

Quantum theory of the development of science, economic and society.

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Abstract: This paper discusses the wave description in biology, chemistry and economics. Using quantum mechanics to study social processes, it was shown that the economic waves of N. Kondratiev are theoretically derived from the quantum theory of the development of science and society. The use of Heisenberg's uncertainty principle for social phenomena shows that the development of society is conceptually probabilistic in nature and cannot be strictly predicted in principle (given the mathematical formula). The rejection of the "time arrow" at the quantum level leads to the conclusion that "time in our world" is a definite "averaging and transformation" of periodic quantum processes at the fundamental level. It also shows the impossibility of achieving technological singularity and the creation of artificial intelligence like human.

Keywords: The quantum theory of the development of science and society, the big Kondratiev waves, fundamental science, Heisenberg's uncertainty principle and the development of society, the "arrow of time", J. Schumpeter's innovations.

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INTRODUCTION.

In this theoretical work we apply quantum mechanics to study the development of science, economics and society. To understand this approach, it is necessary to remember that at the beginning of the 20th century (the time of birth and formation of quantum mechanics) quantum mechanics was called “wave mechanics” (after the work of E. Schrödinger) and in French works it is called so now [1]. Approximately at the same time, that is, at the beginning of the 20th century, when studying the economies of developed countries (mainly England, France and the USA), based on statistical data for the last 200 years, economists began to assume that the economy is developing in waves [2 - 14]. But, with the “wave description” of any process, quanta arise inevitably and automatically, as in quantum mechanics. And therefore, our transition from economic waves to a quantum theory of economics is logical and consistent. In quantum mechanics, theoretical scientists use very simple and convenient method for studying quantum-mechanical phenomena: as a model, they use a process or phenomenon of classical physics and analyzing it indicate the qualitative differences in the classical understanding and in the quantum-mechanical understanding. This approach is due to the fact that the vast majority of quantum processes cannot be visualized. To illustrate this approach, we will give an example of the propagation of electromagnetic waves: in classical physics, such a wave (light) propagates continuously, in quantum mechanics, light propagates in quanta, that is, portions of energy that have strictly defined characteristics. Moreover, it was the “quantization” procedure, that is, the division of light into portions, that in fact led to the birth of new physics, which we call “quantum mechanics”. The year of birth of quantum mechanics can be considered the year 1901, when the German theoretical physicist M. Planck was suggested that electromagnetic energy can be radiated only by quanta [15]:

$$E = h \gamma$$

where E — quantum radiation energy,

h — Planck's constant, which is equal to $h = 6,626 \times 10^{-34} \text{ J} \cdot \text{s}$

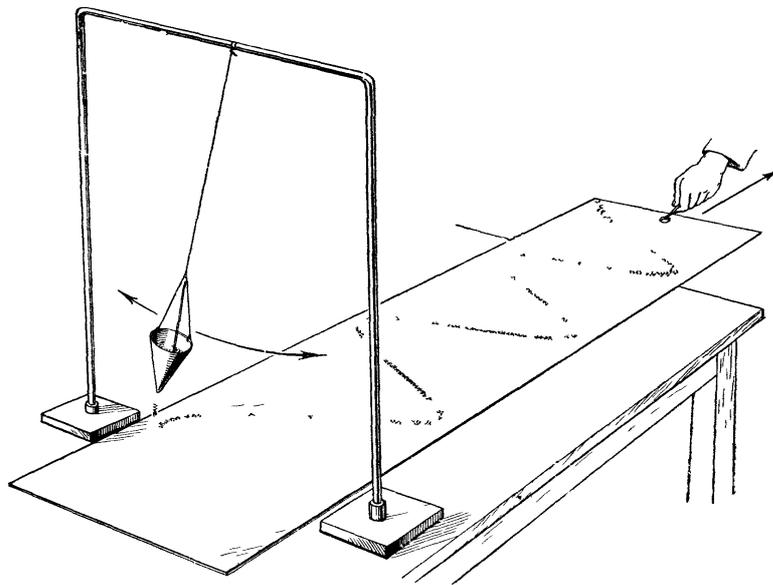
γ — frequency of electromagnetic radiation, the value that determines the radiation energy.

We will do the same: that is, to study economic and social processes, we will use models from various sciences (physics, chemistry, biology), using which we can better understand and explain the development of society. Using this approach, the quantum theory of the development of science, economics and society becomes obvious and logical. We will also be able to imagine and understand how a qualitative leap (gap) is formed during the development of society and science, after which society enters a completely different level.

RESULTS AND DISCUSSION.

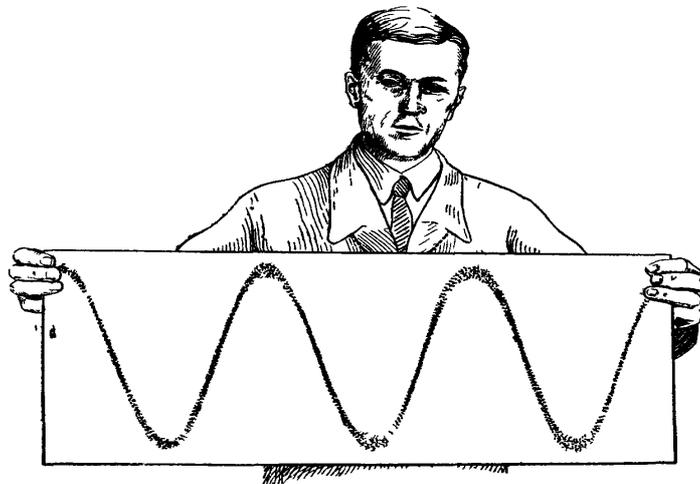
Wave description of physical processes.

Since the wave description is of decisive importance for us, it is necessary to analyze it more deeply: to study when it arises, what it is, and what it can correctly describe. For this you need to briefly familiarize yourself with the theory of oscillations, since the oscillations that propagate in time and there are waves. Consider the oscillation of the pendulum which is designed so that it can draw a graph of the dependence of its deviation from time. Such a pendulum is a conical vessel, which is equipped with a string and filled with sand (the vessel has a thin opening from which sand can spill out in a thin stream) [16].



Picture 1. Self-recording pendulum.

If you move the pendulum with your hand and then let go, and at the same time force a long strip of cardboard to slide in the direction perpendicular to the oscillations of the pendulum, then on paper such a pendulum will draw a typical sinusoid with sand [16]:



Picture 2. “Autograph” of the pendulum.

Pictures 1 and 2, as well as the description of the pendulum, are taken from the book by G. S. Gorelik “Oscillations and Waves. Introduction to Acoustics, Radiophysics and Optics”, which deeply and clearly describes oscillations and waves from common positions, analyzing their particular cases [16]. This book is an excellent textbook for the study of oscillations and waves, as it gives a complete understanding of the wave description.

We continue the study of the “autograph” of the pendulum, that is, the above sinusoid. “With a suitable choice of origin, this curve is described by the equation

$$y = A \cos kx,$$

where A, k — permanent.

Each ordinate y is obviously equal to the displacement of the pendulum at a certain time t , and each abscissa x is equal to the displacement of the cardboard at the same time t . Since the cardboard moves uniformly (with some constant speed v), then

$$x = v t$$

and therefore, the dependence of the pendulum shift on time is expressed by the equation

$$y = A \cos \omega t \quad (1.1)$$

where $\omega = kv$.

Phenomenon described by the form (1.1), where A, ω — constant, called harmonic oscillation.

Function $\cos \omega t$ has the property that with any t

$$\cos \omega(t + T) = \cos (\omega t + \omega T) = \cos \omega t,$$

if $\omega T = 2\pi$,

therefore, if $T = 2\pi/\omega$ or $\omega = 2\pi/T$

The time interval T is called the period of the harmonic oscillation; it is the duration of a full shift, after which the whole movement is exactly repeated.

Value

$$\gamma = 1/T = \omega/2\pi$$

called the frequency of the harmonic oscillation; this is the number of complete oscillations per unit of time. The value of ω is called the circular frequency. This is the number of total oscillations occurring over 2π units of time. If time is measured in seconds, then the frequency is the number of full oscillations per second” [16].

We add that the amplitude of the harmonic oscillation (A) is equal to the maximum value of the deviation of the value of y , which varies in time according to the law $y = A \cos \omega t$.

It is interesting to note that the voltage in the urban network will also draw a sine wave on the screen of an electronic oscilloscope [16, p. 14]. This only means that the voltage (u) of the urban

network also changes according to the same law as the oscillation of the pendulum with sand, but in this case the equation will be written in the form:

$$u = A \cos \omega t$$

where u is the voltage in the city network, the frequency γ is equal to 50 hertz (that is, 50 full oscillations per second).

Similarly, the current changes in the generator of electromagnetic oscillations [16, p. 16]:

$$i = A \cos \omega t$$

where i — current strength arising in the generator.

The strengths of the electric and magnetic fields E and H (which arise in the space surrounding the generator of electromagnetic oscillations) also vary according to the law:

$$E = A_1 \cos \omega t \quad \text{and} \quad H = A_2 \cos \omega t$$

If we move from electromagnetic phenomena to sound propagating in the air, then here on the corresponding device we will see a familiar sinusoid, which the air pressure near the microphone “draws” according to the law [16, p. 15-16]:

$$\Delta P = A \cos \omega t$$

where ΔP — this is the pressure change from the equilibrium value P_0 , near the microphone diaphragm, in the absence of sound. That is, the air pressure around the microphone will be equal to:

$$P = \Delta P + P_0$$

where P_0 — this is the air pressure near the microphone with no sound,

ΔP — this is the amount of change in air pressure near the microphone in the presence of sound, which is changed $\Delta P = A \cos \omega t$.

It is worth noting, however, that with the propagation of sound in the air, not only pressure, but also air temperature and air density changes locally.

From the above it follows that the wave description is applicable when changing various quantities near a certain equilibrium quantity (oscillation in time). This is especially clear when describing changes in air pressure: $P = \Delta P + P_0$, $\Delta P = A \cos \omega t$, where P_0 is the equilibrium value of air pressure. Pressure fluctuation (P), as we already know, occurs according to the law of cosine. It is necessary to understand that with the wave description of any phenomena there is always an equilibrium value of a certain quantity, the oscillation of which in time “gives rise” to the corresponding wave. This wave can change according to arbitrarily complex law, but it can always be mathematically represented as the addition of a certain number of harmonic oscillations. It can be said that where there is a fluctuation of a certain magnitude in time (we note that it is not necessarily harmonic), there is also a correct wave description of this process.

Model “predator - prey” in biology.

Let us demonstrate the universality of the wave description by the example of the change in the number of lynxes and hares living in the same territory over time [17]. This is the “predator - prey” model, that is, the Lotka – Volterra model, which proposed equations independently of each other (Lotka 1925, Volterra 1926).

Let us give a typical derivation of equations for the Lotka-Volterra model given in the book N. V. Karlov, N. A. Kirichenko “Oscillations, waves, structures” [17].

So, lynx (predators) and hares (prey) live together in a certain territory. Hares feed on vegetation which is in excess. Lynx feed only on hares. The territory on which they live is stable in size and does not change. The task is to find the dependence of the numbers of lynx and hares in time.

To begin with, we will consider separately hares and lynxes. Let N_1 - the number of hares, N_2 - the number of lynx. When hares feed on vegetation and are not threatened by anything, they multiply according to the law:

$$dN_1/dt = \alpha_1 * N_1$$

where $\alpha_1 = \alpha_1 * p - \alpha_1 * c$, where $\alpha_1 * p$ – takes into account the birth rate of hares, and $\alpha_1 * c$ — takes into account their mortality (natural). Since the feed is sufficient, the number of hares increases, that is, $\alpha_1 > 0$.

