A Historical Scenario for the Universe's Evolution According to the Net Charged Universe (NCU) Model [1]

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Abstract

Based on the NCU concept presented earlier, this article describes and calculates a historical scenario for the development of the universe without "Dark Energy" but caused by an average excess of unneutralized protons (p_n). This historical scenario consists of the following steps:

Starting with one initial quantum fluctuation, a "Primordial Nucleus" is formed from protons generated by further quantum fluctuations. Based on *Mach's* principle, the nucleus is held together due to the very high gravitational constant which is given because of the tiny mass the nucleus contains in the beginning.

The more p_n are condensed in the nucleus, the lower G becomes according to *Mach's* principle. So, a turning point is reached, and beyond that point the nucleus explodes at a speed of almost c. This event plays the role of the "Big Bang" in the NCU scenario.

Caused by the extremely high acceleration experienced by the p_n, they form an expanding hollow sphere and thereby generate our known 3D space. During the expansion, additional p_n are steadily imported from fluctuations at the horizon.

Because of the steadily impacting *Coulomb* acceleration, all p_n collect more and more energy, which is converted into relativistic mass growth, and finally that mass is transformed into stable particles, i.e. protons and electrons - the known neutral matter.

0. Introduction

As described in [1], the NCU model assumes that the expansion of the universe is driven by a slight average excess of positive charge in the universe's matter (X_{pn}). This charge excess is carried by unneutralized ("naked") protons (p_n) of the number N_{pn}. Thus, the quite implausible idea of "Dark Energy" (DE), which is favored by today's cosmology, can be avoided.
In [1] I have demonstrated that the currently observed expansion rate of the universe (given with the *Hubble* constant H) can be brought about by a very low value of X_{pn} (about 10^{-18}). Therefore the charge asymmetry cannot be measured by current methods and the universe seems to be neutral.

Continuing the considerations on our universe in the light of the NCU idea, this article aims to present and calculate a plausible historical scenario of the universe's expansion and its process of being filled by matter with the charge asymmetry mentioned above.

1. An Essentially Qualitative Description of the Historical NCU Scenario

Formation of a Primordial Nucleus

According to *Mach's* principle, the following equation is at least approximately valid:

$$G \approx \frac{R_U * c^2}{M_U} \quad \text{or} \quad R_U \approx \frac{G * M_U}{c^2} \qquad [1a]$$

(G ≡ gravitation constant, R_U ≡ radius of universe, M_U ≡ mass of universe, c ≡ speed of light)

This equation is mathematically equivalent to the equation that gives the *Schwarzschild* radius R_S of a rotating black hole with mass M:

$$R_S = \frac{G * M}{c^2}$$

On various occasions, this analogy has led to the idea that our universe could act as a black hole with $R_S = R_U$.
If so, the edge of the visible universe would equal the position of the universe's event horizon. At this horizon, the creation of matter could occur (according to *Hawking's* ideas) by quantum fluctuations as pairs of protons and antiprotons appear from a vacuum. If the protons move away from their partners into our universe within a time interval that is short enough to fulfill *Heisenberg's* uncertainty relation, the protons come into real being inside our world. But this idea leads to a problem:
The physical law mentioned above is valid only as long as we look at regions inside the universe. But we do not know anything about the physical laws beyond the event horizon and consequently, we do not know about the partner particles of "our" protons.
It is the vice-versa situation as if a black hole were observed from the outside: Particles formed by fluctuations and attracted into the black hole experience a fundamentally unknown fate. We can only observe their partners which remain in "our" space.
Therefore, I will consider only the inside of our universe and assume that protons (p_n i.e. without electrons) are imported into the universe by quantum fluctuations from the event horizon.

Consequently, I assume that our universe came into existence with the very first fluctuation that left *one* proton (p_n). According to Eq. [1a], this proton exhibited a huge gravitational constant of around 10^{29} m^3/kgs^2 because there was no further matter in the "universe" at this moment. Note that a variable gravitation constant is implied here, although no evidence for that has been found yet. Later on I will show that the current rate of change of G is too low to be observed today.
Because of the high gravitation mentioned above, additional incoming protons are attracted more strongly than they are repelled by the *Coulomb* force. In this way, a kind of primordial nucleus is formed. This nucleus should exhibit a density in the range of a neutron star. According to Eq. [1a], its gravitational constant decreases with the rising number of protons that are condensed in it.

