Considerations and Calculations on the Fraction of Helium in Neutral Matter of the Net Charged Universe NCU [1,2,3]

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Abstract:
As described previously, the concept of a "Net Charged Universe" (NCU) assumes that the expansion of the universe is driven by a slight excess of positive charge in the universe's matter. This excess charge comes into being by means of quantum fluctuations at the universe's horizon. Excess protons experience electrostatic acceleration and therefore gain high relativistic mass, which is the source of the creation of neutral matter at the universe's horizon.
Based on the NCU model, the present article aims to explain the observed fraction of Helium (approximately 7%) in the universe's baryonic matter. For this purpose, calculations on collision rates of excess protons are performed and applied to determine the Helium fraction in the universe's matter. The results of these calculations correspond very well to the observations and thus, they further support the NCU model.

0. Introduction

As described in [1,2,3], the NCU model assumes that the expansion of the universe is driven by a slight excess of positive charge in the universe's matter (X_{pn}). This charge excess is carried by un-neutralized, "naked", protons (p_n) in the amount of N_{pn}. The p_n are not of constant number but are steadily "imported" by quantum fluctuations at the NCU horizon. Based on this concept, the quite implausible idea of "Dark Energy" (DE), which is favored by today's cosmology, can be avoided, or we can even identify DE with the *Coulomb* force brought about by p_n.

In [2], I have further described and calculated how neutral matter (NM) can be created continuously by the decomposition of relativistic p_n, which gain their high mass by *Coulomb* acceleration.
The relativistic p_n are here regarded to be almost completely concentrated at the NCU horizon [3] and, in turn, all decompositions of them occur there. This assumption will be checked in more detail by further calculations in this article.
In terms of creation and amount of NM in the NCU, the previous calculations [2, 3] yielded a result that is consistent to considerations by *Dirac* [4], who discussed a proportionality of the number of all protons (N_P^{all}) to the universe's horizon area. Eq.[1a] expresses that proportionality together with the magnitude of N_P^{all}("*Dirac* number"):

$$N_P^{all} \cong \left(\frac{R_U}{R_p}\right)^2 \quad (\textit{Dirac}[4]) \qquad \text{Eq.[1a]}$$

and for comparison:

$$N_p^{all} \cong \frac{1}{3\pi}\left(\frac{R_U}{R_p}\right)^2 \qquad \text{(NCU concept [2, 3])} \qquad \text{Eq.[1b]}$$

(N_p^{all} ≡ number of protons in the universe, R_U ≡ radius of universe, R_p ≡ radius of proton)

After article [3] had been published, a friend asked me if the NCU model could explain the observed fraction of Helium cores ($X_{He} \approx 7{,}3\%$) in the universe's NM. At first glance, I was convinced I was unable to answer that question. But after some deeper reflection, I had an idea how to estimate X_{He} via calculations on collision rates of p_n at the horizon. The results of these calculations and underlying considerations will be presented in this article.

All calculations below are based on the plausible assumption that NM is generally released from relativistic p_n by collision events between them.
When we therefore compare collision numbers at the horizon with changes of N_p^{all} according to Eq.[1b], we can establish a particle balance that allows for calculations on the relation between ^1H cores (= protons) and ^4He cores in NM.

1. Distribution and movement of p_n between Horizon and Inner NCU, F_m "Mixing Factor"

In order to calculate collision rates of p_n, we have to know the p_n fraction at the horizon.That is because the collision probability in the inner NCU is far too low to allow for any NM formation [3]. Therefore, all p_n in the inner regions of NCU are "lost" for NM creation and NM can emerge only from the horizon, where the p_n density is presumably high enough [3].

So we have to determine an estimate of the F_m "mixing factor", which was introduced in my last article [3]. The F_m factor expresses the fraction of p_n that is distributed more or less homogenously over the entire space inside the horizon ("mixed" with NM). This p_n fraction pushes each single p_n towards the horizon by *Coulomb* force against the gravitational force brought about by NM.