On the contrary, in the absence of hares, lynxes die out according to the law similar to the law of radioactive decay (a probabilistic process, the system contains a large number of elements N_2):

$$dN_2/dt = - \alpha_2 * N_2$$

Let now hares and lynx coexist on this limited theory. The more often the lynx encounters hares, the more lynx will become and fewer hares. In collisions, lynx “eat” hares, and the number of their collisions will be proportional $N_1 * N_2$, then the speed of eating will be equal to some value $\varepsilon_1 * N_1 * N_2$. Now you can record the rate of change in the number of rabbits:

$$dN_1/dt = \alpha_1 * N_1 - \varepsilon_1 * N_1 * N_2$$

Now, we take into account the breeding of lynx (similar to the member $\varepsilon_1 * N_1 * N_2$), i.e. some quantity $\varepsilon_2 * N_1 * N_2$ will take into account the factor of breeding lynx. This follows from a similar argument: the more lynxes encounter hares ($N_1 * N_2$), the better they feed, and therefore multiply, so the additional multiplication factor will be equal to $\varepsilon_2 * N_1 * N_2$. Then the rate of change of the number of trots will be written with the following equation:

$$dN_2/dt = - \alpha_2 * N_2 + \varepsilon_2 * N_1 * N_2$$

This system of equations:

$$dN_1/dt = \alpha_1 * N_1 - \varepsilon_1 * N_1 * N_2$$

$$dN_2/dt = - \alpha_2 * N_2 + \varepsilon_2 * N_1 * N_2$$

describes the number of predators and prey on the same territory and was proposed in 1926 by V. Volterra. Earlier, similar equations were proposed by A. Lotka, applying the equations of chemical kinetics to the coexistence of predator-prey species.

In a state of equilibrium, the following conditions must be met:

$$dN_1/dt = 0$$

$$dN_2/dt = 0$$

From the corresponding equations we obtain the equilibrium values of the number of hares $N_1(0)$ and lynxes $N_2(0)$:

$$\text{hares (balance), } N_1(0) = \alpha_2/\varepsilon_2$$

$$\text{lynx (balance), } N_2(0) = \alpha_1/\varepsilon_1$$

The number of hares and lynx in reality will fluctuate in a certain small interval near the equilibrium value. Then the deviations from the equilibrium position for hares are written in the form

$$n_1 = N_1 - N_1(0)$$

and for lynx in the form

$$n_2 = N_2 - N_2(0)$$

If these deviations from the equilibrium value are small, then the value of $N_1 \cdot N_2$ can be written in the form (we neglect the value of $n_1 \cdot n_2$):

$$N_1 \cdot N_2 = N_1(0) \cdot N_2(0) + N_1(0) \cdot n_2 + N_2(0) \cdot n_1$$

Then from the equations

$$dN_1/dt = \alpha_1 \cdot N_1 - \varepsilon_1 \cdot N_1 \cdot N_2$$

$$dN_2/dt = -\alpha_2 \cdot N_2 + \varepsilon_2 \cdot N_1 \cdot N_2$$

taking into account

$$N_1(0) = \alpha_2/\varepsilon_2$$

$$N_2(0) = \alpha_1/\varepsilon_1$$

we get the following equations

$$dN_1/dt = -\varepsilon_1 \cdot N_1(0) \cdot n_2$$

$$dN_2/dt = \varepsilon_2 \cdot N_2(0) \cdot n_1$$

Eliminating n_2 from these equations, we come to a typical differential wave equation, which shows a wave-like change in the number of hares in our biological problem.

$$d^2 n_1 / dt^2 + \omega \cdot \omega \cdot n_1 = 0$$

where $\omega = (\alpha_1 \cdot \alpha_2)^{(1/2)}$

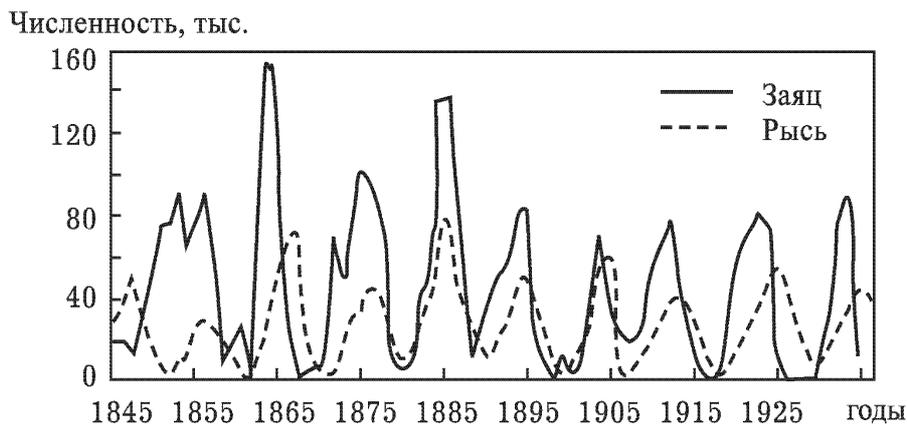
Similarly, one can derive a differential equation (excluding from equations n_1), which shows a wave-like change in the number of lynxes in the “predator – prey” model:

$$d^2n/dt^2 + \omega^2 n = 0$$

These wave differential equations ($d^2n/dt^2 + \omega^2 n = 0$) absolutely identical to the wave equations, which are derived in physics or mathematics when considering classical wave-like processes: string oscillations, voltage oscillations, spring pendulum oscillations, mathematical pendulum oscillations, etc. They differ only in that the constant ω will be derived from other constants (important for a particular process), and the differentiable value will be different (this is the value that changes during the oscillatory process).

It should be noted that the wave equation can also be expressed in terms of a periodic function (for example, $y = \cos x$), since a periodic function, by definition, describes the oscillation of a certain quantity. This is just a bit of a “different look” to the wave description, which we have done above, when the mathematical pendulum drew an explicit sinusoid with sand, and we arbitrarily attributed to it the equation $y = A \cos kx$ and then logically passed to the wave equation $y = A \cos \omega t$.

It is interesting to note that a wave-like change in the number of hares and lynxes was recorded in nature, namely in the territory of Canada. The figure shows fluctuations in numbers for 90 years, from 1845 to 1935 according to the data of the fur company [17]:



Explanation of the figure:

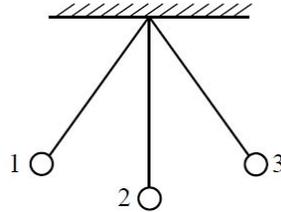
the y - axis shows the number of hares and lynxes in thousands, with the solid line depicting hares and the dotted line - lynx,

the x - axis shows the corresponding years.

The number fluctuations in the “predator – prey” model are simply explained: if there are many hares, then there is a lot of food for lynxes and the number of lynxes increases, but the number of hares decreases and, accordingly, at some point in time, there is little food for lynxes, and their number begins to decrease, and so on, in a cycle.

Model “kinetic energy - potential energy”.

If we analyze the “predator – prey” model from a more general perspective, then it has long been used in physics to describe the oscillations of a mathematical pendulum. The model “predator - prey” in physics goes into a model that can be called “kinetic energy - potential energy”. For further analysis, consider the mathematical pendulum shown in the figure:



Mathematical pendulum can be considered a ball of mass m , suspended from a thread of a certain length. Strictly speaking, the mathematical pendulum is a material point suspended on an inextensible weightless thread, making an oscillatory motion in the same vertical plane under the action of gravity.

If the pendulum is deflected at an angle α , then it will oscillate. Suppose he was rejected in position 1 and released: then he alternately passes position 2 (here his speed is maximum), then position 3 (here his speed is zero), and having changed the direction of motion he will pass position 2 again and then fall into position 1.

Thus, the pendulum will make one oscillation. We already know that if this oscillation is “recorded” in time, then we will get a sinusoid (if instead of a ball we take a vessel with sand that has a small hole). But, in this case, we are interested due to what, precisely the physical nature, oscillations of the pendulum occur, from where the pendulum “draws” energy of these oscillations. To do this, we will have to remember the law of conservation of energy, which states that energy in an isolated system is conserved.

If we consider position 1 as the beginning of oscillations, then in this position the pendulum at rest has potential energy $E = mgh$, where h is the height of position 1 compared to position 2, m is the mass of the ball, and g is the acceleration of free fall. And we especially note that the pendulum in position 1 has no other energy, that is, it is the total energy of the system. But, the situation will change if we release the pendulum: the ball of mass m rushes with increasing speed to position 2, and the potential energy of the pendulum will decrease and the kinetic energy of the pendulum $E = (mv^2)/2$ will increase. But, the sum of the potential and kinetic energy of the pendulum in any position will be equal to the potential energy in position 1, that is, the total energy of the pendulum does not change. When the ball reaches position 2, its kinetic energy will be

maximum, since the speed is maximum, and the potential energy will be zero. But since the energy is conserved, then in position 2 the kinetic energy will be equal to the potential energy in position 1. After the ball passes position 2 and rushes to position 3, its kinetic energy will decrease and the potential energy will increase, but their sum will also be equal to potential energy in position 1. And in position 3, the potential energy of the pendulum will be maximum, and the kinetic energy will be zero. After that the ball will rush to position 2 and everything will be repeated.

When making one full cycle, the pendulum successively passed through such positions:

position 1 - the beginning of the oscillation, the speed at the initial moment of time is zero, the potential energy is maximum, the total energy of the system is equal to the potential energy;

position 2 - the maximum speed, the maximum kinetic energy, the total energy of the system is equal to the kinetic energy;

position 3 - the speed is zero, the potential energy is maximum, the total energy of the system is equal to the potential energy;

position 2 - the maximum speed, the maximum kinetic energy, the total energy of the system is equal to the kinetic energy;

position 1 - the end of the 1st oscillation, the speed is zero, the potential energy is maximum, the total energy of the system is equal to the potential energy.

That is, with one oscillation, we have the following energy values for different positions:

position 1	$E_{pot} = \max = E_{full}$	$E_{kin} = 0;$
position 2	$E_{pot} = 0,$	$E_{kin} = \max = E_{full};$
position 3	$E_{pot} = \max = E_{full},$	$E_{kin} = 0;$
position 2	$E_{pot} = 0,$	$E_{kin} = \max = E_{full};$
position 1	$E_{pot} = \max = E_{full},$	$E_{kin} = 0.$

where E_{pot} is potential energy, E_{kin} is kinetic energy, E_{full} is the total energy of the system.

Note that the transition of potential energy into kinetic energy, and vice versa, when the pendulum oscillates, this is the “predator – prey” model. In the “predator - prey” model, as the number of predators increases, the number of prey drops. Further, the number of predators falls, as there are few “preys”, and then the number of victims increases again. But, in this model, the number of “predators” or “preys” never becomes zero, which is clear, because then the model would stop working (in the biological sense).

In the “kinetic energy - potential energy” model, when the pendulum oscillates, these two types of energy completely transform into each other. This is the difference from the “predator – prey” model, where this cannot be by definition. Also, the change in potential energy will exactly match the change in kinetic energy, which is theoretically necessary. But, in the “predator-prey” model,

changes in the number of “predators” should not be equal to changes in the number of “prey”, there will be a certain “delay” here, which is acceptable for biological systems.

If we continue the analysis of the pendulum (“predator - prey”), then it is easy to show that the oscillations will also be characteristic of economic systems. And this means that a wave description can be applied to economic systems. To do this, recall what potential energy is and what kinetic energy is in a physical sense.

In the general case, the potential energy is the “equilibrium energy” of some particles that interact with each other with the help of certain forces, and moreover, these particles do not move. That is, the potential energy is a kind of equilibrium energy, in the physical sense it is the interaction energy of particles, which are placed in a certain way and interact with each other.

Kinetic energy is the energy of moving particles. That is, it is the energy of changing the position of the particles, in fact, it is “non-equilibrium energy”, or “energy of changes”.

Thus, the potential energy is the “equilibrium energy” that determines the equilibrium of the system. Kinetic energy is “non-equilibrium energy”, which brings the system out of equilibrium, thereby generating certain system fluctuations.

If all of the above is applied to the economic system, then the wave description appears automatically. The economic system always strives for equilibrium, since it has a certain “equilibrium energy” (the desire of society for stability). However, some forces (internal, external), tend to bring it out of balance, because they have “non-equilibrium energy”. And then, the economic system goes into a non-equilibrium state, after that it again tends to equilibrium, and all this is repeated countless times.

