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THE COSMIC EXPANSION AND ITS CONSEQUENCES

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ABSTRACT

Many consequences, manifestations and characteristics of the cosmic expansion are derived from the basic cosmic equations. The exact values of the whole cosmic expansion an gravitational forces as well as elementary quantum of time are calculated. Also other characteristics like the period of one cosmic pulse (expansion and contraction) or relation $E = mc^2$ are deduced.

THE BASIC SPACE-TIME EQUATION OF THE UNIVERSE

In the article "The basic space-time equation of the Universe" www.wbabin.net/philos/kohut3.pdf it was shown that the Universe is an increasing network of elementary quantum relations (connections) - quantum dipoles, where every positive pole "+" is connected with all negative ones "-" and reciprocally. The quantum dipoles represent the basic building blocks of matter (space, energy). The Universe starts its expansion from the initial state as a sole elementary quantum connection (dipole) "+,-". At the quantum state **k** it consists of $\mathbf{k^2}$ quantum connections. The cosmic transition from the quantum state **k** to **k+1** is accompanied by the creation of **2k+1** new elementary quantum connections. The volume of the Universe is given by the number of elementary quantum connections $\mathbf{k^2}$ and the cosmic time is represented by the number of elementary quantum transitions (jumps) **k**.

The basic quantum space-time equation of the Universe has the following form:

$$\mathbf{V_k = k^2}, \qquad \mathbf{k = 1,2, \ldots\ldots , n}$$

Parameter **k** varies from **1** to **n** (expansion) and backwards from **n** to **1** (contraction).

This equation expressed in real dimensional units like meter and second obtains the following form:

$$\mathbf{V = z.t^2}, \qquad \text{where:} \qquad \mathbf{z = (d^2V/dt^2)/2}$$

$$\mathbf{dV/dt = (d^2V/dt^2).t},$$
$$\mathbf{(dV/dt)^2 = 2\ V.d^2V/dt^2}$$

The Universe as a three-dimensional surface of a four-dimensional sphere is closed with no space limit, but with the final volume:

$$\mathbf{V = 2\pi^2 r^3}\ ,$$

where **r** is a radius of spatial curvature.

From the relation for the circumference of the Universe $\mathbf{o} = \mathbf{2\pi r}$ we obtain:

$$\mathbf{V = o^3/4\pi}$$
$$\mathbf{dV/dt = (3o^2 do/dt)\ /(4\pi)}$$
$$\mathbf{d^2V/dt^2 = (3\ (2.o.(do/dt)^2 + o^2.\ (d^2o\ /dt^2))/4\pi}$$

From these relations and basic space-time equation we get the following equation expressing the relation between length and time characteristics:

$$\mathbf{(do/dt)^2 = -2o.d^2o/dt^2}$$

This relation remains valid for every length parameter of the Universe and also for the speed of its change and acceleration. The role of circumference **o** can also play a length of any quantum dipole. It represents the basic law of motion of the Universe that manifests itself at macro and micro levels. It is the basic law of motion for every quantum dipole of the Universe relative to the whole dynamics of the Universe.

The relations between spatial circumference **o** and time **t** are:

$$\mathbf{o = u.t^{2/3}}$$
$$\mathbf{do/dt = (2/3)u.t^{-1/3}}$$
$$\mathbf{d^2o/dt^2 = -(2/9)u.t^{-4/3}},$$

where: $\mathbf{u = (2\pi d^2V/dt^2)^{1/3}}$

These equations show that the spatial circumference **o** increases in time but its speed decreases. So, acceleration is negative. It means that the speed of cosmic expansion decelerates.

Hubble´s constant is:

$$\mathbf{H = (do/dt)/o = (2/3).t^{-1}}$$

The time of cosmic expansion is:

$$\mathbf{t = (2/3).H^{-1}}$$

THE NATURE OF MASS

The cosmic expansion is accompanied by the increase of a network of elementary quantum connections (dipoles**).** During the elementary quantum cosmic jump every quantum dipole forms its elementary quantum connections to the new poles “+” and “-“ and transfers a very small portion of its internal energy to them. Consequently it elongates (expands**)** because of decrease of its internal energy according to the relation $\mathbf{d_i = \delta_i/e_i}$ representing the universal law, which gives the energetic $\mathbf{e_i}$ and length (geometric) $\mathbf{d_i}$ characteristics into the mutual relation.

The reaction of every quantum dipole to the cosmic expansion is manifested by its mass, which represents the measure of its resistance to the cosmic expansion with consequent cosmic deceleration. **The mass is a manifestation of deceleration of cosmic expansion.** This deceleration is at the same time the acceleration in opposite direction, so it is the cosmic gravitational acceleration. Mass is hereby a manifestation of the gravitational acceleration of the Universe. The cosmic gravitation is the reaction (of every quantum dipole) to the cosmic expansion. The relation "**mass – deceleration of cosmic expansion**" is mutual. One predicts the other. The mass is the cause for the deceleration of cosmic expansion as well as the cosmic deceleration is manifested by the mass of the Universe. More precise is the next dialectic formulation: **The mass is manifested by the deceleration of cosmic expansion, which appears as a mass.**

At the level of quantum dipole, the unity of mass and cosmic deceleration is manifested in this way: the shorter and more energetic the quantum dipole is, the higher is its resistance to its extension and so the higher is its mass. The longer and weaker the quantum dipole is, the smaller is its resistance to its expansion and so the smaller is its mass. The internal energy of a quantum dipole is a measure for its internal mass. So, the **internal mass** of any object is given by its internal energy as a sum of energies of all its quantum dipoles. From the constant relation $\mathbf{e_i d_i}$ follows the constant relation $\mathbf{m_i d_i}$ where $\mathbf{m_i}$ is the internal mass and $\mathbf{d_i}$ the length of quantum dipole **i**.

