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A New Relativistic Solution beyond Unique Origin of the Solar System

Emad Eldieb*

Independent Researcher, Egypt

***Corresponding author**: Emad Eldieb, Independent Researcher, Egypt, E-mail: eeldieb@yahoo.com

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Abstract

"The sun – like solar systems with planets" differ from those without planets regards ^{7}Li abundance (lesser about 10 times). Hence, we conclude that they may have unique origin. The planet orbital in our model was momentary found in the primordial universe as a hydrogen giant atom – like system. Later on, gravity replaced it, and maintained orbitals. Ours model can interpret ^{7}Li abundance problem. Thermodynamics of the early universe can define its time of creation as a primordial stage in the evolutionary stages of the sun like solar systems with planets. We defined its probability of finding and hence, the expected value of these systems. Our model matched the observed values.

Keywords: ***Relativistic mass; Gravitational potential; Primordial nucleosynthesis: Light element abundance; Jupiter; Mercury; Pluto; Cleared neighborhood of planets***

Introduction

We will begin from current physics to submit new physics. The first part (the introduction) will look as abstract algebraic logic, while in the part of the discussion there would appear the physical meaning of that abstract mathematics which will necessitate the alternative relativistic solution. Then we will test the validity of that solution throughout astronomy and thermodynamics. The tests were: first, the orbital speed and radius of each planet of the solar system. Second, the total mass of these planets combined; relative to the sun mass. The third one was the mass of Jupiter. And the last one was the cosmological abundance of the light elements, in addition to a suggestive approached solution for the primordial lithium problem. The results matched the observed and the current values.

Let us begin from the common definition of the inertial rest state: m_o , r_o, and E_o of a baryonic particle which is stated by Einstein's famous equation, $k\frac{e^2}{r_o} = E_{(o)} = m_{(o)}c^2$ [1].

If we defined a closed sphere formed of number of protons p, distributed homogeneously in much more number of neutrons n, and

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if we equated the quantity $\frac{r_o\ p}{r_c\ n^{\frac{1}{3}}}$ with the number one we can get:

$$k\frac{e^2}{r_o}\left(\frac{r_o\ p}{r_c\ n^{\frac{1}{3}}}\right)\equiv k\frac{e^2}{r_o}(1)=E\equiv E_o\equiv m_o c^2 \tag{1}$$

This is a nontrivial solution defines the initial boundary conditions $(m=m_o$ and $r=r_o)$ of particles in a bound state.

Where,

$$r_c=r+\Delta r\approx\frac{\hbar}{mc}\approx \text{Compton length} \tag{2}$$

We can consider r_c unknown we have to estimate its value in the bound state. From the above we can do the next intuitive mathematic operation $\frac{1}{2}m_o c^2\equiv k\frac{e^2}{r_o}\left(\frac{1}{2}\frac{r_o\ p}{r_c\ n^{\frac{1}{3}}}\right)$ and then we choose a very small cut of energy equivalent to the extra Δr of equation 2

$$\Delta E=k\frac{e^2}{r_o}\frac{n}{p\,\mu} \tag{3}$$

Where μ is a new unknown we have to find its value, and $\frac{n}{p\ \mu}\ll 1$

$$E_o\approx\frac{1}{2}m_o c^2\approx\frac{1}{2}k\frac{e^2}{r_o}\left(\frac{r_o\ p}{r_c\ n^{\frac{1}{3}}}-\frac{n}{p\times\mu}\right) \tag{4}$$

Or we can write it in the form

$$\frac{k\ e^2}{r_o}\left(\frac{1}{2}\frac{r_o\ p}{r_c\ n^{\frac{1}{3}}}-\frac{1}{2}\frac{n}{p\times\mu}\right)\backsim\frac{1}{2}m_o c^2\backsim\frac{1}{2}m_o v^2 \tag{5}$$

It looks like coulomb's form representing the microstates inside the sphere [2]. Then we can insert it in Einstein's equation which is the macro state

$$\frac{1}{2}k\frac{e^2}{r_o}\left(\frac{r_o\, p}{r_c\ n^{\frac{1}{3}}}-\frac{n}{p\times\mu}\right)+\frac{1}{2}k\frac{e^2}{r_o}\frac{n}{p\times\mu}\equiv\frac{1}{2}m_o c^2 \tag{6}$$

If the free particle is defined by $r_o=k\frac{e^2}{m_o c^2}$.

The bound one inside the sphere gets a new additional definition

$$r_c\approx\frac{\hbar}{mc} \tag{7}$$

This gives a quantum state for the particles

$$v^2 \approx c^2 \tag{8}$$

If the gravitational energy

$$u_g = \Delta E = \frac{1}{2} m_o u^2 \ \ where\ u \ll c \tag{9}$$

Then, we can rewrite equation (1) as follows

$$mc^2 \equiv \left(\frac{1}{2} k \frac{e^2}{r_o} \frac{r_o \ \ p}{r_c n^{\frac{1}{3}}} - u_g \right) + u_g \equiv \frac{1}{2} m_o v^2 + \frac{1}{2} m_o u^2 \tag{10}$$

The quantity between the brackets arises only from the spaces between the particles as defined by equations 3, 7 and 8, but when we add the gravitational energy we get the whole equation. The quantity u_g inside the brackets is the cut energy mentioned in equations 3, 4 and 5 due to the extra size Δr mentioned in equations 2

All the microstates inside the sphere should be defined finally by the boundary conditions of equation 1.

$$m = m_o \ \& r = r_o \ \& E = E_o \tag{11}$$

The kinetic energy in our alternative relativistic solution is defined by the initial boundary condition.

$\because m = m_o$ This enables us to put the mass outside the integral

$\therefore E_k = \int F \times dr = \int m_o \frac{dv}{dt} v dt = m_o \int \frac{dv}{dt} v dt = \frac{1}{2} m_o v^2$

And from equation 10

$$\frac{1}{2}(m_o v^2 + m_o u^2) = \frac{1}{2} m_o c^2$$

$$v^2 + u^2 = c^2 \tag{12}$$

The free particle loses a bit of its mass to reside in a bound state. Here in our sphere, the particle- like rest energy loses a bit of energy $\Delta E \equiv u_g$. After adding the gravitational kinetic energy $\Delta E = u_g$ we get the general form of equation 1 and 10.

Discussion

1.The goal is to realize all the above abstract mathematic equations inside the sphere. That is to prove physically that all the energies; the electric u_e , the 'quantum exclusive' u_c and the gravitational u_g in addition to the energy resulted from magnetic moment u_s all together take the form $u_e + u_c + u_g + u_s \equiv m_o c^2$. If we succeeded to do that then we can say that we realized equation 1, hence we can deal it as rest energy. So, we can deal the total kinetic energy as summation of zeros.

