Light, Gravity, Expansion, Relativity, Black Holes and Black Energy - Considerations at the Scale of Universe

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Abstract: *Light, gravity, the Universe expansion and relativity in a simple but accurate enough model of Universe are studied. The proposed model starts with a singularity (BIG BANG or better said BIG FLASH). Unlike the standard picture where in the first stage there exists a "soup" of light and various particles (electrons, neutrinos, hydrogen, helium etc.), here the light energy is maintained for a longer time interval and a structure by dividing the Universe sphere is introduced. The first stage ends when neutrons (substance) appear by an effect of resonance. Then other particles are first formed by the neutron decay. After the occurrence of the substance, a hydrodynamic model of gravity is introduced through an analogy with the sources interaction in an incompressible fluid. It allows to obtain many interesting results. The model can be easily adapted to include special relativity effects. As regards the general relativity simple expressions for the scale of Universe do not seem to apply to the mass and radius of the Universe, currently accepted. Then, the possibility of using such simple relationships based on the light refractive index in the largest possible regions is studied.*

Key Words: *structure, resonance. refraction coefficient, HD-graviton*

1. INTRODUCTION

The creation of the Universe took place at a singularity (BIG BANG or better said BIG FLASH). Unlike the standard model where the energy of the created Universe came from a black hole, we consider, in an agreement between Physics and Theology, that this energy came from nothing (creation ex nihilo), by taking into account the Heisenberg principle of uncertainty, written as follows [1]:

$$\Delta t . \Delta E \geq h/4\pi, \tag{1}$$

where the deviation ΔE from the energy conservation is allowed for a time interval Δt. In addition, by considering this deviation a constraint, one applies the Gauss principle of minimum constraint from Mechanics [2] to take the sign equal in (1) and write:

$$E_{U0}(\Delta t)_{BF} = h/4\pi; (\Delta t)_{BF} = h/4\pi E_{U0} \quad (2)$$

where E_{U0} is the total energy of the Universe; $(\Delta t)_{BF}$ the time interval of BIG FLASH; h is the Planck constant.

The Universe was created from "nothing but not at random". Thus, from BIG FLASH the radiant form of energy (light) is maintained and a process of "structuring by division" described bellow takes place up to neutron formation.

Associated photon. In order to make comparisons one associates to any amount of energy E a photon of the same energy and a sphere having the radius r_a equal to the associated photon wave length. Then:

$$\lambda_a = \frac{hc_{Vac}}{E} = r_a, \quad (3)$$

c_{Vac} being the speed of light in vacuum (also the expansion speed of the Universe). In particular, a photon of the wave length λ_{Ua0} and a sphere of radius r_{Ua0} are associated to the energy E_{U0}:

$$\lambda_{Ua} = \frac{hc_{Vac}}{E_{U0}} = r_{Ua}. \quad (4)$$

REMARK. After the BIG FLASH the Universe is expanding with a finite speed, c_{Vac}. One may consider that this finite speed is a result of an equilibrium between the pressure at explosion and the force of gravity equilibrium **introduced from the very beginning in Universe.**

During a time, interval equal to $(\Delta t)_{BF}$ the Universe will have a radius r_{UBF} equal to:

$$r_{UBF} = hc_{Vac}/4\pi E_{U0} = r_{U0} = r_{Ua}/4\pi, \quad (5)$$

therefore 4π times smaller than the radius of the associated sphere.

2. THE UNIVERSE EXPANSION. STRUCTURING BY DIVISION

More different structuring processes are possible. We present here one of the simplest [3] alternative.

One considers that during expansion the sphere of the Universe of radius R_U is first divided itself in parts equal to $R_U/3$. Seven such spheres can be arranged using a big circle of the sphere (Fig. 1).

In a normal section of this large circle a similar distribution is taken; this gives all eleven spheres. No other sphere of radius $R_U/3$ has room.

If the entire energy is equally distributed to the eleven spheres, the wave length and the radius of the associated photon and sphere will increase eleven times.