Fluctuations “an equilibrium system - a nonequilibrium system” is a well-known “predator – prey” model or, in other words, a “potential energy – kinetic energy” model. Especially note that in the economic system there will always be forces that try to unbalance it, which will automatically lead to a wave-like development, and as a result to a wave (quantum) description. In the economic system there will be a transition of “non-equilibrium energy” (that is, the energy of innovative changes) into “equilibrium energy”. And this is equivalent to the transition of kinetic energy into potential in a mathematical pendulum, which is equivalent to the “predator - prey” model. From this it becomes obvious that economic waves should be described by the Lotka-Volterra equations, since the general, fundamental reasons for the formation of various cycles are absolutely the same: equilibrium - imbalance.

For an economic system that develops and grows, the “equilibrium energy”, the equilibrium position, is in fact the trend of this system. “Non-equilibrium energy” is the dynamic energy of an economic system, its energy of development.

A simple increase in the number of people due to natural fertility will already bring the economic system out of balance, since this will inevitably entail some redistribution of system resources. From its equilibrium, the reduction of the population of the planet due to wars, epidemics, natural disasters and many other factors will also bring it. Innovative entrepreneurship is the “nonequilibrium energy”, which also inevitably brings the economic systems out of balance. Innovations always eventually redistribute the resources of society, since after their introduction financial, labor, and other resources are transferred to more successful firms.

Based on the foregoing, a wavy description of any economic system appears inevitably, as a consequence of the wave development of society. But, since the forces that balance the economic system may be different, the fluctuations will be different. Therefore, it is important to know the forces that bring the system out of balance, to study their nature, and then the wave process can be accurately described. Strictly speaking, only two fundamental reasons can be distinguished in society, which will always bring the economic system out of balance, if we ignore external factors:

1. The development of science, innovation. There is a view of the development of natural sciences, social, humanitarian, economic, etc., that is, the receipt by society of any new knowledge and skills that are the basis of various innovations.
2. The change in the number of population, which always leads to a redistribution of the resources of society, that is, it brings society out of balance.

Before analyzing this issue, we will present the quantum theory of the development of science with which the quantum theory of the development of the economy and society automatically follows.

And before that, we note that oscillatory cycles of the “predator - prey” type are also observed in chemical systems. This logically follows from the fact that a sufficiently large statistical system can always be described using wave equations, since fluctuations inevitably arise in such a system, which in some cases lead to cyclic processes. Cyclic oscillations can be considered as time-stable fluctuations, which is clear from the very concept of a periodic process.

Cyclic oscillations in chemistry. Reaction Belousov-Zhabotinsky.

During the course of any chemical reaction, an enormous number of reacting molecules take part in it: 1 mol of a substance contains $6.022 \cdot 10^{23}$ molecules, therefore if at least several moles of chemical substances take part in the reaction, then the number of reacting particles will already be more than 10^{24} . A more statistically complex system is hard to imagine, but by weight it's only about 5 to 100 grams of a substance.

So, if we take one substance (a reaction product, or a system of chemical reactions) as a “predator”, then another substance (a reagent, or another system of chemical reactions) will be a typical “prey”.

From this fact, it inevitably follows that during the course of any chemically reversible reaction we must observe cyclic processes (cyclical changes in the concentration of substances, temperature, color and other characteristics), since the reverse reaction reagent can be considered as a kind of “inhibitor” of the direct reaction. But, it is necessary to clarify that such cyclic processes occur in chemical systems that are (still) far from the equilibrium state, and therefore thermodynamics does not impose any restrictions on the change in the concentration of substances, since the concentrations of substances have not yet reached an equilibrium value, and can take in principle, any values, these values can fluctuate in time. Indeed, I. Prigogine in 1955 showed that in an open system, near a stationary state far enough from chemical equilibrium, chemical oscillations are possible [18].

A. Lotka mathematically described the cyclic processes in chemical reactions by equations, which formed the basis of the well-known predator-prey model. First, A. Lotka described a model of a homogeneous chemical reaction with damped oscillations in the concentrations of reagents [19]. And later he described undamped oscillations [20].

In 1951, B. Belousov, when studying the oxidation of citric acid with potassium bromate during catalysis with cerium ions, revealed regular periodic oscillations in the color of the solution from colorless (the color of ions Ce^{3+}), to yellow (color of ions Ce^{4+}), and vice versa [21 - 25].

At the end of 1961, graduate student A. M. Zhabotinsky accepted the offer of his professor S. E. Shnoll to investigate the Belousov reaction. This is how A. M. Zhabotinsky himself tells about it:

“...The starting point of this work was the recipe:
potassium bromate - 0.2 g., cerium sulfate - 0.16 g., citric acid - 2 g., sulfuric acid (1: 3) - 2 ml., water to a total volume of 10 ml. The publication of Belousov [71] was known to me. As a result, for about six months of work, I received oscillations, using also malonic and malic acid as a reducing agent, and I conducted a preliminary study of the system with malonic acid.

It has been shown that oscillations in solution color are determined by variations in concentration Ce(IV) and free Br_2 did not appear in solution in any appreciable amounts. Parallel registration of oscillations of optical density and redox potential of the solution was carried out, the dependence of the oscillation frequency on temperature was measured and it was shown that during the recovery Ce(IV) an oxidation reaction inhibitor is produced Ce(III) . In the spring of 1962 the first version of the article was written ...” [26].

The complete mechanism of citric acid oxidation reaction with potassium bromate is a set of 80 elementary reactions and is a rather complex dynamic system [27]. Zhabotinsky's group conducted detailed studies of the reaction (explanation of the reaction mechanism), including its various

variants, and also compiled the first mathematical model. Further study of the reaction was expanded and refined (various dynamic modes were studied), but it is worth noting that the detailed mechanism is still unknown, especially reaction rate constants. Now the Belousov-Zhabotinsky reaction is a whole class of related chemical reactions, the Briggs-Rauscher reaction is a similar type of reaction [28].

After the discovery of the reaction of B. P. Belousov in 1951, his article was rejected several times by Soviet journals, and only 8 years later he was able to publish an abridged version of the work in a departmental collection published in small editions [21]. The publication was rejected because no one wanted to believe in chemical cycles that occur in homogeneous systems. And this is taking into account the fact that the work is experimental and small in volume !!! Here is a direct confirmation that the paradigm of human thinking decides everything! By that time, some chemical oscillations were already known, but this was explained by the fact that the reaction proceeded in a heterophasic system. And only after the systematic research of the group of A. Zhabotinsky it was unequivocally established: chemical vibrations occur in homogeneous systems, and indeed, in the course of the reaction, fluctuations in the concentrations of the reacting substances occur.

The study of chemical oscillations has a long history, since Robert Boyle observed periodic flashes during the oxidation of phosphorus vapors in the 17th century, and many researchers studied such periodic chemical processes in the following years [29–31, 25].

Quantum theory of the development of science.

We will consider science in the general case, but for analysis and demonstration we will use examples from physics and chemistry (for clarity and indication of important properties). To begin with, we divide science into three types, this is the standard and generally accepted division of science:

- 1) fundamental science;
- 2) applied science;
- 3) engineering science.

The division of science into these three types is due to the fact that these types of sciences have different strategic objectives and therefore use different time, economic, human, monetary and other resources. The most important is fundamental science, since it is precisely its discoveries that determine the development of both applied and engineering sciences for many decades to come (as will be shown later for 40 - 60 years).

Fundamental science is in the literal sense the foundation of the development of science and of society as a whole. It is fundamental science that defines the field of study of applied and

engineering sciences for many years to come, since discoveries in fundamental science bring society to a new quantum level of knowledge, which has very little in common with the previous level of knowledge. In order to more vividly present the quantum level of knowledge and the role of fundamental science, it is necessary to recall the situation in physics in the late 19th century, in the early 20th century.

Physical scientists of that time believed that practically all discoveries in physics were made and future generations would have to refine minor details. How paradoxical it sounds, but the physicists of that time were right. The fact is that the “field of knowledge”, which needed to be worked out and studied, and which was determined by fundamental discoveries made long before that, was actually completely studied, and there could already be no discoveries in it by definition (at this quantum level), what physicists said. But another “field of knowledge”, from another quantum level, could not be considered by scientists, since it was beyond the scope of their understanding, and most importantly, beyond their scientific worldview, which is formed on the basis of precisely fundamental laws.

The “field of knowledge” of the previous quantum level has already been worked out and for the transition to a new quantum level, it was precisely the fundamental discoveries in this area that were needed. The most difficult thing is that “new” fundamental discoveries cannot be made based on previous scientific experience, relying on a proven, but already “past” scientific worldview. Here we need an “explosive idea”, a theory that will explain some of the “insignificant” details of the holistic picture of the world, but which in its essence will be “alien”, non-logical, and absurd in the constructed building of science.

At the beginning of the 20th century, such breakthrough ideas (theories, hypotheses) in physics were E. Rutherford's discovery of the structure of the atom, M. Planck's hypothesis about energy quanta, N. Bohr's model of hydrogen, Louis de Broglie's hypothesis about matter waves, uncertainty principle V. Heisenberg, the principle of V. Pauli and other fundamental discoveries. It was these discoveries that did not correlate with the “past” paradigm of the scientific worldview, they were literally from a different quantum level, and they formed modern physics, that is, quantum mechanics, and most of the scientific discoveries were made on their basis in 20th century physics. Reflecting on the aforementioned discoveries, physicists, without realizing it (or realizing it), were already working on a new quantum-level physics, which was radically different from the previous one.

The main difference between these two levels of physics is the determination of the “old” quantum level and the non-determinism (fundamental) of the new quantum level. In other words, in the “old” physics founded by I. Newton and other physicists, if we have the necessary information

about a physical object at some point in time (speed, position, acting forces, etc.) then we will know for sure what will happen with this object at any time in the future. A good illustration of this is the calculation of the position of the planets (or comets) in the solar system, or the position of the satellite in orbit, or the position of the projectile fired from the cannon. This method of scientific worldview makes it possible to predict (unequivocally and accurately) the position of the planet in 100 years, in 200 years, or in 1000 years.

In the “new” physics, which studied atomic phenomena, it turned out to be fundamentally impossible. And, importantly, not due to the fact that we do not have the necessary information, but due to the fact that there is no such information in principle. Or, physical objects at the quantum level are such new qualities that can no longer be uniquely attributed to the concept of “corpuscle” or “wave”. For example, an electron behaves sometimes as a corpuscle, and sometimes as a typical wave. And the problem here is not that we don’t know something, it’s just that the electron is no longer corpuscle, and it can also be said that the electron is not a wave [32]. It is something new (new quality) that manifests itself in some phenomena as a corpuscle, and in others as a wave. Other elementary particles, atoms, molecules and other quantum objects behave similarly.

Hence the principle of uncertainty of V. Heisenberg follows: if an object can manifest itself as a wave, then it is impossible to speak unequivocally about its characteristics (coordinate, impulse, energy, etc.) at a certain point in time, since the wave is at a certain point in time (“exact”) does not have a “concentrated”, “exact” coordinate, momentum, energy, etc. As you can see, the wave description suggests some uncertainty in the coordinate, momentum and other characteristics. Strictly speaking, the non-determinism of the quantum world is a consequence of the fact that an elementary particle (quantum object), for example, an electron, is not a corpuscle, and not a wave, but a system of higher order. If the electron is not a “corpuscle” in a “pure form”, then it is clear that it cannot have a trajectory by definition. In reality, it is: an electron in an atom has no trajectory, and this is fundamentally and not disputable.

