COSMOS
Universal constants G and h

A Memorandum

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Introduction

This brief memo is not an essay. Its purpose is instead to introduce a number of new equations based on the universal constants of h and G. h is the Planck's constant and G is the Gravitational constant.

Both h and G are used to form two forms of equations. The equations are derived from the physical dimensions of the constants themselves.

The equations that are based on the Planck's constant h tell us something about the atomic and subatomic world, while the equations that are based on the Gravitational constant G tell us something about the universe as a whole.

So, the purpose is to give new meaning and functionality to these constants. In this respect this memo is also experimental in nature. The purpose is to explore mathematically with just "high school level" math and algebra, what these constants can tell us about the physical world.

And based on the examples given in this memo, they can do much.

1 PLANCK'S CONSTANT

In this section we will introduce Planck's constant and the related Planck equations.

¤ Planck's constant

- $h = 6.626\,070\,15 * 10^{-34}\, kg\, m^2\, s^{-1}$

¤ The Planck equation has been derived from the dimensions of the Planck's constant.

- $\frac{kg * m^2}{s} \Rightarrow \frac{m * \lambda^2}{t}$

¤ Planck's constant can be calculated from subatomic variables.

- $h = \frac{m * \lambda^2}{t}$

¤ The Planck Equation (PE1) in its first form.

- $m * \lambda^2 = h * t$

- m = Mass (in kg)
- t = Travel Time of 1 wavelength (in seconds)
- λ = Wavelength (de Broglie for atoms)

¤ Second form of the Planck equation (PE2)

- $m * \lambda^2 = \frac{h}{f}$

- Here we substitute frequency (f) in units of s^-1 for time (t) in the equation.

¤ Planck equations: the first form (PE1) with t

- $m*\lambda^2=h*t$ The first form of the equation.

- $h=\frac{m*\lambda^2}{t}$ Solving h from the equation.

- $t=\frac{m*\lambda^2}{h}$ Solving t from the equation.

- $m=\frac{h*t}{\lambda^2}$ Solving m from the equation.

- $\lambda^2=\frac{h*t}{m}$ Solving λ^2 from the equation.

¤ Planck equations: the second form (PE2) with f

- $m*\lambda^2=\frac{h}{f}$ The second form of the equation.

- $h=m*\lambda^2*f$ Solving h from the equation.

- $f=\frac{h}{m*\lambda^2}$ Solving f from the equation.

- $m=\frac{h}{\lambda^2*f}$ Solving m from the equation.

- $\lambda^2=\frac{h}{m*f}$ Solving λ^2 from the equation.

¤ Other equations and units using Planck's constant

¤ Planck's units (Calculated with h And D)

- Planck length

$$l_p=\sqrt{\frac{h}{(D*c^3)}}=4.051\,350\,544*10^{-35}\,m$$

- Planck time

$$t_p=\sqrt{\frac{h}{(D*c^5)}}=1.351\,385\,078*10^{-43}\,s$$

- Planck mass

$$m_p=\sqrt{D*h*c}=5.455\,511\,861*10^{-8}\,kg$$

- The values for D, h and c used in the above calculations:

- D = 1.498 284 464 *10^10 kg s^2 m^-3

- h = 6.626 070 15* 10^-34 kg m^2 s^-1

- c = 2.997 924 58 * 10^8 m s^-1

¤ Universal constants in Planck units

- $D=\frac{m_p*t_p^2}{l_p^3}$

- $h=\frac{m_p*l_p^2}{t_p}$

- $c=\frac{l_p}{t_p}$

¤ Some example calculations using the Planck's constant and Planck equations.

