to the effect that the cause of the physical occurrences within the celestial bodies is situated in the peripheral layers. However, such a result is possible if, e. g., the energetics of a planet are determined by its compression. In his studies on the internal structure of a star [5], the author concluded that the power of stars is very similar to the power of cooling and compressing bodies. The inadequacy of the knowledge of the essence of the causal relationships prevents us from delving into this question. At the same time, we are compelled to insist on the conclusions which were obtained from a comparison of the asymmetry of the planets with the forces acting upon the gyroscope.

The direction of the perpendicular on the Earth's surface is determined by the combined effect of the forces of gravity, of centrifugal forces, and of the forces of the time pattern ΔQ operating toward the north in our latitudes. In the case of a free fall, the effect on the mounting is absent ($\Delta Q = 0$) and therefore $\Delta Q = 0$. As a result, the freely falling body should deflect from the perpendicular to the south by the value Δl_{S}:

$$\Delta l_{\mathrm{S}} = -\frac{\Delta Q_{\mathrm{N}}}{Q} , \qquad (11)$$

where l equals the height of the body's fall and ΔQ_{N} equals the horizontal component of the forces of the time pattern in the moderate latitudes. A century or two ago this problem of the deflection of falling bodies toward the south attracted considerable attention. Already the first experiments conducted by Hook in January of 1680 at the behest of Newton for the verification of the deflection of falling bodies eastward led Hook to the conviction that a falling body deflects not only eastward but also southward. These experiments were repeated many times and often led to the same result. The best determinations were made by engineer Reich in the mine shafts of Freiburg [6]. At $l = 158$m, he ob-

tained $\Delta l_{\mathrm{S}} = 4.4\,\mathrm{mm}$ and $\Delta l_{\mathrm{east}} = 28.4\,\mathrm{mm}$. These deflections agree well with the theory. Based on (11) from these determinations, it follows that

$$\frac{\Delta Q_{\mathrm{N}}}{Q} = 2.8 \times 10^{-5} \ \ \mathrm{at} \ \ \varphi = 48°, \tag{12}$$

which agrees well with our approximate concepts concerning the asymmetry of the Earth's shape. The experiments on the deflection of falling bodies from a perpendicular are very complex and laborious. The interest in these tests disappeared completely after Hagen in the Vatican [7] with the aid of an Atwood machine obtained a deflection eastward in excellent agreement with the theory, but he did not derive any deflection southward. On the Atwood machine, owing to the tension of the filament, the eastward deflection decreases by only one half. However, the southward deflection during the acceleration equals 1/25 (as was the case for Hagen) and, according to Eqs. (9) and (11), it should decrease by 25 times. Therefore, the Hagen experiments do not refute to any extent the effect of the southward deflection.

Let us now return to the occurrences developing during the vibration of a heavy body on the surface of the Earth. The causal-resultant relationship within the Earth creates on the surface, in addition to the standard time pattern $\pm ic_{2}$, the time pattern $\pm\left[ic_{2} - j\left(u - \bar{u}\right)\right]$. Therefore, on the surface of the Earth, on a body with which a cause is connected, there should act the additional force ΔQ, directed northward along the axis of the Earth and being determined by (9). In the actual place where the effect is located, there should operate a force of opposite sign: i. e., southward. This means that during vibrations a heavy body should become lighter. In the opposite case, where the source of vibration is connected with the mounting, the body should become heavier. In a pendulum, during a vibration of the suspension point, there should occur a deflection toward the south. These phenomena have opened up the remarkable possibility not only of measuring the distribution of the forces of the time pattern of the surface of the Earth but also of studying the causal relationships and the properties of time by the simplest mode, for the conventional bodies, without difficult experiments with gyroscopes.

The tests on the study of additional forces caused by the Earth's rotation have the further advantage that the vibration of the point of the mounting cannot reach the body itself. The damping of the vibrations is necessary in order to express better the difference in the positions of cause and effect. Therefore, it is sufficient to suspend a body on weights on a short rubber band, assuring an undisturbed mode of operation of

the weights during the vibrations. In a pendulum, one should use a fine capron thread. In the remaining objects the tests were conducted in the same way as with the gyroscopes.

