Cosmogenesis - Initial stage

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ABSTRACT

In this paper I attempt to suggest a model of physical genesis that excludes the idea of the big bang and proposes a different hypothesis.

The basic hypothesis attributes to the cosmos a lower limit of density that cannot be be violated, since space collapses when the density reaches that limit. I assume this as a postulate, since proving it is a task that exceeds my scope.

The postulate implies the impossibility of a density equal to zero. The collapse prevents the total lack of density, as it causes the production of something detectable and measurable.

A collapse that occurs at the lower limit of density will produce the most subtle that physical laws allow. What is expected is that it produces in a vacuum a elemental polarization and originate photons. A fraction of them will be suitable for form electron/positron pairs, by mutual collision between photons. After the collapse there will be a fluid made up of photons, electrons and positrons. I propose to analyze that fluid.

The annihilation between electrons and positrons feeds the process of formation of matter. This process stops when the annihilation cannot overcome the threshold of matter formation. The remaining fluid forms spheres that remain as long as are not disturbed. I propose to analyze these spheres.

Section 1 - Ancillary Details

1-a) - Reference Document

It is available for free at the link below.

https://vixra.org/abs/2305.0073

That document begins by describing the properties of the photon in terms of the Maxwellian electrodynamics. Continue describing the electron and positron, more a set of properties and associated consequences. Answer questions that will probably emerge in the task at hand.

1-b) - Vocabulary

I call electrons and positrons hypoluminous particles, since they have a constitutive mass value greater than zero and cannot reach the speed of light.

I call residual spheres the spherical groups made up of electrons, positrons and photons that could not fuel the initial formation of matter and they remained as residue.

Section 2 - Electrogravitational Balance

2-a) - Symbols

m_i → mass of a hypoluminous particle
q_i → absolute value of the charge of an electron or a positron
d → distance between the centers of the residual spheres

n_e $\rightarrow$ number of electrons in a cloud
n_p $\rightarrow$ number of positrons in a cloud
G $\rightarrow$ Newtonian gravitational constant
ε_o $\rightarrow$ vacuum permittivity (dielectric constant)

For the Newtonian attraction to be balanced by a Coulomb repulsion I will assume the following.

$$n_e > n_p \tag{1}$$

Let us refrain from expressing objections regarding the improbability of achieving in the practice such a balance, because the intention is to analyze with known laws the simplest abstract case. If that case does not destroy the compatibility between the laws, we will arrive at a coherent result in logical terms.

The net charge of each sphere is $(n_e - n_p)\, q_e$ and the distance between centersis d . I apply Coulomb's law to formulate the modulus F of the repulsive force between the spheres.

$$F = \frac{1}{4\ \pi\ \varepsilon_o}\ \frac{(n_e - n_p)^2\, q_e^2}{d^2} \tag{2}$$

I express the mass m of each sphere, equal to the total number of particles multiplied by the mass of a particle.

$$m = (n_e + n_p)\, m_i \tag{3}$$

With the Newtonian formula I express the modulus of the gravitational force, which in equilibrium condition is equal to F .

$$F = G\ \frac{m^2}{d^2} \tag{4}$$

In (4) replace m as indicated by (3).

$$F = G\ \frac{[\ (n_e + n_p)\, m_i\ ]^2}{d^2} \tag{5}$$

I equate (5) with (2). Then I simplify.

$$G\ \ [(n_e + n_p)\, m_i]^2 = \frac{1}{4\ \pi\ \varepsilon_o}\ \ (n_e - n_p)^2\, q_e^2$$

Passage of terms.

$$4\ \pi\ \varepsilon_o\ G\ \frac{m_i^2}{q_e^2} = \frac{(n_e - n_p)^2}{(n_e + n_p)^2}$$

$$2\ \sqrt{\pi\ \varepsilon_o\ G}\ \ \frac{m_i}{q_e} = \frac{n_e - n_p}{n_e + n_p} \tag{6}$$

2-b) - Internal Cloud Balancing

The mutual equilibrium of two residual spheres is possible only when there are internal balance in each one. Does that imply something relevant? Let's reason.

The excess electrons have a lot of mobility within the cloud. They are free electrons. A free electron can displace and replace the electron of a positronium. The electron that previously belonged to the atom is released and the electron that arrives replaces it. This happens all the time. Without this dynamical equilibrium regime the cloud would decompose and the electrogravitational balance would be impossible. What laws regulate internal balance?

- The internal functioning obeys the laws of thermodynamics.
- In this case the thermodynamic system is the cloud. The energy of the system is distributedequitably between the degrees of freedom of the component particles, according tothe equipartition theorem.
- The system is mixed with respect to degrees of freedom, since each excess electron has 3 degrees of freedom and each positronium atom has 5 (3 by the translation of its center of mass, one for rotation about the center of mass and one for oscillation of the distance between the two particles that form it).
- There is attraction between the free electrons and the positrons of the positronium atoms. This means that events of the following type happen all the time. A free electron penetrates the constituent field of positronium, displaces the electron which until that moment was linked to the positron and replaces it. The displaced electron its free. This event does not statistically alter the number of positroniums nor the number of free electrons in the cloud, because it produces mutual replacement.
- The positronium atom absorbs the energy of the free electron that arrives to replace the bound electron. With that energy it expels the bound electron and the newly arrived electron replaces it. The energy involved has the value corresponding to 3 degrees of freedom because it comes from the free electron. The Incidence can happen in more than one way and in each one they will participate only 3 of the 5 degrees of freedom of positronium.
- The 3 degrees of freedom involved are a subset of the total 5. In each form of incidence a distinct subset is involved. Calculating the variations of 5 elements taken in 3 we will obtain the number of subsets possible.

$$V_3^5 = 5.4.3 = 60 \tag{7}$$

  V_3^5 $\rightarrow$ variations of 5 elements taken in 3

- The equipartition theorem expresses a statistical average. This means that in each of the 60 modes the exchanged energy has a different value. The electron That which enters provides energy to the positronium and the ejected electron removes energy from the positronium. When contribution and withdrawal have the same value, the net energy exchanged is worth zero. This is the minimum of the set of 60 possible values.
- What does the zero value of the net energy exchanged imply? It implies that the potential difference between the incident electron and the positronium atom before the incidence is equal to zero. So there is no net force driving the free electron toward the atom and the exchange does not happen. That is why there are only 59 effective cases.
- The system cannot be in equilibrium without the simultaneous realization of the 59 cases, because if any were left unmade, a positronium atom would decompose to leave a free electron and enable the missing case. Obviously a positron that would be expelled from the cloud, so that only positron atoms and free electrons remain inside. This means that to maintain balance cannot there are less than 59 free electrons in the cloud.