As mentioned, the basic cosmic law expressed in a form $\mathbf{(do/dt)^2 = -2o.d^2o/dt^2}$ has a general character. It is valid for the whole Universe as well as for every its quantum dipole, whose length $\mathbf{d_i}$ plays the role of parameter **o**. Every motion, as a result of the length change of quantum dipole due to cosmic expansion, subordinates to this law. We can write it in the following form:

$$\mathbf{c_i^2/2 = -a_i.d_i}, \quad \text{or} \quad \mathbf{c_i^2/2 = g_i.d_i}$$

where: $\mathbf{c_i}$ – speed of length increase of quantum dipole **i** thanks to cosmic expansion,
$\mathbf{a_i}$ – acceleration,
$\mathbf{g_i} = \mathbf{-a_i}$ – deceleration of the dipole extension equal to its gravitational acceleration,
$\mathbf{d_i}$ – length of quantum dipole.

In every moment the ratio between the deceleration of the speed of length increase (gravitational acceleration) $\mathbf{g_i}$, speed of length extension $\mathbf{c_i}$ and length $\mathbf{d_i}$ is equal for all quantum dipoles. Then, from the constancy $\mathbf{m_i d_i}$, the next invariants $\mathbf{m_i c_i}$, $\mathbf{m_i g_i}$ follows for all quantum dipoles **i.** So we have next three invariants of cosmic expansion and gravitation:

$\mathbf{m_i g_i}$ - invariant of gravitational (expansion) force
$\mathbf{m_i c_i}$ - invariant of momentum
$\mathbf{m_i d_i}$ - invariant of mass and length

These invariants are the symmetries representing the dialectic unity of quantum dipoles in their relation to the cosmic expansion. The symmetry of gravitational (expansion) force means its equal value for every quantum dipole. So the expansion force $\mathbf{f_e}$, acting through every quantum dipole, is:

$$\mathbf{f_e = m_i . g_i} ,$$

The higher the mass of quantum dipole is, the slower is it extension by cosmic expansion and the slower is its gravitational acceleration.

As the expansion (or gravitational) force $\mathbf{f_e = m_i . g_i}$ is equal for every quantum dipole, the whole expansion force $\mathbf{F_e}$ (or opposite gravitational force **G**) of the Universe, in the quantum state **k** with $\mathbf{k^2}$ elementary quantum dipoles, is:

$$\sum_{i=1}^{k^2} \mathbf{m_i\, g_i = f_e . k^2 = F_e = G}$$

The whole mass of the Universe in the quantum state **k** (time **t**) is a sum of masses of all elementary quantum dipoles:

$$\mathbf{M} = \sum_{i=1}^{k^2} \mathbf{m_i} = \mathbf{m.k^2} ,$$

where: $\mathbf{m = M/k^2}$ - average mass of elementary quantum dipole in the cosmic quantum state **k** corresponding to its time **t**.

As the average mass **m** of quantum dipole corresponds to its average expansion deceleration (gravitational acceleration) $\mathbf{g_a}$, the next relation is valid:

$$\mathbf{F_e = G = k^2 . m . g_a = M . g_a}$$

During the cosmic expansion the mass $\mathbf{m_i}$ of quantum dipole **i** decreases in the same ratio as the deceleration $\mathbf{g_i}$. From the relation for the deceleration of the speed of cosmic expansion $\mathbf{d^2o/dt^2 = (-2/9)zt^{-4/3}}$ follows, that both above mentioned values decrease proportionally to $\mathbf{t^{-4/3}}$. From the relation $\mathbf{M = m.k^2}$ and the increase of $\mathbf{k^2}$ proportionally to $\mathbf{t^2}$ follows that the whole mass **M** of the Universe as a conjunction of **m** and $\mathbf{k^2}$ increases proportionally to $\mathbf{t^{2/3}}$. Also the length characteristics, like the maximum length of the Universe **o/2,** increase proportionally to $\mathbf{t^{2/3}}$ what means that the ratio between the mass of the Universe **M** and its size **o/2** remains constant. So the expression **M/o** is the basic unchanging cosmic constant during the whole existence of the Universe.

From invariants $\mathbf{e_i d_i}$ and $\mathbf{m_i d_i}$ follows, than the shorter connections are more intensive and contain more energy and mass, the weaker connections with low energy are longer. The connections inside elementary particles are intensive because they are very short while the connections between distant material objects are very weak, almost negligible, because they are very long and manifest themselves only gravitationally. Their existence is however hidden and so denied. Quantum mechanics otherwise indicates their existence but Einstein refused them hardly.

