# The origin of the coupling constant (e) and some other important dimensionless physical constants within General Relativity

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**Abstract:** This paper will answer the mystery of the coupling constant ($e$), a puzzle of its origin that was made popular by Richard Feynman, by using what will be defined as "temporal kinematics". Temporal kinematics study the motion of time, we will name this "temporal motion" and provide a detailed explanation and kinematics to why this concept is far more accurate than the current concept of "repulsive gravity" that dominates in the cosmic inflation studies. Temporal motion should not be confused with cosmic inflation, it can only act as an initiator of it most probably caused by quantum vacuum fluctuations.

## Introduction

Some of the unexplained problems in physics can be explained and proven in a relatively simple way if we apply the logic of General Relativity on other fields of physics. The simplest way is to use "temporal motion" instead of "repulsive gravity" [1] to explain the inflation of space from the initial inflation, often called "cosmic inflation", to the present time.

We use a (-, +, +, +) metric, where (-) marks the dimension of time ($t$) as usual [2]. Even in the simplest form of a ($R^4$) flat spacetime with $(t, x, y, z)$ we have a metric:

$$(1)\ ds^2 = -c^2dt^2 + x^2 + y^2 + z^2$$

We will proclaim that temporal motion inflates space; the inflation is its equivalent of what a trajectory is for spatial motion. Temporal motion has a velocity ($c$) which is the speed of light and can be thought of as a speed limit of the Universe. This limit exists due to temporal motion since nothing can move in space faster than time due to the entanglement of space and time known as the spacetime continuum.

### Cosmological model

The Universe will be represented as homogenous and isotropic. Isotropy means that the metric must be diagonal since it will be show that space is allowed to be curved. Therefore we will use spherical coordinates to describe the metric.

The metric is given by the following line element:

$$(2)\ ds^2 = dr^2 + r^2(d\theta^2 + \sin^2\theta\, d\varphi^2)$$

where we measure ($\theta$) from the north pole and at the south pole it will equal ($\pi$).

In order to simplify the calculations, we abbreviate the term between the brackets as:

$$(3)\ d\omega^2 = d\theta^2 + \sin^2\theta\, d\varphi^2$$

because it is a measure of angle, which can be thought of as "on the sky" from the observers point of view [4]. It is important to mention that the observers are at the center of the spherical coordinate system.

Due to the isotropy of the Universe the angle between two galaxies, for the observers, is the true angle from the observers' vantage point and the expansion of the Universe does not change this angle.

Finally, we represent flat space as:

$$(4)\ ds^2 = dr^2 + r^2 d\omega^2$$

Robertson and Walker proved that the only alternative metric that obeys both isotropy and homogeneity is:

$$(5)\ ds^2 = dr^2 + f_K(r)^2 d\omega^2$$

where ($f_K(r)$) is the curvature function given by:

$$(6)\ f_K(r) = \begin{cases} K^{-1/2}\ for\ K > 0 \\ r\ for\ K = 0 \\ K^{-1/2} \sin h\left(K^{1/2} r\right)\ for\ K < 0 \end{cases}$$

which means that the circumference of a sphere around the observers with a radius ($r$) is, for ($K \neq 0$), not anymore equal to ($C = 2\pi r$) but smaller for ($K > 0$) and larger for ($K < 0$).

The surface area of that sphere would no longer be ($S = \left({}^{4\pi}/_{3}\right) r^3$) but smaller for ($K > 0$) and larger for ($K < 0$). If ($r$) is ($r \ll |K|^{-1/2}$) the deviation from ($C = 2\pi r$) and ($S = \left({}^{4\pi}/_{3}\right) r^3$) is very small, but as ($r$) approaches ($|K|^{-1/2}$) the deviation can become rather large.

The metric in the equation (1) can also be written as:

$$(7)\ ds^2 = \frac{dr^2}{1 - Kr^2} + r^2 d\omega^2$$

If we determine an alternative radius ($r$) as:

$$(8)\ r \equiv f_K(r)$$

This metric is different only in the way we chose our coordinate ($r$).