In the weights, during vibrations of the mounting of the balance arm, an increase actually occurs in the weights of a load suspended on an elastic. From the results of many experiments it was proved that the increase in the weight — i.e., the vertical component of the additional force ΔQ_z — is proportional to the weight of the body Q. For Pulkovo, $\Delta Q_z/Q = 2.8 \times 10^{-5}$. The horizontal components, ΔQ_s, were determined from the deflection of pendulums of various length (from 2 to 11 meters) during the vibration of a suspension point. During such vibrations the pendulums, in conformity with the increased load of the weights, deflected southward. For example, at $l = 3.2$ m, we obtained $\Delta l = 0.052$ mm. From this, $\Delta Q_s/Q = \Delta l_z/l = 1.6 \times 10^{-5}$, which corresponds fully to the Reich value [6] found for the lower latitude. If the force ΔQ is directed along the Earth's axis, there should be fulfilled the condition: $\Delta Q_s/Q_z = \tan\varphi$, where φ equals the latitude of the site of the observations. From the data presented, it follows that $\tan\varphi = 1.75$, which completely conforms with the latitude at Pulkovo.

Similar tests were made for a higher latitude in the city of Kirovsk, and here also a good agreement with the latitude was obtained. For the weights and the pendulums, the amplitudes of the vibrations of the mounting point were of the order of tenths of a millimeter, while the frequency changed within the limits of tens of cycles per second.

The measurements conducted at various latitudes of the Northern Hemisphere demonstrated that, in reality, **there exists a parallel where the forces of time are lacking**: $\Delta Q = 0$ at $\varphi = 73°05'$. Extrapolating the data from these measurements, we can obtain for the pole the estimation $\Delta Q/Q = 6.5 \times 10^{-5}$. Having taken the value c_2 found from the tests conducted with a gyroscope (8), let us find from this for the pole: $\bar{u} \simeq 45$ m/sec. At the equator the velocity of the Earth's rotation is 10 times higher. Therefore, the indicated u-value can prove to be less than that expected. However, it is necessary to have it in mind that presently we do not have the knowledge of the rules of combining the time pattern which are necessary for the strict calculation for the $\bar{u}$. Taking into account the vast distance in the kinematics of the rotations of a laboratory gyroscope and of the Earth, we can consider the results obtained for both cases as being in very good agreement.

On the weights (scales), we conducted a verification of the predicted variation in the sign, when the load itself becomes a source of vibration. For this, under the mounting area of the balance arm we introduce a

rubber lining, and in place of the load on the elastic, we rigidly suspend an electric motor with a flywheel which raises and lowers a certain load. In the case of such vibrations, the entire linkage of the balance arm of the weights remained as before. At the same time, we did not obtain an increase in the weight, but a lightening of the system suspended to the fluctuating end of the balance arm. This result excludes completely the possibility of the classic explanation of the observed effects and markedly indicates the role of causality.

In the experiments with vibrations on weights (scales) the variation in the weight of a body, ΔQ_z, occurs in jumps, starting from a certain vibration energy. With a further increase in the frequency of the vibrations, the variation in the weight remains initially unchanged, then increases by a jump in the same value. In this manner, it turns out that in addition to the basic separating stage ΔQ_z, that good harmonic state of the oscillations, we can observe a series of quantized values: $\frac{1}{2}\Delta Q$, ΔQ, $2\Delta Q$, $3\Delta Q$, ..., corresponding to the continuous variation in the frequency of vibrations. From the observations, it follows that the energy of the vibrations of the beginning of each stage evidently forms such a series. In other words, to obtain multiple values, the frequencies of the vibrations must be $\sqrt{2}$, $\sqrt{3}$, etc. The impression gained is that weights in the excited stage behave like weights without vibrations: the addition of the same energy of vibrations leads to the appearance of the stage ΔQ_z. However, we have not yet managed to find a true explanation of this phenomenon.

The appearance of the half quantum number remains quite incomprehensible. These quantum effects also occurred in the tests conducted with pendulums. Subsequently, it turned out that the quantum state of the effects is obtained in almost all of the tests. It should be noted that with the weights, we observed yet another interesting effect, for which there is no clear explanation. The energy of the vibrations, necessary for the excitation of a stage, depends upon the estimate of the balance arm of the weights (scales). The energy is minimal when the load on the elastic is situated to the south of the weights' (scales') supports, and maximal when it is located to the north. The tests conducted with vibrations have the disadvantage that the vibrations always affect, to some extent, the accuracy of the measuring system. At the same time, in our tests vibrations were necessary in order to establish the position of the causes and effects. Therefore, it is extremely desirable to find another method of doing this.

