Fundamental connection between the Planck and Hubble constants

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Abstract
This article claims that there is a fundamental relationship between the basic constant of the quantum theory - the Planck constant *h* and the basic constant of astrophysics - the Hubble constant *H*, which states the material and energy unity of our world.

Keywords: Plancks constant, Hubbles constant, Planck values, the energy density of the Universe, fundamental connection of Plancks and Hubbles constants.

"I consider the search for an entity to be vain and impossible,... if it is in vain to seek a substance ... this does not mean that we can not study their characteristics...» Galileo Galilei

"*The greatest is in the smallest"* Lao Tzu

"All things are inextricably linked to each other and that we ourselves, with all our thoughts, constitute only a part of nature" Ernst Mach

Content

1. Planck constant

"Quantum of action plays a fundamental role in physics" M. Planck

It is known that the Planck constant, equal to h=6,626070040·10^{-34}J s (CODATA-2014), is the basic constant of the quantum theory describing the physics of the microworld, relating the magnitude of the energy quantum to its frequency.

On December 14, 1900, Max Planck at a meeting of the German Physical Society and in the article "To the theory of the distribution of radiation energy in the normal spectrum" proposed a formula for the spectral power density of a blackbody with a constant *h*, which was in good agreement with the experimental data. With this idea of Planck, which consisted in the fact that any energy is absorbed or emitted only by discrete quantum portions, the development of quantum theory has begun.

Max Planck wrote in his "Scientific Autobiography":

"... the quantum of action plays a fundamental role in atomic physics, and with its appearance in physical science a new era has come, for it contains something that

was unheard of until then that is intended to radically transform our physical thinking built on the concept of the continuity of all causal relationships ... "[3, p. 650-666]

In 1933, Einstein wrote: "The true purpose of my research has always been to achieve simplification of theoretical physics and its integration into an integral system. I managed to fulfill this goal satisfactorily for the macrocosm, but not for quanta and atomic structure. ... despite significant success, modern quantum theory is still far from satisfactory solution of the latter group of problems "[7]

A. Einstein in 1947 in a letter to M. Born: "Of course, I understand that a fundamentally statistical point of view ... contains a significant portion of the truth. However, I can not seriously believe in it, because this theory is incompatible with the basic assumption that physics should represent reality in space and time without mystical long-range actions. What I am firmly convinced of is that in the end we will stop at a theory in which the naturally connected things are not probabilities, but facts "[8]

P. Dirac: "I do not rule out that in the end Einstein's point of view may be correct, because the current stage in the development of quantum theory can not be regarded as the final one. Modern quantum mechanics is the greatest achievement, but it is unlikely to exist forever. It seems to me very likely that someday in the future there will be an improved quantum mechanics in which we will return to causality, and which will justify the point of view of Einstein. But such a return to causality can become possible only at the cost of abandoning some other fundamental idea, which we now unconditionally accept "[9, 10]

The basic theories of quantum physics - quantum mechanics and quantum field theory - were created by great scientists (N.Bohr, E.Schrödinger, V.Heisenberg) in the first half of the 20th century. In accordance with the modern scientific paradigm, fundamental physical theories should be quantum, but so far it has not been possible to construct a quantum description of the gravitational interaction and thus combine it with three other fundamental interactions. Quantum gravity tries to relate quantum mechanics and the general theory of relativity, which requires quantizing the geometry of space-time itself with the impossibility of experimental verification and complete loss of physical meaning.

M.P. Bronstein in 1930 wrote: "Future physics will not keep that strange and unsatisfactory division that made the quantum theory" microphysics "and subordinated to it atomic phenomena, and the relativistic theory of gravitation -" macrophysics ", governing not individual atoms but only macroscopic bodies. Physics will not be divided into microscopic and cosmic: it must become and become one and indivisible "

2. Hubble constant

"Red shift" is as yet unknown to the principles of the universe " Edwin Hubble

It is known that in classical astrophysics the Hubble constant is the coefficient H, which is part of the Hubble law, which connects the distance to the space object r with its speed v of its removal:

$$v = H r,$$

thus defining modern physics on a cosmological scale. The value of the Hubble constant H in the modern era[1], having the dimension of the inverse time, according to the latest observations of WMAP1, in the system of dimensions SI (MLT) used in modern physics is $H = 2{,}2816878 \cdot 10^{-18} s^{-1}$ (70,4109 (km/s) Mpc) [4,5], and accordingly the "Hubble" time of expansion of the Universe $T=1/H=0{,}438272 \cdot 10^{18}$ s.