If the Universe would expand by the constant speed of light $\mathbf{c_a}$, than its dimension, equal to the longest quantum dipoles, was $\mathbf{c_a t}$. But the speed of cosmic expansion decelerates proportionally to $\mathbf{t^{-1/3}}$, what means that the average speed of cosmic expansion (light) $\mathbf{c_a}$ is higher than the actual speed **c**:

$$o/2 = \pi r = c_a t = (3/2)\ ct, \quad \text{then:} \quad c_a = (3/2)c, \quad c = (2/3)c_a$$

The speed of light represents the speed of cosmic expansion. It is a speed through which the Universe escapes from itself. It is the escaping speed between two opposite sides of the Universe.

The coefficient 2/3 in the relation between Hubble´s constant and the time of cosmic expansion is the same as in the relation between the actual and average speed of light. It represents the deceleration factor of the Universe. If the speed of cosmic expansion would not decelerate and its deceleration factor was equal to 1, than the Universe was not internally structured and consisted only of one elongating quantum connection. It would not create any resistance to its expansion and so was without any mass and gravitation. Such a Universe could not exist. Thanks to its structural segmentation it resists to its expansion, decelerates its speed and increases its mass.

THE RELATION BETWEEN ENERGY AND MASS

Our analysis of the relation between energy and mass of material objects we will start with the speed of light.

For the longest quantum dipoles representing the highest possible distance equal to the half of circumference of the Universe, **o/2**, the speed of its increase, thanks to the cosmic expansion, represents the highest possible speed – speed of light **c**.

Then:

$$c = (do/dt)/2 = o/3t$$

$$o/2 = \pi r = (3/2)\ ct$$

As the cosmic gravitation is a reaction to cosmic expansion, so we can represent the deceleration of cosmic expansion (represented by the deceleration of the speed of cosmic extension of its longest quantum dipoles with a length **o/2**) as the cosmic gravitational acceleration **g**:

$$g = -(d^2o/dt^2)/2$$

The speed of light represents the speed of cosmic expansion. The deceleration of cosmic expansion is its gravitational acceleration as the expansion and gravitation act in opposite directions. The force of cosmic expansion is equal to the force of cosmic gravitation, only their orientations are opposite.

The relation between the speed of light and the gravitational acceleration is:

$$g = -dc/dt$$

The cosmic gravitational acceleration is equal to the deceleration of the speed of light during cosmic expansion.

From the basic cosmic motion equation $(do/dt)^2 = -2o.d^2o/dt^2$ we obtain:

$$c^2 = g.o$$

The square of the speed of light is equal to the gravitational acceleration multiplied by the cosmic circumference.

The whole energy e_i of a quantum dipole **i** is a sum of its attractive e_{ia} and repulsive e_{ir} parts:

$$e_i = e_{ia} + e_{ir} \quad \text{where: } e_{ia} = e_{ir} = e_i/2$$

The force of attraction and repulsion f_i acting between anti-poles through the entire length d_i of quantum dipole, in conjunction with its length, gives the whole energy e_i of quantum dipole:

$$e_i = f_i . d_i$$

The whole force f_i affecting the quantum dipole is a sum of attractive f_{ai} and repulsive f_{ri} forces:

$$f_i = f_{ia} + f_{ir} \quad \text{where: } f_{ia} = f_{ir} = f_i/2$$

Then:

$$e_{ia} = f_{ia} . d_i$$

The certain part of repulsive (or attractive) force of every quantum dipole represents the expansion (or gravitational) force $f_e = m_i.g_i$ used for the cosmic expansion by expelling of new elementary quantum connections during the elementary quantum jumps of the Universe.

The relation f_{ia}/f_e between the internal attractive force f_{ia} of a quantum dipole and its expansion (gravitational) cosmic force f_e is, that thanks to the constant value f_e, the smaller, the longer the dipole is. By the longest quantum dipoles with the length **o/2**, this relation obtains the value **1**, what means, that these dipoles can just compensate their cosmic expansion forces f_e, used for the expelling of new quantum connections, by their whole attractive forces f_{ia}. This is the reason, why they are the longest quantum dipoles, determining the length dimension of the Universe. So:

$$f_{ia} = f_e$$

For the longest quantum dipoles with the length **o/2**, gravitational acceleration **g**, minimal mass m_{min} and minimal energy e_{min}, the following relations are valid:

$$f_{ia} = f_e = m_{min}g$$
$$e_{ia} = m_{min}go/2$$
$$e_{min} = 2e_{ia} = m_{min}go$$

From the relation $c^2 = g.o$ we have:

$$e_{min} = m_{min}c^2$$

As the ratio e_i/m_i, thanks to invariants $e_i d_i$ and $m_i d_i$, is the same for every quantum dipole in the same time **t** of cosmic expansion, then:

$$e_i/m_i = e_{min}/m_{min} = c^2,$$
$$e_i = m_i c^2$$

We have derived the relation between the internal energy and internal mass for every quantum dipole. This relation in a form $e = mc^2$ is valid for every material object, as its internal energy and mass is a sum of energies and masses of all its quantum dipoles.

