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Non-explosive reversible transformations matter-energy via gravity in universe

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Abstract. The problem of energy is one of the most important problems of the present and future. By consuming energy from various sources and for various purposes, one produces pollution: the human activity generates entropy. One question is: what happens at the Universe scale where large energy transformations are taking place? Is the entropy production leading to some kind of a pollution accumulated in known or unknown regions of the Universe? In the following, several possibilities to examine the problem of the energy changes at diverse scales in Universe are proposed.

Keywords: fluid of HD-gravitons, emission, absorption.

1. Introduction

The whole energy existing in our Universe is finite and comes from the BIG BANG (BIG FLASH). From one point of view, any finite value of this energy (denoted further with E_{U0}) is possible. However, by using the model of the early Universe proposed in [1], a certain value can be assessed.
An important thing is to find the most appropriate connection of the primary energy with a form able to permit to establish the main transformations of this energy. By using a hydro-dynamical analogy between the Newton force of gravity and the sources interaction in an incompressible fluid [2], an intermediate form of energy that can be both emitted and absorbed is conceived. This form of energy is "a fluid of HD-gravitons" where the "HD-graviton" is a photon-like particle having the wave

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length equal to the radius of the Universe [2]. Thus, our HD-graviton is the weakest form of energy in Universe.

If E is an arbitrary amount of energy (other than HD-graviton) it can emit/absorb (according to our hydro-dynamical analogy [2]) a rate of energy E' equal to:

$$E' = \theta_g(t_u)E(t_u), \tag{1}$$

θ_g being the "rate intensity" (s^{-1}), positive for emission, negative for absorption and depending on the age of the Universe t_u. There is force of attraction for both emission and absorption, similar to the gravity force.

By comparing the newtonian and the source forces, one obtains an expression for the intensity θ_g. The form given in [2] is now adapted to take into account the diminution of the HD-graviton intensity due to the Universe expansion and the variation of the universal coefficient of gravity with the age of universe t_u. Finally, one obtains:

$$\theta_g = \pm \frac{2A(t_{u\,HD})}{t_u^3}\sqrt{\frac{E_{gu}(t_u)}{E_{U0}}}; \tag{2-a}$$

$$A(t_{u\,HD}) = \frac{t_{u\,HD}}{2}\sqrt{\frac{3f_{N\,act}t_{u\,act}E_{U0}}{c_V^5}}. \tag{2-b}$$

In the equations (2), $E_{gu}(t_u)$ is the total energy of HD-gravitons, t_{uHD} represents the age of the Universe from where the hydro-dynamical analogy with Newton gravity law can be applied, $f_{N\,act}$ is the actual value of the universal coefficient of gravity ($f_{N\,act} = 6.67\cdot10^{-11}$ N.m^2/kg^2), $t_{u\,act}$ is the present age of Universe ($t_{u\,act} = 1.38\cdot10^{10}$ ys), E_{U0} is the total energy of Universe and c_V represents the speed of light in vacuum.

2. The determination of the total energy of the universe. The initial HD-graviton.

In order to obtain a value for the total energy E_{U0}, one uses the fact that a HD-graviton has a wave length equal to the radius of the Universe [2]. It follows that at BIG FLASH all the existing energy is under the form of a HD-graviton only.

As regards the possibility for the energy E_{U0} to appear, one uses the uncertainty principle of Heisenberg [4;7]:

$$\Delta t \cdot \Delta E \geq h/4\pi, \tag{3}$$

where $h = 6.626\cdot10^{-34}$ J.sec. is the Planck constant. The relation (3) is interpreted as follows: a deviation ΔE from the energy conservation law is possible for a time interval

$$\Delta t = h/(4\pi\cdot\Delta E);\ (\Delta t)_{BF} = h/(4\pi E_{U0}). \tag{4}$$

At BIG FLASH one has $(\Delta E)_{BF} = E_{U0}$, the subscript "*BF*"' standing for BIG FLASH. The primary sphere (the primary HD-graviton) has a radius equal to the wave length of a photon with an energy E_{U0} and its frontier is expanding at the speed of light c_V. After BIG FLASH, a process of structuring is taking place: the primary sphere divides itself in eleven spheres [1] of equal radii (the minimum number of equal spheres that can be inscribed in a given initial sphere, Fig.1). All these eleven spheres are HD-gravitons of lower energy but of larger wave length.