We can now build our model by taking for each point in time a RW space. We allow the scale factor and the curvature of the RW space to vary with time [3]. This gives the generic metric:

$$(9)\ ds^2 = -dt^2 + a(t)^2[dx^2 + f_K(x)^2 x^2 d\omega^2]$$

the function ($a(t)$) is the spatial scale factor that depends on time and it will describe the spatial expansion of the Universe. We use ($x$) instead of ($r$) because the radial coordinate, in this form, no longer has meaning as a true distance.

## Temporal Motion

Temporal motion needs three equations for a trajectory to successfully explain inflation since inflation can only occur in three spatial dimensions, unlike expansion that can happen in one or two dimensions.

The equation for temporal motion has to be on a quantum level to satisfy the observational evidence that suggests the opinion that the Universe comes from a singularity. We do so by establishing ($d$Д) where (Д) represents the number of temporal dimensions which is (1), however having in mind that time has a negative value in the metric $(-,+,+,+)$ we give it a value of $(-1)$. We will represent this as $(-p)$ where $(p = 1)$ and it is a very low constant pressure.

We write a simple equation of motion:

$$(10)\ \delta \twoheadrightarrow = \delta \int d\text{Д}\, L(a(t), \dot{a}(t))$$

Where ($\twoheadrightarrow$) is the symbol for temporal motion, $(a(t))$ is the three-dimensional trajectory/inflation and $(\dot{a}(t))$ is the velocity that equals $(c)$ the speed of light. However:

$$(11)\ \dot{a}^{-1}(t) = -pc$$

Where the pressure $(p)$ equals 1. This allows us to form the equations, three of them, for the temporal course of inflation.

And the trajectory describing inflation $(a(t))$ becomes $(a^{-1}(t))$ and functions as:

$$(12)\ a^{-1}(t) \begin{cases} \twoheadrightarrow (x) = \log_{\lim\limits_{x\to\infty}\left(\frac{p}{x}+p\right)^{x}}(x) \\ \twoheadrightarrow (y) = \log_{\lim\limits_{y\to\infty}\left(\frac{p}{y}+p\right)^{y}}(y) \\ \twoheadrightarrow (z) = \sum\limits_{i=1}^{n} \pi y_i + \delta x_i \end{cases}$$

The equations might seem too complicated to comprehend but they are practical when we apply that $(p = 1)$ we get the solutions $\left(\lim\limits_{x\to\infty}\left(\frac{1}{x}+1\right)^{x}\right)$ equals $(e)$ and $\left(\lim\limits_{y\to\infty}\left(\frac{1}{y}+1\right)^{y}\right)$ equals $(e)$ as well, where the first two equations become $(\twoheadrightarrow (x) = \log_e(x))$ and $(\twoheadrightarrow (y) = \log_e(y))$ and the number $(e)$ is the Euler's number, not the coupling constant we are looking for. The third equation $(\twoheadrightarrow (z))$ is the "wave function", representing "temporal waves". Every temporal wave can be thought of as a spatial layer, or a frame. We will define them as "z-frames" and state that each value of $(i)$ represents every individual z-frame from (1) to $(n)$.

The mathematical core of the equations is:

$$(13)\ e = \pi - \delta$$

This equation is the symmetry of temporal motion and therefore it is the mathematical logic behind the temporal kinematics, simply put the mathematical foundation of temporal motion. We shall name this equation the "logos equation". Now we conclude from the equation that $(\delta = 0.423310825130748)$ and define that:

$$(14)\ \delta = \frac{\boldsymbol{e}}{D} + \Omega + (\delta_{CKM} - \delta_{PMNS})$$

Where ($D = 3$) is the number of spatial dimensions, ($\Omega \approx 0.3$) is the ratio of the actual density of the Universe to the critical minimal density, ($\boldsymbol{e}$) is the coupling constant and it is measured to be ($\boldsymbol{e} = 0.08542455$), ($\delta_{CKM} \approx 0.995$) is the CKM cp-violating phase and ($\delta_{PMNS}$) is the PMNS cp-violating phase and its value is currently unknown. After doing the calculus we conclude that ($\delta_{PMNS} = 0.900164024869252$) however we approximate it to be ($\delta_{PMNS} \approx 0.900164 \pm 0.0000001$) where we are making a prediction that can be tested experimentally in order to confirm the claims of this paper.

