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A comparative study of some models regarding the creation of the early universe

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Abstract. The creation of Universe is a problem which receives a more and more complex answers. The theory of BIG BANG (more correct BIG FLASH because the sound does not propagate through vacuum), is a standard model leaving several open questions. One of them is: where the energy of Universe comes from? If it comes from somewhere then the BIG BANG is not a primordial beginning. A second problem is the further evolution: the standard model considers a "soup" of light where various particles [8] are formed by hazard at instants more or less justified. In authors' opinion, an order shoul dexist from the very beginning. As regards the source of energy, the authors propose a possibility of energy appearance from "nothing" (creation ex nihilo of Theology) in agreement with the uncertainty principle of Heisenberg. Then the radiant energy is maintained for a longer time interval while a structuring by division of the Universe sphere takes place. This structuring is ended when neutrons (substance) appear by an effect of resonance. Then other particles are formed first by the neutron transformation.

Keywords: structuring, resonance, particle temperature.

1. Introduction

The first question we will consider is the source of energy of the Universe. The "*creation ex nihilo*" of Theology can be put in agreement with Physics, by using the uncertainty relation of Heisenberg, written under the form [1]:

$$\Delta t_{U0} \cdot \Delta E \geq h / 4\pi \tag{1}$$

where ΔE represents the deviation from the energy conservation law for a time interval Δt_{U0} and h is the Planck constant (h = 6.626·10^{34} J.s). By considering

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the deviation from the energy conservation as a constraint, one applies the ***principle of minimum constraint*** from Mechanics (Gauss, [2]) by taking in (1) the sign "=". One obtains an extremely small-time interval Δt_{U0}:

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

which can be calculated once the total energy of the Universe E_{U0} is known.

Remark 1. One may ask if the Heisenberg relation, deduced in the Quantum Mechanics, is applicable to BIG-FLASH. We shall use as argument the affirmation:" the *microscopic indeterminism is the ground of the macroscopic determinism*" [3]. For comparison, we recall the quantum indeterminism and the high precision of the astronomic measurements. On the other hand, the uncertainty relation can be seen by Theology as part of the freedom that the **Creator** has introduced from the very beginning in Universe**.**

2. Models of universe

In order to give models of Universe, one uses a few definitions as follows:

2a. **The associated photon.** To any quantity of energy E one associates a photon of the same energy and a sphere having the radius r_a, equal to the wave length of the associated photon λ_a . One writes:

$$\lambda_a = \frac{h c_V}{E} = r_a \tag{3}$$

c_V being the speed of light in vacuum.

2b. **Structuring by division.** One considers that an order in the evolution of the Universe exists from the very beginning. One remembers the Aristotle's "entelechia", the inner principle of evolution which finally it determines. One looks for a simple geometry to divide the sphere of Universe after BIG-FLASH considering only radiant (light) energy instead of a standard model of a "soup" of various particles (photons, neutrinos, nuclei of H2, He, electrons, etc. [8]). The radius of Universe r_{aU0} associated to the energy of the Universe E_{U0} is taken at the instant t_{Ua} larger with a factor 4π than the time interval required by the uncertainty relation, such that:

$$r_{aU0} = h c_V / E_{U0}\,;\; t_{Ua} = r_{aU0}/c_V = 4\pi\,\Delta t_{U0} \tag{4}$$

One considers the time origin $t_{U0}=0$ at BIG-FLASH and the center of Universe C_U at the point of BIG-FLASH. After t_{Ua}, the sphere of radius r_{aU0} whose frontier is expanding at the speed of light c_V is divided itself in smaller spheres filling the big one in a precise geometry and containing specified amounts of energy. This simple geometry of spheres is close to the real sphere of the Universe at given times. It will be named PGSAU, the PHYSICAL GEOMETRICAL SCHEME ASSOCIATED TO UNIVERSE. PGSAU conserves the radius R_U and the total energy E_{U0} of the Universe. The evolution of the Universe according to **PGSAU,** is a ***structured*** scheme, proposed in place of **standard** scheme where the hazard plays the important role.
Several PGSAU-s are possible; we will study two kinds of such schemes: ***complete structuring*** schemes and ***partial structuring*** schemes.
In order to obtain quantitative results, we take into account three data: 1) the order of magnitude of the total energy of universe $E_{U0}\sim 10^{70}\ \mathrm{J}$; 2) the actual age of Universe, $t_{Uact}=1.38\cdot 10^{10}\ \mathrm{ys}$; 3) the actual temperature of cosmic background radiation, $T_{Gact}=2.7\ \mathrm{K}$.

