# FORCE OF TIME

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## Abstract

The review of theoretical and experimental development of causal mechanics is given. In spite of the fact, that ideas of causal mechanics suggested by N.A.Kozyrev met in due course a contradictory reaction because of them weak formalisation of the theory and doubt of strictness of the experiments, discussions about them are going on thanks to them again and again revealing predictability. Recently basic statements of causal mechanics have been strictly formulated. A connection of causal mechanics with action-at-a-distance electrodynamics and quantum nonlocality has been revealed. Kozyrev's experiments have been successfully reproduced at the different labs. A possibility of use of causal mechanics for explanation of the macroscopic dissipative processes interaction and their forecast in geophysical and astrophysical applications has been appeared.

## 1. Introduction

One may divide all diversity of approaches to the problem of time into two classes – a relational one and a substantional one. In the relational approaches time is a co-ordinate. In the substantional ones, less known and developed, time serves not only by a co-ordinate, but possesses number of the properties, allowing, in some sense, to talk about it as a kind of substance. It sounds strange, but it is not difficult to understand logic of such conclusion. In theoretical physics time is considered to be reversible. The fundamental equations are true both for direct and for inverse course of time. Choice of the sign one makes through the initial conditions, i.e. in fact, appealing to intuition brought up by everyday experience, but on no account introducing the irreversibility to the equations. The fact is by force of the most general symmetry principles, the time irreversibility must lead to violation of the energy conservation. That is why the really observed irreversibility is considered to be only a property of the particular macroscopic systems. If to consider time irreversible and to interpret that violation as widening of frames of the energy conservation law, then the energy of time itself appears. Such change of views is too strong to gain acceptance without the direct and faultless experimental facts.

But an interest to time is related just exactly with its inexorable irreversibility. However the triumphal procession of physics of the XX-th century went by the way of evasion of this problem. One can not say that solution of the irreversibility problem is absent at all. This solution reduces that irreversibility is a property of the physical systems, and in the most general view represents that time arrow is determinated by the Universe expansion predeterminated by its origin, Big Bang. So all the problems are drived in one corner. With this they do not become intelligibler, but then as if banish from the sphere of everyday experience.

In contrast to that, acceptance of fundamental irreversibility of time is set to base a new physical line called by its founder N.A.Kozyrev, causal or unsymmetrical mechanics.

## 2. Star's energy paradox

Not only general logic of naturalist had led N.A. Kozyrev to consider the properties of time was necessity, but also reflections on the concrete astrophysical problems. The most important problem of such rind is the question on the energy sources of the stars [1]. Having computed by independently observed parameters (mass, radiant emittance, radius) with the help of conditions of balance, the parameters characterised state of star's interior (temperature, density, energy emission), N.A. Kozyrev had shown statistically reliably that stars in the co-ordinates of the state were on the free cooling surface. It means that there are no other mechanisms of energy emission independent of heatrelinquishing. Absence of the special energy sources in the following way led N.A. Kozyrev to investigate in necessity the nature of time [1, p.175] : "There is received that a problem of stars fire is a particular case of the general problem – why are the equiponderant states in the Universe absent? If there is a general principle of inaccessibility of the equiponderant states, which always means that under any circumstances there is a distinction between the future and the past. If this distinction is real and the course of time is the objective physical property of time, it has to peep by influence upon material systems. This influence will prevent the equiponderant states from realizing, under which there are no distinctions between the future and the past, i.e. there is no course of time. Preventing stars to come in the equiponderant state, the course of time will be the source of their energy". In [1] a special statistical proof has been presented that thermonuclear reactions can not be a source of star's energy. This conclusion is in full contradiction with the conventional theory, but, as far as is known, has nowhere refuted constructively. Moreover, recent discoveries of deficit of the solar neutrino flow, and of low temperature of the central solar interior completely correspond to Kozyrev's predictions.

## 3. Force of time

Not only the problem of the sources of star energy, but other not less significant, e.g. the problem of statistically reliable connection of the processes on the remote heavenly bodies, which do not come from the local gravity and electromagnetic influence [1-8], may be solved by a single way, if to assume existence of the active properties of time. But it turned out difficult to derive these properties by solving the inverse problems. That is why the second stage of N.A. Kozyrev work became upbuilding of theory basement of causal mechanics. Having introduced certain axioms, namely: time possesses direction or course that distinguishes causes from effects (violation of *T*-invarianthess), causes and effects are always separated by nonzero space $\delta\vec{x}$ and time $\delta t$ intervals (discreteness of space-time structure), he obtained in form of theorems number of unexpected inferences.

