Gravity Control by means of Modified Electromagnetic Radiation

Fran De Aquino
Maranhao State University, Physics Department, S.Luis/MA, Brazil.

Here a new way for gravity control is proposed that uses electromagnetic radiation modified to have a smaller wavelength. It is known that when the velocity of a radiation is reduced its wavelength is also reduced. There are several ways to strongly reduce the velocity of an electromagnetic radiation. Here, it is shown that such a reduction can be done simply by making the radiation cross a conductive foil.

Key words: Modified theories of gravity, Experimental studies of gravity, Electromagnetic wave propagation.
PACS: 04.50.Kd , 04.80.-y, 41.20.Jb, 75.70.-i.

It was shown that the *gravitational mass* m_g and *inertial mass* m_i are correlated by means of the following factor [1]:

$$\frac{m_g}{m_{i0}}=\left\{1-2\left[\sqrt{1+\left(\frac{\Delta p}{m_{i0}c}\right)^2}-1\right]\right\} \qquad (1)$$

where m_{i0} is the *rest* inertial mass of the particle and Δp is the variation in the particle's *kinetic momentum*; c is the speed of light.

When Δp is produced by the absorption of a photon with wavelength λ, it is expressed by $\Delta p = h/\lambda$. In this case, Eq. (1) becomes

$$\frac{m_g}{m_{i0}}=\left\{1-2\left[\sqrt{1+\left(\frac{h/m_{i0}c}{\lambda}\right)^2}-1\right]\right\}$$

$$=\left\{1-2\left[\sqrt{1+\left(\frac{\lambda_0}{\lambda}\right)^2}-1\right]\right\} \qquad (2)$$

where $\lambda_0 = h/m_{i0}c$ is the *De Broglie wavelength* for the particle with *rest* inertial mass m_{i0}.

It is easily seen that m_g cannot be strongly reduced simply by using electromagnetic waves with wavelength λ because λ_0 is very smaller than $10^{-10}m$. However, it is known that the wavelength of a radiation can be strongly reduced simply by strongly reducing its velocity.

There are several ways to reduce the velocity of an electromagnetic radiation. For example, by making light cross an *ultra cold atomic gas*, it is possible to reduce its velocity down to *17m/s* [2-7]. Here, it is shown that the velocity of an electromagnetic radiation can be strongly reduced simply by making the radiation cross a conductive foil.

From Electrodynamics we know that when an electromagnetic wave with frequency f and velocity c incides on a material with relative permittivity ε_r, relative magnetic permeability μ_r and electrical conductivity σ, its *velocity is reduced* to $v = c/n_r$ where n_r is the index of refraction of the material, given by [8]

$$n_r=\frac{c}{v}=\sqrt{\frac{\varepsilon_r\mu_r}{2}\left(\sqrt{1+(\sigma/\omega\varepsilon)^2}+1\right)} \qquad (3)$$

If $\sigma >> \omega\varepsilon$, $\omega = 2\pi f$, the Eq. (3) reduces to

$$n_r=\sqrt{\frac{\mu_r\sigma}{4\pi\varepsilon_0 f}} \qquad (4)$$

Thus, the wavelength of the incident radiation becomes

$$\lambda_{\rm mod}=\frac{v}{f}=\frac{c/f}{n_r}=\frac{\lambda}{n_r}=\sqrt{\frac{4\pi}{\mu f\sigma}} \qquad (5)$$

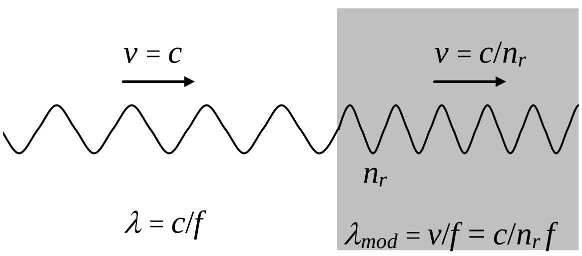


Fig. 1 – *Modified Electromagnetic Wave*. The wavelength of the electromagnetic wave can be strongly reduced, but its frequency remains the same.