So this relation is valid also for the whole Universe:

$$E = Mc^2$$

where: $$M = \sum_{i=1}^{k^2} m_i$$

The relation $e = mc^2$ is the famous Einstein´s formula for the equivalence of energy and mass. We have derived it from the basic motion cosmic equation and by the detection the nature of energy, force and mass.

COSMIC GRAVITY

In the article "The unity of Coulomb´s and Newton´s laws" www.wbabin.net/philos/kohut5.pdf a classical Newton´s gravitational law was derived in a form:

$$f_g = \kappa . m_1 . m_2 / d^2,$$

where: m_1, m_2 - external masses of two bodies with mutual distance **d**,

$\kappa = \alpha hc / (4\pi\varphi^2)$ - gravitational constant.

$\varphi = (\alpha hc/(4\pi\kappa))^{1/2}$ - relation between the mass of body and the number of its positive and negative poles

α - fine structure constant,

h – Planck constant,

c - speed of light

This relation expresses only the attraction between two material bodies, but does not contain the whole attraction inside the system with two bodies, as it does not include the attractive forces of quantum dipoles creating these material bodies. If we want to express the whole attractive force F_a inside some neutral system (structure) – the Universe as a whole can also represent this system – with the whole mass **M** consisting of **k** positive and **k** negative poles, than:

$$F_a = \sum_{i=1}^{k^2} f_{ia}$$

From the relation $f_{ia} = \alpha hc / (2\pi d_i^{\ 2})$ we have:

$$F_a = (\alpha hc/2\pi) \sum_{i=1}^{k^2} 1/d_i^2$$

This relation shows that very short quantum dipoles create the main contribution into the whole attractive force. It is specific for the gravitational force, that it manifests itself only through long distances, where attractive forces are not compensated by the repulsive spatial pressures of quantum dipoles and are mediated by the cosmic vacuum between material bodies.

The following relation between the mass **M** of the Universe and the number of its positive and negative poles **2k** is valid:

$$M = \varphi\ 2k,$$

$$k^2/d_a^2 = \sum_{i=1}^{k^2} 1/d_i^2 ,$$

where: d_a is a length of a quantum dipole with an average attractive force $f_a=F_a/k^2$. The value $\varphi = M/2k$ represents the elementary gravitational mass (elementary gravitational charge) of one pole of quantum dipole. Then:

$$k = M/2\varphi$$
$$F_a = (\alpha hc / 2\pi)\ k.k\ /d_a^2$$
$$F_a = (\alpha hc / 2\pi\varphi^2)\ (M/2)(M/2)\ /d_a^2$$
$$F_a = \kappa.(M/2)(M/2)/d_a^2$$
$$\kappa = \alpha hc/(2\pi\varphi^2) = 4F_a d_a^2/M^2$$

From the invariant value $e_i d_i$ we obtain:

$$e_i d_i = f_i d_i^2 = e_a d_a = ed = 2f_a d_a^2$$

$$E.d = 2\ k^2 f_a d_a^2 = 2F_a d_a^2 = 2F_e(o/2)^2 = 2G(o/2)^2$$

$$\kappa = 2E.d/M^2 ,$$

where: **d** - length of quantum dipole with an average energy **e** and average mass **m**.
E - whole energy of the Universe.

The next relation between the whole mass of the Universe **M** and the number of its elementary quantum connections (dipoles) k^2 is valid:

$$M^2/k^2 = 2\alpha hc / \pi\kappa$$

The expression for the gravitational constant $\kappa = \alpha hc/(2\pi\varphi^2) = 4F_a d_a^2/M^2$ is remarkable as thanks to the invariant relations, e.g. $F_a d_a^2 = G.\ (o/2)^2$, the gravitational constant can be universally applied for the expression of any global cosmic force, not only for its whole attractive force F_a, but also for the whole gravitational force **G** (expansion force F_e) of the Universe.

From the invariant relation $\mathbf{F_a d_a}^2 = \mathbf{G.\ (o/2)^2}$ we obtain the following expression for the gravitational law of the whole Universe:

$$\boldsymbol{\kappa = G.o^2/M^2}$$
$$\mathbf{G = \boldsymbol{\kappa}.M^2/o^2}$$
$$\mathbf{G = \boldsymbol{\kappa}.(M/2)(M/2)/(o/2)^2}$$

It is a classical Newtonian gravitational law for the whole Universe, where its mass is divided into two equal parts, which mutual distance represents the maximum distance of the Universe connecting its two opposite sides.

From both relations for gravitational constant

$$\boldsymbol{\kappa} = \mathbf{2Ed/M^2} \text{ and } \boldsymbol{\kappa} = \mathbf{c^2\,\pi r/(2M)} = \mathbf{g(o/2)^2/M}$$

where $\mathbf{c^2 = go}$ and $\mathbf{E = Mgo}$ we obtain:

$$\mathbf{d = (o/2)/4 = \pi r/4},$$

As we can see, the quantum dipole with an average energy $\mathbf{e = E/k^2}$ and average internal mass $\mathbf{m = M/k^2}$ has a length, which represent the **1/4** part of the length **(o/2=πr/4)** of the longest quantum dipoles, and so it contains four times higher energy and mass than the longest ones.