Explosion of the Primordial Nucleus – a Kind of "Bang"
This process eventually leads to a point at which gravitation and *Coulomb* forces become equal. A few further protons that are now added to the tiny "universe" cause the repelling *Coulomb* force to become stronger than gravitation. As will be shown by calculations below, the nucleus now explodes at an extremely high acceleration of at least 10^{26} m/s^2.
In contrast to the "Big Bang" in current cosmology, the NCU expansion is never faster than c because the moving protons cannot exceed the speed of light. Further amounts of energy brought about by the *Coulomb* acceleration are therefore transformed into rising particle mass according to relativity.
This event can be regarded as the "Big Bang" in the NCU theory. But indeed, it is a rather "Small Bang" since there are only around 16,400 protons involved in it (see calculations below). From the moment of that Bang driven by *Coulomb* forces, a propagating front of protons (p_n) spans the expanding space region that is now called "The Universe".
During the expansion of the universe, quantum fluctuations at its horizon steadily continue to release new protons into our universe. The rate of proton (p_n) formation at the universe's edge will also be calculated below.

Formation of Neutral Matter
The gain of energy by p_n leads to a relativistic growth of their mass. The relativistic p_n formed in that way will undergo collisions with other particles, which causes cascades of particle decomposition. Each of those cascades comes to an end after the formation of the most stable particles we know, electrons and protons, i.e. after the formation of neutral matter.
Additionally, photons are emitted in particle collisions and could be considered as the source of the microwave background observed.
Because of the conservation of charge inside the universe, the number of new protons and electrons released from one relativistic p_n are equal to:

p_n + energy $\rightarrow$ $p_{n}\_m_{rel}$ $\rightarrow$ p_n + yp + ye + photons
(m_{rel} ≡ relativistic mass; yp + ye ≡ protons and electrons; y ≈ m_{rel}/m_p; m_p ≡ proton mass)

Thus, neutral matter is formed with $N_p = N_e$ (N ≡ number of respective particles), leaving photons and N_{Pn} excess protons.
So, an excess fraction of $X_{pn} = N_{pn}/N_p^{all}$ is obtained with $N_p^{all} = N_p + N_{pn}$.
Matter inside the universe then exhibits an average excess charge of $e*X_{pn}$ per proton (e ≡ elementary charge) which is much lower than the charge of one p_n (= e) at the edge of the universe. Thus, due to the *Coulomb* force, known matter experiences a much lower

acceleration than p_n. This low acceleration is the driving force for the expansion of our known matter inside the universe.
For all calculations with respect to the formation of neutral matter see below.

2. Calculations on the Development of the NCU

Creation of protons (p_n) by quantum fluctuations

To obtain protons from vacuum fluctuations, particle pairs must be separated in a time interval Δt that is short enough to fulfill *Heisenberg's* uncertainty relation:

$$h \geq \Delta t * m_P * c^2 \quad \text{or} \quad \Delta t \leq h / (c^2 * m_P) \qquad [2a]$$

(h ≡ *Planck's* constant)

To become ultimately separated, both particles must move a distance within Δt of at least R_p (R_P ≡ proton radius). Since their speed cannot exceed c, Δt must be at least R_P/c:

$$\Delta t \geq R_P/c \qquad [2b]$$

From both inequations [2a, 2b] we obtain:

$$h \geq R_P * m_P * c \quad \text{or} \quad R_P \leq h/ (m_P * c) \qquad [2c]$$

The right-hand term equals the so-called *Compton* wave length of a proton ($\approx 1.3 * 10^{-15}$ m), which is occasionally considered as a plausible (uppermost) value of R_P.
Current measurements with H-atoms yield R_P values of around $8.5*10^{-16}$ m.
Thus, Ineq. [2c] seems to express everything we know about R_P, and one could speculate that the mechanism of proton import by vacuum fluctuations is the underlying reason for the value of R_P we observe.
On the other hand, one could say that the possibility to derive the well-known Ineq. [2c] from the fluctuation mechanism seems to make that mechanism more plausible.
From $\Delta t \approx 2.8…4.4*10^{-24}$ s (see Ineqs. [2a, 2b]), some form of kinetic fluctuation constant k_0 can be derived. This constant expresses the maximal frequency of vacuum fluctuations at one "site" with the radius R_P. k_0 is therefore given by $k_0 = 1/\Delta t \approx 2.3…3.6 * 10^{23}$ s^{-1}.
The true value of k_0 depends on the *effective* value of R_P, which is not fully clear because the measurements mentioned above were performed with H-atoms containing one electron or one muon. Given this, I am not fully sure which *effective* value of R_P is to be taken into account with respect to the fluctuation mechanism for proton (p_n) import.
Therefore, the following estimates will be considered valid in the further calculations:

