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On the Dialectic Unity of Evolution and Involution

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I. INTRODUCTION

Despite some successes in studying the causes and patterns of evolution of living and inanimate nature from the standpoint of nonequilibrium thermodynamics, synergetics, and bioenergetics, "the blatant contradiction of thermodynamics with the theory of biological evolution" [1] remains. This contradiction is not limited to the principle of increasing entropy, which imposes "thermal death" on the Universe as a whole, and degradation on any of its closed parts. The laws of conservation of momentum, its momentum and charge also turn out to be contradictory to evolution, since they exclude the possibility of their occurrence in the processes of evolution. Attempts to solve the problems of evolution with the help of entropy (R. Clausius) [2], the replacement of regular causal processes by "fluctuations" (L. Boltzmann) [3], the concept of the emergence of "order" from "chaos" (I. Prigogine) [4] and the "explanation" of evolution by the consumption of "negentropy" (E. Schrödinger) [5] did not give satisfactory results.

There is a need to create a theory of evolution that would not contradict the modern volume of knowledge. Classical (equilibrium) thermodynamics is not suitable for this purpose, since it is based on the concept of entropy, which does not change when the evolution of the system is carried out due to the work done on it "against equilibrium" [6]. This also applies to the thermodynamics of irreversible processes (TIP),

which excludes from consideration the reversible component of real processes [7]. As a result, the use of equilibrium or locally equilibrium thermodynamics for the analysis of evolutionary problems turns out to be an attempt with obviously unsuitable means.

To study the problems of evolution on a rigorous physical and mathematical basis, parameters, or functions of a nonequilibrium state are required, which characterize the distance of the system from internal equilibrium. This problem is solved by locally nonequilibrium thermodynamics proposed in the author's doctoral dissertation [8] based on the monograph "Thermodynamics of nonequilibrium processes of energy transfer and transformation" (Saratov, SSU, 1991) and further developed in the monographs "Thermokinetics" (Togliatti, 1999) and "Energodynamics" (St. Petersburg, 2008) [9]. It proceeds from the understanding of energy as the most general measure of all forms of motion (translational, rotational and oscillatory) and interaction (gravitational, electromagnetic, etc.) of all elements of a material system, regardless of whether it is a continuum or a collection of particles. This made it possible to extend the methods of consumer goods to locally nonequilibrium systems that perform useful (reversible) work and supplement it with an analysis of the efficiency and productivity of processes of useful energy conversion.

II. SPECIFICITY OF ENERGY DYNAMICS AS APPLIED TO EVOLUTIONARY PROCESSES

The desire to preserve the main advantage of the classical thermodynamic method (the immutable validity of its consequences) led to the construction of energy dynamics on the same methodological principles of deductive (studying an object from the general to the particular) and phenomenological (based on experience) theory. This is expressed in the consideration as an object of study of the entire set of interacting (mutually moving) material objects such as the Universe as a whole, for which all conservation laws were formulated. For isolated systems, the concepts of external kinetic E^k potential E^p energy, depending on the motion and position of the system relative to the external environment, are meaningless, since all their energy is intrinsic (internal) U . Therefore, the law of conservation of the total energy of the system E as their sum

$$E = E^k + E^p + U = \text{const} \quad (1)$$

turns out to be unacceptable for such systems. For this reason, energy dynamics is based on a more general

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expression of the law of conservation of internal energy U , proposed by N. Umov (1873) [10]:

$$dU/dt + \oint j_e d\mathbf{f} = 0, \quad (2)$$

where j_e ($W\ m^{-2}$) is the energy flux density through the vector element $d\mathbf{f}$ of a closed and fixed surface \mathbf{f} (system boundaries) in the direction of the external normal \mathbf{n} (Fig. 1).

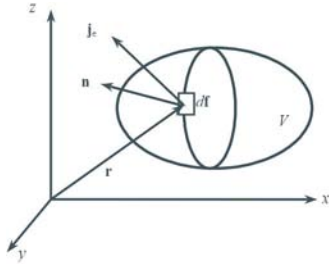


Figure 1: To the law of conservation of energy

According to the concept of short-range action inherent in this equation, the energy of the system U does not just disappear at some points in space and appears in others, but is carried across the boundaries of the system by some material energy carriers Θ_i (k -substances in the amount of N_k moles, their masses M_k , charges Q_k , entropy S_k , momenta $\mathbf{P}_k = M_k\mathbf{v}_k$, etc.).

