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 ($N_{pall}^\text{all}$) to the universe’s horizon area. Eq.[1a] expresses that proportionality together with the magnitude of $N_{pall}^\text{all}$ ("Dirac number"):

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

and for comparison:

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

($N_{pall}^\text{all} \equiv$ number of protons in the universe, $R_U \equiv$ radius of universe, $R_p \equiv$ 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 $N_{pall}^\text{all}$ 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:

$$a_{grav} = -\frac{F_{grav}}{m_p} = -\frac{m_p M_U G}{m_p R_U^2}$$ 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:

$$G \equiv \frac{R_U c^2}{M_U}$$ Eq.[3]
($c$ ≡ speed of light)

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

$$a_{grav} \equiv -\frac{c^2}{R_U}$$ 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]:

$$a_{elstat} = \frac{F_m N_{pn} \alpha h c}{2 \pi m_p R_U^2}$$ Eq.[5a]
($a_{elstat}$ ≡ Coulomb acceleration to horizon, $\alpha$ ≡ fine structure constant, $h$ ≡ Planck’s constant)

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

$$a_{elstat} \equiv \frac{F_m h c}{2 \pi m_p R_p^{3/2} * R_U^{1/2}}$$ Eq.[5b]
With $R_p \cong \frac{3}{4} \times \frac{h}{m_p c} (\cong 10^{-15} m, \ 3/4 \ of \ the \ Compton \ wave \ length \ [2])$ one obtains:

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

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

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

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

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

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 $p_n (\rho_{pn})$:

$$V_{1pn} \cdot \rho_{pn} = CS * L_1 * \rho_{pn} = 1 \quad \text{Eq.[7a]}$$
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 \( \Delta t_1 (= \Delta R_{U1}) \) equals \( L_1 \) and Eq.[7a] can be transformed to:

\[ CS \cdot \Delta R_{U1} \cdot \rho_{pn} = 1 \quad \text{Eq.[7b]} \]

This means, \( R_U \) grows by \( \Delta R_{U1} \) during the time one collision needs, and the number of all collisions at the horizon during that growth of \( R_U \) is:

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

Replacing \( \Delta R_{U1} \) by a generalized \( R_U \) fraction \( \Delta R_U \equiv X_{Ru} \cdot R_U \) yields the following equation expressing the number of \( p_n \) collisions during any \( R_U \) growth by \( X_{Ru} \cdot R_U \):

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

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

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

\( CS \) 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 \( \rho_{pn} \) can be written as:

\[ \rho_{pn} = \frac{N_{pn}}{V_{pnHor}} = \frac{N_{pn}}{4 \pi \cdot R_{U0}^2 \cdot 4 R_{pn}} \]

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

\[ \rho_{pn} = \frac{N_{pn}}{V_{pnHor}} = \frac{R_{U}^{n+1}}{4 \pi \cdot 4 R_{U0}^2 \cdot 4 R_{pn} \cdot R_{pn}^{n+1}} = \frac{1}{16 \cdot R_{U0}^{1-n} \cdot R_{pn}^{2+n}} \]

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

\[ \Delta N_{\text{Coll}}^{\text{Hor}} = 4 \pi R_{pn}^2 \cdot \frac{X_{Ru} \cdot R_U}{16 \pi R_{U0}^{1-n} \cdot R_{pn}^{2+n}} \cdot \left( \frac{R_{U}}{R_{pn}} \right)^{n+1} = X_{Ru} \cdot \frac{R_{U}^{2+n+1}}{4 R_{pn}^{2+n+1}} \quad \text{Eq.[8c]} \]

Please note that the condition \( X_{Ru} < 1 \) must be fulfilled, since \( R_U \) must be approximately constant during its growth by \( \Delta R_U = X_{Ru} \cdot R_U \).
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:

\[
CS = 4R_{pn} \times 2R_{pn} = 8\pi R_{pn}^2
\]

