IV International Conference "Problems of Cybernetics and Informatics" (PCI'2012), September 12-14, 2012
www.pci2012.science.az/4/19.pdf

Informatics Laws Restrict and Define Physical Laws

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Abstract— **Informatics laws have general, universal character, operate in all possible universes with different physical laws. Informatics laws precede physical laws. It is shown, that physical laws and properties of the nature are consequence of informatics laws. Informatics laws together with Physical laws will allow to open all secrets of nature, in particular, to construct the theory of quantum gravitation.**

Keywords— informatics; physical laws; information (informatics) laws

I. INTRODUCTION

From information laws [1-3] of simplicity of complex systems, conservation of uncertainty (information) follows physical laws of energy, an impulse, the moment of an impulse, a charge conservation, electromagnetic, weak and strong interaction, Gibbs thermodynamic equation.

II. THE UNIVERSE STRUCTURE

The Universe is arranged by the simplest image. The description (theoretical model) of the Universe should be the most simple.

Simplicity, complexity of systems is defined by information volume contained in them (volume of information necessary for their description).

The Universe represents hierarchical set of physical systems.

From the principle of hierarchical construction of complex systems, of the law of simplicity of complex systems follows the proof that complex systems have hierarchical modular structure.

III. CLASSICAL AND QUANTUM PHYSICS

Axioms of classical and quantum physics can be formulated in a classic language.

The classical logic - the term used in mathematical logic in relation to this or that logic system, indicate, that for the given logic all laws of (classical) calculation of assertions, including the law of an exception of the third, are fair. The multitude of axioms of classical and quantum physics is limited and is consistent. There are no indemonstrable true assertions among them.

All assertions about physical systems cannot be formulated in a classic language. For the formulation of assertions about physical systems the language of quantum physics should be used.

Owing to Gödel's theorem physics can not be limited to classical theories where potentially unlimited number of assertions about physical systems exist which are always indemonstrable true expressions. It explains obligatory existence of the quantum physics describing physical systems by probability characteristics.

Application of the principle of maximum information entropy at restrictions on the sum of probabilities of ways (=1) and the average action allows to receive distribution of probabilities of ways, statistical sum, average action and wave function of a way [4].

Combination of classical addition of probabilities of distinguishable alternatives to a classical choice of one of several equiprobable ways leads to quantum mechanical wave rule of amplitudes addition.

Let's consider transition of object from the initial state s into a final state f in two distinguishable ways. According to the rule of addition of probabilities of independent events the probability of this transition is equal to $\omega_{s\to f} = \omega_{1\, s\to f} + \omega_{2\, s\to f}$, or $|<f|\, s>|^2 = |<f|\, s>_1|^2 + |<f|\, s>_2|^2$. Probability of uncertainty transition, identical to each way, is equal to amplitude of probability of transition $N_{2\ s\to f} = -\log_2 2|\psi|^2$. At two indiscernible ways of transition from transition uncertainty two distinguishable ways subtract information of a choice of one of two equiprobable ways of transition $I_2 = -\log_2 2 = -1$. Hence, uncertainty of transition of object from the initial status s to the final status f will be equal in two indiscernible ways to the sum of transition uncertainty in two distinguishable ways and information of a choice of one of two equiprobable ways of transfer (with a return sign):$N_{2\, s\to f} = N'_{2\, s\to f} - I_2 =$ $= -\log_2 2|\psi|^2 - \log_2 2 = -\log_2 4|\psi|^2 = -\log_2 |2\psi|^2$. The size standing under the sign of the module expresses the rule of addition of amplitudes of transition probability. Let's consider transition of object from an initial state to the final state f distinguishable in m ways. According to the rule of addition of probabilities of independent events the probability of this transition is equal to $\omega_{s\to f} = \Sigma_i\, \omega_{i\, s\to f}$, or $|<f|\, s>|^2 = \Sigma_i |<f|\, s>_i|^2$. Identical to each way of transition uncertainty of bits transition is equal to amplitude of probability of transition $N_{m\ s\to f} = -\log_2 m|\psi|^2$. At indiscernible ways of transition to transition uncertainty for m distinguishable ways the information from a choice of one of m equiprobable ways (with a minus sign) is added: $I_m = \log_2 m$. Hence, the uncertainty of object transition from an initial state to the final state f at indiscernible m will be equal to the ways of the sum of uncertainty transition for m distinguishable ways and uncertainty of the choice of one of m equiprobable ways of transition: $N_{m\, s\to f} = N'_{m\, s\to f} - I_m$. $N_{m\, s\to f} = -\log_2 m|\psi|^2 - \log_2 m = -\log_2 m^2 |\psi|^2 = -\log_2 |m\psi|^2$. The size standing under the sign of the module expresses the rule of addition of amplitudes of transition probability. The combination of classical addition of probabilities at distinguishable alternatives with a classical choice of one of several equiprobable ways leads to quantum mechanical wave rule of amplitudes addition.