Let us now take into account that the energy flux j_e through the boundaries of the system consists of the energy fluxes j_{ei} of all the i -th energy carriers Θ_i , each of which, in turn, is expressed by the product of the flux of the i -th material energy carrier $\mathbf{j}_i = \rho_i\mathbf{v}_i$ by its potential $\psi_i = dU_i/dM$ (specific energy), where $\rho_i = d\Theta_i/dV$ is the density of the i -th energy carrier; \mathbf{v}_i is the local speed of its transfer across the fixed boundaries of the system:

$$j_e = \sum j_{ei} = \sum \rho_i \psi_i \mathbf{j}_i, \quad (i=1,2,\dots,n). \quad (3)$$

We now transform $\oint \psi_i j_i d\mathbf{f}$ based on the Gauss-Ostrogradskii theorem into the integral $\int \nabla \cdot \psi_i \mathbf{j}_i dV$ over the volume of the system V . Then, after decomposing $\nabla \cdot (\psi_i \mathbf{j}_i)$ into independent components $\sum \psi_i \nabla \cdot \mathbf{j}_i + \sum j_{ik} \nabla \psi_i$, the energy conservation law (2) takes the form:

$$dU/dt + \sum \int \psi_i \nabla \cdot \mathbf{j}_i dV + \sum \int j_{ik} \nabla \psi_i dV = 0, \quad (4)$$

If in (4) we introduce the concept of a local thermodynamic force $\mathbf{x}_i = -\nabla \psi_i$ and take outside the integral sign some average value Ψ_i of the potential ψ_i and the average value \mathbf{X}_i of the force \mathbf{x}_i , then equation (4) can be expressed through the parameters of the system as a whole, as is customary in classical

$$dU/dt = \sum \Psi_i J_i + \sum \mathbf{X}_i \cdot \mathbf{J}_i, \quad (5)$$

where $J_i = -\oint \mathbf{j}_i \cdot d\mathbf{f} = -\int \nabla \cdot \mathbf{j}_i dV$ is the scalar flow of the i -th energy carrier into the system; $\mathbf{J}_i = \int \mathbf{j}_i dV = \Theta_i \bar{\mathbf{v}}_i$ is the

displacement impulse of this energy carrier within the boundaries of the system; is the average speed of this displacement.

As we can see, taking into account the non-static (final velocity) of real processes ($\mathbf{v}_i, \bar{\mathbf{v}}_i > 0$) is inevitably accompanied by the emergence of a local inhomogeneity $\nabla \psi_i$ of the fields of temperatures, pressures, chemical, electrical, gravitational, etc. potentials, i.e., the appearance of additional parameters \mathbf{x}_i and \mathbf{X}_i , meaning the intensity of these fields. This circumstance reveals the internal inconsistency of the TIP, based on the hypothesis of local equilibrium and allowing the possibility of describing an inhomogeneous continuum with the same set of variables as in equilibrium.

Expression (5) focuses on the existence of two fundamentally different forms of energy exchange between the system and the environment. The first sum (5) characterizes the elementary work dW_i' performed on the system per unit time when a certain amount of mass M is introduced into it during mass transfer, a certain number of moles of k substances N_k during diffusion, charge Q_k during electrification, etc.¹:

$$dW_i'/dt = \sum \Psi_i J_i, \quad (6)$$

Energodynamics also refers to this type of work as conductive heat exchange, understanding by it the work of entering the entropy S into the system as a measure of the amount of chaotic motion. All types of input work do not cause the system to move in space and therefore refer to the disordered form of work by energy dynamics. This work replenishes that part of the energy of the system that is incapable of energy conversion and therefore is called *energy* \bar{U} for short.

A different kind of work dW_i'' , performed by vector forces \mathbf{x}_i or \mathbf{X}_i , similar to thermodynamic forces in TIP. They create an internal directional flow of displacement of the energy carrier $\mathbf{J}_i = \Theta_i \bar{\mathbf{v}}_i$ with a speed $\bar{\mathbf{v}}_i = d\mathbf{R}_i/dt$, where \mathbf{R}_i is the radius vector of the center of value Θ_i . This form of energy exchange is related to the redistribution of the energy carrier and its displacement within the system by the value $\Delta \mathbf{R}_i$, which creates in it some "moments of distribution $\mathbf{Z}_i = \Theta_i \Delta \mathbf{R}_i$ of the energy carrier Θ_i . This process is associated with the transfer of the energy carrier Θ_i in the inhomogeneous potential field ψ_i and overcoming the forces $\mathbf{F}_i = \Theta_i \mathbf{X}_i$ in there. In this case, the work $dW_i'' = \mathbf{F}_i \cdot d\mathbf{R}_i = \mathbf{X}_i \cdot d\mathbf{Z}_i$ against equilibrium "in the system is performed. It replenishes the non-equilibrium (ordered) part of the energy of the

¹ The sign of the incomplete differential "d" emphasizes that the work in the general case depends on the path of the process in the space of variables Θ_i .

system, which is called in energodynamics for short *inergy* \tilde{U} ²:

$$d\tilde{U}/dt = \Sigma dW_i/dt = \Sigma \mathbf{x}_i J_i, \quad (7)$$

This work, called useful or technical in classical thermodynamics, is associated with the transformation of energy from one (*i*-th) form to another, *j*-th. Due to this, *inergy*, as a function of the system's performance, gives the researcher a general measure of the distance of the system as a whole from internal equilibrium, the change of which can serve as a universal criterion for both the approach of the system to equilibrium and the distance from it.

