Some Considerations on Physical Constants G and α in Light of the Concept of the Net Charged Universe (NCU) [1,2]

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0. Introduction

As described in [1,2], 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}. Thus, 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 *Coulumb*ian force brought about by X_{pn}.
In [2] I have further described and calculated how neutral matter can be continuously created by the decomposition of relativistic p_n, which gain their high mass by *Coulomb* acceleration. The calculations yielded a result that is consistent to considerations by *Dirac* [3], who discussed a proportionality of the universe's mass to its horizon area:

$$M_U \propto \left(\frac{R_U}{R_p}\right)^2 \qquad (Dirac[3]) \qquad \text{Eq.[1a]}$$ and

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

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

Because it is not very clear how often p_n undergo collisions with other particles (N_p^{all} protons + electrons and atoms formed of them) and how the excess charge is therefore distributed in the whole matter, I must make assumptions on the radial distribution of p_n. In my opinion (see calculations below), it seems most plausible to assume nearly all p_n concentrated are at the universe's horizon. If so, all neutral matter is created at the current horizon of the universe. This scenario will be assumed valid in the present article. Based on the NCU idea, this article aims to discuss the physical constants G (gravitational constant) and α (fine structure constant) with respect to their origin, possible variability, and meaning. The dimensionless value of $\alpha \approx \frac{1}{137}$ in particular has not been explained yet. Using the NCU concept, I am aiming to propose an explanation for that special value and for its origin.
Furthermore, some consequences of the nature of G and α to the movement of matter in NCU are calculated and discussed.

1. Origin and Variability of the Gravitational Constant G

As discussed in [2], the *Mach* principle, expressed in Eq. [2], leads to a variable value of G because the universe expands and its mass M_U increases with R_U^2[2].

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

(G ≡ gravitation constant, c ≡ speed of light)

Thus, all masses of the universe determine the value of G (*Mach*'s principle).

Combining Eqs. [1a or 1b] and [2], we obtain:

$$G \propto \frac{1}{R_U} \propto \rho_U \qquad \text{Eq.[3]}$$

($\rho_U \equiv$ mass density of universe)

The validity of the second proportionality can be seen if one remembers that the density is defined as the quotient of mass and volume. Eqs. [1a, 1b] show that $M_U \propto R_U^2$. The volume of the universe V_U is proportional to R_U^3. Thus, $\rho_U = M_U/V_U \propto \frac{R_U^2}{R_U^3} = \frac{1}{R_U}$.

The validity of Eq. [2] together with the NCU concept leads to an additional consequence, which will turn out to be important for the further discussions.

A consequence of *Mach*'s principle is that all neutral matter that is created at the universe's horizon (according to NCU) will be immediately "known" in the whole universe. In other words, that means that information about the "gravitational presence" of neutral matter propagates with infinite "velocity" (There is indeed no "velocity", see next three sentences).

This idea fits a concept of gravitation by the astrophysicist *Verlinde* [4]. His concept explains the origin of gravitation as a quantum effect connected with the quantum entanglements in the universe. Since these entanglements are of holographic structure, all information in them is immediately present throughout the whole universe.

2. Decreasing G and Anomalies of Stars' Circling in Galaxies

There is a possible consequence of the historically decreasing G. When a young galaxy has been formed as a rotating disk, the decrease of G will lead to an increase of the disk's radius because stars escape from the center when G is diminishing. While the radii of the stars' orbits increase, their track speed will remain nearly constant because of the conservation of energy. Thus, we observe velocities of stars that seemingly do not correspond to their current distance from the galaxy's center and the outer stars we observe today are moving nearly as fast as the inner ones. So I assume that the anomaly of the circling of stars in Galaxies was brought about in history by the decreasing G.

Some recent observations on very faraway young galaxies were interpreted as a state with a low content of "Dark Matter" (DM) because a low anomaly of circling of stars was observed [5]. But the observation seems easier to explain in light of NCU, since G was remarkably higher when the light was emitted compared to what we can see now.

