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PROBLEMS OF SIMILARITY AND PHYSICAL CONSTANTS IN MODERN THEORETICAL PHYSICS

Problems of similarity and physical constants in modern theoretical and mathematical physics are discussed. Main notions of Descartian method and Newtonian four rules of conclusions in physics as foundation of modern physics are represented. Place of similarity in these methods is shown. Short historical review of creation the basic physical and mathematical constants is represented. Various methods of search the physical constants in main chapter of modern physics (theoretical and experimental) are analyzed. More detail analyze is made for basic fundamental constants: Newtonian gravitation constant, velocity of light, electron charge, Planck constant, Boltzmann constant. Role similarity and constants in the formation of physical laws and theories is analyzed. J. Stoney and M. Planck systems of universal units are represented. The role of Planck system in the modern cosmology is observed. Short comparative analysis of various physical, mathematical and other theories for various chapters of knowledge is made. A place method of similarity and physical constants in the creation theory of informative-physical structures is discussed. A role of similarity in the creation various physical theories is shown. Among them: hydrodynamics, magnetic hydrodynamics, astrophysics, electromagnetic theory of optical laser-induced breakdown of matter. Physical numbers (Reynolds, Nusselt, Rayleygh, Prandtl, Tailor and other numbers) are mathematical forms of formulation the conditions of similarity for corresponding chapters of theoretical and applied physics. Principle of similarity was used for the creation the theory of the Thomson-Benard phenomena for electron gas in semiconductors. Theory of this classical hydrodynamical phenomenon was created by Rayleygh and developed by S. Chandrasekar. Perspective directions of using these methods for the development modern theoretical, mathematical and computer physics the search of new synthetic sciences are discussed too.
Key words: *similarity, constants, physical laws, measurement, Stoney, Planck, cosmology, hydrodynamics, Relaxed Optics.*

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ПРОБЛЕМИ ПОДІБНОСТІ ТА ФІЗИЧНИХ КОНСТАНТ В СУЧАСНІЙ ТЕОРЕТИЧНІЙ ФІЗИЦІ

Обговорюються проблеми подібності та фізичних констант у сучасній теоретичній та математичній фізиці. Викладено основні уявлення про метод Декарта та чотири ньютонівські правила умовиводів у фізиці як основи сучасної фізики. Показано місце подібності в цих методах. Представлено короткий історичний огляд створення основних фізико-математичних констант. Проаналізовано різні методи пошуку фізичних констант у основних розділах сучасної фізики (теоретичні та експериментальні). Більш детально проаналізовано основні фундаментальні константи: гравітаційну сталу Ньютона, швидкість світла, заряд електрон, сталу Планка, сталу Больцмана. Аналізується подібність ролей і констант у формуванні фізичних законів та теорій. Представлені системи універсальних одиниць Дж. Стоні та М. Планка. Досліджена роль системи Планка в сучасній космології. Зроблено короткий порівняльний аналіз різних теорій. Обговорюється метод місця подібності та фізичних констант при створенні теорії інформаційно-фізичних структур. Показано роль подібності у створенні різних фізичних, математичних та інших теорій *для різних галузей знань. Серед них: гідродинаміка, магнітна гідродинаміка, астрофізика, електромагнітна теорія оптичного лазерного пробою речовини. Показано що різні числа (Рейнольдса, Нуссельта, Релея, Прандтля, Тейлона та інші) – це математичні форми формулювання умов подібності для відповідних розділів теоретичної та прикладної фізики. Принцип подібності був використаний для створення теорії явищ Томсона-Бенарда для електронного газу в напівпровідниках. Теорія цього класичного гідродинамічного явища була створена Релеєм і розвинена С. Чандрасекаром. Також обговорюються перспективні напрямки використання цих методів для розвитку сучасної теоретичної, математичної та комп'ютерної фізики, а також пошуку нових синтетичних наук.*

Ключові слова: *подібність, константи, фізичні закони, вимірювання, космологія, Стоні, Планк, гідродинаміка, релаксаційна оптика.*

Introduction. The problems and role of similarity and physical and mathematical constants in modern theoretical, mathematical and computer physics in past, present and future are discussed [1 – 15]. This problem is little research in modern physics. Therefore we represent short system analysis of this problem.