- Using the first form of the Planck equation

- $m*\lambda^2 = h*t$

¤ Photon

- h = 6.626 070 15 * 10^-34 kg m^2 s^-1
- λ = 7.494 811 45 * 10^-7 m
- m = 2.948 998 93 * 10^-36 kg

-Result:
- t = 2.5 * 10^-15 s

- λ/t = 299 792 458 m s^-1 = c (the speed of light)

- f = 1/t = 4 * 10^14 s^-1

¤ Hydrogen atom (in ground state)

- h = 6.626 070 15 * 10^-34 kg m^2 s^-1
- m = 1.673 532 86 * 10^-27 kg
- λ = 3.32 * 10^-10 m

- Result:
- t = 2.783 904 815 * 10^-13 s

- f = 3.592 076 836 * 10^12 s^-1

2 GRAVITATIONAL CONSTANT

In this section we will introduce the Gravitational constant G, the Dimensional constant D, and the related equations.

¤ Gravitational constant

- $G = 6.674\,30 * 10^{-11}\, m^3\, kg^{-1}\, s^{-2}$

¤ Dimensional constant

- $D = \frac{1}{G} = 1.498\,284\,464 * 10^{10}\, kg\, s^2\, m^{-3}$

¤ The Dimensional equation has been derived from the dimensions of the Dimensional constant.

- $\frac{kg * s^2}{m^3} \Rightarrow \frac{M * T^2}{R^3}$

¤ The Dimensional constant can be calculated from the variables of the Universe.

- $D = \frac{M * T^2}{R^3}$

¤ The first form of the Dimensional Equation (DE1).

- $M * T^2 = D * R^3$

- M = Mass of the Universe (kg)
- T = Age of the Universe (s)
- R = Radius of the Universe (m)
- D = Dimensional constant

¤ The second form of the Dimensional Equation (DE2)

- This time we use G instead of D

- $M*T^2=\frac{R^3}{G}$

¤ Dimensional equations: The first form with D (DE1)

- $M*T^2=D*R^3$ The first form of the equation.

- $D=\frac{M*T^2}{R^3}$ Solving D from the equation.

- $R^3=\frac{M*T^2}{D}$ Solving R^3 from the equation.

- $M=\frac{D*R^3}{T^2}$ Solving M from the equation.

- $T^2=\frac{D*R^3}{M}$ Solving T^2 from the equation.

¤ Dimensional equations: The second form with G (DE2)

- $M*T^2=\frac{R^3}{G}$ The second form of the equation.

- $R^3=M*T^2*G$ Solving for R^3 from the equation.

- $G=\frac{R^3}{M*T^2}$ Solving for G from the equation.

- $M=\frac{R^3}{T^2*G}$ Solving for M from the equation.

- $T^2=\frac{R^3}{M*G}$ Solving for T^2 from the equation.

Table 1. The Cosmos and its evolution in this model.

The Universe				
T (s)	**R (m)**	**S (m/s)**	**Y (s)**	**U (m)**
Schwarzschild Radius *Rs* (2*R*) 4.12*10^18 s (130.6 billion y)	8.74*10^26 m (92.4 billion ly)			
R (0.5 *Rs*) 1.46*10^18 s (46.3 billion y)	4.37*10^26 m (46.2 billion ly)	2.99*10^8 m/s	1.46*10^18 s (46.3 billion y)	4.38*10^26 m (46.3 billion ly)
Today 4.4*10^17 s (14.0 billion y)	1.97*10^26 m (20.8 billion ly)	4.48*10^8 m/s	6.57*10^17 s (20.8 billion y)	1.78*10^53 kg 1.32*10^26 m (14.0 billion ly)
10^15 s	3.40*10^24 m	3.40*10^9 m/s	1.13*10^16 s	3*10^23 m
10^12 s	3.40*10^22 m	3.40*10^10 m/s	1.13*10^14 s	3*10^20 m
10^9 s	3.40*10^20 m	3.40*10^11 m/s	1.13*10^12 s	3*10^17 m
10^6 s	3.40*10^18 m	3.40*10^12 m/s	1.13*10^10 s	3*10^14 m
10^3 s	3.40*10^16 m	3.40*10^13 m/s	1.13*10^8 s	3*10^11 m
10^0 s (1 s)	3.40*10^14 m	3.40*10^14 m/s	1.13*10^6 s	3*10^8 m
1.35*10^-43 s	4.05*10^-35 m	3*10^8 m/s	1.35*10^-43 s	4.05*10^-35 m
Age	Radius	Recession velocity of the radius (R/T)	Travel time of R with velocity c (R/c)	Radius of the visible Universe (T*c)