From the relations $\boldsymbol{\kappa} = \mathbf{go^2/4M}$ and $\mathbf{o=c^2/g}$ we have:

$$\mathbf{Mg = c^4/(4\boldsymbol{\kappa})}.$$

Then from the relation:

$$\boldsymbol{\kappa} = \mathbf{Go^2/M^2 = go^2/4M}$$

we obtain the formula for the whole gravitational (expansion) force of the Universe:

$$\mathbf{G = F_e = Mg/4 = c^4/(16\boldsymbol{\kappa}) = 7{,}566.10^{42}\ N}$$

where : **g/4** - gravitational acceleration of the quantum dipole with an average mass **m,** average energy **e** and average length $\mathbf{d = (o/2)/4 = \pi r/4}$

So we know the exact value of the expansion and gravitational forces of the Universe.

This value decelerates during the cosmic expansion according to the following relation:

$$\mathbf{G = E/4o = (1/4)(2\pi d^2V/dt^2)^{-1/3}.t^{-2/3}}$$

The cosmic gravity affects all objects, all elementary quanta of space. It means that the gravity, as a reaction to the cosmic expansion, has a global and quantum character.

THE EQUILIBRIUM AND DYNAMICS OF COSMIC FORCES

As the attraction has its contradiction in repulsion, these two opposite parts are mutually balanced. Their equilibrium and symmetry is not static, but dynamic, and manifested in various forms. The global attractive force $\mathbf{F_a}$ of the Universe is totally compensated by the whole repulsive force, which is manifested by the mutual repulsive pressures of quantum dipoles and its kinetics, as well as cosmic expansion.

The gravitational force **G** of the Universe represents a certain part of the global attractive force $\mathbf{F_a}$ as a counterbalance to the whole expansion force $\mathbf{F_e}$.

$$\mathbf{F_e = G}$$

The cosmic expansion force is responsible for the whole mass of the Universe, which, at the same time, is a measure for the gravitational cosmic attraction and creates its global mass charge, determining the whole cosmic gravity, which influences the kinetic motions of material bodies.

The whole mass **M** of the Universe can be expressed in different forms. It represents the **internal mass of quantum dipoles** as a measure of their energy, which is unequally divided between quantum dipoles, as well as **gravitational mass**, which is equally divided between anti-poles creating their elementary gravitational charges. The number of anti-poles inside a body defines its number of mutual connections with other bodies, through which they are gravitationally attracted.

The whole internal mass of bodies, as a consequence of the cosmic expansion, is a starting point for determination of the whole gravitational force of bodies. The different nature of internal and gravitational masses requires the necessity of determination, at what level of cosmic hierarchy we can get the equal sign between them. As the cosmic expansion force is equal to its gravitational one, we must do it at the level of the whole Universe.

The cosmic expansion and gravitational forces represent only certain parts of the whole attraction and repulsion of quantum dipoles. There are also another three known types of forces and interactions: electromagnetic, strong and weak. These forces (interations) are also only manifestations of the mutual dynamics between attraction and repulsion of quantum dipoles.

The mutual dynamics of internal forces of attraction and repulsion between anti-poles of quantum dipoles is manifested as an oscillation (vibration) of photons. In more complicated structures like particles or atoms the active role play the great repulsive pressures of spaces of quantum dipoles which are compensated by very strong attractive forces of short quantum connections. The shorter the quantum dipole is, the stronger is its attractive force. In stable sructures the mutual equilibrium of attraction and repulsion is guaranteed also by the mutual motion of its quantum dipoles. Some dipoles pulsates, some do not move and compensate the strong repulsive spatial pressures by their strong attractive forces. So, some dipoles in particles move and its energy has a kinetic form, others manifest their energy in a potential form. Some pulsates thanks to the mutual dynamics of atraction and repulsion, other only reflects these pulsations.

The structures (short-living particles) whose equilibrium of repulsive and attractive forces is caused by the action of strong external forces (energies) are not stable and easily decay.

Attraction and repulsion are in a dynamic equilibrium as a manifestation of the dialectic bipolarity of the Universe. The Universe thanks to its dialectics cannot reach the static equilibrium of its oppposite forces. So it will never come to its total cosmic death predicted by the law of entropy increase. This law does not accept the structural segmentation of the Universe during its expansion, when the whole cosmic network of quantum connections constantly increases. Indeed, it is right, that the cosmic areas gradually cool down, their energy decrease, but this is only a manifestation of the Universe in its stage of expansion. The equilibrium is gradually realized at lower energetic levels of cosmic objects. The law of entropy increase is derived mainly from the observation of the mechanic motion of particles and molecules (temterature balancing) in a closed system. If the external local presures of quantum dipoles, through which the moving molecules locally act, come to equllibrium, the closed system achieves the highest level of entropy. But the law of entropy cannot explain the huge energetic disproportion between very short quantum dipoles inside particles, atoms and molecules and very weak long vacuum quantum connections between material objects. This disproportion even increases during cosmic expansion. The inner dynamics of quantum dipoles as manifestation of its dialectic nature, as well as the dynamics of the whole Universe, the law of entrophy avoids and so cannot be applied for the forecast of the future fate of the Universe. The law of entropy increase is only a manifestation of the universal dialectic law of motion.