The problem of similarity in modern physics was begun by R. Descartes [4, 5]] (his method) and I. Newton [4, 6]] (four rules of conclusions in physics).

Problems of mathematical and physical constants were begun by number π and developed to Feygenbaum numbers [4, 10, 15] and Klitzing constants [4]. First physical constants are gravitational constant, light velocity, electron charge, Planck constant and Boltzmann constant [1 – 4].

J. Stoney and M. Planck created systems of Stoney's and Planck units [3, 4]. Planck constants were used for the creation of modern cosmology: plankeon as gravitational vacuum [3, 4].

Problems of introduction new constants are represented by Klitzing constant (quantum Hall phenomenon) [4] and Feygenbaum numbers [10, 15].

Similarities principles in hydrodynamics, magnetic hydrodynamics are represented with help Reynolds, Nusselt, Rayleygh, Prandtl, Tailor and other numbers [7, 8, 15]. These quantities allow explaining linear and nonlinear phenomena with united point of view [8, 15]. So, theory of hydrodynamic Thomson-Benard phenomenon as prevortex state was adapted and used for the electron gas in semiconductors [11].

Similarity principle and basic physical constants was used for the creation synthetically theory of informative physical structures [4].

This principle was used for the creation theory of electromagnetic laser-induced optical breakdown (modified Rayleygh theory) [12].

Results and discussions. The idea of similarity was introduced in Descartian and Newtonian methods [4 – 6].

The main rules of the Descartes method are the following [4, 5]:

First: do not regard as true everything that was not before, unless before recognized it without doubt the true, that is, diligently avoid hurried and prejudiced and incorporate into my judgments only what is presented to my mind so clearly and legibly that in no way can not give cause for doubt.

Second: divide each of the difficulties I consider into as many parts as needed to better resolve them.

Third: to guide the course of their thoughts, ranging from the simplest and most easily understood, and to rise slowly, as in degrees, to the knowledge of the most complex, allowing the existence of an order even among those that are not naturally linked between things by itself.

And the last thing to do is to make such complete lists and such general reviews everywhere to be sure that nothing has been missed.

A different way, but also from Descartes, was used by Isaac Newton. First, he approached the problem of not building, but the calculation of tangent to the curves. So the Newtonian version of the mathematical analysis appeared: the method of fluxes and fluent. But unlike Leubniz, who used Descartes' methodology, I. Newton (1643–1727 years) created his own methodology, which is practically a synthesis of methodology of Descartes and F. Bacon. Most clearly it is given in his rules of reasoning in physics [4, 6]:

Rule 1. It is not necessary to require from nature other causes beyond those which are true and sufficient to explain phenomena.

Rule 2. Therefore, as far as possible, we must attribute the same causes to the manifestations of the nature of the same species.

Rule 3. Such properties of bodies that can neither be amplified nor weakenable and which are in all bodies over which tests can be performed must be considered to be the properties of all bodies in general.

Rule 4. In the experimental philosophy, propositions derived from phenomena by means of general induction should be considered to be accurate or approximately correct, despite the possibility of opposing hypotheses, until there are phenomena which they will either be more precise or will be recognized as invalid.

The first two rules are a practically modified dedcort of Descartes; the last two rules are the inductive principle of F. Bacon. By the way, Newton introduced the last rule in the third edition of "The Mathematical Principles of Natural Philosophy," indicating how long he thought and worked on his method. In the manuscript there was also a fifth rule in which Newton contrasts with the Cartesian deduction of Lokk's empiricism [4].