2c. **Resonances.** We remark three important coincidences of data which we name ***resonances***.
- One coincidence consists of almost equal values of the neutron radius in nucleus r_{ne} and the wave length of the neutron associated photon $r_{a\,ne}$ as follows:

$$r_{ane}=1.3186\cdot 10^{-15}\ \mathrm{m};\ r_{ne}=1.2\cdot 10^{-15}\ \mathrm{m} \tag{5}$$

In fact, the free neutron radius could be a little bit larger than $1.2\cdot 10^{-15}\ \mathrm{m}$.
- A second coincidence consists of almost equal values of the particle temperature corresponding to an amount of energy E and the black body temperature of its associated photon of the same density of energy (see equation 16).
- A third coincidence is the very close value obtained for the total energy of Universe E_{U0} for different PGSAU-s, as we will see further.

3. The complete structuring

One considers first the complete structuring when the entire energy E_{U0} is distributed to spheres of equal radii filling the PGSAU in the sense of their tangency to each other and at the frontier. Between spheres there is primordial vacuum [5]. One looks for a simple geometry, as follows.

3.1. The geometry with eleven spheres [4].

One takes a big circle of the outer sphere (Fig. 1) where seven circles of radius $R_U / 3$ are inscribed, representing seven spheres. The same configuration is taken for a big circle normal to the first one. In total one obtains eleven spheres. No other sphere of the radius $R_U / 3$ has room within the two normal sections.

With the initial radius of Universe r_{aU0} given by the relation (4), one can calculate the number of steps S_{ne11} required to obtain the energy of the neutron at rest E_{ne0} starting from an energy of the order of 10^{70} J. For $S_{ne11} = 77$, one obtains:

$$E_{U77} = 11^{77} E_{ne0} = 2.32 \cdot 10^{70} \text{ J}; \; r_{aU0} = 8.568 \cdot 10^{-96} \text{ m}. \tag{6}$$

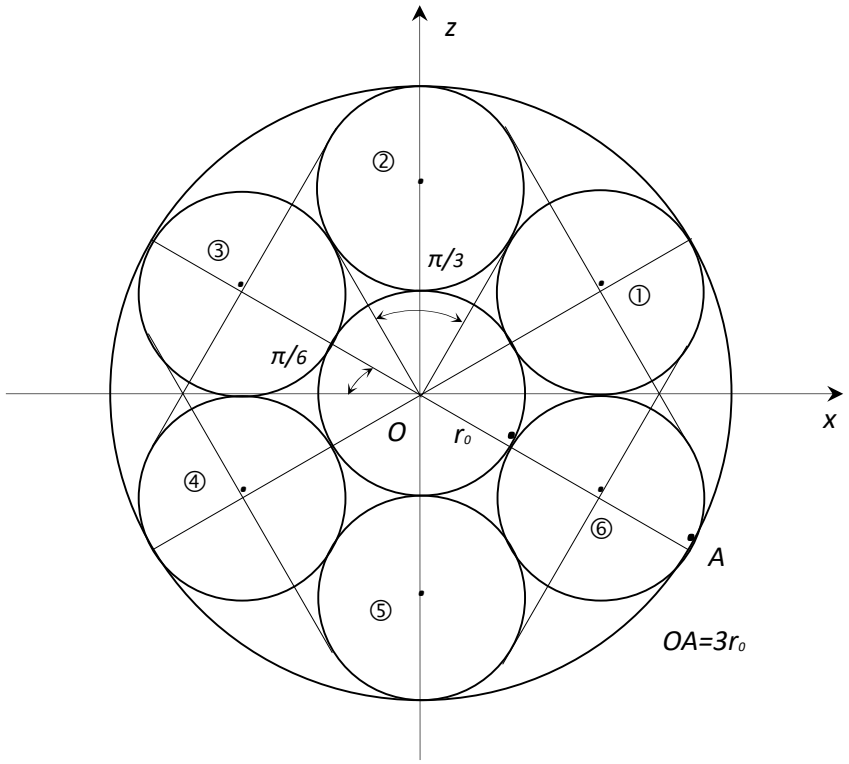

Fig. 1. Structuring by eleven spheres.