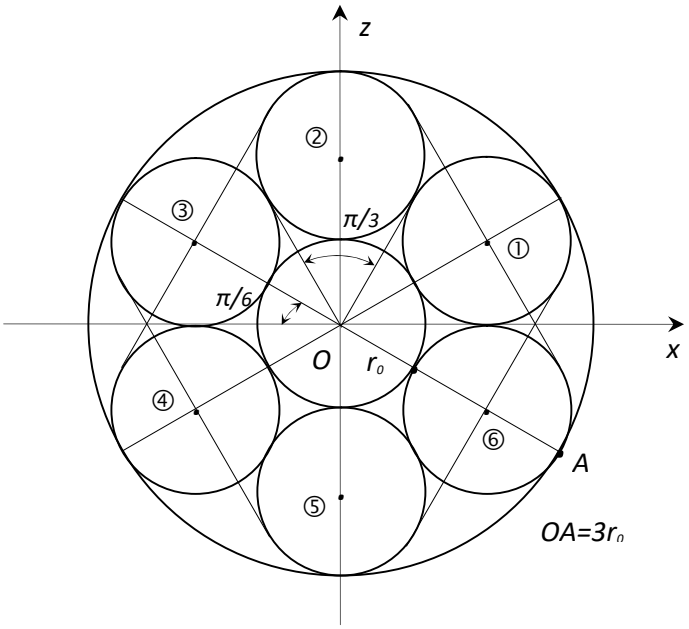

Fig. 1. Schematic view showing part of the eleven inscribed spheres (one configuration).

During the structuring process, the radius of the surrounding sphere increases 33 times at each division. The important fact is that after 77 steps the energy and the radius of a sphere is equal to the energy and the radius of a neutron at rest. This can be **considered as a form of resonance permitting the transformation of energy (HD-gravitons) in substance (neutrons at different speeds).** At this time $(t_u = t_{u77})$ one has:

$$\begin{aligned} &E_{U0} = 11^{77} E_{ne0} = 2.32 \cdot 10^{70} \text{ J};\\ &R_{u77} = 7.2186 \cdot 10^{21} \text{ m};\ \ E_{ne0} = 1.5075 \cdot 10^{-10} \text{ J};\\ &t_{u77} = R_{u77} / c_V = 2.406 \cdot 10^{13} \text{ s} = 7.62473 \cdot 10^{5} \text{ yrs};\\ &E_{g77} = 3^{-77} E_{ne0};\ \ \lambda_{77} = 1.3186 \cdot 10^{-15} \text{ m}. \end{aligned} \tag{5}$$

In this way, a value for the total energy E_{U0} was obtained. As regards the variation of entropy at BIG FLASH, it is positive and equal to the Boltzmann constant [3]. Therefore, the entropy generation at BIG FLASH is very small, one explanation being the very high temperature.
Then one leaves time for the transformation of all HD-gravitons in substance and one introduces a time t_{uHD} representing the age of the Universe from where the hydro-dynamical analogy with Newton gravity law can be applied.

3. The equation of balance

From the instant t_{uHD} , the hydro-dynamical analogy with Newton gravity starts to work. One will consider at that the Universe contains almost in totality normal matter. Then the first transformation will be emission of HD-gravitons. The global equation of transformation via emission/absorption of the average HD-graviton energy is (according to [2]):

$$\frac{dE_{gu}}{dt_u} = \theta_g(t_u)\left(E_{U0} - E_{gu}\right); \quad t_u \geq t_{uHD} > t_{u77} \tag{6}$$

$\theta_g(t_u)$ being given by the relation (2). The equation (6) has an analytical solution given bellow:

$$\ln\left(\frac{1+X}{1-X}\cdot\frac{1-X_{ref}}{1+X_{ref}}\right) = \pm\frac{A(t_{uHD})}{t_{u\,ref}^2}\left[1-\left(\frac{t_{u\,ref}}{t_u}\right)^2\right] \tag{7}$$

where $X = \sqrt{\frac{E_{gu}}{E_{U0}}}$.

$A(t_{uHD})$ is given in (2-b); $t_{u\,ref}$ is a reference (initial) time. The signs $(\pm)$ correspond to emission and absorption, respectively and proves the reversibility of these transformations. That means that, at global scale, it will be no entropy accumulation. One does not know exactly the critical values of the ratio X for the emission or the absorption to start. Anyhow the emission should start when there is lack of HD-gravitons and the absorption when there is excess of HD-gravitons.
As regards t_{uHD} , one takes two values larger than given in relation (5), namely:

$$t_{uHD1} = 10^6 \text{ ys}, \quad t_{uHD2} = 10^7 \text{ ys}. \tag{8}$$

The solution (7) is applicable after a time, the subscript “HD” standing for “hydro-dynamics”. By emission (sign “+”), the substance goes to HD-gravitons as form of energy; by absorption, the HD-gravitons come back to substance inside the absorbent.