- When the system is in equilibrium, the average value of the energy at each degree of freedom is a statistical property that depends only on temperature. The equipartition theoreme informs that all degrees of freedom have the same average value of energy when the system is in equilibrium.
- I symbolize W to that avarage value. Having 3 degrees of freedom, the average energy of each free electron is 3W. With 59 free electrons we would have $3\mathrm{W}.\ 59 = 177\mathrm{W}$ to dump on positronium atoms in the replacement of bound electrons by incident electrons.
- I symbolize A,B,C,D,E to the 5 degrees of freedom of the positronium atom. All of them have the same average energy and participate in the process with the same frequency. That's why the number of quotas W associated with grades of type A, the number associated with grades of type B, etc. up to E, are statistically equal numbers. This requires that the total number of quotas W be a multiple of 5. The number 177 is not a multiple of 5, for being 59 a prime number, the minimum number of free electrons necessary to have an odd number multiple of 5 is $59.5 = 295$.

I repeat equation (6) here.

$$2\ \sqrt{\pi\ \varepsilon_o\ G}\ \ \frac{m_i}{q_e} = \frac{n_e - n_p}{n_e + n_p} \tag{6}$$

Clearance $n_e + n_p$

$$n_e + n_p = \frac{q_e}{m_i}\ \frac{n_e - n_p}{2\ \sqrt{\pi\ \varepsilon_o\ G}} \tag{7}$$

The thermodynamic analysis has given 295 excess electrons, that is, $n_e - n_p = 295$. And the values of the physical constants included in (7) appear in tables. Use values recommended by CODATA in 2018.

$q_e = 1{,}602176634.10^{-19}\ coulomb$

$m_i = 9{,}1093837015.10^{-31}\ kg$

$\varepsilon_o = 8{,}8541878128.10^{-12}\ \dfrac{Coulomb^2}{Newton.m^2}$

$G = 6{,}67430.10^{-11}\ \dfrac{Newton.m^2}{kg^2}$

With these data, equation (7) gives the following result.

$$N = 6{,}02089.10^{23} \quad (8)$$

$N\ \rightarrow$ total number of particles in the cloud

2c - Discussion

The number N indicated in (9) and Avogadro's number N_A differ very little. Let's see how much the difference is worth divided by N_A . I will use the first 4 digits of each number.

$$\frac{N_A - N}{N_A} = \frac{6{,}023 - 6{,}020}{6{,}023} = 4{,}98.10^{-4} \simeq 5.10^{-4} \rightarrow 0{,}05\,\%$$

Although both numbers coincide within the expected error, metrology does not expose relationship between N_A and electrogravitational balance. Our obligation is assume that the coincidence is random.

In case of disagreement with the idea of random, a dystopian question emerges. It could happen that the metrologists have chosen $N_A = N$ without informing publicly the decision?

Let's imagine that we are metrologists and we have the responsibility of choosing a numerical pattern useful for sets of particles, specifically for sets that can be detected at the macroscopic level. What would we base the choice on? Surely on a umber determined by fundamental physical laws, applied to a particle system. The agreement to use that number is conventional. The number no, because it is determined by physical laws.

Could such an election be made without being publicly informed? In this case we would be faced with something incompatible with ethical principles. The ideal of transparent exchange of information would be an entelechy with no correlation in reality. And questions would emerge that university scientists did not they usually nor want to do.

Section 3 - Density, mass and volume of the residual sphere

3-a) - Condition of permanence

Before continuing the mathematical task we can reason the following. The residual sphere could not survive without being in balance with the environment. This implies equality of density and temperature between the residual sphere and space surrounding, mediator between astronomical objects.

What could be the raw material in the formation of these objects? The reasonable thing is that has been the type of fluid that constitutes the residual spheres, since that fluid is the only thing available in the initial stage of the process. The transformation of fluid into objects does not alter the average density of the universe, since it only implies modifying the distribution of what exists.

The equality between the average density of the residual sphere and the average density of the universe is a reasonable and falsifiable hypothesis. In this case falsifiability comes late, since astronomers have long ago determined the average density of the universe.

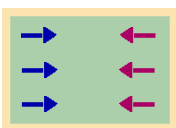
A late falsifiable detail seems preferable to the absence of the detail.

3-b) - Density

There are photons inside the residual sphere because the electron and positron of each positronium execute accelerated movements that produce electromagnetic waves.

Each photon has a linear momentum and each positronium atom has its own. The Average values of these linear moments are related to temperature. I wish to propose an equilibrium condition in terms of quantities of linear momentum.

The approach would be simple if instead of moving chaotically the photons moved like one army lined up and the positroniums like another, resembling an ancient battle, with all the photons moving in one direction and all the positrons in the same direction, but in the opposite sense.



Could the analogy of the ancient battle be useful in formulating the condition of balance in the system we are trying to analyze?

Let's reflect a little. Statistical mechanics was investigated by many physicists. Maxwell and Boltzmann finally formalized it. Boltzmann managed to relate entropy with the number of complexions. In rustic language, we can say that a complexion of the system is one of the possible ways to accommodate oneself internally. In condition of balance, all complexions correspond to the same average values of the conservative variables. This means that our ancient battle has the same average values than the other complexions. In terms of average values, the battle ancient is a valid resource to raise the equilibrium condition. This is how it is formed the following equation.

$$N\,\overline{p} = N_r\,\overline{p}_r \tag{9}$$

N $\rightarrow$ number of positrons
$\overline{p}$ $\rightarrow$ mean value of the linear momentum of a positronium
N_r $\rightarrow$ number of photons
$\overline{p}_r$ $\rightarrow$ mean value of the linear momentum of a photon

The first member of (9) is the sum of the modules of the linear moments of all positronium atoms. The second member is the sum of the modules of the linear moments of all photons.

