Decreasing of the Gravitational Mass in materials with *Extremely High Permeability* subjected to an Alternating Magnetic Field of Extremely Low Frequency.

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Here we propose a very simple experiment in order to check the decreasing of the *Gravitational Mass* in materials with *Extremely High Permeability* subjected to an Alternating Magnetic Field of Extremely Low Frequency.

Key words: Gravitational Mass, Magnetic Field of Extremely Low Frequency, Extremely High Permeability.

INTRODUCTION

In this paper it is proposed a very simple experimental set-up in order to check the decreasing of the *Gravitational Mass* in materials with *Extremely High Permeability* subjected to an Alternating Magnetic Field of Extremely Low Frequency.

THEORY

In a previous paper [1] we shown that there is a correlation between the gravitational mass, m_g, and the rest inertial mass m_{i0}, which is given by

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

where Δp 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/kg); ρ is the matter density (kg/m^3) and c is the speed of light.

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

$$W = \tfrac{1}{2}\varepsilon E^2 + \tfrac{1}{2}\mu H^2 \qquad (2)$$

where $E = E_m \sin\omega t$ and $H = H\sin\omega t$ are the *instantaneous values* of the electric field and the magnetic field respectively.

It is known that $B = \mu H$, $E/B = \omega/k_r$ [2] and

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

where k_r is the real part of the *propagation vector* $\vec{k}$ (also called *phase constant*); $k = |\vec{k}| = k_r + ik_i$; ε , μ and σ, are the electromagnetic characteristics of the medium in which the incident (or emitted) radiation is propagating ($\varepsilon = \varepsilon_r\varepsilon_0$; $\varepsilon_0 = 8.854\times10^{-12}F/m$; $\mu = \mu_r\mu_0$ where $\mu_0 = 4\pi\times10^{-7}H/m$; σ is the electrical conductivity in *S/m*). From Eq. (3), we see that the *index of refraction* $n_r = c/v$ is given by

$$n_r = \frac{c}{v} = \sqrt{\frac{\varepsilon_r\mu_r}{2}\left(\sqrt{1+(\sigma/\omega\varepsilon)^2}+1\right)} \qquad (4)$$

Equation (3) shows that $\omega/\kappa_r = v$. Thus, $E/B = \omega/k_r = v$, i.e.,

$$E = vB = v\mu H \qquad (5)$$

Then, Eq. (2) can be rewritten as follows

$$W = \tfrac{1}{2}\varepsilon\, v^2\mu^2H^2 + \tfrac{1}{2}\mu H^2 = = \tfrac{1}{2}\mu H^2\left(\varepsilon v^2\mu\right) + \tfrac{1}{2}\mu H^2 = \mu H^2 \qquad (6)$$

For $\sigma >> \omega\varepsilon$, Eq. (3) gives

$$n_r^2 = \frac{c^2}{v^2} = \frac{\mu\sigma}{2\omega}c^2 \qquad (7)$$

Substitution of Eqs. (6) and (5) into Eq. (1) gives

$$\chi = \frac{m_g}{m_{i0}} = \left\{1 - 2\left[\sqrt{1 + \left(\frac{\mu^3\sigma}{4\pi f \rho^2 c^2}\right)H^4} - 1\right]\right\} \qquad (8)$$

Note that if $H = H_m \sin \omega t$. Then, the average value for H^2 is equal to $\frac{1}{2}H_m^2$ because H varies sinusoidaly (H_m is the maximum value for H). On the other hand, we have $H_{rms} = H_m/\sqrt{2}$. Consequently, we can change H^4 by H_{rms}^4, and the Eq. (8) can be rewritten as follows

$$\chi = \frac{m_g}{m_{i0}} = \left\{1 - 2\left[\sqrt{1 + \left(\frac{\mu^3\sigma}{4\pi\ f \rho^2 c^2}\right)H_{rms}^4} - 1\right]\right\} \qquad (9)$$

Note that in this equation the value of the *magnetic permeability*, μ, is raised to the *third* power. This means that the decreasing of the Gravitational Mass in materials with *Extremely High Permeability* ($\mu_r > 100{,}000$; $\mu = \mu_r \mu_0$; $\mu_0 = 4\pi \times 10^{-7} H/m$) subjected to an Alternating Magnetic Field (H_{rms}) of *Extremely Low Frequency* ($f < 100Hz$) can be easily observed experimentally.