Now consider a $1GHz$ ($\lambda \cong 0.3m$) radiation incident on *Aluminum foil* with $\sigma = 3.82\times10^7 S/m$ and thickness $\xi = 10.5\mu m$. According to Eq. (5), the *modified wavelength* is

$$\lambda_{mod} = \sqrt{\frac{4\pi}{\mu f \sigma}} = 1.6\times10^{-5}\,m \qquad (6)$$

Consequently, the wavelength of the 1*GHz* radiation *inside the foil* will be $\lambda_{mod} = 1.6\times10^{-5}\,m$ and not $\lambda \cong 0.3m$.

It is known that a radiation with frequency *f*, propagating through a material with electromagnetic characteristics ε, μ and σ, has the amplitudes of its waves decreased in e^{-1}=0.37 (37%), when it passes through a distance *z*, given by

$$z = \frac{1}{\omega\sqrt{\frac{1}{2}\varepsilon\mu\left(\sqrt{1+(\sigma/\omega\varepsilon)^2}-1\right)}} \qquad (7)$$

The radiation is totally absorbed at a distance $\delta \cong 5z$ [8].

In the case of the 1*GHz* radiation propagating through the Aluminum foil Eq. (7), gives

$$z = \frac{1}{\sqrt{\pi\mu\sigma f}} = 2.57\times10^{-6} = 2.57\mu m \qquad (8)$$

Since the thickness of the Aluminum foil is $\xi = 10.5\mu m$ then, we can conclude that, practically all the incident 1*GHz* radiation is absorbed by the foil.

If the foil contains n atoms/m^3, then the number of atoms per area unit is $n\xi$. Thus, if the electromagnetic radiation with frequency f incides on an area S of the foil it reaches $nS\xi$ atoms. If it incides on the total area of the foil, S_f, then the total number of atoms reached by the radiation is $N = nS_f\xi$. The number of atoms per unit of volume, n, is given by

$$n = \frac{N_0\rho}{A} \qquad (9)$$

where $N_0 = 6.02\times10^{26}\,atoms/kmole$ is the Avogadro's number ; ρ is the matter density of the foil (in *kg/m*^{3}) and A is the atomic mass. In the case of the *Aluminum* $(\rho = 2700kg/m^3, A = 26.98kmole)$ the result is

$$n_{Al} = 6.02\times10^{28}\,atoms/m^3 \qquad (10)$$

The *total number of photons* inciding on the foil is $n_{total\ photons} = P/hf^2$, where P is the power of the radiation flux incident on the foil.

When an electromagnetic wave incides on the Aluminum foil, it strikes on N_f front atoms, where $N_f \cong (nS_f)\phi_{atom}$. Thus, the wave incides effectively on an area $S = N_f S_a$, where $S_a = \frac{1}{4}\pi\phi^2_{atom}$ is the cross section area of one Aluminum atom. After these collisions, it carries out $n_{collisions}$ with the other atoms of the foil (See Fig.2).

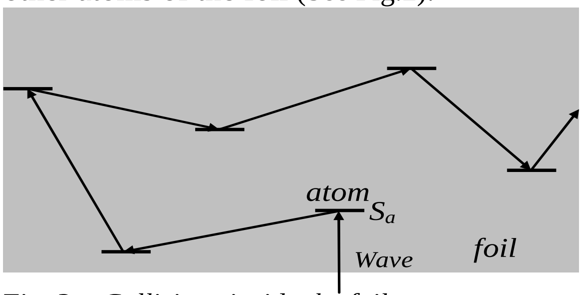


Fig. 2 – *Collisions inside the foil.*

Thus, the total number of collisions in the volume $S\xi$ is

$$N_{collisions} = N_f + n_{collisions} = nS\phi_{atom} + (nS\xi - nS\phi_{atom}) =$$
$$= nS\xi \qquad (11)$$