For example, we can pass a direct electric current through a long metal wire, to which the body of the pendulum is hung. The current

can be introduced through a point of the suspension and passed through a very fine wire at the body of the pendulum without interfering with its oscillations. The Lorentz forces, the interaction of current, and the magnetic field of the Earth operated in the first vertical and cannot cause a meridianal displacement of interest to us. These experiments were crowned with success. Thus, in starting from 15 V and a current of 0.03 amps, there appeared a jump-like deflection toward the south by an amount of 0.024 mm, which was maintained during a further increase of the voltage up to 30 V. To this deviation there corresponds the relative displacement $\Delta l/l = 0.85 \times 10^{-5}$, which is almost exactly half of the stage observed during the vibrations. In the case of a plus voltage at the point of the suspension, we obtained a similar deflection northward. In this manner, knowing nothing of the nature of the electrical current, we could already conclude, from only a few of these tests, that the cause of the current is the displacement of the negative charges.

It turns out that in the pendulum, the position of the cause and effect can be established even more simply by heating or cooling the point of the suspension. For this, the pendulum must be suspended on a metal wire which conducts heat well. The point of the suspension was heated by an electrical coil. During a heating of this coil until it glowed, the pendulum deflected southward by half of the stage, as during the tests conducted with the electrical current. With a cooling of the suspension point with dry ice, we obtained a northward deflection. A southward deflection can also be obtained by cooling the body of the pendulum, such as placing it in a vessel containing dry ice. In these experiments, only under quite favorable circumstances did we succeed in obtaining the full effect of the deflection. It is obvious that the vibrations have a certain basic advantage. It is likely that not only dissipation of the mechanical energy is significant during the vibrations; it is probable that the forces of the vibrations directed along ju cause the appearance of additional forces.

In the study of the horizontal forces, the success in the heat experiments permitted us to proceed from long pendulums to a much more precise and simpler device: namely, the torsion balance. We applied torsion balances of optimal sensitivity, for which the expected deflection was 5–20 degrees. We utilized a balance arm of apothecary weights (scales), to the upper handle of which we soldered a special clamp, to which was attached a fine tungsten wire with a diameter of 35 microns and a length of around 10 cm. The higher end of the wire was fastened by the same clamp to a stationary support. To avoid the accumulation of electrical charges and their electrostatic effect, the weights (scales)

were reliably grounded through the support. From one end of the balance arm we suspended a metal rod along with a small glass vessel, into which it entered. At the other end was installed a balancing load of the order of 20 grams. The scale, divided into degrees, permitted us to determine the turning angle of the balance arm. The vessel into which the metal rod entered was filled with snow or water with ice. Thereby, there developed a flow of heat along the balance arm to the rod, and the weights (scales), mounted beforehand in the first vertical, were turned by this end toward the south. The horizontal force ΔQ_s was computed from the deflection angle a with the aid of the formula:

$$ a = \frac{T^2 - T_0^2}{4\pi^2}\, \frac{g}{2l} \left(\frac{\Delta Q}{Q}\right), \tag{13} $$

where T equals the period of the oscillation of the torsion balances; T_0 equals the period of oscillations of one balance arm, without loads; g equals the acceleration of gravity; and $2l$ equals the length of the balance arm: i.e., between the suspended weights. In this equation the angle a is expressed in radians. For example, in the weights with $l = 9.0\,\mathrm{cm}$, $T = 132$ seconds, and $T_0 = 75$ seconds, we observed a southward deflection by an angle of $17.5°$. Thence, based on (13), it follows that $\Delta Q_\mathrm{s}/Q = 1.8 \times 10^{-5}$ is in good agreement with the previously derived value of the horizontal forces. Half and multiple displacements were also observed in these experiments conducted with the torsion balances. Another variation of the experiment was the heating, by a small alcohol lamp, of a rod suspended together with a vessel containing ice. The same kind of alcohol lamp was placed at the other end of the balance arm with a compensating weight, but in such a way that it could not heat the balance arm. During the burning of both alcohol lamps, the weights did not deviate from equilibrium. In these experiments we invariably obtained the opposite effect: i.e., a turning to the north of the end of the balance arm with the rod.