IV. DESCRIPTION OF PHYSICAL SYSTEMS

Physical systems, the objects observed are described by wave function or the amplitude of probability containing quality of parameters and variables physical characteristics.

The square of the module of wave function or amplitude of probability is density of probability or probability.

Physical systems, objects, the observable are described by the information characteristic - uncertainty (information). A measure of uncertainty (information) is the Shannon information entropy, defined as functional on wave function or amplitudes of probability.

C. Shannon [5] has entered the concept of information entropy. Entropy of a discrete random variable is: $H=-\sum p_i \log_2 p_i$ [bit] ($H=-\sum p_i \ln p_i$ [nat], Entropy H of a continuous random variable $H(x) = -\int p(x)\log_2 p(x)dx$ [bit], ($H(x) = -\int p(x)\ln p(x)\, dx$ [nat]). Heterogeneity of physical system is described by the information characteristic of - divergence, defined as functional on wave function or amplitudes of probability [6, 7]. Unitary transformations are described by the information characteristic - joint entropy [5, 7]. Interaction of physical systems, objects is described by information characteristic - the mutual information [5, 7]. The mutual information can be considered as a measure of entanglement of physical systems.

V. INFORMATION RESTRICTIONS ON PHYSICAL TRANSFORMATIONS

Transformations U of the state $|\psi\rangle = \sum_x c_x |x\rangle$ in the complex Euclidean space, saving probability structure of a state (*the sum of probabilities received at measurement of one of the basic states x for the initial state $|\psi\rangle = \sum_x c_x |x\rangle$ equal to unit $\langle\psi|\psi\rangle = \sum_x |c_x|^2 = 1$, and the sum of probabilities received at measurement of one of basic states x for the final state $U|\psi\rangle = U\sum_x c_x |x\rangle = \sum_x c_{ux} |x\rangle$ equal to unit $\langle|Ux\rangle||Ux\rangle\rangle = \sum_x |c_{ux}|^2 = 1$*), are unitary.*

Transformations O of the state $|\psi\rangle = \sum_x c_x |x\rangle$ in the real Euclidean space, saving probability structure of the state are orthogonal.

Transmitting transformations are the most simple.

Such movement of space at which the movement of all points is equal $y = x + z$ is called translation motion (shift). Transmitting transformations of coordinates in n-dimensional Euclidean space E^n are defined by no more than n parameters that is less in comparison with other kinds of transformations.

Linear transformations of coordinates, as well as transmitting, are the most simple transformations.

Linear transformations of coordinates in n-dimensional Euclidean space E^n are defined by no more than n^2 parameters that is less in comparison with other kinds of transformations, except the transmitting ones.

The real variables are the most simple.

The real variables are described by one number, and complex ones are described by two numbers.

In the Universe transmitting transformations of coordinates operate as the most simple.

In the Universe linear transformations of coordinates operate as the most simple.

The observable is the real variables as the most simple.