At this time, denoted by t_{U77}, one obtains the radius of Universe:

$$\begin{aligned} R_{U77} &= (3 \cdot 11)^{77} r_{aU0} = 7.2187 \cdot 10^{21} \text{ m}; \\ t_{Une77} &= R_{U77} / c_V = 2.406 \cdot 10^{13} \text{ s} \; = \; 7.629 \cdot 10^{5} \text{ ys} \end{aligned} \tag{7}$$

Once the neutron has appeared, one considers the beginning of the transformation of the radiant energy in substance possible. From neutron, other particles are formed via the neutron decay [6]:

$$n \to p + e^- + \overline{\nu}_e \tag{8}$$

i.e. the proton (p), the electron (e^-) and the anti-neutrino ($\overline{\nu}_e$).

REMARK: In the initial "soup" of the standard model, the appearance of neutrons is estimated at a much shorter time (of order of 10^{-5} … 0.2 s) [7]. Even so, there is a small number of neutrons whereas in our model, a bulk mass apparition is considered. On the other hand, a longer period of a radiant energy could be preferable. The expansion implies anyhow a region of photons at the frontier.

3.2. The geometry with thirteen spheres.

A model with thirteen spheres of radius $R_U/3$ and centers on the tips of a regular icosahedron and one in the center (Fig.2) is also possible. The number of structurings to obtain the neutron at rest energy E_{ne0} is $S_{ne13} = 72$ and the corresponding energy of Universe E_{U013} and the radius of the associated sphere r_{aU013} are:

$$E_{U72} = 13^{72} E_{ne0} = 2.41 \cdot 10^{70} \text{ J};\ r_{aU0} = 8.248 \cdot 10^{-96} \text{ m}. \tag{9}$$

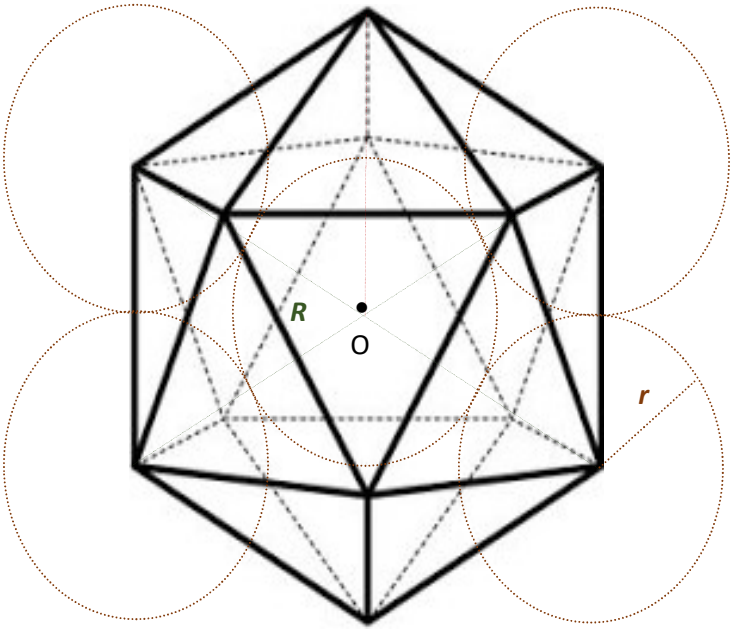

Fig. 2. Regular icosahedron with 13 division spheres.

As one can see very close values for E_{U0} and r_{aU0} are obtained as compared with the geometry of eleven spheres structuring. The time of the neutron occurrence is however much shorter. Indeed, one obtains for the corresponding radius of Universe and time the values:

$$\begin{aligned} R_{U72} &= \left(3\cdot 13\right)^{72} r_{aU0} = 2.972\cdot 10^{19} \text{ m;} \\ t_{Une72} &= R_{U72}/c_V = 9.907\cdot 10^{10} \text{ s } = 3141.5 \text{ ys} \end{aligned} \tag{10}$$

4. The partial structuring

Let us consider the geometry with eleven spheres but each sphere contains initially only 1/27 of the total energy of Universe i.e. proportional to its volume. The rest of energy equal to $16/27\,E_{U0}$ is uniform distributed among the eleven spheres. Then the necessary number of structuring to obtain the neutron at rest energy E_{ne0} and E_{U0} of the order of 10^{70} J is 56. The corresponding energy of Universe E_{U027} and the radius of the associated sphere r_{aU027} are:

$$E_{U027} = 27^{56} E_{ne0} = 2.16\cdot 10^{70} \text{ J; } r_{aU027} = 9.203\cdot 10^{-96} \text{ m.} \tag{11}$$

For the corresponding radius of Universe and neutron occurrence time one obtains:

$$\begin{aligned} R_{U56} &= \left(3\cdot 27\right)^{56} r_{aU027} = 6.904\cdot 10^{11} \text{ m;} \\ t_{Une56} &= R_{U56}/c_V = 2301.3 \text{ sec} \end{aligned} \tag{12}$$

Thus, the time of neutron appearance is even shorter, but a smaller amount of energy is necessary for that.