The power density, D, of the radiation on the foil can be expressed by

$$D = \frac{P}{S} = \frac{P}{N_f S_a} \qquad (12)$$

The same power density as a function of the power P_0 radiated from the antenna, is given by

$$D = \frac{P_0}{4\pi r^2} \qquad (13)$$

where r is the distance between the antenna and the foil. Comparing equations (12) and (13), we get

$$P = \left(\frac{N_f S_a}{4\pi r^2}\right)P_0 \qquad (14)$$

We can express the *total mean number of collisions in each atom*, n_1, by means of the following equation

$$n_1 = \frac{n_{total\ \ photons}N_{collisions}}{N} \qquad (15)$$

Since in each collision is transferred a *momentum* h/λ to the atom, then the *total momentum* transferred to the foil will be $\Delta p = (n_1 N)h/\lambda$. Therefore, in accordance with Eq. (1), we can write that

$$\frac{m_g}{m_{i0}}=\left\{1-2\left[\sqrt{1+\left[(n_1 N)\frac{\lambda_0}{\lambda}\right]^2}-1\right]\right\}=$$

$$=\left\{1-2\left[\sqrt{1+\left[n_{total\ photons}N_{collisions}\frac{\lambda_0}{\lambda}\right]^2}-1\right]\right\} \quad (16)$$

Since Eq. (11) gives $N_{collisions}=nS\xi$, we get

$$n_{total\ \ photons}N_{collisions}=\left(\frac{P}{hf^2}\right)(nS\xi) \quad (17)$$

Substitution of Eq. (17) into Eq. (16) yields

$$\frac{m_g}{m_{i0}}=\left\{1-2\left[\sqrt{1+\left[\left(\frac{P}{hf^2}\right)(nS\xi)\frac{\lambda_0}{\lambda}\right]^2}-1\right]\right\} \quad (18)$$

Substitution of Eq. (14) into Eq. (18) gives

$$\frac{m_g}{m_{i0}}=\left\{1-2\left[\sqrt{1+\left[\left(\frac{N_f S_a P_0}{4\pi\ r^2 f^2}\right)\left(\frac{nS\xi}{m_{i0}c}\right)\frac{1}{\lambda}\right]^2}-1\right]\right\} \quad (19)$$

Substitution of $N_f\cong(nS_f)\phi_{atom}$ and $S=N_f S_a$ into Eq. (19) it reduces to

$$\frac{m_g}{m_{i0}}=\left\{1-2\left[\sqrt{1+\left[\left(\frac{n^3S_f^2S_a^2\phi_{atom}^2P_0\xi}{4\pi\ r^2 m_{i0}cf^2}\right)\frac{1}{\lambda}\right]^2}-1\right]\right\} \quad (20)$$

In the case of a 20cm square Aluminum foil, with thickness $\xi=10.5\mu m$, we get $m_{i0}=1.1\times10^{-3}kg$, $S_f=4\times10^{-2}m^2$, $\phi_{atom}\cong10^{-10}m^2$ $S_a\cong10^{-20}m^2$, $n=n_{Al}=6.02\times10^{28}\,atoms/m^3$, Substitution of these values into Eq. (20), gives

$$\frac{m_{g(Al)}}{m_{i0(Al)}}=\left\{1-2\left[\sqrt{1+\left[\left(8.84\times10^{11}\frac{P_0}{r^2f^2}\right)\frac{1}{\lambda}\right]^2}-1\right]\right\} \quad (21)$$

Thus, if the Aluminum foil is at a distance $r=1m$ from the antenna, and the power radiated from the antenna is $P_0=32W$, and the frequency of the radiation is $f=1GHz$ then Eq.(21) gives

$$\frac{m_{g(Al)}}{m_{i0(Al)}}=\left\{1-2\left[\sqrt{1+\left[\frac{2.8\times10^{-5}}{\lambda}\right]^2}-1\right]\right\} \quad (22)$$

In the case of the Aluminum foil and $1Ghz$ radiation, Eq. (6) shows that $\lambda_{mod}=1.6\times10^{-5}m$. Thus, by substitution of λ by λ_{mod} into Eq. (22), we get the following expression

$$\frac{m_{g(Al)}}{m_{i0(Al)}}\cong-1 \quad (23)$$

Since $\vec{P}=m_g\vec{g}$ then the result is

$$\vec{P}_{(Al)}=m_{g(Al)}\vec{g}\cong-m_{i0(Al)}\vec{g} \quad (24)$$

This means that, in the mentioned conditions, *the weight force* of the Aluminum foil *is inverted*.