Later, thanks to Ch. Wolf, I. Kant, L. Euler, this methodology was associated with measurement. So the modern physics, mathematics and a number of other sciences arose. It was on the path of optimal deductive synthesis that modern electrodynamics, thermodynamics, cybernetics, and quantum theory [4] were created.

Now we represented some problems of fundamental constants in modern theoretical physics according [3, 4].

First fundamental constant was introduced by I. Newton (gravitational constant γ). Second fundamental constant – light velocity in vacuum c was received in experiment. Electron charge e was received by J. Stoney from formula

$$e = \frac{F}{A}, \tag{1}$$

where F – Faradey number, A – Avogadro number [3, 4].

Third fundamental constant h (Planck constant, quantum of action) was received by Planck for the resolution of ultraviolet catastrophe [4]. M. Planck introduced Boltzmann constant k_B (quantum of entropy) too [4].

J. Stoney to construct such a system in 1874 [3, 4]. He selected the following constants: the Newtonian gravitational constant, the speed of light and the electron charge. Based on considerations of dimension, he received the length l_s, time t_s and mass m_s.

$$l_S = \left(\frac{\gamma e^2}{c^4}\right)^{1/2} \sim 10^{-35}\,cm, \tag{2}$$

$$t_S = \left(\frac{\gamma e^2}{c^6}\right)^{1/2} \sim 3 \cdot 10^{-46}\,s, \tag{3}$$

$$m_S = \left(\frac{e^2}{\gamma}\right)^{1/2} \sim 10^{-7}\,gm, \tag{4}$$

Some years later, in 1906, and apparently not knowing to Johnstone Stoney's work, Planck also considered the question of "natural units" [3, 4]. He chose the velocity of light and Newtonian gravitational constant like his predecessor and but his third choise was the newly introduced quantum of action, h, which we now call Planck's constant [3, 4]. The Planck's units (length l_p, time t_p and mass m_p) there

$$l_P = \left(\frac{\gamma\hbar}{c^3}\right)^{1/2} \sim 10^{-33}\,cm, \tag{5}$$

$$t_P = \left(\frac{\gamma\hbar}{c^5}\right)^{1/2} \sim 5 \cdot 10^{-44}\,s, \tag{6}$$

$$m_p = \left(\frac{c\hbar}{\gamma}\right)^{1/2} \sim 10^{-5}\,gm. \tag{7}$$

Where $\hbar = h/2\pi$ – Dirac constant.

Plank constants were used for the modeling "gravitational" vacuum" (plankeon) [1 – 4].

The connection of the integrals of motion with the integral of action is established by Noether's theorems. Thanks to them it is possible to establish which integrals of motion correspond to which symmetry (group). This theorem plays an important role in quantum physics and in theories of everything [1–4].

The classical application similarity for formulation proper criteria of similarity we demonstrated on example the stationary flows of uncompressed Newtonian fluid [7, 8].

Let us define the concept of similarity, for which we consider two different stationary flows. If each point r_1 of space in the case of one flow can be assigned a point r_2 of space in the case of another flow by conversion

$$r_2 = kr_1, \tag{8}$$

where k is the same for all points of the comparative spatial regions, and it turns out that any value Q_1 that characterizes the first flow and which is taken at any point Q_2 that is associated with the corresponding value that characterizes the second flow and taken in point $r_2 = k\,r_1$, as ratio

$$Q_2(r_2)\big|_{r_2 = kr_1} = k_Q Q_1(r_1) \tag{9}$$

with a constant k_Q, then such stationary flows are called similar, and constants k, k_Q are called similarity coefficients.