So F_m can be calculated from the balance of both forces when they equal each other and no further p_n can enter the inner NCU regions. In that case, the number of mixed p_n ($=F_m*N_{pn}$) will remain constantly close to the equilibrium, value and the calculations in this chapter will estimate F_m via the equilibrium of forces.

According to *Newton*'s shell theorem [5], we can imagine both the entire NM and the mixed p_n fraction inside the horizon as being condensed in the center of the NCU. Based on this idea, the calculations on gravitational and *Coulomb* forces are conducted.

If one imagines a "sample p_n" close to but inside the horizon, this p_n will **not** experience the *Coulomb* force of p_n located at the horizon – because of *Newton*'s shell theorem [5]. Therefore, the "sample p_n" will experience only the attracting gravity of the entire NM inside the horizon and the repelling *Coulomb* force of the mixed p_n fraction there. For these competing forces (expressed here as accelerations), the following equations (Eqs.[2…5c])are valid:

$$a_{grav} = -\frac{F_{grav}}{m_P} = -\frac{m_P*M_U*G}{m_P*R_U^2} \qquad \text{Eq.[2]}$$

(a_{grav} ≡ gravitational acceleration towards the inner NCU,m_P ≡ mass of proton, M_U≡ mass of the universe, G ≡ gravitation constant)

According to *Mach*'s principle, the time-variable G is given as:

$$G \cong \frac{R_U*c^2}{M_U} \text{ [2, 3]} \qquad \text{Eq.[3]}$$

(c ≡ speed of light)

Inserting Eq.[3] in Eq.[2] yields a_{grav} for the "sample p_n" through the following equation:

$$a_{grav} \cong -\frac{c^2}{R_U} \qquad \text{Eq.[4]}$$

For the *Coulomb* acceleration of one p_n, brought about by the mixed p_n fraction($=F_m*N_{pn}$), we obtain [2]:

$$a_{elstat} = \frac{F_m*N_{pn}*\alpha*h*c}{2\pi*m_P*{R_U}^2} \qquad \text{Eq.[5a]}$$

(a_{elstat} ≡ *Coulomb* acceleration to horizon, α ≡ fine structure constant, h ≡ *Planck*'s constant)

With $\alpha \cong 1$ (valid for p_n close to horizon [3]) and $N_{pn} \cong (R_U/R_P)^{3/2}$[2], Eq.[5a] changes to:

$$a_{elstat} \cong \frac{F_m*h*c}{2\pi*m_P*R_P^{3/2}*{R_U}^{1/2}} \qquad \text{Eq.[5b]}$$

With $R_P \cong 3/4 * \frac{h}{m_P\,c}$ ($\cong 10^{-15}m$, 3/4 of the *Compton* wave length [2]) one obtains:

$$a_{elstat} \cong \frac{2*F_m*c^2}{3\pi*R_P^{1/2}*R_U{}^{1/2}} \qquad \text{Eq.[5c]}$$

In the case of "equilibrium of forces" when the "sample p_n" does not experience any acceleration, the following equation is valid:

$$a_{elstat} = -a_{grav};\ \frac{2*F_m*c^2}{3\pi*R_P^{1/2}*R_U{}^{1/2}} \cong \frac{c^2}{R_U} \qquad \text{Eq.[6a]}$$

After solving for F_m, we obtain from Eq.[6a]:

$$F_m \cong \frac{3\pi}{2} * \left(\frac{R_P}{R_U}\right)^{1/2} \ll 1 \qquad \text{Eq.[6b]}$$

This means, an extremely low fraction (currently $\cong 10^{-20}$) of mixed p_n is sufficient to prevent all further p_n from leaving the horizon towards the inner regions of the NCU. So the assumption that all p_n are concentrated at the horizon is basically certain by now.

Please note that mixed p_n are completely decoupled from NM inside the NCU horizon. That is because of the extremely low collision probability there [3]. Thus, NM carries no net charge and is therefore influenced exclusively by gravity. So NM is able to form galaxies by gravitationally driven compression of cosmic gas.
In opposition, mixed p_n repel each other by *Coulomb* force and therefore stay spatially isolated.