It was shown [1] that there is an additional effect of *Gravitational Shielding* produced by a substance whose gravitational mass was reduced or made negative. This effect shows that just *above the substance* the gravity acceleration g_1 will be reduced at the same ratio $\chi_1=m_g/m_{i0}$, i.e., $g_1=\chi_1 g$, (g is the gravity acceleration *bellow* the substance). This means that above the Aluminum foil the gravity acceleration will be modified according to the following expression

$$g_1=\chi_1 g=\left(\frac{m_{g(Al)}}{m_{i0(Al)}}\right)g \quad (25)$$

where the factor $\chi_1=m_{g(Al)}/m_{i0(Al)}$ will be given Eq. (21).

In order to check the theory presented here, we propose the experimental set-up shown in Fig. 3. The distance between the Aluminum foil and the antenna is $r=1m$. The maximum output power of the $1GHz$ transmitter is 32W CW. A 10g body is placed above Aluminum foil , in order to check the *Gravitational Shielding Effect*. The distance between the Aluminum foil and the 10g body is approximately 10 *cm*. The alternative device to measure the weight variations of the foil and the body (including the *negative* values) uses two balances (200g / 0.01g) as shown in Fig .3.

In order to check the effect of a *second* Gravitational Shielding above the first one(Aluminum foil), we can remove the 10g body, putting in its place a second Aluminum foil, with the same characteristics of the first one. The 10g body can be then placed at a distance of 10cm above of the second Aluminum foil. Obviously, it must be connected to a third balance.

As shown in a previous paper [9] the gravity above the second Gravitational Shielding, in the case of $\chi_2 = \chi_1$, is given by

$$g_2 = \chi_2 g_1 = \chi_1^2 g \qquad (26)$$

If a third Aluminum foil is placed above the second one, then the gravity above this foil is $g_3 = \chi_3 g_2 = \chi_3 \chi_2 \chi_1 g = \chi_1^3 g$, and so on.

In practice, *Multiple Gravitational Shieldings* can be constructed by inserting N several *parallel* Aluminum foils inside the dielectric of a parallel plate capacitor (See Fig. 4). In this case, the resultant capacity of the capacitor becomes $C_r = C/N = \varepsilon_r \varepsilon_0 S_f / Nd$, where S_f is the area of the Aluminum foils and d the distance between them; ε_r is the relative permeability of the dielectric. By applying a voltage V_{rms} on the plates of the capacitor a current i_{rms} is produced through the Aluminum foils. It is expressed by $i_{rms} = V_{rms}/X_C = 2\pi f C_r V_{rms}$.

Since $j_{rms} = \sigma E_{rms}$ and $j_{rms} = i_{rms}/S_f$ we get $E_{rms} = i_{rms}/S_f\,\sigma$, which is the oscillating electric field through the Aluminum foils. By substituting this expression into Eq. (20), and considering that $\lambda = \lambda_{mod} = (4\pi/\mu f \sigma)^{\frac{1}{2}}$ (Eq.6) and $D = P_0/4\pi r^2 = n_r E_{rms}^2/2\mu_r \mu_0 c$, where $n_r = (\mu_r \sigma / 4\pi\varepsilon_0 f)^{\frac{1}{2}}$ (Eq. 4), we obtain:

$$\chi = \left\{1 - 2\left[\sqrt{1 + \frac{n_{Al}^6 S_a^4 \phi_{atom}^4 i_{rms}^4}{64\pi^2 \rho_{Al}^2 c^2 S_f^2 \sigma_{Al}^2 f^4}} - 1\right]\right\} \qquad (27)$$