To find out the similarity criterion that interests us, we present the Navier – Stokes equation in dimensionless form [8]. To do this, set the constants that characterize the flow of incompressible viscous fluid, namely: specific (kinetic) viscosity ν, the size of the inhomogeneity l and the velocity U of the flow (for example, in the case of flow around the sphere l and U will be equal to the radius of the sphere and flow velocity at infinity). Then, introducing dimensionless functions and operators we have

$$\tilde{r} = \frac{r}{l} , \quad \tilde{\nu} = \frac{\nu}{U} , \quad \tilde{p} = \frac{p}{\rho U^2} , \qquad (10)$$

$$\tilde{\nabla} = l\nabla , \qquad \tilde{\Delta} = l^2\Delta ,$$

Navier-Stokes equation for stationary currents without outside forces has next form [8]

$$\left(\tilde{\nu}\tilde{\nabla}\right)\tilde{\nu} = -\tilde{\nabla}\tilde{p} + \frac{1}{R}\tilde{\Delta}\tilde{\nu} , \qquad (11)$$

where

$$R = \frac{Ul}{\nu} \qquad (12)$$

– Reynolds number (this is the only dimensionless combination of dimensional quantities U, l, v, which characterize the flow).

Equation (11) implies Reynolds's similarity law, according to which two stationary flows of uncompressed viscous fluid that flow around geometrically similar bodies in the absence of given forces are similar if both flows are characterized by the same Reynolds number [8].

We begin this chapter from Quantum Hall effect – quantization of transverse conductivity of two-dimensional electronic gas in strong magnetic fields for low temperatures [4].

Measurements for $T \sim 5°K$ shown [4], that Hall conductivity σ_{xy} is changed stepwise with increasing of magnetic induction B and concentration n^* (Fig. 1).

Each step is corresponded of increasing σ_{xy} on value the quantum of conductivity [4]

$$\sigma_0 = \frac{e^2}{h} . \qquad (13)$$

That corresponded to quantum of resistivity

$$R_k = \frac{1}{\sigma_0} = \frac{h}{e^2} = 25812,807449 \; Ohm. \qquad (14)$$

Last value was called Klitzing constant.

Precision of determination the steps and its accordance to multiple values $N\sigma_0$ (N – integer numbers) is 7-9 significant digits. Theory of this phenomenon is absented.

With help similarity principle we received the formula for determination maximal radiuses of laser-induced nanovoids $R_{\max}$ [12]

$$R_{\max} = \frac{2R}{0.915r}\sqrt{\frac{E_{ir}}{\pi\tau_i cE}} , \qquad (15)$$

where r is the radius if macroscopic zone of destruction, R – radius of nanoneeds (microscopic channel of breakdown, E_{ir} energy of pulse irradiation, E – Young module [15]. If we substitute $r = 250$ *nm*, $R = 10$ *nm*, E=600 *GPa* [118, 147], E_{ir}=300 *nJ*, $\tau_i = 130$ *ps*, c=·10^8 *m/s*, than have $R_{\max}$=11 *nm* [12]. These results allow explaining the corresponding experimental data [12].

In classic hydrodynamics Rayleygh formula we changed the velocity of sound on velocity of light. The basic mechanism of generation this shock process is multiphotonic absorption of light (interference maxima of short-wave range of laser-induced Cherenkov radiation). This process has short range electromagnetic nature.

The Feygenbaum numbers were received in computer mathematics but now it used for the resolution many problems of nonlinear dynamics: from demography to nuclear and laser technologies [10, 15].

Principle similarity was used for the creation an equilibrium econometrics. P. Samuelson physical-chemical Le Chatelier – Brown principle

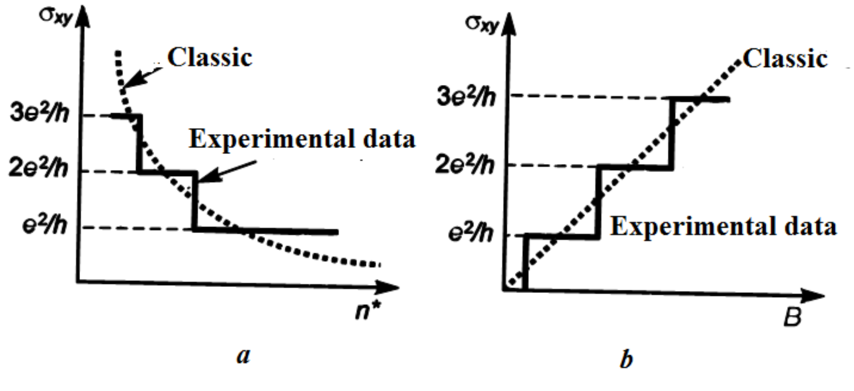

Fig. 1. Stepwise dependences transverse conductivity σ_{xy} from concentration n^* (*a*) and magnetic induction B (*b*) [4]