Note further, that all p_n at the horizon should form a monolayer or double layer (see below) because of the electrostatic pressure from mixed p_n in the inner universe. Thus, each p_n at the horizon experiences the repelling *Coulomb* force of **all** p_n in the NCU (i.e. the mixed fraction **and** all p_n at the horizon). This partially tangential and partially radial force drives all p_n away from each other and towards the horizon. As a result, the horizon tends to expand in lateral and radial directions, leading to expansion of the universe as described and calculated in [2].

Since new p_n steadily appear at the horizon, the whole p_n layer there should be permanently "stirred" and p_n collisions occur just like collisions of molecules in a gas.

2. Collision Rate of p_n at the Horizon

Firstly, I will consider which distance (L_1) a "sample p_n" at the horizon has to move on average to experience **one** collision with a "partner p_n". The collision between two p_n exhibits a cross sectional area (CS). We thus have to regard a tube-shaped volume $V_{1pn} = CS * L_1$ that contains exactly one p_n (the "partner p_n") according to a certain density of p_n (ρ_{pn}):

$$V_{1pn} * \rho_{pn} = CS * L_1 * \rho_{pn} = 1 \qquad \text{Eq.[7a]}$$

The relativistic p_n at the horizon moves with a speed close to c and therefore the time interval for one collision is:

$$\Delta t_1 \cong \frac{L_1}{c}$$

Since R_U grows with a speed close to c as well, the change of R_U during Δt_1 ($= \Delta R_{U1}$) equals L_l and Eq.[7a] can be transformed to:

$$CS * \Delta R_{U1} * \rho_{pn} = 1 \qquad \text{Eq.[7b]}$$

This means, R_U grows by ΔR_{U1} during the time one collision needs, and the number of **all** collisions at the horizon during that growth of R_U is:

$$\Delta N_{Coll}^{Hor} = CS * \Delta R_{U1} * \rho_{pn} * N_{pn} \qquad \text{Eq.[8a]}$$

Replacing ΔR_{U1} by a generalized R_U fraction $\Delta R_U \equiv X_{Ru} * R_U$ yields the following equation expressing the number of p_n collisions during any R_U growth by $X_{Ru} * R_U$:

$$\Delta N_{Coll}^{Hor} = CS * X_{Ru} * R_U * \rho_{pn} * N_{pn} \qquad \text{Eq.[8b]}$$

The following expressions for the factors in Eq.[8b] are valid:

$CS = 4\pi R_{pn}^2$ where $h/m_P\, c \geq R_{pn} \geq R_{p0}$.
($R_{p0} \equiv R_p$ measured on earth $\cong$ 8,5*10^{-16} m, $R_{pn} \equiv R_p$, effective value in collision events)

CS is the area of a circle with the radius of $2R_{pn}$, which means that the p_n should form a kind of double layer, and the horizon where p_n are located exhibits a "thickness" of $4R_{pn}$. Thus, we can associate a volume V_{pnHor} to the range where p_n are located at the horizon and ρ_{pn} can be written as:

$$\rho_{pn} = \frac{N_{pn}}{V_{pnHor}} = \frac{N_{pn}}{4\pi * R_U^2 * 4R_{pn}}$$

Since $N_{pn} \cong \left(\frac{R_U}{R_{pn}}\right)^{n+1}$ with $n \cong 0.5$ [2], we obtain:

$$\rho_{pn} = \frac{N_{pn}}{V_{pnHor}} = \frac{R_U^{n+1}}{4\pi * R_U^2 * 4R_{pn} * R_{pn}^{n+1}} = \frac{1}{16 \quad * R_U^{1-n} * R_{pn}^{2+n}}$$

Finally, the number of collisions at the horizon with a double layer of p_n applies as:

$$\Delta N_{Coll}^{Hor} \cong 4\pi {R_{pn}}^2 * \frac{X_{Ru} * R_U}{16\pi {R_U}^{1-n} * {R_{pn}}^{2+n}} * \left(\frac{R_U}{R_{pn}}\right)^{n+1} = X_{Ru} * \frac{{R_U}^{2n+1}}{4{R_{pn}}^{2n+1}} \qquad \text{Eq.[8c]}$$

Please note that the condition $X_{Ru} \ll 1$ must be fulfilled, since R_U must be approximately constant during its growth by $\Delta R_U = X_{Ru} * R_U$.