It is necessary to mention one important conclusion which follows from the combination of the occurrences which have been observed. In the case of the effect on the mounting, this might not influence a heavy body; and at the same time, forces, applied to each point of it, develop in the body: i.e., mass forces and, hence, identical to the variation in the weight. This signifies, by influencing the mounting, where the forces of the attraction are located, comprising a result of the weight, we can obtain a variation in the weight, i.e., a change in the cause. Therefore, the tests conducted indicate a distinct possibility of reversing the causal relationships.

The second cycle of tests on studying the qualities of time began as a result of the observations of quite strange circumstances, interrupting a repetition of the experiments. As early as the initial experiments with the gyroscopes, it was necessary to face the fact that sometimes the tests could be managed quite easily, and sometimes they proved to be fruitless, even with a strict observance of the same conditions. These difficulties were also noted in the old experiments on the southward deflection of falling bodies. Only in those tests in which, within wide limits, it is possible to intensify the causal effect — as, e.g., during the vibrations of the mounting of the weights (scales) or of the pendulum — can we almost always attain a result. Evidently, in addition to the constant pattern c_2, in the case of time, **there also exists a variable property which can be called the density or intensity of time**. In a case of low density it is difficult for time to influence the material systems, and a requirement arises for an intensive emphasis of the causal-resultant relationship in order that a force caused by the time pattern should appear. It is possible that our psychological sensation of empty or substantive time has not only a subjective nature but also, similarly to the sensation of the flow of time, an objective physical basis.

Evidently many circumstances exist affecting the density of time in the space surrounding us. **In late autumn and in the first half of winter all of the tests could be easily managed. However, in summer these experiments became difficult to such an extent that many of them could not be completed.**. Probably, in conformity with these conditions, the tests in the high altitudes can be performed much more easily than in the south; in addition to these regular variations, there often occur some changes in the conditions required for the success of the experiments: these transpired in the course of one day or even several hours. Obviously, the density of time changes within broad limits, owing to the processes occurring in nature, and our tests utilized a unique instrument to record these changes. If this be so, **it strongly suggests the possibility of having one material influence after another through time**. Such a relationship could be foreseen, since the causal-resultant phenomena occurred not only in time but also with the aid of time. Therefore, in each process of nature time can be extended or formed. These conclusions could be confirmed by a direct experiment.

Since we are studying the phenomenon of such a generality as time, it is evident that it is sufficient to take the simplest mechanical process in order to attempt to change the density of time. For example, using any motor, we can raise and lower a weight or change the tension of

a tight elastic band. We obtain a system with two poles, a source of energy and its outflow: i.e., the causal-resultant dipole. With the aid of a rigid transmission, the pole of this dipole can be separated for a fairly extensive distance. We will bring one of these poles close to a long pendulum during the vibrations of its point of suspension. It is necessary to tune the vibrations in such a way that the full effect of southward deflection would not develop, but only the tendency for the appearance of this effect. It turns out that this tendency increases appreciably and converts even to the complete effect if we bring near to the body of the pendulum or to the suspension point that pole of the dipole where the absorption of the energy is taking place. However, with the approach of the other pole (of the motor), the appearance of the effect of southern deflection in the pendulum invariably became difficult. In the case of a close juxtaposition of the poles of the dipole, their influence on the pendulum practically disappeared. Evidently in this case, a considerable compensation of their effects occurs. It turns out that **the effect of the causal pole** does not depend on the direction along which it is installed relative to the pendulum; rather its effect **depends only on the distance (spacing)**. Repeated and careful measurements demonstrated that **this effect diminishes**, not inversely proportional to the square of the distance, as in the case of force fields, but **inversely proportional to the first power of the distance**. In the raising and lowering of a 10-kg weight suspended through a unit distance, its influence was sensed at a distance of 2–3 meters from the pendulum. **Even the thick wall of the laboratory did not shield this effect.** It is necessary to comment that all of these tests, similarly to the previous ones, also were not always successful.

