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THE BASIC INFORMATION CHARACTERISTICS OF OUR UNIVERSE

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1. Information volume in our Universe

Information is inseparably linked with matter and energy. Information is physical heterogeneity steady for certain time, heterogeneity of matter and energy. The energy necessary for formation of one bit of microinformation is equal to $E_{bit} = kT \ln 2$. The mass necessary for formation of one bit of the microinformation is equal to $m_{bit} = kT \ln 2 / c^2$. The values of energy and mass of the carrier of 1 bit of microinformation are resulted at temperatures 3K (300K). The minimum energy for 1 bit is equal to 4,14199E-23 (4,14199E-21) joule. The minimum mass for 1 bit is equal to 4,60858E-40 (4,60858E-38)kg. On the average in atoms for 1 bit of information is used $\approx 1,69 \cdot 10^{-28}$ kg of mass of substance (for example, in atom of hydrogen is used $\approx 1,6 \cdot 10^{-28}$ kg, in atom of lithium - $\approx 1,93 \cdot 10^{-28}$ kg). It is approximately by $\approx 10^{12}$ times more than the mass necessary for formation of one bit of microinformation.

The reason and source of information formation is expansion of the Universe and initial heterogeneity. At symmetry infringement between weak and electromagnetic interactions in the Universe it is formed 10^{90} bits. The information mechanism of particles formation in the inflationary Universe generates quantity of particles, comparable with the standard estimation of the number of particles in the Universe, - an order of 10^{80} - 10^{90}.

The minimum possible volume of information in the Universe with prevalence of substance is $\approx 1,7 \cdot 10^{79}$, in the Universe with prevalence of radiation is $\approx 10^{91}$ bits. The greatest possible volume of information in the Universe is $\approx 10^{120}$ bits. Growth of volume of information at sedate expansion of the Universe is $\propto \log_2 t$. Reduction of density of information at sedate expansion of the Universe is $\propto (\log_2 t) / t^2$. Growth of information volume at inflation expansion of the Universe is $\propto \alpha t$. Reduction of density of information at inflation expansion of the Universe is $\propto te^{-3\alpha t}$.

2. Information volume in some fundamental, elementary particles and atoms

Fundamental particles are the most simple physical systems (elementary systems by Zeilinger A.).

- There is 1 bit in a lepton.
- There is 1 bit in a quark.
- One photon with circular polarisation contains 1 bit.
- One photon, Z^0-bozone - product of electroweak interaction contains 0,78 bits.

Elementary particles represent physical systems of the second level of complexity.

- There are 9,422 bits in a proton, a neutron (taking into account the structure of proton, neutron, the information in quarks, colors of quarks).

Atoms represent physical systems of the third level of complexity.

- There are 11,422 bits in the atom of hydrogen (1st element) - (taking into account the structure of atom, the information in protons, neutrons).
- There are 39,688 bits in the atom of helium (2nd element).
- There are 109,642 bits in the atom of carbon (6th element).
- There are 544,21 bits in the atom of iron (26th element).

• There are 2334,436 bits in the atom of uranium (92nd element). In the above-mentioned cases the structure of atoms and external uncertainty electrons is not considered.
• the estimates of the joint entropy of matrixes mixture of electroweak interaction (1,7849; 1,7787; 1,7645; 1,7945) according to dfferent independent experimental data, are close to the estimates of the joint entropy of matrixes mixture of quarks (1,7842, 1,7849).

3. Information volume in stars

• the Sun contains $\approx 1,3 \cdot 10^{58}$ bits.

• the White dwarf with the mass of solar mass contains $\approx 1,24 \cdot 10^{59}$ bits.

• the Neutron star of solar mass contains $\approx 2,38 \cdot 10^{59}$ bits.

4. Information volume in black holes

• the Plank's black hole contains one nut of information, thereby it is possible to consider nut as one Plank's information unit (one bit is Shannon's information unit).
• Existence of matter of two types: with square-law and linear dependence of volume of information on mass is source, reason of existence of the optimal black holes which minimize volume of information in any region of the Universe and in the Universe as a whole.
• information and mass volumes, received at the decision of the direct problem (Minimization of volume of information in the system «usual substance – black hole» at the set mass of system) and the dual problem (maximization of mass of the system «usual substance – black hole» at the set volume of information in the system), coincide.

There are $\approx 10^{62}$ bits in the optimal black hole generated in the system «radiation (photons) - black hole» at the temperature of radiation - 2,7K. There are $\approx 2,57 \cdot 10^{38}$ bits in the optimal black hole generated in the system «hydrogen (protons) - black hole».

At the temperature of radiation $T = m_p c^2 / 9,422k \ln 2 = 1,555 \cdot \mathrm{E} + 12$ K (at the time from «the big explosion» of the Universe 10^{-5}) the mass of the optimal black holes which have arisen in the systems «radiation - black hole», is equal to the mass of the optimal black holes which have arisen in the systems «hydrogen (protons) - black hole». In transition from «the Universe with prevalence of radiation to the Universe with prevalence of substance (10^4K> T> 10^3K) the mass of the optimal black hole in the system « radiation - black hole» varies from 2,45E+19kg to 2,45E+20kg.