But it was precisely the non-determinism of knowledge about quantum phenomena that was the strongest barrier in the understanding and study of quantum processes. The “old” level of knowledge is not only the “old” laws of physics, or any other science, but also the same style of thinking, that is, deterministic, in this science. Moreover, this style of thinking, this scientific worldview, is transferred to other sciences, and to society as a whole. In fact, this is an algorithm of actions. And it is precisely this style of thinking of scientists of that time that turned out to be the greatest brake on the development of science. But it could not be otherwise, since the quantum level of the development of science implies not only the elaboration of a certain field of knowledge (based on fundamental discoveries), but also the formation of a certain type of thinking that relies

on the fundamental scientific concepts of its time. Naturally, the formed style of thinking of people, conditionally speaking “generations of people”, cannot be changed in an instant, it takes some time. For this reason, fundamental scientific discoveries very often meet with resistance among scientists and society as a whole. In order for a fundamental discovery to become generally accepted, time is needed, and since this discovery goes against the worldview of the “old” time, as a rule, only the new “scientific generation” includes it in its scientific paradigm. For this reason, one generation corresponds to the quantum level of civilization. The next generation, as a rule, is already developing at the next quantum level, etc., of course, if the previous generation has “worked” its quantum level (we have seen this for the last 200 years). If the “generation of scientists” does not have time to discover the “new” fundamental laws, then society will remain at the same quantum level, and for the next 40 - 60 years, society will again try to move to a higher level.

Fundamental discoveries are the most general laws of the new quantum level of science, using which you can logically construct all the other laws of science. The demonstration of what has been said can be classical mechanics, where using three Newton's laws, one can logically derive (as a consequence) the equations of motion of mechanical systems and conservation laws, that is, in fact, all classical mechanics. This is the essence of fundamental discoveries: they “initially contain” all the basic laws of their quantum level (in their field). In the future, scientists of these discoveries “extract”, that is, open, and on the basis of this new knowledge, applied and engineering, a new technological level is built.

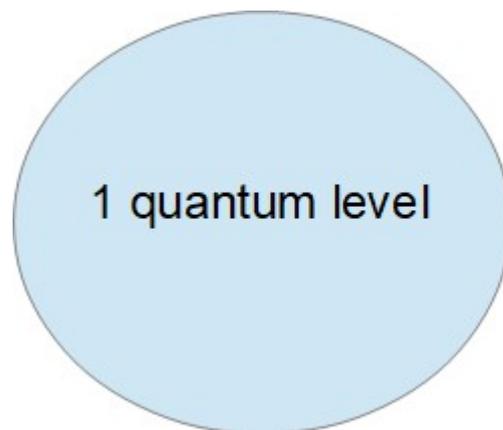
It should be noted that with the development of science, scientific concepts are “simplified”, become more visual and easy to understand. For a visual demonstration of what has been said, you can visually compare the trajectories of the planets of the solar system according to the Copernican theory (heliocentric system, the Sun in the center, the planets move in a circle), and the geocentric system (Earth in the center, the planets and the Suns move along very complex trajectories).

The fundamental scientific discoveries of the new quantum level will always be concentrated in time (20 - 30 years). This is explained by the fact that the fundamental discoveries are literally “new knowledge” from a new level, and they can be opened only when the previous quantum level has already been fully completed. Only in this case will be visible “holes” in the constructed building of science, its imperfection. And even one “breakthrough” discovery actually “cuts through” the window to another level, and other fundamental discoveries will follow an avalanche. Therefore, the time span over which most of the fundamental discoveries of the new level will be made will be short-term. And only after that, the explosive development of applied and engineering sciences will follow, which in time will lead society to a new technological order.

Building a new technological level, after the discovery of fundamental laws, takes time: the

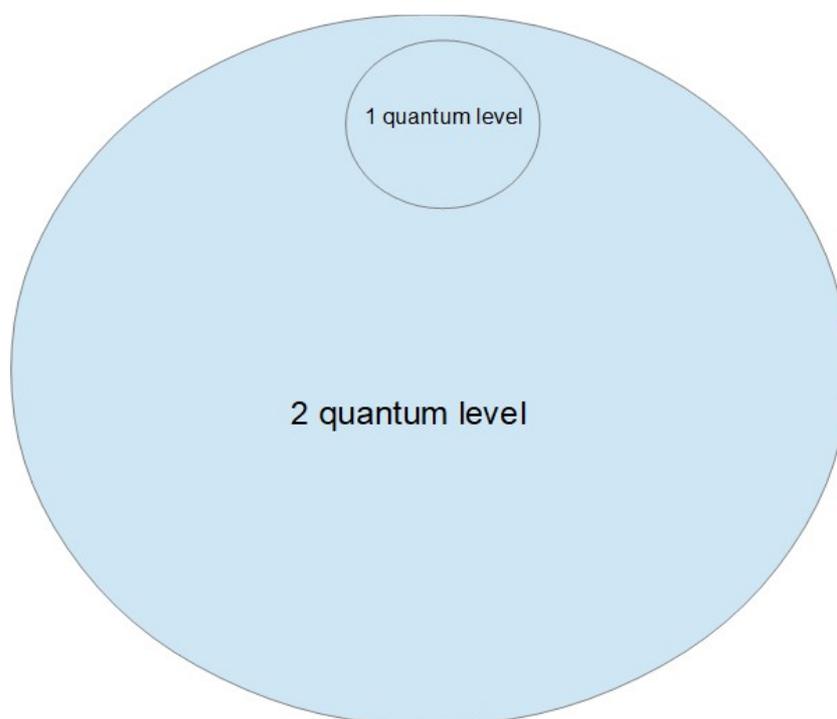
discovery of applied laws, the implementation of engineering solutions, the industrial production of products, etc. But the key ones here are the fundamental laws that are opened after the “development” of the previous quantum law. level and contain “the whole innovation impulse” of a new quantum level by definition. And on the basis of these fundamental laws, after their “elaboration” by society, the era of applied discoveries and engineering solutions begins. But, since the fundamental laws actually cause a shift in worldview, only the “new generation” “accepts” them, which both develops applied and engineering science and also builds its new technological structure of society. It is worth noting here that fundamental laws are discovered by scientists of all ages, as well as they develop science in general, and our use of the term “generation” is convenient in terms of classification and binding to a time period, which is inextricably linked to the duration of a person’s life.

After the foregoing, we can easily describe and clearly demonstrate the quantum theory of the development of science. We will depict the “field of knowledge” of a particular science, which the basic discoveries fool with the usual circle, as shown in the figure.



The circle that limits the “field of knowledge” of a given quantum level of science development is called the “knowledge front”. From the figure it is obvious that the larger the field of knowledge, the greater the front of knowledge. That is, the more we know, the more we will come into contact with a larger area of ignorance, and the more resources, scientists and time will be needed to work this area of knowledge.

After developing the field of knowledge of the quantum level, let's call it the 1st quantum level (when all the discoveries at this level have already been made and fundamental, and applied, and engineering), when solving “minor” inaccuracies in this picture of the world, there will always be “breakthrough” fundamental discoveries. “New” fundamental discoveries are knowledge from a higher level (let's call it quantum level 2), and they will draw a new area of knowledge of the next quantum level. Let us demonstrate what has been said by the drawing on which 1 and 2 quantum levels are depicted.



It is clearly seen from the figure that the knowledge area of 2 quantum levels is much larger than the knowledge area of 1 quantum level. Moreover, a higher level knowledge area (in our case 2 levels) includes a lower level knowledge area (1 level).

Since the next quantum level is much more, then scientists need more time, money and more scientists to work it out, because despite the generalization of scientific concepts in a particular field (this is always observed during the development of science), the scientific field will “specialize” , that is, further divided into new sciences in their field of activity. This can be demonstrated by the example of chemistry.

Chemistry has long been divided into inorganic chemistry, organic chemistry, physical chemistry, analytical chemistry, high-molecular chemistry, natural chemistry, etc. Moreover, interestingly, as science develops, theoretical concepts are always simplified (if viewed from general positions), but with intensive development, science itself is “divided” into other more specialized sciences, which from a slightly different “angle of view” consider the subject of this science. In organic chemistry, heterocyclic chemistry can be distinguished, which studies various heterocycles, for describing the actual material of which there will not be enough 100 volumes, and it is further intensively developed. Moreover, in the heterocyclic chemistry itself, pyrimidine chemistry, pyridine chemistry, imidazole chemistry, etc. can be distinguished, and there will be a lot of such specialized chemistry, and as their own fields of knowledge develop, they also increase, which requires an increase in human and financial resources.

Therefore, it is possible to make a general conclusion that as society and science develop, to

maintain sustainable development of science, and therefore the progress of society, it is necessary to increase the share of science funding and the share of people employed in it, since the field of science knowledge will inevitably increase. The number of sciences themselves will also increase, and if scientists cannot “work through” this area of knowledge, then there will be no question of any fundamental discoveries, which means there will not be a significant increase in progress, and as a result of comfort. And since it is the development of science that is the main reason for the development of society, if society does not have time to “work out” the field of science knowledge and discover the “new” fundamental laws of the next quantum level, the development of society will stop and can be reversed: there is simply no energy moving forward which science produces, there is no innovation impulse.

“Simplification” of theoretical concepts means that with the development of science at each subsequent quantum level, the foundation of theoretical knowledge becomes more accurate, more general, and as a result more simple. We can recall Newton's three laws in physics or the development of concepts about acids and bases in chemistry, but there are similar examples in every science.

In the end, we note that fundamental discoveries need to be understood more broadly than just scientific discoveries: this applies to the humanities, social sciences, the structure of society, culture, ethics, morality, and religion, etc. That is, the fundamental discoveries should be understood as the basic laws and basic principles (nature, society, morality, economy, etc.), on the basis of which the rest of the variety of human knowledge, skills and relationships is formed.

Quantum theory of the development of economic and society.

The quantum theory of the development of the economy and society logically follows from the quantum theory of the development of science: naturally, the quantum level of development of science inevitably leads us to the quantum level of development of society, which is characterized by a certain technological order.

Moreover, the wave description of the development of society and the economy inevitably follows from the quantum description of society, which is in fact the theoretical rationale for N. D. Kondratiev's long economic cycles (waves) [6, 8-14]. This follows from the fact that the quantum theory of the development of science and society, by definition, is a “nonequilibrium theory”, from which N. D. Kondratiev’s long economic waves automatically follow. It is worth noting that the wave description has been known in the economic literature for almost 100 years [2-5, 7], and the long waves of N. D. Kondratiev have been intensively studied by many scientists in the last 30 – 40

years [33]. But, for theoretical substantiation, it was necessary to explain the nature of the “disequilibrium of the economic system”, and if we consider more specifically, it was necessary to explain the uneven development of science, namely the “explosive” periods of fundamental discoveries. From the quantum theory of the development of science, “explosive periods of discovery” follow logically, and they are due to the discovery of new fundamental laws of the already “new” quantum level. “Explosive” periods of discoveries cannot be “stretched in time”, since after one “breakthrough” discovery, others will follow an avalanche. Since the number of fundamental discoveries of a given quantum level is limited, a limited time interval will follow when most of these discoveries are made. That is, fundamental discoveries, most of them, will always be made in a rather limited time interval. And only after some “assimilation” of them by applied and engineering sciences there will follow “an explosion of new technologies”, which will also be limited in time, and which occurs at the beginning of each Kondratiev cycle and is the impulse that “gives rise” to Kondratiev's wave. From the above, N. D. Kondratiev's long cycles follow automatically: a non-equilibrium development of science inevitably “gives rise” to N. D. Kondratiev's waves, which has been shown by numerous works starting with J. A. Schumpeter's innovations and ending with the technological order of modern scientists [34, p. 192-193].

It should be added that any non-equilibrium processes in society “give birth” to Kondratiev's long cycles: that is, a change in population, productivity, capital, and any other macroeconomic characteristics of society will lead to Kondratiev's wave. Changes in these characteristics (increase or decrease) can be caused by wars, epidemics, high or low social development, cultural traditions, the influence of invaders, colonial dependence, etc., but in essence, all these changes can be described by the “predator – prey” model. But, as society develops, when science becomes a necessary condition for this development, in fact, after the formation and “maturing” of science, economic processes will always have a wave-like character, and will be described by waves (or cycles) by N. D. Kondratiev. This is due to the specifics of the development of fundamental science, more precisely, its “explosive periods”, and such cycles will always be 40 to 60 years long, as N. D. Kondratiev pointed out.