5. The entropy variation. the ordering principle at the universe scale

It is interesting to study the entropy variation which gives a measure of the irreversibility of transformations. To this aim, one defines the entropy variation as the difference between the ratios of the transferred energy and two corresponding temperatures. One takes two possible temperatures into account:
(a). One assigns to any amount of energy *E* the threshold (particle) temperature T_P given by the relation:

$$E = \alpha k_B T_P \,, \alpha \approx 5/2 \tag{13}$$

k_B being the Boltzmann constant. Because the "photonic gas" adiabatic evolution is closer to a bi-atomic gas one has taken $\alpha \approx 5/2$ corresponding to five degrees of freedom.

(b). One uses the black body temperature at equilibrium T_b giving for the energy density ρ_{Eb} the relation [1]:

$$\rho_{Eb} = \frac{8\pi^5 \left(k_B T_b\right)^4}{15\left(h c_V\right)^3} \tag{14}$$

One notes that for a photon of energy *E* (the spheres of energy appearing in the process of structuring have radii corresponding to the wave length of the associated photon) formula (13) leads to an energy density ρ_{EP} given by:

$$\rho_{EP} = \frac{3E^4}{4\pi\left(hc_V\right)^3} = \frac{3\left(\alpha k_B T_P\right)^4}{4\pi\left(hc_V\right)^3} \tag{15}$$

For equal energy densities $\left(\rho_{EP} = \rho_{Eb}\right)$ one obtains the temperature ratio:

$$\frac{T_b}{T_P} = \frac{\alpha}{\pi\sqrt{\pi}}\left(\frac{45}{32}\right)^{0.25} = 0.1956\alpha = 0.4889 \tag{16}$$

i.e. temperatures of the same order of magnitude. For convenience we take the threshold temperature T_P.

5.1. The case of the complete structuring

Let us consider in the complete structuring by division two successive states, denoted by 1 and 2. The number of spheres N_{SPh} $\left(N_{SPh} = 11;13\right)$ have the radii R_1 , R_2 , the energies E_1, E_2 and the temperatures T_1, T_2 such that:

$$R_2 = N_{SPh} R_1,\ T_2 = T_1 / N_{SPh};\ E_2 = E_1 / N_{SPh} \tag{17}$$

One denotes by $Vol1, Vol2$ the volumes of the N_{SPh} spheres in each states. One has:

$$Vol2 = N_{SPh}\left(\frac{R_2}{R_1}\right)^3\left(\frac{Vol1}{N_{SPh}}\right) = N_{SPh}{}^3 Vol1 \tag{18}$$

Because through the Universe frontier there is no transfer, one considers the transformation 1 - 2 ***adiabatic*** of an exponent γ, under the form: $T\left(Vol\right)^{\gamma-1} = const.$, which leads to the value $\gamma = 4/3$ of the adiabatic exponent, a value close to the exponent $\gamma_{gas} = 7/5$ of the adiabatic transformation of the bi-atomic gases.

The entropy variation [5] between the two states is due to the energy transfer E_{U0} between the temperatures T_1, T_2:

$$\left(S_2 - S_1\right)_{N_{SPh}} = E_{U0}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) = \frac{\left(N_{SPh} - 1\right)E_{U0}}{T_1} \tag{19}$$

$$\left(S_2 - S_1\right)_{11} = \frac{10\,E_{U0}}{T_1};\ \left(S_2 - S_1\right)_{13} = \frac{12\,E_{U0}}{T_1} \tag{20}$$

One remarks that the case $N_{SPh} = 11$, has a smaller entropy rise than for $N_{SPh} = 13$ fore one structuring, but for the entire number of 77 structuring steps as well (starting from the same temperature T_1. In fact, in case $N_{SPh} = 11$ has a slower speed of transformation.