Then the initial sphere radius is increases 33 times to obtain all the inner spheres of radius R_U. The sequence S is:

$$R_{US} = 33R_{U,S-1},; E_S = E_{S-1}/11, S = 1; 2; 3. \ldots; R_{U0} = r_{U0} \quad (6)$$

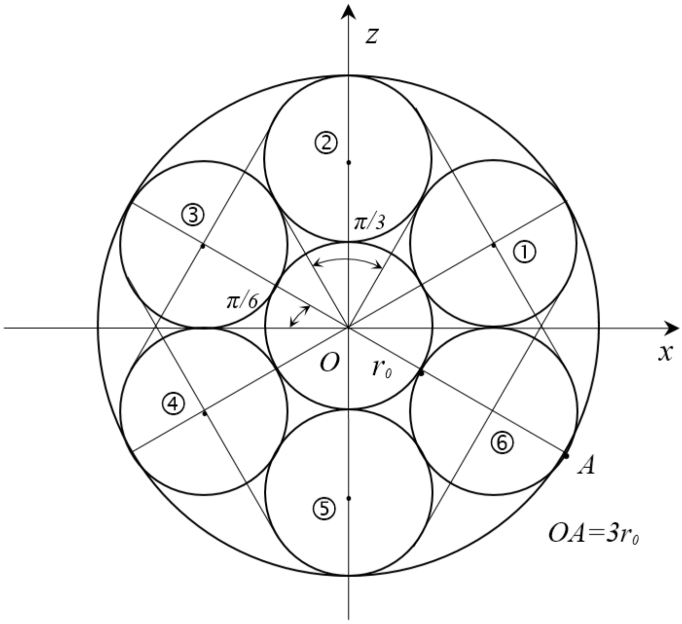

Fig. 1 Structuring by division

Two main conditions are imposed on the structuring process: 1) to obtain for the total energy E_{U0} a value of the order $10^{70}J$ (minimum $10^{53}kg$ equivalent mass); 2) to obtain a sphere of energy and radius corresponding to the neutron at rest. In this way one obtains **a state of resonance** that prepares the transformation of the radiant energy in substance. This is possible because the photon associated to the neutron has the wave length, λ_{ne0}, very close to the neutron radius:

$$\lambda_{ne0} = \frac{hc_{Vac}}{E_{ne0}} = 1.3186E - 15m \tag{7}$$

In the relation (7) $E_{ne0} = 1.5075E - 10J$ is the neutron energy at rest.
After *S=77* structuring divisions one obtains:

$$\begin{aligned} &E_{U0} = E_{U77} = 11^{77}E_{ne0} = 2.32E70J; \\ &R_{U77} = 33^{77}r_{aU0} = 7.2187E21m; \ \frac{\backslash R_{U77}}{3^{77}} = \lambda_{ne0} \\ &t_{U77} = 2.406E13\, sec = 7.6247E5ys \end{aligned} \tag{8}$$

After the neutron formation the structuring process in the above presented manner stops.

3. THE SPECIAL THEORY OF RELATIVITY AT THE UNIVERSE SCALE

The proposed model is a Universe in expansion with the limit speed c_{Vac}. It has a center at the BIG FLASH point C_U. In addition, one considers a linear velocity distribution in the interval $(0;R_U)$.This velocity distribution is a good average being confirmed by the value obtained by this for the Hubble constant (70.87 km/sec/Mpc [6]).
One takes two systems of reference: one with the origin C_U, denoted by $(x_{U1};x_{U2};x_{U3};t_U)$; another one with the origin in a point P, on a Universe radius, denoted $(x_1;x_2;x_3;t_P)$ - Fig. 2. The velocity $V_P = V_P(C_UP/R_U) = const.$