Let us go step by step:

The paired microstate inside the proton well

Let us define

$$\gamma^2 = \frac{1}{1-\beta^2} \equiv c_o \tag{13}$$

Where $\beta^2 = \frac{v^2}{c^2}$ and c_o is a new symbol.

We can see that the relativistic electric energy $u_e(v)$ is affected by one γ , while the gravitational $u_g(v)$ is affected by γ^3

$$u_e(v) = ke^2 p \frac{\gamma}{r_s} \text{ where } r_s = r_c n^{\frac{1}{3}} \tag{14}$$

$$u_g(v) = -G\left(m_p n m_n \gamma^2\right)\frac{\gamma}{r_s} \tag{15}$$

So, when $v \approx c$ as in equations 2, 4 and 8, and from equations 14 and 15 we can define $\frac{n}{p}$ to reach the equality

$$u_g(v) = u_e(v) \tag{16}$$

Inside a closed sphere, the Gaussian surface could be applied to the gravitation and electric field, so at any point we have the same equality. If $m_p \approx m_n$ then from equation 13 we can realize the existence of the sphere by equating the electric energy per proton to the gravitational energy per the same proton. We can use the new symbol, of equation 13, in the equality

$$u_e(v) = ke^2 p \frac{c_o^{\frac{1}{2}}}{r_s} = u_g(v) = -Gnm_o^2 c_o \frac{c_o^{\frac{1}{2}}}{r_s} \approx \frac{1}{2} m_o c^2 \tag{17}$$

This equation represents the microstate inside the sphere which should be bounded by the boundary conditions of equations 1 and 11. From equations 13 and 14:

$\because \gamma^2 \equiv c_o \gg 1$

$\therefore ke^2 p \frac{c_o^{\frac{1}{2}}}{r_s} \gg m_o c^2$ (Refused)

So, we have to do cancelling of c_o between the two sides to eliminate the left side $c_o^{\frac{1}{2}}$ (and between the numerator and denominator if needed). After cancelling, we can get,

$$k\frac{e^2}{r_o} = ke^2 \frac{p}{r_s} = -G\left(nc_o\right)\frac{m_o^2}{r_s} = \frac{1}{2} m_o c^2 = u_G(v) \neq u_g(v) \tag{18}$$

(Where r_o and r_s are defined in equation 14)

You notice the factor $nc_o \equiv n\gamma^2$ appears as alternate relativistic solution which we will discuss later on.

$$u_e(v) = u_e \approx \frac{1}{2} m_o c^2$$

$$u_G(v) \neq u_g(v)$$

The quantum state

On the same way of Fermi sphere we can understand the Compton sphere defined by equations 2 and 7.

The particles density is the inverse of infinitesimal volume $\frac{n}{V}$. The quantum energy density inside neutron well $u_c = \frac{h^2}{2m}(\frac{3\pi^2}{V}n)^{\frac{2}{3}} = \frac{A}{r_c^2 m_o}$ [3].Where A is a non-arbitrary constant. As we did in equation 17, and respecting the initial boundary conditions we can process the cancelling to get $u_c(v) = \frac{Ac_o^{\frac{1}{2}}}{r_c^2 m_o}$.

Again, as we did in equation 16 and 17, we expect the equality $\frac{A}{r_c^2 m_o} = u_c = -\frac{G m_o^2 (n \times c_o)}{r_s} = u_G(v) \neq u_g(v)$.

You notice again the factor $nc_o = \gamma^2 n$ appears as alternate relativistic solution which we will discuss later on.

The average energy density in our sphere

$$\int_0^n u_c\, dn = \frac{h^2}{2m}(\frac{3\pi^2}{v})^{\frac{2}{3}} n^{\frac{2}{3}}\, dn = \frac{3}{5}u_c n$$

$$\langle u_c \rangle = \frac{3}{5}u_c$$

$$\frac{A}{r_c^2 m_o} = u_c = -\frac{G m_o^2 (n \times c_o)}{r_s} = u_G(v) \approx \frac{1}{2}m_o c^2 \neq u_g(v) \tag{19}$$

$$\langle u_c \rangle = \frac{3}{5}u_c \approx \frac{1}{2}m_o c^2$$

Summarizing all above:

$$\frac{3}{5}u_e(v) = \frac{3}{5}u_e = \frac{3}{5}u_G(v) \approx \frac{1}{2}m_o c^2 \neq u_g(v) \tag{20}$$

$$\frac{3}{5}u_c(v) = \frac{3}{5}u_c = \frac{3}{5}u_G(v) \approx \frac{1}{2}m_o c^2 \neq u_g(v) \tag{21}$$

These above equations are the physical synonymous of equation 4.

The imaginary and the alternate relativistic solution

You can notice equations 18 and 19 speak about the quantity $\approx \frac{1}{2}m_o c^2$ and not the quantity $= \frac{1}{2}m_o c^2$.

So, we search for a solution realizes a complete (not approximate) equality like:

$$u_e(v) + u_g = m_o c^2$$

$$u_c(v) + u_g = m_o c^2$$

Where u_g is the non-relativistic gravitational energy.

Let us apply the imaginary solution

$$\text{At } v^2 = 2c^2 \tag{22}$$

$$\because m^2 = \frac{m_o^2}{1-\frac{v^2}{c^2}} = \gamma^2 m_o^2$$

$$\therefore m^2 = -m_o^2 \tag{23}$$

And then insert it in equation 17

$$Gn\frac{-m_o^2}{r_s}\gamma^2 = Gn\frac{m^2}{r_s} = \text{positive non-relativistic } u_g \tag{24}$$

This positive energy could be add to u_c and u_e

$$u_c + u_g = u_e + u_g = \frac{1}{2}m_o c^2 \tag{25}$$

But, how is equation 22 realized?

Each particle inside the sphere has its own rest intrinsic energy $= m_o c^2$ which expresses its own rest radius $r_o = k\frac{e^2}{m_o c^2}$

And here, we add from equation 25 another half $(\frac{1}{2}m_o c^2)$.

This additional half expresses the additional space length of equation 2 which is $r_c \approx \frac{\hbar}{mc}$. This new state, as we will show, adds a second half coming from its own magnetic moment. So, as a net result, we have

$$m_o c^2 + \left(\frac{1}{2}m_o c^2 + \frac{1}{2}m_o c^2\right) = 2m_o c^2 = m_o(2c^2) \tag{26}$$

You notice that the particle does not duplicate its mass, such that the equation realizes equation 22. Equation 25 shows the deep meaning of the alternate relativistic solution of equations 18 and 19 as multiplication of the particles by the factor c_o.