These transformations are reversible; in the early stages one can have cycles "to and from". The calculations given in Table 1 indicate that several cycles emission-absorption are necessary. The critical ratio $\left(E_{gu}/E_{U0}\right)_{em}$ was taken equal for emission and absorption. In this way one could execute an integer number of cycles emission-absorption:
729 for $t_u = t_{uHD1} = 10^6$ ys and 71 for $t_u = t_{uHD2} = 10^7$ ys. The next transformations are emissions leading to a value X^2_{ref} close enough to unity in order to start at time $t_{u\,ref}$ an absorption capable to lead to a given value of the actual ratios $\left(E_{gu}/E_{U0}\right)_{act}$ of the "black energy" [5] (see Table 1).

Table 1. *Evolutions to the actual values of the "black energy".*

t_{uHD} [ys]	$(X^2)_{act}$	$(X^2)_{729em}$	$10^{22}\lvert\theta_{g\,ref}\rvert$ [s^{-1}]	$10^{-7}t_{u\,em}$ [ys]	Cycle number	$1 - X^2_{ref}$	$10^{-7}t_{u\,ref}$ [ys]
10^6	0.75	10^{-8}	$3.0053\cdot10^8$	2.11628	729	$1.0601\cdot10^{-7}$	3.1235
10^7	0.75	10^{-8}	$9.504\cdot10^7$	7.39218	71	$19.4364\cdot10^{-7}$	11.01818

4. Explosive and non-explosive transformations matter-energy. Comparisons.

In the following one makes comparisons between several transformations matter-energy and energy-matter. Of course, the most explosive transformation is the BIG FLASH (BF) although it is not an usual transformation but a creation of energy "ex nihilo".
Taking into account the very short time interval $(\Delta t)_{BF}$ (see equation (4)), one calculates the power necessary for the creation of the Universe:

$$P_{BF} = 4\pi E^2_{U0}/h = 1.00208\cdot10^{175}\ \text{W}. \tag{9}$$

Considering the radius of the Universe at BIG FLASH R_{BF} equal to the wave length of the attached photon one obtains the density $\rho_{P\,BF}$. Then one has:

$$R_{BF} = hc_V/E_{U0};\ \ \rho_{P\,BF} = 3P_{BF}/\left(4\pi R^3_{BF}\right). \tag{10}$$

For comparison, one considers the combustion of kerosene-air mixture at 1m/sec speed of reaction propagation as *limit for non-explosive irreversible chemical reaction* and the annihilations of pairs neutron-antineutron and electron-positron. For the time of those annihilation, one has considered time intervals similar to the one given by the uncertainty relation (3). In order to obtain a radius for electron, its

density was taken equal to the neutron density. The annihilations have been considered reversible as their inverse transformations (particle creation) are also taking place [4].

The results are given in Table 2 for $t_{uHD} = 10^6$ ys. The local derivative at three instants was calculated using the equation (6).

Table 2. *Powers and power densities for explosive and non-explosive transformations energy-matter.*

Transformation	**Power [W]**	**Power density [W/m^3]**	**Specific Entropy Rise [J/kg/K]**	**Entropy/ Power ratio [J/kg.K/W]**	**Time interval [s]**
BIG FLASH(Explosive Irreversible)	$1.0208 \cdot 10^{175}$	$3.876 \cdot 10^{459}$	$8.5684 \cdot 10^{-96}$	$9.395\ 10^{-271}$	$2.2728 \cdot 10^{-105}$
Electron annihilation (Explosive Reversible)	$1.9473 \cdot 10^{9}$	$3.723 \cdot 10^{56}$	$1.0768 \cdot 10^{-16}$	$5.530\ 10^{-26}$	$1.6455 \cdot 10^{-22}$
Neutron annihilation (Explosive Reversible)	$1.7230 \cdot 10^{15}$	$1.7952 \cdot 10^{59}$	$1.318 \cdot 10^{-15}$	$7.649\ 10^{-31}$	$1.7489 \cdot 10^{-25}$
HD-graviton Emission $t_u = t_{u729}$ (Explosive Reversible)	$2.0917 \cdot 10^{57}$	$1.6764 \cdot 10^{12}$	$6.6785 \cdot 10^{14}$	$3.193\ 10^{-43}$	Local derivative
HD-graviton Absorption $t_U = 3.1235 \cdot 10^7$ ys (Explosive Rev.)	$2.0917 \cdot 10^{50}$	60.72	$9.369 \cdot 10^{15}$	$4.478\ 10^{-35}$	Local derivative
HD-graviton Absorption $t_u = t_{uact} ys$ (Explosive Rev.)	$1.575 \cdot 10^{49}$	$8.0961 \cdot 10^{-26}$	$3.5945 \cdot 10^{24}$	$2.382\ 10^{-25}$	Local derivative
Kerosene (NLIR) combustion	$2.1950 \cdot 10^{9}$	$2.1950 \cdot 10^{12}$	$2.1945.\ 10^{4}$	10^{-5}	$2 \cdot 10^{-2}$ (1m/s)

As one can see from Table 2, the most explosive transformation takes place at BIG FLASH, where both the radius and the time interval of the Universe are very small. The transformation is irreversible [3;6] although the entropy increasing is very small (equal to the Boltzmann constant $k_B = 1.3805 \cdot 10^{-23}$ J/K).