The release of energy from more complicated structures, with their consequent transfer to the lower energetic level, is a manifestation of the cosmic expansion accompanied by the increase of the number of elementary quantum dipoles in a global cosmic network.

THREE FORMS OF MASS

It could seem that every material object manifetsts itself only through one mass. But it is not truth. The reason is evident. While the **internal mas** of a body is defined by the energy of all its quantum dipoles, its **external gravitational mass** is defined by the number of its possitive and negative poles, from which all external quantum dipoles come out and connect it with all other objects in the Universe.

Every material object is dead defined by the number of possitive and negative poles, whose elementary quantum connections create its inner structure. If two objects have the same number of possitive and negative poles, they have the same gravitational mass.

Let us have two neutral objects (structures). The first has $\mathbf{k_1}$ positive and $\mathbf{k_1}$ negative poles, the second – $\mathbf{k_2}$ positive (or negative) ones. The first object has $\mathbf{k_1^2}$ quantum dipoles, the second $\mathbf{k_2^2}$. The system consisted of both objects have $(\mathbf{k_1}+\mathbf{k_2})^2$ quantum dipoles, so it contains $\mathbf{2k_1k_2}$ quantum dipoles in addition, which mutually connect both objects. Its external gravitational mass is proportional to the sum of positive and negative poles $(\mathbf{k_1}+\mathbf{k_2})$. The internal mass and energy is the sum of energies of all quantum dipoles. If two objects are connected into one object, their external mutual $2k_1k_2$ connections transform to the internal connections of new object. These connection become much shorter and energetic, their increase of energy must be compensated by energetic weakening of others internal quantum dipoles. Then the internal mass of a new object is equal to the sum of masses of both previously separated objects. So the balance between the internal mass and external gravitational mass is maintained. This balance is a consequence of equilibrium between attraction and repulsion of matter created by stable material structures of atoms and molecules.

The material structure connected from two previously independent structures is stable only if the attractive forces of its quantum dipoles are in equilibrium with repulsive ones. The increase of repulsive pressures of quantum dipoles connecting two previously separate structures must be compensated by the decrease of energy of quantum dipoles in previous structures. The mutual equilibrium of attraction and repulsion as a condition for the existence of stable material structures is possible only if the internal energy (mass) is proportional to the number of its positive and negative poles. Then the internal mass of a body is the same as its external gravitational mass. By the synthesis of atomic nuclei, a part of energy is release even in a form of flying away particles carrying the energy of quantum connections being before parts of components entering to the synthesis. This is only the way to make stable the new material structure. The released energy is known as a binding energy, which, indeed, is the energy of released quantum connections.

If the body moves, it manifests itself through its **external inertial mass**, expressing its motion relation towards other objects. This motion is a manifestation of its resistance against its acceleration or deceleration. If the massive body is at rest, all three masses – **internal, external gravitational and inertial** – are in equilibrium and have the same value.

If the body does not change its internal structure, what means, that the number of positive and negative poles is the same, its external gravitational mass remains unchanged. But its internal energy (mass), as well as external inertial mass, changes during its motion. If the body accelerates, its resistance against the next acceleration increases what causes the increase of its external inertial mass. But its internal mass (energy) decreases whereby the resistance of the environment (vacuum) is compensated. Then the decrease of the internal energy of quantum dipoles of moving body is accompanied by their elongating, what enables the body more effective puncture of resistance of external vacuum quantum connections of environment. The decrease of internal energy of moving body means also the deceleration of all its internal processes what is represented by the time dilation. This is the reason for the real relativity, which will be explained in detail in a separate article. Time dilation means the deceleration of all internal processes inside a moving body, what meens the decrease of its internal energy and mass.

Einstein built its theory of gravity by the assumption of equivalence of inertial and gravitational masses. This equivalence is valid only by slow motions. It loses its validity by great speeds and also by elementary particles, mainly by particles with zero rest mass (photons, neutrinos) but with the gravitational mass given by the number of their positive and negative poles. They act gravitationally with other objects. The problem of the so-called dark mass is a consequence of an erroneous absolutization of the principle of equivalence between inertial and gravitational masses.

The equilibrium between the internal and gravitational masses is valid only if the material body is at rest towards near surroundings

At the level of elementary particles both masses can be quite different. For example, the photons, as simple quantum dipoles, consist of two anti-poles. They can have various internal masses (energies), but their gravitational mass is always the same, as it is proportional to the number of anti-poles. It means that the gravitational force of mass body affecting the photon is always the same and independent of the internal mass (energy) of photon. The gravitational mass responding to the one pole creates its gravitational charge. All elementary quantum dipoles have the same gravitational mass although their internal mass (energy) is quite different and indirect proportional to their length.