It is replication of the rest energies which defined by $r_o = k\frac{e^2}{m_o c^2}$ and $r_c = \frac{\hbar}{mc}$

The operation $nc_o = N$ means replication of null sets or zeros of energy.

Equations 17 and 18 (and also 19) need further comment. Because we did cancelling in the equality 17 then, from this point of view, we can consider $u_e(v)$ is the equal quantity of $u_G(v)$ so, $u_G(v) \approx \frac{1}{2}m_o c^2$ means $u_e = \frac{1}{2}m_o c^2$ (after adding u_g) which consequently means that the quantity $u_e(v)$ appears as the manner inserted inside the formula of $u_G(v)$. This manner is $c_o n = N$ or:

$$\sum_n^N E_o = \sum_n^N m_o c^2 = \sum_n^N zeros = \frac{N}{n}m_o c^2$$

Where $E_o = m_o c^2 = f(r_c) = f\left(\frac{\hbar}{m_o c}\right)$. This is equivalent to $E_o = f(r_o) = f\left(\frac{ke^2}{m_o c^2}\right) \to \sum_n^N E_o = \frac{N}{n} m_o c^2$. The net result is multiplication (replication) of the sphere by the same factor. The word multiplication is the precise expression (rather the word replication) as we will see on speaking about thermodynamics of the giant atom.

Now, each proton inside the sphere has $u_e(v) + u_g = \frac{1}{2} m_o c^2$.

And each particle has additional $u_c(v) + u_g = \frac{1}{2} m_o c^2$ but because $p \ll n$ we can say that each proton has $u_c(v) + u_g = \frac{1}{2} m_o c^2$.

Now, each proton inside the sphere has $u_e(v) + u_g = \frac{1}{2} m_o c^2$

Now we will search for the remainder half. Let us at first study the free particle as defined by $r_o = k\frac{e^2}{m_o c^2} \to E_o = m_o c^2$. This could be seen as formed of two half's $(2\frac{1}{2} m_o c^2)$.

The electric energy density $u = \frac{1}{2} E^2 \varepsilon_o$

$$u_x + u_y + u_z = u = 3\frac{e^2}{32\pi^2 a^4 \varepsilon_o}\int_o^{2\pi}\int_o^{\pi}\int_o^{r} r^2 \sin\theta \, dr \, d\theta \, d\varphi = \frac{e^2}{8\pi\epsilon_o} = \frac{1}{2} m_o c^2$$

The spin of the particle adds the second half as follows

$$u_s = m \times B = \left(i\pi a^2\right) \times B$$

$$B = \frac{\mu}{4\pi a^2} i \int dl = \frac{\mu i}{2r}$$

$$i = \frac{e}{T} = \frac{ev}{2\pi r} \to B = \frac{\mu e v}{4\pi a^2}$$

From all above

$$u_s = \frac{e^2}{8\pi\epsilon_o} = \frac{1}{2} m_o c^2$$

On the same way, the particle inside the sphere has the definition

$$r_c = \frac{\hbar}{mc} \to E_o$$

So, this rest energy is formed also of two half's: the first was discussed from equation 1 till 24. The second goes straight forward with

$$u_s = \frac{e^2}{8\pi\epsilon_o} = \frac{1}{2} m_o\, c^2 \quad (27)$$

Now we want to define r_c

We have the quantum exclusive energy per particle u_c and the electric energy per proton u_e

The total energy per particle:

$$u_t = u_c + u_e \frac{p}{n}$$

$\frac{p}{n} = 10^{-12}$ (as we will see soon).

$$u_c = u_e = mc^2$$

$$\frac{A}{r_c^2} + \frac{A}{r_c^2}\left(10^{-12}\right) = \frac{A}{r_c^2}\left(1+10^{-12}\right) = mc^2$$

$r_c^2 = \frac{A\left(1+10^{-12}\right)}{mc^2}$ (Where A is a constant)

$$r_c = \sqrt{\frac{A\left(1+10^{-12}\right)}{mc^2}} \approx \frac{A}{mc^2} = 3.13\times 10^{-16}\, m$$

The total energy per particle

$$u_t = \left(\frac{u_c n}{n+p} + u_c \frac{p}{n+p}\right) + u_e \frac{p}{n+p} + u_g = \frac{1}{2} m_o c^2$$

Where, the exclusive quantum energy of the proton inside the proton well is defined by $r = r_c (\frac{n}{p})^{\frac{1}{3}}$

The above is the exact physical formula of the rest energy which could be defined exactly and precisely by the domain r_c.

Mathematically, because $p \ll n$ and $u_g \ll u_c$ we can use an approximate formula like $u_c \approx u_c + u_g = \frac{1}{2} m_o c^2$.

Finally from equation 27, $u_T = u_t + u_s = m_o c^2$

This is the goal we have been searching for.

Definition of the giant proton

Up till now we were interested in the qualitative form of the equations. Here we will be interested in the quantities only. So something like $\left(= mc^2\right)$ and $\left(\approx mc^2\right)$ would make no considerable quantity difference.

$$v^2 = c^2 - u^2$$

$$\frac{1}{2}mc^2 = u_G = u_g\, c_o$$

$$u_g = \frac{1}{2}mc^2 \div c_o$$

$$u^2 = c^2 \div c_o$$

$$v^2 = c^2 - \frac{c^2}{c_o} = c^2\left(1 - \frac{1}{c_o}\right) = c^2\left(1 - \frac{1}{c_o}\right)$$

$$c_o = \frac{N}{n} = \frac{P}{p} = \frac{u_G}{u_g} = \frac{\mu p}{n}$$

$$\frac{1}{2}mc^2 = o.78 \times 10^{-10}\ joule$$

We will see, soon, from the giant orbit that

$$N = 3 \times 10^{45} \text{ Particle}$$

From all above we can get

$$p = 2.4 \times 10^{9} \text{ Proton}$$

$$n = 2.95 \times 10^{21} \text{ Neutron}$$

$$c_o = 10^{24}$$

$$\mu = 1.2 \times 10^{36}$$

$$v^2 = c^2\left(1 - \frac{1}{10^{24}}\right) \approx c^2$$

$$u^2 \approx 10^{-7}$$

$$\frac{n}{p} = 1.2 \times 10^{12}$$

It is useful to notice the physical meaning of equation 12 from the relation $\gamma^2 = \dfrac{1}{1 - \dfrac{c^2 - u^2}{c^2}} = \dfrac{c^2}{u^2}$.