The results indicate that the more proximate to the system with the causal-resultant relationship, the density of time actually changes. **Near the motor there occurs a thinning (rarefaction of time), while near the energy receiver its compaction takes place. The impression is gained that time is extended by a cause and, contrariwise, it becomes more advanced in that place where the effect is located.** Therefore, in the pendulum, assistance is obtained from the receiver, while interference arises from the part on the motor. By these conditions we might also explain the easy accomplishment of these experiments in winter and in northern latitudes, while in summer and in the south it is difficult to perform the tests. The fact of the matter is that in our latitude in winter are located the effects of the dynamics of the atmosphere of the southern latitudes. This circumstance can assist the appearance of the effects of the time pattern. However,

generally and particularly **in summer the heating by solar rays creates an atmosphere loader, interfering with the effects**.

The effect of time differs basically from the effect of force fields. The effect of the causal pole on the device (pendulum) immediately creates two equal and opposite forces, applied to the body of the pendulum and the suspension point. There occurs a transmission of energy, without momentum, and, hence, also without delivery to the pole. This circumstance explains the reduction of the influences inversely proportional to the first power of the distances, since according to this law an energy decrease takes place. Moreover, this law could be foreseen, simply by proceeding from the circumstance of time as expressed by turning, and hence with it a necessity to link the plane, passing through the pole with any orientation in space. In the case of the force lines emerging from the pole, their density decreases in inverse proportion to the square of the distance; however, the density of the planes will diminish according to the law of the first power of the distance. The transmission of energy without momentum (pulse) should still have the following very important property: Such a transmission should be instantaneous: i. e., it cannot be propagating because the transmission of the pulse is associated with propagation. This circumstance follows from the most general concepts concerning time. Time in the universe is not propagated but appears immediately everywhere. On a time axis the entire universe is projected by one point. Therefore, the altered properties of a given second will appear everywhere at once, diminishing according to the law of inverse proportionality of the first power of the distance.

It seems to us that such a possibility of the instantaneous transfer of information through time should not contradict the special theory of relativity — in particular, the relativity of the concept of simultaneity. The fact is that the simultaneity of effects through time is realized in that advantageous system of coordinates with which the source of these effects is associated.

The possibility of communications through time will probably help to explain not only the features of biological relationship but also a number of puzzling phenomena of the psychics of man. Perhaps instinctive knowledge is obtained specifically in this manner. It is quite likely that in this same way are realized also the phenomena of telepathy: i. e., the transmission of thought over a distance. All these relationships are not shielded and hence have the property for the transmission of influences through time.

Further observations indicate that in the causal-resultant dipoles a complete compensation of the effect of its poles does not take place. Ob-

viously, in the process there occurs the absorption or output of certain qualities of time. Therefore, the effect of the process could be observed without a preliminary excitation of the system.

The previously applied torsion weights (balances) were modified in such a manner that, when possible, we would increase the distance between the weights suspended on the balance arm. This requirement was realized with a considerable lengthening (up to $1.5\,\mathrm{m}$) of the suspension filament of one of the weights. As a result, the torsion balances came to resemble a gravitational variometer, only with the difference that in them the balance arm could be freely moved around a horizontal axis. The entire system was well grounded and shielded by a metal housing in order to avert the electrostatic effects. The masses of the weights were of the order of 5–20 grams. In the realization of any reversible process near one of the weights, we obtained a turning of the balance arm toward the meridian by a small angle a of the order of $0.3°$, with a sensitivity of the weights (scales) corresponding to a slewing by $9°$ for the case of the effects of the forces of a time pattern of full magnitude. In this manner, the forces which were occurring proved to be quite similar to those previously investigated. They act along the axis of the Earth and yield the same series of quantized values of the slewing angle: $\frac{1}{2}a$, a, $2a$, ... It turns out that the vertical components of these forces can be observed in the analytical scales, if we separate the weights in them far enough, by means of the same considerable lengthening of the suspension filament of one of the weights.

These tests indicated the basic possibility of the effect through time of an irreversible process upon a material system. At the same time, the very low value of the forces obtained testifies to a certain constructive incorrectness of the experiment, owing to which there takes place an almost complete compensation of the forces originating in the system. As a result, only a small residue of these forces acts on the system. Obviously, in our design, during the effect upon one weight, there also develops an effect upon the second weight, stopping the turning of the torsion balances. Most likely, this transmission of the effect to the second weight occurs through the suspension point. In reality, the appearance of forces of the time pattern in one of the weights signifies the transformation of the forces of the weight of this load and its reaction in the mounting point to a new time pattern, associated with the Earth's rotation. The transformation of the time pattern in the suspension point of the torsion balances can also cause the transformation of all of the forces acting here, signifying also the reaction of the second weight. However, the appearance of an additional reaction re-

quires the appearance of the additional force of the weight of the second load. Therefore, in this design, during the effect upon one load there also originates an effect upon the second load, stopping the turning of the torsion balances. The concept discussed indicates that to obtain substantial effect in the torsion balances, it is necessary to introduce an abrupt asymmetry in the suspension of the loads.