$$R_P = 3/4 * h/ (m_P * c) \approx 10^{-15}\text{m} \qquad [3a]$$

$$k_0 = c/R_P \approx 3 * 10^{23} \text{ s}^{-1} \qquad [3b]$$

The Primordial Nucleus

For calculations with respect to the primordial nucleus, a variable gravitational constant G has to be assumed according to *Mach's* principle. However, it is often argued that the astrophysical data does not show any change in G. At first, I therefore want to show that there is no contradiction because the present rate of change of G is too small to be measured currently.

The transformation of Eq. [1a] leads to the following formula for the value of N_P^{all} with $M_U \approx N_p^{all} * m_P$:

$$N_P^{all} \approx R_U * c^2 / (m_P * G) \qquad [1b]$$

As mentioned above, Eq. [1a] implies a variable value of G, except the radius R_U and the mass of the universe ($\approx m_P * N_P^{all}$) were proportional, i.e. R_U/N_P^{all} = const. But this is obviously not the case because, according to *Dirac's* ideas [2], the following equation is valid:

$$N_p^{all} = A * R_U^2 / R_P^2 \qquad [4a]$$

Using Eq. [1b] and Eq. [4a] to calculate the factor A in Eq. [4a], one can see an interesting coincidence. The factor is (depending on the correct values of R_P and R_U) close to the fine structure constant $\alpha \approx 1/137$. This finding possibly points to the electromagnetic way in which matter is created according to the NCU scenario. Eq. [4a] can therefore be written as:

$$N_p^{all} \approx \alpha * R_U^2 / R_P^2 \qquad [4b]$$

Since I do not assume that Eq. [1a] and Eq. [4b] are presently given by a kind of historical contingency, they are taken here to be valid over the whole history of the universe. This allows for a calculation of the rate of change of G.

From Eq. [1b] and Eq. [4b] we obtain for the present expanding universe (indicated by *):

$$G^* \approx \frac{R_P^2 * c^2}{\alpha * m_P * R_U^*}$$

Differentiation with respect to time yields with $\dot{R_U}^* \approx$ c:

$$\dot{G}^* \approx -\frac{R_P^2 * c^2}{\alpha * m_P} * \frac{\dot{R_U}^*}{R_U^{2\,*}} \approx -10^{-28} \frac{m^3}{kgs^3} \approx -2 * 10^{-18} \frac{G^*}{s}$$

Hence, G^* has changed by a factor of around 10^{-8} over about 200 years of measurements. Due to the inaccuracy of the currently known G^* is around 10^{-6}, its variability is still not measurable and G^* is seemingly constant. Having done these calculations, we can now determine the turning point at which the primordial nucleus is no longer kept together by gravitation but starts to expand, or in other words, to explode.

In the nucleus, there are two forces in competition, which can be expressed as accelerations according to *Newton's* law F = m*a (F ≡ accelerating force, m ≡ mass, a ≡ acceleration).

The gravitational (attracting) acceleration experienced by one proton in the nucleus can be written as follows (with $N_P = N_{Pn}$ before the creation of neutral matter):

$$a_{grav} = -\frac{N_P * m_P * G}{R_U^2}$$

For the electrostatic component based on the repelling *Coulomb* force between p_n, the following equation applies:

$$a_{elstat} = \frac{N_P * e^2}{4\pi * \varepsilon_0 * m_P * R_U^2}$$ and with $\alpha = \frac{e^2}{2 * \varepsilon_0 * h * c}$ one obtains:

$$a_{elstat} = \frac{N_P * \alpha * h * c}{2\pi * m_P * R_U^2}$$

Hence, the overall acceleration of one p_n in the nucleus is the following:

$$a = a_{grav} + a_{elstat} = \frac{N_P}{R_U^2} * \left(\frac{\alpha * h * c}{2\pi * m_P} - m_P * G\right) \quad [5a]$$

Since the nucleus is regarded here as a highly condensed sphere, the following equation is taken to be valid (differing from Eq. [4b] which applies to the expanding NCU after the "Bang"):

$$N_P = \frac{R_U^3}{R_P^3} \quad [5b]$$

Combining Eqs. [1b, 5b], we obtain for the gravitational constant:

$$G = \frac{R_P^3 * c^2}{m_P * R_U^2}$$ and with Eq. [5a]:

$$a = \frac{N_P}{R_U^2} * \left(\frac{\alpha * h * c}{2\pi * m_P} - \frac{R_P^3 * c^2}{R_U^2}\right) \quad [5c]$$