The giant orbital

We saw how an internal observer sees the relativistic micro-states inside the sphere. An outer observer does not see that. It feels gravity as:

$u_g = -G\dfrac{Nm^2}{r}$ Where $N = nc_o$ while r is the radius of the sphere $= r_c N^{\frac{1}{3}}$.

A giant electron feels the giant proton as an external observer so it feels

$u_e = k\dfrac{e^2P}{R}$ where $P = pc_o$ and R is the orbital radius. Let us go back to equation, and let m_e is the rest mass of the electron (in the giant electron), and let us replace the protons by an equal quantity of electrons in the same sphere:

$\because m_p \approx 1840 m_e$

$\therefore ke^2\dfrac{p}{r_s} = -G\left(nc_o\right)\dfrac{m_e^2}{r_s} = \dfrac{1}{2}m_e c^2$

To maintain the above equality (which is equivalent to equation 18), n should be 1840 times as much as that of the giant proton. By other words;

$$(u_g)_e = \frac{1}{1840}(u_g)_p = m_e c^2$$

This means that $\dfrac{N_e}{N_p} = 1840$

The above means that the giant electron mass = 1840 times the giant proton mass. Hence, the second would rotate around the first. This inverted atom is not a physical step in creation of the giant atom; it is just a mathematical operation to understand how physics of the giant atom works.

The giant proton to orbit as a whole (one body) its particles have to be tied well with its sphere otherwise, the protons will depart its sphere and orbit as a singled-particles like rosary beads. So, we need

$$G\frac{m^2}{r}N\frac{N}{P} \gtrsim \frac{1}{2}m\frac{N}{P}v_o^2 \gtrsim \frac{1}{2}k\frac{e^2}{R}P \qquad (27')$$

Where v_o is the speed of the first orbit which equals the escape velocity of an orbiting object.

But, there is still a hidden factor, let us search for.

Suppose we have two cases. The first is a giant proton orbits as one body, and the second case is that its orbital is arranged one by one as rosary beads. To prevent 'case one' from breaking up, we need a further factor. The next discussion may reveal this factor.

The stored energy E_s in a capacitor (charging one by one).

$$E_s = \int_0^q \frac{q}{c}dq = \frac{1}{2}Vq$$

There is a lost electric energy (in resistance as heat), and we have only half the quantity. Inserting this factor in equation 27 then the condition which we need is

$$G\frac{m}{r}N\left(m\frac{N}{P}\right) \gtrsim \frac{1}{4}(m\frac{N}{P})v_o^2$$

$$\gtrsim \frac{1}{4}k\frac{e^2}{R}P \qquad (28)$$

We need only the critical value or the least possible energy $G\frac{m^2}{r}N\frac{N}{P}$ therefore we used the symbol $(\gtrsim)$ in the above equations. This symbol is physically meaningful. It enables us to estimate the orbital radius of the giant proton which orbits as one body from equation in which the orbital looks as rosary beads like

$$R=\left(\lambda\frac{P}{N}\right)P \tag{29}$$

Where λ is equivalent to the wave length of the hydrogen atom [4], while in the giant atom, the in-between brackets is representing the wave length of one proton weighted by $\frac{P}{N}$ (this means that the giant atom orbital length equals its wave length $\lambda\frac{P}{N}$ times number of protons). Hence, the wave length of the giant atom is very small and narrow, so that the probability of finding the particle looks like Kronecker delta function

$$\psi_i^2=\begin{cases}1 & i=\lambda\frac{P}{N}\\ 0 & i\neq\lambda\frac{P}{N}\end{cases}$$

The above orbital form does not mean that our orbital looks as rosary beads. It only means that the first orbital just needs the critical form of equation 28 to prevent the rosary beads form, but mathematically we can use equation 29 to define the orbital radius approximately. After defining $v_o=5\times10^4$ m per second [4] we can estimate $N=3\times10^{45}$ particle.

It is important to notice that the giant proton is a massive object, so definition of each of its orbital speed and radius does not contradict with the uncertainty principle. In equations 28 and 29 you notice a new form appears as $\frac{N}{P}$ for each proton. This could be called 'huge proton' which is the unit of the giant orbit. Actually, equation 28 carries more than physical meaning: first, it is coincident with equation 29 where both go straight forward with the physical meaning of the huge proton. That is, it puts a definition to the huge proton in reaction with the external electric field as a part of definition of the orbit. From the first chapter we can define u_c of the giant proton (or the giant electron) as Fermi gas, but due to its new defined interior density I can sculpt a new terminology and call it Compton gas (after adding u_g it becomes rest energy as we showed in the first chapter). The unit of the energy level –as defined only by the orbit- is the huge proton. Each huge proton represents a macro-state n_i therefore the orbit is represented by number of the macro-states pn_i.

Basically, we have two microstates for each macro state $(\pm\frac{1}{2}spin)$. In Compton gas (Fermi), the orbit is formed of number of protons (= number of the macro states = twice the number of the microstates) times' the wavelength of the huge proton. Second, the left side of the equation speaks about the outermost layer of the sphere (the factor 0.6 is absent). This second point needs further comment as follows:

The gravitational potential inside a solid sphere with radius r, at a point distant x from the center of the same sphere equals

$$u_g = -GM\,\frac{3r^2 - x^2}{2r^3}$$

Then, the work done to move a particle from the outermost layer to a reference outside the sphere is the least, comparative to the deeper layers. If a work cannot move a particle located in the outermost layer then necessarily it cannot do that for the deeper one. Let us suppose that the equation needs to define the least quantity of the neutrons. When I studied the relations inside our sphere I noticed from the equations mentioned under the sub-title "definition of the giant proton" the next relations;

N is proportional with $n^3, p, \frac{1}{P}$ and $\frac{1}{c_o^2}$.

And from equation 12 we can see the deepest physical meaning of equation 28 that is it searches for the least N, consequently the biggest c_o and consequently, the least u or the highest possible v (the nearest to speed of light which a particle can gain that takes the form $u_e = u_c \approx mc^2$.

Now, we can estimate $P = pc_o = 2.5\times10^{33}$

And then from equation 29, we estimate the orbital radius $R = 12\times10^{10}\,m$. And from $m\frac{N}{P}v_o^2 = k\frac{e^2}{R}P$ we can ensure the same result.

