OBSERVABLE UNIVERSE EVENT HORIZON .

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Abstract

The standard cosmological model defines the *Observable Universe* as the region of the Universe observed from the earth at the present time ; all the signals that have arrived to the earth since the beginning of the cosmological expansion .We introduce a *quantifier* parameter .The use of such parameter allow us to understand the amount of items involved in any system . First we analyze the posible topology of the event horizon of the observable universe and how such surface area depends on the time .Finally will describe a numerical depiction about the evolution of the observable universe wich involves the Hubble parameter , the number of stars , the hydrogen molecule , the degrees of freedom of the hydrogen mulecule related to the amount of information of ordinary matter as well as the surface area of the observable universe event horizon .

Keywords . *Observable universe , Life time of the Universe , Universe topology, Universe evolution , Cosmic event horizon ,surface area of universe ,Hubble parameter,hydrogen molecule,degrees of freedom, number of stars .*

Introduction .

In Cosmology the event horizon of the observable universe [1] is the largest comoving distance from wich light emitted at the present cosmological time can ever reach an observer in the future . Light of any event beyond that distance has not had time to reach our place in the universe .

Holographic principle [2] states that the universe can be seen as two-dimensional information on the cosmological horizon . The inspiration of the holographic principle comes from the study of the black hole entropy [3] . In a larger sense , the maximal entropy in any region scales with the radius squared .Surface fluctuations of the event horizon contains all the physical information of a three-dimensional universe.

The aim of this article is to study numerically a relationship among the surface area of the event horizon of the universe , the amount of energy of the observable universe and also we consider the life time as an associated variable. On the other hand we hypothesize about the posible topology of the event horizon . With respect to this subject we assume a toroidal topology [4].

Finally we write an equation that shows the evolution of the surface area of the event horizon in a dynamic universe : an expanding universe in wich Hubble parameter is explicitly incorporated to the equation .

Method and results .

Let's start defining a dimensionless number that Works as a quantifier parameter , i.e. a parameter that informs how many items are involved in any system

$$(N_{...}) = \frac{1}{ne^m}\frac{a_0}{L_P} \qquad (1)$$

a_0 refers to Bohr radius $= 5.291772\ x\ 10^{-11}\ m$

L_P refers to Planck's length $= 1.6162\ x\ 10^{-35}\ m$

$e = 2.7182818\ \dots$, is the Euler number

n and m are rational numbers

We use this value $(N_{...})$ as a *quantifier* of the amount of items involved in any system . In the case at hand , the system is the observable universe . Parameter $(N_{...})$ could take a broad range of values . Here we'll apply

$n = 2$ and $m = 1$ therefore

$$(N_{...}) = \frac{1}{2e}\frac{a_0}{L_P} = 6.0225\ x\ 10^{23} \qquad (2)$$

Write the equation

$$t_0\ \sigma E\ \frac{1}{\hbar} = \frac{1}{4L_P^2}\ U_A \qquad (3)$$

Detailed explanation of symbols

$t_0 \sim 4.4\ x\ 10^{17} s$ refers to the universe life time [5]

$\sigma E = (N_{...}) M\ C^2$

$(N_{...})$ is the quantifier parameter already defined

$(N_{...}) = 6.0225\ x\ 10^{23}$

$M = N_S\ m_p$

$N_S = 10^{57}$ approximate number of hydrogen atoms required to ignite a star [6]

$m_p = 1.673 \; x \; 10^{-27} kg$ refers to the mass of the proton

$C = 299792458 \; m \, s^{-1}$ is the speed of light in vacuum

The quantum of action or reduced Planck constant

$\hbar = 1.054572 \; x \; 10^{-34} \, Js$

$L_P^2 = 2.612 \; x \; 10^{-70} \; m^2$ where L_P refers to the Planck's length

U_A refers to the surface area of the observable Universe . According to the standard cosmological model , the radius of the observable universe is about $10^{26} m$ [7] therefore

$U_A \sim 10^{52} \; m^2$

we hypothesize that the *external surface* (figure 2)of the observable universe (universe's event horizon surface area) shows a toroidal shape , wich means

$$U_A = 4\pi^2 \, rR \quad (4)$$

Where r and R refers to the two radius that defines a torus (figure 1)

Set the specific values for the two radius

$R = 1 \; x \; 10^{26} m$ and $r < 1 \; x \; 10^{26} m$

Therefore

$$U_A \sim 4 \, \pi^2 \;\; x 10^{52} \; m^2 \quad (5)$$

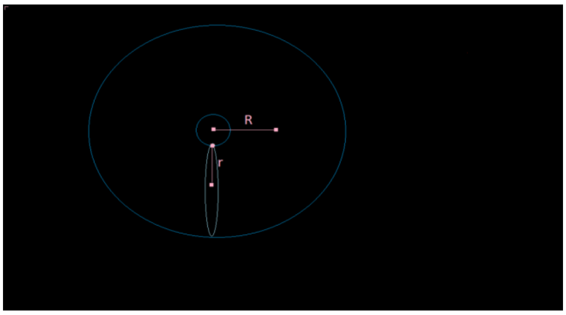

Figure 1 . Torus radius R and r .