III. ALTERNATIVE TO THE ENTROPY CRITERIA OF EVOLUTION

According to the postulate of R. Clausius [2], all thermodynamic systems (possessing to one degree or another internal thermal energy) tend to thermodynamic equilibrium, characterized by the termination of any macroscopic processes in them. Since the concept of force and the condition of equality of forces in thermodynamics was absent, as a criterion for such an equilibrium, he introduced a new parameter entropy *S*, the change in which during heat exchange *TdS* plays the same role in relation to thermal energy³ as the impulse $\mathbf{P}_k = M_k \mathbf{v}_k$ with an increase in kinetic energy $\mathbf{v}_k d\mathbf{P}_k$. It is therefore natural that the entropy increases for any processes in isolated systems, in which ordered forms of energy transform into disordered (thermal), i.e., dissipate (dissipate). As a result, the efficiency of thermal energy also decreases, due to the presence in the system of sources and receivers of heat with different temperatures. Seeing no exceptions to this circumstance, R. Clausius raised it to the rank of the second law of thermodynamics, giving it the name of the principle of increasing entropy and extending it to the Universe as a whole. This was most clearly manifested in his catchphrase "the energy of the Universe is unchanged, the entropy of the Universe is increasing".

The paralogism of this statement, called the "heat death of the Universe", has given rise to many attempts to prove or disprove this principle. However, they all turned out to be so lax that the scientific community saw in this an "incorrigible logical flaw." Only with time did the facts come to light, indicating that dissipation is by no means limited to the appearance of heat sources. It is known, for example, that when cutting metals, a part of the dissipative work expended is transferred into the

internal energy of the chips and exceeds the amount of frictional heat generated Q^d . The same is observed in the processes of crushing bodies, in which part of the work is spent on increasing the surface energy of the powder. In technology, both of these effects are taken into account by introducing a "heat output coefficient" less than one. It is also known "indirect impact" of bodies when part of the energy expended on accelerating the translational motion increases the impulse of the rotational motion. The number of moles N_k of the *k*th products of chemical reactions, tensors of deformation of plastic materials, etc., which also change in irreversible processes along with entropy, behave similarly. From this point of view, the very idea of R. Clausius to describe all dissipation processes with parameters of only one (thermal) degree of freedom looks at least strange.

Indeed, a change in the amount of any energy carrier $d\Theta_i/dt$ in nonequilibrium systems is caused not only by its transfer across the system boundaries ($d_e\Theta_i/dt = -J_i$), but also by the presence of "internal sources" $d_u\Theta_i/dt = \int \sigma_i dV$ with a density σ_i . This circumstance is taken into account in TIP by the balance equation $d\Theta_i = d_e\Theta_i + d_u\Theta_i$, which in differential form has the form [7]:

$$d\rho_i/dt + \nabla \cdot \mathbf{j}_i = \sigma_i. \quad (8)$$

Considering (8) together with (5), we find that for an isolated system (where $J_i = 0$)

$$dU/dt = \Sigma \Psi_i d\Theta_i/dt - \Sigma_i \int \Psi_i \sigma_i dV + \Sigma_i \int \mathbf{x}_i \cdot \mathbf{j}_i dV. \quad (9)$$

Because in equilibrium

$$dU = \Sigma_i \Psi_i d\Theta_i, \quad (10)$$

then from (9) follows a previously unknown connection between energy sources σ_i and local thermodynamic forces \mathbf{x}_i :

$$\Sigma_i \Psi_i \sigma_i = \Sigma_i \mathbf{x}_i \cdot \mathbf{j}_i, \quad (11)$$

In TIP, as in classical thermodynamics, the presence of sources of σ_i was recognized only for the entropy σ_s , which reduced expression (11) to the dissipative function $T\sigma_s = \Sigma_i \mathbf{x}_i \cdot \mathbf{j}_i$ and turned the entropy into a "scapegoat" for any irreversibility [7]. Meanwhile, according to (11), internal sources should exist in principle for any energy carriers Θ_i . In particular, they are present in all *k*-x substances, the number of moles N_k of which change in the course of chemical reactions, as well as in their impulses $\mathbf{P}_k = M_k \mathbf{v}_k$, which change in the processes of mutual diffusion of the components of a heterogeneous mixture and internal friction in closed systems. Otherwise, new degrees of freedom in the system could not arise if they are not present in the environment.