Defining the solar system

Solution of vagueness and obscurity of this paper underlies in our realization that all the above events of the giant charge are synchronized. The events are the mathematics which drew the planets orbitals. The events disappeared burst with the first decay of the neutrons inside the giant charge (see later), so, we are in no need to search or ask about the giant charge evolution with time.

Once the electric field disappeared and was replaced by the gravitational field then we can speak about evolution of the planet as a function in time pass but after the giant charge left its imprints of its momentary primordial exist. Some of these imprints lie in the planets orbitals, and other lie inside the planets and sun.

Now, we can suggest that:

Each planet was formed of typical units and was related to a defined model. The model of the same planet was formed of typical systems. Each system was formed of a giant proton (with mass equal m_p) orbiting its giant electron (with mass equal m_e).

All the units, even of the different planets, had the same N and P. Also, all the units of the "small suns" had the same number of the electrons and neutrons. Each system (giant proton and its giant electron) obeyed the invariant principle (number of protons equal number of electrons). The systems of the different planets (different models) obey

$$m\frac{N}{P}\left(\frac{v}{d}\right)^2 = k\frac{e^2}{d^2R}P \tag{30}$$

We suppose that "d" is a natural or rational number takes variant values from one till ten (that is to satisfy the current astronomic orbital speed of the far planets, so d equals one for Mercury and ten for Pluto). Due to neutrons decay there would be burst and rapid repulsion for the protons inside the giant protons (adding new charges inside the giant charge disturb its physics), and also for electrons inside the giant electron. This would result in dramatic decrease of the mutual electric energy between the giant proton and its giant electron. To conserve the same quantity of energy and the same quantity of angular momentum for each particle, the physical properties (R and v) of the orbit should be maintained as we will explain in the chapter of thermodynamics. This needs the small suns to unify by gravity to replace the dramatic disappearance of the electric energy. This is accompanied with rapid union of the orbiting units which had the same parameters. At the end we would have the solar system. We can expect that the sun mass M_s relative to the mass of all the planets $\sum M_p$ obeys $\frac{M_s}{\sum M_p} = 1840$.

From the present physical values of the solar system; sun mass is about $2\times10^{30}\,kg = 700$ times as massive as the mass of all the planets combined [5]. Jupiter; the massive planet in the solar system was born small with mass about one over fifteen from its present mass, then it reached gradually to its present mass after millions of years [6]. Taking this old mass of Jupiter in our estimation, we can get the present ratio $\frac{M_s}{\sum M_p} = 700$.

Now, we can estimate the orbital speed (from above, it equals the orbital speed of the ground state of the giant atom) and radius for the nearest planet to the sun.

$$v_o = 5\times10^4 \text{ m per second} \tag{31}$$

$$R = 12\times10^{10}\,m \tag{32}$$

And also we can state that

$$\frac{M_s}{\sum M_p} = 700$$

Or, in its oldest primordial form (as the cosmologists agree with me)

$$\frac{M_s}{\sum M_p} = 1800 \tag{33}$$

So, we can estimate the orbital speed and radius of each of the other planets. This is matching the physical characteristics of the solar system with error factor equal $\frac{1}{2}$ regarding equation 32 (astronomically $R \approx 5.5\times10^{10}\,m$) and about $\frac{1}{2.5}$.

I suggest for this factor the next:

Mathematically, multiply N in equations 29 and 30 by a factor equals 2. This leads to reducing the orbitals into the half. We suggest that the cause of inserting this factor is to resist the destructive thermal effect. But as we will see soon from the point of view of thermodynamic statistics that this factor may be any rational number more than one. But physics of the giant atoms define the value of this factor to be the least natural number more than one. The giant unit is a proton, electron or also may be a giant neutron. The last one is allowed as a giant proton having the same physics and consequently the same number of neutrons but without 'protons well' which means that it is formed only of neutrons (you can go back to the first chapter), So adding the least possible extra number of neutrons to the giant proton is possible by adding one giant neutron. Inserting this factor in equations 29 and 30 reduces the orbital size into the correct value, while inserting it into equation 28 doesn't affect the right sides of the equation because the inequality sign allows that, so it takes the form

$$G\frac{m}{r}2N\left(m\frac{2N}{P}\right)>\frac{1}{4}(m\frac{N}{P})v_o^2>\frac{1}{4}k\frac{e^2}{R}P$$

The equation in this form doesn't affect any of P, n, pu and v. This means that the least amount of the neutrons (realized by equation 28) required for defining the sphere and consequently to guard against the probable dissociative electric effect is half the true amount. You can notice that each of the giant proton and giant electron needs this factor so it doesn't affect the ratio of equation 33.

We will see that although the thermal energy is much more than each of the binding energy inside the giant proton and inside the giant atom yet by the aid of thermal statistics we can get a good outcome of abundance of the giant atoms and consequently of solar-like systems.

Let $l=r\times\sqrt[3]{2}$

$$\therefore G\frac{m}{l}2N\left(m\frac{2N}{P}\right)>\frac{1}{4}(m\frac{N}{P})v_o^2<KT$$

$$>\frac{1}{4}k\frac{e^2}{R}P<KT \quad (34)$$

Thermodynamics of the giant proton (GP)

Notice: In this chapter we will be interested only in the general form of the equations, while its numerical values would be approximated.

First, we have to define the gravitational binding energy of the giant proton per particle

$$u_g\left(N\right)=-G\frac{3}{5}\frac{m.N}{r}m\approx 10\,eV\approx 10^{-5}MeV \quad (35)$$

Let us remember the next information's:

At time of freeze out $\left(\approx 0.7\,MeV\right)$ in the early universe, as in the Standard model, the ratio $\frac{n}{p}=\frac{e^{-\left(\Delta mc^2\right)}}{kT}\approx\frac{1}{6}$

The binding energy of deuterium $B_D\approx 2.2\,MeV$.

$\eta=\frac{n_b}{n_p}\approx 5\times 10^{-10}$ [7]

The peak of synthesis of deuterium (at $t\approx 2\,minute$ of BB)

$$u_D=\frac{B_D}{-\ln\eta}\approx 0.1MeV \quad (36)$$

At this time, there is sudden burst of deuterium synthesis and rapid consumption of the free neutrons. The curve grows rapidly at 2 minute. After 2 minutes the rate becomes roughly constant [8].

Now, we will search for the suitable time in the early universe which enables $u_g\left(N\right)$ to survive. Because it is small (10eV) so, the universe should be cold enough to it's survive otherwise it would be destroyed by the energetic photons. But also it should be hot enough to precede the peak rate of deuterium synthesis otherwise the giant charge would not find enough considerable amount of free neutrons. This means that the suitable time to discuss probability of finding the giant protons is roughly at 0.1 MeV.