E. Hubble's observation was the first visual confirmation of the Big Bang theory, proposed by J. Lemeter in 1927, and which is consistent with the model of A. Friedman, built on the basis of general relativity. In 1931, Hubble wrote to de Sitter about the theoretical interpretation of the relation "redshift-distance": *"We use the expression 'visible' velocities to emphasize the empirical nature of their connection." Hubble's disciple Allan Sandage recalled: "Hubble ... adhered ... positions, welcoming ... a model where there is no real expansion, and therefore that the redshift" represents as yet unrecognized principles of the universe. "*
Modern astrophysics interprets Hubble's law unambiguously as a manifestation of the expansion of outer space of the Universe according to GRT.

3. Einstein on the cosmological problem of general relativity and the cosmological structure of space

The article by A. Einstein "On the cosmological problem of the general theory of relativity" (104, 1931) [1, p.349]:

"The cosmological problem is understood as the problem of the properties of space and the distribution of matter on a large scale, the matter of stars and stellar systems being replaced for simplicity continuously distributed substance. ... on this issue appeared ... Habble's research on the Doppler shift and the distribution of extragalactic nebulae, opening new paths for the theory "[1, p.349]

"In my initial research, I proceeded from the following premises.
1. All parts of the universe are equivalent, in particular, the local average density of the stellar matter must also be everywhere the same.
2. The spatial structure and density of matter must be constant in time.
At that time, I showed that these two assumptions can be combined with a non-zero mean density ρ if we introduce into the field equations of the general theory of relativity the so-called cosmological term[λ]...»

"But after it became clear from the results of Hubble that the extragalactic nebulae are uniformly distributed in space and that they are scattered (at least if their systematic redshifts are explained by the Doppler effect), the assumption (2) about the static nature of space is no longer justified and The question is whether the general theory of relativity can explain these results. Various researchers have attempted to relate new facts to a spherical space whose radius P depends on time. A. Fridman took the first step, regardless of the facts observed. In subsequent arguments I use the results of his calculations" [1, p. 349-350]

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[1] Hubble constant for the WMAP mission is H_{0W}=71,00 (km/s) Mpc =$2{,}3007 \cdot 10^{-18} s^{-1}$, T_W=13,75 billion years =$0{,}43392 \cdot 10^{18}$ s, and according to the latest information of the mission "Planck" [6] - Hubble's constant H_{0P}=67,80 (km/s) Mpc = $2{,}197 \cdot 10^{-18} s^{-1}$, T_P=13,82 billion years =$0{,}436126 \cdot 10^{18}$ s, on 4.06.2016 there is a message that H_{0W}=73,23 (km/s)Mpc.

"... I do not think it is more possible to attribute a physical meaning to my previous decision. Under these circumstances, one should ask whether it is possible to describe experimental facts; without introducing λ-term, clearly unsatisfactory from the theoretical point of view. Let's see to what extent this is possible; while we, like Friedman, will neglect the influence of radiation. "[1, p.350]
"the general theory of relativity, apparently, is natural (ie, without the λ-term) agrees more with new observations of Hubble than with the postulate of the quasistatic nature of space, now discarded under the influence of experimental facts" [1, p.352]

A. Einstein in his article "On the cosmological structure of space" written in 1933 specifically for a collection of articles translated into French by M. Solovin [1,p.407], after studying the astrophysical experimental results of Hubble in 1929, that "the difference between the density of matter and zero should not theoretically be related to spatial curvature, but must be associated with the expansion of space" [1, p.415]

"The simplest possible space structure after the Euclidean structure should be a static structure (all components $g_{\mu\nu}$ do not depend on t) with constant curvature in "spatial" sections (t=const)» [1, c.410]

"If the theory leads us to dynamic solutions for the structure of space, then the need to introduce a universal constant disappears λ,since equations (1) have dynamic solutions of the type (3a) for which λ=0.'

"Recently, the solution to the problem has received a strong push thanks to experimental results in astrophysics. Measurements of the Doppler shift (in particular, the measurements of Hubble), carried out for extragalactic nebulae similar to the Milky Way, showed that these nebulae move away from us at a speed the greater, the greater the distance to them. Among other things, Hubble's studies have shown that these objects are distributed in space statistically uniformly. Thus, the assumption of the theory of a uniform average density of matter is experimentally confirmed. The discovery of the dispersal of extragalactic nebulae justifies the transition to dynamic solutions for the structure of space, which previously had to appear only as a consequence of the unsatisfactory position in theory.
So, without introducing a member from λ can theoretically be explained on the basis of equations (1) the existence of a finite (average) density of matter ρ, assuming in formula (3a) P (and ρ) depending on the time. "[1, p.413-414]