Moreover, it directly follows from relation (11) that in locally equilibrium systems ($\mathbf{x}_i = 0$) the appearance of any new forms of energy $\Psi_i \sigma_i$ is excluded

² *Inergy* is the antipode of *energy*, like *exergy* *Ex*, but in contrast to it, it characterizes the system's ability to perform not external (technical) but internal work (against equilibrium).

³ For this property, energodynamics calls entropy "thermoimpulse" - an impulse that has lost its vector nature due to the chaotic nature of thermal motion.

$(\sum_i \psi_i \sigma_i = 0)$. This means that the evolution of isolated systems is possible only as a result of the transformation of various forms of energy in it, when $\sum_j \mathbf{x}_j \neq 0$, that is, if their energy carriers exchange impulses \mathbf{j}_i with each other. However, this is impossible, these impulses obey the laws of conservation of their mass, impulse, its moment, charge, etc. Therefore, not only the principle of increasing entropy but also the laws of conservation of energy carriers comes into conflict with the laws of evolution. It is no accident that these laws have been proved only for homogeneous systems ($\mathbf{x}_i = 0$), when the occurrence of internal sources σ_i is excluded.

It is also no coincidence that classical thermodynamics lacks rigorous proofs of the principle of increasing entropy. The point is that there can be no such evidence in the framework of equilibrium thermodynamics. Indeed, suppose we have an equilibrium system with two degrees of freedom: thermal (characterized by entropy S) and deformation (characterized by volume V). The internal energy of such a system U as a function of its state has the form $U = U(S, V)$. In this case, considering the entropy S as the inverse function $S = S(U, V)$, we find that in isolated systems ($U, V = \text{const}$), the entropy remains unchanged:

$$S_{\text{is}} = S(U, V) = \text{const}, \quad (12)$$

From a physical point of view, this conclusion is quite obvious: in an equilibrium system, no processes, including dissipation processes, can arise. They are possible only in the absence of equilibrium, when the number of parameters characterizing the energy of the system U includes the parameters of nonequilibrium, for example, the forces \mathbf{X}_i , which can change in isolated systems, i.e., $U_{\text{is}} = U(S, \mathbf{X}_i, V)$. Then the entropy of such a system can change in place with \mathbf{X}_i . However, in this case, the very principle of increasing entropy will not be needed, since the parameters \mathbf{X}_i themselves can play the role of criteria, evolution, moreover, much simpler, understandable, easily computable and informative, since they can reflect not only involution, but also the evolution of the system, and not only the system as a whole, but also each degree of its freedom separately:

$$d\mathbf{X}_i < 0 \text{ (involution); } d\mathbf{X}_i > 0 \text{ (evolution)}. \quad (13)$$

If the researcher wants to find out the behavior of the system as a whole, then here too the energy of the system can serve as an alternative to entropy, which is also capable of reflecting both its evolution and involution:

$$d\tilde{U}/dt = \sum_j \mathbf{X}_j \mathbf{J}_j < 0 \text{ (involution); } d\tilde{U}/dt = \sum_j \mathbf{X}_j \mathbf{J}_j > 0 \text{ (evolution)}. \quad (14)$$

This expression, like (13), makes it possible to establish the cause of irreversibility and evaluate the

contribution to the dissipation process of each real process, which is extremely important in analyzing the ways of its improvement.

IV. DOES "ORDER" ARISE FROM "CHAOS"?

In recent decades, the idea has become popular that the process of evolution has the character of "self-organization" of the system and that "order" in systems far from equilibrium arises due to "chaos" [4]. At the same time, there are often statements about the possibility of self-organization not only of open but also of isolated systems, which is in even greater contradiction with thermodynamics. As a rule, this is done without any evidence of the erroneousness or limitations of thermodynamics, that is, it is essentially postulated in the same way as the concept of equilibrium as molecular "chaos". As a result, the concept of the emergence of order from chaos not only does not eliminate the contradictions between thermodynamics and evolution but already diverges from both of them.

Meanwhile, the very opposite of "chaos" to "order" is purely intuitive. Most often, "chaos" is understood as disorder, unpredictability, randomness. However, it is necessary to distinguish between what we refer to these concepts: a state or a process. If to a state, then in it the signs of chaos are the variability of the relationships between the parameters characterizing this state, their inconstancy. If we are talking about a process, the signs of its chaos (stochasticity) will be the unpredictability of the nature of this process, that is, its trajectory in the space of the above variables. The concepts of state and process are so different that their confusion can only occur from misunderstanding.

In particular, when we talk about entropy as a measure of "disorder" and "chaos," we mean the chaotic nature of thermal motion, that is, the unpredictability of the trajectory of each particle separately. Thus, the concept of "chaos" is referred to as completely deterministic states of thermal, mechanical, chemical, electrical, etc. balance. It is no coincidence that a homogeneous state has recently been increasingly called "equilibrium order", which exists due to the inhomogeneous, and nevertheless the most probable and quite predictable "Maxwell-Boltzmann" distribution of particles in terms of velocities and momenta.