From all above, the density of particles in a defined phase (giant protons) relative to the number density of a defined medium (universe) equals the probability of the giant proton to survive or equals the probability to find number of particles with $10^{-5} MeV$ among $kT = 0.1 MeV$.

I will use Boltzmann distribution function in the three dimensions. Its normalized form is

$$f(v) = 4\pi v^2 (\frac{m}{2\pi KT})^{\frac{3}{2}} e^{-\frac{mv^2}{2KT}}$$

And then I will rewrite it as

$$f(v) = 2\frac{m}{KT} v^2 (\frac{m}{2\pi KT})^{\frac{1}{2}} e^{-\frac{mv^2}{2KT}} \quad (37)$$

I need you to remember physics of the giant charge, and to be aware that thermodynamics doesn't construct the giant charge but only it conserves or destroys it. Let us see the behavior of the particles either these inside our sphere or those outside. Both, in the high thermal bath would behave as identical particles. Hence, we apply Boltzmann thermodynamic statistics. Thermodynamics tells us that there is average speed which most particles would move with, but there is also some particles move up and other move down this average. Now we want to define number of the particles which move with thermal velocity equal the value of equation 35, $v = \sqrt{2\frac{10^{-5}}{m}} m/s$. This is first physically allowed, and secondly, this guarantees that this ratio of the spheres would not destroyed, at least, at moment of its creation (as we will see soon).

So, I need to equalize the average kinetic energy of each particle $\frac{1}{2}mv_g^2$ of the gravitational potential u_g (of the sphere) with the thermal energy of some particles outside the spheres. This means that I will treat only with part of the particles of the universe whose own speed is defined by $\frac{1}{2}mv^2 \equiv \frac{1}{2}mv_g^2 = u_g \approx 10^{-5} MeV$

Notice: This means that the particles of the sphere had been cut from the universe particles whose energy is defined by the last equation. This appears from the next equation after substitution in equation 37

$$f(v) = \frac{n}{N} = 2\frac{2\times10^{-5}}{0.1} (\frac{m}{2\pi 0.1})^{\frac{1}{2}} e^{-\frac{2\times10^{-5}}{0.2}} = 5.2\times10^{-11} \quad (38)$$

The function defines the probable ratio of the number of all the particles of all the spheres (of a planet) combined, to all the number of all the particle of the entire observed universe. Here, m is the mass of the particle, and $KT = 0.1 MeV$, while we neglected the exponential factor which approached one.

But, we are treating with indistinguishable particles. This means that the particles are not marked, and we cannot define which particle was known by a definite location or momentum. In thermal equilibrium; collisions of the particles allow energy exchange. This is bad news: If the sphere (which has critical and defined physical values) allowed some of its own particles to escape outside or even collide with the outside particles, this would mean complete destruction of the sphere (giant charge, whose physics doesn't accept any numerical changes). On the other hand, if annihilation happened in a moment, creation is not allowed in the same or in the next moment. That is because the favor time of creation of the sphere was frozen out: no extra free neutrons -in the universe- are allowed. Fortunately, as we said before all the events, up till now, are synchronous. Physics laws would not wait, and would not allow the giant charges to be destroyed. As the giant proton attracts with its corresponding giant electron, the similar ones (the giant protons with each other, and the giant electrons with each other) repel. On the other side, on the level of particles, with the first 'pulse of heat transfer' into the sphere, the 'silent' singled-charges (remember that the interior of the giant charge is defined by equation 1) would repel with each other. As they repel, they would be pushed outside the spheres, allowing the spheres (where the entire massive sphere, as a whole, according to definition of the kinetic energy has comparatively very small thermal speed) to be pulled by the resistance force, and to attract by their gravitational energy. In thermal equilibrium and in infinitesimal time pass; the repulsion generates resistance force (equal in quantity and opposite in direction). Migration of the singled-charges from the inside of the sphere means disappearance of the repulsive force between the similar giant charges. This would generate equal but opposite (in direction) resistance force. This mechanism of unification of the units leads to conservation of the angular momenta and energy by the next equation forms:

$\frac{P}{R} = v^2$ (the old electric form of the spheres).

$\frac{M}{R} = v^2$ (the new gravitational effect).

As the singled-charges were disappearing from the physical scene, the masses M were appearing efficiently and replacing the migrating p .

Nevertheless $KT \gg u_g$, however the 'authority' of the probability function guarantees abundance of good number of the spheres (as we will see). The first 27 equations of this study determined the details of the giant atom, while equation 38 realizes the final definition of the sphere.

From definition of the giant proton the number N of the particles inside the giant proton $\approx 6\times10^{45}$

And the number of particles in the seen universe $\approx 10^{80}$ [9].

From above, and from equation 38 the expected number of the giant protons in the early universe $\approx \frac{10^{80}}{6\times10^{45}\times5\times10^{11}} \approx 3.3\times10^{22}$.

But, the sun has about 10^{57} particle and consequently, all the planets (of our solar system) have about 10^{54} particle. So that, they had number of giant charges (in the early universe) $\approx \frac{10^{54}}{6\times10^{45}} \approx 1.7\times10^{8}$

From above we expect that there were most probably,

$$\frac{3.3\times10^{22}}{1.7\times10^{8}} \approx 2\times10^{14} \quad (39)$$

Solar system in the universe had been created as in our model. At the next infinitesimal moment, the orbital was controlled by gravitational field, and union took place. Hence, we can search for probability of survival of this planet (which was born from its giant charge) and its evolution throughout time. Earth mass, as example, $=6\times10^{24}$ while that of the giant charge was $6\times10^{45}\times1.7\times10^{-27}\approx10^{19}$ kilogram which means that it had about 5×10^5 units. This leads to that the equation 35 becomes

$$u_g=-G\frac{3}{5}\frac{m.N}{r}m(5\times10^5)^{\frac{2}{3}}\approx10^{-1}MeV \tag{40}$$

And the probability of finding throughout space becomes

$$\frac{0.1}{0.1}\times e^{-\frac{u_g}{KT}}\approx\frac{1}{e}\approx\frac{1}{2.7} \tag{41}$$

This means that the phase is in thermal equilibrium.

Inserting the above with equation 38 we expect to have number of earth-like planets had created as in our model equal

$$E\left(X\right)\approx0.5\times2\times10^{14}\approx10^{14} \tag{42}$$

Now, we want to draw a general picture for the expectation value of any planet. From equation 38,

$$u_g=Am^{\frac{2}{3}}e^{-m} \tag{43}$$

Where, A is the proportional constant while m (in this equation) is the combined mass of the units of the planet.