Since the acceleration at the turning point (indicated by index "T") equals zero ($a_T = 0$), we are now able to calculate R_{UT} and N_{PT} (note that R_{UT} is the radius of the nucleus before the "Bang"):

$$\frac{\alpha * h * c}{2\pi * m_P} = \frac{R_P^3 * c^2}{R_{UT}^2} \quad [5d]$$

With Eq. [3a] we come to the following equation:

$$\frac{2\alpha}{3\pi} = \frac{R_P^2}{R_{UT}^2} \quad [6a]$$

After rearranging we obtain:

$$R_{UT} = R_P\sqrt{\frac{3\pi}{2\alpha}} \approx 2.5*10^{-14} \text{ m} \qquad [6b]$$

$$N_{PT} = \frac{R_{UT}^3}{R_P^3} = \left(\frac{3\pi}{2\alpha}\right)^{\frac{3}{2}} \approx 16400 \qquad [6c]$$

Having determined these two values, I will now attempt to estimate the acceleration that protons experience in the NCU "Bang". If we imagine that the nucleus gains a small number of further protons $\Delta N_P << N_{PT}$ beyond the turning point, the resulting radius R_U is slightly larger than $R_{UT,}$ and we obtain with Eq. [5b]:

$$\frac{R_U^3}{R_P^3} = N_P = N_{PT} + \Delta N_P \qquad [6d]$$

Furthermore, Eqs. [5c, 5d] combine to the following equation:

$$a \approx \frac{N_{PT}}{R_{UT}^2} * \left(\frac{R_P^3 * c^2}{R_{UT}^2} - \frac{R_P^3 * c^2}{R_U^2}\right) = \frac{N_{PT}\ R_P^3 * c^2}{R_{UT}^2} * \left(\frac{1}{R_{UT}^2} - \frac{1}{R_U^2}\right) \qquad [7]$$

In order to be inserted in Eq. [7], $1/R_U^2$ is calculated from Eqs. [6c, 6d]:

$\frac{R_U^3}{R_{UT}^3} = \frac{N_{PT}+\Delta N_P}{N_{PT}}$ and thus:

$$\frac{1}{R_U^2} = \frac{1}{R_{UT}^2} * \left(\frac{N_{PT}}{N_{PT} + \Delta N_P}\right)^{\frac{2}{3}} \qquad [8]$$

Combining Eqs. [6c, 7, 8] leads to:

$$a \approx \frac{c^2}{R_{UT}} * \left[1 - \left(\frac{N_{PT}}{N_{PT} + \Delta N_P}\right)^{\frac{2}{3}}\right] \approx 1.6 * 10^{26} \frac{m}{s^2} \qquad [9]$$

The value of the acceleration during the "Bang" is here calculated for $\Delta N_P = 1$ (i.e. *only one* p_n was added after the turning point). That means that all protons of the nucleus reach approximately the speed of light within $\leq 10^{-18}$ s. From that viewpoint, it seems plausible to imagine that all protons of the nucleus are pushed to immediately form a hollow sphere and expand at the speed of nearly c. *And so our universe is born.*

Import of p_n into the expanding NCU

At the horizon of the expanding NCU, additional p_n are steadily imported by vacuum fluctuations. I will now attempt to calculate the rate at which this import occurs. In [1], the value of X^*_{pn} (the current proton excess fraction of matter) was calculated to be around $1.3*10^{-18}$.

According to Eq. [4b], N_p^{all*} (the overall number of protons in the present universe) is about $1.2*10^{80}$. Thus, the number of p_n (unneutralized excess protons) in the present universe amounts to $N^*_{pn} \approx 1.5*10^{62}$. From that number and from the value of $R_U^*/R_P \approx 1.3*10^{41}$, the rate of proton import $\dot{N}_{pn}$ to the NCU can be estimated when the following general approach for that process is chosen:

$$\dot{N}_{pn} = k * \left(\frac{R_U}{R_P}\right)^n \quad [10]$$

After integration one obtains (with $\dot{R}_U \approx c$):

$$N_{pn} = \frac{k*R_P}{c*(n+1)} * \left(\frac{R_U}{R_P}\right)^{n+1} \quad [11a]$$