No less controversial is the concept of evolution as a "self-organization" of a system. The etymology of this term indicates the spontaneity of this process, that is, the absence of any external compulsion. Meanwhile, according to the main postulate of classical thermodynamics (the principle of self-inviolability of equilibrium), no system that has reached equilibrium can spontaneously leave it. On the other hand, in isolated systems all internal processes are

spontaneous. Therefore, it would be more correct to speak not about the "self-organization" of the system as a whole, but about individual processes taking place in isolated systems in the direction of moving away from the state of equilibrium. Indeed, according to the conservation law (5), for closed systems in which there is no transfer of any energy carrier J_i across the boundaries of the system, the law of conservation of energy during interconversions is also valid:

$$dU/dt = \sum_i X_i J_i \tag{15}$$

This means that in isolated nonequilibrium systems ($dU/dt = 0$; $X_i, J_i \neq 0$)

$$\sum_i X_i J_i = 0, \tag{16}$$

that is, it contains $X_i J_i$ terms of different signs, characterizing the work dW_j/dt both against the forces of scattering and against equilibrium. In other words, in the processes of interconversion of energy, some types of work are performed against equilibrium due to the inertia of other degrees of freedom. This means that, contrary to the ideas of I. Prigogine, the order in such degrees of freedom of the system arises not from chaos, but from "order" in others, including due to the inertia of the environment, contained in its force fields. It is advisable to start the analysis of such processes with a very widespread crystallization process.

a) *Crystallization as removal from equilibrium.*

The process of formation of single crystals can be thought of as a kind of phase transformation processes associated with the formation of elementary volumes V_j of a new phase [6]. Let us imagine a single crystal of volume V as the sum of volumes V_j of imaginary pyramids with height h_j , the vertices of which are located at some common "Wolfe point" inside the crystal, and the base of which is the corresponding j -th face of the single crystal with area f_j . In this case, the formation of a single crystal appears as a growth process of the crystalline phase with a volume $V = \sum_j V_j = \frac{1}{3} \sum_j f_j h_j$, which satisfies the Wolfe law

$$X_j/h_j = \text{const}, \tag{17}$$

where X_j is the surface tension of the faces. According to this law, the stable shape of a single crystal is characterized by the fact that its faces are removed from the common top of the pyramids by a distance proportional to the surface tensions of the faces. According to this law, the growth rate of individual faces of a single crystal is proportional to surface tensions X_j .

It is easy to see that in such a model of the crystallization process, the centers of the volume of each of the pyramids turn out to be displaced relative to the center of the single crystal (Wolfe's point) by an average value of $dR_j = \frac{2}{3} h_j$ under the action of the driving force X_j . Therefore, the formation of a single crystal requires the cost of some work dW_j [17]:

$$dW_j = X_j dR_j = \frac{2}{3} X_j h_j > 0, \tag{18}$$

which leads to a corresponding increase in the energy of the single crystal by the evolution criterion (14).

b) *The emergence of new degrees of freedom of ordered motion*

Let us now consider an example when the evolution of a system is expressed in the emergence of another form of ordered motion in the system. Suppose we have a system that is stationary as a whole, the macroscopic part of which (the k th component) rotates like an unbalanced top (Fig. 2).

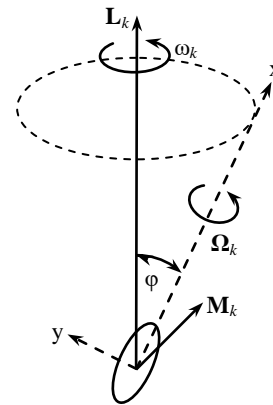


Fig. 2: Top precession

The angular momentum of such a top L_k does not coincide with its axis of rotation, as a result of which, in addition to rotation around its axis with an angular velocity Ω_k , it experiences precession with an angular velocity ω_k . If we combine the x-axis with the symmetry axis of the top, and the y-axis with the plane formed by the vectors L_k and Ω_k , then the angular velocity of rotation of the top about its axis $\Omega_k = |\Omega_k|$ and the angular velocity of its precession $\omega_k = |\omega_k|$ can be expressed by the ratio:

$$\Omega_k = L_k \cos \varphi / I_x; \quad \omega_k = L_k / I_y, \tag{19}$$

where $L_k = |L_k|$; I_x, I_y is moments of inertia of the top relative to the x and y axes; φ is the angle formed by vectors L_k and Ω_k . These angular velocities correspond to the internal kinetic energies of the main $U_k^c = L_k^2 \cos^2 \varphi / 2I_x$ and precession $U_k^p = L_k^2 / 2I_y$ rotation so that the total kinetic energy of the top under consideration $U_k = L_k^2 (\cos^2 \varphi + I_x / I_y) / 2I_x$ is in the general case a function of not only the momentum L_k but also the angle φ , which determines the orientation of the axis of its rotation in space. Comparing it with the value $U_{k0} = L_k^2 / 2I_x$, we find that it exceeds that in the absence of precession (at $\varphi = 0$) by the value:

$$U_k - U_{k0} = L_k^2 (I_x / I_y - \sin^2 \varphi) / 2I_x. \tag{20}$$

This corresponds to the criteria of evolution (14) and means that new degrees of freedom in ordinary (baryonic) matter arise as the system moves away from the state of equilibrium due to the work done "against equilibrium". In isolated systems, this work can be done only by those degrees of freedom of the system that are not themselves in internal equilibrium, that is, are ordered. Consequently, "order" in some degrees of freedom of an isolated system can arise only due to "order" in others, but not due to "chaos", as it is stated [11].

c) *Antidissipative processes in biosystems*

The application of consumer goods to biosystems encounters serious difficulties. One of them is that according to the laws of Onsager

$$J_i = \sum_j L_{ij} X_j, \quad (21)$$

all the terms of the "flow" J_i (generalized velocity of the i -th relaxation process) have the same sign and disappear simultaneously with the onset of complete equilibrium. As a result, these equations describe only the processes of involution and turn out to be inapplicable to the analysis of evolutionary processes. Moreover, for relaxation processes, they contradict the experiment, according to which the fluxes J_i disappear not simultaneously, but one after the other as the corresponding degrees of freedom "degenerate", that is, in the order opposite to their appearance as the system evolves. This is expressed in the passage of the system as it approaches equilibrium of the so-called "stationary states of a lower order", in other words, states of "partial" (incomplete) equilibrium.

Further, according to the principle of energy interconversion (16), even after the isolation of biosystems from the environment, along with relaxation processes in which $\mathbf{X}_i \cdot \mathbf{J}_i < 0$, "antidissipative" processes take place in which $\mathbf{X}_i \cdot \mathbf{J}_i > 0$. This is expressed in different signs of individual terms (21). These processes include, in particular, the transfer of a substance to an area with its increased concentration (the so-called "active transport" of substances), as well as the so-called "conjugate" chemical reactions "going in opposite directions in relation to their affinity, including "Chemical clock" (Belousov - Zhabotinsky reaction) [12,13]. As is known, these phenomena play a decisive role in ensuring the life of biosystems. It is due to the performance of work against equilibrium that the approach of the biosystem to equilibrium (physical death) slows down. Here lies the key to understanding the basic law of evolution of biosystems - the "principle of survival", according to which those bioorganisms live longer, for which the share of work "against equilibrium" is higher.

d) *Wave formation process in the primary matter of the Universe*

From the energy conservation law in the form (5) it follows that any forces, both $\mathbf{X}_i = \nabla \psi_i$ and $\mathbf{F}_i = \Theta_i \mathbf{X}_i$, are generated by the spatial inhomogeneity of the medium. This also applies to that overwhelming part of the mass of the Universe, which for three centuries was called ether, and after its expulsion from theoretical physics - "hidden mass", "physical vacuum", "dark matter", "non-baryonic matter" etc. etc. In energy dynamics, it is called primary matter (prototype), so as not to associate its properties with any specific model. The density of this "primary" matter, from which all types of matter in the Universe were formed, ranges from 10^{-27} g / cm³ in "voids" to 10^{18} g / cm³ in stars of the "white dwarf" type, that is, it is extremely unevenly distributed in it. Since all types of ordinary (observed) matter of the Universe were formed from it. Therefore, oscillations inevitably arise in it, associated with the formation of standing waves between any celestial bodies or ring waves, closed on themselves [14].

The formation of such waves is associated with the transfer of a certain amount of it M from a position with a radius vector \mathbf{r}' to a position \mathbf{r}'' , that is, a shift of the center of mass M by a half-wavelength $\lambda/2$ (Fig. 3). The speed of this shift \mathbf{v} changes from zero in the antinode of the wave to the maximum in its nodes. Therefore, the process of formation of standing waves is inextricably linked with overcoming the Newtonian forces of inertia $\mathbf{F}_i = -d\mathbf{P}_i/dt$ and with the performance of work [15].