Regarding u_g>KT; the exponential function becomes greater than one, so we expect that there should be upper limit for the mass of the planet (which had created as in our model). The maximum mass is that which gives expectation value equals one which means that we expect that there is only one (from such planet) among the expected 10^{14} solar-like systems (it is nonsense to expect rational number).

∵ the least E(X)=1

And from solution of the above equations;

∴ $m_{maximal}$≈230 times as much as earth mass.

Putting this maximal mass and substitution in equation 38, we get the expectation value approaches one. Jupiter has mass about $315m_{earth}$ [10]. Anyway, the cosmologists say that Jupiter began in the past much smaller; it reached gradually to its present mass after millions of years [6].

For the planets of small mass:

$e^{-\frac{u_g}{KT}}\approx1$, and the expectation value goes, approximately, straight forward proportional with $u_g=Am^{\frac{2}{3}}$

Mercury as example whose mass is about twenty two times as less as the earth mass, and consequently directly, from equation 40, its potential u_g is less than that of earth about seven times, and the expectation value becomes 3.5 times as less than that of earth. The comparative small potential exposes the combined units (the newly born planet) for a time-dependent destructive function. This destruction although terrible for future of the planet, however it is bearable on the contrary to the unbearable destruction which could have happened for the 'sensitive' giant charge (before union). The mass of Pluto planet (the smallest planet of the solar system) equals about 0.0022 of earth mass as estimated recently by Buie *et al*. [11]. Or, 0.1 of earth mass, as estimated by Cruikshank, Pilcher and Morrison [12]. Anyway, according to IAU resolution there are three conditions for an object in the solar system to be considered a planet. Pluto fails to meet the third one which is it must have cleared the neighborhood around its orbit. Pluto mass is less than the other objects in its orbit about 0.07 times, where Earth is 1.7 million times the remaining mass in its orbit excluding moon [13]. I can conclude that all (or most of) these bodies in Pluto orbit combined, were created as one body, while those bodies which involves Pluto in its orbit are rudiment evidences on the time-dependent destructive function which broke down its mass into parts: one of them had Pluto present mass. This proposal succeeds to put Pluto as a typical planet in the solar system. From all the above Pluto is a planet in the solar system, and it had (in the past) cleared neighborhood. We have to differentiate between the big planets which had primordial $u_g \geq u_{g\ earth}$) and the other smaller planets which had $u_g < u_{g\ earth}$. The first, although had small expectation value (as equation 38) however, they were not exposed for the time-dependent destructive function (due to the comparative high potential), in contrary to the smaller planets which faced terrible future with this destructive function. The continuous decrease of temperature with the time pass, and the expected increase of the molecular mass (due to formation of atoms may carry happy news for these small primordial planets (as equation 38 says).

It should be clear that the probability of finding is a momentary event, and must be maintained by abundant number of units as in equation 40. If the number of units was equal or more than that of earth then the destructive rate would be zero and the expectation value would be maximal. From all above, we can say that; we submitted for a new theory for unique model for the origin and creation of our solar system and other solar-like systems.

This model in preliminary inspection is a probable event (equation 39). That event acquires validity from abundance of the particles and the great volume of the universe (equation 41). Unfortunately, the event –from the side of view of thermodynamics- is momentary (the interior of giant charge is based on physical values don't accept any change, even heat exchange): the event appears in a moment, and is destroyed in the next infinitesimal time. But fortunately, the abundance of the units (equation 41), and the rapid mechanism of union (as explained before) maintained the model and conserved its survival.

General Insight

The expected date of the onset of creation of the giant atom was a genius choice. The temperature at that time was low enough for survival and abundance of the electrons and consequently the giant electrons (about 0.1 MeV). Under the chapter titled 'definition of the giant proton' we saw that the equations of the sphere were unable to define the physical values of the giant charge without defining at first the value of N which we couldn't define it without defining at first the value of the orbital speed. It is the giant atom which bequeathed our solar system its measured physical values. Radius of the universe at that time was big enough to allow existence of the giant atom (at t≈3, and from Friedmann equation, the radius of the universe was in magnitude of order of seventeen), while the primordial Pluto perihelion was (and still) about 4.3×10^{12} m [14].

Equation 38 and its sequel $\frac{1}{2}mv^2 \equiv \frac{1}{2}mv_g^2 = u_g \approx 10^{-5}MeV$ were actually genius choice as an onset of birth of the giant atom. This equation has the validity to select, among the particles of the hot universe (10^{-1}MeV), a partition of particles having average $u = 10^{-5}MeV$. Fluctuat ion of energy and the broadened Boltzmann curve allowed that.

One could have imagined that thermodynamic had to walk step by step with the first 27 equations of the physics of the giant atom: so, one could have imagined that thermodynamics had to define particles as $\frac{1}{2}mv^2 \equiv \frac{1}{2}mv_g^2 = u_g \approx mc^2$ to represent the onset of the equations of the giant charge. Yes, the tail of the broadened curve (Maxwell-Boltzmann distribution) at high temperature (of the primordial universe) might allow to find particles with $v \approx c$. But, even if that was possible, however it had necessitated that the thermal statistic tells us how to aggregate a magnitude of order of forty five of these particles (number of only one giant proton) among a magnitude of order of eighty (particles of the universe) to collect them inside the sphere. Yes, but this is not the definition of the sphere. The genius equation summarized and crated, with great care, the entire definition of the giant charge. Each particle of the population of the closed sphere was really that particle which was defined by equation 38 which actually embodies the 'rest energy' of the interior of the sphere except the gravitational potential which conserved its reality and life. (In the same equation we also hint the equivalency between the thermal and gravitational energies which remember us with the missed factor in equation 28, and which we found it later and said that it has a relation with the thermal energy).

This defined quantity of energy, which appeared in equation 38, discovers the deep physical meaning of the alternative relativistic solution of equations 18 and 19. These two equations cut, from the surrounding environment, multiple of particles (c_o), corresponding to the potential energy of the sphere, and consequently was corresponding with the thermal energy which was offered by thermal statistics. Both; equations 18 and 19, from a side, and equation 38 from the other side, serve each other, and translate one physical state (u_g=10^{-5} MeV). If equation 38 was compatible with the alternative relativistic solution of the giant charge, equation 40 has a different meaning. This last equation acts far away from the entire physics of the giant charge. It acts by the aid of the thermodynamics to unify the giant atoms (as we explained before).