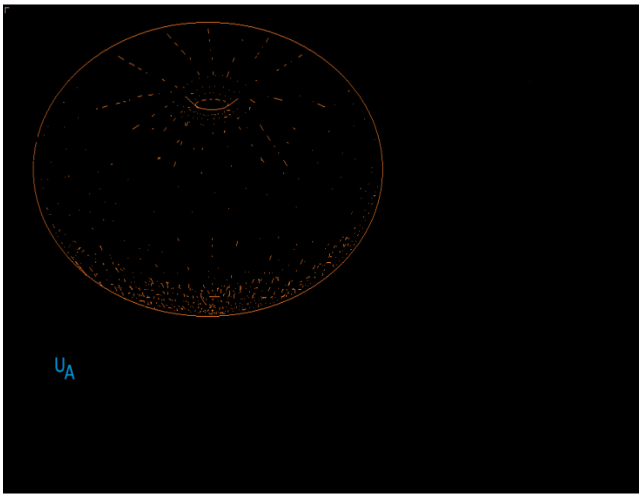

Figure 2 . Universe event horizon surface area .

Observable universe evolution

Getting back to the definition of the parameter $(N_{...})$

$$(N_{...}) = \frac{1}{2e}\frac{a_0}{L_P} = 6.0225\ x\ 10^{23}$$

According to that , we'll explore a numerical relationship between the Newtonian constant of gravitation , speed of light in vacuum , the ratio megaparsec-Hubble parameter , parameter $(N_{...})$ defined above , the mass of hydrogen molecule , degrees of freedom of such diatomic molecule , the number of hydrogen atoms required to ignite a star and finally the surface area of the observable universe

$$\frac{G_N}{C}\frac{M_{pc}}{3H_0}\ [(N_{...})N_S\ H_2\ f\ ] = U_A \qquad (6)$$

G_N refers to the newtonian constant of gravitation = $6.674\ x\ 10^{-11}\frac{m^3}{kgs^2}$

C refers to the speed of light in vacuum

$M_{pc} = 3.0857\ x\ 10^{22} m$ astronomical unit of distance measurement called megaparsec

$H_0 \sim 70630\ ms^{-1}$ current value of Hubble parameter that fits best in the equation (6)

$N_S \sim 10^{57}$ approximate number of hydrogen atoms required to ignite a star

$H_2 = 3.37\ x\ 10^{-27} kg$ the mass of the hydrogen molecule : sum of the mass of the proton and the mass of the electron multiplied by two

$9.11\ x\ 10^{-31} kg$ is the mass of the electron

$f\ = 6$ refers to the effective degrees of freedom (dof) of a molecule of hydrogen [8] wich means 3 translational dof + 2 rotational dof + 1 vibrational dof .

The set [$(N_{...}) N_S\ H_2\ f$] involved in the equation (6) represents the amount of information of most of ordinary matter in the observable universe , represented by hydrogen molecule .

In cosmology , the event horizon of the observable universe is the largest comoving distance from wich light emitted can ever reach the observer in the future . An example of a cosmological model with an event horizon is an universe dominated by the cosmological constant .We have hypothesized that the surface area of the event horizon of the observable universe has the topological shape of a torus . Thus the value U_A has been included in the result of the equation (6) . Analyzing such equation it's worth to note the inverse dependence of some parameters associated with the dynamics of the observable universe . According to the standard model of cosmology , the Hubble parameter is actually thought to be decreasing with time . Euler number , wich is explicitly involved in the definition of the parameter $(N_{...})$ drives an exponential behaviour observed in the dynamics of the universe evolution and the increase of the entropy over time. Therefore the value of the surface area of the observable universe U_A varies over time also . According to that we could schematize an evolutionary setting represented in the figure 3

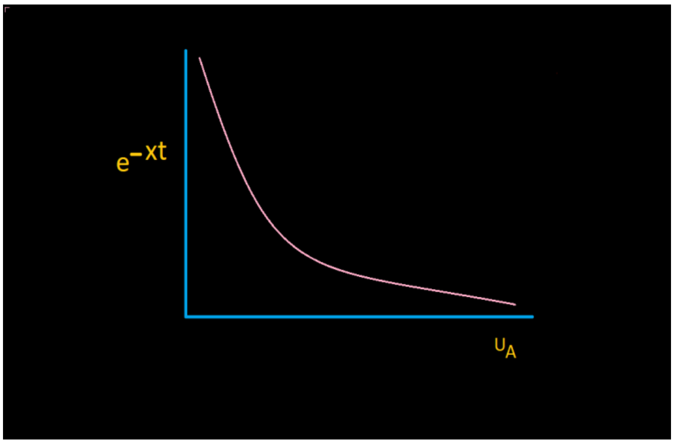

Figure 3 . Universe's surface area evolution over time .

Whatever the physical meaning of variable x in the exponential formula e^{-xt}

For the existing observable universe at $t_0 \sim 10^{17} s$ and universe's event horizon surface area next to $U_A \sim 10^{52}\ m^2$ the likely value of $(-xt)$ is obviously next to one.

Discussion .

We have found very useful the application of the quantifier parameter $(N_{...})$ .For example in the equation (3) such parameter allow us to know how much energy the observable universe has . Taking into account the life time of the universe we have compared it with the quantum of action or reduced Planck constant $\hbar$

It's worth to note that the right side of the equation (3) shows a dimensionless value . Such value consists of dividing two surface areas : in the numerator is the surface area of the observable universe that looks like the surface of a geometric body termed torus . In the denominator is writed $4L_P^2$ wich refers to four times the Planck's area . Exists a numerical parallelism between this issue and the black hole entropy based on the knowledge of Bekenstein-Hawking formula [9]. But here we are speaking about the observable universe .

Conclusion .

We have performed a particular *quantifier* parameter .The use of such parameter allow us to understand the amount of items involved in any system . First we have studied the topology of the event horizon of the observable universe in wich time is explicitly included . Finally we have described a numerical depiction about the evolution of the observable universe wich involves the Hubble parameter , the number of stars , the hydrogen molecule , the degrees of freedom of the hydrogen mulecule related to the amount of information of ordinary matter as well as the surface area of the observable universe event horizon .

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