The value of this work is easy to calculate if we take into account that the displacement modulus $|\mathbf{r}'' - \mathbf{r}'|$ radius vector of the center of mass M , equal to the half-wavelength $\lambda/2$, occurs during the half-period of the wave $\tau/2 = (2v)^{-1}$ so that the average the speed of this displacement is:

$$\bar{v}_i = \lambda_i v_i \quad (22)$$

This value determines, as is known, the speed of propagation of oscillations in the considered medium c_i . In the absence of dispersion when this speed does not depend on the frequency $c_i \neq c_i(v) = c$, the required work is determined especially simply:

$$W_i = \int \mathbf{v}_i \cdot d\mathbf{P}_i = \int c^2 dM = Mc^2. \quad (23)$$

Hence it follows that the "condensation" of primary matter under conditions with $= \text{const}$ is associated with an increase in the energy of ordinary (baryonic) matter by the amount $dU = c^2 dM$. This energy is then spent on all types of evolutionary processes in it, from the formation of nuclei of future atoms to metagalaxies. Thus, the only source of ordered energy (inergy) for the baryonic matter of the Universe is the vibrational component of the gravitational energy of its prototype [16].

It is so great that in the processes of substance synthesis, its excess amount is released in the form of radiation, mistakenly taken for the energy of "cold" or "hot" synthesis in condensation products.

The fact of the presence of such radiation can be easily explained if we take the displacement $|r-r'| = \lambda_i/2$ for half the amplitude of the longitudinal wave A_k . This immediately leads to the well-known expression for the wave energy density [17]:

$$\rho_v = \rho_i v_{ik}^2/2 = \rho_i A_i^2 v_i^2/2, \text{ J m}^{-3}. \quad (24)$$

The power of this radiation dU_i/dt is expressed similarly to other types of work by the product of some "radiation" force X_r by the flux J_r of its energy carrier [17]:

$$dW_i/dt = X_r J_r \quad (25)$$

Due to the presence in this study of a deeply penetrating component of a non-electromagnetic nature, it becomes responsible for the synthesis of all living things.

V. COUPLING OF THE PROCESSES OF EVOLUTION AND INVOLUTION

The energy of the system U and any of its extensive parameters Θ_i can be represented by the integral of its (his) density $\rho_u = dU/dV$ and $\rho_i = d\Theta_i/dV\Theta_i$. On the other hand, the same parameters can be expressed through their average value $\bar{\rho}_u = U^{-1} \int \rho_u dV$ or $\bar{\rho}_i = \Theta_i/V = \Theta_i^{-1} \int \rho_i dV$. Hence,

$$\int [d(\rho_u - \bar{\rho}_u)/dt] dV \equiv 0 \quad (26)$$

The vanishing of this integral at $\rho_u \neq \bar{\rho}_u$ is possible only if there are subsystems (regions, phases, components) in the volume of the system V , in which the velocities $d(\rho_u - \bar{\rho}_u)/dt$ of any i -th energy conversion process have the opposite sign. In other words, in any non-equilibrium system, there are subsystems that simultaneously and oppositely change their state [18]. This most important position referred to in energy dynamics as the "principle of the opposite direction of processes", is true for both isolated and non-isolated systems. Due to its generality, identity (26) can serve as a mathematical expression of the dialectical law of "unity and struggle of opposites".

The application of this principle to the processes of the evolution of the Universe as a whole makes dramatic changes in our understanding of the origin and evolution of the Universe. If moving away from equilibrium (evolution) $d(\rho_u - \bar{\rho}_u)/dt > 0$ in some of its regions is inevitably accompanied by the approach to equilibrium (involution) of other $d(\rho_u - \bar{\rho}_u)/dt < 0$, then acoustic fluctuations of its density inevitably arise in the prototype of the Universe. This means that in any

inhomogeneous isolated system there are always regions in which the change in energy and the direction of the processes are opposite. In other words, the evolution of the visible (observable) substance of the Universe (from atomic nuclei to metagalaxies) is invariably accompanied by the involution of that part of its hidden mass (proto-matter) that is not yet involved in oscillatory motion. This circumstance, illustrated in Fig. 3, provides a permanent concentration of matter in some of its regions (up to singularity) and expansion ("big bang", "big gap" - in others, which ensures the unlimited existence of the Universe in time.

To show that the homogeneous distribution of matter in the Universe is unstable, we represent the modulus of gravitational acceleration $g = GM/R^2$ in Newton's law of universal gravitation as a function of the density ρ of the gravitational field, writing this law for a sphere of unit volume V with radius R and mass $M = \rho V$:

$$g = (GV/R^2)\rho, \quad (28)$$

where G is the gravitational constant, R is the distance from the center of mass M to a point on its surface with the potential $\psi_g = -GM/R$.

According to this expression, the specific gravitational force g on the surface of a unit sphere is proportional to the density of the substance contained in it and increases with its increase. This means that if any density gradient of matter spontaneously arises in any region of the Universe, then the forces of gravity lead to its further increase, i.e. to the compaction of some, and the rarefaction of other regions of the Universe, followed by the "condensation" of proto-matter in areas of increased density and the formation of baryonic (structured) matter from it with other forms of energy (thermal, deformation, chemical, electrical, nuclear, etc.) and its subsequent compaction [19].