"We can consider P_0 as a cosmic radius P at a certain moment t_0. The only variable in time is the "expansion coefficient" P/P_0 ($=A$)»
"... it is impossible to reconcile the uniform density of matter ρ,Making the assumption about the curvature of the space under A, constant in time, that is, without the "expansion" of space. ... final density ρ does not require the necessity of the existence of curvature of space (three-dimensional) [1, p.414]

"From the above considerations it follows that, in the present state of our knowledge, the difference between the density of matter and zero should not theoretically be related to spatial curvature, but must be associated with the expansion of space" [1, p.415]

In this article, we propose to go beyond A. Einstein and, taking into account the new fundamental components of the "cosmological structure of space" - "dark matter" and "dark energy", to determine "with the current state of our knowledge" the

total energy density of the universe, and, (convergence-divergence) of matter-energy, to find the fundamental connection between the Hubble cosmological constant H not only with the average density of the universe ρ, but also with the quantum theory constant - the Planck constant h.

4. Power of motion and the energy density of the Cosmos

"The axiomatic basis of physics must be freely invented!" A. Einstein

The power N of the motion (material-energy current) of the absolute Cosmos, as the velocity of the energy E in a unit of volume per unit time t, is a constant and single-valued, ie, a universal physical absolute invariant:

$$N=\frac{dE}{dt}=\frac{h}{t_P},$$

and the work done by the Cosmos in a unit of time is equal to:

$$N\ t_P=\frac{dE}{dt}t_P=h$$ – quantum energy of the motion of the Cosmos.

The only known global observable fundamental factor in the movement of the cosmos in time T and 3-dimensional space - this is the *Hubble constant* $H=1/T$, which determines the motion of all derived processes.

In space-time, in which we describe our world, in a system of dimensions LT^2 (length-time), the Hubble constant describes the speed the formation of baryonic matter in the universe, or the mass (material) current per unit volume per unit time and has a dimension m^3s^{-3} ($m^3\,s^{-2}\cdot s^{-1}$),that is, it is equal to the dimension of the mass m^3s^{-2}, divided by time s.

Let us determine the density of baryonic matter ρ_{bm} Cosmos in a single spherical volume ($1m^3$),as equal to the time derivative of the cube of the constant Hubble H^3 (a change in the three directions of space in a spherical volume) in a system of dimensions LT:

$$\rho_{\mathrm{bm}}=\left(H^3\right)'=\frac{\mathrm{dH}^3}{\mathrm{dV}}=3H^2 \qquad m^3s^{-2} \quad \text{in } 1\ m^{-3},$$

in a system of dimensions SI: $\rho_{\mathrm{bmSI}}=\frac{3H^2}{4\pi G}$ kg in $1\ m^{-3}$

Let us agree, for convenience, with the agreement already reached before us, or "convention", as A. Poincaré wrote, that the difference in the energy potentials of baryonic matter is c^2 с размерностью m^2s^{-2} (one could take ~ H^2). Then the energy densities of baryonic matter and "dark matter" in a unit of volume for a time T in the system of dimensions LT will be (in parentheses {} the latest data of the mission "Planck"[3]):

[2] the dimension analysis in LT gives in this system for the gravitational constant $G=1/4\pi$ and with $G=6{,}67384\cdot10^{-11}\ m^3\,kg^{-1}s^{-2}$, $1kg=4\pi G=8{,}386595\cdot10^{-10}\ m^3s^{-2}$; ie the conversion factor from SI in LT ie the conversion factor from $4\pi G\ m^3s^{-2}$; and, accordingly, the dimension of the energy in LT will be m^5s^{-4},and the cardinality has dimension $m^5\,s^{-5}$.

[3] According to the latest results (2015) of the space mission «Planck» ESA the Hubble constant is $H_0=67{,}74\ s^{-1}\ Mpc^{-1}$ and accordingly the age of the universe $T_0=13{,}799$ billion years, the density of baryon and dark matter, respectively $\Omega_b h^2=0{,}02230$ ($\Omega_b=0{,}049$), $\Omega_{CDM}h^2=0{,}1188$ ($\Omega_{CDM}=0{,}259$), and their relative sum is the density of matter $\Omega_m=0{,}3089$, density of "dark energy" $\Omega_\Lambda=0{,}6911$ [2]

1. The energy density of the motion of baryonic matter

$\rho_{ebm} = 3H^2c^2$ m^5s^{-4} in 1 m^3 Ω=0,0596831 {Ω_b= 0,049}

2. The energy density of "dark matter" in a single spherical volume in $4\pi/3$ times more: $\rho_{edm}=4\pi H^2c^2$ Ω=0,2500000 {Ω_{CDM}= 0,259}