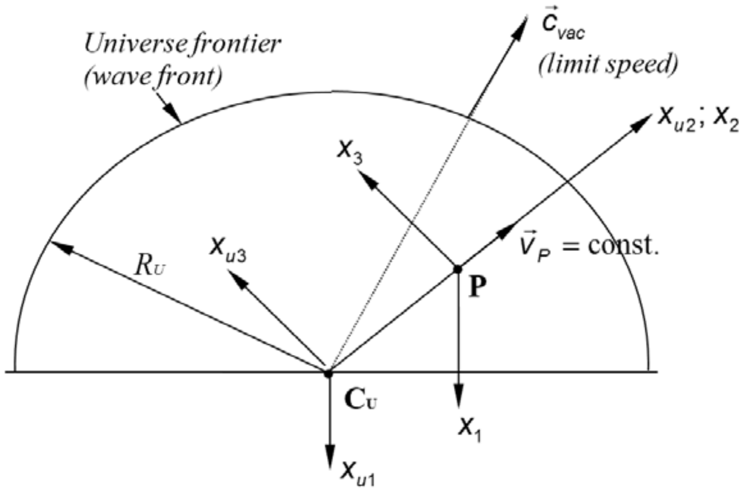

Fig. 2 Systems of coordinates for special relativity

From a relativistic point of view one considers that from any point of Universe its frontier is seen as a spherical wave moving with the limit speed, c_{Vac} that can be written as:

$$x_{U1}^2 + x_{U2}^2 + x_{U3}^2 - c_{Vac}^2 t_U^2 = x_1^2 + x_2^2 + x_3^2 - c_{Vac}^2 t_P^2 = 0. \tag{9}$$

Then by considering simple, linear dependences between space and time coordinates under the form:

$$x_1 = A(x_{U1} - v_P t_U); x_2 = x_{U2}; x_3 = x_{U3}; t_P = Bx_{U1} + At_U;$$
$$(x_{U1} = 0, t_U = 0): (x_1 = 0, t_P = 0) \tag{10}$$

and by imposing the conditions (3-1), one obtains the Lorenz-Einstein transformations of the special relativity [1;7]:

$$x_1 = \frac{(x_{U1} - v_P t_U)}{\sqrt{1-\beta_P^2}}; x_2 = x_{U2}; x_3 = x_{U3};\ t_P = \frac{t_U - \frac{x_{U1} v_P}{c_{Vac}^2}}{\sqrt{1-\beta_P^2}};$$
$$\beta_P^2 = \frac{v_{Vac}^2}{c_{Vac}^2}; \qquad A = \frac{1}{\sqrt{1-\beta_P^2}} \tag{11}$$

REMARK. The limit speed at the Universe frontier is a definitive one. On one part, it was established even from the BIG FLASH due to an equilibrium between the gravity force and the pressure at singularity.

It contains all the gravity influences whilst other photons in the Universe suffer various actions all the time. In addition, the frontier photons are propagating in the primordial vacuum. This is why the formulation of the special relativity at global scale could be advantageous and safer.

4. A HYDRODYNAMIC MODEL OF GRAVITY

We do not have a law of gravity yet during the early Universe. However a hydrodynamic analogy of gravity [4] can be used at least starting with an age of Universe denoted t_{UHD}, after the neutron formation ($t_{UHD} \geq t_{U77}$). The proposed analogy is based on the remark that two sources in an incompressible fluid are in attraction both if they are emitting or absorbing fluid, analog to the gravity Newtonian force. In the proposed model, the emitted /absorbed fluid consists of photon-like particles named **HD-gravitons** having the wave length equal to the Universe radius at the instant t_U.

The HD-graviton can be considered the weakest energy particle in Universe, very difficult to be detected.

On allows that any quantity of energy, *E*, (except the HD- graviton) emits /absorbs a quantity of energy on unit time, *E'*, given by:

$$E'(t_U) = \theta_g(t_U)E \tag{12}$$

where $\theta_g(t_U)$ represents the intensity of emission/ (absorption) in $\sec^{-1}$. By equating the hydrodynamic and the Newton forces of attraction, one obtains:

$$\theta_g{}^2(t_U) = \frac{3E_{gU}}{c_V^2 R_U^3} f_N(t_U), \tag{13}$$

where $E_{gU}, f_N(t_U)$ represent respectively the total energy of the fluid of HD-gravitons in Universe and the coefficient of gravity attraction, depending on the age of Universe.