In particular it has turned out that course of time, i.e. velocity of converting the cause into the effect $c_2$:

$$c_2=\delta x/\delta t \qquad (1)$$

is a pseudoscalar. In other words $c_2$ has sense a linear velocity of rotation, a sign of which is defined by direction of time of our World. In classical limit $\delta t \to 0 \Leftrightarrow |c_2| \to \infty$. But $\delta t \neq 0$, $\delta x \neq 0$, by the axioms, therefore $c_2$ has also a finite value. Formal definition the terms "cause" and "effect" will be considered below, in the meanwhile it may be realized a cause as a source of the free energy, an effect as its gutter. If the cause and the effect are in real relative rotation, then course of time into the system turns out changed and the theory predicts arising of internal forces $\pm\Delta\vec{F}$ which do not change the momentum of the system, but change its energy. In particular, if the cause *X* is placed on the giro, while the effect *Y* – on its support, then a new force called the force of causality (in fact, force of time!) arises acting along the axis of the gyro [1,9]:

$$\Delta\vec{F}_Y = -\vec{j}\,\frac{\pi u}{c_2}\left|\vec{F}_Y\right| cos\,\theta\,, \qquad (2)$$

$$\Delta\vec{F}_X = -\Delta\vec{F}_Y\,, \qquad (3)$$

where $\vec{j}$ is ort of the gyro, *u* is gyro linear velocity of rotation, $\Delta\vec{F}_Y$ is an unelastic force of the cause affecting on the effect: $\vec{F}_Y = \vec{F}_X - \delta\vec{P}_X / \delta t = \delta\vec{P}_Y / \delta t$, $\vec{F}_X$ is applied force in the point *X*, $\vec{P}$ is momentum, $\theta = \vec{i}\,\hat{}\,\vec{j}$, $\vec{i}$ is ort of the causal link *XY* [9]. By rearrangement the cause and the effect the sign of $\Delta F$ changes. For the force of causality to be measured in the macroscopic system it is necessary that cause and effect had a finite arm relatively the axis of the gyro.

There is no the classical forces directed along the axis in any gyro system. Therefore the experiment, conducted by N.A. Kozyrev, which really had shown existence such forces, was so important. At the same time the constant $c_2$ had been determined: $c_2 = +(2.2\pm0.1)\cdot10^6$ *m/s* in the right co-ordinate system [1]. The experiment repeated many times at different performance (vertical and horizontal orientation of the gyro axis), different positions the cause and the effect, different kinds of the exciting dissipative process (providing unelastic interaction the gyro and the support), at last, use of the Earth gyro-effect.

## 4. Interaction of the dissipative processes

It turned out that force of causality arised by leap beginning with some threshold energy of the exciting causal-effectual (dissipative) process. As this took place the threshold energy level changed from one experiment to another. It had been found, that level depended on intensity of any dissipative processes occurring near the gyro and distance to them. Hence large series of the experiments arised, which led to discovery of a new on principle type of interaction between the dissipative processes. Essence of those experiments was simple (at obvious complexity of technical execution): the parameters of a probe dissipative process insulated from classical influences in the detector were studied depending on parameters of some external dissipative process. It should be noted, that existence of the interaction of the processes through the active properties of time had been foreseen by N.A. Kozyrev on the beginning astrophysical stage yet [1, p.175]: "Time cannot be considered distractly from substance. All processes occurring in the Universe are sources, feeding a general flow of time. Therefore it should expect an existence of relation between the systems and a possibility of influence one system upon another one through time". The experiments performed by N.A. Kozyrev allowed to study such interaction in detail.

Generalisation of Kozyrev’s experimental results might be formulated in the following statements.

(1) A new type of interaction between the dissipative processes of any nature exists.

(2) This interaction transmit the energy, the rotational moment, but not the momentum.

(3) The energy of interaction directly related with the entropy production and inversely related with the squared distance.

(4) The interaction is screened by the matter, but the screening properties of the matter does not coincide with such properties for the electromagnetic field.

(5) The interaction can have positive, zero and symmetrical negative time lag.

## 5. Development of causal mechanics and relation with other achievements of modern physics

### 5.1. Theory

With the exception of the dissipativity one can see similarity mentioned above statements (1)-(5) with quantum nonlocality.  It is generally believed that quantum nonlocality is only microscopical effect. However beginning with [10] the theoretical reasoning has evolved on holding of the effect of nonlocality with indefinitely increasing of number of particles in the system. In most clear - cut formulation a contention on holding of the effect of nonlocality in the strong macroscopic limit has done by D.Home and A.S.Majumdar [11]. True is none of these works an idea of experimental verification of such conclusion has been suggested (the standard blueprint of the interference experiment in the macrolimit is wittingly unfit).