Let me please add a remark:

The explanation of the observed velocities of stars in galaxies I gave in [1], might not be valid because I assumed the excess charge to be homogeneously distributed over the whole matter. Since I recently had to change my preferred NCU scenario because of new arguments, I probably cannot keep the explanation for the rotational anomalies I gave in [1].

Instead, decreasing G can be regarded as a much better explanation.

3. Origin, Variability and Meaning of the Fine Structure Constant α

The value of α we observe today is a mystery, especially for its dimensionless character that seems to indicate its fundamental meaning.

Reflecting on NCU, I recently noticed an interesting connection. Our galaxy, the Milky Way, is around 13.6 billion years old [6].The universe is 13.7 billion years (t_U) old, according to current cosmology. This means that, according to the NCU concept, the matter that forms our

galaxy was created when the universe was about 0.1 billon years ($t_U°$) old. The relation $t_U°/t_U$ is therefore close to $\frac{1}{137} \cong \alpha$.
I think that this is not a historical accident but a fundamental connection. If so, the following equation should be valid for all galaxies at any time:

$$\alpha \cong \frac{t_U^0}{t_U} \qquad \text{Eq.[4a]}$$

Of course, this means that α is not a constant but varies in time and space. Since the equation $R_U \cong c * t_U$ is generally valid (at any time), we obtain:

$$\alpha \cong \frac{r_0}{R_U} \cong \frac{\rho_U}{\rho_U^0} \qquad \text{Eq.[4b]}$$

(r_0 ≡ radius of universe att_U^0;ρ_U^0 ≡ mass density of universe att_U^0)

Thus, α is just like G proportional to ρ_U. This coincidence indicates a similar manner of the formation of G and α by the whole universe or by a large part of it.
How can we understand the historical and spatial change in α expressed in Eqs. [4a, 4b]? Since $\alpha = \frac{e^2}{2*\varepsilon_0*h*c}$, one could consider α as an expression of a kind of "electromagnetic presence" of matter in the universe. This seems to be analogous to the "gravitational presence" of matter mentioned above. So Eq.[4b] appears as the electromagnetic analog of Eq.[2] *(Mach*'s principle).
But there is an important difference. In contrast to gravity, the electromagnetic information of matter created at the horizon is not immediately "known" throughout the whole universe. Instead, the electromagnetic information is obviously identical to the photons emitted by the visible matter we observe. Therefore, the electromagnetic information spreads with the speed of light into the inner universe. Consequently, the bigger R_U becomes, the lower the fraction of all matter whose "electromagnetic presence" can be experienced in a certain region within the inner universe – e.g. the Milky Way– becomes.
So I would propose to recognize α as a measure for the historically decreasing fraction of all matter which is known here via electromagnetic signals, that is to say via photons.
At the horizon where matter is created, all electromagnetic information of the entire matter in the current universe (i.e. inside the horizon) is present there, and $\alpha = 1$ just like Eq.[4b] yields for R_U=r_0. This means that each quantity of neutral matter created at the horizon will start its existence with $\alpha = \frac{r_0}{r_0} = 1$. Thus, Eq.[1b] changes to:
$N_p^{all} \cong \frac{1}{3\pi}\left(\frac{R_U}{R_p}\right)^2$ - very close to the relation discussed by *Dirac* [3]. Eq.[1c]

The horizon steadily expands at nearly c, while all neutral matter should follow more slowly the further its radial distance is to the horizon. Thus, new matter that is created later on at the escaping horizon, will not be seen immediately in inner regions of the universe– e.g. in our "shell". I think this effect is expressed by Eq. [4b] as the relation between visible and "gravitationally present" amounts of neutral matter observable from any inner "shell" created at t^0 (at a horizon with r_0).
In such situation, we have a large part of the universe's matter that is not (yet) visible to us, but we feel the gravitational impact of it. Matter showing such properties might be identical to the mysterious "Dark Matter" (DM) that physicists are searching for. So, the answer to why we

cannot observe DM seems very simple in the light of NCU:
The light from DM is not yet here but its gravity is!
And it is essentially the growing amount of this seemingly "dark" matter that leads to the decreasing value of G and causes the anomalies of stars' orbits in outer regions of galaxies.