SUGGESTED EXPERIMENT

Let us consider some known materials with Extremely High Permeability. For example: Metglas, Supermalloy and pure Iron, which the following characteristics [3, 4]:

Metglas (Metglas 2714A, annealed)
$\mu_r = 1{,}000{,}000$ At 0.5 T
$\sigma = 7.04 \times 10^5 S/m$
$\rho = 7590\ kg.m^{-3}$
Supermalloy (annealed in H controlled cooling)
$\mu_r = 1{,}000{,}000$ At 0.7 T
$\sigma = 1.6 \times 10^6 S/m$
$\rho = 8770\ kg.m^{-3}$
Iron (99.95% pure Fe annealed in H)
$\mu_r = 200{,}000$
$\sigma = 1.05 \times 10^7 S/m$
$\rho = 7600\ kg.m^{-3}$
For these materials Eq. (9), respectively, gives

$$\chi_{Metglas} = \left\{1 - 2\left[\sqrt{1 + 2.1 \times 10^{-20}\left(\frac{H_{rms}^4}{f}\right)} - 1\right]\right\} \qquad (10)$$

$$\chi_{Supermalloy} = \left\{1 - 2\left[\sqrt{1 + 3.6 \times 10^{-20}\left(\frac{H_{rms}^4}{f}\right)} - 1\right]\right\} \qquad (11)$$

$$\chi_{Iron} = \left\{1 - 2\left[\sqrt{1 + 2.5 \times 10^{-21}\left(\frac{H_{rms}^4}{f}\right)} - 1\right]\right\} \qquad (12)$$

For $f = 60Hz$, the result is

$$\chi_{Metglas} = \left\{1 - 2\left[\sqrt{1 + 3.5 \times 10^{-22} H_{rms}^4} - 1\right]\right\} \qquad (13)$$

$$\chi_{Supermalloy} = \left\{1 - 2\left[\sqrt{1 + 6.0 \times 10^{-22} H_{rms}^4} - 1\right]\right\} \qquad (14)$$

$$\chi_{Iron} = \left\{1 - 2\left[\sqrt{1 + 4.1 \times 10^{-23} H_{rms}^4} - 1\right]\right\} \qquad (15)$$

Then, for $H_{rms} = 4 \times 10^5 A/m\ (B = 0.5T)$, we get

$$\chi_{Metglas} = -3.3 \quad \Rightarrow \quad m_{g(Metglas)} = -3.3 m_{i0(Metglas)}$$
$$\left(P_{(Metglas)} = m_{g(Metglas)}g = -3.3 m_{i0(Metglas)}g = -3.3P\right)$$

$$\chi_{Smalloy} = -5.1 \quad \Rightarrow \quad m_{g(Smalloy)} = -5.1 m_{i0(Smalloy)}$$
$$\left(P_{(Smalloy)} = m_{g(Smalloy)}g = -5.1 m_{i0(Smalloy)}g\right)$$

$$\chi_{Iron} = -0.13 \quad \Rightarrow \quad m_{g(Iron)} = -0.13 m_{i0(Iron)}$$
$$\left(P_{(Iron)} = m_{g(Iron)}g = -0.13 m_{i0(Iron)}g\right)$$

The results above can be easily checked by means of the experimental set-up shown in Fig.1.