The first objective of the paper was to explain how the coupling constant ($\boldsymbol{e}$) arises or comes to be in physics, explaining its origin along with the other important dimensionless constants which provide the basis for a "finely tuned" Universe.

When we draw the functions, we get an image:

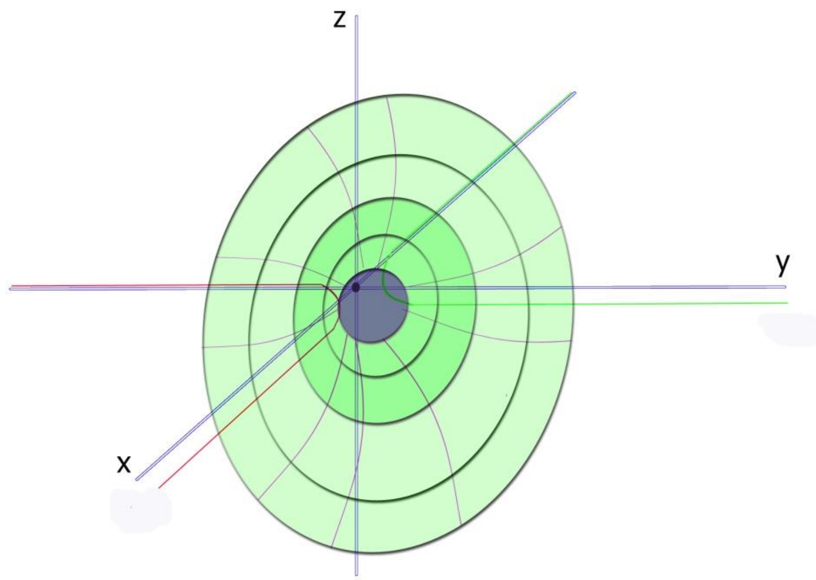


*Figure 1: Functions* $\twoheadrightarrow (x)$ *is red,* $\twoheadrightarrow (y)$ *is green and* $\twoheadrightarrow (z)$ *are the ellipses from 1 to n.*

When we remove the coordinate system it looks like this:

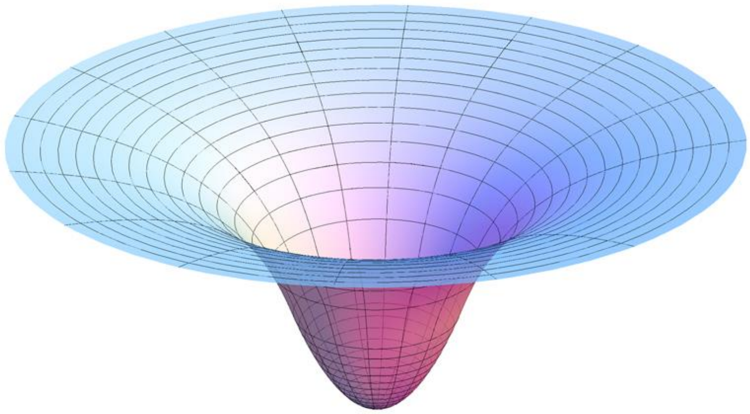

*Figure 2: Trajectory of temporal motion.*

Since space and time are entangled in a relationship that is spacetime, all fundamental forces function in a reverse way than temporal motion but within the same symmetry, forming potential wells or local potential minimums while temporal motion constantly strides to form a global potential maximum which results in a constant increase in entropy on the global level. This led to the shape of atoms, celestial bodies etc. and to time dilatation. The low constant pressure ($p$) prevents anything in space to travel faster than time ($c$) due to the equation (12).