(Geometrically, CS is a “rectangle” which includes two \( p_n \) touching each other)

\[
\rho_{pn} = \frac{N_{pn}}{V_{pnHor}} = \frac{R_{U}^{n+1}}{4\pi \times R_{U}^{2} \times 2R_{pn} \times R_{pn}^{n+1}} = \frac{1}{8\pi \times R_{U}^{1-n} \times R_{pn}^{2+n}}
\]

\[
\Delta N_{Coll}^{Hor} \equiv 8R_{pn}^2 \times \frac{X_{Ru} \times R_{U}}{8\pi R_{U}^{1-n} \times R_{pn}^{2+n} \times R_{pn}^{n+1}} = X_{Ru} \times \frac{R_{U}^{2+n} \times R_{pn}^{n+1}}{\pi R_{pn}^{2+n+1}} \quad \text{Eq.[9]}
\]

Comparing Eq.[8c] and Eq.[9], one can see that the collision rates \( \Delta N_{Coll}^{Hor} \) for both types of “\( p_n \) layers” exhibit the relation of \( \text{double/mono} = \pi/4 \) 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 \( \Delta N_{Coll}^{Hor} \) and the change of \( N_p^{all} (\Delta N_p^{all}) \) during a certain \( \Delta R_U \) 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 \( \Delta N_p^{all} \).

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 “\( ^4He \) collisions”, 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]:

\[
N_p^{all} \approx \frac{1}{3n} \left( \frac{R_{U}}{R_{p0}} \right)^{2n+1} \quad \text{Eq.[1c]}
\]

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
conducted 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 $\approx$ for the current values):

$$N_{p}^{all} \approx \frac{1}{3\pi} \left( \frac{R_U}{R_{p0}} \right)^{2n+1} \approx \frac{R_U^{n+c^2}}{m_p G}$$

Eq.[10a]

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

$$n = \frac{1}{2} * \left( \log \left( \frac{3\pi R_{p0} R_U}{m_p c^2} \right) \right) - 1 = 0.483$$

Eq.[10b]

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

Besides $n$, the value of $R_{p0}$ (effective collision radius of $p_n$) is not exactly known, but again we probably know the range it is in:

$$1.33 * 10^{-15} m \leq R_{p0} \leq 8.5 * 10^{-1} m$$

Furthermore, we need to express $\Delta N_{p}^{all}$ during the $R_U$ growth by $\Delta R_U$. According to Eq.[1c], the following equation applies:

$$\Delta N_{p}^{all} \approx \frac{1}{3\pi} \left( \frac{R_{U} + \Delta R_{U}}{R_{p0}} \right)^{2n+1} - \left( \frac{R_{U}}{R_{p0}} \right)^{2n+1} = \frac{1}{3\pi} \left( \frac{R_{U} + X_{Res} R_{U}}{R_{p0}} \right)^{2n+1} - \left( \frac{R_{U}}{R_{p0}} \right)^{2n+1}$$

Eq.[11]

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

$$X_{Coll} \equiv \frac{\Delta N_{Coll}^{Hor}}{\Delta N_{p}^{all}} \approx \frac{X_{Res} R_{U}^{2n+1}}{4 R_{p0}^{2n+1}} \left( \frac{R_{U} + X_{Res} R_{U}}{R_{p0}} \right)^{2n+1} - \left( \frac{R_{U}}{R_{p0}} \right)^{2n+1}$$

Eq.[12a]

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

$$X_{Coll} \approx \frac{3\pi X_{Res} R_{U}^{2n+1}}{4 R_{p0}^{2n+1}} \left( \frac{1}{(1 + X_{Res})^{2n+1} - \left( \frac{1}{R_{p0}} \right)^{2n+1}} \right)$$

Eq.[12b]

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

$$X_{Coll} \approx \frac{3\pi X_{Res} R_{U}^{2n+1}}{4 R_{p0}^{2n+1}} \left( \frac{1}{(1 + X_{Res})^{2n+1} - \left( \frac{1}{R_{p0}} \right)^{2n+1}} \right)$$

Eq.[12b]
Finally, the stoichiometric concept described above allows for determining $X_{He}$ from $X_{Coll}$:

$$X_{He} = \frac{1}{3} \times \left( \frac{1}{X_{Coll}} - 1 \right) \text{ (valid for } \frac{1}{4} \leq X_{Coll} \leq 1)$$  

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:**

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<th>0.485</th>
<th>0.49</th>
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**Monolayer model:**

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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 $\approx$ 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.
References:


[6] http://hyperphysics.phy-astr.gsu.edu/hbase/Astro/hydhel.html