As a result of a number of tests, the following design of the asymmetrical torsion balances proved successful: one cylindrical load of considerable weight was chosen, around 300 grams. This main weight was suspended from the permanent filament made of capron, with a length of around 1.5 meters and a diameter of 0.15 mm. To this weight there was rigidly fastened, arranged horizontally, a light-weight metal plate around 10 cm in length. The free end of this plate was supported by a very thin capron filament fastened at the same point as the main filament. From this free end of the plate, we suspended on a long thin wire a weight of the order of 10 grams. For damping the system the main weight was partly lowered into a vessel containing machine oil. By a turn at the suspension point, the horizontal plate was set perpendicular to the plane of the meridian.

Let us now assume that in the system a force has developed affecting only the main weight in the plane of the meridian: i. e., perpendicularly to the plate. This force deflects the main weight by a certain angle a. The free end of the plate with a small load will also be deflected by this same angle. Therefore, upon the small load there will act a horizontal force, tending to turn the plate toward the plane of the meridian and equalizing the weight of the small load multiplied by the angle a. Since the deflection angle a equals the relative change in the weight, a force equaling the additional force of the time pattern for the weight of a small load will act on the small load. Therefore, the turning angle of the torsion balances can be computed according to the previous (13), assuming that in it $T_0 = 0$. The same turning, but in an opposite direction, should be obtained during the effect upon only one small load. This condition was confirmed by experiments with strong influences from close distances. However, it turned out that a heavy weight absorbed the effect better than a small weight. Therefore, weak remote forces are received (absorbed) by only one large load, which permitted us to observe the effects upon the device at very considerable distances from it, of the order of 10–20 meters. However, the optimal distance in these tests was around 5 meters.

The asymmetrical torsion balances described proved to be a successful design. The calculated angle of their turning under the effect

of additional forces of the time pattern should be of the order of $14°$. In the case of a contactless effect over a distance, we obtained large deflections, which reached the indicated values. In these tests, as in the previous ones, we once again observed the discrete state of the stable deflections with a power of one fourth of the full effect: i. e., $3°5'$.

A variety of processes caused a deflection of the weights: heating of the body; burning of an electric tube; cooling of a previously heated body; the operation of an electrical battery, closed through resistance; the dissolving of various salts in water; and even the movement of a man's head. A particularly strong effect is exerted by a nonstationary process: e. g., the blinking of an electric bulb. Owing to the processes occurring near the weights and in nature, the weights behave themselves very erratically. Their zero point often becomes displaced, shifting by the above-indicated amounts and interfering considerably with the observations. It turned out that **the balances can be shielded, to a considerable extent, from these influences by placing near them an organic substance consisting only of right-handed molecules: for example, sugar. The left-handed molecules — e. g., turpentine — evidently cause the opposite effect**.

In essence, the tests conducted demonstrate that it is possible to have the influence through time of one process upon another. In reality, the appearance of forces turning the torsion balances alters the potential energy of the balances. Therefore, in principle, there should take place a change in the physical process which is associated with them.

At a session of the International Astronomical Union in Brussels in the fall of 1966, the author presented a report concerning the physical features of the components of double stars. In binary systems a satellite constitutes an unusual star. As a result of long existence, a satellite becomes similar to a principal star in a number of physical aspects (brightness, spectral type, radius). At such great distances the possibility is excluded that the principal star will exert an influence upon its satellite in the usual manner: i. e., through force fields. Rather, the binary stars constitute an astronomical example of the effect of the processes in one body upon the processes in another, through time.