**Z-frames**

Every individual z-frame is represented by a value of ($i$) from eq. (13), for example the current period is ($i = 1$), to represent different eras of the Universe. [5]

For:

$$(15)\ (i \simeq 1000)$$

we have a value:

$$(16)\ a(t) \simeq \left(\frac{3}{2}H_0\sqrt{\Omega_{m;0}}t\right)^{2/3}$$

which is a z-frame know as “matter dominated era”. Earlier than that, in a z-frame known as the “radiation dominated era”, a period when the Universe was dominated by radiation, around ($i \gtrsim 3200$) we have a value:

$$(17)\ a(t) \simeq \left(2H_0\sqrt{\Omega_{r;0}}t\right)^{1/2}$$

The early, radiation dominated Universe expanded as:

$$(18)\ a \propto \sqrt{t}$$

Every frame has slightly more temporal-kinetic energy, or "dark energy", than the previous one but since the differences in the trillions of frames is complicated to determine it is therefore simpler and more productive to use only some frames.

Due to the low negative pressure of temporal motion, its kinetic energy which is "dark energy", also has a low negative pressure ($-p = -1$) [6]. Having such a pressure, dark energy accelerates the inflation of space conducted by temporal motion.

**Fundamental forces**

Due to the relationship of space and time fundamental forces also have their temporal equations, which are the same for all of them, they function opposite to temporal motion.

$$(19)\ P_{compress}^{-1}(t) \begin{cases} \twoheadrightarrow (x) = \log_{\lim\limits_{a^{-1}\to 0}\left(\frac{p}{\alpha_x}+p\right)^{x/\alpha_x}}(x) \\ \twoheadrightarrow (y) = \log_{\lim\limits_{a^{-1}\to 0}\left(\frac{p}{\alpha_y}+p\right)^{y/\alpha_y}}(y) \\ \twoheadrightarrow (z) = \sum_{i=1}^{n} \pi y_i + \delta x_i \end{cases}$$

All the forces are centralized due to ($a^{-1} \to 0$) and function as potential wells. We will draw an imaginary temporal line to represent the axis. Angles ($\alpha_x$) and ($\alpha_y$) are the angles between the imaginary line, the axis, and dimensions ($x$) and ($y$). Same as with the first temporal equations, ($p = 1$) providing the solutions ($\lim\limits_{a^{-}\to 0}\left(\frac{1}{\alpha_x}+1\right)^{x/\alpha_x} = e$) and ($\lim\limits_{a^{-}\to 0}\left(\frac{1}{\alpha_y}+1\right)^{y/\alpha_y} = e$) meaning that ($\twoheadrightarrow (x) = \log_e(x)$) and ($\twoheadrightarrow (y) = \log_e(y)$) where ($e$) is the Euler's number. The third equation also functions as a wave equation, depending on the nature of waves and the ($e = \pi - \delta$) also applies explaining how waves spread though space and time, that is the spacetime continuum. What we get are timelike curves that form spatial potential wells.

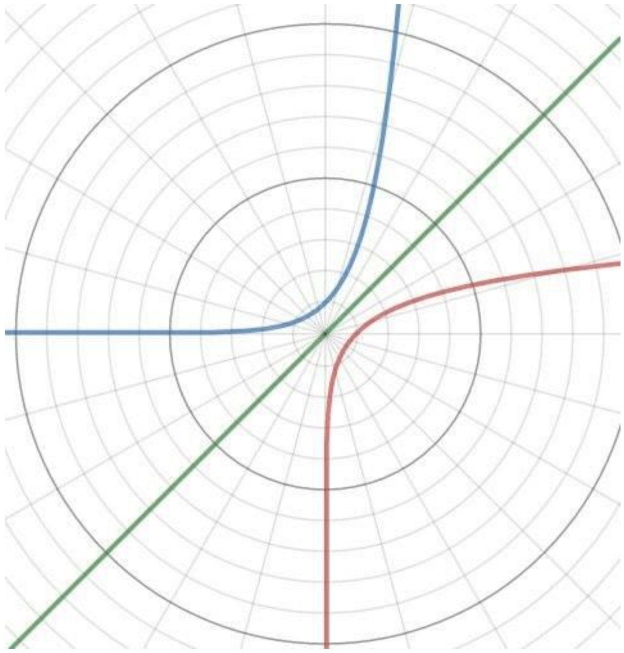

*Figure 3: Two dimensional representation of the temporal equations for fundamental forces.*