The total mass used was 5.9*10^53 kg for the Universe. For the Planck scale it was the Planck mass 5.6*10^-8 kg. And for Today for U it is 1.78*10^53 kg. This is the visible mass inside the visible Universe for today. The Schwarzschild Radius is calculated for the total mass of 5.9*10^53 kg. The values for T and R were derived using the equation M*T^2=D*R^3, where D = 1.5*10^10 kg s^2 m^-3. The Schwarzschild radius was derived using the equation *Rs* = 2M/(D*c^2). And *R* = M/(D*c^2). The Age for Today was derived from the Hubble constant with the value Ho = 70 km/s/Mpc.

¤ In the Table:
- T = The Age of the Universe in seconds.
- R = The Radius of the Universe in meters.
- S = Recession velocity of the Radius on meters per second.
- Y = Travel Time of Radius with the Speed of Light in seconds.
- U = The Radius of the Visible Universe in meters.

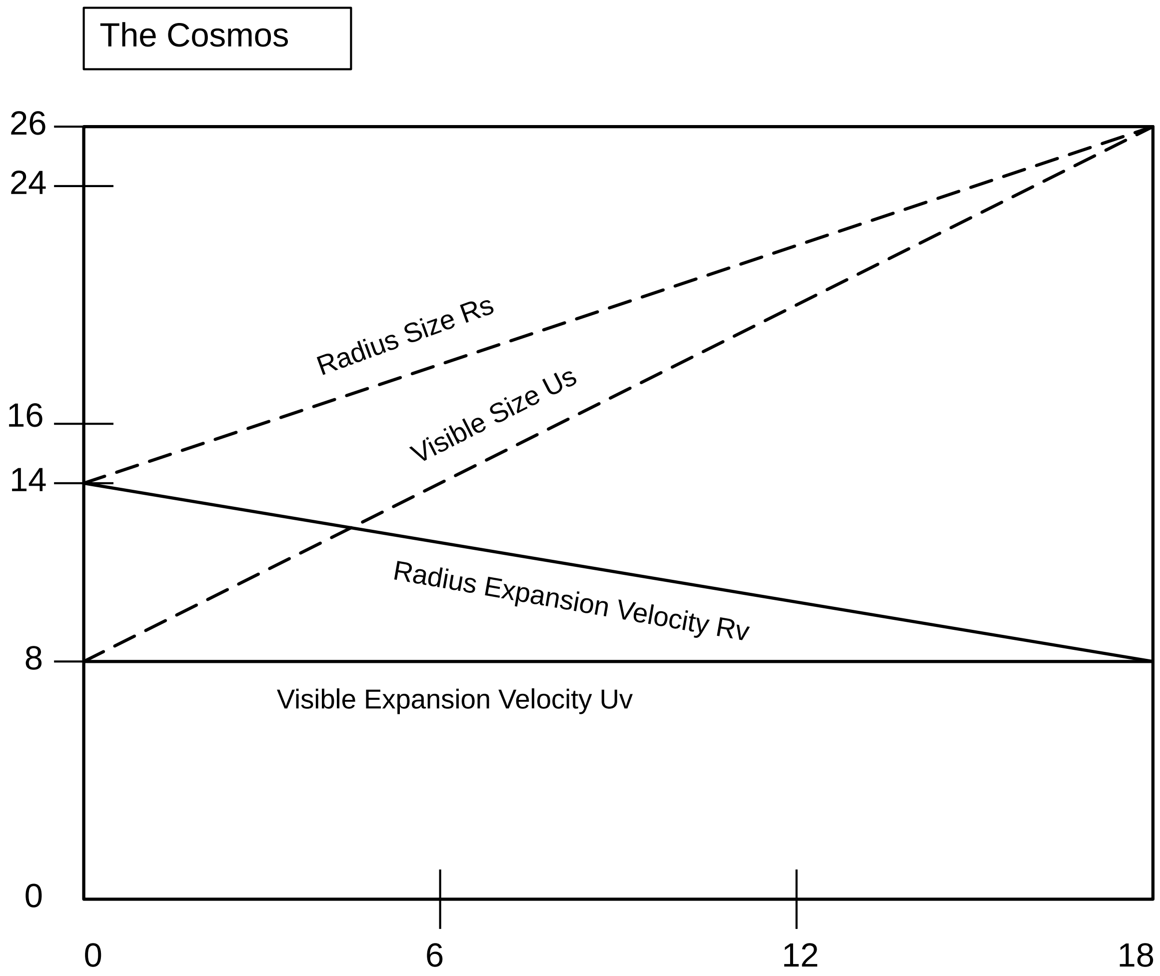

Figure 1. The Cosmos

- Horizontal dimension: Time (s) in powers of 10.
- Vertical dimension: Length (m) and velocity (m/s) in powers of 10.

- ΔRs per 10^3 s = 10^2
- ΔRv per 10^3 s = 10^-1
- Total change = 10^3

- ΔUs per 10^3 s = 10^3
- ΔUv per 10^3 s = 10^0
- Total change = 10^3

- Expansion of the Visible Universe (Us) happens at the speed of light and is driven by time.
- Expansion of the Radius (Rs) happens at a decreasing velocity and is driven by both mass and time.

- The relative size to expansion velocity ratios are the same. (10^3).

¤ The previous two pages illustrate how the Dimensional Equation can be used to analyze the dynamics of the whole Universe.
¤ It is a model of the universe, not the Universe itself.
¤ The model differs from the standard cosmological ΛCDM model. In the standard model the Radius of the Universe "today" is around 45 billion light years. In this model the radius "today" is about 21 billion light years.

¤ An example of the Milky Way Galaxy using the first form of the Dimensional Equation:

- $M*T^2=D*R^3$

- Data for 30 000 light years from the center of the Galaxy:

- R = 2.8 * 10^20 m (30 kly)