It is indeed uncertain that p_n at the horizon form a double layer. They might instead move at the horizon like the balls on a billiard table. That means they might be distributed as a monolayer at the horizon area. In that case, the p_n layer would exhibit a "thickness" of $2R_{pn}$ and the following equations would be valid:

$CS = 4R_{pn} * 2R_{pn} = 8\pi {R_{pn}}^2$
(Geometrically, CS is a "rectangle" which includes two p_n touching each other)

$$\rho_{pn} = \frac{N_{pn}}{V_{pnHor}} = \frac{R_U^{n+1}}{4\pi * R_U^2 * 2R_{pn} * R_{pn}^{n+1}} = \frac{1}{8\pi * R_U^{1-n} * R_{pn}^{2+n}}$$

$$\Delta N_{Coll}^{Hor} \cong 8{R_{pn}}^2 * \frac{X_{Ru} * R_U}{8\pi {R_U}^{1-n} * {R_{pn}}^{2+n}} * \left(\frac{R_U}{R_{pn}}\right)^{n+1} = X_{Ru} * \frac{{R_U}^{2n+1}}{\pi {R_{pn}}^{2n+1}} \qquad \text{Eq.[9]}$$

Comparing Eq.[8c] and Eq.[9], one can see that the collision rates ΔN_{Coll}^{Hor} for both types of "p_n layers" exhibit the relation of $double/mono = \pi/4$ as the only difference between them.

3. Determining X_{He} in NM from Collision Rates of p_n – Concept and Equations

Considering particles possibly formed in collision events, ^1H and ^4He are by far the most stable ones [6]. Hence, I assume that regardless of specific reaction chains each collision ultimately creates either a ^1H or a ^4He core. In order to determine the fraction of ^4He cores created in p_n collisions, it is therefore crucial to know the relation between ΔN_{Coll}^{Hor} and the change of N_p^{all} (ΔN_p^{all}) during a certain ΔR_U interval. This is why the lower the p_n collision rate, the higher the average relativistic mass of the p_n, and, in turn, the probability of ^4He formation. Note that all neutrons bound in ^4He cores are subsumed here in the value of ΔN_p^{all}.
If $\frac{\Delta N_{Coll}^{Hor}}{\Delta N_p^{all}} = 1$, each collision will release one ^1H as the most stable particle. If $\frac{\Delta N_{Coll}^{Hor}}{\Delta N_p^{all}} < 1$, each "missing" collision must be compensated for by a higher mass release of a collision that actually occurs. After all, each collision that releases more mass than one ^1H may produce unstable cores which are finally transformed into ^4He cores (for reasons of stability). Thus, the mass of 3 additional protons/neutrons (compared to ^1H) is captured after one of these "^4Hecollisions", which compensates for 3 "missing" collisions.

These considerations lead finally to Eq.[13], which can be seen below. Based on that concept, the fraction of ^4He cores created in p_n collisions will be determined. But initially, Eq.[1b] must be written more generally with variable n, as derived in [2, 3]:

$$N_p^{all} \cong \frac{1}{3\pi}\left(\frac{R_U}{R_{p0}}\right)^{2n+1} \qquad \text{Eq.[1c]}$$