There are three cases to explain in order to understand the evolution of fundamental forces.

1) The Gravitational force. We draw an ellipse to represent a celestial body:

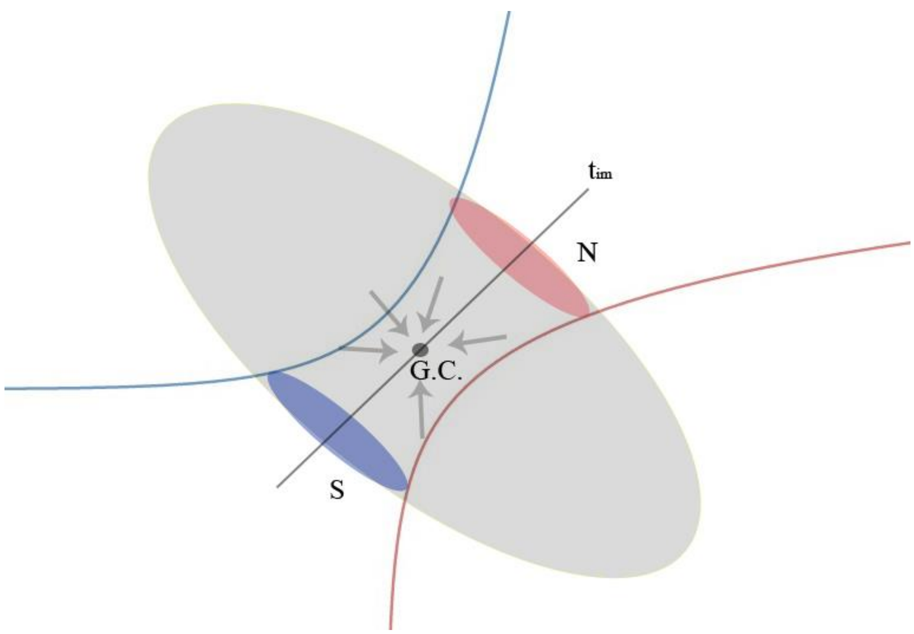


*Figure 4: The Gravitational field of Earth.*

The best way to describe the centralized nature of gravity is by gravitational compression, meaning that we need to describe the center of a gravitational field.

Any body that falls under the influence of a gravitational field of a celestial body will instantaneously react to its gravitational center regardless of the distance from the center. The body will react by gaining its own center of weight which is essentially the gravitational center of the body. A good example for this is a stick, holding a stick by its end takes more effort than to hold it by its center.

For uniform gravitational fields the gravitational center is the same as the center of mass, making it relatively simple to determine it. For non-uniform gravitational fields the gravitational center ($cg\ W = \int з\ dw$) becomes ($cg\ W = g\ \iiint з\ \rho\ dx\ dy\ dz$) where ($W$) is total weight, ($\rho$) is the density, (з) is the distance from a reference line, ($dw$) is an increment of weight and ($cg$) is the gravitational center. Here ($cg\ W = P_{compress}$) therefore for gravity we have:

$$(20)\ P_{compress}^{grav} = g \iiint з\ \rho\ dx\ dy\ dz$$

What we get is a gravitational well. Due to such a nature, the gravitational time dilatation is the strongest at the poles of a celestial body.

2) The Electromagnetic force which is similar to the gravitational force on a macroscopic scale but much stronger than it.