The dependence of $f_N(t_U)$ on the age of Universe was established [6] <u>by applying the conservation laws to the evolution of **stable configurations**</u> **(**example, Sun- Earth-Moon system), having the form:

$$f_N(t_U) = f_{Nref}\left(\frac{t_U}{t_{Uref}}\right)^{\nu}; f_N(t_{U2}) = f_N(t_{U1})\left(\frac{t_{U2}}{t_{U1}}\right)^{\nu_{12}}, \tag{14}$$

where the value $\nu_{12} = \nu \approx -1$= const. is a very good approximation on large time intervals. By using the value $\nu = -1$ in the expression (13) of the intensity $\theta_g(t_U)$ of emission/absorption of HD- gravitons, one obtains:

$$\theta_g(t_U) = \pm \frac{2A(t_{UHD})}{t_U^3}\sqrt{\frac{E_{gU}}{E_{U0}}}; A(t_{UHD}) = \frac{t_{UHD}}{2}\sqrt{\frac{3f_{Nref}t_{Uref}E_{U0}}{c_V^5}}, t_U \geq t_{UHD}, \tag{15}$$

t_{UHD} being a time from where the hydrodynamic model is applicable ($t_{UHD} \geq t_{U77}$).

A balance equation of the energy of the HD-graviton fluid was given, leading to the expression:

$$ln\left(\frac{1+X}{1-X}\frac{1-X_{ref}}{1+X_{ref}}\right) = \pm\frac{t_{UHD}}{2}\left[1-\left(\frac{t_{Uref}}{t_U}\right)^2\right]; X = \sqrt{\frac{E_{gU}}{E_{U0}}}; t_U \geq t_{UHD}. \tag{16}$$

The sign (+) is for emission, and the sign (-) for absorption. In the actual time the Universe is in absorption. [6].

The HD-gravitons, as they are very difficult to be detected, can be connected with the black energy in Universe.

5. THE GENERAL RELATIVITY AT EXTENDED SCALE

To introduce the general relativity effects, one considers punctual masses and the metric tensor $g_{\mu\nu}$ of Rastall [8;9], the universe element of length having the form:

$$dS^2 = g_{\mu\nu}dx^{\mu}dx^{\nu} = \frac{1}{n}(c_{Vac}dt)^2 - n(d\vec{r})^2; \mu, \nu = (0; 3) \tag{17}$$

where t is the time, $\vec{r}$ is the position vector ***in the proper system of each considered part. One has denoted:***

$$x^0 = t, x^1 = x, x^2 = y, x^3 = z. \tag{18}$$

***n* is the refraction index** given by the relation:

$$ln(n) = \frac{2f_N M_0}{c_{Vac}^2 r}, \tag{19}$$

M_0 being the mass creating (mainly) the gravitation and f_{Nact}=6.67E-11 N m^2 /$(kg)^2$. At large distances from M_0 the refraction index is very close to unity but the general relativity effects are not negligible.The quation (17) also satisfies the equation of Einstein [1;7]:

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = -\frac{8\pi f_N}{c_{vac}^2}T_{\mu\nu} \tag{20}$$

where $R_{\mu\nu}, R, T_{\mu\nu}$ are: the tensor of curvature of Ricci [7], the static curvature and the tensor of mass, respectively. The problem is to find a simple expression for the mass tensor $T_{\mu\nu}$, the simplest form corresponding to the punctual mass.

The total energy has the expression [9;10]:

$$E_{tot} = \frac{m_0 c_{Vac}^2}{\sqrt{n(1 - (nv/c_{Vac})^2)}}; \frac{dE_{tot}}{dt} = 0 \tag{21}$$

being constant along the particle trajectory.