The time function and the thermal pressure

Let us begin from equation 30, it put d=1 for Mercury, and d=10 for Pluto. Mass of the giant proton (and of the giant electron) was defined strictly to be fixed well on the electric orbit. After union, the equation would take the form of $\frac{M}{R} = v^2$. Conservation laws as we explained kept the orbital speed (and length) constant, so the mass of the united sphere (sun) should be defined by equation 30. This means that mass of the Sun is dependent variable and consequently the total combined mass of all the planets was defined by the oldest primordial ratio $\frac{M_s}{\sum M_p} =\approx 1800$. From all the above we conclude that each of $M_s \approx 10^{57}$ particle and $\sum M_p \approx 10^{54}$ particle in addition to Mercury d=1 is dependent variable (defined by physics of the giant atom), while mass of each planet alone (number of units) was not defined (independent variable). The equations above say nothing more than that we expect 10^{14} solar systems had created as in our model. Each one contains ill-defined number of planets (may be one, two or more).

The temperature of the universe decreases proportional to the second root of the time pass. T proportional with $\sqrt{t}$, and temperature is irreversibly proportional with the expanding radius of the sphere. This stage was next to the stage above when the thermal energy was equal the energy of the interior of the united spheres. This means that the probability became fixed. Henceforth, the interior of the planet goes straight forward with the current astrophysics.

Elements abundance in our model

BBN results in mass abundance about seventy five percent hydrogen and the reminder as helium. At the universe temperature was 0.7 Mev the proton neutron ratio was 6:1 but few minutes later, by decay of neutrons, it became 7:1.

Our model agrees with all above. It speaks only about very small zones of the early universe occupied by the giant charges as well as it speaks about few moments began at the second minute of beginning of BB. Inside the giant protons the neutron proton ratio was roughly one to zero. The neutrons were two minutes old, and have to decay because they have average life time about fifteen minute.

$$N = N_o e^{\frac{-t}{T}} \approx N_o e^{\frac{-2}{15}} \approx 0.87$$

$$\begin{array}{ccc} n & : & p \\ \downarrow & & \downarrow \\ 87 & : & 13 \\ \downarrow & & \downarrow \\ 75n + 6\,pairs & : & 6\,pairs \end{array}$$

These six pairs (percent) fuse to form about twenty-five percent mass abundance of helium. By time the temperature falls enough to prevent further considerable fusion, but of course would not prevent neutron to decay. So, the remainder seventy five, by time and by neutron decay, would construct seventy five percent mass abundance of hydrogen (you notice my alternative mechanism which gives results matching the observed values.

The cosmologic lithium problem

The sun- like stars with planets has lithium abundance about ten times less than the other stars without planets [1].

It is known that the number of nucleons in ^{7}Li is more than in helium, and since the neutrons, in our model, are available hence we have to search in the availability and abundance of the protons, definitely after time of primordial helium synthesis (at time of lithium synthesis) and definitely inside the giant charges.

To submit an approximate solution we choose an approximate suitable time 3.5 minute after BB as the peak of lithium synthesis (no considerable further addition as in the next figure). Then, we estimate the free proton abundance at that time. By neutron decay

$N = N_o e^{\frac{-t}{T}} \approx N_o e^{\frac{-3.5}{15}} \approx 0.79$. The remainder is the proton ratio $\approx 100 - 79 = 21$

As estimated above thirteen of this quantity was consumed in deuterium synthesis (which fuse to form helium), so the remainder represents the free protons ratio at this time $\approx 21 - 13 = 8$.

After that we compare this ratio (eight percent) with the proton abundance outside the giant charge which is seventy five percent $8 : 75 \approx 1 : 10$.

This gives the result that the cosmologic lithium mass abundance in the sun-like stars with planets (which we expect to be created as in our model) is about ten percent that in the other stars.

I think that my model predictions match all the observed cosmological observations.

The last point which has to be discussed is the life time of the free neutrons in the view of the Alternate Relativistic Solution (ARS). What is the age of the newly born neutrons of the big sphere? We showed that the small sphere $\left(n \approx 10^{21}\right)$ gave by ARS the big sphere $\left(N \approx 10^{45}\right)$ at time 2 minute after BB. Was its age at this time two or zero minute?

My answer is two minute, because ARS does not add extra particles. It just means cutting up a big zone from the universe to represent the big sphere of the giant charge. The small one has no existence outside the big sphere but its mathematics is acting inside it. The mass, length and time is not affected by ARS (**FIG. 1**). The big sphere did not come after the small one, but both came at the same moment. ARS does not mean more than it is the solution which enables us to equate $\sum_n^N zeros = \frac{N}{n} m_o c^2$.

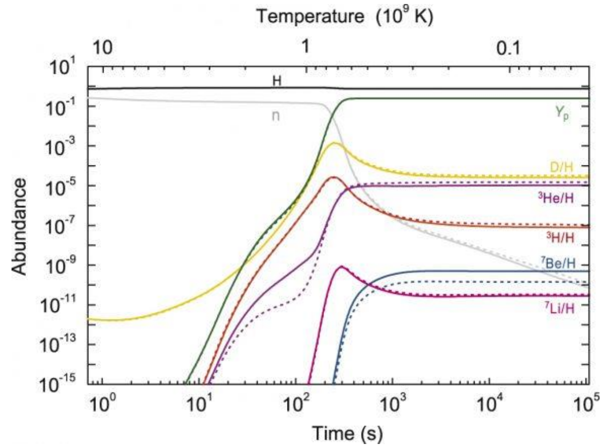

FIG. 1 **Hou *et al* 20017**

Conclusion

The famous Einstein's equation $\left(E_o = m_o c^2\right)$ described the rest energy of a particle, similarly, I submitted for describing a closed sphere, filled with particles, to be described by the same equation. Hence, we put all the energies inside the sphere which contains this bound state of the particles in a rest state. Hence, we can add these rest energies of the particles as summation of zeros. This led me to submit for physics of the relativistic giant atom.

This giant atom was created in the early universe. We defined its time of existence after BB, as well as its life time. After that, the orbitals of these giant atoms were maintained by gravity. The old existence of these giant atoms left its cosmological implications in the orbital radii and velocities of the planets of the solar system. Our model found a reasonable explanation for the small mass of Pluto relative to the combined masses of the dwarf planets which orbit in its same orbital. Our model succeeded to put explanation for the light elements abundance matching with the standard model. Also, it put approximate explanation for the poverty of lithium in the 'sun-like solar systems with planets' relative to those without planets.

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