The constant, or rather minimal, Kondratiev wavelength is due to the length of human life, because the paradigm of society's thinking changes fundamentally only when the “new generation” “absorbs” this new paradigm from its birth, with its first sigh. But it may happen that scientists will not make new fundamental discoveries (of a new level), for example, they simply do not have time, or a new generation of people will remain with the “old” thinking paradigm, and then Kondratiev's wave will double (provided that there are no other non-equilibrium processes). The maximum wavelength of Kondratiev is not limited by anything, and therefore it can be 100 years, 1000 years,

and 2000 years. Such long Kondratiev waves undoubtedly existed in the pre-scientific period of the development of society, that is, before capitalism. It is clear that if we look at the history of mankind over the past 5000 years, then as society (and science) developed, Kondratiev's wavelength decreased approximately like this (length is taken conventionally for demonstration): 2000 years, 1000 years, 700 years, 400 years, 200 years, 100 years, and finally, under capitalism and scientific and technical progress, 50 years. Different wavelengths in the ancient world were due to various non-equilibrium processes in society as well as the slow development of science, and their "true" length can be calculated by studying the corresponding historical interval.

As well as macroeconomic non-equilibrium processes "give rise" to Kondratiev's macro-waves (50 years), and medium-term economic non-equilibrium processes "give rise" to Kuznets's medium-term waves (15 - 25 years) [34], and Juglier (7 - 11 years) [35] and microeconomic nonequilibrium processes "give birth" to Kitchin's microwave (3 - 4 years) [36]. But, it is necessary to understand the difference between Kondratiev's macro waves and other economic waves: Kondratiev's macroeconomic waves express the "averaging" of the whole "complexity" of the macroeconomic system as a whole, and therefore, express the fundamental properties of the development of society and science.

The macroeconomic system is unusually complex, but "averaging" of its fundamental parameters over a period of 40 - 60 years will inevitably lead us to Kondratiev waves. The very complexity of the macro-economic system, as well as the period of vigorous activity of one generation of people (40 - 60 years), are a guarantee of reproducibility and loyalty to the theory of the wave development of society. Moreover, the more complex the economic system will be, the more clearly and unambiguously Kondratiev waves will manifest, since the "system complexity" parameter plays a decisive role. Therefore, during the transition from the economic systems of individual states to the economic systems of the regions, or to the global economy, Kondratiev's waves will appear more accurately and clearly. Since they are essentially civilizational economic waves and "carry", and "contain", the most general and averaged information about the economic development of mankind. But, the world economy will only be described by Kondratiev waves, when individual states in it will be "separate organs" and the world economy will be a single organism. If individual states do not agree to develop, but will be separate "independent islands", then no wave description will succeed, since the Kondratiev wave describes the development of a single "economic organism". Then the "external" wave will "carry" on itself such a state, and the economic wave, which it itself generates, has too low an intensity to significantly affect the global economy.

Obviously, the cause of the Kondratiev waves should be the most general and fundamental,

which, as we know and is in fact, is the development of basic science. The reason for the Kuznets medium-term waves, respectively, will be the development of applied and engineering science. In science, only once in 40 - 60 years, truly fundamental discoveries can occur, which are the cause of the Kondratiev waves. After the “explosive” period of fundamental discoveries, there will be a period (15 – 25 years) of their “assimilation” by applied and engineering science, which will lead to a massive renewal of basic technologies [37], and therefore Kuznets’s cycles are infrastructure (technological) cycles. Juggler’s medium-term waves (7 – 11 years old) are “born” by the development of engineering science as an independent field, which is actively developed after “assimilation” of fundamental discoveries by applied science: positive results of applied research require engineering solutions. Naturally, the Juggler cycles (7 – 11 years), by definition, will be “included” and in a certain way aligned with the Kuznets cycles (15 – 25 years). Also note that the Kitchin micro-waves are caused by various non-equilibrium processes occurring at the level of individual firms.

It is interesting to note that by analyzing the length of various business cycles, we can determine the full development cycle of fundamental, applied and engineering science:

- 1) fundamental science 40 - 60 years;
- 2) applied science 15 - 25 years;
- 3) engineering science 7 - 11 years.

But, it is worth noting that these numbers are a full cycle. Therefore, at the maximum of the cycle (that is, at the half-wave), we will already have tangible scientific results, and therefore the temporary “return interval” of scientific research will be two times smaller. This is important when planning the expected results of scientific activity.

Engineering sciences will be able to give a return, to get a result, in 4 - 6 years already (unforgettable about a semi-wave). Applied research will bring significant results only after 8 - 13 years. A scientific results in basic science will be able to appear only after 20 - 30 years. But, it should not be forgotten that the cause of the development of applied and engineering research is precisely the fundamental science. These values are confirmed by the number of years that applicants of scientific degrees spend on work on the dissertation: no matter how long postgraduate studies last, normal PhD work is done in approximately 7 to 8 years (I mean applied research). Work can be done in 4 – 5 years, but this is only when the scientific theme is “developed”, and then the work becomes “a matter of technology”, that is, it actually goes into the category of “engineering sciences”.

In the further reasoning, we briefly describe N. D. Kondrat'ev’s waves using the quantum theory of the development of science, economics and society. For this, we will rely on the research

of N. D. Kondratiev and J. A. Schumpeter. The studies of N. D. Kondratiev and J. A. Schumpeter complement each other so harmoniously, and so logically explain the essence of the theory of quantum development, that later in the text we will often quote their quotes for a complete and exhaustive explanation of the important moments of the quantum theory of development.

Heisenberg uncertainty principle and social phenomena.

Developing N. D. Kondratiev's thoughts on predictions in economic systems, we can apply Heisenberg's uncertainty principle to economic and social phenomena, and we will see that predictions have numerical limitations that also logically flow from Kondratiev waves.

If we consider the development of the economy (with quantum levels), then this situation is reminiscent of the Bohr model of the hydrogen atom with energy quantum levels. In the Bohr model of the atom, in order for the electron to transfer from the first level ($n = 1$) to the second energy level ($n = 2$), it needs to obtain additional energy ΔE ($\Delta E = h * \gamma$). Similarly, in the quantum theory of development, in order to move to a higher quantum level, it is necessary to obtain "additional innovative energy", which is "contained" in fundamental discoveries. Also in the Bohr model, the electron on the first and on the second energy level does not have a trajectory of motion; therefore, it is impossible to specify the path of transition from the 1st energy level to the 2nd level. This is very important and fundamental, and it is the absence of a trajectory that indicates the non-determinism of quantum phenomena.

The absence of a trajectory is also present in the quantum theory of the development of society, where it can be called "the absence of a trajectory of development". And it manifests itself in the fact that it is impossible to accurately indicate the moment of transition from one quantum level of development to another. This is a consequence of the principle of uncertainty of the development of society, which is the actual manifestation of the principle of uncertainty of Heisenberg at the level of society, so to speak. This principle of developmental uncertainty, as we shall see later, prohibits predicting social phenomena, which are essentially "social development fluctuations", to accurately indicate the time frame of the quantum level (when society is at a given quantum level), since the development trend can be mistaken fluctuation.

The principle of uncertainty in the development of society explains why only in the future, by studying economic and social phenomena, can we distinguish (in physics this is called "measurement") the quantum levels of development. Being in the "thick of social phenomena", in "developmental fluctuations", living at a certain quantum level, it is fundamentally impossible to do this. Moreover, if we had studied and predicted a social phenomenon, or some event, it would have already influenced the development of society, and this phenomenon would not have taken place.

For example, studying the development of society has led us to the fact that the specific technology “A” will develop very intensively, and it will be the basis of development for the next 20 - 30 years, and it is with this that you can make good money and become leaders. But the very prediction changes the “future”: since the majority of entrepreneurs will start to invest in technology “A”, this direction will be very competitive, and therefore it will not be possible to make much money, which means after a while “money will go” to a more favorable technology “B”, which will determine the development of society for the next 20 – 30 years. As we see, our prediction did not come true, since the prediction itself changed the “trajectory” of the development of society. This phenomenon is well known in quantum mechanics: when the measurement itself changes the properties of a micro-object. In our case, the “dimension” was a prediction about the prospects of technology “A”, which also changed the way of development of society. The “development trajectory” of society will always be uncertain, and this is fundamentally: we can only predict social phenomena with some probability, and no one can ever accurately and unequivocally indicate. But, we can indicate the maximum probability of such predictions, and as will be shown below, it will be small.

Let us show how the Heisenberg uncertainty principle can be applied to social phenomena. To do this, we write down the principle of uncertainty in the form convenient for the study of economic and social phenomena:

$$\Delta p * \Delta t \leq h/2$$

where Δp — probability of an event,

Δt — the event prediction period,

h — is a numerical value ($h = 100$), which has the dimension [years * %], and the value of which strictly follows from Kondratiev's wavelength (50 years).

All social phenomena that can be predicted in any way are “inside” the Kondratiev wave. Off-wave predictions are meaningless by definition. Kondratiev's wavelength is 50 years, so $h = 100$ ($h/2 = 50$, $h = 100$). Considering the fact that the probability of an event cannot be more than 100 %, we have to accept the minimum time interval for forecasting for 0.5 years, which is logical, because firms plan their budget for 1 year. Then, we get the formula

$$\Delta p * \Delta t \leq h/2$$

which, when taking into account the value of h , goes into a numerical form

$$\Delta p * \Delta t \leq 50 \text{ [years * \%]}$$

We point out once again that the time interval for this formula is 0.5 to 50 years.

From this formula, it is obvious that it does not make sense to talk about forecasts of a longer period than 50 years, due to the fact that this will be another Kondratiev cycle (another quantum level of development), and therefore, the probability of the predicted event will be

insignificant. We give the maximum probability of social predictions, depending on the period of time based on the formula:

$\Delta t = 0.5$ years,	$\Delta p \leq 100$ %
$\Delta t = 1$ year,	$\Delta p \leq 50$ %
$\Delta t = 2$ years,	$\Delta p \leq 25$ %
$\Delta t = 3$ years,	$\Delta p \leq 16.67$ %
$\Delta t = 4$ years,	$\Delta p \leq 12.5$ %
$\Delta t = 5$ years,	$\Delta p \leq 10$ %
$\Delta t = 10$ years,	$\Delta p \leq 5$ %
$\Delta t = 15$ years,	$\Delta p \leq 3.33$ %
$\Delta t = 20$ years,	$\Delta p \leq 2.5$ %
$\Delta t = 25$ years,	$\Delta p \leq 2$ %
$\Delta t = 40$ years,	$\Delta p \leq 1.25$ %
$\Delta t = 50$ years,	$\Delta p \leq 1$ %

These are the maximum values of the probabilities of events, which mean that no prediction in society can have a greater probability of realization than is obtained from this formula. For example, for a time interval of 5 years, the probability of a predicted event cannot be more than 10 %, for a 2 year interval 25 %, and for a 25 year interval 2 %.

We note once again that the percentages we received are maximal, and for any predictions, for all social phenomena, can no longer be by definition. Smaller may be, bigger never. That is, in social phenomena, as in physical ones (the “long-range effect” effect), everything is decided at the present moment, from which it follows that there is essentially no future. It, the future, appears only from our actions and the efforts we have taken at the moment. There is no ready, “frozen” future, to which we “swim up” (as it is portrayed in science fiction films). This logically brings us to the idea that perhaps time is an exclusively human category, and therefore, time exists only in our consciousness, in our brain. But real, “physical” time does not exist. But, there is a mathematical abstraction “time”, which is well applicable to some physical phenomena, but not to all.

If we accept that time (more precisely, the “arrow of time”) does not exist, then the uncertainty of quantum phenomena, as well as the effect of “long-range action”, follow from this assumption strictly and logically. If there is no time, more precisely, the “arrow of time”, then there is no law of causality, and therefore, uncertainty appears at the most fundamental level. And the fact that we feel time in our world should not mislead us, since our world is not fundamental. And therefore, our “human time” that flows from point t_1 to point t_2 may be some kind of “averaging of the processes” taking place at a fundamental level, or it may even be an illusion created by our

brain. Obviously, the non-existence of time (“arrows of time”) at the fundamental level (at the micro level) is a rather successful assumption.