Since

$$i_{rms} = V_{rms}/X_C = 2\pi f C_r V_{rms} = 2\pi f (\varepsilon_r \varepsilon_0 S_f / Nd) V_{rms}$$

Then

$$\frac{i_{rms}}{f} = 2\pi (\varepsilon_r \varepsilon_0 S_f / Nd) V_{rms} \qquad (28)$$

Substitution of this equation into Eq. (27) gives

$$\chi = \left\{1 - 2\left[\sqrt{1 + \frac{\pi^2 n_{Al}^6 S_a^4 \phi_{atom}^4 \varepsilon_r^4 \varepsilon_0^4 S_f^2 V_{rms}^4}{4\rho_{Al}^2 c^2 \sigma_{Al}^2 N^4 d^4}} - 1\right]\right\} \qquad (29)$$

Substitution of the known value of $n_{Al} = 6.02\times10^{28} atoms/m^3$, $\phi_{atom} \cong 1\times10^{-10} m$, $S_a = \frac{1}{2}\left[4\pi(\phi_{atom}/2)^2\right] = \frac{1}{2}\pi\phi_{atom}^2 \cong 1\times10^{-20} m^2$, $\varepsilon_r = 2.1$ (Teflon $24KV/mm$, Short Time, 1.6 mm [10]), $\rho_{Al} = 2700 kg.m^{-3}$, we get

$$\chi = \left\{1 - 2\left[\sqrt{1 + 1.4\times10^{-29}\frac{S_f^2}{N^4}\left(\frac{V_{rms}}{d}\right)^4} - 1\right]\right\} \qquad (30)$$

Note that, based on the equation above, it is possible to create a device for moving very heavy loads such as large monoliths, for example.

Imagine a large monolith on the Earth's surface. If we place below the monolith some sets with *Multiple Gravitational Shieldings* (See Fig.4), the value of the gravity acceleration above each set of Gravitational Shieldings becomes

$$g_R = \chi^\eta g \qquad (31)$$

where η is the number of Gravitational Shieldings in each set.

Since we must have $V_{rms}/d < 24KV/mm$ (dielectric strength of Teflon) [10] then, for $d = 1.6mm \rightarrow V_{rms} < 38.4KV$. For $V_{rms} = 37KV$, $d = 1.6mm$, $S_f = 2.7m^2$, $N = 2$ and $\eta = 3$ Eq. (30) gives $\chi = -0.36$ and Eq. (31) shows that $g_R = \chi^3 g \cong -0.46 m/s^2$. The sign (-) shows that *the gravity acceleration above the six sets of Gravitational Shieldings* becomes *repulsive* in respect to the Earth. Thus, by controlling the value of χ it is possible to make the total mass of the monolith slightly negative in order to the monolith can float and, in this way, it can be displaced and carried to anywhere with ease.

Considering the dielectric strength of known dielectrics, we can write that $(V_{rms}/d)_{max} < 200KV/mm$. Thus, for a single capacitor $(N = 1)$ Eq. (30) gives

$$\chi = \left\{1 - 2\left[\sqrt{1 + \left(<< 2.2\times10^4 S_f^2\right)} - 1\right]\right\} \qquad (31)$$

The Gravitational Shielding effect becomes negligible for $\chi < 0.01$ (variation smaller than 1% in the gravitational mass). Thus, considering Eq. (31), we can conclude that *the Gravitational Shielding effect becomes significant only for* $S_f >> 10^{-2} m^2$. Possibly this is why it was not yet detected.