5.2. The case of partial structuring

In this case there is a mixture of "fluids": a) a structured one with the temperature decreasing 27 times at each structuring; b) an unstructured one having a decreasing temperature due to the Universe expansion with a law which is to be established.
To obtain a law of transformation for this "fluid mixture", we remember that in case of complete structuring the fluid had an adiabatic transformation with an exponent $\gamma = 4/3$. On the other hand, considering the "fluid" evolution complete unstructured, there is an adiabatic transformation as well because there is no energy transfer through the Universe frontier. One starts from the temperature T_{U0BF} after BIG-FLASH at the time t_{U0BF} and one arrives at the temperature of background microwaves at actual time t_{Uact}. One has:

$$T_{U0BF} = E_{U027}/k_B;\ t_{U0BF} = r_{aU027}/c_V;\ t_{Uact} = 1.38\cdot 10^{10}\ \text{ys};\ T_{Uact} = 2.7\ \text{K} \tag{21}$$

By denoting γ_{non} the adiabatic exponent for the non-structured case, one writes:

$$T_{U0BF}\left(r_{aU0}\right)^{3(\gamma_{non}-1)} = T_{Uact}\left(R_{Uact}\right)^{3(\gamma_{non}-1)};\ \gamma_{non} = 1.294 \tag{22}$$

Therefore, the two adiabatic exponents $\gamma = 4/3$ and γ_{non} are very close. Then, for the fluid mixture one takes a mean value γ_{mean}:

$$\gamma_{mean} = \frac{4}{3}\left(\frac{11}{27}\right) + 1.294\left(\frac{16}{27}\right) = 1.310 \tag{23}$$

to obtain the ratio of temperatures between the two steps 1, 2:

$$\frac{T_2}{T_1}=\left(\frac{Vol1}{Vol2}\right)^{\gamma_{mean}-1}=\left(\frac{1}{81}\right)^{3(\gamma_{mean}-1)}=\frac{1}{59.551} \tag{24}$$

The entropy variation is:

$$\left(S_2-S_1\right)_{N_{SPh}}=E_{U0}\left(\frac{1}{T_2}-\frac{1}{T_1}\right)=58.551\frac{E_{U0}}{T_1} \tag{25}$$

therefore, much bigger than in case of complete structuring (20).
One starts from the first incomplete structuring when the temperature corresponds to eleven structured spheres of $E_{U0}/27$ J each and the remaining non-structured energy, as follows:

$$T_{1struct}=T_{U0BF}/27;T_{1nonstruct}=16T_{1struct} \tag{26}$$

$$T_1=\frac{11}{27}T_{1struct}+\frac{16}{27}T_{1nonstruct}=T_{1struct}\frac{267}{27}=\frac{T_{U0BF}}{27}\frac{267}{27}>\frac{T_{U0BF}}{27} \tag{27}$$

5.3. The ordering principles at the Universe scale

From the above considerations one can conclude that in authors opinion at the Universe scale act several ordering principles which select the structured forms of evolution rather than the ones considered more probable on a maximum entropy production. Of course, at local scale the principle of maximum entropy is still valid. Among the main factors acting at the Universe scale is the gravity force which is ordering. Another ordering factor is the Universe expansion which gives a general direction in Universe. The ordering factors work together with some resonances.

6. Conclusions

Various models for the creation of Universe are analized. Unlike the standard model which leads to a random evolution from a BIG-BANG of a pre-existent amount of energy (for example, from a pre-existent black hole), the proposed models consider the possibility of the creation of Universe from "nothing" (creatio ex nihilo of Theology) admitted by the principle of uncertainty of Physics. Therefore, the authors consider that "**the Universe was created from nothing but not at random"**. The future evolution of Universe takes place by maintaining the energy in the light (radiant) form submitted to a process of **structuring by division** until the substance apparition first under the form of neutrons due to a phenomenon of **resonance between neutron and its associated photon.** Thus, the time of neutron (substance) occurrence is longer than in case of the standard model, a "soup" containing various elementary particles and even nuclei [8]. Once the

neutron is formed, protons, electrons and antineutrinos appear by the neutron transformation.

A possibility of mixing between the structured (ordered) and non-structured evolution is also studied proving that non-structuring shortens the time of substance apparition whereas the entropy rising is larger due to the introduced disorder. The ordering factors acting at Universe scale and existing resonances are evidenced.

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