In mass bodies the equilibrium between internal and gravitational mass is maintained thanks to the compensation of increasing binding energies by the release of internal energies of initial structures. The other situation is, if we take into account a system of mass bodies, e.g. celestial bodies. The sum of gravitational masses of separate bodies equals to the gravitational mass of the whole system. It is because the number of anti-poles is the same whether we analyse the system as a whole or as a sum of its parts. But if we study the internal mass of the system, we must take into account besides the internal masses of all bodies also the masses of their mutual quantum connections. If the number of celestial bodies in a chosen system is small, the energy and internal mass of the whole system only slightly differs from the sum of internal masses of separate bodies. It is because the energy of mutual quantum connections is negligible thanks to their great lengths. But if the number of celestial bodies in the system is huge, for example, galaxies or the whole Universe, the number of mutual quantum connections creating the cosmic vacuum is enormous and important in respect to the whole mass. Their energy (mass) creates the energy of cosmic vacuum inside the galaxy or whole Universe.

Historically the mass of bodies was firstly defined by their resistance to their acceleration (inertial mass) and by the mutual gravitational attraction between the Earth and material objects (gravitational mass). The Newtonian gravitational law established the relation between the gravitational masses of bodies and their mutual gravitational attractive forces. From the discovery that the bodies with different inertial masses fall towards the Earth with the same gravitational acceleration followed: the greater the inertial mass, the higher the gravitational one. So the principle of equivalence between inertial and gravitational masses was postulated. But the validity of this principle is limited and vanishes by the speeds close to the speed of light.

Later was discovered that the mass bodies contain enormous internal energy proportional to their mass multiplied by the square of speed of light. It is a famous Einstein´s law of equivalence between energy and mass, which unifies the internal mass with internal energy. As we have deduced this internal mass is a manifestation of the deceleration of cosmic expansion and consequent cosmic gravitation.

The quantity of the whole internal mass of the Universe given by the relation $\mathbf{M = E/c^2}$ is a measure for the whole cosmic gravitational mass (or the whole gravitational charge of the Universe). Then the elementary gravitational charge of one pole is $\boldsymbol{\varphi = M/2k}$ and the gravitational constant is $\boldsymbol{\kappa = \alpha hc/(2\pi\varphi^2)}$. From Newton´s gravitational law, when the attraction was defined for two bodies with masses $\mathbf{m_1, m_2}$, we have received the next formula for the gravitational constant $\boldsymbol{\kappa = \alpha hc/(4\pi\varphi^2)}$. So we have two slightly different formulas. As the gravitational constant is the same in both cases, the difference is in a quantity of a gravitational mass charge $\boldsymbol{\varphi}$ associated with one pole, which is $\mathbf{\sqrt{2}}$ – times higher if we calculate it through the whole mass of the Universe then through the masses of both bodies.

This fact confirms that the mass of the whole system consist not only of masses of celestial bodies but also of masses of their mutual quantum connections. If we consider all masses of the long elementary vacuum quantum dipoles connecting mutually all celestial bodies of the Universe, we only add the deficit, which occurs when we take into account only the masses of celestial bodies. This deficient mass hidden in vacuum quantum connections however is not the so-called dark matter, as the gravitational force acting between systems is given by the number of elementary positive and negative poles which represent the sum of anti-poles of all bodies in these systems.

The problem of the missing dark matter can be easily removed, if we take into account, that the particles with zero rest mass (photons, neutrinos) have a gravitational mass. Contemporary theories suppose that the gravitational attraction can create only objects with non-zero rest inertial mass and do not accept the gravitational attraction of particles with zero rest mass. If we take into account all quanta of electromagnetic energy (photons) and all neutrinos in the observed system, we can see that no mass is missing for the explanation of a whole amount of gravitational forces in the observed system, e.g. galaxy. No dark matter is needed for understanding the gravitational behaviour of cosmic structures. Probably there are also gentle worlds created by long quantum connections unreachable for contemporary measuring instruments. The problem of dark matter is only a consequence of misunderstanding the real essence of mater and erroneous principle of equivalence between inertial and gravitational masses.

The mathematical relation between three forms of mass will be derived in a separate article.

THE CYCLE OF COSMIC PULSATION

If the quantum dipole is a free photon, it pulsates. The time of its one pulse is $\mathbf{\Delta t_i}$. It internal energy can be expressed by Planck´s relation:

$$\mathbf{e_i = h\nu_i = h/\Delta t_i = hc/\lambda_i} ,$$

where:

kde: $\mathbf{\nu_i = 1/\Delta t_i}$ - frequency of quantum dipole (photon)
$\mathbf{\lambda_i}$ – wavelength of quantum dipole
$\mathbf{c}$ – speed of light

By using Planck´s relation for $\mathbf{e_i}$ in Coulomb´s relation $\mathbf{e_i d_i = \alpha hc/\pi}$ we get:

$$\mathbf{d_i/\lambda_i = \alpha/\pi}$$
$$\mathbf{d_i/\Delta t_i = \alpha c/\pi}$$

There are very interesting relations which, through the fine structure constant, connect the length of elementary quantum dipole with its wavelength and pulse time. The longer the quantum dipole, the longer the period of its one pulse.

