A new type of device for controlling gravity is here proposed. This is a quantum device because results from the behaviour of the matter and energy at subatomic length scale ($10^{-20}$ m). From the technical point of view this device is easy to build, and can be used to develop several devices for controlling gravity.

**Key words:** Gravitation, Gravitational Mass, Inertial Mass, Gravity, Quantum Device.

### Introduction

Some years ago I wrote a paper [1] where a correlation between gravitational mass and inertial mass was obtained. In the paper I pointed out that the relationship between gravitational mass, $m_g$, and rest inertial mass, $m_{i0}$, is given by

\[
\chi = \frac{m_g}{m_{i0}} = \left[1 - 2 \left(1 + \left(\frac{\Delta p}{m_{i0}c}\right)^2\right)^{-1}\right] = \\
1 - 2 \left[1 + \frac{U n_r}{m_{i0}c^2}\right]^{-1} = \\
1 - 2 \left[1 + \frac{W n_p}{\rho c^2}\right]^{-1}
\]

where $\Delta p$ is the variation in the particle’s kinetic momentum; $U$ is the electromagnetic energy absorbed or emitted by the particle; $n_r$ is the index of refraction of the particle; $W$ is the density of energy on the particle ($J/\text{kg}$); $\rho$ is the matter density ($\text{kg/m}^3$) and $c$ is the speed of light.

Also it was shown that, if the weight of a particle in a side of a lamina is $\vec{P} = m_g \vec{g}$ (perpendicular to the lamina) then the weight of the same particle, in the other side of the lamina is $\vec{P}' = \chi m_g \vec{g}$, where $\chi = \frac{m_g'}{m_{i0}'}$ ( $m_g'$ and $m_{i0}'$ are respectively, the gravitational mass and the inertial mass of the lamina). Only when $\chi = 1$, the weight is equal in both sides of the lamina. The lamina works as a Gravity Controller. Since $P' = \chi P = (\chi m_g)g = m_g (\chi g)$, we can consider that

\[
m_g' = \chi m_g \quad \text{or that} \quad g' = \chi g
\]

In the last years, based on these concepts, I have proposed some types of devices for controlling gravity. Here, I describe a device, which acts controlling the electric field in the Matter at subatomic level ($\Delta x \approx 10^{-20} \text{ m}$). This Quantum Controller of Gravity is easy to build and can be used in order to test the correlation between gravitational mass and inertial mass previously mentioned.

### 2. The Device

Consider a spherical capacitor, as shown in Fig.1. The external radius of the inner spherical shell is $r_a$, and the internal radius of the outer spherical shell is $r_b$. Between the inner shell and the outer shell there is a dielectric with electric permittivity $\varepsilon = \varepsilon_f, \varepsilon_0$. The inner shell works as an inductor, in such way that, when it is charged with an electric charge $+q$, and the outer shell is connected to the ground, then the outer shell acquires an electric charge $-q$, which is uniformly distributed at the external surface of the outer shell, while the electric charge $+q$ is uniformly distributed at the external surface of the inner shell.
Under these conditions, the electric field between the shells is given by the vectorial sum of the electric fields $\vec{E}_a$ and $\vec{E}_b$, respectively produced by the inner shell and the outer shell. Since they have the same direction in this region, then one can easily show that the resultant intensity of the electric field for $r_a<r<r_b$ is $$E_r = E_a + E_b = q/4\pi\varepsilon_0 r^2.$$ In the nucleus of the capacitor and out of it, the resultant electric field is null because $\vec{E}_a$ and $\vec{E}_b$ have opposite directions (See Fig. 2(a)).

Note that the electrostatic force, $\vec{F}$, between $-q$ and $+q$ will move the negative electric charges in the direction of the positive electric charges. This causes a displacement, $\Delta x$, of the electric field, $\vec{E}_b$, into the outer shell (See Fig. 2(b)). Thus, in the region with thickness $\Delta x$ the intensity of the electric field is not null but equal to $E_b$.

The negative electric charges are accelerated with an acceleration, $\ddot{a}$, in the direction of the positive charges, in such way that they acquire a velocity, given by $v = \sqrt{2a\Delta x}$ (drift velocity).

The drift velocity is given by [2]$$v = \frac{i}{nS} = \frac{V}{\sqrt{R^2 + X_c^2}} = \frac{V}{nSe}$$