But, it is worth noting that the non-existence of the “time arrow” at the fundamental level has nothing to do with the duration of the flow of various physical processes at the quantum level. Naturally, various processes at the quantum level have a certain duration, the value of which depends on the reference system in which the observer is located, and which fixes the duration of the process. Developing this idea further, it is possible to show how the “arrow of time” “forms”. Assume that at the micro level we observe a periodic process (a certain oscillation) with a certain period of the cycle. Further, in the 1st reference frame we will “see” the T_1 period, in the 2nd reference frame we will see the T_2 period, in the n th reference frame we will see the T_n period. Now let's imagine the human perception of time, that is, the “arrow of time”, as a certain function, or a certain operator that in a certain way “transforms and averages” all the presented time periods from T_1 to T_n , and at the output we get the “arrow of time”, there is a flow of time in one direction from point A to point B. This can be represented by the formula:

$$\text{“Arrow of time” or } T \rightarrow = F [\forall (T_1, T_2, T_3, \dots T_n) * K (k_1, k_2, \dots k_n)]$$

where the function K (or operator) displays the number of periodic processes occurring at a fundamental level.

Note also that various reference systems (from the 1-st to the n -th) and the periodic processes themselves (from k_1 to k_n), with “averaging and transforming”, can oscillate themselves with a certain frequency and according to a certain law.

It can be seen from the formula that human perception of time (“the arrow of time”) is “averaging and transforming” the duration of many periodic processes occurring at a fundamental level. That is, our, “human time converter” sees the evolution of the Universe in this way, that is, in a human way. And if we reconfigure it, we will see a completely different evolution of the Universe, and a completely different Universe. And there is no contradiction here, since there are no “arrows of time” at the fundamental level, but the duration of certain cyclical processes. Consequently, the “transformation and averaging” of such processes can be many. And therefore, you can get a virtually infinite number of different “arrows of time” for our Universe (fundamental), similar to our “human arrow of time” (and different from it).

The hypothesis that the “arrows of time” does not exist is also confirmed by the A. Einstein's STR, since the duration of any processes in the STR depends on the reference system and can be literally any (from 0 to ∞). In addition, if the time interval has a beginning at point A and an end at point B (or we conditionally select such an interval), then strictly speaking, the beginning and the end of Einstein's STR can be swapped, and this only depends on the choice of reference system

(here again the law of causality is violated). Therefore, everything indicates that at the fundamental level the “arrows of time” do not exist. That is, there is no flow of time from the past to the future, thus time “flows” only in our brain, in our consciousness. And there is only the duration of certain cyclic processes at the quantum level. Note that if these processes were not periodic, this would indicate the existence of an “arrow of time” and the appearance of causality at the quantum level, and this is not so — the quantum world is probabilistic and this is an indisputable fact.

The “arrow of time” is formed by our perception as a certain averaging of an infinite number of fundamental processes. This is how our human view of the Universe and its evolution is formed. In fact, if we assume the existence of another “reasonable time transformer” (different from our human one), then this will create a different Universe and a completely different evolution of that Universe. It is remarkable that at the fundamental level the physical world is one, and when “averaging and transforming” processes depending on the “time converter”, we can get an infinite number of different universes and their different history.

Let us return again to the consideration of social phenomena. Both at the fundamental level and at the social level, the world is probabilistic. The world of social phenomena is very changeable, which greatly limits the prediction of certain events in the life of society. This can be confirmed by quoting N. D. Kondratiev:

“... The more distant from us in time the predicted event, the, as a rule, foresight becomes less possible and reliable. ... the world of social phenomena differs from the world of nature apart from everything else in that it is more volatile. It is subject to change under the influence of not only the internal conditions, but also the entire totality of the surrounding biologically and cosmic factors, the laws of which influence on social life, in principle, we do not know. This world appears to be less autonomous in its existence and development than nature” [14, pp. 394-395]. The quote from N. D. Kondratiev actually retells the thought of V. Heisenberg on understanding the causality of events in quantum mechanics:

“... in a strong formulation of the law of causality: “... if you know the present precisely, you can predict the future”, the premise is wrong, not the conclusion. In principle, we cannot recognize the present in all details ... Since the statistical nature of quantum theory is very closely related to the inaccuracy of all perceptions, one could be tempted by the assumption that there is another “true” world behind the perceived statistical world in which the law of causality . Such speculations seem to us - and we specifically emphasize this - fruitless and meaningless. Physics should give a formal description of only the connections between perceptions” [38].

These quotes once again vividly demonstrate the similarity of quantum and social phenomena, and their probabilistic nature, which confirms the legitimacy of applying the Heisenberg uncertainty

principle to social phenomena, and indicates the unity of the laws of nature and society.

Waves of N. D. Kondratiev and social phenomena.

Social phenomena can be considered as social fluctuations, like quantum fluctuations, and only stable social fluctuations will tangibly influence society. Based on Kondratiev's wavelength, which is 50 years, we can estimate the magnitude of the maximum social fluctuations over time. Since Kondratiev's wavelength varies from 40 to 60 years, it can be assumed that it is precisely social fluctuations that are the cause of the change in wavelength. Then we can conclude that social fluctuations have a maximum value of no more than 10 years. That is, only those phenomena and events that continue (or their impact continues) in society for at least 10 years and therefore are not social fluctuations will be significant for society. Social phenomena that have lasted less than 10 years, or more precisely, whose effects on society last less than 10 years, may simply be social fluctuations that will disappear without a trace and will not significantly affect the development of society.

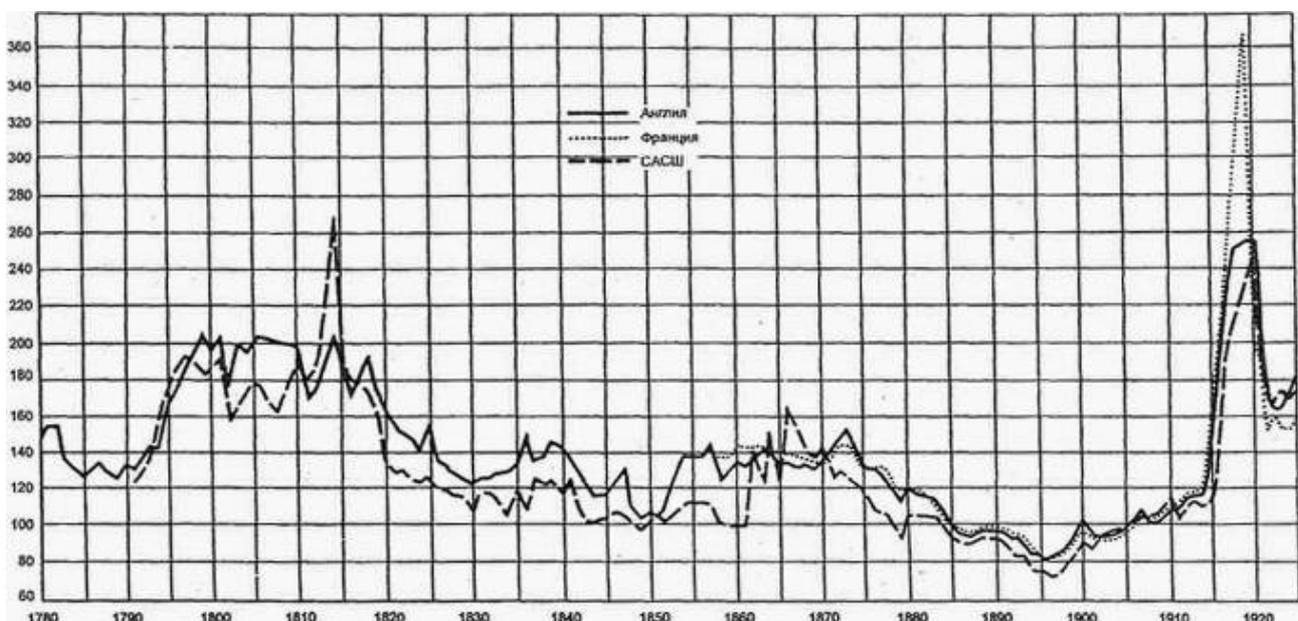
Proceeding from the description, social life can be represented as social fluctuations that disappear and appear, destroy each other and reinforce each other. The length of such fluctuations ranges from several days to 10 years. And only some of the fluctuations are fixed, become stable, are amplified from other fluctuations and phenomena, and then pass into sustainable trends in the development of society, which significantly affect its development vector. In such a description, society is a social boiling broth from an innumerable number of social phenomena (fluctuations), which very much resembles the idea of modern physics about the vacuum, which is also a boiling bouillon of antiparticle particles at their birth-annihilation.

N. D. Kondratiev determines the length of a large economic cycle of 50 years [14, p. 238]. Moreover, he clearly indicates that "... a theoretical curve can be matched by real general evolutionary trends in economic development ... the question of the nature of a theoretical curve is subject to further development" [14, p. 256].

Economic waves Kondratiev describe the economy as a whole. The driving force of the economy is entrepreneurs, whose life expectancy is on average 70 - 75 years. From here, it is logically possible to derive the length of the Kondratiev wave. A person grows up, gets education, life experience, entrepreneurial experience and, therefore, he will be ready for successful entrepreneurship not earlier than at the age of 30 - 40 years. That is, he has about 20 – 30 years of active and successful business activity ($30 + 30 = 60$, and $40 + 30 = 70$). Therefore, 20 - 30 years is the peak of a wave, that is, a semi-wave, since a person for more than 20 - 30 years will not be able

to physically actively and successfully (!) engage in entrepreneurial, or for example, scientific activity. It means precisely productive activities that greatly change the vector of development of the whole society. The second half-wave is formed by direct young students or colleagues of an entrepreneur (or a scientist), who have assimilated the spirit and the very philosophy of a successful entrepreneur (or a scientist), and who will be able to bring his ideas to life with him for another 20 - 30 years or alone.

N. D. Kondratiev builded his cycles on the basis of changes in parameters from time to time. As parameters, it uses commodity prices, interest on capital, wages, foreign trade, coal mining and consumption, production of iron and lead [14, pp. 257-272]. Here is an example of such a schedule given by N. D. Kondratyev for the commodity prices of England, France and the USA for the period from 1780 to 1925 [14, p. 257].



As can be seen from the graph, one can clearly distinguish the cycles of 1790 - 1850 and 1850 - 1900 years. The empirical deviations from the ideal wave that we see on the graph are our social fluctuations, many of which, as we see, are erroneous.

The fact that Kondratiev's economic cycles are caused by scientific discoveries (first fundamental, then applied and engineering) is indicated by his following quotation: "... For about two decades before the beginning of the upward wave of a large cycle, there has been a revival in the field of technical inventions. Before the beginning and at the very beginning of the upward wave, there is a wide application of these inventions in the field of industrial practice related to the reorganization of production relations. The beginning of large cycles usually coincides with the expansion of the orbit of world economic relations" [14, p. 275]. This is the birth of a new quantum

level in the “depths” of the old quantum level. From the quotation it clearly follows that technical inventions appear at the end of the cycle, and when they are already beginning to be used in industry and change world economic relations, this will mark the beginning of a new cycle, or, equivalently, a transition to a new quantum level.

Moreover, “... the material basis of large cycles is the wear, change and expansion of the main capital goods, which require a long time and high costs for their production. The change and expansion of the fund of these benefits does not go smoothly, but shocks, another expression of which is the big waves of the conjuncture. The period of enhanced construction of these basic capital goods is a period of recovery, a period of deviation of the real level of economic elements upward from the existing level of equilibrium ... the upward wave of a large cycle is associated with the renewal and expansion of the basic capital goods, with radical changes and the over-division of the main productive forces of society ” [14, pp. 285-286]. That is, the material basis of large cycles is the exhaustion of the previous quantum level of the economy, when there is nowhere to grow, and the use of the potential of the new quantum level, which begins to unfold on the basis of new fundamental discoveries.

N. D. Kondratiev also points out that “periods of upward waves are rich in major social upheavals” [14, p. 275]. This is explained by the fact that when moving to a new quantum level, the very structure of the world structure changes, the “leaders” and “outsiders” change on a global scale (science, industry, politics, the army). And new leaders in their new world sometimes have an evolutionary position, but more often with the help of wars and various economic cataclysms, since former leaders peacefully leave very rarely.