This is necessary because the value of n is probably not exactly 0.5. The value of n was derived in [2] as 0.511 and will be calculated here anew by the following alternative method to

conduct an independent check of that value:
From Mach's principle (see Eq.[3], $M_U = m_P * N_p^{all}$) and Eq.[1c], the following equation can be established (with * for the current values):

$$N_p^{all} \cong \frac{1}{3\pi}\left(\frac{R_U^*}{R_{p0}}\right)^{2n+1} \cong \frac{R_U^* * c^2}{m_P * G^*} \qquad \text{Eq.[10a]}$$

Assuming that equation to be exact and not an estimate, a certain value of n must be given. Solving for n yields:

$$n = \frac{1}{2} * \left[\frac{log\left(\frac{3\pi * R_U^* * c^2}{m_P * G^*}\right)}{log\left(\frac{R_U^*}{R_{P0}}\right)} - 1\right] = 0.483 \qquad \text{Eq.[10b]}$$

Thus, we find n most probably in the range between 0.483 and 0.511**.**

Besides n, the value of R_{pn} (effective collision radius of p_n) is not exactly known, but again we probably know the range it is in:

$$1.33 * 10^{-15} m = \frac{h}{m_P\, c} \geq \boldsymbol{R_{pn}} \geq R_{p0} = 8.5 * 10^{-1}\ m$$

Furthermore, we need to express ΔN_p^{all} during the R_U growth by ΔR_U. According to Eq.[1c], the following equation applies:

$$\Delta N_p^{all} \cong \frac{1}{3\pi} * \left[\left(\frac{R_U + \Delta R_U}{R_{p0}}\right)^{2n+1} - \left(\frac{R_U}{R_{p0}}\right)^{2n+1}\right] = \frac{1}{3\pi} * \left[\left(\frac{R_U + X_{Ru} * R_U}{R_{p0}}\right)^{2n+1} - \left(\frac{R_U}{R_{p0}}\right)^{2n+1}\right] \text{Eq.[11]}$$

From Eqs.[8c, 11] we thus obtain (for the "double layer model" of p_n):

$$X_{Coll} \equiv \frac{\Delta N_{Coll}^{Hor}}{\Delta N_p^{all}} \cong \frac{X_{Ru} * \frac{{R_U}^{2n+1}}{4{R_{pn}}^{2n+1}}}{\frac{1}{3\pi} * \left[\left(\frac{R_U + X_{Ru} * R_U}{R_{p0}}\right)^{2n+1} - \left(\frac{R_U}{R_{p0}}\right)^{2n+1}\right]}$$

After factoring out the term ${R_U}^{2n+1}$ and rearranging, that equation changes to:

$$X_{Coll} \cong \frac{\frac{3\pi X_{Ru}}{4{R_{pn}}^{2n+1}}}{\left[\left(\frac{1+X_{Ru}}{R_{p0}}\right)^{2n+1} - \left(\frac{1}{R_{p0}}\right)^{2n+1}\right]} = \frac{3\pi}{4} * \frac{X_{Ru}}{(1+X_{Ru})^{2n+1} - 1} * \left(\frac{R_{p0}}{R_{pn}}\right)^{2n+1} \qquad \text{Eq.[12a]}$$

For the "monolayer model" of p_n, we obtain corresponding to Eq.[9]:

$$X_{Coll} \cong \frac{\frac{3\pi X_{Ru}}{\pi {R_{pn}}^{2n+1}}}{\left[\left(\frac{1+X_{Ru}}{R_{p0}}\right)^{2n+1} - \left(\frac{1}{R_{p0}}\right)^{2n+1}\right]} = 3 * \frac{X_{Ru}}{(1+X_{Ru})^{2n+1} - 1} * \left(\frac{R_{p0}}{R_{pn}}\right)^{2n+1} \qquad \text{Eq.[12b]}$$

Finally, the stoichiometric concept described above allows for determining X_{He} from X_{Coll}:

$$X_{He} = \frac{1}{3} * \left(\frac{1}{X_{Coll}} - 1\right) \text{ (valid for} \frac{1}{4} \leq X_{Coll} \leq 1) \qquad \text{Eq.[13]}$$

