Apes, quants and subquantum world

or

Quo vadis

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Abstract

My colleagues suggested that I publish an overview of my works which could be of interest to a free-thinking reader. Some results and claims of these works may at first sight, and often at the second sight, seem paradoxical. The first reaction to this type of results is ⎯it can't be, the second is ⎯there may be something in it, the third is ⎯well, that's common knowledge. I must underscore that the papers covered in this overview
have been published in high ranking international journals after robust discussions with peer reviewers. Thus, the results presented in these papers are not fantasies of an amateur. In this overview, I made an effort to make the main ideas of my works understandable for non-specialists without formulas. Specialists, I think, will agree with the formulas, too.

Preamble

My colleagues suggested that I publish an overview of my works which could be of interest to a free-thinking reader. Some results and claims of these works may at first sight, and often at the second sight, seem paradoxical. The first reaction to this type of results is "it can't be", the second is "there may be something in it", the third is "well, that's common knowledge". I must underscore that the papers covered in this overview have been published in high ranking international journals after robust discussions with peer reviewers. Thus, the results presented in these papers are not fantasies of an amateur. In this overview, I made an effort to make the main ideas of my works understandable for non-specialists without formulas. Specialists, I think, will agree with the formulas, too.

Before delving into the results, it is important to review the goofs and misconceptions which accompanied the development of the foundations of quantum physics.

As I started writing about this background, though, I had an uncomfortable feeling of writing about "a feast during a plague". No, the plague in this expression is not the covid-19 pandemic caused by a mildly malicious virus. Compared to what humankind might face in the not-so-distant future, this pandemic may end up looking like a small episode. In many parts of the world, in the jungles and in the deserts, there live viruses to which the local populations have become immune over many generations. Other, even worse viruses, may crawl out of laboratories. The modern transportation created on the basis of scientific discoveries, air travel above all, has the capability to spread them around our small planet very swiftly. We may all end up like the majority of Native Americans, who perished because of the viruses brought over by the Europeans, to which they were not immune; there may not be enough time for a vaccine.

It felt irresponsible to talk about science and not to talk about the catastrophes it has caused and may cause in the future. We say that science has given humanity the modern civilization with all its benefits. It is absolutely correct. But that obscures the other side of the coin.

Therefore, I decided to write not only about science, but also to include a chapter about the nature of humans, about our trajectory, and about the responsibilities of science. This decision justified the writing of what you are about to read (hopefully), and made the process more palatable.

The resulting book is a mixture of some banal ratiocinations and original scientific results. And dishes which contain seemingly incompatible *ingredients* (as my five-year-old granddaughter Anja used to say), can unexpectedly turn out quite edible. This is what I am counting on.

Chapter one. Who we really are, why science appeared, and how it is bad for you

Disclaimer: I must emphasize from the start that I am not at all a misanthrope, and wrote the below singularly out of humanitarian motives.

It is widely said that humans descended from apes. Less widely, it is said that apes descended from humans. Both are wrong. Zoologically speaking, Homo Sapiens are talking apes of the hominidae family. This does not bother me, since this family besides humans contains very likable and inquisitive animals - gorillas and chimpanzees. I am proud to be related to these wonderful creatures. I am writing this to point out that humans are part of nature, which we are trying to destroy while hoping to pull through ourselves. Separating humans from nature is dangerous both for humans and for nature. I am reminding that humans are apes not only for the sake of truth, but also because our

fate troubles me. I am not sure that "sapience" is a completely fitting endonym for our species of primates - look how often humans act ignorantly and unwisely! Be it as it may, by leading up to humans, evolution has allowed matter at this stage of its organization to become self-aware.

Besides looks and ability to talk (regrettably, often not making much sense), humans differ from their family members by our need to create a worldview, and to find explanations for phenomena in the world. This need may be called the knowledge instinct. Children are bottomless sources of questions, which is why there is a phase of childhood called "the why phase".

The knowledge instinct requires to be satisfied. Modern civilization is the consequence of satisfying this instinct through intellect by representatives of humanity who are called scientists. The knowledge instinct pushes them deeper and deeper into the innermost mysteries of nature, ignoring the possible consequences.

If one gives up the work which satisfies the knowledge instinct, it is usually a painful sacrifice, even if the replacement work yields higher financial satisfaction. I will give just one example. In 1998 I was invited to a conference in Paris to talk about my time reversal experiments (which we will discuss in a later chapter). Times were hard, I barely scraped together enough money to buy a ticket to Paris from Kazan. During a layover in Moscow I was strolling down a street and out of the blue a Mercedes-Benz W140 pulled up (a status symbol in Russia at the time, the darling of businessmen and mafiosi). The door opened and out swaggered an old acquaintance, a physicist who did his Ph.D. at Kazan University. "How do you like my ride?" he proudly asked. "Coffin on wheels," I replied, and asked what he was doing these days. He had given up physics, started a business, got support from friends, was successful. Then he asked "And what brings you to Moscow?" I explained that that night I was flying to Paris for a conference talk about time reversal experiments. He asked for details of the experiments; being a knowledgeable scientist, he understood my explanations, and somehow deflated. Then he waved dejectedly at his Mercedes with a downbeat comment: "yeah, and here are my achievements." He wished me a good time at the conference and was on his way.

The knowledge instinct begat science and modern civilization with all its foreseeable and unforeseeable consequences. As a reminder, the Earth radius is 6370 km; there is practically no life 5 km. above sea level. Thus, the thickness of the biosphere is less than 1/1000th of the Earth radius. This means that life exists within a

ridiculously thin film which is sticking to the surface of our planet. There are too many of us within this thin film, considering how we are behaving. Hundreds of millions of cars and other machines are crawling on the surface of the Earth, several million airplanes are plowing through the atmosphere. All of them burn oxygen which we and other animals breathe, and poison the environment. Before the fantastic scientific achievements, the Earth had a fantastic diversity of plant and animal species. Humans led to the extinction of thousands of them. The dynamic equilibrium of nature has been disturbed. Now the debate is whether we have reached the point of no return. And just to think, because of science there are almost no horses in so-called civilized countries - let alone horse manure, which is so good for growing cucumbers!

Throughout history, there have been tribal wars. Before the triumphs of science, the death toll of those wars was relatively small. Then chemistry gave us industrial scale explosives and poisons, biology gave us bacteriological warfare, physics gave us the monstrous thermonuclear weapons. Does it mean scientists know not what they do? They know, but they do anyway. Science allowed humans to kill each other by the million.

We, hominids claiming to be sapient, behave like an occupying alien force on the planet. As a result, humanity may perish from an asteroid hit in an indeterminate future, or from its own actions rather soon, unless humanity comes to its senses.

Now, it is a good time to talk about physics.

Chapter two, the short one. No need to be star struck

The material component of civilization is grounded primarily in the successes of the following branches of physics: classical mechanics, thermodynamics, electrodynamics, and quantum mechanics. In the foundation of each of these disciplines, there are specific mathematical formulas. These formulas cannot be derived from other, more general formulas; they are the results either of successful inductions from observations of physical processes, or of a daring conjecture. The authors of these formulas become known as great scientists, are called "founders", and are recorded in history.

Formulas do not explain the nature of physical processes. They allow us to find the numerical value for the physical quantities involved in those processes. To explain the nature of the processes, it is natural to use images formulated during observations of the phenomena which are perceptible through our senses. But what about phenomena which are not perceptible by our senses, and thus are not accessible through direct observation? Using the same images there can hardly yield an adequate picture. Often, when familiar images and notions cannot be used to interpret a new phenomenon, the phenomenon can be misunderstood.

New images may be developed when scientists use instruments where direct observation is impossible. Preferably, these new images would correspond to physical reality. In other words, new foundational formulas should be accompanied by an adequate physical interpretation. It is the interpretation that should create an acceptable description of physical phenomena at each new stage of science.

The founders are not geniuses who received a superhuman revelation and ability to first divine the nature of physical phenomena, and then to create formulas to mathematically describe what they have divined. They are knowledgeable and curious human beings whose social position allowed them to dedicate themselves to satisfying the human knowledge instinct. The interpretation of the physical processes described by their formulas is always the biggest problem of their work, and often of their lives.

In the following chapters we will illustrate this based on the lives and work of the founders of quantum mechanics: Max Planck, Louis de Broglie, and Erwin Schrödinger.

Chapter three. Jack-in-the-box

By the early XX century it seemed like physical science had reached the pinnacle of perfection. However, there accumulated a number of questions which could not be answered within classical physics. Classical physics could not explain the line

absorption and emission spectra of gasses. Radioactivity, discovered by Antoine Becquerel in 1896 and studied by Marie and Pierre Curie at the end of the XIX century, evidenced that atoms contain enormous energy, whose origin was also inexplicable within classical physics.

The new, quantum physics was born from the study of black-body radiation. The black-body experiments use an opaque closed cavity whose walls have the same temperature, and which has a small hole. The light passing through the whole into the cavity will be reflected many times and completely absorbed, and the hole will look completely black from the outside. But when the cavity is heated, it begins to emit its own visible radiation. The radiation emitted by the inner walls of the cavity in the overwhelming majority of cases will go through countless new absorptions and emissions. Therefore, we can confidently say that the radiation within the cavity is in the thermodynamic equilibrium with the walls of the cavity.

So while serious people were creating all types of electric engines, lighting cities with electricity, inventing telephone communication, and so much more, some even more serious people were, figuratively speaking, huddled around the aforementioned cavity and gazed curiously into the aforementioned hole. The gazing turned out to be productive, because out of the hole, like jack-out-of-the-box, there sprang quantum mechanics.

This is what happened:

By the end of the XIX century a series of measurements established a few regularities of the black-body radiation. Josef Stefan (empirically, in 1879) and Ludwig Boltzmann (using Maxwell theory, in 1884) established the law connecting the black-body radiation to its temperature:

$$\frac{P}{S} = \sigma T^4 \tag{1}$$

Here, P is the full radiation flow, S is the radiating surface, T is the temperature of the radiating body, and σ is the so-called Stefan-Boltzmann constant. This law was experimentally confirmed by L. Gretz in 1880.

In 1896 Wilhelm Wien, based on empirical observations, suggested a form of the function of black body radiation density for frequency υ unit:

$$\frac{dP}{dv} = C_1 v^3 e^{-C_2 \frac{v}{T}} \tag{2}$$

However, this formula does not correctly describe low-frequency behavior. Besides, it contains unknown constants C_1 and C_2.