There is a relationship between $\overline{p}$ and temperature. We can use the classical relationship, because the residual sphere would not survive if the positrons moved with too much speed and/or the separation between them was too small. That implies very low temperature and density, which do not require relativistic considerations or quantum. We can use the Maxwell-Boltzmann statistic, which specify the following.

$$\overline{v} = \sqrt{\frac{8}{\pi}\,\frac{k\,T}{2\,m_i}}$$

$\overline{v}$ $\rightarrow$ average value of the velocity of a positronium
k $\rightarrow$ Boltzmann constant
T $\rightarrow$ thermodynamic temperature
$2\,m_i$ $\rightarrow$ positronium mass

I simplify

$$\overline{v} = \sqrt{\frac{4}{\pi}\,\frac{k\,T}{m_i}} \tag{10}$$

m_i $\rightarrow$ mass of an electron or a positron

I write the average value of the linear momentum of a positronium

$$\overline{p} = 2\,m_i\,\overline{v} \tag{11}$$

In (11) I express $\overline{v}$ as indicated by (10) .

$$\overline{p} = 2\,m_i\,\sqrt{\frac{4}{\pi}\,\frac{k\,T}{m_i}}$$

I operate

$$\overline{p} = 4\,\sqrt{\frac{k\,T\,m_i}{\pi}} \tag{12}$$

I express the relationship formulated by Maxwell between the linear momentum and the energy of an electromagnetic wave.

$$p_{(wave)} = \frac{energy}{C}$$

C $\rightarrow$ speed of propagation in vacuum

I apply the relation to the photon

$$\overline{p}_r = \frac{\overline{E}_r}{C} \tag{13}$$

$\overline{p}_r$ $\rightarrow$ average value of photon's linear momentum
$\overline{E}_r$ $\rightarrow$ average value of photon energy

I express the average value of the photon energy in thermodynamic equilibrium.

$$\overline{E}_r = k\ T \tag{14}$$

$\overline{E}_r$ $\rightarrow$ average value of photon energy
k $\rightarrow$ Boltzmann constant
T $\rightarrow$ thermodynamic temperature

In (13) replace $\overline{E}_r$ as indicated by (14)

$$\overline{p}_r = \frac{k\ T}{C} \tag{15}$$

I repeat equation (9) here

$$N\ \overline{p} = N_r\ \overline{p}_r$$

I replace $\overline{p}$ as indicated by (12) and $\overline{p}_r$ as indicated by (15)

$$N\ 4\ \sqrt{\frac{k\ T\ m_i}{\pi}} = N_r\ \frac{k\ T}{C}$$

I clear and then simplify

$$\frac{N}{N_r} = \frac{1}{4\ C}\sqrt{\frac{\pi\ k\ T}{m_i}} \tag{16}$$

We can relate the first member of (16) to the density of the system, if we take into account the following.

$$\delta_p = \frac{2\ N\ m_i}{V} \tag{17}$$

δ_p $\rightarrow$ positroniums density

$$\delta_r = \frac{N_r\ m_r}{V} \tag{18}$$

δ_r $\rightarrow$ photon density

Member by member I divide (17) by (18), then I simplify and order

$$\frac{\delta_p}{\delta_r} = \frac{2\ m_i}{m_r}\ \frac{N}{N_r}$$

Solving δ_p

$$\delta_p = \delta_r \, \frac{2 \, m_i}{m_r} \, \frac{N}{N_r} \tag{19}$$

I express the density of the system

$$\delta = \delta_r + \delta_p \tag{20}$$

In (20) replace δ_p as indicated by (19)

$$\delta = \delta_r + \delta_r \, \frac{2 \, m_i}{m_r} \, \frac{N}{N_r}$$

$$\delta = \delta_r \left(1 + \frac{2 \, m_i}{m_r} \, \frac{N}{N_r} \right) \tag{21}$$

3-c) - Density value

The Stefan-Boltzmann law expresses the energy density of radiation in the following form.

$$U_r = \alpha \, T^4 \tag{22}$$

U_r $\rightarrow$ energy density of radiation
α $\rightarrow$ is the Stefan-Boltzmann constant for radiation
T $\rightarrow$ thermodynamic temperature

The mass-energy relationship allows us to express δ_r in the following form

$$\delta_r = \frac{U_r}{C^2} \tag{23}$$

In (23) I apply (22)

$$\delta_r = \frac{\alpha \, T^4}{C^2} \tag{24}$$

In (21) replace δ_r as indicated by (24)

$$\delta = \frac{\alpha \, T^4}{C^2} \left(1 + \frac{2 \, m_i}{m_r} \, \frac{N}{N_r} \right) \tag{25}$$

I repeat here equation (14)

$$\overline{E}_r = k \, T$$

I apply the mass-energy relationship to m_r

$$\overline{m}_r = \frac{k \, T}{C^2} \tag{26}$$

In (25) I replace m_r as indicated by (26). Then I operate.

$$\delta = \frac{\alpha \, T^4}{C^2} \left(1 + C^2 \, \frac{2 \, m_i}{k \, T} \, \frac{N}{N_r} \right)$$

$$\delta = \alpha\ T^4 \left(\frac{1}{C^2} + \frac{2\ m_i}{k\ T}\ \frac{N}{N_r} \right) \tag{27}$$

I repeat here equation (16)

$$\frac{N}{N_r} = \frac{1}{4\ C}\ \sqrt{\frac{\pi\ k\ T}{m_i}}$$

In (27) I make the replacement allowed by (16). Then I simplify.

$$\delta = \frac{\alpha\ T^4}{C} \left(\frac{1}{C} + \frac{1}{2}\ \sqrt{\frac{\pi\ m_i}{k\ T}} \right) \tag{28}$$

We have previously reasoned that the residual sphere and the surrounding space should have the same temperature. What order of temperature would we expect in the conditions of this system, with its density equal to the lower limit prior to vacuum collapse? A temperature slightly above thermodynamic zero would be logical.

$$T\ \rightarrow\ \textit{slightly greater than thermodynamic zero}$$

In section 3-a the condition of permanence was discussed, which implies equality of density and equality of temperature between the residual sphere and its surroundings. The lastsection of this document contains the development that allows calculating the value of T . But to skip ahead to that section is to betray the natural way of linking concepts in physics. Instead, we can conceive of (28) as analogous to a translator. Between what and what can (28) translate? Between the two unknowns that contains, δ and T .