As one can infer from (21), in case the particle is a photon, one has m_0 = 0; therefore to obtain a total energy different from zero, the speed of photon, v_{ph}, in a gravitational field depends on the refraction index n, One has the expression:

$$\underline{v_{ph} = c_{Vac}/n} \tag{22}$$

As a consequence, the speed of photon is variable with the distance from the mass M_0.
Let us apply the expression for the total energy E_{U0} concentrated at center C_U. One obtains:

$$E_{U0} = 2.32E70J, R_{Uact} = 1.38E10 lightys, ln(n_{U\,act}) = 2.924; n_{U\,act} = 18.6156, \tag{23}$$

therefore, the photon speed at frontier is different from the limit speed c_{Vac} existing in the Universe expansion. In fact, the resulting speed at frontier is even smaller as mass exists at distances shorter than R_{Uact}. **This proves that simple formulas for the mass tensor are not applicable at the Universe scale.**

The solution to this difficulty could be to find a more complicate (and more accurate expression for the mass tensor $T_{\mu\nu}$**) or to look how the simple formula (5.3) can be applied on the most extended regions of the Universe. To this aim we use the results from our previous paper [10].**

Let one consider two representative masses: 1) one mass equal to our Sun mass (M_{Psun}= 2.*E30* kg, in the fixed system of reference); 2) a second mass of a galaxy mass order (M_{PG}= 2.*E42* kg, in the fixed system of reference). One important parameter is the ratio M_P / r_f , r_f being the radius at frontier. The radii r_f are given in Table 1. $M_P = M_0$ denotes a part of the Universe mass.

If one takes the corresponding values for Sun-like and Galaxy-like cases in formula (5.3), one obtains refraction indexes very close to unity (with an error smaller then 10^{-5}).

In this scheme applied to a Sun-like model one has the number of parts N_P=N_{Psun} = $1.9284E23$; in case of a Galaxy model one obtains N_P=N_{PG} = $1.9284E11$. The results are given in Table 1 for an earlier age of Universe equal to 9.15 billion of years.

In the case of the Galaxy model an arrangement of spheres (Suns) can also be done, the radius being obtained by arranging 10^{12} Suns in zones as above. One obtains the radius of a part R_p=1.099*E18* meter. For the actual universe characteristics, one admits: E_U=2.32*E70* J; M_U=2.578 *E53* kg; R_U=1.38 *E10* light years [5]; M_{Sun}=2*E30* kg;
Because one expects transformations in time of the universe structure, one has selected as moment of our discussion the value R_U = 0.915 *E10* light years.

Table 1. Some regional characteristics for R_U= 0.915 E10 l.ys.

M_P, kg	N_P	R_P, l.ys./meter	r_f, m	M_P/r_f	(n-1). *E6*
2E30	1.288E23	1.119 E2/ 1.099E18	6.955 E8	2.876 E21	4.00
2E42	1.288E11	1.119 E6/ 1.099E22	1.314 E22	1.425 E20	0.211
7.894E36	3.947E6	7.318E-9/ 0.6923E8	1.170E10	6.747 E26	Black hole

6. POSSIBLE FORMATION OF BLACK HOLES. DARK MATTER AND BLACK ENERGY

From Table 1, one can see that the numbers of parts, N_P, are big enough for various situations to appear. One of them could be the ***black holes formation*** as a consequence of the mass concentration. The main condition for the definition of a black hole is the impossibility to emit photons [10;11]. Then, denoting by E_{ph} the energy of a photon at the black hole frontier of the radius R_{Bh} and by using the expression of the gravity force given by the general relativity for photon and considering the mechanical work of this force from R_{Bh} to infinity, one obtains the condition:

$$E_{ph} \leq 2\frac{f_N M_0}{R_{Bh}}\frac{E_{ph}}{c_{vac}^2}; \frac{M_0}{R_{Bh}} \geq \frac{c_{vac}^2}{2f_N(t_U)} = \left(M_P/r_f\right)_{crit}; \left(M_P/r_f\right)_{critact} = 6.747E26 \qquad (24)$$