In 1890 Rayleigh derived the spectrum function $\frac{dP}{dv}$ based on classical physics. In 1905 this derivation was updated by Jeans. According to the Rayleigh-Jeans law,

$$\frac{dP}{dv} = \frac{2v^2 kT}{c^2} \tag{3}$$

Here, k is the Boltzmann constant, and c is the speed of light.

At low frequencies, classical theory provided correct predictions. However, as frequencies rise, the spectrum density $\frac{dP}{dv}$ would increase indefinitely, so the total radiated energy would end up being infinite. This conclusion was called "the ultraviolet catastrophe".

By 1900, when German physicist Max Planck started working on the heat radiation theory, this discipline was facing a problem which went to the foundations of physics: to calculate the distribution of energy of the black body radiation at all frequencies. Planck wrote down the expression which interpolated the extreme cases of long and short wavelengths. He arrived at the following formula for energy distribution:

$$E = \frac{C\lambda^{-5}}{e^{\frac{c}{\lambda T}} - 1} \tag{4}$$

where λ is the wavelength, and C and c are some constants.

The scientist noted that this expression seemed to accurately describe experimental results. He now faced the problem of explaining the physical reality behind the formula he found.

In order to fit his formula to the requirements of thermodynamics, Planck divided the radiation energy of given frequency into an exact number of parts (elements, or quants) equal $\varepsilon=h\upsilon$, where h is the "universal constant", now known as the Planck constant. As a result, the formula of black body radiation density for wavelength λ became

$$R(\lambda, T) = \frac{2\pi hc^2}{\lambda^5} * \frac{1}{e^{\frac{hc}{\lambda kT}} - 1} \tag{5}$$

Here, $R(\lambda,T)$ is the power of radiation per surface unit of the radiating surface per wavelength unit, c is the speed of light. Accordingly, the distribution of radiation energy by frequency is recorded as

$$R(\upsilon, T) = \frac{2\pi h\upsilon^3}{c^2} * \frac{1}{e^{\frac{h\upsilon}{kT}} - 1} \tag{6}$$

where $R(\upsilon,T)$ is the power of radiation per surface unit of the radiating surface per frequency unit, and c is the speed of light.

Formulas (5) and (6) turned out to accurately describe the distribution of energy for the whole range of the black body radiation.

The appearance of quantity h signals the beginning of the quantum era in physics, and Planck is considered the founder of quantum physics.

Chapter four. The thorny path of discovery

Planck believed that the main goal of the further development of quantum theory is to explain the origins of the mysterious quantity h. He linked the solution of this problem to the detailed study of the light emission process at the microscopic level, i.e. the electronic theory of matter, which was formulated by the early XX century.

Planck's works of this period do not mention the quantization of radiation energy, i.e. the representation of the energy through a discrete set of certain number of portions

(quants) at the value of *hυ*. Planck himself at that time did not consider such a possibility, and his view of his own results remained purely classical not only in his works of 1900-1901, but also in the first edition of his Lectures on Thermal radiation [1]. The equation *ε=hυ* was used only to calculate the equilibrium distribution of energy.

Planck did not completely appreciate the full consequences of his work; at that time, the concept of quantum discretion itself did not seem terribly important to him. He expended a lot of effort trying to reconcile his results with the concepts of classical physics; he was very sceptical of further moves leading away from the old views. We witness a situation which is unprecedented in the history of science: having given the world an extremely effective theory, its creator became intimidated by the scale of the consequences and made every effort to prevent the theory from taking hold in science. He failed in those efforts, of which he wrote in his scientific autobiography [2]: "My futile attempts to introduce quant actions into the classical theory continued for several years and took a lot of effort. Some of my colleagues viewed this as a tragedy of sorts. But I thought differently, because this deep analysis yielded significant value" [2].

Do not think that this diminishes Planck's role in the development of physics, or that the "father of quantum physics" did nothing substantial in 1900. He identified the constant *h* and created the formal scaffolding for what could later be considered the quantum-theoretical proof of the black-body radiation law. Planck's dilemma is simply the first instance of the typical situation in quantum theory: the "correct" interpretation of new mathematical schemes usually appears after the formulas themselves have been developed.

Another founding father of quantum mechanics is Louis de Broglie. He studied the nature of x-ray radiation and discussed its properties with his brother Moris; in the process, Louis de Broglie realized the need for a theory which would connect corpuscular and wave representations. All that was left to do was to extend the wave

ideas to all massive particles, and in 1923 a decisive breakthrough took place. De Broglie proposed the idea that the propagation as a wave, which had been established for photons, is universal. It should manifest for all particles which have an impulse p. All particles with an impulse p have wave properties, including being subjected to interference and diffraction.

De Broglie presented his ideas in a short paper ¨Waves and quants¨ (Ondes et quanta) [3], presented at the meeting of the Paris Science Academy September 10, 1923). In that paper the scientist proposed that a moving particle with energy E is characterized by a certain internal periodic process with the frequency E/h, where h is the Planck constant. De Broigle assigned a wave to the moving body, which later was named the de Broglie wave.

De Broigle's formulas establish the dependence of the length λ of the moving particle's wave on the impulse p of that particle, and the dependence of the total energy E on the frequency v. The relationship is expressed in the equations:

$$\lambda = h/p \tag{7}$$

$$E = hv \tag{8}$$

 where h is the Planck constant.

Louis de Broglie wrote that "it may be, that each moving body is accompanied by a wave, and that it is impossible to separate the movement of the body and the propagation of the wave". According to de Broglie, this logic must be true for material particle, e.g. electrons. But in 1924 de Broglie's ideas about the wave properties of particles were just a hypothesis. He presented his results in detail in his doctoral thesis "Research on quantum theory", which he defended in the Sorbonne on November 25, 1924. The dissertation committee, which included four well known scientists - the physicists Jean Perrin, Charles Victor Mauguin, and Paul Langevin, and a mathematician Elie Cartan - duly recognized the originality of the results, but may not have fully appreciated their full significance. Langevin was an exception; he reported about de Broglie's work at the Solvay conference in April 1924. Einstein was interested in this work, which brought de

Broglie's hypothesis to the attention of some leading physicists, but few people were taking it seriously at the time.

In 1927 the evidence of the diffraction of electrons were discovered, primarily due to the experiments of Clinton Davisson and Lester Germer in the USA, and of George Paget Thomson in the UK. This discovery made de Broglie's achievements widely acknowledged, as evidenced by his receiving of the Nobel Prize in physics for 1929, with the citation "for the discovery of the wave nature of the electron".

In his article "Wave mechanics and the atomic structure of matter and radiation", published in Journal de Physique in May 1927, de Broglie proposed the existence of two objects with different physical nature: a material particle and a continuous wave, where the wave directs the movement of the particle. This wave was called "the pilot wave" (l'onde pilote).

That article did not attract much attention from the scientific community. However, Wolfgang Pauli spoke highly about the originality of the French scientist's ideas. Thus, in his letter to Niels Bohr of August 6, 1927, he said "even if this article by de Broglie is missing the mark (and I hope it is), it is still very rich in ideas, very sharp…" During the fifth Solvay conference (October 1927), de Broglie failed again to persuade his colleagues in the accuracy of his theory of the pilot wave. The theory was received coolly by the participants. De Broglie said later that this unfavorable reaction was one of the reasons he did not pursue the development of his original ideas.

In 1951 de Broglie found a reason to return to his previous views thanks to the works of the American physicist David Bohm. Bohm's theory in fact repeats the pilot-wave ideas in a slightly different form.

De Broglie's paper "Waves and Quants" launched the development of wave mechanics. The next step was made by the Autrian theoretical physicist Erwin Schrodinger, who in the early 1926 developed the mathematical formalism of the wave mechanics, based on the ideas of the French scientist. The immediate prompts for

Schrodinger were his learning about Louis de Broglie's dissertation in early November 1925, and Einstein's paper on quantum theory of gasses, where Einstein quoted the French scientist. Shrodinger's success in that project was founded on his knowledge of the relevant mathematical apparatus, including the method for solving problems for eigenvalues.

We know from mathematics that equations of the type

$$\hat{A}\psi = A\psi \tag{9}$$

where operator $\hat{A}$ refers to an operation on the following function, and A is constant, can be solved only for certain (discrete) values A_n of that constant; such eigenvalues of the operator. Each eigenvalue of A_n corresponds to a solution ψ_n, which is called the eigenfunction of the operator.

Schrodinger knew that the energy levels of a hydrogen atom are a discrete set of values. So he proposed that those levels are the eigenvalues of the operator of the atom's energy. In the first half of 1926 the journal Annalen der Physik received four parts of Schrodinger's famous work "Quantization as an Eigenvalue Problem" [4]. In the first part, which the journal received on January 27, 1926, the author wrote the equation

$$\hat{H}\psi = E\psi \tag{10}$$

now known as the time-independent (stationary) Schrödinger equation.

Mathematically, equation (10) is the equation for the eigenvalues of the energy operator (Hamiltonian) $\hat{H}$. When this equation was used to find discrete energy levels of a hydrogen atom, the solution agreed with experiment. Thus, Schrodinger's proposal turned out to be rather fortunate.

The introduction to installment 3 of the paper, which was received by the journal on May 10, 1926, for the first time features the term "wave mechanics" (Wellenmechanik) to describe the approach developed by Schrodinger. In the fourth installment, received June 21, 1926, the scientist formulated the equation

$$i\hbar\frac{\partial\psi}{\partial t} = \hat{H}\psi, \tag{11}$$

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which was later named time-dependent (non-stationary) Schrodinger equation. He used the equation to develop the theory of time-dependent disturbances.

Schrodinger equations are the generalizations from experimental data. They should be considered as postulated equations; they cannot be derived in quantum mechanics, just as Maxwell equations cannot be derived in electrodynamics nor Newton's equations in classical mechanics.

The wave function ψ, which is the solution to Schrodinger equation (11), may be resented as the superposition

$$\psi = \sum_n c_n(t)\psi_n(x), \tag{12}$$

where t is time, x is the generalized coordinate, $\psi_n(x)$ are eigenfunctions of system Hamiltonian.