In (28) δ is the unknown. The most practical thing is to attribute a value to T and see the resulting value for δ . Does any concept allow attributing a value at T ?

The surrounding medium should be the cosmic microwave background, which has a blackbody spectrum corresponding to 2.721 K in the blue region, according to data published by NASA.

CODATA in 2018 recommended the following values for the other constants.

$\alpha = 7{,}56579.10^{-16}\ \frac{J}{m^3\ K^4}$

$C = 299792459\ \frac{m}{s^2}$

$m_i = 9{,}1093837015.10^{-31}\ kg$

$k = 1{,}380649.10^{-23}\ \frac{J}{K}$

I use the value of T obtained by NASA for the blue region.

$T = 2{,}721\ K$

With these values (28) gives the following result.

$$\delta = 1{,}909.10^{-26}\ \frac{Kg}{m^3} \tag{29}$$

The average density of the type of universe that cosmology calls flat coincides with the result shown in (29).

3-d) - Can we conceptually describe the residual spheres?

- They are made up of electrons and positrons that have not annihilated each other, because they have been grouped spherically in balance with the cosmic background.
- These spheres have characteristic and specific properties, with values determined by physical laws.
- Normal telescopes cannot detect them, because they have the same temperature than the space where they are formed and that implies the same spectrum.
- The balance is delicate and eventually a sphere can lose it.
- The imbalance enables the mutual annihilation of electrons and positrons, producing gamma rays.
- This emission is astronomically detectable and allows us to know the place where the sphere collapsed.
- When the emission is detected the sphere does not exist and the gamma radiation is the only testimony of its existence in a previous time.
- Gamma ray emissions of the mentioned type have been and are detected by astronomers, who search for the cause and explanation of the details.
- The residual spheres contain relevant information regarding the beginning of the cosmogenesis. Collapse emission propagates that information.

3-e) - Mass and size of the residual sphere

We have the necessary data to calculate the mass of the sphere.

In mechanical terms, it is appropriate to attribute a mass to the photon, given by the relationship between mass and energy.

$$m_r = \frac{kT}{C^2} \qquad (a)$$

In the residual sphere there are N hypoluminous particles and N_r photons. The mass of the sphere is expressed in the following way.

$$m_s = N\ m_i + N_r\ \frac{kT}{C^2} \qquad (b)$$

m_s $\rightarrow$ residual sphere mass

Equation (9) implies the following.

$$N\ m_i\ v_i = N_r\ \frac{k\ T}{C}$$

Divide by C both members

$$N\ m_i\ \frac{v_i}{C} = N_r\ \frac{k\ T}{C^2} \qquad (c)$$

In (b) I make the substitution allowed by (c)

$$m_s = N\ m_i + N\ m_i\ \frac{v_i}{C}$$

$$m_s = N\ m_i \left(1 + \frac{v_i}{C}\right) \qquad (d)$$

Write Maxwell's law of velocity distribution

$$v_i = \sqrt{\frac{8}{\pi}\ \frac{k\ T}{m_i}}$$

Divide by C both members

$$\frac{v_i}{C} = \sqrt{\frac{8}{\pi}\ \frac{k\ T}{m_i\ C^2}} \qquad (e)$$

I apply (e) in (d)

$$m_s = N\ m_i \left(1 + \sqrt{\frac{8}{\pi}\ \frac{k\ T}{m_i\ C^2}}\right) \tag{30}$$

Write the density formula

$$\delta = \frac{m_s}{V}$$

$V\ \rightarrow$ volume of residual sphere

I clear the volume.

$$V = \frac{m_s}{\delta}$$

I replace m_s as indicated by (30).

$$V = \frac{N\ m_i \left(1 + \sqrt{\frac{8}{\pi}\ \frac{k\ T}{m_i\ C^2}}\right)}{\delta} \tag{31}$$

We have all the data to calculate V .

$$V = \frac{6{,}023.10^{23}\ \ 9{,}109.10^{-31}\ Kg}{1{,}91.10^{-26}\ \frac{Kg}{m^3}} = 2{,}8731.10^{19}\ m^3 \tag{32}$$

I write the expression for the volume of a sphere as a function of the radius.

$$V = \frac{4}{3}\ \pi\ r^3$$

$r\ \rightarrow$ radius of the sphere

I clear the radio.

$$r = \left(\frac{3\ V}{4\ \pi}\right)^{\frac{1}{3}} \tag{33}$$

For the volume indicated in (32), expression (33) gives the following.

$$r = 1{,}900007.10^6 \ m \simeq 1900 \ Km \qquad (34)$$

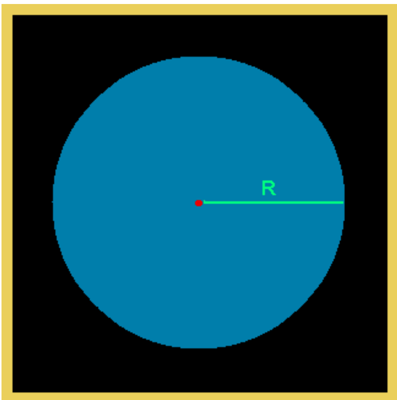
The radius of the residual sphere is close to 1900 km, on the order of one third of the earth's radius.

Section 5 - Self-containment of the universe

- The proposed model is a finite system that occupies a portion of space cosmic. The cosmos can accommodate an unlimited number of self-contained universes.
- Are all self-contained universes required to have the same values of the physical constants?
- Answering that question is a task beyond my scope. In the proposal I will use the usual values.