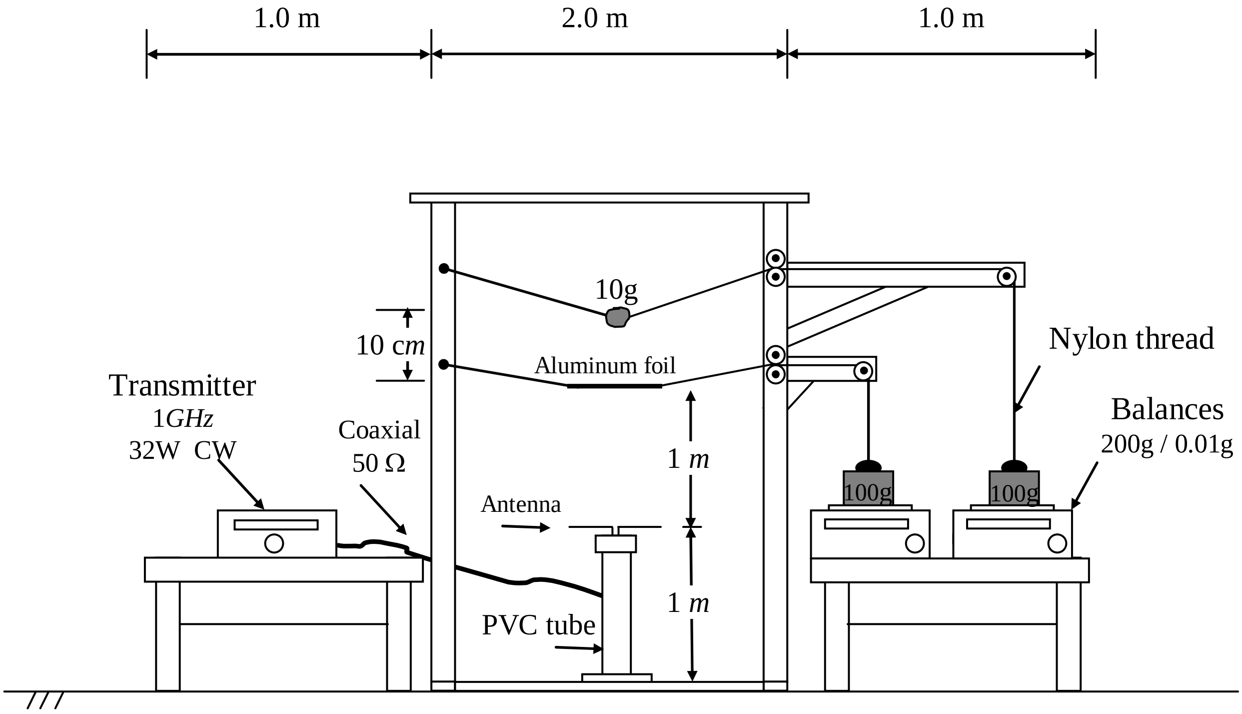
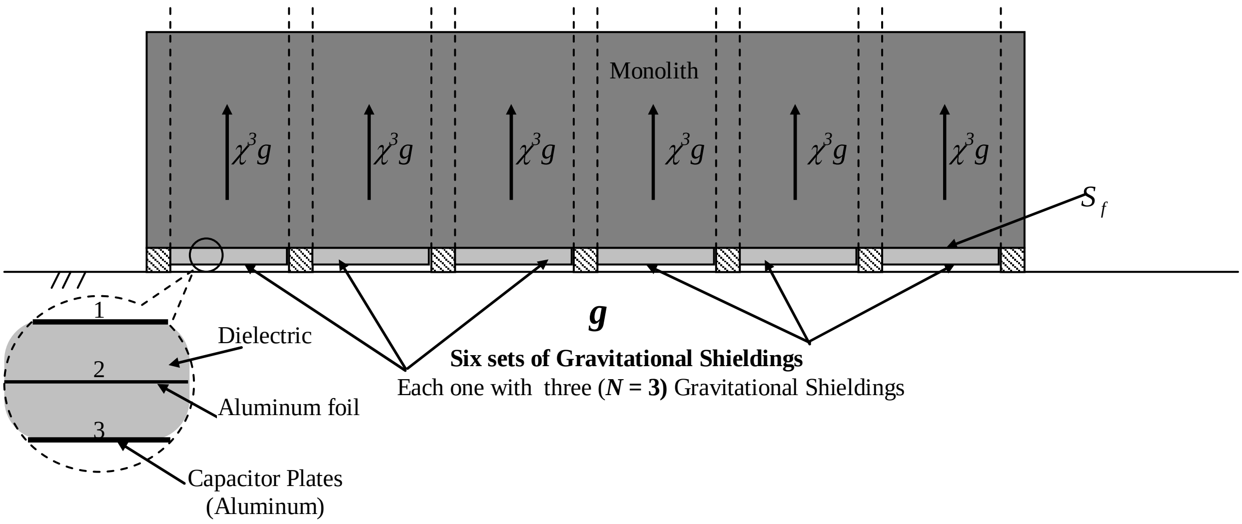
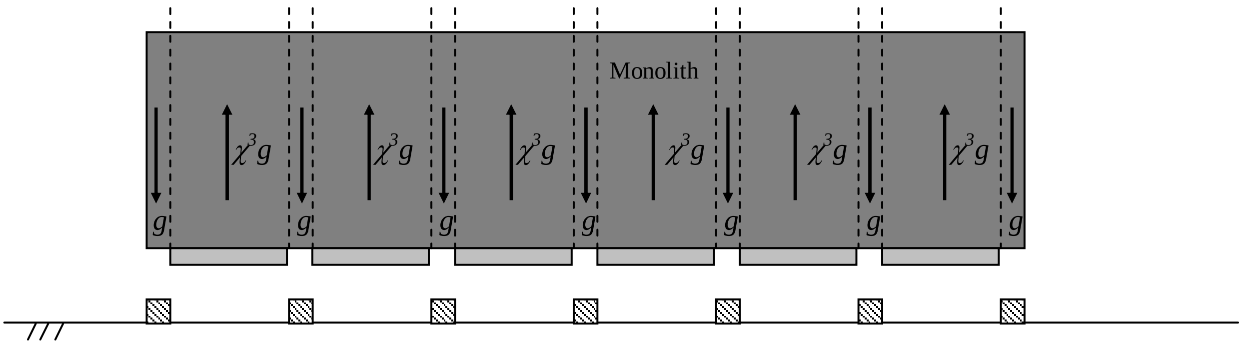