where $V$ is the positive potential applied on the inner shell (See Fig. 1); $X_c = 1/2\pi fC$ is the capacitive reactance; $f$ is the frequency; $C = \frac{4\pi\varepsilon}{r_a r_b/r_b - r_a}$ is the capacitance of the spherical capacitor; $R$ is the total electrical resistance of the external shell, given by $R = (\Delta \varepsilon/\sigma S) + R_{10}$, where $\Delta \varepsilon/\sigma S$ is the electrical resistance of the shell ($\Delta \varepsilon = 5\text{ mm}$ is its thickness; $\sigma$ is its conductivity and $S$ is its surface area), and $R_{10}$ is a 10gigaohms resistor. Since $R_{10} \gg \Delta \varepsilon/\sigma S$, we can write that $R \approx R_{10} = 1 \times 10^{10} \Omega$.
If the shells are made with Aluminum, with the following characteristics: 
\[ \rho = 2700 \text{kg/m}^3, \] 
\[ A = 27 \text{kg/kmol}, n=N_0 \rho / A \approx 6 \times 10^8 \text{m}^{-3} \] 
(\( N_0 \) is the Avogadro’s number \( N_0 = 6.02 \times 10^{23} \text{kmol}^{-1} \)), and \( r_a = 0 \text{m}; r_b = 0.105 \text{m}; S = 4\pi (r_b + \Delta r)^2 \approx 0.152 \text{m}^2 \); 
\( r_b - r_a = 5 \times 10^{-3} \text{m} \), then \( R >> \chi_c = (6.8 \times 10^6 / f) \text{ohms} \), 
\( (f > 1 \text{Hz}) \), and Eq. (2) can be rewritten in the following form:

\[ v = \frac{i}{n_S e} \frac{V}{R_0} \approx 6.8 \times 10^{-30} V \]  
(3)

The maximum size of an electron has been estimated by several authors [3, 4, 5]. The conclusion is that the electron must have a physical radius smaller than \( 10^{-22} \text{m} \).

Assuming that, under the action of the force \( \vec{F} \) (produced by a pulsed voltage waveform, \( V \)), the electrons would fluctuate about their initial positions with the amplitude of \( \Delta x \approx 1 \times 10^{-20} \text{m} \)(See Fig. 3), then we get

\[ \Delta x = \frac{2\Delta x}{v} = \frac{2\Delta x}{v} \approx 0.294 V \]  
(4)

However, we have that \( f = 1/\Delta T = 1/2\Delta t \). Thus, we get

\[ f = 1.7V \]  
(5)

Now consider Eq. (1). The instantaneous values of the density of electromagnetic energy in an electromagnetic field can be deduced from Maxwell’s equations and has the following expression

\[ W = \frac{1}{2} c \vec{E}^2 + \frac{1}{2} \mu \vec{H}^2 \]  
(6)

where \( \vec{E} = E_{\text{e}} \sin \omega t \) and \( \vec{H} = H_{\text{e}} \sin \omega t \) are the instantaneous values of the electric field and the magnetic field respectively.

It is known that \( B = \mu \vec{H}, \ E|B| = \omega|k_r, \) [6] and

\[ v = \frac{dz}{dt} = \frac{\omega}{\kappa_r} = \frac{c}{\frac{E_{\text{e}} \mu_r}{2} \left( 1 + (\sigma/\omega c)^2 \right) + 1} \]  
(7)

where \( k_r \) is the real part of the propagation vector \( \vec{k} \) (also called phase constant); \( k = |\vec{k}| = k + ik_r ; \) \( c, \mu \) and \( \sigma \) are the electromagnetic characteristics of the medium in which the incident (or emitted) radiation is propagating \( (\varepsilon = \varepsilon_r \varepsilon_0; \varepsilon_0 = 8.854 \times 10^{-12} \text{F/m} ; \mu = \mu_r \mu_0 \) where \( \mu_0 = 4\pi \times 10^{-7} \text{H/m} \)). It is known that for free-space \( \sigma = 0 \) and \( \varepsilon_r = \mu_r = 1 \). Then Eq. (7) gives

\[ v = c \]

From Eq. (7), we see that the index of refraction \( n_r = c/v \) is given by

\[ n_r = \frac{c}{v} \left( \sqrt{1 + (\sigma/\omega c)^2} + 1 \right) \]  
(8)

\[ \Delta x \approx 1 \times 10^{-20} \text{m} \]

Fig.3 - Controlling the Electric Field in the Matter at subatomic level \( (\Delta x \approx 1 \times 10^{-20} \text{m}) \).

Equation (7) shows that \( \omega/k_r = v \). Thus, \( E/B = \omega/k_r = v \), i.e.,

* Inside of the matter.
\[ E = \nu B = \nu \mu H \]

Then, Eq. (6) can be rewritten in the following form:

\[ W = \frac{1}{2} \left[ \epsilon \frac{\mu}{\sqrt{\varepsilon, \mu}} \right] \mu H^2 + \frac{1}{2} \mu H^2 \]

(9)

For \( \sigma \ll \omega \epsilon \), Eq. (7) reduces to

\[ v = \frac{c}{\sqrt{\varepsilon, \mu}} \]

Then, Eq. (9) gives

\[ W = \frac{B^2}{\mu} \]

(10)

or

\[ W = \epsilon E^2 \]

(11)

For \( \sigma \gg \omega \epsilon \), Eq. (7) gives

\[ v = \sqrt{\frac{2\omega}{\mu \sigma}} \]

(12)

Then, from Eq. (9) we get

\[ W = \frac{1}{2} \left[ \epsilon \frac{\mu}{\sigma} \right] \mu H^2 + \frac{1}{2} \mu H^2 \]

\[ \approx \frac{1}{2} \mu H^2 \]

(13)

Since \( E = \nu B = \nu \mu H \), we can rewrite (13) in the following forms:

\[ W \approx \frac{B^2}{2 \mu} \]