At transformations of systems of coordinates uncertainty (information) is saved in that and only in that case when Jacobean transformations is equal to unit: $J(x_1, ..., x_n / y_1, ..., y_n) = 1$.

The law of simplicity of complex systems demands realization in the Universe of linear transformations of co-ordinates (as the most simple).

Uncertainty (information) is saved in that and only in that case, when value of a determinant of linear transformation of coordinates is equal to one unit.

At global gauge transformations [8] $\psi'(x) = e^{i\alpha}\psi'(x)$, $\alpha = const$ *uncertainty (information) is saved.*

Let's estimate $\bar\psi(x)\psi(x) = e^{-i\alpha}\bar\psi(x)e^{i\alpha}\psi(x) = e^{-i\alpha}e^{i\alpha}\bar\psi(x)\psi(x) = \bar\psi(x)\psi(x)$. ($e^{-i\alpha}$ and $\bar\psi(x)$ - as complex numbers switch). Hence, uncertainty (information) is saved.

At local gauge transformations [8] $\psi'(x) = e^{i\alpha(x)}\psi'(x)$ *uncertainty (information) is saved.*

Let's estimate $\bar\psi'(x)\psi'(x) = e^{-i\alpha(x)}\bar\psi(x)e^{i\alpha(x)}\psi(x)$. As $\psi(x)$ - complex number, and $e^{i\alpha(x)}$, generally a matrix, $e^{-i\alpha}\bar\psi(x)\psi(x)e^{i\alpha} = e^{-i\alpha}|\psi(x)|^2 e^{i\alpha} = |\psi(x)|^2 e^{-i\alpha}e^{i\alpha} = |\psi(x)|^2$ (complex number $\psi(x)$ switches with matrix $e^{-i\alpha(x)}$). Hence, $-\int|\psi'(x)|^2\log_2|\psi'(x)|^2 dx = -\int|\psi(x)|^2\log_2|\psi(x)|^2 dx$ - uncertainty (information) is saved.

Observables as real variables are represented by Hermitian operators.

VI. RELIABILITY OF PHYSICAL TRANSFORMATIONS

Transmitting transformations save uncertainty (information), therefore owing to the law of conservation of uncertainty (information), they are physically realized.

Owing to the law of conservation of uncertainty, transformations of the isolated (closed) systems are physically realized in the only case when they save uncertainty (information). Jacobean matrix transmitting transformation $y_i = x_i + z_i$ is equal to identity matrix $J(x_1,...,x_n / y_1,...,y_n) = E$.

The determinant Jacobean transformation matrix of translation (shift) is equal to one unit. The physical reliability of transmitting transformations directly follows from the law of conservation of uncertainty (information): uncertainty (information) of isolated (closed) system is saved at physically realized transformations and only at physically realized transformations.

Own rotations are conservation uncertainty (information), therefore owing to the law of conservation of uncertainty (information), they are physically realized.

Unitary transformations with a determinant equal to one unit are transformations of its own rotation. Such transformations save uncertainty (information), hence, in the isolated (closed) systems they are physically realized.

The group of unitary matrixes with a determinant equal to one unit, is isomorphic to the group of its own rotations of space, and the group of own rotations of coordinates system.

Transformations of classical mechanics (Galilee transformations*) save uncertainty (information), therefore owing to the law of conservation of uncertainty (information), they are physically realized.*

Transformations of the special theory of relativity (Lorentz transformation) save uncertainty (information), therefore owing to the law of conservation of uncertainty (information), they are physically realized.

To each transformation in initial n-dimensional Euclidean space E^n with coordinates x there corresponds a set of transformations in subspaces E^i of initial space E^n ($E^i \subseteq E^n$), and private transformations should also conserve uncertainty.

Reflexions, not own rotations, time inversion in isolated (closed) system are forbidden and physically unrealizable.

Reflexions, not own rotations, time inversion are forbidden and physically unrealizable as determinants of corresponding transformations are equal to a minus unit.