The density of the residual sphere has been found to coincide with the average density of the model of the universe that cosmology calls a plane. In that theory the adjective plane has a four-dimensional connotation, not a three-dimensional one.

What are the consequences of the proposal to conceive the universe as a sphere with average density equal to the density of a residual sphere?



I adopt the spherical model of the universe. I guess the average density δ_m has the value indicated in (29) . To calculate the radius R an additional condition is necessary. It is the condition of self-containment. What does it mean ? The system will maintain its stability if possible prevent energy leakage into the surrounding space. Is that possible ? Yeah. Gravity gives negative energy to everything there is. within the universe. When something reaches radius R, the energy of negative sign due to gravity equals in absolute value to mC^2 .

5-a) - Calculation of the radius R

The electrodynamic nature of gravity and the constitution of particles is set out in the document titled James Clerk Maxwell Forbidden Knowledge, freely available at the following link.

http://www.vixra.org/abs/1711.0313

The same condition of balance governs all entities present in the surface of the universe, including photons.

The spherical surface of the universe is surrounded by cosmic space. If any entity present on that surface had net energy greater than zero, could deliver that energy to cosmic space and the condition of balance would not be met. It is fulfilled when the net energy of the entity is equal to zero on that surface.

I formulate the eneergy.

$$E_n = m\ C^2 + E_g \tag{35}$$

E_n $\rightarrow$ net energy of the entity on the surface of the universe
m_r $\rightarrow$ mass of the entity
E_g $\rightarrow$ gravitational potential energy of the entity

I express in Newtonian terms the gravitational potential energy of the entity on the spherical surface.

$$E_g = -G\ \frac{m\ M_u}{R} \tag{36}$$

G $\rightarrow$ Newtonian gravitational constant
M_u $\rightarrow$ mass of the universe
R $\rightarrow$ radius of the universe

In (35) I express E_g as indicated by (36)

$$E_n = m_r\ C^2 -\ G\ \frac{m\ M_u}{R} \tag{37}$$

I write the equilibrium condition.

$$E_n = 0 \tag{38}$$

In (37) I replace E_n by zero. Then I simplify.

$$0 = C^2 - G\ \frac{M_u}{R} \tag{39}$$

I formulate the mass M_u of the universe

$$M_u = \delta\ V_u \tag{40}$$

δ $\rightarrow$ average density of the universe
V_u $\rightarrow$ volume of the universe

The universe and the positronium spheres have the same average density and the same temperature, because these spheres are in thermodynamic equilibrium with the environment. That's why I use the same symbol δ in both cases.

I formulate the volume of the universe

$$V_u = \frac{4}{3}\ \pi\ R^3 \tag{41}$$

V_u $\rightarrow$ volume of the universe

In (40) I express V_u as indicated by (41). Then I solve for M_u .

$$M_u = \frac{4}{3}\ \pi\ \delta\ R^3 \tag{42}$$

I repeat here equation (39)

$$0 = C^2 -\ G\ \frac{M_u}{R}$$

I express M_u as indicated by (42). Then I simplify and order.

$$0 = C^2 - \delta \, \frac{4}{3} \, \pi \, G \, R^2$$

Clearance R

$$R = \frac{1}{2} \, C \, \sqrt{\frac{3}{\pi \, G \, \delta}} \qquad (43)$$

With the value of δ indicated in (29) the following results.

$$R = 1{,}3075.10^{26} \ m \simeq 13820 \ \textit{million of light years} \qquad (44)$$

The result shown in (41) is consistent with astronomical data.

5-b) - Reflection

Although the approach shown in this document is rudimentary, it allows us to understand that there is an intimate relationship between the structure of the universe and the constants physical. These constants are not conversion factors between measurement systems. units, since they determine the physical and geometric characteristics of the universe.

My impression is that nature's design is encoded in the constants fundamental physics, how the design of a living being's body is codified in the genome.

Physics will probably benefit from understanding the essential role of these constants and we manage to extract the information they contain.

Section 6 - Cosmic Background Temperature

The residual spheres and the cosmic background have the same temperature, so balance between those spheres and the cosmic background.

In the previous section, I use the value of T determined empirically by NASA. The objective of this section is the theoretical calculation of T , without using that empirical data. To complete the scheme coherently we need to express that temperature in terms of fundamental physical constants. That is what this section is dedicated to.

6-a) - Adopt a criterion

I wish to use Maxwell's law of velocity distribution, based on the free particle mechanical model. Is our system compatible with that model ? Not directly. Yeah with a simple artifice, which will be explained in the development.

- Why do I want to use that law? Because it formulates the average value of the speed of a particle when the system is in thermodynamic equilibrium.
- What system model does this law correspond to? To the ideal gas model.
- Does our system have properties in common with an ideal gas? In the ideal gas collisions are elastic. It means that the sum of the modules of the linear moments of all particles is conserved. Is also conserved the sum of the kinetic energies of all of them. The same thing happens in our system, because photons mediate in a way that is equivalent to having elastic collisions between electrons and positrons. Other details in common are pressure,

volume and constant temperature. The conditions that validate Maxwell's law are present in the system we analyze.

- The analysis will be useful if the result is expressed in terms of data available.
- What is the data available? One is the total number N of electrons and positrons and another the mass m of the electron or positron.
- Is this data enough? I can't find an adequate answer before advance development. I only propose to pay attention to connective details, that is, similarities that help to mutually link the available data.
- For example, the particle that has mass m_i has constitutive energy $m_i C^2$ and average kinetic energy $\frac{3}{2}kT$. Is there any energy connective details in that pair of energies? Do physical laws allow both energies to be linked in terms of the available data? Yes. That makes the calculation of T possible.
- The criterion that I propose includes taking into account physical details that allow abbreviate the mathematical formulation. How will we do that? The idea is to understand physically what each term in the equations we are using means and represents. We need to recognize the difference between operating mathematically in an abstract way and operate with physical terms, that allows group, compare, recognize relevant terms and insignificant terms. This way we can use simple equations to propose a reasonable approximation.