The dissipativity may be included by interpretation of nonlocality within Wheelr-Feynman action-at-a-distance electrodynamics. Statement (5) also has to call attention to this interpretation [12]. But first of all take notice to likeness of axioms of causal mechanics and action-at-a-distance electrodynamics. In the last the main postulate is interaction of the charges separated by finite $\delta\vec{x}$ and $\delta t$ (with zero interval). Self-action of the charges is absent. Two from three Kozyrev' s axioms assert the same with replacement terms "charges" by "cause" and "effect", while in [13] N.A. Kozyrev has grounded that interaction occurs through zero interval. In [14] uncertainty of the terms inherent in [1] has been removed. Essentially the formalist is as follows. For the observables $X$ and $Y$ through conditional and unconditional Shannon`s entropies $H$ the independence functions are introduced:

$$i_{Y|X} = \frac{H(Y|X)}{H(Y)},\ i_{X|Y} = \frac{H(X|Y)}{H(X)},\ 0 \le i \le 1. \qquad (4)$$

For example, if $Y$ is one-valued function of $X$ then $i_{Y|X}=0$, if $Y$ does not depend on $X$ then $i_{Y|X}=1$. Next the causality function is considered:

$$\gamma = \frac{i_{Y|X}}{i_{X|Y}},\ 0 \le \gamma < \infty, \qquad (5)$$

and it definited that cause $X$ and effect $Y$ called observables for which $\gamma<1$. The case $\gamma=1$ means adiabatic (non-causal) relation $X$ and $Y$.

It allows to formulate all three Kozyrev' s axiom in the form of one :

$$\begin{aligned} &\gamma < 1 \Rightarrow t_Y > t_X,\ \vec{x}_Y \ne \vec{x}_X; \\ &\gamma > 1 \Rightarrow t_Y < t_X,\ \vec{x}_Y \ne \vec{x}_X; \qquad (6) \\ &\gamma \to 1 \Rightarrow t_Y \to t_X,\ \vec{x}_Y \to \vec{x}_X. \end{aligned}$$

The case $\gamma=1$ means adiabatic (non-causal) relation $X$ and $Y$. On theoretical and multiplicity of experimental examples (e.g. [15-18]) it has been shown that such formal definition of causality does not contradict intuitive understanding of causality in obvious situations and can be used in unobvious ones.

Further action-at-a-distance electrodynamics justify unobservebility of the advanced field and in fact the only observable result of its existence reduces to the phenomenon of radiation damping. But the last represents a typical dissipative process. Moreover, any dissipative process ultimately related with the radiation and therefore with the radiation damping. Third time derivation of position $x$ appearing in formulae of the radiation damping can be directly related with the entropy production. Indeed, for oscillating charge $q$ the advanced field $E^{\mathrm{adv}}$ is related with the retarded one $E^{\mathrm{ret}}$ and radiation damping [19]:

$$E^{\mathrm{adv}} = E^{\mathrm{ret}} - \frac{4e^2}{3qc^3}\dddot{x}. \qquad (7)$$

On the other hand, radiation power is

$$P = \frac{2}{3}\frac{e^2}{c^3}\left\langle \ddot{x}^2 \right\rangle = -\frac{2}{3}\frac{e^2}{c^3}\left\langle \dddot{x}\,\dot{x} \right\rangle. \qquad (8)$$

The entropy (dimensionless) production per a particle by temperature $T$ is $S=P/kT$ and therefore

$$\left\langle \dddot{x}\dot{x} \right\rangle = -\frac{3}{2}\frac{c^3}{e^2}kT\dot{S}\,. \qquad (9)$$

(The specific thermodynamical entropy $S$ featuring here and the entropy of levels $H$ from Eq. (4) are distinguished by the definition spaces of the probability operator and easily related within the exfoliated spaces theory [18])

From Eq. (7) - (9) it can assert that advanced fields carry out relationship between the dissipative processes.

One of the basic statements of action-at-a-distance electrodynamics is perfect absorption of the field by substance (here from its known second name is absorber theory of radiation). However according to the modern treatment of the theory developed by F.Hoyle and J.V.Narlicar [19] it concerns only the retarded field, absorption of the advanced field bound to imperfect. Having accepted that total field $E$ is superposition

$$E=AE^{\mathrm{ret}}+BE^{\mathrm{adv}}, \qquad (10)$$

where $A$ and $B$ are constants and having denoted efficiency of absorption of retarded field $a$ ($a$=1corresponds to perfect absorption, $a$=0 – to absence of absorption), advanced one by $b$ it is easy to obtain, that

$$A = \frac{1-b}{2-a-b}, \quad B = \frac{1-a}{2-a-b}\,. \qquad (11)$$

Substitution to Eq. (10) $A$=1, $B$=0 corresponds to really observing situation, that is compatible with Eq.(11) only if $a$=1, 0≤$b$<1. It should be stressed wide a priori arbitrariness in value $b$ which may be close as to unit so to zero. Therefore the screening properties of the matter must be in one degree or another attenuated. It quite corresponds to statement (4) at last, the fact itself of imperfect absorption of the advanced field means availability of a possibility of its separate detection (statement (5)). Zero time lad also mentioned in statement (5) might be a result of interference of the retarded and symmetrical advanced effects, that is in agreement with proved by J.C.Cramer [12] the possibility of nonlocal-connection through the space-like interval.