3. density of the "gravitational" energy of the actual "baryonic matter"

$\rho_{Gbm}=9H^2c^2/5$ Ω=0,035809862

4.density of "gravitational" energy of "dark matter"

$\rho_{Gde}= 16\pi H^2c^2/5$ Ω=0,62831853 {Ω_Λ= 0,6911}

5. the energy density of spin (spin) of baryonic matter

$\rho_{Sbm}= 6H^2c^2/5$ Ω=0,02387324

6. the energy density of neutrinos, relict, "dark" radiation and other radiations will be taken ρ_{nr}~0,9261% от ρ_{edm} ~0,002315268 $\sum \rho_e$ Ω=0,002315268

The total energy density of the motion of the Cosmos in LT is

$$\sum_V \rho_e = 4\,\rho_{edm} = 16\,\pi H^2 c^2$$ m^5s^{-4} in 1 m^3 Ω=1,000000 {Ω= 1,0000}

The energy of the motion of the cosmos in V=1m^3 in 1s, that is, the power of the motion of the Cosmos τ in LT, is:

$\tau=\sum\rho_e T=16\pi Hc^2$ = constant m^5s^{-4} in 1m^3 in 1s.

To the same results of the density of matter-energy of the Universe-Cosmos, one can come from considerations of the stability of the Metagalaxy, equality in the Universe of gravitational force to the centrifugal force, taking into account the equivalence of mass and energy.

5. Planck values

In our paradigm, in which the Planck constant is $h=\tau t_P=\frac{32H^2}{c}$ ($m^5s^{-4}\cdot s$), there is an opportunity, according to the example of M. Planck, to establish Planck units for Cosmos with the absolute value of the power of energy $\tau= 16\,\pi Hc^2$ (m^5s^{-4}) in 1m^{-3} in 1s and with the difference in energy potentials c^2 (m^2s^{-2}) in a system of dimensions LT:

$$t_p=\frac{\tau}{8\pi^2c^5}=\frac{2H}{\pi c^3}$$ s

$$l_p=\frac{\tau}{8\pi^2c^4}=\frac{2H}{\pi c^2}$$ m

$$m_{PLT}=\frac{\tau}{2\pi c^2}=8H$$ m^3s^{-2}

$$E_{PLT}=m_Pc^2=\frac{\tau}{2\pi c}=8Hc^2$$ m^5s^{-4}

$N=\frac{E_{PLT}}{t_P}=4\pi c^5$ m^5s^{-5}= *constant* - power of energy of the motion of Cosmos.

6. Fundamental connection between the Planck and Hubble constants

At the above-mentioned energy density of the Cosmos corresponding to the energy potential, the spherical sink of matter during Planck's time t_P quantum of matter-energy is uniquely and necessarily formed:

$$h=\tau t_P=\frac{32H^2}{c} \quad \text{m}^5\,\text{s}^{-3} \text{ - Plancks constant in LT!}$$

In the MLT dimension system:

$$h=\frac{8H^2}{G\pi c}$$

The physical meaning of Planck's constant is the energy generated by the motion of the Cosmos, in unit volume 1 m^3 per unit time of the Planck t_P, that is, the absolute power of the energy of the Cosmos in the Planck system of units.

From the energy point of view, the Heisenberg uncertainty relations for the coordinate and momentum and energy and time, expressed by the formulas:

$$\Delta x\Delta p_x \geq \hbar = h/(2\pi),$$
$$\Delta E\Delta t \geq \hbar,$$

are relations that show that the minimum possible work-energy in nature can not be less than the Planck constant, as is easily seen by dividing both sides of the relations by unit of time.

Ratio $h_{LT}/h=4\pi G$, which is the transition coefficient between the systems of MLT and LT dimensions, that is, the "appearance" of the mass in the MLT system 1kg=$4\pi G$.

7. Conclusion

To date, it is believed that "dark matter" and "dark energy" are outside the real material world and accordingly outside the orthodox physical science. The standard model explains our world only within baryonic matter. But our research, stated in this article, speaks of the need to "legalize" dark matter and dark energy and the corresponding expansion of physics beyond the Standard Model, for only in this way can one explain and combine the motion of matter in the microcosm and the macrocosm, describing it as the movement of energy, as a deterministic energy process, determined by the energy characteristics of a single Cosmos. [11]

The fundamental connection in this paper between the fundamental constant of the quantum theory - the Planck constant h and the basic constant of astrophysics - the Hubble constant H, determines the dynamic material-energy unity of our world.

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