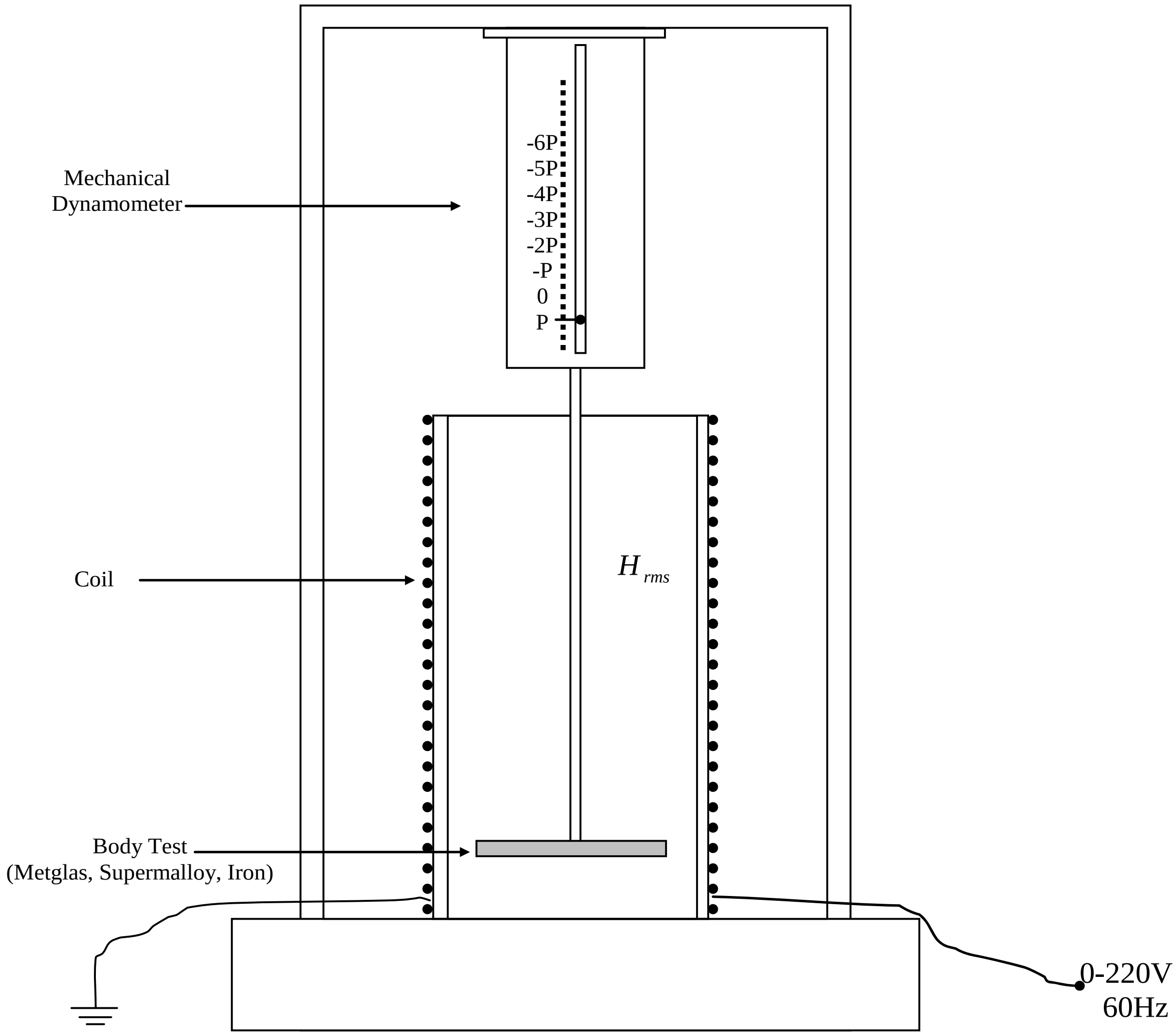

Fig. 1 – Schematic diagram of the experimental set-up to check the decreasing of the *Gravitational Mass* in materials with *Extremely High Permeability* subjected to an Alternating Magnetic Field with frequency $f = 60Hz$.

APPENDIX A: **How the Inertial Properties of a Spacecraft can be strongly reduced.**

Consider the schematic diagram of a spacecraft shown in Fig. 2. At the center of the spacecraft has a ferromagnetic material with *Extremely High Permeability*, μ , *subjected* to an alternating magnetic field H_{rms} of *Extra-low frequency*, f . According to Eq. (9), its *gravitational mass*, m_{gC} , is then given by

$$m_{gC} = \left\{1 - 2\left[\sqrt{1 + \left(\frac{\mu^3 \sigma}{4\pi\ f\rho^2 c^2}\right) H_{rms}^4} - 1\right]\right\} m_{i0C} \qquad (A1)$$

In the equation (A1), σ is the electrical conductivity of the ferromagnetic material; ρ is its mass density, and m_{i0C} is the *rest* inertial mass of the mentioned material.

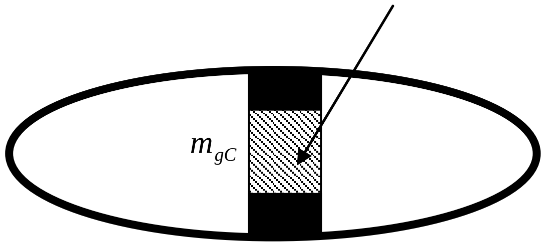

Fig.2 – Schematic diagram of an Ellipsoidal Spacecraft

Then, the *total* gravitational mass of the spacecraft, $M_{gS(total)}$, can be expressed by means of the following expression:

$$M_{gS(total)} = M_{gS} + m_{gC} \qquad (A2)$$

where M_{gS} is the total gravitational mass of the spacecraft *without* the gravitational mass of the ferromagnetic core. Assuming that density of *external* electromagnetic energy in M_{gS} is negligible, then we can write that $M_{gS} \cong M_{i0S}$, where M_{i0S} is the *rest* inertial mass of the spacecraft (without the ferromagnetic core) (See Eq. 1). Thus, Eq. (A2) can be rewritten as follows:

$$M_{gS(total)} \cong M_{i0S} + m_{gC} =$$

$$\cong M_{i0S} + \left\{1 - 2\left[\sqrt{1 + \left(\frac{\mu^3 \sigma}{4\pi\ f\rho^2 c^2}\right) H_{rms}^4} - 1\right]\right\} m_{i0C} \qquad (A3)$$

