ESTIMATION OF INFORMATION VOLUME IN COSMOLOGY OBJECTS

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Estimation of information volume in cosmology objects is necessary for definition of restrictions on their occurrence, evolution and mutual interconversions. Resulted estimations are based on the main principle of quantum mechanics by A. Zeilinger: «elementary system contains one bit of the information» [1], and the works of author [2, 3].

1. ABOUT RESTRICTIONS ON VOLUME OF THE INFORMATION IN THE UNIVERSE.

Information is an integral part of Universe. Information is indissolubly connected with a matter (energy). Information in Universe has been formed at the phase transitions, inflationary, and usual expansions either. The information carriers are heterogeneities of matter (energy). The degree of heterogeneity is measured by Shannon's information entropy [4]. From the informational point of view five types of mass (energy) are available: the black hole, containing heterogeneities (information) in the volume proportional to a square of mass; the usual substance, containing heterogeneities (information) in the volume proportional to mass; the dark matter, containing heterogeneities (information) in the volume essentially smaller then the usual substance contains (researches are under way now); the dark energy that contains no heterogeneities (information) [2, 3]; neutron stars and the white dwarfs, containing heterogeneities (information) in the volume proportional to mass of the star increased by the logarithm binary mass. It is known [5] that Universe would contain the greatest possible volume of the information, if it were the only one black hole. The maximum volume of the information in our Universe is 10^{120} bits. Let's consider the Universe consisting of radiation and black holes. Universe by the mass of M, which consists of optimum black holes everyone by mass of $M_{opt} = \frac{\hbar c^3}{4\pi GkT} \approx 9{,}09 \cdot 10^{22}$ kg, $I_{opt} = \frac{\hbar \cdot c^5}{8\pi \cdot G \cdot k^2 \cdot T^2 \cdot \ln 2} \approx 1{,}26 \cdot 10^{62}$ bits ($T = 2{,}7K$) contains the minimally possible volume of the information that equals 10^{91} bits. Designation: $\hbar$ – reduced Planck constant, c – speed of light, G – gravitational constant, k – Boltzmann constant, T - temperature of the Universe. Mass of the optimum black hole, which minimal volume of information in Universe is reached, has approximately one fortieth of Earth's mass. The minimal volume of the information in our Universe is 10^{91} bits. The range of information volumes in Universe I_{Un} by the mass of M is $\frac{Mc^2}{2kT} < I_{Un} < \frac{M^2 2\pi G}{\hbar c}$ bits. The range of information volumes in our Universe is $10^{91} < I_{Un} < 10^{120}$ bits. In the Universe consisting of usual substance (protons) and black holes $M_{opt} = \frac{5{,}837 \cdot \ln 2 \cdot \hbar \cdot c}{4\pi \cdot m_p \cdot G} = 9{,}12 \cdot 10^{10}$ kg (m_p -the mass of the proton),

$I_{opt} = \frac{(5{,}837)^2 \cdot \hbar \cdot c \cdot \ln 2}{8\pi \cdot m_p^2 \cdot G} \approx 1{,}59 \cdot 10^{38}$ bit. The minimal volume of the information in our Universe is $\approx 1{,}7 \cdot 10^{79}$ bits. Minimal possible volume of information in Universe, which filled with optimum black holes only, is as twice as less than volume information in Universe, filled with only ordinary substance.

2. FORMATION OF BLACK HOLES. INFORMATION ESTIMATIONS

Let's assume, that the black hole by mass $M_n = nm_0$ is formed of usual substance (radiation) (m_0 – in information model of a black hole [2, 6] the minimal mass of the black hole is equal to $5{,}1 \cdot 10^{-9}$ kg. Black hole contains $I = \frac{n(n+1)}{2}$ bits of the information. Consequently, for its formation it is necessary $\frac{n(n+1)}{2}$ particles of usual substance (quantums of radiation), where each contains 1 bits. For formation of a black hole by mass of M it is necessary to use $\approx \frac{1}{2}\left(\frac{M}{m_0}\right)^2$ quantums of radiation. So for formation of a black hole of solar mass $\approx 2 \cdot 10^{30}$ kg it is necessary to use $\approx 10^{76}$ quantums of radiation. Below characteristics of black holes of various mass are resulted: type of a black hole; a) number of the absorbed quantums of radiation (volume of the absorbed information); b) number subplanck particles in the black hole; c) mass black hole (kg). T=2,7K. The minimal black hole: a)1; b) 1; c) $5{,}1 \cdot 10^{-9}$. Black hole is generated at explosion supernew with radiation 10^{50} erg: a) 10^{59}; b) $1{,}47 \cdot 10^{29}$; c) $2{,}28 \cdot 10^{21}$. Optimum black hole: a) $1{,}26 \cdot 10^{62}$; b) $1{,}58 \cdot 10^{31}$; c) $9{,}09 \cdot 10^{22}$. Black hole of solar mass: a) $7{,}72 \cdot 10^{76}$; b) $3{,}93 \cdot 10^{38}$; c) $2 \cdot 10^{30}$. Black hole of mass 10^6 solar: a) $7{,}72 \cdot 10^{88}$; b) $3{,}93 \cdot 10^{44}$; c) $2 \cdot 10^{36}$. Black hole of mass 10^9 solar: a) $7{,}72 \cdot 10^{94}$; b) $3{,}93 \cdot 10^{47}$; c) $2 \cdot 10^{39}$. The maximal black hole: a) 10^{120}; b) $1{,}41 \cdot 10^{60}$; c) $7.2 \cdot 10^{51}$. Mass of black holes formed after explosions of supernew stars are close to mass of an optimum black hole ($9{,}09 \cdot 10^{22}$ kg). For this value of mass of the black hole volume of the information in system «the black hole – usual substance» is minimal. For black holes generation by mass of one million (billion) solar the volume of the information is $7{,}72 \cdot 10^{88}$ ($7{,}72 \cdot 10^{94}$) bits, close (more) to volume of the information in the usual substance of Universe (10^{90} bits [2-3, 5]) is required. Significant volumes of the information are indispensable for formation of black holes by mass solar ($7{,}72 \cdot 10^{76}$ bits) is required. It means, that locally (in a region of formation of a black hole) intensive physical processes of formation of radiation should be realized.