At ages of the Universe of the order of $t_u \geq 10^6$ ys, the powers of the Universe transformations via gravity are larger than the powers of the reactions of annihilation

but the corresponding power densities are much smaller, which gives them a non-explosive character with respect to annihilation reactions. In addition, the energy-matter transformations via gravity are reversible, therefore non-pollutant.

5. Conclusions

1. The explosive character of a transformation or of a creation of energy is given by its power density, whereas the reversibility is given by the corresponding entropy variation [3;6]. The most explosive is the Universe creation at BIG FLASH, the power density being of the order of 10^{459} W/m^3 (see Table 2). However, the entropy increasing at BIG FLASH is very small due to the very high temperature (taken equal to the particle temperature [3]), but the time interval (taken from the uncertainty relation) is so small that the specific entropy jump is $2.2356 \cdot 10^{29}$ J/K/(kg/s).

Further, the entropy production is due to the Universe expansion which can be assimilated to an adiabatic process [3;6] slowed down by a structuring in the early stage of the Universe up to a moment $t_{u77} = 7.6247 \cdot 10^5$ ys when the temperature is $T_{u77} = 1.092 \cdot 10^{13}$ K (the particle temperature of the neutron). It follows that the entropy production in the time interval $(0; t_{u77})$ is $3.4252 \cdot 10^{-10}$ J/kg/K.

After the neutron formation, the diversity of bodies and particle combination in Universe is very complex [4] and one cannot give a simple evaluation of the whole entropy generation in Universe.

As a general remark, all natural transformations are producing at most a quantity of entropy equal to the Boltzmann constant. In the same time the entropy production per watt obtained is much smaller than in case of the industrial processes, the quantity of the pollutants being practically null. By comparison, the burning of one kg kerosene in an internal combustion engine gives 16 kg pollutants and many order of magnitude of the entropy produced per/kg/watt - see Table 2).

2. A second important role connected with the Universe expansion is played by gravity. The energy-matter (back and forth) transformations via gravity are non-explosive and half-reversible (the inverse transformation exists), which is a fact suggested by the presence of "$\pm$ "signs in the solution (7). The power densities of these transformations are smaller and smaller being at present of the order of 10^{-26} W/m^3. For comparison, the power densities of the electron-positron and neutron-antineutron annihilations are of the orders 10^{56} and 10^{59} W/m^3, respectively.

3. An interesting consequence of the HD-graviton absorption to create gravity is the mass increasing of bodies. In particular, the HD-graviton flux of absorption at our Sun surface is equal to $8.937 \cdot 10^7$ W/m^2 for $t_{uHD} = 10^6$ ys (or ten times larger, for $t_{uHD} = 10^7$ ys), in comparison with the Sun thermal emission which is equal to $6.3 \cdot 10^7$ W/m^2. ***Therefore the Sun life will be longer than estimated in the absence of absorption.*** More than that, because the absorption has started in the early times (at

$t_{u\,abs} = 3.1235 \cdot 10^7$ ys for $t_{uHD} = 10^6$ ys and at $t_{u\,abs} = 11.01818 \cdot 10^7$ ys for $t_{uHD} = 10^7$ ys - see Table 1) the life of our Sun has been prolonged due to absorption of HD-gravitons, by maintaining the conditions for the thermonuclear reactions inside the Sun [7].

As regards the Earth. at its surface the flux of HD-gravitons ($3.16635 \cdot 10^5$ W/m^2) is about 200 times larger than the thermal flux received from Sun ($1.3544 \cdot 10^3$ W/m^2). It is present as gravity force.

4. In fact one has two pollution factors: one related to entropy production and a second one related to pollutant matter related to energy transformation. We remark that natural transformations are non-pollutant with respect to both factors whereas the artificial transformations are at least double pollutant.

An important fact is that the energy in Universe is "well mixed" by means of the HD-gravitons coming from extended regions of space. In addition, the absorption and the emission of HD-gravitons are examples of non-explosive transformation matter-energy.

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