Measurements show one of the energy eigenvalues. The system's total energy equals

$$E = \sum_n |c_n(t)|^2 E_n. \tag{13}$$

The value $|c_n(t)|^2$ is the probability that energy value E_n will be observed. Accordingly,

$$\sum_n |c_n(t)|^2 = 1 \tag{14}$$

After the publication of Schrodinger's papers, physicists started widely using his convenient and consistent mathematical formalism to solve all sorts of quantum theory problems. Quantum concepts have allowed us to find adequate mathematical descriptions of the processes in the nuclei of atoms and depths of stars, radioactivity, particle physics, solid state physics, low temperature physics (superconductivity and superfluidity). These concepts have become the theoretical basis of numerous practical applications of physics: nuclear energy, semiconductor technology, lasers, and others.

The physical reality behind the eigenvalues of the energy operator in Schrodinger equation was clear from the beginning. The main question posed by Schrodinger's fundamental work was "what is the physical reality behind and properties of the wave function, which is the solution to the wave equation".

The author of the wave equation himself, Erwin Schrödinger, first thought that we may imagine particles as wave packets and thus abandon the corpuscular view altogether. Wolfgang Pauli in his letter to Niels Bohr about de Broglie's paper, which we already cited above, wrote that de Broglie's work was "written on a much higher level than the childish works of Schrodinger, who keeps thinking even now that he can ... abolish material particles." The flaw of Schrödinger interpretation quickly became obvious: wave packets inevitably dissipate, which contradicts the obviously corpuscular behavior of particles in electron scattering experiments.

Chapter five. Shut up and calculate

Since then, scientists spent decades looking for the physical reality behind the successful mathematical formulas.

Max Born proposed the probability interpretation, or statistical interpretation, which allows us to use the Schrödinger equation to describe physical processes without abandoning the corpuscular view. According to Born, every measurement act identifies with a certain probability the value of a physical quantity (e.g. the particle coordinates). The wave function determines this probability. For instance, quantity $|c_n(t)|^2$ in the formula (13) is the probability of observing energy value E_n. It remains unknown, however, if the wave function contains all needed information about the physical system, because of the inconvenient fact that while the function is the same for every measurement, the result is different every time. Born surmised that the system may possess some properties which are not reflected in the wave function. What these properties are and how they manifest during observation remained unclear.

The probability interpretation offered by Born was unacceptable to Schrodinger, because it contradicted his ideas about the real quantum mechanical waves, keeping in

place the quantum leaps and other elements of discreteness, which Schrodinger wanted to abolish.

Copenhagen interpretation, the most popular one in our days, was formulated in 1927. While Born's statistical interpretation does not claim that the probability appears as a result of measurement, Copenhagen interpretation claims that when the system is not being measured, it does not have specific physical properties, and it is only as a consequence of the measurement that the probability of physical values appears. Wave function can predict only the probability of a value appearing as an outcome of measurement. Unlike Born's interpretation, the Copenhagen interpretation argues that the wave function contains all necessary information about the physical system.

The wave function relates at any given time to the entire interval of coordinates on which the function is defined. Most likely, this fact provoked the emergence of the Copenhagen interpretation of quantum mechanics, which rejects questions like "where was the particle before I registered its location?" as meaningless. However, the inability of the wave function to specify the location of the particle at a particular time does not in any way imply the meaninglessness of the question about this location. <u>I believe that, at least before the Copenhagen interpretation, particles existed in nature independently of observation</u>. I am convinced that the particle is located in a specific place at a specific time, where it is detected during observation.

Schrödinger found the Copenhagen interpretation unacceptable, because it contradicted his idea of the real quantum-mechanical waves. He was trying to eliminate quantum leaps and other elements of discreteness. He continued to insist on the wave nature of the electron and to treat the electron within the atom as a negatively charged cloud. Schrodinger finally joined the probabilistic interpretation of the nature of waves in 1950. In his paper "What is an elementary particle?" he wrote: "We now say that all waves, including light, are better viewed as "probability waves". They are just a mathematical construct to calculate the probability of finding the particle". Schrödinger

never accepted the Copenhagen interpretation and till the end of his life he insisted that the wave function should have a real physical meaning.

Many physicists have objected to Copenhagen interpretation, because it treats the wave function as just an auxiliary mathematical tool, whose only purpose is to allow us to calculate probability. Einstein exclaimed in a conversation with Abraham Pais: "Do you really think the moon isn't there if you aren't looking at it?" [5].

Like many physicists, we do not agree with any of the commonly known interpretations. We also do not think it productive to subscribe to the "no interpretation" position. We will not discuss other interpretations of wave function here. The fact that very many exist testifies to the absence of a satisfactory one. Nobel Laureate in physics Richard Feynman said "I think I can safely say that nobody understands quantum mechanics". That is why many physicists lean towards the instrumentalist interpretation, best summed up in the succinct slogan "Shut up and calculate!" formulated by David Mermin [6].

Chapter six. What's inside

Ernest Rutherford in a letter to Niels Bohr noted: "Physicists are submerged in the foggy atmosphere of matrices and wave mechanics, in the mathematical operations; they provide the correct solutions, but at the same time do not understand the physical reality behind them".

De facto, mathematics has substituted physics in quantum theory. Physics formulas must have corresponding physical processes. But the formulas we have do not describe processes, they only allow us to calculate the measurement results. Louis de Broglie stated the obvious: "Quantum physics urgently needs new images and ideas, which can appear only if its foundational principles are deeply revised" [7].

However, quantum mechanics is a very single-minded field. Where it rules, an attitude and an organized system develop which strangle any sign of dissent, any bud of

a new living theory which is yet too young to fight back effectively. In spite of that, we will try to break out of the foggy atmosphere about which Rutherford wrote, using new images and ideas in accordance with de Broglie's call.

For de Broglie, understanding means ability to visualize. In the early 1960ies, he formulated an approach adding a chance element to the movement of a particle; this chance element is caused by the particle's interaction with a hidden "subquantum environment" [8].

In our view, for a particle to be found in a point in space, it must actually be there at the moment when it is found. It is clear that for a particle to be manifested at a point in space, physical processes are needed to provide for this manifestation. In papers [9,10] we offer an interpretation of the wave function in which wave function is the mathematical reflection of real physical processes taking place at the subquantum level of the organization of matter which underlies the phenomena described by quantum mechanics; this subquantum world generates all matter and sets the parameters for the matter with which our visible world is built. From this point of view, material particles can be viewed as excitations in the subquantum world which possess specific properties.

Below we will see how the acceptance of the existence of the subquantum world helps to answer questions which intrigue intelligent and thoughtful people who are interested in quantum mechanics.

6.1. Quantum mechanics and probability

Value E in equation (13) equals the full energy of the system only if $|c_n(t)|^2$ is the probability of observing the energy value E_n. This requires the observed system to visit the states with the energy value E_n many times. This means there must exist certain processes which would provide for the transitions between states with different energy values E_n. Quantum mechanics says nothing about such processes, because they are

subquantum. Cleary, the subquantum processes must be extremely fast; otherwise the probability theory could not have been used in quantum mechanics.

6.2. Electrons within the atom

If electrons were moving on an orbit within the atom, this would have been a movement with centripetal acceleration. We know from electrodynamics that a particle moving with acceleration radiates energy. Accordingly, very soon the electrons would have given off all their energy and would have fallen on the nuclei, and the Universe to which we are so accustomed would have ceased to exist. Fortunately, it does not happen. The electrons do not move around nuclei on orbits. Instead, the subquantum world (according to laws which science has not yet discovered) generates electrons in different spots within the atom, with the probability determined by the square module of the wave function. It is meaningless to say "which" electron disappeared from one place and appeared in another. This means that the electrons in the atom are identical.

Let us consider a helium atom as an example. Wave functions of a helium atom, which contains two electrons, and the energy corresponding to those functions, can be written as [11,12]:

$$\Phi_p(r_1.r_2) = \frac{1}{\sqrt{2}}\{\psi_n(r_1)\psi_m(r_2) + \psi_m(r_1)\psi_n(r_2)\}, \; E_p = E_n + E_m + K + A, \quad (15)$$

$$\Phi_o(r_1.r_2) = \frac{1}{\sqrt{2}}\{\psi_n(r_1)\psi_m(r_2) - \psi_m(r_1)\psi_n(r_2)\}, \; E_o = E_n + E_m + K - A, \quad (16)$$

where $\psi_l(r_i)$ are the wave functions of the electrons in the Coulomb field of the nucleus, and E_n and E_m are their energy values in this field,

$$K = e^2 \int \frac{|\psi_n(r_1)|^2 |\psi_m(r_2)|^2}{r_{12}} dv_1 dv_2$$

$$A = e^2 \int \frac{\psi_n^*(r_1)\psi_m(r_1)\psi_n(r_2)\psi_m^*(r_2)}{r_{12}} dv_1 dv_2$$

Quantity K has a simple physical meaning: it is the average energy of Coulomb interaction of two electrons in their independent states $\psi_n(r_1)$ and $\psi_m(r_2)$. Quantity

A is called the exchange energy and has no analogues in classical mechanics. Exchange energy is the consequence of the particles being identical and of the existence of states $\Phi_p(r_1.r_2)$ and $\Phi_o(r_1.r_2)$ which are the superposition of products of states of two electrons (such states are usually called "the entangled states" in modern physics).

The states $\Phi_p(r_1.r_2)$ and $\Phi_o(r_1.r_2)$ are the states of parahelium and orthohelium. Parahelium and orthohelium, like the Moon, exist in nature independently of observations. Consequently, the probability of the value of the electron coordinates, which allows us to calculate helium atom energy independently of observations, does not appear as a result of the observations. Instead, it is determined by physical processes, which we call subquantum processes.

Without the idea of subquantum processes, which determine the electron's disappearance in one spot and its appearance in another one, it is impossible to explain why the electrons are identical and thus lead to the atom properties that we see (e.g. the existence of exchange energy). This means that subquantum processes represent that physical reality which the mathematical formalism of quantum mechanics describes.

6.3. The collapse of wave function during observation

The movement of the electron in free space is described by the wave equation. In the context of subquantum processes it means that the subquantum world makes the electrons manifest in points of space with the probability determined by the square module of the wave function in those points. When an electron at some point of space encounters an obstacle capable of interacting with it, the electron may be absorbed by the obstacle, and cause measurable changes in it. Experience shows that the subquantum world will not generate a replacement electron instead of the one that was captured. Naturally, in this case the electron wave, together with the wave function which describes it, will cease to exist. The wave function of the electron will collapse.

