Micro Black Hole Entropy and Fine Structure Constant: A Numerological Approach.

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Abstract

The issue we'll lead with below consists of a brief *numerological* exploration of certain arithmetic relationships between various physical constants. This short numerological journey has led us to find a curious relationship between the Bekenstein-Hawking formula of black holes entropy and a dimensionless physical constant that draws the strength of the electromagnetic force , namely fine structure constant or, in the case at hand , the inverse of fine structure constant. In addition, a discrete vision has been explicitly chosen , namely the hypothesis that assumes a non-continuum space.

Keywords *Arithmetic*, *Numerology,Black hole entropy, fine structure constant*, *discreteness*.

Introduction

Someone had said that *Numerology* is one subject that only offers questions but no answers.
Numerology [1]can be defined as the juggling of dimensionless constants with a view to producing significant relations.
Number games can occasionally lead to insights and even spark a theory proper. Also it's known that P.A. Dirac, inspired by Eddington, Milne and others [2] suggested a reconsideration of Cosmology based on the large dimensionless numbers that could be constructed from the fundamental constants of nature. Namely, all very large numbers occurring in nature are , in some way that we still don't know how to explain ,interconnected.

Assuming as true, in a first approximation, that numerology by itself doesn't offer any kind of physical answer , at best simple numerical curiosities , we have been developing various numerological connections between some fundamental physical constants for some time.
We call this project the *Arithmetic of physical constants*. This is so because one of the basic and elementary sets of arithmetic rules play a fundamental role in our inquiries and explorations.
We refer to the *division* operation, or ratio, whereby when dividing two physical quantities that have the same unit, be it grams, seconds or meters, we get a dimensionless number.

It really only makes *sense*, so to speak, when each result from the arithmetic of physical constants consists of *dimensionless quantities*.
On the other hand, let us say that from a purely philosophical point of view, we feel a certain affinity with the hypothesis that maintains that just as the matter and energy that constitute the observable universe is made of *particles* or discrete *quanta* of energy, it could be that space also had in its deepest structure or fabric a *discrete texture*, which could be summarized in the sentence that says that the universe is finite and that, according to a *principle of economy* that governs nature, there is *no room* for a continuous and infinite space.

Method and results

In the course of our arithmetic exploration , some time ago, we found a dimensionless quantity that caught our attention. Inspired by a *granular* (not continuous) vision of physical reality, we wonder what kind of physical constants of length dimension do we use to achieve the desired dimensionless number of large orders of magnitude ?
We focussed our attention on two physical constants of length: Bohr radius and Planck length.
Bohr radius [3], in the hydrogen atom, is the longitudinal measure of the radius of the hydrogen atom's orbital at its fundamental energy level.

Planck length [4] is a limit of length magnitude , below which Physics as such is meaningless.
Therefore the first thing we did was divide both constants.
The result is orders of magnitude of 10^{24} , which was intriguing, as we remembered that Avogadro constant [5] , N_A, was on an order of magnitude of 10^{23}. The next thing we did already entered directly into the field of what is known as *intuition*. It came in the form of an abstract concept that represents *exponential* growth or decline, depending on the case.
It basically consisted of dividing the previous result by Euler's constant [6] $e = 2.71828...$, which is the base of *natural logarithms*.
In summary, when calculating it we saw that

$$(N...) = \frac{a_0}{e\,L_P} = 1.2045\, x\, 10^{24} \qquad (1)$$

$a_0 = 5.29177\, x\, 10^{-11} m$, $l_P = 1.6162\, x\, 10^{-35} m$ where

a_0 and l_P represents Bohr radius and Planck length respectively.
That formula shows that , once divided by 2 , the figure obtained was *equal to* Avogadro constant

$$\frac{1}{2}(N...) = 6.0225\, x\, 10^{23} \qquad (2)$$

Actually, it could be said that the parameter symbolized by (N...) has been found *serendipitously* [7]. It is still striking that half its value coincides with the value of the Avogadro constant. Even more so, when the physical constants used in the definition of (N...) have nothing to do with those used in the definition of the Avogadro constant.

How to weigh the probability that the simple arithmetic operation of the division between two physical constants , Bohr radius and Planck length , and a mathematical constant as Euler constant , turns out to be a result that is equal to twice the Avogadro constant?