Since $N_{Pn} = 1$ when $R_U = R_P$, Eq. [11a] changes to:

$$N_{pn} = \left(\frac{R_U}{R_P}\right)^{n+1} \quad [11b]$$

and consequently $\frac{k*R_P}{c*(n+1)} = 1$ [11c]

Taking the logarithm from Eq. [11b] one obtains:

$$log(N_{pn}) = (n+1) * log\left[\frac{R_U}{R_P}\right] \quad [11d]$$

To determine n from Eq. [11d], a second pair of N_{pn} and R_U/R_P seems helpful. For this purpose, I will look at the NCU immediately after the "Bang" moment. Here, $N_{pn} \approx 16400$ and, according to Eq. [4b], $R_U/R_P = \sqrt{N_P/\alpha} \approx 1500$. Furthermore, for N_{Pn}=1, $\log(N_{Pn}) = \log(R_U/R_P) = 0$ applies.

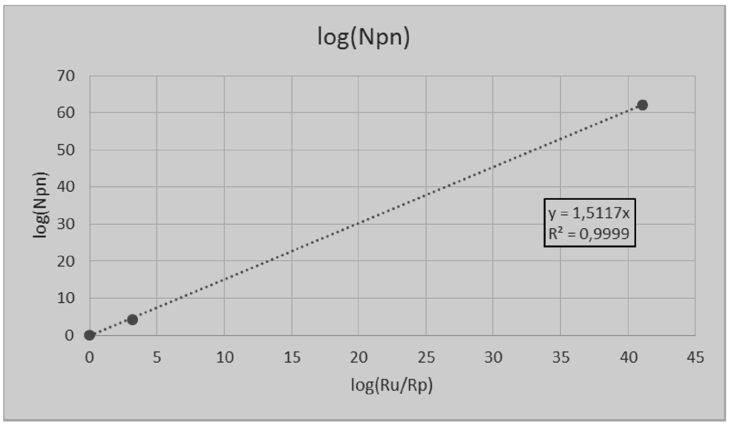

Fig. 1: Linear Regression to Determine Parameter n for the Rate of Proton Import

The graph in Fig. 1 is obtained from this data, and the slope of the straight line therein equals n+1 (Eq. [11d]). Thus, we obtain n ≈ ½.

Furthermore, k is determined from Eq. [11b]:

$1 = \frac{k*R_P}{c*(n+1)} \approx \frac{2*k*R_P}{3*c}$. After rearranging the equation

$k \approx \frac{3*c}{2*R_P} \geq k_0$ (since $k_0 \leq c/R_P$; see above) is valid [12a]

This means that k is greater than the one which was shown above to be the uppermost value (k_0). This point will be discussed further below.
But let me first look at the value of n.
Considering the dependency of the p_n import rate on R_U, one would expect it to be proportional to the area of the spherical NCU horizon, i.e. $\dot{N_{pn}} \propto \left(\frac{R_U}{R_P}\right)^2$ instead of $\dot{N_{pn}} \propto \left(\frac{R_U}{R_P}\right)^{1/2}$ as shown above. The value of n (≈ ½) seems to indicate a kind of fractal geometry in the space region(s) where p_n are generated by vacuum fluctuations. To analyse this idea, I will now attempt to adopt a geometrical concept that is, for instance, described in [3]: The concept of hyperspheres or n-spheres. This concept considers the possibility of spheres in n-dimensional spaces and supplies mathematical tools to calculate the volume, the surface, etc. of the n-spheres.

The surface area of an n-sphere is generally expressed by the following equation in which the dimension number n is replaced here by the letter D ("dimension") to avoid confusion with the variable n in Eqs. [10 et sqq.]:

$S_D = F(D) * R^{D-1}$ [13a]

(F(D) ≡ factor dependent on D; R ≡ dimensionless unity radius)

Since R in hypersphere theory is a dimensionless unity radius, it is replaced here by R_U/R_P in order to rearrange Eq. [11a] according to hypersphere geometry:

$S_D = F(D) * \left(\frac{R_U}{R_P}\right)^{D-1}$ [13b]

According to Eq. [10], the rate of p_n creation should be proportional to the fractal surface area of the horizon. Therefore, the exponent n in Eq. [10] equals D-1 (Eq. [13b]) and D is found to be 3/2. This means that the horizon generating p_n might exhibit the geometry of a hypersphere with D = 3/2. Therefore, I will now attempt to determine the F(D) value for this fractal D, i.e. F(3/2). Since the recursive procedure in [3] does not work for fractal dimensions, I will first try to derive a function that allows for interpolation between D = 1 and D = 2. The recursively determined factors F(D) for the respective dimensions 1…4 are [3]:

$D = 1: F(1) = 2$

$D = 2: F(2) = 2\pi$

$D = 3: F(3) = 4\pi$

$D = 4: F(4) = 2\pi^2$

For spheres with D = 1…4, the graph in Fig. 2 compares the F(D) values which were determined by the recursive procedure [3] with those approximated by the following fit function:

$$F(D) = \pi * (D^2/4 + D/2) \qquad [14]$$

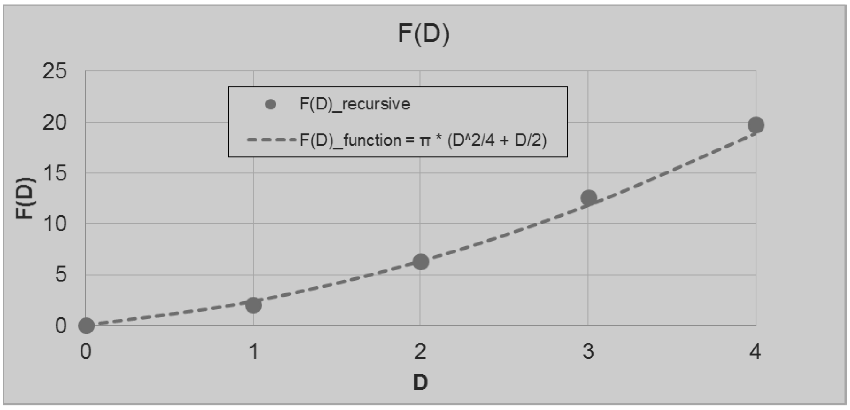

Fig. 2: F(D) vs. D from the recursive procedure [3] and from the fit function Eq. [14]

As one can see, the fit function is suitable to interpolate F(D) between D = 1 and D = 2 and the surface area for every value of D up to D = 4 can be generally expressed as:

$$S_D = \pi * (D^2/4 + D/2) * R^{D-1} \qquad [15]$$

This mathematical operation is done here in order to determine a "true" k value that must be lower than k_0. Therefore, Eq. [11a] is transformed into the following form (with D = n+1):

$$N_{pn} = \frac{k*R_P}{c*D} * \pi * (D^2/4 + D/2) * \left(\frac{R_U}{R_P}\right)^D \qquad [11e]$$

With D = 3/2 we obtain:

$$N_{pn} = \frac{k*R_P}{c} * \pi * (3/8 + 1/2) * \left(\frac{R_U}{R_P}\right)^{3/2} = \frac{7\pi*k*R_P}{8*c} * \left(\frac{R_U}{R_P}\right)^{3/2} \qquad [11f]$$

Hence, $\frac{7\pi*k*R_P}{8*c} = 1$ and we obtain: $k = \frac{8*c}{7\pi*R_P} = \frac{8}{7\pi} * k_0$ (Eq. [3b]) [12b]

One can see from Eq. [12b] that the "true" k is a fraction of k_0 - as one would expect. This means that assuming fractal geometry at the NCU horizon is necessary to obtain a plausible result with respect to k.

But how can one interpret such geometry? The NCU model assumes that the p_n which are moving outward from the horizon create "our" 3D space. "Beyond" the horizon, one can therefore conclude that there is *no space*, i.e. D = 0.

So we have to imagine a (possibly very narrow) transition zone which exhibits a D value between zero and three. Interestingly, the fractal dimension of D = 3/2 that was found above is exactly the average of D = 0 and D = 3. And it must be exactly this transition zone (i.e. the NCU border) where p_n are created nearly as fast as theoretically possible ($k = {}^{8}/_{7\pi} * k_0$).
Therefore, we can conclude that the NCU model gives us a very plausible idea about the geometry and the processes on the edge of our universe.

Formation of Neutral Matter

The amount of neutral matter in the NCU approximately equals the relativistic energy of all p_n (E_n^{all}) divided by $m_p * c^2$:

$$N_P^{all} = \frac{E_n^{all}}{m_P * c^2} \quad [13]$$

In order to calculate the value of N_P^{all} at a given moment (i.e. at a given value of R_U), we therefore have to determine E_n^{all}, i.e. the energy all p_n have collected since their appearance at the horizon. As shown in the above calculations on the primordial nucleus, two accelerations (gravitational and electrostatic one) are to be taken into account. For one p_n, the accelerations can be expressed as follows:

$$a_{grav} = -\frac{N_P^{all} * m_P * G}{R_U^2}$$

With Eq. [1a] and $M_U \approx m_P * N_P^{all}$, we obtain:

$$a_{grav} = -\frac{c^2}{R_U}$$

For the *Coulomb* acceleration:

$$a_{elstat} = \frac{N_{Pn} * \alpha * h * c}{2\pi * m_P * R_U^2}$$ is valid.