Thus, one has obtained ***a critical value for the ratio*** M_0 / R_{Bh} for the black hole formation. According to Newton formula this ratio is half only; therefore, the general relativity effects help the black hole formation. The dependence $f_N(t_U)$ of the gravity coefficient on the age of the Universe was also considered. Because the gravity coefficient decreases in time the critical ratio $\left(M_P/r_f\right)_{crit}$ increases in time. The critical radius is the largest radius for a given mass to form a black hole. The refraction index at the critical black hole frontier is n_{Bh}=$e^1 = 2.718$. Of course, black holes of higher densities can be formed at smaller values of the frontier radii, the refraction index increasing exponentially. A suggestion can be made with respect to so called ***dark matter.*** This could be given by black hole formations close to the actual critical value $6.747E26kg/m$; thus the black hole is weak, not able to act visible to surroundings; in addition at such a body surface the speed of a coming photon is sensibly reduced due to the big values of the refraction index. From Table 1 it results that both the Sun-like and the Galaxy models presented, comparing the ratios M_P/r_f, are in present far from a state of black hole. The same behavior has a Sun- like body within a Galaxy: M_P/r_f= 1.522*E18 Kg/ m.*

In the last line of Table 1 the characteristics of a black hole made from 3.947*E6* Sun masses at the limit for a black hole formation are given. Such a mass would correspond to a super-massive black hole supposed to exist in the center of our Galaxy. At limit the density of the weakest black hole is about 8245 times the actual Sun density. The calculation suggests a possible formation of a black hole in more steps: first the Sun-like body is concentrated at about the tenth of its radius; then a big number (3.947*E6*) of the obtained body are clustered to form a weak black hole. Further the cluster is concentrated to form a final strong black hole. Thus it results a black hole similar to the one supposed to exist in the center of our Galaxy (named ***Sagittarius*** *A*, [10]), having the Sun diameter. Its density is 3.947*E6* times the actual Sun density!

As regards the black energy it could be assimilated to the the energy of HD-gravitons, E_{gU}, given in (4.2). According to our hydrodynamic model of gravity (see solution (4.5).

Is the Universe a black hole? The ratio M_P/r_f for the actual Universe is 2.632E27 kg/m, a value exceeding the critical value for black hole formation (5.8). In the earlier stages this value was larger. **However, the Universe cannot be considered a black hole as it is in expansion with the speed of the frontier photons equal to the limit speed.** Anyhow from the Universe frontier nothing comes out.

7. CONCLUSIONS

The main conclusions of the present study are:

1) The Universe creation from "nothing" at BIG FLASH (BIG BANG) can be argued on the basis of the uncertainty principle (Heisenberg), combined with the principle of minimum constraint (Gauss);

2) The Universe evolution from BIG FLASH takes place as a structuring by division of the radiant energy up to a ***resonance between the neutron and its associated photon***, making possible the substance formation by means of a single particle (neutron);

3) the Universe is a spherical sphere whose frontier is moving at a limit speed c_{Vac} (speed of light), as an equilibrium between the pressure at BIG FLASH and the force of gravity;

4) the special relativity relations at the Universe scale (Lorenz-Einstein transformations) are re-found by considering that from any point of the Universe (moving at the constant speed according to the proposed linear model) the Universe frontier is seen as a spherical light wave;

5) the general relativity by using simple relations for the element of Universe and for the mass tensor of Einstein cannot be applied to the Universe scale giving too small values for the photon speed at the Universe frontier. However simple relations can be used on pretty large regions (ex. at galaxy scales);

6) a hydro-dynamic model for the Newton gravity by using an analogy between the sources interaction in an incompressible fluid and Newton formulas is approached. To this aim a photon-like particle named **HD-graviton**, having a wave length equal to the radius of Universe

was introduced. By applying the conservation laws of momentum and mechanical energy to stable configuration systems of bodies (example, the Sun-Earth-Moon) a dependence of the gravity coefficient in Newton law of universal attraction on the age of the Universe was established;

7) a critical ratio mass/frontier radius for black bole formation was given considering the general relativity effects and the gravity coefficient variation with the age of the Universe;

8) an interpretation of the black energy and black matter as well as their evolution is suggested by using the HD-gravitons. The actual Universe being in absorption the total black energy is decreasing.

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