Avogadro constant tells us how many particles, atoms, or molecules there are in a *mole* of a certain substance.The mole is also included in the international system of units.
The Italian physicist Amadeo Avogadro proposed for the first time, at the beginning of the 19th century, that a volume of any gas contained, in principle and at a specific temperature and pressure, the same number of particles, regardless of the nature of the gas.
Almost a century later, the French physicist Jean Perrin [8] managed to experimentally calculate the precise value of Avogadro constant N_A. The value he obtained was

$$6.023 \ x \ 10^{23} \ mol^{-1}$$

If Avogadro's constant tells us how many particles there are in a mole of any substance, what the parameter (N...) could tell about? If (N...) was already a curious result, we could explore one more step forward using the Arithmetic of physical constants and see if it gives us any other unexpected results.
The paragraph below will give an account of one of those curious and unexpected results.

Black hole entropy

Let's begin writing the concise formula of entropy of a black hole as proposed by Bekenstein and Hawking [9]

$$S_{BH} = S_{con} + \frac{A}{4\, l_P^2} \qquad (3)$$

meaning S_{con} the entropy *outside* of the event horizon as an *observer* outside the black hole's event horizon might observe it. A is the event horizon surface area of a black hole and l_P refers to Planck's length $= 1.6162\ x\ 10^{-35} m$

We will start by describing some constraints :

1. Let us consider that the area symbolized by A is the area of a geometrical-topological body called *torus* [10] whose formula is given by

$$A = 4\pi^2 R\, r \tag{4}$$

Focusing , for now , on the second term of the equation (3), obviating S_{con} and assuming , in a first approximation, a value of r equal to $r = \frac{1}{2}R$

(By the way , it is not *fragrant* to assume this type of topology, as has been recently studied through the Event Horizon Telescope [11] by showing astonishing pictures)

2. We will use the *discreteness* criterion to that area, which means to discretize the space using the parameter $(N...)$, so the entropy S_D is equal to

$$S_D = \frac{(N...)^2 A}{4\, l_P^2} = 2.741\, x\, 10^{118} \tag{5}$$

symbol S_D for the entropy of a black hole , assuming a *discretized area* of the event horizon , with respect to four times the length of planck squared.

It is immediate to observe how the value obtained is two times the inverse of the fine structure constant [12] multiplied by 10^{116}, since

$\alpha = 0.00729735...$ and $\frac{1}{\alpha} = 137.036...$

so we can make some arithmetic and assume that $r = \frac{1}{4} R$

$A = 4\pi^2 R \frac{1}{4} R$ therefore

$$S_D = \frac{(N\ldots)^2 A}{4\, l_P^2} = 1.3705\, x\, 10^{118} \quad (6)$$

The best way to solve the huge disparity in orders of magnitude is to use another physical equation that *translates* the mass of a particle into a quantity of dimension length, the units of mass being the kilogram and that of length the meter, both belonging to the international system of units (SI).
A *mass-to-length converter* is the Schwarzschild formula [13]

$$R_S = \frac{2G\, M}{c^2} \quad (7)$$

$G = 6.674\, x\, 10^{-11}\, m^3 kg^{-1} s^{-2}$ Newtonian constant of gravitation.
and $c = 299792458\, ms^{-1}$, speed of light in vacuum.
According to formula (6) if we want S_D to be equal to $\frac{1}{\alpha}$ it is mandatory that $R_S = 1\, x\, 10^{-58} m$ which implies that the mass of the particle is equal to $M = 6.735\, x\, 10^{-32} kg$

It means a mass whose order of magnitude is ten times lighter that of the electron and 24 orders of magnitude lighter that of Planck mass.It can be easily checked by

$$R_S = \frac{2G\,(6.735\,x\,10^{-32})}{c^2} = 1\,x\,10^{-58} m \tag{8}$$

Numerically recapitulating all the antecedent, *micro black hole* entropy associated to a *discretized area* reads

$$S_D = \frac{1}{4l_P^2} 4\pi^2\,(N\ldots)R_S\,x\,(N\ldots)\frac{R_S}{4} = \frac{1}{\alpha} \tag{9}$$

Yet , if we write the formula

$$S_D = \frac{1}{4l_P^2} 4\pi^2\,(N\ldots)R_S\,x\,(N\ldots)\frac{\alpha R_S}{4} \tag{10}$$