Among the many tests conducted, we should mention the observations which demonstrated the existence of yet another interesting feature in the qualities of time. It turns out that in the experiments with the vibrations of the mounting point of the balances or of the pendulum, additional forces of the time pattern which developed did not disappear immediately with the stoppage of the vibrations, but remained in the system for a considerable period. Considering that they decreased ac-

cording to the exponential law e^{-t/t_0}, estimations were made of the time t_0 of their relaxation, which was shown not to depend on the mass of the body but upon its density ρ. We obtained the following approximate data: for lead, $\rho = 11\,\mathrm{g/cm^3}$, $t_0 = 14$ seconds; for aluminum, $\rho = 2.7\,\mathrm{g/cm^3}$, $t_0 = 28$ seconds; for wood $\rho = 0.5\,\mathrm{g/cm^3}$, $t_0 = 70$ seconds. In this manner it is possible that t_0 is inversely proportional to the square root of the body's density. It is curious that the preservation of the additional forces in the system, after the cessation of the vibrations, can be observed in the balances in the simplest manner. Let us imagine balance scales in which one of the weights is suspended on rubber. Let us take this weight with one hand and, with the pressure of the other hand upon the balance arm, replace the effect of the weight taken from it. We will shake the removed weight with one hand and, with the pressure of the other hand upon the balance arm, replace the effect of the weight taken from it. We will shake the removed weight for a certain time (around a minute) on the rubber, and then we will place it back upon the scales. The scales will indicate the gradual lightening of this load, in conformity with the above-listed values for t_0. It is understandable that in this test it is necessary to take measures in order that one's hand does not heat the balance arm of the scales. In place of a hand, the end of the balance arm from which the weight is taken can be held by a mechanical clamp. Sometimes this amazingly simple test can be accomplished quite easily, but there are days when, similarly to certain other tests, it is achieved with difficulty or cannot be accomplished at all.

Based on the above-presented theoretical concepts and all of the experimental data, the following general inferences can be made:

1. The causal states, derived from three basic axioms, of the effect concerning the properties of a time pattern are confirmed by the tests. Therefore, we can consider that these axioms are substantiated by experiment. Specifically, we confirm axiom II concerning the spatial non-overlapping of causes and effects. Therefore, the force fields transmitting the influences should be regarded as a system of discrete, non-overlapping points. This finding is linked with the general philosophical principle of the possibility of cognition of the world. For the possibility of at least a marginal cognition, the combination of all material objects should be a calculated set: i.e, it should represent a discrete state, being superimposed on the continuum of space.

As concerns the actual results obtained during the experimental justification of the axiom of causality, among them the most important are

the conclusions concerning the finiteness of the time pattern, the possibility of partial reversal of the causal relationships, and the possibility of obtaining work owing to the time pattern.

2. The tests proved the existence of the effects through time of one material system upon another. This effect does not transmit a pulse (momentum), meaning it does not propagate but appears simultaneously in any material system. In this manner, in principle it proves possible to have a momentary relationship and a momentary transmission of information. Time accomplishes a relationship between all phenomena of nature and participates actively in them.

3. Time has diverse qualities, which can be studied by experiments. Time contains the entire universe of still unexplored occurrences. The physical experiments studying these phenomena should gradually lead to an understanding of what time represents. However, knowledge should show us how to penetrate into the world of time and teach us how to affect it.

1. Reichenbach H. The direction of time. Berkeley, 1956.

2. Whitrow G. J. The natural philosophy of time. London, 1961.

3. Gauss C. F. Theoria residuorum biquadraticorum, commentatio sugunda. *Göttingishe Gelehrte Anzeigen* (*Göttingen learned review*), 1831, Bd. 1, 635.

4. Kozyrev N. A. Possible asymmetry in shapes of planets. *Doklady Acad. Sci. URSS*, 1950, vol. 70 (3), 389–392.

5. Kozyrev N. A. *Bull. of Crimean Astrophysical Observatory*, 1948, vol. 2, 3–43; *ibid.*, 1950, vol. 6, 54–83.*

6. Reich F. Drop tests concerning Earth's rotation. (Fallversuche über die Umdrehung der Erde.) Freiberg, 1832.

7. Hagen I. G. The Earth's rotation: its ancient & modern mechanical proofs. (La rotation de la Terre, ses Preuves mécaniques anciennes et nouvelles.) *Specola Astronomica Vaticana*, Roma, 1912, vol. 1, Append. 2.

*English translation: Kozyrev N. A. Sources of stellar energy and the theory of the internal constitution of stars. *Progress in Physics*, 2005, vol. 3, 61–99. — *Editorial comment.*

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