• The masses of the optimum black holes shaped of various types of atoms of usual substance or mixture of various types of atoms of usual substance, and information contents in them are approximately identical.

• The black holes of solar mass contain $\approx 7,72 \cdot 10^{76}$ bits.

• The black holes with the mass of one million solar contain $\approx 7,72 \cdot 10^{94}$ bits.

• The black holes in centers of galaxies contain $\approx 10^{90} - 10^{107}$ bits.

5. Information volume in galaxies

In the galaxies having 10^{11} of stars, there are about 10^{69} bits. In the galaxies having 10^{11} of stars

and containing in kernels super massive black holes with the mass of $\approx 10^6 - 10^{10}$ of solar mass, there are $\approx 10^{99} - 10^{107}$ bits.

6. Information dependence of temperature of radiation on mass

• For a black hole the dependence of temperature on mass (S. Hawking's spectrum) looks like $T = (\hbar c^3 \ln 2) / (4\pi GMk)$.

• For a neutron star the dependence of temperature on mass (an information spectrum) looks like $T = (m_n c^2) / k(9,422 + \log_2 M / m_n)$.

7. Information restrictions at creation of black holes from stars

• the mass of the black hole formed from the star of the sun's type is no more than $\approx 8 \cdot 10^{20}$ kg.

• the mass of the black hole formed from the white dwarf of solar mass is no more than $\approx 2,5 \cdot 10^{21}$ kg.

• the mass of the black hole formed from the neutron star of solar mass is no more than $\approx 4,17 \cdot 10^{21}$ kg.

Note. The black hole at formation uses only part of mass. Other mass in the form of usual substance dissipates in surrounding space and other objects can be formed of it.

8. Information restrictions at the merge of black holes

• At the merge of two black holes having the mass M_1 M_2, without the use of additional usual substance, the mass of the resulting black hole is less, than $\sqrt{M_1^2+M_2^2}$.

• At the merge of two black holes having the mass M_1 M_2, with the use of additional usual substance, the mass of the resulting black hole is more than $\sqrt{M_1^2+M_2^2}$.

9. Classical information

• Nitrogenous basis contains $\log_2 4 = 2$ bits of the classical information.

• Amino acids contain $\log_2 20 = 4,32$ bits of the classical information.

• For 1 bit of information formed by amino acids and nitrogenous basis it is needed 4,43E-25 and 1,05E-25kg of mass.

• Redundancy of classical information formed by life, in relation to micro information at the temperature of 300K is by factor of $\approx 10^{13}$ times more.

• Proteins and DNA for formation of 1 bit of information use mass by three orders more than atoms. Hence, life is effective way of formation of classical information.

• Redundancy of classical information generated by modern civilization, in relation to microinformation is by factor of $\approx 10^{23-25}$ times more. Efficiency of nature in formation of classical information exceeds efficiency of person, a terrestrial civilization by $\approx 10^{10}$ times.

• Proteins of yeast contain about 2000 bits of classical information.

• One chromosome of a person contains $(1-5) \cdot 10^8$ bits of classical information.

• One person contains $\approx 10^{26}$ bits of classical information.

• Biomass of the Earth contains about 10^{40} bits of classical information. If 100 % of the Earth's mass is used for formation of live substance it will generate about 10^{50} bits of classical information.

• If 1 % of the Universe's mass is used for formation of live substance it will generate approximately 10^{75} bits of classical information.

• The greatest possible volume of classical information in the Universe is $\approx 10^{77}$ bits.

• $10^{40} - 10^{77}$ bits is a range of possible volume of classical information in the Universe, defined by the data known now.

• Volume of classical information formed by terrestrial civilization is $< 10^{30}$ bits/year. Parity of volumes of information in the Universe in a year, generated by matter and civilization is $\approx 10^{-49}$. The share of information formed by civilization on one star system is equal to 10^{-27}. It

shows, that now the contribution of terrestrial civilization to information formation of the Universe is insignificant.

10. Cognitive process of the Universe

- the Universe, information volume of which is finite, effective and completely knowable.
- the Subject of cognitive process is classical object (for example, terrestrial civilization).
- In the course of the Universe cognitive process compression of information is not less, than $\approx 10^{20}$ times and no more, than $\approx 10^{76}$ times.
- the gravitation Law, in particular, compresses the information not less than by factor of $4 \cdot 10^{183}$ times.
- interpretation of cognitive process by methods of quantum mechanics (the description and measurement) on the basis of information parities is possible. The knowledge is carried out through a hypothetical information channel - «the knowledge channel of nature». The limited throughput of "the knowledge channel of nature» defines as impossible "exact" (in classical sense) descriptions and measurements of quantum objects. Increasing accuracy (uncertainty) of the description/measurement of one of the components, the observer is compelled to reduce accuracy (uncertainty) of the description/measurement of the other.

11. Information unity of all possible universes

- As heterogeneity should exist in the Universes with any physical laws the approach which is based on information properties of heterogeneities of any nature and corresponding information laws and restrictions, and also physical laws of conservation following from them, such approach extends on all possible Universes. Thereby, physical laws of conservation and information restrictions on other possible physical laws in different Universes are identical. Does it mean that all of possible universes are identical?

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