According to the law of conservation of uncertainty (information) an isolated (closed) physical system cannot pass from the state $\psi(x)$ to the state $\psi(-x)$ (reflexion), from the the state $\psi(x)$ to the state $\psi(-Ux)$ (not own rotation) and from the state $\psi(x,t)$ to the state $\psi(x,-t)$ (time inversion), but the systems described by the wave functions $\phi(x) = \psi(-x)$, $\phi(x) = \psi(-Ux)$, $\phi(x,t) = \psi(x,-t)$ can exist.

Global gauge transformations [8] $\psi'(x) = e^{i\alpha}\psi'(x)$, $\alpha = const$ *save uncertainty (information), therefore owing to the law of conservation of uncertainty (information), they are physically realized.*

Local gauge transformations [8] $\psi'(x) = e^{i\alpha(x)}\psi'(x)$ *save uncertainty (information), therefore owing to the law of conservation of uncertainty (information), they are physically realized.*

VII. Properties of Space-Time

The physical realizability of transmitting transformation of time means uniformity of time.

The physical realizability of transmitting transformation of space means uniformity of space.

The physical realizability of transformation of own rotation of space means isotropy of space.

VIII. Physical Laws as Consequence of Informatics Laws

Spatial uncertainty (information on a particle arrangement in space) defines Newton gravitational potential and Coulomb potential (the first derivative of uncertainty on radius), intensity of gravitational field and Coulomb's fields (the second derivative of uncertainty on radius).

Newton gravitational potential in point b created mass M_a, being in point a and, $\phi = -(G \cdot M_a)/r_{ab}$, where G - a gravitational constant, r_{ab} - distance from point a to point b. Potential energy of a body with mass m_b, being in point b, is equal to $\phi \cdot m_b$, i.e. ϕ potential energy of a body of individual mass in the given point of gravitational field, and intensity of a gravitational field is equal to the gradient of gravitational potential. Let's consider three-dimensional Euclidean space R^3. We will allocate in him a sphere with radius r and volume $V = 4/3\pi r^3$. We will assume, that in the sphere there is a particle which radius is equal to r_0 and volume $V_0 = 4/3\pi r_0^3$. Uncertainty of a particle arrangement in a sphere (spatial uncertainty of a particle) is equal to

$N = \log_2(V/V_0) = 3\log_2 r - 3\log_2 r_0$. The first derivative of uncertainty on radius $dN/dr = 3/r\ln 2$ to within a constant is gravitational potential of unit mass. The second derivative of uncertainty on radius $d^2N/dr^2 = -3/r^2 \ln 2$ to within a constant is intensity of gravitational field. Thus, spatial uncertainty (information on a particle arrangement in space) defines Newton gravitational potential (the first derivative of uncertainty on radius) and intensity of a gravitational field (the second derivative of uncertainty on radius). It is similarly connected with Coulomb interaction.

From the time uniformity the law of conservation of energy follows. From space uniformity the law of conservation of an impulse follows. From space isotropy the law of conservation of the moment of an impulse follows. From Lagrangian invariance concerning global gauge type transformations φ ' = $e^{i\alpha Q}$ *φ where Q - a charge of the particle described by field φ, and α - any number which is not dependent on existential coordinates of a particle, follows the law of conservation of a charge. From Lagrangian invariance concerning local gauge transformations of type* $\psi'(x) = e^{i\alpha(x)}\psi'(x)$, *where α (x) - generally a matrix depending on existential coordinates, laws of electromagnetic, weak and strong interaction follow.*

From the law of conservation of uncertainty (information) Gibbs thermodynamic equation (the basic thermodynamic identity) follows.