4. **Further Calculations and Related Thoughts**

In order to investigate which further consequences arise from the variable character of G and α, I am aiming to calculate the acceleration matter will experience after its creation – regardless of the geometrical effect the expanding space itself creates.

Firstly, I shall examine the case that all p_n are concentrated at the horizon (my preferred scenario). If so, the inner universe is indeed neutral and gravity is the only force the matter there experiences. Each "shell" of neutral matter "feels" the gravitational force of the amount of matter that was inside the horizon at t_0 (R_U=r_0). All masses outside that region cannot affect the "shell" because of *Newton*'s shell theorem [7]. Therefore, every "shell" is attracted towards the center of the universe. That force is expressed here as a negative acceleration, and the acceleration *one* proton in the "shell" experiences is:

$$a_{grav} = -\frac{F_{grav}}{m_P} = -\frac{m_P * M_U(r_0) * G}{m_P * r^2} \qquad \text{Eq.[5a]}$$

(F_{grav}≡ gravitational force, r ≡ current radius of the "shell", m_P ≡ mass of proton)

Together with Eq. [2] that equation gets the following form:

$a_{grav} \cong -\frac{c^2 * R_U * M_U(r_0)}{M_U(R_U) * r^2}$ and based on Eq. [1c] $\left[\frac{M_U(r_0)}{M_U(R_U)} = \frac{{r_0}^2}{{R_U}^2}\right]$ we obtain:

$$a_{grav} \cong -\frac{c^2 * {r_0}^2}{R_U * r^2} \qquad \text{Eq.[5b]}$$

As one can see from this equation, no physical constants except c affect the acceleration of neutral matter. The movement of the matter of each "shell" is solely controlled by geometric values (radii) that change over time.
Note that according to NCU, the mass of the universe (or N_p^{all}) is also exclusively controlled by one geometrical variable (Eq. [1c]).

But how about a scenario in which p_n were distributed over the whole inner universe ("perfect mix")? Such a situation seems possible if p_n collide often enough with other particles so that the excess charge is homogeneously distributed over the whole amount of matter in the universe. A scenario of this kind was taken into account in [1]. In that case, we have to additionally calculate the average electrostatic (*Coulumb*ian) acceleration one proton experiences. This acceleration is positive, i.e. directed towards the horizon. Based on calculations in [2], the following equation applies for the *Coulumb*ian acceleration of *one* p_n created at r_0:

$$a_{elstat} = \frac{N_{Pn}(r_0) * \alpha(r_0, R_U) * h * c}{2\pi * m_P * r^2} \qquad \text{Eq. [6a]}$$

In the case of a "well mixed" excess charge, each proton of the whole matter carries an average excess charge of X_{pn}*e, and Eq. [6a] changes to:

$$a_{elstat} = \frac{N_{Pn}(r_0)*X_{Pn}(r_0)*\alpha(r_0,R_U)*h*c}{2\pi*m_P*r^2} \qquad \text{Eq. [6b]}$$

With $X_{Pn}(r_0) \equiv N_{Pn}(r_0)/N_P^{all}(r_0)$ we obtain:

$$a_{elstat} = \frac{N_{Pn}^2(r_0)*\alpha(r_0,R_U)*h*c}{2\pi*m_P*N_P^{all}(r_0)*r^2} \qquad \text{Eq. [6c]}$$