The idea that each Kondratiev wave corresponds to a certain technological level of production, now called “technological order”, comes from N. D. Kondratiev and J. A. Schumpeter, and at the moment it is very well developed by a number of economists [33, p. 192-193]. Kondratiev waves, which logically lead us to an understanding of the quantum level (wave description = quantum description), are most correctly interpreted as integral waves of the economy, which reflect the general economic situation. By a conjuncture, we will understand, like Kondratiev himself, a certain integral indicator of economic activity, one can say the direction and degree of change of the set of economic characteristics [14, pp. 4-5].

It is such integral (theoretical) waves that lead us to a new technological order. But there is one nuance: N. D. Kondratiev himself used various values for the analysis: prices for goods, wages, foreign trade, pig iron, etc. That is, it is obvious that in the same period you can find the infinite the number of different economic waves that show the dependence of a particular parameter on time (prices, wages, etc.). Therefore, the wave itself does not play a special role, there may be thousands

of them, it just clearly demonstrates the wave development of the economy. Much more important is the integral, theoretical wave, which logically leads us to the concept of “quantum level of development of society”.

As we already know, at the new quantum level, it is important not only its technological content (“technological order”), but also the paradigm of people's thinking, the structure of their social institutions, ethical and moral norms, religion and other basic for the people of the edge of their social life. It is the principles of thinking, moral norms, the social structure of society that irreversibly affect the discovery of fundamental laws in science. It can even be argued that the discovery of the fundamental laws of nature by a particular person is in fact a projection of his (scientist) scientific world view and view of the world, on a certain aspect of nature. Hence, it is obvious that the worldview of a scientist will be influenced by education, family relations, moral norms of society, and social structure, that is, the whole immense spectrum of human relations. Depending on these relations, the worldview of a particular physicist or chemist will be formed, and it is this worldview that will “crystallize” the fundamental law of nature in a certain form, which this person will “write down”.

Therefore, as society develops, the worldview of people will inevitably change, which means both a new world view and the constant discovery of new laws of nature (“new world view” = “new law” of nature). People will never have “eternal books”, “eternal knowledge” or “eternal theories”, as the human worldview will change constantly, which means all laws of nature will be revised and rewritten beyond recognition. So we come to the conclusion that the humanitarian aspect of a person is no less important than the technological structure: one can say that it is the humanitarian aspect of a person that determines the form of the technological mode of life at a certain quantum level of development.

It should be emphasized: the quantum level of the development of society includes all aspects of human relations, both in the production sphere and in the humanitarian sphere. And there are no major and minor relations, because everything affects the human worldview: the technological level of society, its humanitarian, moral, ethical and other attitudes. Certain quantum level of the development of society is the quintessence of all sorts of interactions as economic waves, and humanitarian and worldview waves of society. And the technological structure here is only a part, and not decisive, since it is the paradigms of people's behavior that determine the vector of development of society, or the vector of its fall and the cessation of the existence of society as a civilization, and possibly physical destruction. Unfortunately, history knows many examples of the “gratuitous” disappearance of certain civilizations or cultures, but the causes of such disappearances are always the same: the destructive use of their quantum level resources, the degradation of the

scientific and humanitarian spheres of society, and as a result the collapse of civilization.

Now we will demonstrate that Kondratiev waves can be very much. Let us define the Kondratiev waves by the example of the development of physics from 1790 to our time. If we take into account the main types of energy used and the main discoveries in physics, and their influence on physics, then we can distinguish such cycles (waves) of 50 years:

- 1) The first cycle, mechanical, 1790 — 1840 years.
- 2) The second cycle, steam, 1840 — 1890 years.
- 3) The third cycle, electric, 1890 — 1940 years.
- 4) The fourth cycle, atomic, 1940 — 1990 years.
- 5) The fifth cycle, information, 1990 — 2040 years.
- 6) ? The sixth cycle, ?Quantum, ?2040 — 2090 years.
- 7) ? 2090 — 2140 years.

As we see, in each cycle there is a certain, predominant type of energy, which basically determines the development of society and its technological developments in a given period of time. Note that Leslie White also considered the amount of energy used by society as the cause of the development of society and culture [39].

Such cycles (or waves) for different aspects of the whole life can be defined infinitely many, some of them will be matched with Kondratiev's integral wave, others will be in antiphase to it, others will have a certain phase shift, but what is important is that they will all be included in the quantum level of development of society, and all cycles will reflect a certain pattern in the development of a particular characteristic of society.

From these periods we can conclude that now, in 2019, the information cycle is at a “maximum”, and therefore, there will be a decline in the development of information technologies (in terms of speed, since the introduction into the social sphere and similar fields may be new breakthroughs like Facebook). Now, the physical speed limit of computers has actually been reached with these production technologies of processors, and therefore no super-fast computers are out of the question, which is confirmed by the above mentioned periodization. If we are now at the point of maximum information cycle, then further 20 years will be its decline, which means that practically applicable new technologies (fundamentally new, including quantum ones) will appear. Superfast computers can appear only when there is a fundamental theoretical “breakthrough discovery”, and only after such an discovery, after some time, will practically practical technological solutions appear. Based on the above, we can forget, for at least 20 years, about quantum computers (their practical implementation), since there have not yet been any fundamental breakthrough discoveries in this area. And only after them, in 5-10-15 years, industrial

technological solutions that are significant for society can appear. As we see from this periodization and our predictions, Kondratiev cycles can be useful both for the primary analysis and for some prediction of the trend of society.

But, it must be remembered that this is just a prediction, even if it is based on Kondratiev's cycles, and therefore there is always uncertainty about Heisenberg for society. According to the principle of uncertainty of social phenomena, the probability of a predicted event cannot be more than 2.5 % (for 20 years). Therefore, it is necessary to relate to the forecasts very carefully, since real life is complex and unpredictable, which reflects the principle of uncertainty of social phenomena.

We present the calculations of the probability of events according to this principle for 5, 10, 15 and 20 years.

The calculation will be carried out according to the above formula:

$$\Delta p * \Delta t \leq h/2 \text{ или } \Delta p * \Delta t \leq 50$$

where Δp — event probability,

Δt — event prediction period,

$$\Delta t = 5 \text{ years, } \Delta p \leq 10 \%$$

$$\Delta t = 10 \text{ years, } \Delta p \leq 5 \%$$

$$\Delta t = 15 \text{ years, } \Delta p \leq 3.33 \%$$

$$\Delta t = 20 \text{ years, } \Delta p \leq 2.5 \%$$

And once again we are convinced that the world has a probabilistic interpretation not only in quantum mechanics, but also in public life. These percentages for the period from 5 to 20 years indicate the complete uncertainty of the development of our future, since the probability of our predictions for the information cycle is extremely small and amounts to 2.5 % (for 20 years). Obviously, the real world is probabilistic in its essence, like quantum mechanics, and quantum development theory predicts only changes in society that will have either a development vector or a degradation vector. This “vector of change” depends only on people living in society, on its most active individuals, those whom J. A. Schumpeter called entrepreneurs-innovators.

J. A. Schumpeter and the quantum theory of development.

If we use the quantum theory of development, then innovative entrepreneurs are those entrepreneurs who are introducing the scientific developments of a new quantum level into society. And therefore, “... entrepreneurs (Unternehmer), we call economic entities whose function is just the implementation of new combinations and which act as its active element ... this or that person is in principle an entrepreneur only if it “implements a new combination” - it ceases to be such when the “business” established by it begins to function further within the framework of the circuit - and

therefore, an entrepreneur who has remained so for decades is as rare as a businessman who never had never been even a little entrepreneur” [40]. “New combinations” of J. A. Schumpeter are literally new technological solutions of the emerging new quantum level of development.

“... The form and content of development in our understanding in this case is given by the concept of “the implementation of new combinations”. This concept covers the following five cases:

1. Production of a new, i.e., yet unknown to consumers, of a good or the creation of a new quality of one or another good.

2. The introduction of a new, that is, this industry is still virtually unknown, the method (method) of production, which is not based on a new scientific discovery and which may also consist in a new way of commercial use of the relevant product.

3. The development of a new sales market, i.e., a market in which the industry of this country has not yet been represented, regardless of whether this market existed before or not.

4. Obtaining a new source of raw materials or semi-finished products, equally regardless of whether this source existed before, or was simply not taken into account, or was considered unavailable, or was yet to be created.

5. Carrying out an appropriate reorganization, for example, securing a monopoly position (by creating a trust) or undermining the monopoly position of another enterprise” [40, p. 159].

We can add new thinking to the “new combinations”: scientific, ideological, humanitarian, and cultural. That is, in fact, a new paradigm of thinking is also a “new combination”. Any truly “new combinations” in industry, in culture, in worldview, in the humanitarian sphere give impetus to a new development in the economy and society. “New combinations” are the driving force of development, therefore, fundamental science is so important - it essentially defines all new combinations, in all spheres, for at least 50 - 60 years. And if society “does not work” its quantum level, then for a period longer than 50 - 60 years.

“... Thus, from a technical or economic point of view, to produce is to combine the things and forces that we have at our disposal. Each production method means a certain combination. Different production methods can differ only in the nature and manner in which they constitute a combination, that is, either according to the objects of the combination, or according to the ratio of their quantities. Each concrete act of production is for us a similar combination. This understanding is also related to transport, etc., in short, to all that is production in the widest sense of the word. And in the enterprise as such, and in the framework of the relations of production of the national economy as a whole, such combinations can be seen” [40, p. 72].

J. A. Schumpeter also characterizes the inertia of the “old quantum level”, namely the “old” paradigm of thinking: “The very essence, as well as the energy-saving and motivating function of

firmly established thinking habits (inertia of thinking) rest on the fact that they are rooted in our subconscious, that the results of this thinking are given automatically. These habits are invulnerable to criticism and even immune to the fact that certain facts contradict each other. The well-established habits of thinking continue to be them and fulfill their function even when their hour has already passed and they become a brake. Similar happens in the field of economic activity. Involuntarily, in the soul of one who plans to do something new, elements of the ordinary, the traditional revolt against the nascent plan. In addition to those already expended, new efforts of will, besides of a different nature, are required in order to find time and space for conceptual substantiation and development of a new combination among everyday works and concerns, to consider a real opportunity in it, and not just a dream or a game of imagination. Such spiritual emancipation presupposes the presence of strength and energy, the volume of which goes far beyond limits of the needs of ordinary everyday life. This quality is something peculiar and is rarely found by nature” [40, p. 182].

Also J. A. Schumpeter clearly indicates that “new combinations, as a rule, do not arise from the old ones and do not directly occupy their places, but appear side by side and compete with them ... this moment ... is very important for explaining the clarity of the wave-like development movement” [40, p. 402]. His quotation directly describes the process of the emergence of new applied technologies, already a new quantum level. “... The economic essence of the depression process consists in spreading — through the mechanism of striving for balance — technical advances to the entire national economy ... after the rise, the demand for labor decreases as new combinations take effect and new specialists are needed, and besides, new firms and manufactures produce more products ... Equilibrium, which ultimately is restored ... differs from that which would be restored in other conditions. Everything that is lost in this process cannot usually be repaired and restored ... and forced to use special ... ways of adaptation” [40, pp. 427-428]. According to the old, it is no longer possible to adapt, since inevitably a new quantum level comes, which in the technological aspect introduces the new technological structure of society into life. Therefore, slowly, gradually, but inevitably, the old quantum level goes away and a new quantum level of the development of society begins.

CONCLUSION.

Thus, using the quantum theory of the development of science and society, one can theoretically substantiate the economic cycles of Kondratiev and the wave development of society. The application of Heisenberg’s uncertainty principle to society has shown that social processes are probabilistic and fundamentally cannot be strictly predicted (they have maximum numerical

limitations). Also, the quantum theory of the development of science and society clearly implies the impossibility of reaching the point of “technological singularity” by society, and the fundamental impossibility of creating artificial intelligence similar to human intelligence.