According to quantum mechanics, the value $|c_n(t)|^2$ in the equation (13) determines the probability of system energy being equal to E_n. However, the value $|c_n(t)|^2$ cannot be considered the probability of eigenstates ψ_n (see textbooks on quantum mechanics). Truly, according to (12) the quantum mechanical average value of any observable A is

$$\bar{A} = \langle\psi|\hat{A}|\psi\rangle = \sum_{n,m} c_n^* c_m A_{nm} e^{-i(E_m - E_n)\frac{t}{\hbar}} , \qquad (17)$$

$$A_{nm} = \langle\psi_n|\hat{A}|\psi_m\rangle$$

If the value $|c_n(t)|^2$ determined the probability of eigenstates ψ_n, then we would have had

$$\bar{A} = \sum_n |c_n(t)|^2 A_{nn.} \qquad (18)$$

It follows that if during measurement we find the system, with a certain probability, in a state with energy E_n, it does not mean that we find it with the same probability in an eigenstate ψ_n corresponding to that energy. At the same time it is obvious that some physical state of the system must correspond to every different E_n. We posit that these states appear as a result of subquantum processes. Let us emphasize that these states should not be confused with the system's eigenstates which are described by wave functions – the eigenfunctions of the system's Hamiltonian (it may be supposed that the combination of all states with this particular energy forms the eigenfunction).

After the system is found by a measurement tool in one of the states with energy E_n caused by the subquantum processes, it can no longer be described by the wave function which existed before the measurement, which means the collapse (or reduction) of the wave function.

The above interpretation of the wave function collapse complies both with scientific criteria and with common sense.

6.4. Subquantum processes and quantum entanglement.

In recent years, the study of entangled states is generating much interest (see, e.g. [13-16]). It is stimulated by the possibility of using quantum entanglement in computation and communication [17].

The wave function of an entangled system is the sum of products of the wave functions of the parts of the system. For example, the wave function of an entangled state with zero spin of the pair of particles possessing spin is:

$$\Phi = \frac{1}{\sqrt{2}}(\psi_1^+\psi_2^- - \psi_1^-\psi_2^+) \qquad (19)$$

Here ψ_i^+ and ψ_i^- (i = 1,2) are the states where a particle has a clockwise and a counterclockwise spin on a certain axis.

The entangled particles are "one organism" and cannot be considered separately. The measurement results of the state of the entangled particles correlate a priori. For instance, if the total spin of the entangled particles is zero, then when one particle is found to have a clockwise spin on a certain axis, the other particle will be found to have a counterclockwise spin on the same axis. It appears as if the particles "know" about each other's state. Most interestingly, this "knowledge" is preserved even when the particles are separated by such a distance that information about the particle states would have to travel from one particle to another much faster than the speed of light in order to reach it between the measurements of the states of each particle. This is why Einstein was not happy with the concept of entanglement and called such transfer of information "spooky action at a distance" [18].

Because a pair of entangled particles represents "one organism", it is natural to infer that the subquantum world simultaneously generates pairs of particles whose wave functions are entangled. In this case it is meaningless to talk about transfer of information from one particle to another, i.e. about the speed of Einstein's "spooky action at a distance". Attempts to measure this speed should result in enormous values. For instance, in experiments [19,20] lower boundary of speed of the spooky action in entangled photon pairs was 4 orders of magnitude of the speed of light (note that these

experiments did not measure movement of a mass above the speed of light, which, of course, would have contradicted the theory of relativity).

If the measurement process does not change the states of entangled particles beyond recognition, then the results for different particles will be correlated. This will violate the Bell's inequality [21]; this violation was demonstrated in a significant number of experiments. Experience shows that the subquantum world preserves the "one organism" of entangled particles even at great distances (how the subquantum world does it, neither Schrodinger nor Einstein would have told us). A system consisting of two particles whose state is described by an entangled wave function is not a simple "sum" of those particles.

The wave function (which reflects a result of processes in the subquantum world) is a non-local quantity and the distance between the particles is irrelevant.

In this chapter we have proposed to consider that the distribution of the probability of the physical values, which is determined by the wave function, arises from subquantum processes which take place on the level of the organization of matter which underlies the phenomena described by quantum mechanics, i.e. in the subquantum world. These processes allow to explain from one position the meaning of the wave function, behavior of electrons in the atom, the collapse of this function during measurement and the paradoxes of entangled states,

From our point of view, it is necessary to recognize the existence of the subquantum processes and to study them. The subquantum processes defining the behavior of physical systems are one of manifestations of the general properties of a matter in the Universe. The study of these processes will further our knowledge of the laws of the microworld and macroworld.

Chapter seven. What can be where there is nothing. Just a regular paper

Full waves, empty waves and subquantum processes

Abstract

In this paper the appearance of a particle in a certain point in space, the full waves, and the empty waves are considered as a consequence of subquantum processes. The paper describes an experiment which measured the absorption of single photons by absorbers with various absorption coefficients, in one of the beams, after the photons interacted with the beam splitter. The measurements showed that the absorption corresponds to a single photon traveling in either one or another beam. The results of our measurements and of single photon interference experiments, combined, demonstrate the existence of the empty waves, that is, the excitations in the subquantum world which do not contain a photon. We show that seemingly justified criticism of our interpretation of the experiment is not valid. New experiments are proposed to study single-photon interference involving an empty wave.

Introduction

In 1986, Grangier, Roger and Aspect [22] demonstrated the interference of the two output beams from the beam splitter in experiments using single photon states, even though the photon can only be detected in one of the two output beams for a given run of the experiment. Paper [23] considers the supposition that one of the beams contains a wave which is not accompanied by a particle, i.e. an empty wave. This supposition is consistent with the de Broglie–Bohm theory.

According to the de Broglie-Bohm theory, it can be assumed that while a single photon travels in one particular beam, the so-called "pilot wave" that influences it travels in both. Thus, the empty wave can be considered part of the pilot wave. A number of

works suggest experiments for the detection of empty waves (see, e.g. [24-26]); however, until now no experimental evidence of the existence of such waves has been received.

The Born rule connects the wave function to the probability density of finding the particle at a given point. However, this rule is an interpretation, and not a fundamental law. In de Broglie-Bohm theory, the wave is considered a physical reality, and the link between the probability density and the wave function has the status of a hypothesis. It can be said that Born's interpretation is the truth, but not the whole truth. This means that the wave function may not equal zero even in the part of space where the particle is not observed. Hence the empty wave may also be described by the wave function, which may explain the interference of the wave containing the photon, i.e. the probability wave, or full wave, and the empty wave.

Clearly, in order to discuss the empty wave it is important to understand the physical meaning of the wave function, i.e. to have an adequate interpretation of the wave function. We will proceed from our interpretation, according to which wave function is some mathematical reflection of real physical processes taking place at the subquantum level (we think that the road into the structure of matter is a staircase with an infinite number of steps, and the subquantum level is one of these steps).

Our view is that it is impossible to exclude the existence of a region of subquantum excitation associated with a particle, where subquantum processes do not manifest the particle itself. Given the absence of a particle, this area can be called empty. Accordingly, the subquantum excitation wave, in which the particle is present, can be called the probability wave or the full wave, and the excitation wave in which the particle is absent can be called the empty wave. The full wave and the empty wave are created by real subquantum processes, that is, they are physical reality, not just mathematical objects.

Experiments observe the manifestation of the particle in a certain point of the probability wave. It is common knowledge that behind every chance there is a rule. We

do not know the rules of the subquantum world determining the formation of wave trains in which the particle manifests as an observable object. It is clear, however, that the photon can manifest anywhere in the wave train, and that this possibility is determined by some subquantum processes. A direct proof of the existence of the empty wave would mean that along with the wave train where the photon manifests, there also exists a wave train containing the potential possibility of the photon manifestation, but the actual photon does not manifest, and thus cannot be detected. Note that at any given time the photon manifests only in one of the points of the probability wave train. In all other points at that moment the wave may be considered empty.

According to [22], after the recombination of two beams the interference picture is observed. This implies that two coherent wave trains appear as a result of the interaction of the photon with the beam splitter. If the photon were to manifest in both wave trains, it would mean that its wave function is the superposition of two probability waves: the transmitted one and the reflected one. The empty wave hypothesis is consistent with the suggestion that the photon manifests in only one of the two output beams. In this case the photon wave function cannot be a superposition of two probability waves. Thus, experiments are needed which will clarify whether the photon wave function after the interaction with the beam splitter is the superposition of two probability waves or the superposition of a probability wave and an empty wave.

Experiment and discussion

Our experiment is illustrated in figure 1.

<center>single photon   beam splitter   detector 1</center>
<center>source</center>

<center>absorber</center>

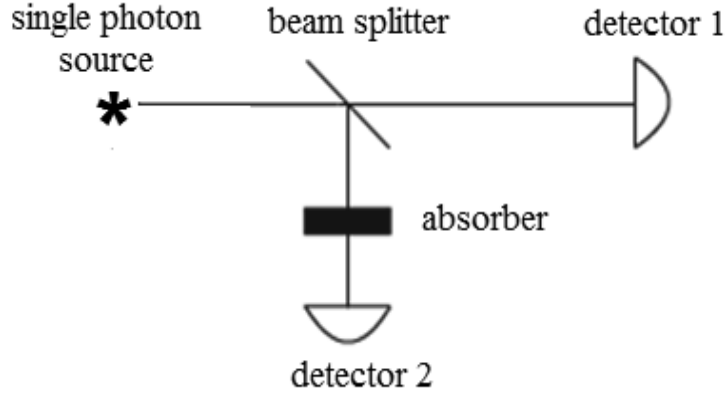<center>detector 2</center>

<center>Fig.1</center>

Let us assume that after the beam splitter the wave function of the single photon is the superposition of the wave functions corresponding to the transmitted and the reflected probability waves:

$$\psi = c_1\psi_{tr} + c_2\psi_{re} . \tag{20}$$

where the ratio of $|c_1|^2$ and $|c_2|^2$ | is equal to the ratio of the probability of the photon's manifestation in the transmitted and reflected waves. In this case the ratio of $|c_1|^2$ and $|c_1|^2$ | will be equal to the ratio of the number of photons registered by the detectors 1 and 2 in the absence of the absorber. Let N_0 is the number of the photons registered by both detectors in the absence of the absorber. Then numbers of the photons registered by the detector 1 and by the detector 2 will be equal to $N_0|c_1|^2$ and $N_0|c_2|^2$ accordingly.