The overall acceleration for 1 p_n is then obtained similarly to the expression for the nucleus:

$$a = a_{grav} + a_{elstat} = \frac{N_{Pn} * \alpha * h * c}{2\pi * m_P * R_U^2} - \frac{c^2}{R_U} \quad [14]$$

Hence, the energy gained by all p_n during the expansion through a distance dR_U is:

$$dE_n^{all} = N_{Pn} * m_P * \left(a_{elstat} + a_{grav}\right) * dR_U$$ and with Eq. [14]:

$$dE_n^{all} = \left(\frac{N_{Pn}^2 * \alpha * h * c}{2\pi * R_U^2} - \frac{N_{Pn} * m_P * c^2}{R_U}\right) * dR_U \quad [15]$$

Expressing N_{Pn} by Eq. [11c] $\left[N_{Pn} = \left(\frac{R_U}{R_P}\right)^{n+1}\right]$, we obtain:

$$dE_n^{all} = \left[\frac{\alpha*h*c}{2\pi*R_U^2} * \left(\frac{R_U}{R_P}\right)^{2n+2} - \frac{m_P*c^2}{R_U} * \left(\frac{R_U}{R_P}\right)^{n+1}\right] * dR_U$$

With n = ½ , after rearranging one obtains:

$$dE_n^{all} = \left[\frac{\alpha*h*c}{2\pi*R_P^2} * \left(\frac{R_U}{R_P}\right) - \frac{m_P*c^2}{R_P} * \left(\frac{R_U}{R_P}\right)^{1/2}\right] * dR_U$$

From that, with Eqs. [3a, 13] the following expression for dN_P^{all}/dR_U is valid:

$$\frac{dN_P^{all}}{dR_U} = \frac{2\alpha}{3\pi*R_P} * \left(\frac{R_U}{R_P}\right) - \frac{1}{R_P} * \left(\frac{R_U}{R_P}\right)^{1/2}$$

After integration we find (with N_{PT} as the number of p_n at the turning point explained above):

$$N_P^{all} = \frac{\alpha}{3\pi} * \left(\frac{R_U}{R_P}\right)^2 - \frac{2}{3} * \left(\frac{R_U}{R_P}\right)^{3/2} + N_{PT} \quad [16a]$$

For the very early stages of history, Eq. [16a] yields N_P^{all} values of around N_{PT}. However, with rising R_U, the first term in Eq. [16a] quickly becomes much larger than the second term and N_{PT}. So, as soon as rising R_U/R_P exceeds 10^9 ($R_U>10^{-6}$m, $t>10^{-14}$ s after the "Bang"), we can write:

$$\boldsymbol{N_P^{all} = \frac{\alpha}{3\pi} * \left(\frac{R_U}{R_P}\right)^2} \quad \textbf{[16b]}$$

Eq. [16b] may be regarded here as the final (the "ultimate") equation expressing the amount of matter in the universe created by the NCU mechanisms. I will now discuss Eq. [16b] with respect to its meaning and plausibility.

3. Discussion of Eq. [16b]

As shown above, there is a coincidence discussed by *Dirac* [2] that the number of protons in the universe is not far from the number that could fill its outer area (the horizon). This is expressed in Eq. [4a]: $N_p^{all} = A * R_U^2/R_P^2$ respectively Eq. [4b]: $N_p^{all} = \alpha * R_U^2/R_P^2$. At first glance, that relation seems to be implausible because one would expect the amount of matter in the universe to be proportional to R_U^3 instead of R_U^2.

The first interesting result produced by the NCU model is to explain how the relation $N_P^{all} \propto R_U^2$ is brought about. As we saw above, the relation is determined by the fractal geometry at the NCU horizon and by the specific NCU mechanisms which bring matter into being.

Furthermore, the calculations on the NCU scenario indicate the reason why the factor α appears in Eq. [4b] when combining ideas by *Mach* and *Dirac* (Eqs. [1a, 4a]). It is due to the *Coulomb* force that drives the expansion of the NCU.