- v = 2.2 * 10^5 m s^-1 (Radial velocity of the orbiting star.)

- With these values we can calculate the time t it takes to travel the radius with the velocity v:

- t = R/v = 1.29 * 10^15 s (About 40.9 million years.)

- Mass M can be calculated with the equation given above:

- $M=\frac{D*R^3}{T^2}$ Effective mass inside Radius R.

- M = 2 * 10^41 kg

- We can thus see that the dimensional equation can be used to calculate values for both the whole Universe and the Milky Way Galaxy.
- In the Milky Way Galaxy the form of the equation resembles that of Kepler's III law.
- This equation can also be used to calculate the orbits of the planets in our Solar System, but in this case we have to use the average distances of the planets from the Sun.

General conclusions

So we have reached the conclusion of this brief memo. It has been shown mathematically that both h and G can be used to form equations that tell us something about the physical world.

The equations based on h give us exact results about atomic and subatomic values of different variables.

The equations based on G give us the correct results on the scale of our home galaxy, the Milky Way. They also tell us something about the Universe as a whole. However, the results differ somewhat from the standard accepted cosmological model, the ΛCDM model.

In this respect, some caution is warranted in the use of these equations. But one may wonder that if the equations based on the Planck's constant give us the correct results, then shouldn't the equations based on the Gravitational constant do the same?

So, only time will tell us whether these equations based on G do give us correct answers about the Universe.

But what is undeniable is that we have known these universal constants for over a century now, and what this memo has shown is that they reveal something more fundamental about themselves when turned into equations from the physical dimensions of the constants themselves.

There is thus a hidden symmetry and meaning behind h and G!