If the number of the absorbed photons is N_{ab}, then the number of the unabsorbed photons is $(N_0 - N_{ab})$. Photon absorption has no effect on the wave function (20) of the unabsorbed photon after the beam splitter. If the wave function of the single photon were the superposition (20) and the absorber did not influence unabsorbed photons, then at the presence of the absorber the numbers of the photons registered by the detector 1 and by the detector 2 would be equal to $(N_0 - N_{ab})|c_1|^2$ and to $(N_0 - N_{ab})|c_2|^2$. The

numbers of the photons registered by the detectors 1 and 2 would diminish on $N_{ab}|c_1|^2$ and $N_{ab}|c_2|^2$ accordingly.

The measurement results are provided in Table 1.

K	T	N_1	N_2	N_1/N_2	$(N_1/N_2)_{av}$
0	2	44730	33745	1.325	
0	0.02	459	343	1.339	1.346
0	0.002	45	33	1.373	
0.1	2	44271	26068	1.698	
0.1	0.02	433	255	1.696	1.701
0.1	0.002	43	25	1.710	
0.2	2	44188	20502	2.155	
0.2	0.02	446	210.6	2.118	2.096
0.2	0.002	44	28	2.016	

Table 1. Column names:

K - absorption coefficient of the absorber

T $= 20\, T_m$

T_m - duration of one measurement cycle

N_1 - average number of photons registered by detector 1 in one measurement cycle

N_2 - average number of photons registered by detector 2 in one measurement cycle

$(N_1/N_2)_{av}$ - average ratio of the number of photons registered by the detector 1 and the detector 2 at different T

Table 1 shows that the ratio of the number of the photons registered by the detector 1 and the detector 2 without the absorber is 1.346 (with variation in the third decimal at various values of T). This means, that in the absence of the absorber the number of the photons registered by the detector 1 is

$$(N_1)_0 = 0.574 N_0 \qquad (21)$$

and the number of the photons registered by the detector 2 is

$$(N_2)_0 = 0.426 N_0 \qquad (22)$$

Let us suppose that after the beam splitter the wave function of the single photon is the superposition

$$\psi = c_1 \psi_{tr} + c_2 \psi_{re} \qquad (23)$$

$$|c_1|^2 + |c_2|^2 = 1$$

where $|c_1|^2 = 0.574, |c_2|^2 = 0.426$.

Let us admit that the absorber does not influence unabsorbed photon and the photon wave function remains the superposition (23). Then, when absorber is present, the number of the photons registered by the detector 1 would be equal to $0.574(N_0 - N_{ab})$ and the number of the photons registered by the detector 2 would be equal to $0.426(N_0 - N_{ab})$. The ratio of the numbers of the photons registered by the detectors 1 and 2 would remain equal to the ratio 0.574 and 0.426, i.e. equal to 1.346. Our measurements have shown, however, that the presence of the absorber in the path of the reflected beam does not change the number of the photons registered by detector 1. In the presence of the absorber, the number of unabsorbed photons registered by the detector 2 corresponds up to the third decimal to the expression

$$N_2 = (N_2)_0 10^{-k} \tag{24}$$

Because the presence of the absorber does not change the number of the photons registered by the detector 1, the number of absorbed photons is equal to

$$N_{ab} = (N_2)_0 - N_2 = (N_2)_0 \left(1 - 10^{-k}\right) = 0.426 N_0 (1 - 10^{-k}) \tag{25}$$

In the presence of the absorbers the ratio of the numbers of photons registered by the detectors 1 and 2 also corresponds to the expression

$$\frac{N_1}{(N_2)_0 10^{-k}} = 1.346 * 10^k \tag{26}$$

up to the third decimal, so it does change.

Let us suppose that the photon wave function after the beam splitter is the superposition (23) and the absorber influences the unabsorbed photon. Let us suppose also that as a result of the absorber influence the photon appears in the reflected beam (like an electron appears under influence of light in two slits experiments). This photon will be registered by detector 2. Obviously, it cannot increase the number of the photons registered by the detector 1 and make it equal to $N_0 |c_1|^2$.

Let's suppose for a moment that the tricky absorber transforms the wave function of an unabsorbed photon (23) into a superposition

$$\psi = c_{tr}\psi_{tr} + c_{re}\psi_{re} \tag{27}$$

where

$$|c_{tr}|^2 = \frac{N_0|c_1|^2}{N_0 - N_{ab}} \quad \text{and} \quad |c_{re}|^2 = \frac{N_0|c_2|^2 - N_{ab}}{N_0 - N_{ab}}$$

In this case, the number of photons recorded by detectors 1 and 2 will be equal to

$$(N_0 - N_{ab})|c_{tr}|^2 = N_0|c_1|^2 \text{ and } (N_0 - N_{ab})|c_{re}|^2 = N_0|c_2|^2 - N_{ab},$$

as in our experiment. However, it is obvious that the real absorber is not able to perform such a transformation.

Thus, it is not possible to explain our results based on superposition (23). The results of our measurements, reflected in formulas (21), (24) and (26), correspond to the photon traveling after the beam splitter in either one or another beam.

Let us now discuss the seemingly justified criticism of our interpretation of the experiment. Let us consider the experiment proposed by critics that uses a second beam splitter instead of the absorber (Fig.2).
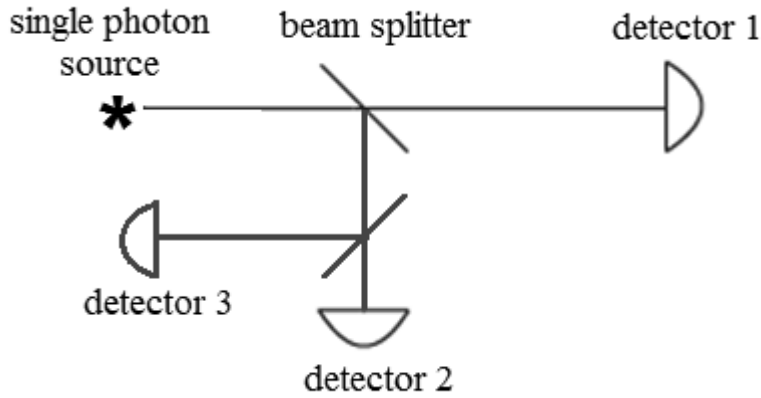

Fig.2

If we assume that after the second beam splitter we have a superposition of the wave $\psi_{tr(2)}$ that passed this beam splitter and the wave $\psi_{re(2)}$ reflected from it, then the wave function of the photon can be represented as

$$\psi = c_1\psi_{tr} + c_{1(2)}\psi_{tr(2)} + c_{2(2)}\psi_{re(2)} \tag{28}$$

Let the ratio $|c_{1(2)}|^2$ and $|c_{2(2)}|^2$ be equal to the ratio of the number of photons recorded by detector 2 and the number of photons absorbed in our experiment. Then the number of photons recorded by the detectors 1 and 2 in the experiment with two beam splitters will be equal to the number of photons recorded by the detectors 1 and 2 in our experiment. The number of photons recorded by the detector 3 will be equal to the number of photons absorbed in our experiment. From this fact critics conclude that the experiment with two beam splitters is equivalent to our experiment. The results of

measurements in the experiment with two beam splitters can be interpreted in the traditional way based on the superposition (28). Therefore, according to critics, the results of our measurements can also be interpreted without involving the idea of the empty wave.

If our experiment were equivalent to the experiment in which the absorber is replaced by a second beam splitter, then we could not claim that the results of our measurements indicate the existence of an empty wave. But these experiments could be considered equivalent only if the photon wave function in our experiment were a superposition of the functions ψ_{tr} and $\psi_{tr(2)}$ corresponding to the waves passed beam splitter and absorber, as well as some wave function φ corresponding to the absorbed photon, that is if

$$\psi = c_1\psi_{tr} + c_{1(2)}\psi_{tr(2)} + c_{2(2)}\varphi \tag{29}$$

However, according to the basic principles of quantum mechanics, the wave function Ψ can be considered the superposition

$$\Psi = \sum_n c_n \psi_n$$

of wave functions ψ_n only if the functions ψ_n are eigenfunctions of the same operator. As a result of the absorption of a photon, a state of the substance of the absorber occurs, which could be described by a certain wave function φ. However, there is no operator whose eigenfunctions are both the function $\psi_{tr(2)}$ and the function φ. Accordingly, we do not have the right to assert that the absorber transforms the photon wave function into the superposition of the wave functions $\psi_{tr(2)}$ and φ. This means that superposition (29) does not exist.

If in the experiment with two beam splitters the wave function is described by superposition (28), then before absorption by one of the detectors the photon belongs concurrently to all three beams. In our experiment, we can't claim that the photon belongs concurrently to the transmitted beam, the reflected beam and the absorber. Detectors record only unabsorbed photons whose number is equal to $N_0 - N_{ab}$.

Therefore, it is impossible to consider our experiment equivalent to the experiment with two beam splitters.

The results of measurements in the experiment with two beam splitters can be interpreted both on the basis of the superposition (28) and under the assumption the photon traveling after the beam splitters in either one or another beam. If there were a superposition (29), then the results of our experiment could also be explained both on the basis of the traditional approach and under the assumption of the photon traveling only in one of the possible beams. However, due to the fact that superposition (29) does not exist, it is impossible to explain the results of our measurements on the basis of the traditional approach.

Conclusion

Our measurements show the photon traveling after the beam splitter in either one or another beam. At the same time, for the interference in the experiments [22] to be observed, two waves must be superposed. This means that while the photon is traveling in one beam, the empty wave is traveling in the other beam. In other words, the wave function of the photon after the interaction with the beam splitter is the superposition of the probability wave (full wave) and the empty wave.

The need to perform further experiments is obvious. For example, similar double-slit experiments are possible. It would be very interesting to study single-photon interference in the presence of an absorber. If the absorber does not absorb the empty wave, then the interference pattern will be created by photons which passed the free beam and corresponding empty waves, as well as photons which passed through the absorber and their empty waves. Otherwise, the interference pattern can only be created by photons which passed the absorber. We can also consider the case when the absorber affects the empty wave, but does not absorb it, as well as the case of complete absorption of photons by the absorber.

Quantum mechanics is a fundamental theory which allows us to describe a vast number of physical phenomena. However, as a truly fundamental theory, it cannot explain and describe itself.