converted to economical Le Chatelier – Samuelson principle [13, 14].

A. Einstein expanded "mechanical" E. Mach theory of relativity on all physics [1–4]. He added fourth postulate about a constancy of the light velocity in vacuum for all inertial reference frames [1–4]. This theory was called special theory of relativity [1–4].

Principle of similarity may be used for the synthesis and unification various theories in one system (theory). Example of this theory is theory of information-physical structures [4].

In contrast to classical representations that exist in cybernetics and physics, the theory of information-physical structures is the synthesis of physical and information theory. The following problem is practically addressed: is it not possible to construct the theory so that it is based on both informational and physical laws and principles. Such a program was implemented in the theory of information and physical structures [4], the main element of which is the Rayleygh ratio. We give it in a one-dimensional form:

$$\Delta k \cdot \Delta x = \Delta\omega \cdot \Delta t = 1, \qquad (16)$$

where Δk, Δx, $\Delta\omega$, Δt – changes in the wave number, coordinates, frequency and time, respectively.

When multiplying this relation by h (Planck constant) and replacing the sign of equality with a sign more than equal ($\geq$), then we will have

$$\Delta p \cdot \Delta x = \Delta E \cdot \Delta t \geq h. \qquad (17)$$

This is nothing more than a mathematical expression of Bohr's complementarity and the uncertainty principle.

The main concepts of the theory of information-physical structures are [4:

1) the principle of fundamental harmonic equilibrium;

2) the equivalence of all canonical parameters: E – energy; p – linear momentum; k – wave number; x – coordinate; ω – frequency; t – time;

3) polymetry, that is, for each physical phenomenon corresponds to its own metric (symmetry, geometry, dimension, etc.).

Definition 1. Information-physical (dynamic) structures will be called mathematical structures (constructive), which are formed and changed under the influence of the change of any of the canonical parameters or group of parameters, or the type of functional dependence (communication) between them [4].

Definition 2. A dynamic structure with pure bonds is called a structure in which

$$k \cdot x = N_1; \ \omega \cdot t = N_2, \qquad (18)$$

where N_1, N_2 – numbers.

***Principle of fundamental harmonic equilibrium*:** When in the information-physical structure with pure bonds the form of connections does not change (does not change its dimension), the structure is in a state of harmonic equilibrium.

***Principle of dynamic equilibrium*:** A structure is called dynamically equilibrium if

$$k \cdot x - \omega \cdot t = 0 \qquad (19)$$

or

$$k \cdot x = \omega \cdot t. \qquad (20)$$

Roughly speaking, correlations (18) and (19) are expanded Rayleygh ratio.

Now we rewrite Rayleygh ratio and (16) in the form:

$$\Delta k \cdot \Delta x = \Delta\omega \cdot \Delta t, \qquad (21)$$

$$\Delta p \cdot \Delta x = \Delta E \cdot \Delta t. \qquad (22)$$

We replace the operator Δ on a differential *d*. If only the parameter under the differential does not go to zero, then this substitution is mathematically correct. In this case we have

$$dk \cdot dx = d\omega \cdot dt, \quad dp \cdot dx = dE \cdot dt, \qquad (23)$$

or equivalent

$$\frac{dx}{dt} = \frac{d\omega}{dk} = const, \quad \frac{dx}{dt} = \frac{dE}{dp} = const. \qquad (24)$$