Technological singularity is the moment after which technical progress will become so fast and complex that it will be inaccessible to the understanding of a person (according to supporters). In physics, a similar situation was at the end of the 19th century, and it is called the “ultraviolet catastrophe”. The ultraviolet disaster is the conclusion that (according to the Rayleigh-Jeans law) that the total power of thermal radiation of any heated body must be infinite. It was successfully solved by M. Planck in 1900 by introducing radiation quanta into physics. Similarly, the technological singularity is overcome with the help of the quantum theory of development: there will be no singularity, since in reality only a person can discover the fundamental laws, and therefore develop and control progress. Some illusion that progress has greatly accelerated (public fluctuation) is simply a stage in the “elaboration” of fundamental discoveries at a given quantum level of development.

Recall that science develops moving from one quantum level to the next. The “doors” to the next quantum level “discover” the fundamental laws. Moreover, it is the fundamental laws that determine the limits of this quantum level: both at the technological level, and also at the level of human consciousness, since a certain behavior paradigm, certain worldview and installation are established. When “working through” science and technology of fundamental discoveries, people literally, after a while, begin to live in a new reality that amazes them with its complexity and perfection (at first). But, this is just a temporary illusion, which after some time will disappear without a trace, as people are faced with the fact that only they can solve new problems, not computers or artificial intelligence (or other cybernetic devices).

But there is one more nuance: when all fundamental discoveries (of their level) are “worked through” by applied and engineering sciences, it seems that our knowledge of the world is complete and perfect. And then, our knowledge can be mistakenly perceived as absolute, such “knowledge of God”. But, this is just knowledge of a certain quantum level, which holistically describes the world. Based on them, we can never explain the complexity of the world, since there will always be certain unresolved issues and inaccuracies. It must be remembered that our knowledge is always incomplete. Moreover, our knowledge will never be complete, and this is fundamental. There will be a transition to a new quantum level with a different horizon of knowledge, and this process will never cease. And it will be like this all the time, mankind will never have “eternal knowledge”, nor will there be “eternal theories” and textbooks. Textbooks will always write again, sometimes completely and beyond recognition.

To move to the new quantum level of “pure knowledge” of the existing level is not enough, since the logical algorithm “worked” all the fundamental laws. Here we need intuition, faith, emotions, emotional rejection of some laws and theories, and love for others, the ideological experience of man. Therefore, developmental waves make up 50 years, since a person cannot change his worldview, which he accepted while living in society. From this it follows logically that there can be no question of any artificial intelligence. Artificial intelligence has no emotions and worldview experience, and therefore it can never discover new fundamental laws, and “drag” society to a higher quantum level. Artificial intelligence is just an algorithm that can learn and work at the quantum level at which it is created. Its development is limited by its level of existence. This is an assistant of a person who will “work out” fundamental knowledge at a specific level, but who can never discover a single fundamental law.

This can be clearly shown. Ptolemy's geocentric system came from the premise that the Earth is in the center of the solar system. And on the basis of this fact, a mathematical apparatus was developed that could explain any trajectory of the planets (simply add the following epicycles). Similarly, the worldview of people was appropriate: people considered themselves to be the center of the Universe, and the peak of evolution. Now we no longer think that our species will be the end point of evolution. The heliocentric system of N. Copernicus showed that the Sun is in the center of our solar system. But it took more than 100 years to mathematically and physically understand the essence of this system. And only the law of Newton was able to finally explain everything. But now people will not be able to explain any drawn trajectory of the planet (or satellite), since there are laws of nature that have their own area of application and have their limitations. Similarly, the complex of human knowledge that we have (the quantum level of knowledge) will also always have its own scope and limitations.

It is interesting to note that if artificial intelligence had been created in the time of Ptolemy, he would have worked to improve the theory of epicycles until now. Artificial intelligence would never go beyond its quantum level (Ptolemy's geocentric model), and therefore would always refine the theory of epicycles. And of course, he (AI) would never have accomplished the scientific feat that N. Copernicus did.

Finally, we will briefly demonstrate how using the “predator – prey” model (or “potential energy - kinetic energy”) to model the intellect and human emotions. For this, instead of potential and kinetic energy, it is necessary to consider the oscillations of the following categories: for an intellect it is logic and emotions, for emotions it is love and hate.

Intellect: “logic — emotions”.

Emotions: “love — hate”.

Then, we can rightly say that intelligence is a function of logic and emotions, and express it with a mathematical formula:

$$\text{Intellect} = F(\text{emotions, logic})$$

Similarly, emotions are a function of love and hate, and can also be expressed by the formula:

$$\text{Emotions} = F(\text{love, hate}).$$

If by this approach we describe the development of the system as a function of the equilibrium position and the nonequilibrium position, then we obtain the following formula:

$$\text{System development} = F(\text{equilibrium position, non-equilibrium position})$$

It follows from these formulas that both the human intellect, and emotions, and the development of any systems, is a dynamic process similar to the oscillation of a mathematical pendulum, and therefore they must also be described by the corresponding wave equations.

REFERENCES.

1. Bykov G. V. History of organic chemistry. Structural theory. Physical organic chemistry. Calculation methods. Moscow, Chemistry, 1976, p. 74.
2. Van Gelderen J. [J. Fedder pseudo.] 1913. Springvloed: Beschouwingen over industrieele ontwikkeling en prijsbeweging (Spring Tides of Industrial Development and Price Movements). De nieuwe tijd 18.
3. Bunyatyan M. 1915. Economic crises. Experience of morphology and theory of periodic economic crises and conjuncture theory. Moscow, Thought.
4. Beveridge W. H. 1921. Weather and Harvest Cycles. The Economic Journal 31: 429–449.
5. Beveridge W. H. 1922. Wheat Prices and Rainfall in Western Europe. Journal of the Royal Statistical Society 85/3: 412–475.
6. Kondratyev N. D. 1922. The world economy and its conjuncture during and after the war. Vologda: Regional Department of the State Publishing House.
7. De Wolff S. 1924. Prosperitats- und Depressionsperioden. Der Lebendige Marxismus. Ed. by O. Jossen. Jena: Thuringer Verlagsanstalt. P. 13–43.
8. Kondratyev N. D. 1925. Large conjuncture cycles. Questions of conjuncture 1/1: 28–79.
9. Kondratieff N. D. 1926. Die langen Wellen der Konjunktur. Archiv fuer Sozialwissenschaft und Sozialpolitik 56/3: 573–609.
10. Kondratyev N. D. 1928. Large conjuncture cycles. Moscow: Institute of Economics RANION.
11. Kondratiev N. D., Oparin D. I. 1928. Large cycles of the conjuncture. Reports and discussion at the Institute of Economics. Moscow: Institute of Economics RANION.

12. Kondratieff N. D. 1935. The Long Waves in Economic Life. *The Review of Economic Statistics* 17/6: 105–115.
13. Kondratieff N. D. *The Long Wave Cycle*. New York, NY: Richardson & Snyder, 1984.
14. Kondratyev N. D., Yakovets Y. V., Abalkin L. I. Large cycles of conjuncture and the theory of foresight. *Selected Works*. Moscow, Economy, 2002.
15. Planck M. On the Law of Distribution of Energy in the Normal Spectrum. *Annalen der Physik*, vol. 4, p. 553 (1901).
16. Gorelik G. S. *Oscillations and waves. Introduction to acoustics, radiophysics and optics*. Second edition edited by Professor Rytov S. M. State publishing house of physical and mathematical literature. Moscow 1959, pp. 9 - 10.
17. Karlov N. V., Kirichenko N. A. *Oscillations, waves, structures*. Moscow: FIZMATLIT, 2003. ISBN 5-9221-0205-2, pp. 15 – 17.
18. Prigogine I. *Introduction to thermodynamics of irreversible processes*. Moscow, foreign literature publishing house, 1960.
19. Lotka A. J. Contribution to the Theory of Periodic Reactions *J. Phys. Chem.* 1910, v.14, p. 271.
20. Lotka A. J. Undamped Oscillations Derived from the Law of Mass Action *J. Amer. Chem. Soc.*, 1920, v. 42. pp. 1595 - 1599.
21. Belousov B. P. Periodically acting reaction and its mechanism. *Collection of essays on radiation medicine*, 1958, Moscow, Medgiz, 1959, pp. 145-147.
22. Belousov B. P. Periodically operating reaction and its mechanism. *Collection: Autowave processes in systems with diffusion*. Collection of scientific papers edited by M.T. Sin Gorky State University, Gorky, 1981, pp. 176-186.
23. Zhabotinsky A. M. Periodic progress in the oxidation of malonic acid in solution (investigation of the Belousov reaction kinetics). *Biophysics*, 1964, V. 9, pp. 306-311.
24. Zhabotinsky A. M. *Oscillations and waves in homogeneous chemical systems*. Physical chemistry. Moscow, Chemistry, 1987.
25. Shnol S. E. Heroes, villains, conformists of Russian science. *Science in the USSR: Through thorns to the stars*. Edition 4. Moscow, Librokom, 2010, 720 p. ISBN 978-5-397-01363-5. (Chapter 16. Boris Pavlovich Belousov (1893-1970) and its oscillatory reaction).
26. Zhabotinsky A. M., Ogmer H., Field R., and others. *Fluctuations and traveling waves in chemical systems*. Translated from English by R. Field, M. Burger. Moscow, World, 1988, p. 20.
27. Gyorgyi L., Turanyi T., Field R. J. *Mechanistic Details of the Oscillatory Belousov-*

- Zhabotinskii Reaction. *J. Phys. Chem.*, 1990, 94 (18), pp. 7162-7170.
28. Briggs T. S., Rauscher W. C. An oscillating iodine clock. *J. Chem. Educ.*, 1973, v. 50, № 7, p. 496.
 29. Zhabotinsky A. M. A history of chemical oscillations and waves. *CHAOS* 1(4), 1991, pp. 379-385.
 30. Vavilin V. A. Autoscillations in liquid-phase chemical systems. *Nature*, No. 5, 2000.
 31. Voltaire B.V. Legend and the story of chemical vibrations. *Knowledge-Power*, 1988, № 4, pp. 33-37.
 32. Bezverkhniy V. D., Bezverkhniy V. V. Quantum-mechanical analysis of the wave–particle duality from the position of PQS. *SSRN Electronic Journal*, January 2018.
<http://dx.doi.org/10.2139/ssrn.3308190> , <http://vixra.org/pdf/1812.0486v1.pdf>
 33. N. D. Kondratiev: crises and forecasts in the light of the theory of long waves. A look from the present. Edited by L. E. Grinina, A. V. Korotayev, V. M. Bondarenko. Moscow, Teacher, 2017, 384 pages. ISBN 978-5-7057-5167-9.
 34. Kuznets S. *Secular Movements in Production and Prices. Their Nature and their Bearing upon Cyclical Fluctuations*. Boston: Houghton Mifflin, 1930.
 35. Juglar C. *Des Crises Commerciales Et De Leur Retour Periodique En France*. Paris, 1862.
 36. Kitchin J. (1923). *Cycles and Trends in Economic Factors*. *Review of Economics and Statistics*. 5 (1): 10—16.
 37. Forrester J. W. *New Perspectives on Economic Growth. Alternatives to Growth — A Search for Sustainable Futures*. Ed. by D. L. Meadows. Cambridge, MA: Ballinger, 1977. P. 107—121.
 38. Jemmer M. *Evolution of the concepts of quantum mechanics*. Translated from English by V. N. Pokrovsky. Edited by L. I. Ponomarev. Moscow, Science, 1985, p. 319.
 39. Leslie White. *Favorites: the evolution of culture*. Moscow, ROSSPEN, 2004, pp. 47-62.
 40. Schumpeter J. A. *The Theory of Economic Development*. Moscow, Progress, 1982 (Directmedia Publishing, Moscow, 2008), pp. 169-170, 174.
 41. Korotaev A. *New technologies and future scenarios, or is the Singularity near?* Moscow, publishing house LKI. URSS, 2008, 2nd edition. (History and Synergetics: Research Methodology. Responsible Editor S. Y. Malkov, A. V. Korotayev. 2nd edition, revised and updated. Librok, Moscow, URSS, 2010. P. 183–191).