Quantum mechanics cannot specify the location of a particle, since it does not describe the subquantum processes that ensure the manifestation of a particle at a certain point in space. Also, quantum mechanics says nothing about subquantum processes which provide for the existence of the empty wave. Experimental proof of the existence of the empty wave may be useful in developing a more general theory, to which quantum mechanics will be an approximation.

Chapter eight. Why tomorrow is not yesterday

8.1. Time reversal experiments

There is a contradiction between the reversibility of equations in mechanics, and the irreversibility of real-world macroscopic processes. This contradiction is called "the irreversibility problem". It is one of the Great Problems of Science. Maxwell, Boltzmann, Planck, Poincare, Einstein, Von Neuman, Born, and many other outstanding physicists have tackled it. Over the century and a half, a Mont Blanc worth of papers devoted to this problem has accumulated, but it still has not been solved. The reason is that scientists tried to arrive at irreversibility from the reversible equations of mechanics without questioning whether these equations are even applicable to describing macroscopic systems. Remember, the science of mechanics was created on the basis of observing systems with a small number of particles. There really isn't a reason to assume that mechanics will be equally precise is the macroworld, where the second law of thermodynamics reigns supreme.

It is impossible to solve the mechanics equations for macrosystems with the number of particles 10^{23}. But it is possible to compare the predictions of mechanics with the predictions of thermodynamics without having to solve the equations! We made such a comparison in the experiments reversing the sign of time in quantum mechanics equations for macroscopic systems. Here is what happened.

The general solution of the Schrödinger equation

$$i\hbar \frac{\partial \psi}{\partial t} = \hat{H}\psi, \tag{30}$$

has the following form

$$\psi(t) = e^{-i\frac{\hat{H}}{\hbar}t}\psi(0) \tag{31}$$

Let the macroscopic system at the initial moment be described by the wave function $\psi(0)$. .

Then in accordance with (31) by the moment t_1 we will get

$$\psi(t_1) = e^{-i\frac{\hat{H}t_1}{\hbar}}\psi(0) \tag{32}$$

If at this moment we succeed in reversing the sign of the operator $\hat{H}$, then after time t_2 we have

$$\psi(t_1 + t_2) = e^{i\frac{\hat{H}t_2}{\hbar}}e^{-i\frac{\hat{H}t_1}{\hbar}}\psi(0) \tag{33}$$

If $t_2=t_1$, then it follows from (33) that

$$\psi(t_1 + t_2) = \psi(0) \tag{34}$$

We know from mathematics that (-a)b = a(-b). Hence, the change of sign of the operator $\hat{H}$ in the expression (33) is equivalent to the change of sign of time, i.e. reversal of time.

Consequently, if the Schrodinger equation correctly describes the evolution of a macroscopic system, then the system should revert to its original state by the moment

$2t_1$, after we change the sign of the Hamiltonian $\widehat{H}$ at the moment t_1, i.e. the system' evolution will be reversible in time.

It might seem impossible to influence a macroscopic system to change the sign of $\widehat{H}$, because in such systems the energy operator includes all the interactions between the particles in the system. However, the method of high resolution magnetic resonance allowed us to conduct this procedure for the macroscopic system of interacting magnetic moments of Fluorine nuclei in CaF_2 [27,28]. Using a specific sequence of impulse influences on the system, we tracked the evolution of energy reservoir of the magnetic interactions of the nuclei under the conditions of the changing sign of the Hamiltonian, or - which is the same thing - the sign of time. The measurements showed that equations (30) and (31) do not describe that evolution.

The magnetic resonance methods allow to measure spin system states very precisely. Our experiments were conducted in Kazan, Russia, the city where magnetic resonance was discovered in 1944 by E. Zavoisky, and the home of the magnetic resonance school recognized around the world. The papers were published in serious journals after intense peer reviews. The results have not been challenged or overturned in the years since their publication.

If the evolution of the macroscopic system had turned out to be reversible in our experiment, then the Second Law of Thermodynamics would have faced a problem. Fortunately, this did not happen. From the point of view of mechanics yesterday and tomorrow are the same. We are fortunate that the second law of thermodynamics exists and makes yesterday, today, and tomorrow possible.

If subquantum processes determine the behavior of separate particles, then clearly these processes are also responsible for the evolution of systems with the macroscopic number of particles. This implies that the second law of thermodynamics is the consequence of subquantum processes.

The Problem of Irreversibility was born from the belief that the equations of mechanics can fully describe the evolution of macrosystems. Our results have shown

that it is inappropriate to extrapolate the mechanics equations to macrosystems, which was to be expected. So what is left of the irreversibility problem?

8.2. Subquantum processes and statistical physics

The formula

$$\rho(E_n) = \frac{e^{-\beta E_n}}{\sum_n e^{-\beta E_n}}.$$

(35)

plays a fundamental role in statistical physics. It allows us to calculate the observed values of physical quantities belonging to a macroscopic system in equilibrium. In this formula, $\rho(E_n)$ is the probability of a macroscopic system state with energy E_n. The name for expression (35) is the formula of canonical distribution, or simply canonical distribution.

When deriving formula (35), textbooks on statistical physics don't mention any subquantum processes, and don't question the absolute accuracy of quantum mechanics. Instead, they assume either that the Universe is in the state of thermodynamic (heat) equilibrium, or that the Universe consists of a legion of systems which are identical to the system which is being studied, i.e. identical to each other (see, e.g. the well known textbook [29]). The first assumption means we are all dead. The second is just as scientifically credible as an assumption that inside the Earth there is a second globe which is much larger than the first. Both assumptions lead to the desired formula, but a correct end result can be derived from delirious assumptions (see collections «Physicists joke»). The correct end result does not make the delirium true.

Misconceptions in modern science can be more stunning than misconceptions of the past. It is wrong to consider that scientists of the past centuries were sillier than us. Scientific delusions of the past very often didn't contradict common sense. For instance, to be convinced that the Earth is flat, it is enough to live in an open country, and it is much more natural to assume that the small Sun which ascends in the east and sets in the

west revolves around the huge Earth, rather than the reverse. Today physicists have convinced themselves and tell the students that it is possible to consider the Universe being in equilibrium or consisting of a huge number of identical systems.

The oddities don't stop at making such marvelous assumptions. Another premise which leads to formula (35) is that the system energy may equal only to eigenvalues of its Hamiltonian [29]. But that would require the interaction between the system and its environment to be vanishingly small, i.e. the system must be practically isolated from its environment.

Let us see what happens in reality.

According to formula (13), the full energy of the isolated system is

$$E = \sum_n |c_n|^2 E_n \,, \tag{36}$$

where

$$\sum_n |c_n|^2 = 1. \tag{37}$$

Also,

$$c_n(t) = c_n(0)\exp(-\frac{i}{\hbar}E_n t) \,, \tag{38}$$

from which it follows that

$$|c_n(t)|^2 = |c_n(0)|^2. \tag{39}$$

For a macroscopic system, equations (36) and (37) have an infinite number of solutions for $|c_n|^2$. This means that at a given value of energy E there are numerous different states of the system and not at all one state equal to some eigenvalue of energy. In other words, with the same value of the total energy E we have a great number of different system states which cannot originate one from another as a result of temporal system evolution.

From the point of view of quantum mechanics, the probability of energy values E_n cannot change (see (39)). However, in the process of the system arriving at equilibrium this probability does change, and arrives at the values determined by formula (35).

The textbooks on statistical physics explain the changes in macrosystem states by its interaction with the environment. In the same breath, the system's interaction with its environment is considered extremely weak. The values of the system's physical quantities are calculated by averaging all possible states using formula (35). It is obvious that formula (35) can be used to calculate the observed quantities only if during the measurement the system has time to visit all states of the spectrum repeatedly, which is unrealistics if the interaction with the environment is extremely weak. The aforementioned models do not link the values of the contact with the environment, spectral diapason of the system energy and measurement time.

Thus we can safely say that statistical physics textbooks do not offer a derivation of canonical distribution which is in any way justified. What's left is either to follow the inspirational advice "Shut up and calculate!", or to offer a derivation for formula (35) which would not contain some physically absurd assumptions.

The speed at which a macrosystem arrives at the canonical distribution does not depend on the properties of the surface of the macrosystem nor on the structure of its environment. Thus, the influence of the environment does not explain the transition of the probabilities of the macrosystem's eigenstates to canonical distribution. This means that there must be internal processes which determine the transition of the initial distribution of probabilities to the canonical distribution. Hence, canonical distribution may be derived as a result of internal processes within the macrosystem – the processes not described by the existing quantum formalism, i.e. the subquantum processes.

In papers [9,10] we have proposed the derivation of canonical distribution (35) as a consequence of subquantum processes (in [10] we called them "hidden internal processes", which was not a very felicitous name). Our derivation proceeds on the assumption that subquantum processes cause the macrosystem to arrive at states with energy equal to eigenvalues of the Hamiltonian, while the total energy of the system remains unchanged. Using the method of the most probable distribution [29,30], we

found that it's canonical distribution (35) that corresponds to the most probable distribution of those states. We did not have to resort to any improbable assumptions

In ch.6 in 6.1 we saw that the subquantum processes are extremely fast on the time scale we are used to. It is obvious that it is exactly thanks to the speed of the subquantum processes that we can use formula (35) to solve practical problems.

We know from statistical physics that

$$\sum_n \rho(E_n) \, ln\rho(E_n) = -ln\rho(E) = \ S, \tag{40}$$

where S is the system's entropy.

Formula (40) connects entropy to the maximum number of system state realizations as a consequence of subquantum processes. We consider that the states which are described by canonical distribution (35) are the consequence of the macrosystem's irreversible tendency towards the maximum freedom in realizing its state with a given total energy, i.e. towards maximum entropy. This tendency is captured in the second law of thermodynamics, thanks to which tomorrow is not the same as yesterday.

Chapter nine. Akela has missed

As is known, the phenomenological theory of the second-kind phase transitions (the Landau theory), based on the expansion of the thermodynamical function in terms of the order parameter, does not adequately describe phenomena near the critical point.

Believing in phenomenology, we decided to take a closer look at the phenomenological theory. Our efforts were rewarded. One small but principle mistake revealed itself before our careful eye. The correction of this mistake makes it possible for the phenomenological theory to describe phenomena near the critical point in the right way. How it was done and what came out of it we describe below.