6-b) - Utilitarian artificial model

The Maxwell-Boltzmann statistic was formulated for a set of free particles that not have parts. Our system differs, since positronium is made up of bonded pairs. We cannot directly apply Maxwell's law to the positron system. Has the time come to abandon the task? No. We can propose an artificial model consisting of free electrons and positrons, accompanied by photons. The first step is to formulate the binding energy and apply the conservation principle to define the free state.

Positronium is composed of two particles that attract each other. For separating them requires work.

Each free particle has three degrees of freedom and if they were free would have $\frac{6}{2}\ k\ T$. Positronium has 5 degrees of freedom and its average kinetic energy equal to $\frac{5}{2}\ k\ T$. The difference $\frac{1}{2}\ k\ T$ is equal to the work of separation. That's why the average value of the bonding potential energy in a positronium is equal to $-\frac{1}{2}\ k\ T$. I formulate these details.

$$E_c = \frac{5}{2}\ k\ T \tag{45}$$

E_c → average value of the kinetic energy of a positronium
k → Boltzmann constant
T → thermodynamic temperature

$$E_L = -\frac{1}{2}\ k\ T \tag{46}$$

E_L → average value of the binding energy in a positronium

Within the sphere, the net energy of positronium is composed of the constitutive energy $m_i C^2$ of the electron, the constitutive energy $m_i C^2$ of the positron, the binding energy expressed in (46) and the kinetic energy of the whole positronium expressed in (45).

$$E_a = 2\ m_i\ C^2 - \frac{1}{2}\ k\ T + \frac{5}{2}\ k\ T \tag{47}$$

Simplified.

$$E_a = 2\ m_i\ C^2 + 2\ k\ T \tag{48}$$

E_a $\rightarrow$ average value of the net energy of a positronium
m_i $\rightarrow$ mass of an electron or a positron

In absolute value, the kinetic energy is five times the binding energy. It means that the electron and positron could eventually break free. Would not be absurd an artificial utilitarian model that treats them as free particles endowed with negative potential energy. Can we put it mathematically?

To make the statement possible we need to define the average value of the net energy of each particle, in the free state that the artifice supposes. We will do it for energy conservation. Adding the average values of the net energies of both particles we must obtain a result equal to E_a .

$$2E = E_a \tag{49}$$

E $\rightarrow$ average value of the net energy of an electron or a positron

Clearance

$$E = \frac{1}{2}\ E_a$$

I express E_a as indicated by (48). Then I simplify and order.

$$E = m_i\ C^2 + k\ T \tag{50}$$

> Equation (50) expresses the average value of the energy that an electron or a positron if it were free. That is not the physical situation. It's the artifice which makes possible the use of the Maxwell-Boltzmann statistics.

6-c) - Net energy of the system

In the context of artifice, the word system refers to the region of constant volume that houses free electrons and positrons accompanied by photons.

Counting electrons and positrons, there are N particles in the system. There is also N_r photons. I formulate the net energy of the system.

$$E_s = N\ E + N_r\ E_r \tag{51}$$

E_s $\rightarrow$ net energy of the system
E_r $\rightarrow$ average value of the energy of a photon

In (51) I express E as indicated by (50)

$$E_s = N\ \left(m_i\ C^2 + k\ T\right) + N_r\ E_r \tag{52}$$

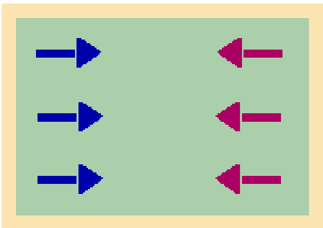
I express the energy E_r of the photon in thermodynamic equilibrium

$$E_r = k\ T \tag{53}$$

In (52) I express E_r as indicated by (53). Then I distribute.

$$E_s = N\ \left(m_i\ C^2 + k\ T\right) + N_r\ k\ T$$

$$E_s = N\ m_i\ C^2 + N\ k\ T + N_r\ k\ T \quad (54)$$



One of the complexions computed in statistics thermodynamics is analogous to an ancient battle, with all the soldiers on one side advancing in one direction and all the soldiers on the other side in the same direction, but in the opposite sense. In terms of average values, all complexions meet the same equilibrium condition. The complexion represented in the figure facilitates the approach, since on balance the sum of the modules of the linear moments of all hypoluminous particles is equal to the sum of the modules of the linear moments of all the photons. It is expressed in the following equation.

$$N\ m_i\ v_i = N_r\ \frac{k\ T}{C} \quad (55)$$

m_i $\rightarrow$ mass of a hypoluminous particle
N $\rightarrow$ total number of hypoluminous particles
v_i $\rightarrow$ average value of the velocity of a hypoluminous particle
N_r $\rightarrow$ total number of photons
$\frac{k\ T}{C}$ $\rightarrow$ average value of photon linear momentum

The average value of the linear momentum of the photon is given by Maxwell's theorem, who showed that the linear momentum of electromagnetic radiation is equal to the energy divided by the speed of light. The average value of the photon energy at thermodynamic equilibrium it is equal to $k\ T$.

Equations (54) and (55) are two of the three basic equations. The third is Maxwell's law of velocity distribution, which formulates the square of the average velocity of a particle in the ideal gas model.

$$v_i^2 = \frac{8}{\pi}\ \frac{k\ T}{m_i} \quad (56)$$

6-e) - Calculate T

I divide member by member (56) by (55). Then I simplify. After passage of terms.

$$\frac{v_i}{C} = \frac{8}{\pi}\ \frac{N}{N_r} \tag{57}$$

Divide by C both members of (54) .

$$\frac{E_s}{C} = N\ m_i\ C + N\ \frac{k\ T}{C} + N_r\ \frac{k\ T}{C} \tag{58}$$

In (55) passage of terms.

$$\frac{N}{N_r}\ m_i\ v_i = \frac{k\ T}{C} \tag{59}$$

In (58) I replace $\frac{k\ T}{C}$ by the first member of (59). Then I simplify.