Thus there is every reason to suppose that experimentally established and partly theoretically justified by N.A. Kozyrev the statements (1)-(5) might be a result of manifestation of quantum nonlocality on the macroscopic level related with concurrent existence of the retarded and advanced electromagnetic field. As this takes place, two treatments are possible: either, utterly following by J.C.Cramer [12] nonlocality must be taken as direct consequence of action of such fields, or of the electromagnetic field must be taken as a classical channel necessary for existence of nonlocal one. Without regard to this, the reasoning mentioned above obviously relates causal mechanics with quantum nonlocality and action-at-a-distance electrodynamics. It is interesting that within such approach asymmetry of time is expressed through asymmetry of $a$ and $b$.

Another way of development of causal mechanics was suggested by L.S. Shikhobalov [20-23]. This way a consists in successive more accurate definition and elaboration of Kozyrev' s ideas within just theoretical mechanics. He managed to show that causal mechanics fit to consistency principle in classical and quantum mechanics, relativity and quantum field theory. In particular, causal-mechanical interpretation of the CPT theorem had been presented.

At last D.Savage [24-28] developed Kozyrev' s approach in the context of some interesting astronomical regularities (e.g. conservation of momentum with distance). He also advanced the concept of stress of time, extended the force of causality.

## 5.2. Experiments

Kozyrev' s experiments have been successfully reproduced at different labs, thougt doubt of their strictness have remained.

M.M. Lavrentyev et al [29-32] reproduced those experiments in its primary performance, while D.Savage [26-28] offered and completed them in his original performance, specifically in the most direct relation with usual understanding time as duration [28]. Their experiments were very important as independent corroborations of Kozyrev' s results. But in both cases they suffers from two shortcomings. Firstly, there was not quantitatively formulated hypothesis, secondly, there was not strict control of all possible noise-forming factors. Hence, in spite of qualitative validation of causal mechanics predictions their results have not attracted wide attention.

In some instances Kozyrev' s results were reproduced unconsciously. An example of (highly strict) experiment of this kind was [33]. H.Hayasaka and S.Takeuchi obtained good quantitative agreement with the Kozyrev' s result (it is possible to estimate by data of [34] through Eq.(2) $c_2$=1.7·10$^6$*m/c*, just equal to Kozyrev' s first estimation at the same performance of the experiment [1]), but they did not attach importance taking place dissipation in the studied process. The authors [34-36], attempting to reproduce their experiment, reduced this dissipation and obtained zero result.

The experiment in original performance (using measuring of fluctuation of the conductivity in the electrolyte cell) directed to verification of existence of Kozyrev' s interaction between the dissipative processes had been performed by A.N. Morozov [37]. This experiment was noted for its rigorous technical performance but was also not directed on verification of quantitative formulated hypothesis. Therefore its results turned out positive but weaker than they would have been.

## 5.3. Applications

N.A.Kozyrev had applied causal mechanics to the problems of geophysics and astrophysics: zonal asymmetry of the Earth and other planets, lunar-terrestrial relationships evolution of the double stars and so on. Recently some of these investigations were continued.

In [38] the distribution of force of causality over the Earth had been computed. As a consequence numerous facts of zonal asymmetry of the Earth, namely, its figure, structure, dynamics and physical field distribution (which before were represented accidental) have been managed to explain at least half-quantitatively. These results have already direct significance for geotectonics and meteorology. Moreover this approach is open to development to other branches of geophysics. For example, violating symmetry, only force of causality can by natural way violate the bun of generation of the magnetic field by any axial-symmetric movements imposed by Cowling' s theorem, and so to solve one of old problem of geodynamo (which at present also have to solve by reference to some accidental factors).

V.E. Zhvirblis [39] had performed the experiments with closed thermodynamical systems leaning upon Kozyrev' s ideas of interaction of distant dissipative processes. He had gained the convincing evidences, specifically on relationship of such systems with solar activity as manifestation of Kozyrev' s interaction or macroscopic nonlocality.

## 6. Conclusion

Start of causal mechanic was rather difficult and not only due to scientific reasons, but also even due to political ones. But now we can see its deep relations with other branches of physics. It has proved its predictibility. Its theoretical and experimental development is burning beyond any doubt.

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