(14)

or

\[ W \approx \left( \frac{\sigma}{4 \omega} \right) E^2 \]

(15)

Substitution of Eq. (15) into Eq. (2), gives

\[ m = \left[ 1 - 2 \left[ 1 + \frac{\mu}{4\sigma^2} \left( \frac{\sigma}{4\sigma} \right)^3 \frac{E^4}{\rho^2} - 1 \right] \right] m_{0} = \]

\[ = \left[ 1 - 2 \left[ 1 + \frac{\mu_0}{25\sigma^3 c^2} \left( \frac{\mu_0}{\rho^2 f^3} \right) E^4 - 1 \right] \right] m_{0} = \]

\[ = \left[ 1 - 2 \left[ 1 + 1.758 \times 10^{-27} \left( \frac{\mu_0}{\rho^2 f^3} \right) E^4 - 1 \right] \right] m_{0} \]

(16)

Using this equation we can then calculate the gravitational mass, \( m_{g(\Delta \chi)} \), of the region with thickness \( \Delta \chi \), in the outer shell. We have already seen that the electric field in this region is \( E_b \), whose intensity is given by \( E_b = q/4\pi\epsilon_0(r_a + \Delta \chi)^2 \).

Thus, we can write that

\[ E_b \approx \frac{q}{4\pi\epsilon_0} = \frac{CV}{4\pi\epsilon_0r_b^2} \]

(17)

where \( C = 4\pi\epsilon_0(r_a r_b / r_a - r_a) \) is the capacitance of the spherical capacitor; \( V \) is the potential applied on the inner shell (See Fig. 1 and 3). Thus, Eq. (17) can be rewritten as follows

\[ E_b = \frac{r_a V}{r_a(r_a - r_b)} \approx 1.9 \times 10^6 V \]

(18)

Substitution of \( \rho = 2700 kg m^{-3}, \sigma = 3.5 \times 10^7 S / m, \mu = 1 \) (Aluminum) and \( E = E_b \approx 1.9 \times 10^6 V \) into Eq. (16) yields

\[ m_{g(\Delta \chi)} = \left[ 1 - 2 \left[ 1 + 1.3 \times 10^3 \frac{1}{f^3} - 1 \right] \right] m_{0(\Delta \chi)} \]

(19)

Equation (5) shows that there is a correlation between \( V \) and \( f \) to be obeyed, i.e., \( f = 1.7V \). By substituting this expression into Eq. (19), we get

\[ \chi = \frac{m_{g(\Delta \chi)}}{m_{0(\Delta \chi)}} = \left[ 1 - 2 \left[ 1 + 2.64 \times 10^3 V - 1 \right] \right] \]

(20)
For $V = 35.29 \text{ Volts} \ (f = 1.7 V = 60\text{Hz})^\dagger$, Eq. (20) gives
$$\chi = \frac{m_{g(\Delta x)}}{m_{0(\Delta x)}} \approx 0.91 \quad (21)$$

For $V = 450 \text{ Volts} \ (f = 1.7 V = 765\text{Hz})$, Eq. (20) gives
$$\chi = \frac{m_{g(\Delta x)}}{m_{0(\Delta x)}} \approx 0.04 \quad (22)$$

For $V = 1200 \text{ Volts} \ (f = 1.7 V = 2040\text{Hz})$, Eq. (20) gives
$$\chi = \frac{m_{g(\Delta x)}}{m_{0(\Delta x)}} \approx -1.1 \quad (23)$$

In this last case, the weight of the shell with thickness $\Delta x$ will be $\Delta g \approx -1.1 m_{0(\Delta x)} g$; the sign (-) shows that it becomes repulsive in respect to Earth’s gravity. Besides this it is also intensified 1.1 times in respect to its initial value.

It was shown that, if the weight of a particle in a side of a lamina is $\Delta P = m_{g} \ddot{g}$ ($\ddot{g}$ perpendicular to the lamina) then the weight of the same particle, in the other side of the lamina, in the other side of the lamina is $\Delta P' = \chi m_{g} \ddot{g}$, where $\chi = m'_{g} / m'_{0}$ ($m'_{g}$ and $m'_{0}$ are respectively, the gravitational mass and the inertial mass of the lamina) [1]. Only when $\chi = 1$, the weight is equal in both sides of the lamina. The lamina works as a Gravity Controller. Since $P' = \chi P = (\chi m_{g}) g = m_{g} (\chi g)$, we can consider that

$$m'_{g} = \chi m_{g} \quad \text{or that} \quad g' = \chi g$$

Now consider the Spherical Capacitor previously mentioned. If the gravity below the capacitor is $g$, then above the first hemispherical shell with thickness $\Delta x$ (See Fig.4) it will become $\chi g$, and above the second hemispherical shell with thickness $\Delta x$, the gravity will be $\chi^{2} g$.

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$^\dagger$ Note that the frequency $f$ must be greater than 1Hz (See text above Eq. (3)).
Fig. 4 – Experimental Set-up using a Quantum Controller of Gravity (QCG).
References