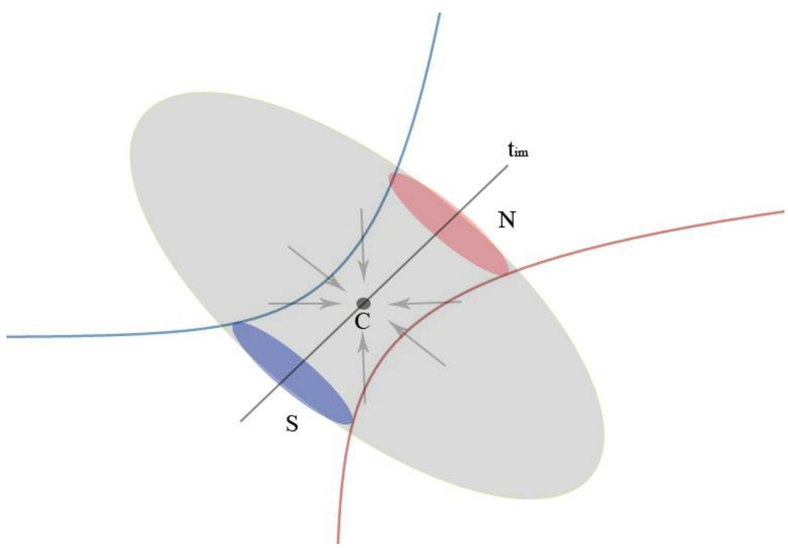


*Figure 5: Electromagnetic force of Earth.*

Similarly to the gravitational force, electromagnetic force will instantaneously polarize during a reaction; in essence it is forming dipoles instantaneously which is the ability known as polarizability.

Electromagnetic fields, such as Earths, function similarly as gravitational fields specifically it is their compression that is similar, with charge instead of mass.

In case of non-uniform electromagnetic field it is difficult to determine them without examining each field individually. For uniform electromagnetic fields we have:

$$(21)\ P_{compress}^{em} = \frac{4\sigma}{3c} T^4$$

where ($\sigma$) is the Stefan-Boltzmann constant and ($T$) is temperature.

We get an electric and a magnetic potential well, in short electromagnetic well.

3) The strong and the weak interaction.

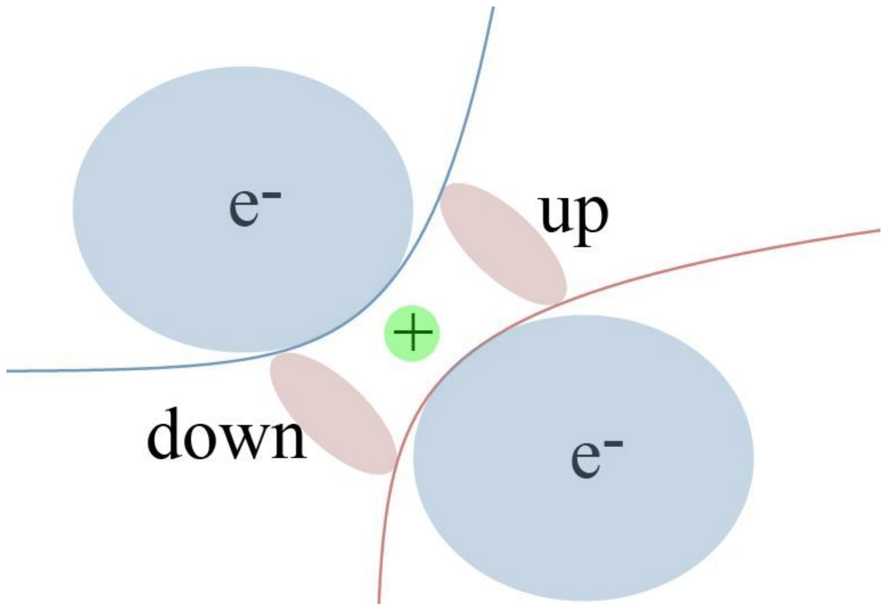


*Figure 6: The Atom, where + and the green center is the nucleus and the blue cloud and $e^-$ represents the electrons.*

Most of the mass is in the nucleus where the nuclear force interacts between protons and neutrons and it is a product of the strong nuclear force that interacts between the quarks which form the protons and neutrons. The electromagnetic force interacts between protons and electrons, keeping electrons in a "cloud".