3. INFORMATION RESTRICTIONS ON MERGING OF BLACK HOLES

The black hole can reduce mass, radiating in space usual substance. The black hole can increase mass, absorbing from space usual substance. During the merge of two black holes one of them should radiating in space usual substance, another to absorb usual substance from space. Any black hole cannot be a result of confluence of black holes and only black holes. Merging of black holes can occur only through additional absorption and/or radiation of usual substance. Let's consider an example. Black holes have masses $M_1 = n_1 m_0$, $M_2 = n_2 m_0$ (m_0, as before, -the minimal mass of a black hole) and contain volumes of the information $I_1 = \frac{n_1(n_1+1)}{2}$ and $I_2 = \frac{n_2(n_2+1)}{2}$. The mass of the new black hole should be equal to the sum of mass of initial black holes $M_{1+2} = (n_1 + n_2)m_0$. Volume of the information of a new black hole must be equal to $I_{1+2} = \frac{(n_1+n_2)(n_1+n_2+1)}{2}$. It is obvious, that for any mass of initial black holes the volume of the information in a new black hole will not coincide with total volume of the information in initial black holes. Next statements follow from information restrictions. After merging of two black holes having masses M_1, M_2, without additional usual substance, square of the mass of the resulting black hole is less than $M_1^2 + M_2^2$, or $M_{1+2} < \sqrt{M_1^2 + M_2^2}$. After merging of two black holes having identical masses $M_1 = M_2 = M$, without additional usual substance, square of the mass of the resulting black hole is less $(2M)^2$, or $M_{1+2} < M\sqrt{2}$. After merging of black holes having masses $M_1, \dots M_k$, without usage of additional usual substance square of the mass of the resulting black hole is less than $M_1^2 + \dots + M_k^2$, or $M_{1+\dots+k} < \sqrt{M_1^2 + \dots + M_k^2}$. After merging of k black holes with identical masses $M_1 = \dots = M_k = M$ without usage of additional usual substance square of the mass of the resulting black hole is less than $(kM)^2$, or $M_{1+\dots+k} < M\sqrt{k}$.

Merging of two black holes having masses $M_1 = n_1 m_0$, $M_2 = n_2 m_0$ and containing volumes of the information $I_1 = \frac{n_1(n_1+1)}{2}$ and $I_2 = \frac{n_2(n_2+1)}{2}$, into one black hole demands additional usage not less than $n_1 n_2$ quantums of radiation – $n_1 n_2$ particles of usual substance either containing one bit of the information.

4. ESTIMATION OF INFORMATION VOLUME IN THE NEUTRON STARS

During an estimation of volume of the information in a neutron star we consider volume of the information in structure of a star and volume of the information in neutrons. The volume of the information in the structure of degenerate fermi-gas is equal to $n \log n$ bits. Here n - quantity of the filled power levels (number of neutrons). In a neutron star $n = \frac{M}{m}$, where M - mass of a neutron star, m - mass of a neutron. The volume of the information in structure and quarks of one neutron is equal to $5{,}837$ bits. The volume of the information in neutrons of a star is equal to $5{,}837 \cdot n$. The total volume of the information in neutron star (without taking into account the information in nickel and iron of a bark) is equal to $\frac{M}{m} \cdot \log_2(57{,}16 \cdot \frac{M}{m})$ bits. The volume of information in a neutron star is proportional to the mass of the star increased by the logarithm binary mass of the star. The volume of the information in white dwarfs depends on mass similarly. In a neutron star of the solar mass, including the information in structure of the star and neutrons, contains $\approx 2{,}34 \cdot 10^{59}$ bits. The structure of a neutron star contains by two orders more information ($\approx 2{,}27 \cdot 10^{57}$ bits), than in neutrons ($\approx 6{,}99 \cdot 10^{57}$ bits). The volume information in the considered neutron star is enough for formation of a black hole by mass of $\approx 3 \cdot 10^{21}$ kg. This mass is close to mass of an optimum black hole.