Integrating (24), with $const = V$ (speed) we have

$$E = pV \pm C_1; \ x = Vt \pm C_2; \ \omega = kV \pm C_3; \qquad (25)$$

where C_1, C_2, C_3 – integration constants. Having put $C_1 = E_0$, $C_2 = x_0$, $C_3 = \omega_0$, we have

$$E = pV \pm E_0; \ x = Vt \pm E_0; \ x = Vt \pm E_0; \qquad (26)$$

that is nothing else than the law of conservation of energy, the law of inertia and the law of addition of frequencies, and also the law of constant interaction velocity in an isotropic medium (relation (24) . In an electromagnetic environment, this will be the speed of light *c*. If in the first case, replace *V* on *c*, and E_0 on m_0c^2, where m_0 – the initial mass of the moving body, then we have

$$E = p \cdot c \pm m_0 \cdot c^2, \qquad (27)$$

that is, the law of conservation of energy in an isotropic electromagnetic environment.

Further, the expansion of the relation (18) is carried out through the harmonic potential [4]

$$\varphi = \varphi_0 \exp\{i(k \cdot x - \omega \cdot t)\}. \quad (28)$$

As shown in [4], is nothing more than a dimensionless entropy; for large it becomes equal to Boltzmann or Shannon (in more detail it is disassembled in [4]) entropy, that is

$$S_e = k \cdot x - \omega \cdot t \quad (29)$$

when $\delta S_e = k \cdot x - \omega \cdot t > 0$ we have the law of increasing the entropy, and with $\delta S_e = k \cdot x - \omega \cdot t < 0$ the negetntropic principle of information theory.

As we see at the level of laws, physics and information theory are synthesized.

The main task is to understand the meaning that these values will have in wave mechanics and to associate them with the fundamental parameters of atomic level particles, such as mass, frequency or wavelength.

De Broglie's attempt to establish this relationship is very similar to his first thoughts on wave-corpuscular dualism. Let us dwell now on this approach. In wave mechanics, with every particle of mass *m*, a periodic phenomenon of frequency ν is connected. To express this relation quantitatively, where Broglie compares the Einstein formula $E = mc^2$ with Planck formula hv and deduces the equality [4]

$$mc^2 = hv, \quad (30)$$

which in the most general form reflects the correspondence between the postulate of quanta and the principle of relativity.

To satisfy the principle of relativity – means to demand that the law be the same for all observers, who are in a straightforward uniform motion relative to each other. However, neither mass nor frequency is what is called relativistic invariants, that is, values that do not vary from one observer to another. It is necessary that both of them change in the same way so that the equality in which they enter can be preserved, which leads to serious difficulties.

Wave mechanics appeared, in a sense, with de Broglie theorem, according to which everything proceeds as if there was a wave propagating at a much higher speed than a particle, and which is a standing wave with frequency 0 for the observer being in a state of rest, and every other observer always sees it in the phase with the internal cyclic motion of a particle. De Broglie showed that the frequency of such a wave varies from one observer to another as well as mass, and hence it follows that the quantum relation (30) will be relativistic covariant when we replace it with a cyclic frequency, which we denote by ν_c to the frequency of this wave.

Let's consider thermodynamics. As shown by M. Plank, A. Einsteyn, M. von Laue, its principles are influenced by the principle of relativity. For example, when entropy is relativistic invariant, that is, it has the same value for all observers, and then the temperature and heat should be considered differently. When an observer in a state of rest relative to the physical system exchanges with it a certain amount of heat Q_0 at a temperature T_0, then another observer moving relative to the first uniformly and rectilinear will fix the amount of heat Q and temperature T which will be less than Q_0 and T_0. Both the temperature and the heat vary equally, but opposite to energy or mass, despite the fact that heat is a form of energy. But the nature of the temperature change is the same as for the cyclic frequency v_0, and de Broglie attached great importance to this [4].