Let's assume, that at transition of system from an initial state to a final state particles are formed (quanta of radiation with zero mass of rest), each of which contains I_p =1 bit and has energy $E_p = h\nu$. Owing to the law of conservation of uncertainty (information) the generated particles should possess the information equal to $\Delta I = I' - I''$, i.e. $n = I' - I'' = \Delta I$ radiation quanta should be generated . Owing to the law of the energy conservation, the generated quanta of radiation should possess energy $nh\nu$ equal to $\Delta U = U'' - U'$. Thus, $nh\nu = \Delta U$. We will consider that the system represents absolutely black body. Average energy of radiation is connected with temperature of thermal radiation of absolutely black body $E_p = h\nu = 2,7kT$ [9]. As $n = \Delta I$, $\Delta I \cdot 2,7kT = \Delta U$, or $T = \Delta U / 2,7k\Delta I$. At $\Delta S = k\Delta I$ $T = \Delta U / 2,7\Delta S$ or $\Delta U = 2,7T\Delta S$. In differential kind $T = dU / 2,7kdI$ or $dU = 2,7kTdI$. At $dS = kdI$ $T = dU / 2,7dS$ or $dU = 2,7TdS$. Thus, from the laws of conservation of uncertainty (information) and energy, in that specific case at $dS = kdI$ Gibbs thermodynamic equation (The expression for the total differential of the internal energy is called the Gibbs equation) $dU = 2,7TdS$ follows. Generalization on more general case $dU = TdS - PdV + \sum_j \mu_j dN_j$ is made by the account of performed job and the account of addition of particles in system without fulfillment of job and addition in the right part of the corresponding composed. The difference of resulted expression from the standard form of Gibbs thermodynamic equation should be noted - presence in the right part of factor 2,7. Let's assume, that at transition of system from an initial state to a final state particles are formed (hadrons are baryons and mesons with nonzero mass of rest), each of which contains I_p bit and has energy $E_p = m_p c^2 + m_p c^2 / 2$. Owing to the law of conservation of uncertainty (information) the generated particles should possess the information equal to $\Delta I = I' - I''$, i.e. $n = \Delta I / I_p$ particles should generate.

Owing to the law of conservation of energy the generated particles should possess energy $nE_p = nm_p c^2 + nm_p c^2 / 2$ equal to $\Delta U = U'' - U'$. Thus, $(\Delta I / I_p)m_p c^2 + (\Delta I / 2I_p)m_p c^2 = \Delta U$. We will consider, that each particle has three degrees of freedom. Then $m_p c^2 / 2 = (3/2)kT$. As $(\Delta I / I_p)m_p c^2 + (\Delta I / 2I_p)m_p c^2 = \Delta U$, $(\Delta I / I_p)m_p c^2 + (\Delta I / I_p)(3/2)kT = \Delta U$, or $\Delta U - (\Delta I / I_p)m_p c^2 = (3/2)(\Delta I / I_p)kT$. At $\Delta S = k\Delta I$ $\Delta U - (\Delta I / I_p)m_p c^2 = (3/2I_p)T\Delta S$. In differential kind $dU - (dI / I_p)m_p c^2 = (3/2I_p)TdS$. Thus, from laws of conservation of uncertainty (information) and energy, in that specific case at $dS = kdI$, Gibbs thermodynamic equation represents: $dU - (dI / I_p)m_p c^2 = (3/2I_p)TdS$. Generalization on more general case $dU = TdS - PdV + \sum_j \mu_j dN_j$ is made by the account of performed job and the account of addition of particles in system without fulfillment of job and addition in the right part of the corresponding composed. The differences of resulted expression from the standard form of Gibbs thermodynamic equation should be noted - presence in the left part of additional composed $-(dI / I_p)m_p c^2$ and in the right part of factor $(3/2)I_p$. As the law of conservation of energy follows from the law of conservation of uncertainty (information) thermodynamic Gibbs equation follows from the law of conservation of uncertainty (information). From information laws of simplicity of complex systems, conservation of uncertainty (information) follows physical laws of conservation of energy, an impulse, the moment of an impulse, a charge, electromagnetic, weak and strong interaction, Gibbs thermodynamic equation.

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