The simplest way to explain the electron cloud would be with an electrostatic potential well. We could describe this with ($P_{compress} = \frac{E^2 \varepsilon_0}{2}$) where ($E = \frac{z \cdot e}{4\pi\varepsilon_0 \gamma^2}$) however it is difficult to apply a term such as pressure within the small microscopic size of the atom which is why we will describe the electrostatic well in a different manner.

The atom doesn't have poles but it does have "kinetic currents", two of them or more, and the two sides of the electron cloud have to be equal if there are two currents or the atom will grow increasingly unstable until it reaches the state of radioactive decay (a neutron turns into a proton, electron and a anti-electron neutrino in some cases) which is governed by the weak interaction.

Here we have a way to explain how the electrostatic potential well functions by using the kinetic energy of electrons. We describe the kinetic currents as up:

$$(22)\ \left|\hat{E}\right\rangle = -\frac{\hbar^2}{2m_e}\sum_{i=1}^{n}\left|\Psi\middle|\nabla_i^2\middle|\Psi\right\rangle$$

and down:

$$(23)\ \left\langle\hat{E}\right| = -\frac{\hbar^2}{2m_e}\sum_{i=1}^{n}\left\langle\Psi\middle|\nabla_i^2\middle|\Psi\right|$$

where $(\nabla_i^2)$ is the Laplacian of the system and $(m_e)$ is the mass of the electron. The currents change their positions often.

Further on we define that:

$$(24)\ \Psi_{n_x n_y n_z} = \sqrt{\frac{8}{L_x L_y L_z}}\sin\left(\frac{n_x \pi x}{L_x}\right)\ \sin\left(\frac{n_y \pi y}{L_y}\right)\sin\left(\frac{n_z \pi z}{L_z}\right)$$

also:

$$(25)\ E_{n_x n_y n_z} = \frac{\hbar^2\pi^2}{2m_e}\left[\left(\frac{n_x}{L_x}\right)^2 + \left(\frac{n_y}{L_y}\right)^2 + \left(\frac{n_z}{L_z}\right)^2\right]$$

which defines the electrostatic potential well. It could be argued that the kinetic currents give a “kinetic shape” to the atom by functioning to define its orbitals. There can be more than two currents, depending on the nature of the atom, for example ($\langle\hat{E}|, |\hat{E}\rangle, \langle\check{E}|, |\check{E}\rangle$ ).

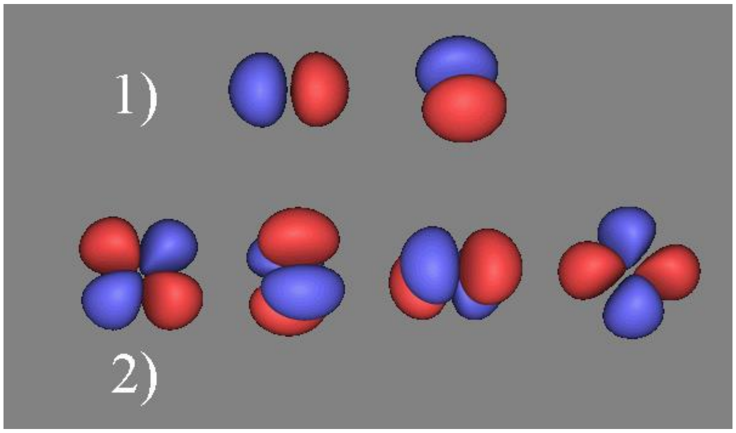

*Figure 7: Atomic orbitals where 1) represents two currents and 2) represents four currents*

Atoms can have even more than four currents and due to them, atoms put under high pressure will start forming crystallized structures that are mistakenly defined by chemists as counter-intuitive.