In these "coupled" processes, the gravitational energy of the proto-matter U_g decreases by the value of the total energy $\Sigma_j U_j$ of all newly acquired j -x forms by baryonic matter, without violating the law of conservation of energy. In this case, the process, which is evolutionary for baryonic matter, is relaxation for *protomatter*. This conclusion does not depend on any physical models of baryonic or non-baryonic matter.

The non-trivial consequences of this approach are the confirmation not only of the principle of mutual convertibility of energy (16) but also of the principle of counter-directionality of processes in the baryonic and non-baryonic parts of the Universe matter, without requiring the involvement of general relativity and without going beyond the Newtonian theory of gravity. At the same time, energy dynamics does not exclude the possibility of singularities and "big bangs" emerging in the Universe, which are the cause of the circulation of matter and energy in the Universe. The latter means that the concept of "arrow of time" does not apply to it as a whole.

The simultaneity (conjugation) of the processes of evolution and involution reveals their dialectical unity and exposes the fundamental inadmissibility of the postulation by D. Hilbert, A. Einstein and A. Friedman of a unified gravitation equation for the Universe in the form of a postulate that the space curvature tensor $G_{\mu\nu}$ is proportional to the energy-momentum tensor $T_{\mu\nu}$ [20] :

$$G_{\mu\nu} = 8\pi G T_{\mu\nu}. \quad (27)$$

where G is the gravitational constant, which serves as the proportionality coefficient in this equation.

It was enough to take into account the opposite direction of the evolutionary processes in various regions of the infinite Universe and to limit this ratio (with or without the Λ term) to those regions where these processes are in phase so that the mathematical analysis of this ratio given by A. Friedman would lead to quite consistent with observations the conclusion about the inevitability of the concentration of matter in some of its areas, and its dispersion - in others. This would prevent the emergence of an absurd "standard model" of the evolution of the Universe, asserting the birth of the entire Universe from a single "singularity".

REFERENCES RÉFÉRENCES REFERENCIAS

1. Prigogine I. Time, structure, and fluctuations (Nobel lecture 1977)//Uspekhifizicheskikh Nauk. 1980. T. 131. S. 185–207. (In Russian).
2. Klausius R. Die mechanische Wärmetheorie. Draundschweig, Bd. I, 1876.
3. Boltzmann, L. The second law of thermodynamics (1886).
4. Prigogine I., Stengers I. Order from chaos: a new dialogue between man and nature. Moscow: Progress, 1986.(In Russian).
5. Schrödinger, E. . What is Life?: London: Cambridge University Press, 1944.
6. Bazarov I.P. Thermodynamics. Ed. 4th, M.: Higher School, 1991.(In Russian).
7. De Groot SR, Mazur P. Nonequilibrium thermodynamics. Moscow, 1964.(In Russian).
8. Etkin V.A. Synthesis and new applications of theories of energy transfer and transformation: Diss. Doctors of technical sciences: 05.14.05- Theoretical foundations of heat engineering. M., MEI, 1998 (In Russian).
9. Etkin V. A. Energodynamics (synthesis of theories of energy transfer and transformation) - St. Petersburg; "Science", 2008(In Russian); Etkin V. Energodynamics (Thermodynamic Fundamentals of Synergetics) .- New York, 2011.
10. Umov A. I. Selected Works. M. L., 1950. (In Russian).
11. Prigogine I., Stengers I. Order from chaos: a new dialogue between man and nature. Moscow: Progress, 1986. (In Russian).
12. Belousov BP Periodically acting reaction and its mechanism. Sat: Autowave processes in systems with diffusion. - Gorky: Publishing house of GSU, 1951, p. 76(In Russian).
13. Zhabotinsky A. M. "Concentration fluctuations". Moscow: Nauka, 1974. (In Russian).
14. Jeans J.H. The New Background of Science. - London, 1933.
15. Etkin VA. On Wave Nature of Matter.//World Scientific News 69, 220-235 (2017).
16. Etkin V. Gravitational repulsive forces and evolution of the universe.//Journal of Applied Physics (IOSR-JAP), 8 (6), 2016.43-49 (DOI: 10.9790/4861-08040XXXX).
17. Crawford F. Berkeley Course in Physics. T.3: Waves. Moscow: Mir, 1965.(In Russian).
18. Etkin V. A. On the potential and driving force of radiant heat transfer.//Bulletin of the House of Scientists of Haifa, 20 (2010) .2-6. (In Russian).
19. Etkin V. Principle of non-equilibrium processes counters directivity.//Reports by independent authors, 37 (2016), 86 - 92. (In Russian).
20. Misner, Ch., Thorn K., Wheeler J. Gravity. V.3.— M. : Mir, 1977.