$$\frac{E_s}{C} = N\ m_i\ C + N\ \frac{N}{N_r}\ m_i\ v_i + N\ m_i\ v_i$$

Divide by N both members

$$\frac{E_s}{N\ C} = m_i\ C + \ \frac{N}{N_r}\ m_i\ v_i + m_i\ v_i$$

Common factor $m_i\ v_i$

$$\frac{E_s}{N\ C} = m_i\ C + \ m_i\ v_i\ \left(\frac{N}{N_r} + 1\right) \tag{60}$$

By physical criteria we can modify (60) to obtain a simpler equation, making an insignificant error. Mathematically the equilibrium condition, described in section 6-d, could be achieved with few very impulsive photons or with many not very impulsive. Physically, the second is essential, to minimize the probability of collapse. This implies the following.

$$\frac{N}{N_r} <<< 1 \tag{61}$$

Condition (61) allows modifying (60) in the following way.

$$\frac{E_s}{N\ C} = m_i\ C + \ m_i\ v_i$$

Common facor $m_i\ C$

$$\frac{E_s}{N\ C} = m_i\ C\left(1 + \frac{v_i}{C}\right)$$

I multiply both members by $\left(1 - \frac{v_i}{C}\right)$

$$\frac{E_s}{N\ C}\ \left(1 - \frac{v_i}{C}\right) = m_i\ C\left(1 + \frac{v_i}{C}\right)\left(1 - \frac{v_i}{C}\right)$$

I operate

$$\frac{E_s}{N\ C}\ \left(1-\frac{v_i}{C}\right)=m_i\ C\left(1-\frac{v_i^2}{C^2}\right)$$

Replace v_i^2 as indicated by (56)

$$\frac{E_s}{N\ C}\ \left(1-\frac{v_i}{C}\right)=m_i\ C\left(1-\frac{\frac{8}{\pi}\ \frac{k\ T}{m_i}}{C^2}\right)$$

$$\frac{E_s}{N\ C}\ \left(1-\frac{v_i}{C}\right)=m_i\ C\left(1-\frac{8}{\pi}\ \frac{k\ T}{m_i\ C^2}\right)$$

I multiply both members by C. Then I operate.

$$\frac{E_s}{N}\ \left(1-\frac{v_i}{C}\right)=m_i\ C^2-\frac{8}{\pi}\ k\ T \tag{62}$$

Let's look at equation (57) again.

$$\frac{v_i}{C}=\frac{8}{\pi}\frac{N}{N_r}$$

By physical criterion I have assumed the condition expressed in (61), that is,

$$\frac{N}{N_r}<<<1$$

That implies the following.

$$\frac{v_i}{C}=<<<1 \tag{63}$$

Making an insignificant error, condition (63) allows modifying (62) to obtain a simpler equation, in the following form.

$$\frac{E_s}{N}=m_i\ C^2-\frac{8}{\pi}\ k\ T \tag{64}$$

In (64) we see the term $\frac{8}{\pi}\ k\ T$. What does that term correspond to? Brief answer to the interactions between system components. That is, it is determined by the entire system. The attempt to relate it solely to the kinetic energy of the hypoluminous particles, or simply with the kinetic and potential energies is an error, since it depends on the composition of the system and its internal function, which includes mechanostatistical and electrodynamics phenomena.

Fluctuations happen in the system. To avoid collapse the system needs to equality holds after differentiating both members of (64) with respect to T .

I derive (64) with respect to T , taking into account that the system does not release energy towards the environment nor does it receive energy from the environment, that is, taking into account that E_s is constant.

$$E_s\ \left(-\frac{1}{N^2}\right)\ \frac{dN}{dT} = 0 - \frac{8}{\pi}\ k$$

$$E_s\ \frac{1}{N^2}\ \frac{dN}{dT} = \frac{8}{\pi}\ k$$

I multiply both members by dT

$$E_s\ \frac{1}{N^2}\ \frac{dN}{dT}\ dT = \frac{8}{\pi}\ k\ dT$$

I apply $dN = \dfrac{dN}{dT}\ dT$

$$E_s\ \frac{1}{N^2}\ dN = \frac{8}{\pi}\ k\ dT$$

$$\frac{\pi}{8}\ \frac{1}{N}\ dN = \frac{k\ dT}{\frac{E_s}{N}} \qquad (65)$$

The indefinite integral of the first member is equal to $\ln N^{\frac{\pi}{8}}$. Let's see what shape is the function $\frac{E_s}{N}$ located in the second member.

I repeat here equation (54)

$$E_s = N\ m_i\ C^2 + N\ k\ T + N_r\ k\ T$$

Divide by N both members. Then I simplify.

$$\frac{E_S}{N} = m_i\ C^2 + k\ T + \frac{N_r}{N}\ k\ T \qquad (66)$$

$N_r\ k\ T$ is the sum of energy of all photons. Maxwell's theorem that links energy with linear momentum in the electromagnetic wave helps us avoid a mistake. I symbolize S to the last monomial of the right member of (66) .

$$S = \frac{1}{N}\ N_r\ k\ T \qquad (67)$$

At first glance we could believe that S is a function of T . That doesn't happen because interactions between photons and hypoluminous particles are equivalent, in mechanical terms, to elastic collisions. This behavior keeps the sum of modules of the linear moments of all the photons constant. Maxwell's theorem states the following.

$$p = \frac{E}{C} \qquad \Rightarrow \qquad E = p.C \qquad (68)$$

Reports (68) that the energy is directly proportional to the magnitude of the linear momentum of the photon. This means that variations in T do not affect S, since the the sum of the modules of the linear moments of the photons does not change. In the integral with respect to T the term $\frac{1}{N}\ N_r\ k\ T$ behaves as a constant.

Divide by N both members of (54)

$$\frac{E_s}{N} = m_i\ C^2 + k\ T + \frac{1}{N}\ N_r\ k\ T \tag{69}$$

The terms m_iC^2 and $\frac{1}{N}\ N_r\ k\ T$ behave as constants in the integration with respect to T . The second term is not data and I cannot find way to determine its value. Is there anything that helps to continue? Yes, it's the following.