Since $N_{Pn}(r_0) \cong \left(\frac{r_0}{R_P}\right)^{3/2}$ [2], Eq. [6c] changes to:

$$a_{elstat} \cong \left(\frac{r_0}{R_P}\right)^3 * \frac{\alpha(r_0,R_U)*h*c}{2\pi*m_P*N_P^{all}(r_0)*r^2} \qquad \text{Eq. [6d]}$$

Thus, together with Eq. [1c] $\left[N_p^{all}(r_0) \cong \frac{1}{3\pi}\left(\frac{r_0}{R_P}\right)^2\right]$ and Eq. [4b] $\left[\alpha(r_0,R_U) \cong \frac{r_0}{R_U}\right]$ we obtain :

$$a_{elstat} \cong \frac{r_0}{R_U} * \frac{3*r_0*h*c}{2*m_P*R_P*r^2} \qquad \text{Eq. [6e]}$$

Finally, we remember the relation from [2] which expresses R_P as a fraction of the *Compton* wave length of a proton $\left[R_P \cong \frac{3}{4} * \frac{h}{m_P*c}\right]$ and come eventually to the following equation:

$$a_{elstat} \cong \frac{2*c^2*{r_0}^2}{R_U*r^2} \qquad \text{Eq. [6f]}$$

Comparing this equation with Eq. [5b], one can see a complete equivalency of the mathematical structures for both the gravitational and the *Coulumb*ian acceleration. This finding again points to a fundamentally common nature of both physical phenomena, gravitation and electromagnetic properties of matter.
Note that this relation can be revealed and explained exclusively by the NCU concept.

Eventually, the total acceleration that "well mixed" matter would experience is:

$$a = a_{elstat} + a_{elstat} \cong \frac{2*c^2*{r_0}^2}{R_U*r^2} - \frac{c^2*{r_0}^2}{R_U*r^2} = \frac{c^2*{r_0}^2}{R_U*r^2} \qquad \text{Eq. [7]}$$

Since I cannot clearly say which degree of homogeneous mixing of the excess charge is really given in the universe, I would like to introduce a "mixing factor" F_m ($0 < F_m < 1$) to express the unknown and possibly variable degree of mixing of the excess charge. Thus, Eq. [7] changes to:

$$a \cong F_m * \frac{2*c^2*{r_0}^2}{R_U*r^2} - \frac{c^2*{r_0}^2}{R_U*r^2} = \frac{c^2*{r_0}^2}{R_U*r^2} * (2F_m - 1)$$ Eq. [8]

To get an impression on the distribution of excess charge over the universe, we can try to calculate an estimate which distance L a straight flying proton had to move on average to experience *one* collision in our universe. To consider a situation with maximal collision probability, we imagine the whole matter to be homogeneously distributed ("proton by proton"). By the way, in case of atoms (mostly H atoms) there is nearly no different collision probability compared to protons (as shown e.g. by *Rutherford*'s scattering experiments).
The collision between two protons exhibits a cross sectional area of $4\pi * R_P^2$ which means that we have to regard the volume $V_{1P}=4\pi*R_P^2*L$ that contains exactly one proton:

$$V_{1P} * \rho_P = 4\pi * R_P^2 * L * \rho_P = 1$$ Eq. [9a]

($\rho_P \equiv$ proton density of the universe)

$$\rho_P = \frac{N_P^{all}}{V_U}$$ Eq. [9b]

($V_U = \frac{4}{3}\pi * R_U^3 \equiv$ volume of the universe)

From Eqs. [9a, 9b], together with Eq. [1c] $\left[N_p^{all} \cong \frac{1}{3\pi}\left(\frac{R_U}{R_P}\right)^2\right]$ we obtain:

$$L \cong \pi * R_U$$ Eq.[10]

As one can see from Eq. [10], a proton has to fly about half a circumference of the universe's horizon to experience *one* collision independent of the current historical state. This is an astonishing result to me and I do not yet feel able to interpret it more deeply. But despite it being only a rough estimate, this calculation seems to support my opinion that $F_m << 1$, and almost the entire excess charge remains forever concentrated at the universe's horizon.