Even R. Clauzius and L. Boltzmann [4] understood that when it is possible to interpret heat as an unregulated part of energy, then the difference between heat and work is mainly due to the difference between two types of movements, one of which is rapid and chaotic, and second slow and orderly. As a result, the thermodynamic analogy is observed in phenomena that have no relation to thermodynamics.

Consider an example, which led R. Clauzius and L. Boltzman [4]. Take the violin whose string is in a state of stationary oscillation. We press the string finger and very slowly we will approach it to the support for the strings, thus reducing the part of the fluctuating string. With a fairly slow motion, our finger will only perceive the average effect of very fast oscillations of the string, which will remain stationary. The analysis shows that this average effect is manifested in the form of a force that tries to push the toe from the support, and in order to overcome this force, it is necessary to carry out work that causes an increase in the energy of oscillations.

It is easy to see an analogy between this process and what happens when a piston is slowly pushed into a heat-insulated gas process: in this case, we are dealing with the slow movement of the piston and rapid molecular movement, which leads to an average action on the piston. This action manifests itself as a force pushing away the piston, so that it can move only by doing work, which will result in an increase in the energy of molecular excitation, which means an influx into the gas of a certain amount of heat.

Thus, we see that an analogy is established between the calorific energy of the gas and the energy of the fluctuation of the string, the analogy is so deep that Clauzius and Boltzmann were able to even calculate the increase in the "heat" of the string by slipping the finger and found that it is equal to the product of the frequency of the stationary fluctuations on the mechanical gain a quantity which is related to the average energy of oscillation and which is called an action. It is this formula that serves as the starting point of the thermodynamics of an isolated point (particle). When a particle is a source of periodic motion, it can indeed be attributed to the cyclic frequency v_c, which we already know. It can also be attributed to the "action", and the Clauzius-Boltzmann formula allows you to express the amount of heat that the particle exchanges with the environment. But the same amount of heat is expressed by the function of entropy and temperature, the main Clausius formula, which in fact is a thermodynamic definition of entropy. Therefore, the relationship between the action S and the cyclic frequency v_c, on the one hand, and the entropy of S_e and temperature T, on the other, must exist. de Broglie [4] expressed the following formulas:

$$hv_c = kT, \tag{31a}$$

$$S/h = S_e/k_B = S_g, \tag{31b}$$

where k_B – Boltzmann constant.

Here we arrive at the principle of relativity. Since the cyclic frequency and temperature vary equally from one observer to another, the law written in formula (31a) will be the same for all observers. One can show that the same will be the case with relation (31b), and from here we can conclude that thermodynamics that controls the heat exchange between a particle and a subquantum environment does not give privileges to any observer. The air thus determined does not allow to distinguish the absolute motion and does not contradict the principle of relativity.

The formulas (31b) describe those phenomena that occur quite slowly near the state of the thermodynamic equilibrium. Therefore, these states naturally coincide with the stationary states of wave mechanics. But one can extrapolate these calculations to a more general case where such a balance, and hence stationary state, does not occur. The Carnot principle shows that the entropy of the system must go to a state of stable equilibrium, that is, to a quantum state. It follows that when stationary states are not the only possible states, they are, because of their thermodynamic stability, realized with a higher probability. Since the electron is always of great disturbance, it will always fluctuate near one of its aggregate states, when only a greater disturbance does not disturb the equilibrium. In the latter case, the electron will move to another stationary state as a result of the transient process, which can be described in space and time [4].

It should be noted that the relations (31) have a wider meaning than those given above. Namely, these relations practically correspond to a single ordered and disordered movement and practically show that for a stationary state the order of magnitude of the motion is equal to the degree of disordered.

Let's note the next. Thermodynamics of isolated particle can lead to such synthesis. It can be shown that when a particle is in constant contact with a thermal reservoir formed by a subquantum medium, then the action with (31) should be close to not entropy, and to another thermodynamic function with similar properties, namely to free energy. In contrast to entropy, this function, according to Carnot principle, should be minimal for stable states, and where de Broglie was able to give its expression in wave mechanics.