In the white dwarf of the solar mass including the information in structure of the star, protons, neutrons, electrons, contains $1{,}13 \cdot 10^{59}$ bits. For comparison we should note, that the volume of information in usual substance is proportional to mass, the volume of the information in a black hole is proportional to a square of the mass. The sun basically consists of hydrogen (~74 % from mass) and helium (~25 % from mass). An atom of hydrogen contains ~7 bits of the information. An atom of helium contains ~25 bits of the information. Taking into account the information both in atoms of hydrogen and helium summarized information is equal to $\approx 7{,}91 \cdot 10^{57}$ bits.

5. INFORMATION ESTIMATES OF LIFE OCCURRENCE IN THE UNIVERSE

Classical information (macroinformation) is information which can be stored, copied, used; the microinformation is not fixed information [7]. Life is an effective way of formation of the classical information. Occurrence of life can be characterized by estimations of classical information volume in the Universe formed by amino acids and the nitrogen bases. At a temperature $T = 3K$ the minimum energy for 1 bit– $E \approx kT = 4{,}14 \cdot 10^{-23}$ joule, the minimum mass for 1 bit mikroinformation is $M \approx \frac{kT}{c^2} = 4{,}6 \cdot 10^{-40} kg$ [8. 9]. Mass of amino acids and nitrogen bases used for 1 bit of classical information is by 10^{15} times more than minimal mass. The volume of microinformation in the usual substance of the Universe is equal to 10^{90} bits. Let us estimate possible volume of classical information in the Universe, galaxies, stars under the assumption of usage of all mass of the Universe, the galaxies, star systems, and planets for the formation of classical information. The maximum volume of classical information in the Universe is $\approx 10^{77}$ bits. The maximum possible volume of classical information in the galaxy similar to ours is $\approx 10^{66}$ bits. The maximum possible volume of classical information in the stellar system similar to the solar is $\approx 10^{55}$ bits. The maximum possible volume of classical information on the earth-type planet is $\approx 10^{50}$ bits. On the other hand, the mass of Earth is $\approx 5{,}9710^{24}$ kg, the biomass is $\approx 10^{15}$ kg. It contains $\approx 10^{40}$ bits of classical information. If the Earth is the only place of life occurrence, the minimal possible volume of classical information in the Universe is equal to the volume of classical information in the biomass of the Earth and is equal to $\approx 10^{40}$ bits. If the Earth is a typical planet of all star systems and all galaxies the volume of classical information in the Universe is $\approx 10^{62}$ bits, the volume of classical information in a galaxy is $\approx 10^{51}$ bits, the volume of classical information in a star system is $\approx 10^{40}$ bits. Thus, $10^{40} - 10^{77}$ bits is a range of possible volume of the classical information in the Universe, defined by contemporary knowledge. Measurements of mass of amino acids and nitrogen based in space will specify the present estimations.

6. THE ESTIMATION OF VOLUME OF THE INFORMATION IN THE PLANK'S PARTICLE. Energy necessary for formation of one bit (binary digit) not less then $kT\ln 2$ [8, 9]. Energy necessary for formation one nut (natural unit of information) not less then kT. Mass necessary for formation of one bit not less $\frac{kT\ln 2}{c^2}$. Mass necessary for formation of one nat (natural digit) is not less then $\frac{kT}{c^2}$. At Plank's temperature $T_{пл} = \frac{1}{k}\sqrt{\frac{\hbar c^5}{G}} = 1{,}41696\,K$ [10] the mass necessary for formation of one nat **is** not less then Plank's mass $m_{пл} = \frac{kT_{пл}}{c^2} = \sqrt{\frac{\hbar c}{G}} = m_{пл} = 2{,}17671 \cdot 10^{-8}$ kg [10]. Thus, the Plank's particle contains one nut information and nat it is possible to consider as one Plank's unit of the information (one bit is Shennon's unit of the information). «Fourteen billions years ago, during the moment of a birth, all Universe has been concluded in a point in radius of 10^{-33} sm, that immeasurably less than radius of a proton - 10^{-13} sm. In this volume the information on the future of the Universe has already been incorporated. There was a Big explosion» (Cherepashchuk A.M. [11]). 10^{-33} sm is the size Plank's particle. As the Plank's particle contains one nut of the information (1,45 bits) while the information on the Universe contains not less than 10^{14} bits of the classical information [2]. Hence, Plank's particle could not contain the information upon the Universe future. This information must be distributed through part of space with radius more than 10^{-33} sm.

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