Therefore , the entropy associated to the *discretized* event horizon area of a black hole is

$$S_D = 1 \tag{11}$$

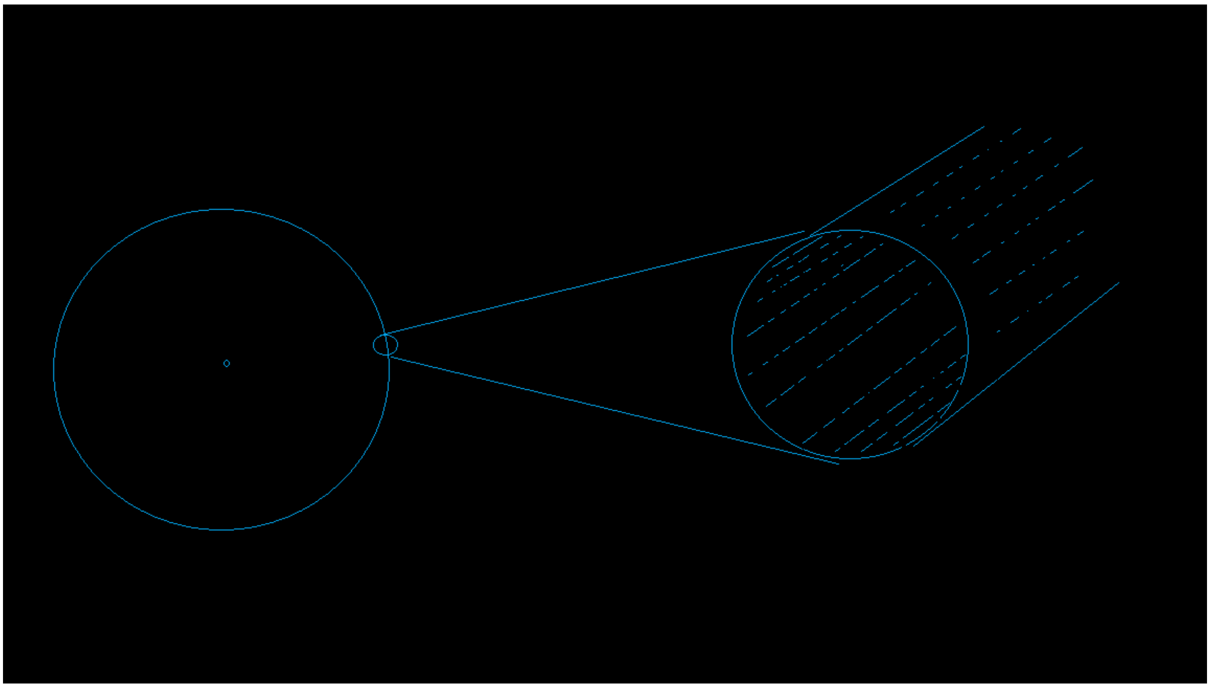

Figure 1

Discussion

Several *secondary* quantities have appeared from the arithmetic pathway we have followed here . We take the liberty of renaming for purely descriptive purposes.

edecino : hypothetical particle whose mass is equal to

$6.735\ x\ 10^{-32} kg.$

we can also express *edecino's* mass in electron volts :

$6.735x\ 10^{-32} kg\ =\ 37780\ eV$

which is about five orders of magnitude greater that of neutrinos.

edecim : hypothetical unit of length equal to $1\ x\ 10^{-58} m$

edecixel : hypothetical unit of area equal to $(1\ x\ 10^{-58} m)^2$

According to the above definitions , involving the fundamental parameter $(N...)$, the concept of black hole entropy and the geometrical particular view of the event horizon surface area , it would be interesting to draw a toroidal geometric body whose surface is made of $(N...)^2$ *edecixels* . (sketch of figure 1 attempts to schematically outline the underlying topology of the event's horizon area)

Rewriting equation (3)

$$S_{BH} = S_{con} + \frac{A}{4\, l_P^2} = S_{con} + S_D \qquad (12)$$

A classical approach for S_{con} would be Ludwig Boltzmann formulation of entropy

$$S_{con} = - K_B Ln\, \Omega \qquad (13)$$

K_B , Boltzmann constant = $1.38065\ x\ 10^{-23} JT^{-1}$

since $\Omega = 1$ because we are considering an unic *state* i.e. one *edecino* , then

$S_{con} = 0$ which means

$$S_{BH} = S_{con} + S_D = 1 \qquad (14)$$

Conclusion

In this article we have tried to apply the use of Arithmetic in the relations between a bunch of physical constants. From a superficial point of view our work would enter into what is known as Numerology , a subject outside the realm of mainstream Physics. Even so, some numerological developments can offer curious results along the assumption that postulates a *granular* , not continuous space .

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