## Conclusion

If we apply the new values from the temporal equations assuming no distinction between the spatial directions, we can change some of the equations in the cosmic inflation theory in order to make them more logical. We write the FRWL metric as:

$$(26)\ ds^2 = -dt^2 + a(t)^2 \left[\frac{dr^2}{p - kr^2} + r^2(d\theta^2 + \sin^2\theta d\phi^2)\right]$$

With a time-invariant Hubble constant, we have a de Sitter metric where:

$$(27)\ ds^2 = -dt^2 + e^{2Ht}(dx^2 + dy^2 + dz^2)$$

We also define the density parameter:

$$(28)\ \Omega \equiv \frac{\rho}{\rho_c} = \frac{{}^{3}/_{8\pi G}\left(H^2 + {}^{k}/_{a^2}\right)}{{}^{3H^2}/_{8\pi G}} = p + \frac{k}{a(t)^2\, H^2}$$

When $(a(t) = e^{Ht})$ and $(H = const.)$ we have:

$$(29)\ \Omega_{inflation} = p + \frac{k}{a(t)^2\, H^2} = p + kH^{-2}e^{-2Ht}$$

Where, as before $(p = 1)$ therefore the pressure drives $(\Omega)$ very rapidly to the value of (1). With enough influence by temporal motion, the initial value of $(\Omega)$ that may have differed from (1) could have been driven close enough to (1) that it would be approximately equal to it in the present period of the Universe.

Using temporal equations allows for a much simpler and more accurate theory of inflation since quantum vacuum fluctuations were enough to produce the temporal motion and to start the Big Bang. Temporal kinematics create the cone, setting the course of inflation from the beginning and, possibly to an end as well. The only necessary aspect is the low negative pressure and quantum vacuum fluctuations to occur in the same point which results with temporal motion.

Possible quantum fluctuations:

$$(30)\ \phi(\vec{x}, t) = \phi(t) + \delta\phi(\vec{x}, t)$$

Resulting in:

$$(31)\ \delta\phi = \left[\left(L\, a(t)\right)^3\right]^{-1/2} \sum_{\vec{k}} \left[a_{\vec{k}} g_k(t) e^{i\vec{k}\vec{x}\vec{y}} + H.C.\right]$$

The time dependent part of the fluctuation is:

$$(32)\ \Psi_k \equiv a(t)^{-3/2} g_k$$

Therefore:

$$(33)\ |\delta\phi|^2 = L^{-3} |\delta\Psi_k|^2$$

where ($L \to \infty$).

We consider an inflation field composed of a spatially homogenous term plus a first order:

$$(34)\ \phi(\vec{x}, t) = \phi^{(0)}(t) + \delta\phi(\vec{x}, t)$$

In units f ($\hbar = c = 1$) we get the evolution equation:

$$(35)\ \partial_t^2 \delta\phi + 3H\partial_t \delta\phi - a^{D\cdot Д + p}(t) \sum_{i=1}^{D} \partial_i^2\, \delta\phi + m\left(\phi^{(0)}\right)^2 \delta\phi = 0$$

Knowing the values of constants ($D \cdot Д + p = 3 \cdot (-1) + 1 = -2$), we get:

$$(36)\ \partial_t^2 \delta\phi + 3H\partial_t \delta\phi - a^{-2}(t) \sum_{i=1}^{D} \partial_i^2\, \delta\phi + m\left(\phi^{(0)}\right)^2 \delta\phi = 0$$

The mass term is related to the inflationary potential:

$$(37)\ m\left(\phi^{(0)}\right)^2 = \frac{d^2 V}{d(\phi^{(0)})^2}$$

We can conclude that temporal kinematics provide effective answers, from dimensionless physical constants to improving cosmic inflation studies. The low constant pressure ($p$) is necessary in order for the kinematics to function properly. Temporal kinematics have to be applied within General Relativity due to the necessity of a four-dimensional manifold.

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