Fig. 3 – Experimental Set-up



(a)



(b)

Fig. 4 – *System with six sets of Gravitational Shieldings for moving very heavy loads.* For $V_{rms} = 37KV$, $d = 1.6mm$, $S_f = 2.7m^2$, $N = 2$ and $\eta = 3$ Eq. (30) gives $\chi = -0.36$ and Eq. (31) shows that $g_R = \chi^3 g \cong -0.46 m/s^2$. The sign (-) shows that *the gravity acceleration above the six sets of Gravitational Shieldings* becomes *repulsive* in respect to the Earth. Thus, by controlling the value of χ it is possible to make the total mass of the monolith slightly negative in order to the monolith can float and, in this way, it can be displaced and carried to anywhere with ease.

References

[1] De Aquino, F. (2010) *Mathematical Foundations of the Relativistic Theory of Quantum Gravity*, Pacific Journal of Science and Technology, **11** (1), pp. 173-232.

[2] Hau, L.V., et al., (1999) Nature, 397, 594-598.

[3] Kash, M. M. et al., (1999) Phys. Rev. Lett. 82, 5229.

[4] Budiker, D. et al., (1999) Phys. Rev. Lett. 83, 1767.

[5] Liu, Ch. et al., (2001) Nature 409, 490.

[6] Dutton, Z., et al., (2001) Science 293, 663.

[7] Turukhin, A. V., et al., (2002) Phys. Rev. Lett. 88, 023602

[8] Quevedo, C. P. (1977) *Eletromagnetismo*, McGraw-Hill, p. 270.

[9] De Aquino, F. (2010) *Gravity Control by means of Electromagnetic Field through Gas at Ultra-Low Pressure*, Pacific Journal of Science and Technology, **11**(2) November 2010, pp.178-247.

[10] Teflon® PTFE, *Properties Handbook*, Du Pont, (7/96) 220313D, USA.