The re-examined phenomenological phase transitions theory for ferromagnets [31]

Abstract. The existence of the linear on the order parameter term of the thermodynamic functions expansion near the critical point is justified. The criticism of the arguments, used for the rejection of the odd-power expansion terms of the ferromagnets thermodynamic functions is presented. It is shown, that taking into account the linear term in expansion one achieves the consentience with experimental data on the magnetization behavior near the transition temperature in ferromagnets.

I. INTRODUCTION

Experimental investigations of the critical phenomena show, that the Landau phase transitions theory does not agree with an experiment. Usually, this fact is attributed to the large fluctuations near the critical point. However the Landau conclusions contradict even the experimental data, which are received as an exact measurements result (fluctuations are proved negligible). The experiments of Heller and Benedek [32] may be the example. In these experiments the temperature dependence of the magnetization near the critical point has been studied. The measurements were carried out by the nuclear magnetic resonance method. In the case of large fluctuations the measurements of the magnetization would be impossible. Therefore, the explanation of discrepancy of the theory and the experiment [32] by very large fluctuations seems to be not convincing enough.

The assumptions, which lie in the basis of the Landau theory, look natural and simple. That is why we decide to re-analyze carefully this theory. In the process of our analysis we have found one essential circumstance, with which it is necessary to acquaint the reader.

II. THE CORRECTION OF THE LANDAU THEORY

By examining the symmetry change at the second type phase transitions, Landau presented the crystal density function in the form:

$$\rho = \sum_{i,n} n_i^{(n)} \psi_i^{(n)} \tag{41}$$

Here n is the index of the irreducible representation of the crystal symmetry group G in the high symmetry phase and $\psi_i^{(n)}$ are the basic functions of these irreducible representations.

Denoting by ρ_0 the invariant at all transformations of the G group function (this function realizes the unit representation of the G group), Landau wrote:

$$\rho = \rho_0 + \delta\rho' \tag{42}$$

where

$$\delta\rho' = \sum_{i,n}^{l} n_i^{(n)} \psi_i^{(n)} \tag{43}$$

and the unit representation ($n=1$) is excluded from the summation.

Near the phase transition temperature (critical point T_c) the expansion of thermodynamic functions in the Landau theory is realized on the powers of small $\delta\rho'$ with ρ_0 kept invariable. We suggest that the contribution to the crystal density of the function ρ_0 cannot remain equal to $\rho_0(T_c)$ as the temperature changes. Otherwise, far from the critical point, $\rho_0(T)$ would be equal to $\rho_0(T_c)$, which is obviously not the case.

Instead, it is naturally to present the crystal density ρ as

$$\rho = \rho_0(T_c) + \delta\rho \tag{44}$$
$$\delta\rho = \delta\rho_0 + \delta\rho' \tag{45}$$

$$\delta\rho_0 = n^{(1)}\psi^{(1)} \tag{46}$$

We believe that the expansion of thermodynamic functions on powers of $\delta\rho$ is mathematically and physically more correct, than the expansion on powers of $\delta\rho'$ (43). We verify this conjecture in the next Section by calculating the critical index for magnetization and general thermodynamic relations for ferromagnets.

The invariants of the second and higher orders in the expansion of the thermodynamic functions near the critical point correspond to the density change $\delta\rho'$, which does not consist the unit representation. In particular, the second order invariant has the form

$$\eta^2 = \sum_i \eta_i^2 \tag{47}$$

with η being the quantitative measure of the deviation from the critical point.

The linear invariant $\eta^{(1)}$ corresponds to the density change $\delta\rho_0$, which transforms according to the unit representation. This invariant does not determine the symmetry change and does not independent. The magnitudes $\delta\rho_0$ and $\delta\rho'$ are of the same order. Hence, $\eta^{(1)}$ is proportional to η. This means, that in the expansion of the thermodynamic functions the linear on η term presents. Below we will show for ferromagnets, that keeping the linear term provides the consistency of experiment and theory.

III. THE LINEAR TERM AND THE CRITICAL PHENOMENA IN FERROMAGNETS

Following Landau the linear terms of the thermodynamic potentials expansion are rejected in description of the critical phenomena. One usually uses some additional arguments to exclude the odd terms in the expansion of the ferromagnet's thermodynamic functions. In the book [33] it is claimed, that the scalar function

expansion on the vector quantity may only contain the even power of this quantity. However it is not difficult to show, that this statement is incorrect. Indeed, the first law of thermodynamics for the magnetic systems can be written as

$$dU = TdS + \mathbf{H}d\mathbf{M} \tag{48}$$

For the Helmholtz potential $A(T;M)$ we have

$$dA = -SdT + \mathbf{H}d\mathbf{M} \tag{49}$$

From the expression (49) it follows that

$$\mathbf{H} = \frac{\partial A}{\partial M} = \mathbf{n}\frac{\partial A}{\partial M} \tag{50}$$

where $\mathbf{n}$ is the unit vector along the $\mathbf{M}$ direction. Thus, we can rewrite Eq. (49) in the following way:

$$dA = -SdT + HdM \tag{51}$$

The example illustrates the general situation that only numerical characteristics of the vectors do appear (via the scalar products) in the expression for the thermodynamic functions. Therefore, it is instructive to expand the ferromagnet's thermodynamic functions on powers of magnetic moment magnitude. Thus, it is not possible to reject the terms of the expansion with odd powers of the magnetic moment magnitude declaring that the magnetic moment is vector.

In the book [34] the absence of the M odd powers in the ferromagnet's thermodynamic functions expansion is justified by the statement, that these functions are even regarding M. However, the change in the M sign in a ferromagnets is confined to the change of the magnetic field sign (see Eq.(50)). At the simultaneous change of M and H signs the thermodynamic functions values do not change. If we expand the thermodynamic function on the magnetic moment magnitude, when M changes sign, the

non-zero coefficients at odd M powers also change the sign, and the independence of the thermodynamic function on the M sign will be ensured.

Let us expand the potential $A(T;M)$ up to fourth power on M near the critical point:

$$A(T,M) = \sum_{n=0}^{4} L_n(T)M^n \qquad (52)$$

For the ferromagnetic phase the equilibrium value of M is determined from the expression:

$$H = \left(\frac{\partial A}{\partial M}\right) = L_1(T) + 2L_2(T)M + 3L_3(T)M^2 + 4L_4(T)M^3 \qquad (53)$$

Then consider separately the term $L_1(T)$ of equation (53). The expansion of $L_1(T)$ on $t = T - T_c$ powers up to the first power has the form:

$$L_1(T) = L_1(T_c) + t\left(\frac{\partial L_1}{\partial T}\right)_{T_c} \qquad (54)$$

In the ferromagnetic phase $L_1(T) = 0$, since at $T = T_c$ the equilibrium value $M = 0$ in the case $H = 0$. Hence, the coefficient $L_1(T)$ is given by

$$L_1(T) = at \qquad (55)$$

where

$$a = \left(\frac{\partial L_1}{\partial T}\right)_{T_c} = \left(\frac{\partial^2 A}{\partial T \partial M}\right)_{T_c} = \left(\frac{\partial H}{\partial T}\right)_{T_c} \qquad (56)$$

Therefore, the coefficient L_1 changes the sign at the M sign change that is confined with the H sign change. Thus, the rejection of the linear term of the expansion (52) has no serious theoretical reasons.

Expanding the coefficients L on powers of t, we rewrite Eq.(53) in the form:

$$H = \sum_{m,n}^{m+n\leq 3} a_{mn} t^m M^n \tag{57}$$

For the magnetic systems at the phase transition point we have the following relations (in accordance with the general theory of the second-type phase transitions):

$$\left(\frac{\partial H}{\partial M}\right)_{T_c} = \left(\frac{\partial^2 A}{\partial M^2}\right)_{T_c} = 0$$

$$\left(\frac{\partial^2 H}{\partial M^2}\right)_{T_c} = \left(\frac{\partial^3 A}{\partial M^3}\right)_{T_c} = 0 \tag{58}$$

$$\left(\frac{\partial^3 H}{\partial M^3}\right)_{T_c} = \left(\frac{\partial^4 A}{\partial M^4}\right)_{T_c} > 0$$

Hence, the terms with M and M^2 must be absent in Eq.(57). The terms proportional to tM, t^2, t^2M, tM^2 and t^3 are smaller than the term at, and we may neglect these terms. At the same time we must keep the terms with M^3, since a *priory* the relative values of t and M unknown. As a result, in the case $H=0$ the equation (57) takes the form:

$$H = at + cM^3 = 0 \tag{59}$$

where

$$c = \frac{1}{6}\left(\frac{\partial^4 A}{\partial M^4}\right)_{T_c} = \frac{1}{6}\left(\frac{\partial^3 H}{\partial M^3}\right)_{T_c} \tag{60}$$

From Eq.(59) we easily find:

$$M = \left(-\frac{at}{c}\right)^{\beta}, \quad \beta = \frac{1}{3} \tag{61}$$

In the experiments of Heller and Benedek [32] the dependence of M^3 on t in MnF_2 in zero external field was studied (Fig.1). This dependence occurs to be linear. Thus, taking into account the linear term in the expansion (52) one achieves the good agreement with the experiments in zero fields.
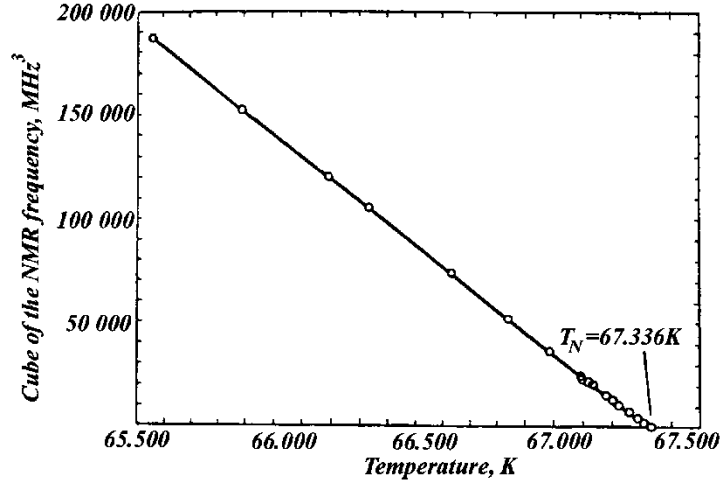

Fig.1 The dependence of the magnetization third power on the temperature in zero field for MnF_2

If the odd terms in the expansion (52) are rejected, we return to the Landau-type theory, and get instead of Eq. (59)

$$H = btM + cM^3 = 0 \tag{62}$$

where

$$b = \left(\frac{\partial^3 A}{\partial M^2 \partial T} \right)_{T_c} = \left(\frac{\partial^2 H}{\partial M \partial T} \right)_{T_c} \tag{63}$$

From Eq.(62) it follows:

$$M = \left(-\frac{bt}{c} \right)^{\beta}, \quad \beta = \frac{1}{2} \tag{64}$$

which contradicts with experiments. Moreover, in the Landau-type theory one of the equilibrium values of M is zero. At the discussion of this fact it is affirmed, that zero solution corresponds to the temperature, which is higher than the Curie point. This statement seems internally inconsistent with physical meaning of the equation (62), for which both zero and non-zero solutions correspond to the same temperature. Alternatively, in our theory the spurious, non-physical solution, $M = 0$, does not appear.