4. Results

In order to determine the fraction of ^4He in the universe's NM, Eqs.[12a, 12b, 13] were applied, while n and R_{pn} were varied within the ranges specified above. The following tables show the results of the respective calculations:

Double layer model:

Rpn [m]	0,48	0,485	0,49	0,495	0,5	0,505	0,51	0,515	0,52	<--n
9,70E-16	0,0259	0,0282	0,0305	0,0328	0,0351	0,0375	0,0398	0,0421	0,0445	<--X_He
9,80E-16	0,0332	0,0356	0,0380	0,0404	0,0428	0,0452	0,0476	0,0500	0,0525	
9,90E-16	0,0405	0,0430	0,0455	0,0480	0,0505	0,0530	0,0555	0,0580	0,0606	
1,00E-15	0,0480	0,0505	0,0531	0,0557	0,0583	0,0609	0,0635	0,0661	0,0687	
1,01E-15	0,0555	0,0581	0,0608	0,0635	0,0662	0,0688	0,0715	0,0742	0,0770	
1,02E-15	0,0631	0,0658	0,0686	0,0713	0,0741	0,0769	0,0797	0,0825	0,0853	
1,03E-15	0,0707	0,0735	0,0764	0,0793	0,0821	0,0850	0,0879	0,0908	0,0937	
1,04E-15	0,0784	0,0814	0,0843	0,0873	0,0902	0,0932	0,0962	0,0992	0,1022	
1,05E-15	0,0862	0,0893	0,0923	0,0954	0,0984	0,1015	0,1046	0,1077	0,1108	
1,06E-15	0,0941	0,0972	0,1004	0,1035	0,1067	0,1099	0,1131	0,1163	0,1195	
	yellow: better than 0.5% deviation from measured value of X_He (=7,3%)									

Monolayer model:

Rpn [m]	0,48	0,485	0,49	0,495	0,5	0,505	0,51	0,515	0,52	<--n
1,10E-15	0,0276	0,0304	0,0332	0,0360	0,0388	0,0417	0,0445	0,0473	0,0502	<--X_He
1,11E-15	0,0341	0,0370	0,0398	0,0427	0,0456	0,0485	0,0515	0,0544	0,0574	
1,12E-15	0,0406	0,0436	0,0465	0,0495	0,0525	0,0555	0,0585	0,0615	0,0646	
1,13E-15	0,0472	0,0502	0,0533	0,0563	0,0594	0,0625	0,0656	0,0687	0,0719	
1,14E-15	0,0538	0,0569	0,0601	0,0632	0,0664	0,0696	0,0728	0,0760	0,0792	
1,15E-15	0,0605	0,0637	0,0669	0,0702	0,0734	0,0767	0,0800	0,0833	0,0866	
1,16E-15	0,0672	0,0705	0,0739	0,0772	0,0805	0,0839	0,0873	0,0907	0,0941	
1,17E-15	0,0740	0,0774	0,0808	0,0843	0,0877	0,0912	0,0946	0,0981	0,1016	
1,18E-15	0,0809	0,0844	0,0879	0,0914	0,0949	0,0985	0,1021	0,1057	0,1093	
1,19E-15	0,0878	0,0914	0,0950	0,0986	0,1022	0,1059	0,1095	0,1132	0,1170	
	yellow: better than 0.5% deviation from measured value of X_He (=7,3%)									

As one can see from both tables, the NCU concept of our universe is able to explain the observed He fraction (23…25% of mass ≅ 7.3% mole fraction) in baryonic matter. Within the plausible ranges of n and R_{pn}, we obtain very satisfying results while regarding the NCU concept as the underlying idea for all thoughts and calculations.

5. Conclusions

Based on the NCU model, the present article aims to explain the observed fraction of Helium (approximately 7%) in the universe's baryonic matter. For this purpose, calculations on collision rates of excess protons are performed and applied to determine the Helium fraction in the universe's matter.

The results of these calculations correspond very well to the observations and thus further support the NCU model.

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