Let's compare $\frac{N_r}{N}\ k\ T$ with m_iC^2 , posing the division. I symbolize u to the quotient.

$$u = \frac{m_i\ C^2}{\frac{N_r}{N}\ k\ T}$$

$$u = \frac{N\ m_i\ C}{N_r\ \frac{k\ T}{C}}$$

I replace the numerator as indicated by (55). Then I simplify.

$$u = \frac{C}{v_i}$$

$$u^2 = \frac{C^2}{v_i^2}$$

I apply Maxwell's law of velocity distribution, expressed in (56)

$$u^2 = \frac{C^2}{\frac{8}{\pi}\ \frac{k\ T}{m_i}}$$

$$u^2 = \frac{\pi}{8}\ \frac{m_i\ C^2}{k\ T}$$

$$u = \sqrt{\frac{\pi}{8}\ \frac{m_i\ C^2}{k\ T}} \tag{70}$$

kT is the average value of the photon energy. If kT were of the same order as m_iC^2 or of a slightly lower order, instead of mediating protectively between hypoluminous particles the photons would propel them against each other and the system would collapse. This means that the system will be able to maintain its constitution only if m_iC^2 is greater than kT by many orders of magnitude, a condition equivalent to $C > v$ in many orders of magnitude.

Consequently we will make a negligible error if instead of (66) we use the following equation.

$$\frac{E_s}{N} = m_i\ C^2 + k\ T \tag{71}$$

In (65) replace $\frac{E_s}{N}$ as indicated by (71)

$$\frac{\pi}{8}\ \frac{1}{N}\ dN = \frac{k\ dT}{m_i\ C^2 + k\ T} \tag{72}$$

In the second member of (72) the numerator is the differential of the denominator. Both members can be easily integrated. I propose the indefinite integral.

$$\int \frac{\pi}{8}\,\frac{1}{N}\;dN = \int \frac{k\;dT}{m_i\;C^2 + k\;T}$$

$$\frac{\pi}{8}\int \frac{1}{N}\;dN = \int \frac{k\;dT}{m_i\;C^2 + k\;T}$$

I resolve

$$\ln N^{\frac{\pi}{8}} = \ln\left(m_i\;C^2 + k\;T\right) - \ln x$$

$$\ln N^{\frac{\pi}{8}} = \ln\left(\frac{m_i\;C^2 + k\;T}{x}\right)$$

Equal logarithms imply equal arguments

$$N^{\frac{\pi}{8}} = \frac{m_i\;C^2 + k\;T}{x} \tag{73}$$

The constant x remains to be determined. Is there an accessible way to do it? Yes. The constant is independent of the condition we analyze. So we ask what would happen if we gradually removed electron/positron pairs. In all stages of process, photons are more abundant than hypoluminous particles, that is, in any condition $N_r > N$ is satisfied. How many photons will remain when all the electron/positron pairs have been removed? At that instant it is $N = 0$ and one photon is enough to satisfy the condition $N_r > N$.

In the final instant there are no hypoluminous particles and the term m_iC^2 is null. Then (28) is in the following form.

$$N^{\frac{\pi}{8}} = \frac{k\;T}{x} \tag{74}$$

How much is N worth when the system is made up of only one photon? Although the initial instant N was the number of hypoluminous particles, the nonexistence of them in the final moment requires assigning the value linked to the only thing that remains. Because ? The photon has wave behavior and also mechanical behavior, analogous to the behavior of a particle. That single photon plays both roles, wave and particle. That means that the value consistent with physical laws is $N = 1$.

$$1^{\frac{\pi}{8}} = \frac{k\;T}{x} \tag{75}$$

$$1 = \frac{k\;T}{x}$$

$$x = k\;T \tag{76}$$

In (73) I apply (76)

$$N^{\frac{\pi}{8}} = \frac{m_i\ C^2 + k\ T}{k\ T}$$

$$T = \frac{m_i\ C^2 + k\ T}{k\ N^{\frac{\pi}{8}}}$$

$$T = \frac{m_i\ C^2}{k\ N^{\frac{\pi}{8}}} + \frac{k\ T}{k\ N^{\frac{\pi}{8}}}$$

$$T = \frac{m_i\ C^2}{k\ N^{\frac{\pi}{8}}} + \frac{T}{N^{\frac{\pi}{8}}}$$

$$T - \frac{T}{N^{\frac{\pi}{8}}} = \frac{m_i\ C^2}{k\ N^{\frac{\pi}{8}}}$$

$$T\left(1 - \frac{1}{N^{\frac{\pi}{8}}}\right) = \frac{m_i\ C^2}{k\ N^{\frac{\pi}{8}}}$$

$$T = \frac{m_i\ C^2}{k\ N^{\frac{\pi}{8}}}\ \frac{1}{\left(1 - \frac{1}{N^{\frac{\pi}{8}}}\right)} \tag{77}$$

Equation (8) indicates $N = 6{,}02.10^{23}$. We will make an almost inexistent error if instead of (77) we propose the following equation.

$$T = \frac{m_i\ C^2}{k\ N^{\frac{\pi}{8}}} \tag{78}$$

For m_i and for k I use the values recommended by CODATA in 2018. For N use the value given by (8) .

$m_i = 9{,}1093837015.10^{-31}\ kg$

$C = 299792458\frac{m}{s^2}$

$k = 1{,}380649\frac{J}{Kg}$

$N = 6{,}02089.10^{23}$

With these values (78) it gives the following result.

$$T = 2{,}721\ K \tag{79}$$

The value given by (79) coincides with the data published by NASA for the blue region of the cosmic radiation spectrum. In (79) I indicate the first three decimal places of the result, because the others are not safe.

Final comment

What can we rescue from this document? My impression is that the initial stage of the cosmogenesis admits of a simple analysis. It is not my intention to recommend the rustic approach that I have presented. Other people can make more appropriate and more faithful to reality.

I suppose I can rescue the following concept. If a rustic and archaic approach produced an accessible panorama, with much more certainty the current methods of physics explain the basic properties of the universe, plus other characteristics less obvious and more subtle that have not yet been discovered.

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