The realization of the stationary state is now bound, thus, with the principle of minimum free energy, and since the latter is related to action, that action should also be minimal. This conclusion is in accordance with the Maupertui principle, which allows us to derive the laws of mechanics from a single hypothesis: the actual movements of the system are only those that make its action minimal. Thus, there is a synthesis of the Carnot principle and the Maupertui principle, we can say that the Fermat principle is also synthesized [4].

It should be noted that in this direction studies of J. Schwinger [4] were conducted. He synthesized the object-source as a synthesized field and particle element, but the Lagrangian formalism was used. Further synthesis of physical principles from a mathematical point of view is fairly well presented in [286, 304, 305]. However, there are mainly understood and refined well-known dynamic principles.

Further synthesis in physics, obviously, is expedient to carry through the expansion and its connection with the theory of information. For the first time in detail it was disassembled by L. Brillouin [4].

To do this, we need to consider the negentropic principle of information in more detail.Two types of information is existed:

1. free information I_f, which arises when possible cases are considered abstract and as not having a specific physical meaning;

2. coupled information I_b, which arises when possible cases can be presented as microscopes of the physical system. Thus, the linked information is a partial case from the free one.

In [4], the view was expressed that an electromagnetic vacuum is basically a dynamic environment, and Newtonian ether is static.

According to [4], we introduce the concept of vacuum from a polymetric analysis.

Definition 3. A generalized vacuum is the state of a system in which the change of the generalized measure is zero.

Here are examples:

1. Ether of Newton – Mach. The reference system – the absolute and spatial-temporal measure is also absolute, so the change of this measure is zero.

2. Electromagnetic vacuum. Measure is the quantum of action Planck constant h, $\delta h = 0$.

3. The theory of informational-physical structures: the measure is or dimensionless entropy, or action, the vacuum states will be states with $\delta S_e = 0$ and $\delta S_a = 0$.

From the latter, the role of the principle of dynamic equilibrium is very clearly visible: it is the principle of equilibrium between physics and information. Entropical representations and the principle of dynamic equilibrium itself can be summarized as follows (for a generalized measure we denote Sg):

$$\delta S_g > 0; \quad S_g > 0; \tag{32}$$

$$\delta S_g < 0; \quad S_g < 0; \tag{33}$$

$$\delta S_g = 0; \quad S_g = 0; \tag{34}$$

The ratio (32) is nothing more than the action principle, the Carnot principle and the uncertainty principle. The ratio (33) is a generalization of the negentropic principle of the theory of information, the Prigogine-Glensdorff principle, etc. Formula (34) is the condition for the existence of vacuum: $\delta S_g = 0$ is relative, $S_g = 0$ is absolute. Condition (32) is main principle in theory of open systems and action principle $\delta S_g = 0$ too [4].

Thus in the theory of information-physical structures and in this section in terms of laws the most general unification was carried out.

Here are some thoughts on the relationship between physics and information theory. Consider a more detailed relationship $S_g = k \cdot x - \omega \cdot t$.

In fact, if $S_g > 0$, that is, $k \cdot x > \omega \cdot t$, then the structure changes, which means that over time the structural part of the measure increases, that is, it increases its entropy, action, etc. When $S_g < 0$, this means that the structural part of the measure of relatively intense (frequency-time) changes little, so physical processes pass at a different speed than information.

It should be noted that besides the Newtonian synthesis program in physics there are some modifications.

Conclusions.

1. Short historical analysis the problems of similarity and physical constants in physics and mathematics is represented.

2. Role of physical constants in modern physical theories is analyzed.

3. Stoney and Planck systems of fundamental constants are observed.

4. Role the simplicity in the unification of theories is represented on the example of synthesis physics and theory of information.

5. Problems of simplicity in wave physics and physics of shock processes are analyzed too.

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