It is known, that for magnetic systems the correlation must be fulfilled [34]:

$$-\left(\frac{\partial M}{\partial T}\right)_H \left(\frac{\partial H}{\partial M}\right)_T = \left(\frac{\partial H}{\partial T}\right)_M \tag{65}$$

Using Eq.(59) and Eq.(61), we find at $T = T_c$ in correspondence with relation (65):

$$-\left(\frac{\partial M}{\partial T}\right)_H \left(\frac{\partial H}{\partial M}\right)_T = a = \left(\frac{\partial H}{\partial T}\right)_M \tag{66}$$

If linear term in the expansion is rejected, from Eq.(62) and Eq.(64) at $T = T_c$ we find:

$$-\left(\frac{\partial M}{\partial T}\right)_H \left(\frac{\partial H}{\partial M}\right)_T = t^{\frac{1}{2}} \left(\frac{\partial^2 H}{\partial M \partial T}\right)^{\frac{3}{2}} \left[-\frac{6}{\left(\frac{\partial^3 H}{\partial M^3}\right)}\right]^{\frac{1}{2}} = 0 \tag{67}$$

Hence, the relation (65) does not hold, that is incompatible with thermodynamics of magnetic systems. In the presence of the external field we rewrite Eq.(57) in the form:

$$H = at + btM + cM^3 = 0 \tag{68}$$

We retain in the above equation the term proportional to tM, since this term is essential for the explanation of the critical phenomena in the strong magnetic fields.

The dependence of the magnetic moment on the external field near the critical point (Fig. 2,3) was studied in the work [35]. In strong magnetic fields the dependence

of H/M on M^2 occurred to be linear. This result is in agreement with Eq.(68). Indeed, this equation can be converted to the form:

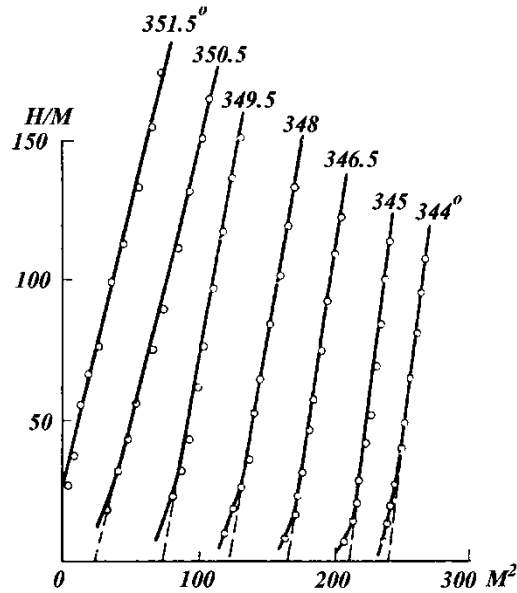$$\frac{H}{M}\left(1 - \frac{at}{H}\right) = bt + cM^2 \tag{69}$$
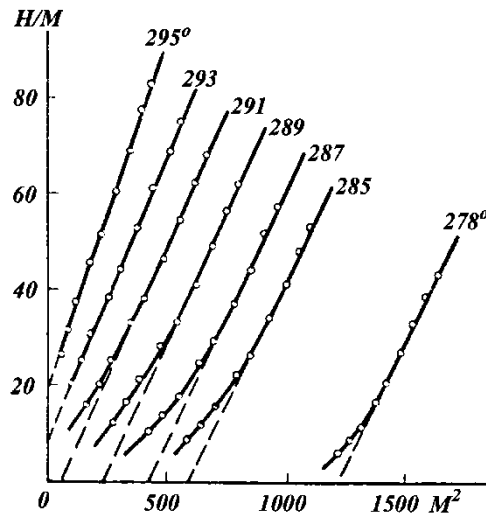

Fig.2 The dependence of H/M on M^2 for Ni

Fig.3 The dependence of H/M on M^2 for alloy of 36% Ni and 64% Fe

In the strong field we can neglect the term at/H in the left-hand part of Eq.(69) in comparison with unity. As a result we obtain the linear dependence of H/M on M^2.

In the Landau-type theory the term at/H is absent from the very beginning. That is why the experiments [35] were considered as the confirmation of the Landau-type theory.

With the decrease of the field the domain structure is starting to influence the dependence of H/M on M^2. Therefore it is impossible to pick out the contribution of the at/H term of Eq.(69) to the above experimental results.

We may conclude, that the taking into account the linear term in the expansion of thermodynamic functions is consistent with the experiment both in the strong and zero magnetic fields.

IV. CONCLUSION

We have the serious reasons to consider, that the thermodynamic function expansion up to the fourth power in order parameter is correct at least for the three dimension systems. The origin of the Landau-type theory failures is connected with incorrect disregard of the linear term in thermodynamic functions expansion. Keeping of the linear term restores consistency of the theory with an experiment and may promote the better comprehension of phenomena near the critical point.

Epilogue

They say that "man is the king of nature", but in our time he is more likely the executioner of nature. Let's ask the question "Who harms nature more, a human or a dog?" Would you like a hint?

The leaders of so-called civilized countries, having fallen greedily on power, and having received bloodcurdling weapons from the scientists of the Hominidae family, are dancing around their tribal fires, beating their chests and brandishing those weapons.

Other governing apes, looking at those dances, also reach out their grabby hands for such weapons. Mass destruction methods are mushrooming on the planet. I can only hope that the results of my scientific endeavours presented in this essay will not be used for creating new methods of mass destruction or to perfecting the old ones.

Premeditated murder of one human being is considered a grave offense in all UN countries. Creating an army and equipping it with deadly weapons designed to kill a maximum possible number of people is considered natural and even respectable by the leaders of the same countries. Design and manufacture of such weapons enriches the gangs of industrialists, politicians and scientists. Poets, writers, musicians and organs of mass disinformation glorify those heroes of real and imaginary wars who destroyed the largest number of human lives.

Now is good time to break this news: we have unexpectedly found ourselves in the 21st century! The situation has changed but we have remained the same, which is bound to result in big trouble. Here is a Russian fable to illustrate:

"Once upon a time there lived an old man and an old woman who were very poor and had nothing at all to their name. And they kept getting poorer and poorer till there was nothing left to eat in the house, not even bread, Said the old man: "Do bake us a bun, old woman! If you scrape out the flour-box and sweep out the bin, you'll have enough flour."

So the old woman scraped out the flour-box and swept out the bin, she made some dough and she shaped a little round bun out of it. She then lit the oven, baked the bun and put it on the window sill to cool. But the bun jumped out of the window and onto the bench outside, and from the bench onto the ground, and away it rolled along the road!

On and on' it rolled, and it met a Rabbit coming toward it. "I'm going to eat you up, Little Round Bun!" called the Rabbit. "Don't do that, Fleet-Feet, let me sing you a song instead," said Little Round Bun. "All right, let's hear it!" "Here it is!"

"I was scraped from the flour-box

And swept from the bin

And baked in the oven

And cooled on the sill.

I ran away from Grandpa,

I ran away from Grandma,

And I'll run away from you, this minute I will!"

    And off it rolled and away.

    By and by it met a Wolf coming toward it. "I'm going to eat you up, Little Round Bun!" called the Wolf. "Don't do that, Brother Wolf, let me sing you a song instead."

"All right, let's hear it!"

"I was scraped from the flour-box

And swept from the bin

And baked in the oven

And cooled on the sill.

I ran away from Grandpa,

I ran away from Grandma,

And I'll run away from you, this minute I will!"

    And away it rolled.

    By and by it met a Bear coming toward it. "I'm going to eat you up, Little Round Bun!" called the Bear. "Don't do that, Brother Bear, I'll sing you a song instead!" "All right, let's hear it!"

"I was scraped from the flour-box

And swept from the bin

And baked in the oven

And cooled on the sill.

I ran away from Grandpa,

I ran away from Grandma,

And I'll run away from you, this minute I will!"

And away it rolled and away!

By and by it met a Fox coming toward it. "I'm going to eat you up, Little Round Bun!" called the Fox. "Don't do that, Sister fox, I'll sing you a song instead." "All right, let's hear it!"

Little Round Bun began to sing:

"I was scraped from the flour-box

And swept from the bin-"

But before it could go on, the Fox opened her mouth and - snap! -she gobbled it up".

This fable has a tragic ending. The Little Round Bun did not realize that the situation has changed, and kept singing the same tune. So it was eaten.

Power-hungry hominids are calculating how many times they can destroy their geopolitical enemies, and all humanity as collateral damage, with the help of the modern weapons. More effective weapons of mass destruction are developed and widely demonstrated. Political prostitutes of all genders and paid-off journalists-propagandists stoke up mutual hate in the unstable world. The likelihood of a global catastrophe is rising every day.

So is there a way out? Yes there is! Even two!

Way out #1.

Change the nature of humans. It won't take more than 100,000 years, and serenity will reign on Earth, if no serious problems occur until then.

Way out #2

Create effective international special forces which will be taking out the government leaders who start a war. It's better to take out a small number of reprobates than to allow them to kill a large number of innocent civilians. This approach will certainly save numerous humans who so want to live.

The implementation of the idea of taking out those who start a war will bring peace to the world and will save humankind. It is time to realize that the middle ages are over, and to stop being Little Round Buns.

So, to work, United Nations!

Homo Sapiens is a part of life which appeared remarkably on our small planet. If we really are sapiens, we must do everything to preserve this life. I hope we will make it, if we try very hard.

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