Conclusions

The present article aims to investigate several impacts of the NCU concept on our physical worldview in cosmological terms.
One of the related goals is to understand something about the origin and meaning of the "fundamental constants" G and α in physics.
Furthermore, some gravitational and electromagnetic aspects of matter are described in a mathematical manner. The resulting equations are compared for conclusions on possible commonalities between the underlying physical phenomena.
Several additional thoughts and testing calculations are presented to assist in finding probable ideas on the radial distribution and movement of neutral matter and excess charge in the universe.
Further work in terms of thoughts and calculations on that topic is in progress.

The following essential results of the article can now be given as a number of fairly well-justified theses – if one only accepts the NCU concept as the possibly correct description of the cosmological reality:

I. The creation of matter from relativistic excess protons (p_n) happens at the horizon of the universe because all p_n are imported from there and remain mostly concentrated there. This conclusion seems true since p_n undergo only about *one* collision during an

assumed straight flight through the whole universe. Thus, approximately no mixing of the excess charge with the entire matter should be assumed.

II. $G \propto \frac{1}{R_U} \propto \rho_U$; the gravitational "constant" G is proportional to the mass density of the universe. This proportionality can be derived from *Mach*'s principle and the NCU concept [2]. G is determined by all masses of the universe due to a quantum mechanism based on quantum entanglements in the universe [4]. Thus, newly created amounts of matter will immediately affect the whole universe with respect to gravity. This is called "gravitational presence" here.

III. The historical decrease of G leads to increasing radii of galaxies (stars escape from the galactic center) while stars' velocities stay as high as they were at their radial positions in young galaxies. Thus, the anomalies in stars' velocities we observe can be explained without the assumption of "Dark Matter" surrounding the galaxies.

IV. Based on the NCU concept we come to the well-justified assumption that $\alpha \cong \frac{t_U^0}{t_U}$, and with $R_U \cong t_U * c$ we obtain $\alpha \cong \frac{r_0}{R_U} \cong \frac{\rho_U}{\rho_U^0}$.

Thus, α is a variable as well and exhibits the same proportionality ($\propto \rho_U$) as G. This relation seems to indicate deep commonalities between G and α.
However, newly created matter does not immediately affect the whole universe in an electromagnetic way. Instead, a kind of "electromagnetic presence" of new matter obviously spreads at the speed of light into the inner universe.
The propagating front of this electromagnetic presence possibly shows up as the microwave background we observe. If this were the case, the extremely homogeneous character of that background could be explained very easily, and it would no longer be necessary to assume something like "Inflation".

V. Although they were derived in fully independent ways, the acceleration equations of both the gravitational and the *Coulumb*ian force yield mathematically identical expressions (see Eqs. [5b, 6f]). This conformity again seems to indicate a deep interdependency between gravitational and electromagnetic properties of the universe's matter.
And again, this interdependency can only be revealed and justified according to the NCU concept.

VI. Finally, the fundamental equations discussed here do not contain any physical constants except the speed of light. So one could obviously say:
There is nothing constant about the universe except the geometrical equations.

Some Open Questions

I. What are the true natures of masses and the electrical charges of particles? Why do they exhibit the well-known values for protons and electrons?

II. Why can they all be removed from the equations (see e.g. Eqs. [5b, 6f]) during calculations based on NCU?

III. Are masses and charges therefore derivative (not fundamental) and possibly as variable as G and α?

IV. Could we explain the missing anti-matter in the NCU by the assumption that matter and anti-matter reject each other (anti-gravity) and stay therefore separated in two complementary "universes"? Currently, measurements with anti-particles in terms of anti-gravity are in progress at CERN [8].

V. Does the obvious commonality and interdependence of G and α point towards a path to unification of quantum theory (α) and gravitation (G)?

Let us stay astonished and open to different ideas!

References:

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