The fine structure constant, whose nature has been unknown, has a great importance, as it allows definition of the whole cycle of cosmic pulsation, i.e., period of cosmic expansion and contraction.

As the dimension of the Universe is defined by the longest quantum dipoles with the length **o/2**, the time of its one pulse Δt_i represents the time of one cycle of cosmic expansion and contraction T_{cyc}. After adding the relation $d_{max} = o/2 = \pi r = (3/2)\,ct$ to the relation $d_i/\Delta t_i = \alpha c/\pi$ we get:

$$d_{max}/T_{cyc} = 3ct/(2T_{cyc}) = \alpha c/\pi,$$

where: $T_{cyc} = 3\pi t/(2\alpha) = \pi/(\alpha H) =$ **9 040 billion years**

For the period of cosmic expansion T_{exp} we have:

$$T_{exp} = 3\pi t/(4\alpha) = \pi/(2\alpha H) = 4\,520 \text{ billion years}$$

It means that the whole period T_{exp} of cosmic expansion to the moment of its transition to its contraction, is $3\pi/(4\alpha)$, i.e. 322,88 times longer, than the contemporary period of cosmic expansion **t**. If we suppose that the time of cosmic expansion is 14 billion years from the Big Bang, it means, that the Universe will expand still 4 506 billion years until it starts it contraction. So the whole time period of it expansion is 4 520 billion years.

From the relations $M^2/k^2 = 2\alpha hc/(\pi\kappa)$ and $t = k\Delta t$ we get:

$$M^2/t^2 = 2\alpha hc/(\pi\kappa\Delta t^2).$$

where: Δt – time of elementary quantum jump of the Universe from one quantum state to the next.

After dividing the relation $Mg = c^4/4\kappa$ with $go = c^2$, when $o = 3ct$, we obtain:

$$M/t = 3c^3/4\kappa$$
$$M^2/t^2 = 9c^6/16\kappa^2.$$

From both relations for M^2/t^2 we obtain the relation for the elementary quantum of time representing by the elementary quantum cosmic jump between two neighbour symmetric quantum states of the Universe:

$$\Delta t^2 = 32\kappa h\alpha / 9\pi c^5$$
$$\Delta t = (4/3)(2\kappa h\alpha / \pi c^5)^{1/2}$$
$$\Delta t/2 = (2/3)(2\kappa h\alpha / \pi c^5)^{1/2}$$

One quantum jump Δt corresponds to $1{,}228.10^{-44}$ seconds. This Planck time is calculated in contemporary physics from the relation $(\kappa h/ 2\pi c^5)^{1/2}$, which was deduced by the artificial combination of constants. This time represents the mystery and impenetrable barrier and evokes fruitless discussions about what happened during this period after Big Bang. But the situation is very simple. We only allocate the certain time interval Δt (or $\Delta t/2$) to the elementary quantum jump what evokes the illusion that the elementary quantum jump takes a certain time. But the reality is quit different. The number of elementary quantum jumps defines the elapsed time. So the quantum jump is not measured by elapsed time, but contrarily, the time is measured by the number of elementary quantum jumps. One second is represented by $\mathbf{1/\Delta t = (3/4)/(\pi c^5/2\kappa h\alpha)^{1/2} = 8,144.10^{43}}$ elementary quantum jumps of the Universe. The second, defined by this number of quantum jumps, creates the stable time etalon for the Universe, which allows comparing the different periods of cosmic evolution by contemporary earth seconds. Time has a quantum character consisting of elementary quantum jumps (transitions) of the Universe.

The number of cosmic quantum jumps **k** from the beginning of expansion (Big Bang) up to now:

$$\mathbf{k = t/\Delta t = (\pi c^5/(8H^2\kappa h\alpha))^{1/2} = 3,6.\ 10^{61}}$$

The number **k** represents also the number of positive and negative poles of contemporary Universe and $\mathbf{k^2}$ - the number of elementary quantum connections (dipoles):

$$\mathbf{k^2 = \pi c^5/(8H^2\kappa h\alpha) = 1,295.10^{123}}$$

The cosmic number **n**, which determines the maximum number of quantum jumps of the Universe from the beginning to the end of cosmic expansion, can be calculated by the following relation:

$$\mathbf{n = T_{exp} / \Delta t = 1,16.\ 10^{64}}$$

The average energy of one quantum dipole is:

$$\mathbf{e = E/k^2 = 9,29.10^{-54}\ J}$$

The average length is:

$$\mathbf{d = \pi r/4 = c/(4H) = 4,97.10^{25}\ m}$$

THE COSMIC CONTRACTION

Although we are now in a stage of cosmic expansion, after about 4 500 billion years the expansion will stop and the Universe transfers to the stage of cosmic contraction. The time arrow will change its orientation. After every symmetrical quantum jump one pair of anti-poles + and – will disappear together with all its outgoing quantum connection. Their energy will absorb to the rest existing quantum connections. The whole contractive force of the Universe will be compensated by its anti-gravitational force. Antigravity of the bodies will be manifested by their mutual repulsion. This process will continue to the moment when the Universe becomes only a sole quantum dipole and starts its new expansion (new Big Bang).