As opposed to Eq. [4b], Eq. [16b] includes an additional factor of 1/3π.
This factor seems to point to an additional geometrical topic. Since this factor depends on the assumed *effective* R_P, its "true" value is not fully clear. Note that the factor is close to 3/8π, a factor that appears in solutions of *Friedman's* equations [4]. These solutions are related to the critical density of energy in the universe and to the expansion of the universe according to relativity. This coincidence can be seen in the following equation [4]:

$$\rho_c = H^2 * \frac{3}{8\pi * G}\left(\approx \frac{\mathbf{3}}{\mathbf{8\pi * G}} * \frac{\boldsymbol{c^2}}{\boldsymbol{R_U^2}} \text{ because } H = \frac{\dot{R_U}}{R_U} \text{ and } \dot{R_U} \approx c\right) \qquad [17]$$

(with ρc ≡ critical energy density for a flat universe in kg/m^3; H ≡ *Hubble* constant)

If, for instance, the *effective* R_P in the NCU model is assumed to equal 2/3*h/(mp*c) instead of 3/4*h/(mp*c) according to Eq. [3a], the factor mentioned above changes from 1/3π to 3/8π, which can be found in Eq. [17] as well. The difference between both figures is only about 10%.
In the NCU calculations, the factor of 1/3π or 3/8π appears because of the equation for *Coulomb* acceleration (see Eq. [14]), the fractal geometry at the NCU horizon (n ≈ ½, D ≈ $^3/_2$), and the integration steps carried out.
In contrast to that, I do not now feel able to explain the geometrical reason why 3/8π appears in *Friedman's* solutions.

4. Conclusions

This article (together with [1]) leads to the following conclusions:

Aiming to avoid the more or less implausible idea of a "Dark Energy" that drives the expansion of the universe, the assumption of a slight excess of positive charge (as unneutralized protons p_n) is sufficient to explain the expansion that is observed.

For this "Net Charged Universe" (NCU), a historical scenario is made plausible by a number of calculations describing each step thereof. The following steps are proposed and are checked by calculations and comparison of the results with observations and plausible physical ideas:

I. History starts with one initial quantum fluctuation that leaves one proton (p_n).

II. The initial p_n exhibits a very high gravitational constant G, according to *Mach's* principle, expressed by Eq. [1a]. Therefore, further p_n that are generated by fluctuations are held together against the repellant *Coulomb* force. Thus, a kind of growing primordial nucleus is formed from condensed p_n.

III. The more p_n are condensed in the nucleus, the lower G becomes according to Eq. [1a]. So, a turning point is reached, and beyond that point the nucleus explodes at a speed of almost c. It is this event that plays the role of the "Big Bang" in the NCU scenario.

IV. Caused by the extremely high acceleration experienced by the p_n, they form an expanding hollow sphere and thereby generate our known 3D space. During the expansion, additional p_n are steadily imported from fluctuations at the horizon.

V. Because of the steadily impacting *Coulomb* acceleration, all p_n collect more and more energy, which is converted into relativistic mass growth, and finally that mass is transformed into stable particles, i.e. protons and electrons - the known neutral matter.

Calculations show that we have to assume fractal geometry (D=3/2) at the NCU horizon, i.e. the region where p_n are generated by fluctuations.

The amount of neutral matter that we observe today is predicted very well by the NCU approach. Some theoretical ideas by *Dirac* with respect to the matter in our universe seem to find a geometrical and mechanistic explanation.

It is also remarkable that this very satisfying result was obtained using Eq. [1a], which expresses *Mach's* principle. Thus, it seems to be more plausible now to take that principle into account.
In summary, I think there is no need to search the depths of our universe for "Dark Energy" because there is no need to assume its existence.

5. **Outlook**

According to my current observations, the following outlook can be given:

Based on the state of the NCU model discussed here, we could attempt to calculate the radial distribution and evolution of the speed and density of neutral matter in our universe. An attempt to do such work is in progress.
Furthermore, a deeper discussion on the meaning of some physical constants and general topics could be attempted in light of NCU, for example R_P, the microwave background, the large scale distribution of matter, etc.

References:

[1] http://vixra.org/abs/1602.0158

[2] P.A.M. Dirac, Proc. R. Soc. Lond. A165 (1938) 199-208

[3] https://en.wikipedia.org/wiki/N-sphere
and citations therein

[4] https://en.wikipedia.org/wiki/Accelerating_expansion_of_the_universe
and citations therein