Therefore, for $\left(\mu^3\sigma / 4\pi\ f\rho^2 c^2\right) H_{rms}^4 >> 1$, we get

$$M_{gS(total)} \cong M_{i0S} - \left[\sqrt{\left(\frac{\mu^3 \sigma}{\pi\ f\rho^2 c^2}\right) H_{rms}^4}\right] m_{i0C} \qquad (A4)$$

If the ferromagnetic material is the *Supermalloy*, then Eq. (A4) gives (See Eq. (11))

$$M_{gS(total)} \cong M_{i0S} - \left[\sqrt{3.6 \times 10^{-20} \left(\frac{H_{rms}^4}{f}\right)}\right] m_{i0C} \qquad (A5)$$

For example, if $M_{gS} \cong M_{i0S} = 10{,}000 kg$; $m_{i0C} = 100 kg$; $f = 1 Hz$ and $H_{rms} = 7.2597 \times 10^5 A/m$, $\left(B_{rms} \cong 0.9T\right)$, then Eq. (A5) yields

$$M_{gS(total)} < 1 kg .$$

This means a decreasing greater than 10,000 times in the gravitational mass of the spacecraft.

Mach's principle predicts that *inertial forces* acting on a particle are the result from the *gravitational* interaction between the particle and the other particles of the Universe. Thus, the inertial forces F_{ii} acting on a particle are proportional to *gravitational mass*, m_g , of the particle, i.e., $F_{ii} = m_g a_i$ [1]. This fact shows that the inertial effects upon a spacecraft can be strongly reduced because, as we have seen, the *gravitational mass* of the spacecraft $M_{gS(total)}$ can be strongly reduced ($F_{ii} = M_{gS(total)} a_i$). In practice, it means that will be possible to become *quasi*-null the inertial properties of the spacecraft.

Under these circumstances, the spacecraft can describe incredible trajectories, and to make super accelerations and super decelerations in a very short time interval (<1s), without be destructed (See *The Gravitational Spacecraft* [5]).

APPENDIX B: **Gravitational Motor with design similar to an Internal Combustion Engine**

Based on the possibilities described in this paper, we show now how it is possible to convert *gravitational energy* into *rotational kinetic energy* by means of a Gravitational Motor, which design is similar to the Internal Combustion Engine (See Fig.3). In that Gravitational Motor the pistons are made of ferromagnetic material with *Extremely High Permeability*, μ, *subjected* to an alternating magnetic field, H_{rms}, of *Extra-low frequency*, f. According to Eq. (9), the *gravitational mass* of *one* piston, m_{gP}, is given by

$$m_{gP} = \left\{1-2\left[\sqrt{1+\left(\frac{\mu^3\sigma}{4\pi\ f\rho^2c^2}\right)H_{rms}^4}-1\right]\right\}m_{i0P} \qquad (B1)$$

In the equation (B1), σ is the electrical conductivity of the ferromagnetic material; ρ is its mass density, and m_{i0P} is the *rest inertial mass* of the piston.

If the pistons are made of Supermalloy, the result is

$$\chi = \frac{m_{gP}}{m_{i0P}} = \left\{1-2\left[\sqrt{1+3.6\times10^{-20}\left(\frac{H_{rms}^4}{f}\right)}-1\right]\right\} \qquad (B2)$$

If $f = 1Hz$ and $H_{rms} = 7.2597\times10^5 A/m$, $(B_{rms} \cong 0.9T)$, then Eq. (B2) yields

$$\chi = \frac{m_{gP}}{m_{i0P}} \cong -197 \qquad (B3)$$

Then, the gravitational force, $\vec{F}$, acting on *one* piston (See Fig.3) is

$$\vec{F} = m_{gP}\vec{g} = \chi m_{i0P}\vec{g} = m_{i0P}(\chi\vec{g}) = m_{i0P}\vec{a}\ ,\ ^*$$

and the average power is $\bar{P} = F\bar{v}$, where

$$\bar{v} = \tfrac{1}{2}\sqrt{2aH} = \sqrt{|\chi g|H/2} \qquad (B4)$$

Thus, we can write that

$$\bar{P} = F\bar{v} = m_{i0P}a\sqrt{|\chi g|H/2} = m_{i0P}\sqrt{|\chi g|^3 H/2} \qquad (B5)$$

For $g = 9.81m.s^{-2}$, $\chi = -197$ (See Eq. (B3), $m_{i0P} = 5kg$ and $H = 0.15m$ we get

$$\bar{P} = 1.1\times10^5 W \cong 147HP \qquad (B6)$$

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* Note that the acceleration $\vec{a}$ has direction opposed to $\vec{g}$, because χ is *negative* (See B3).

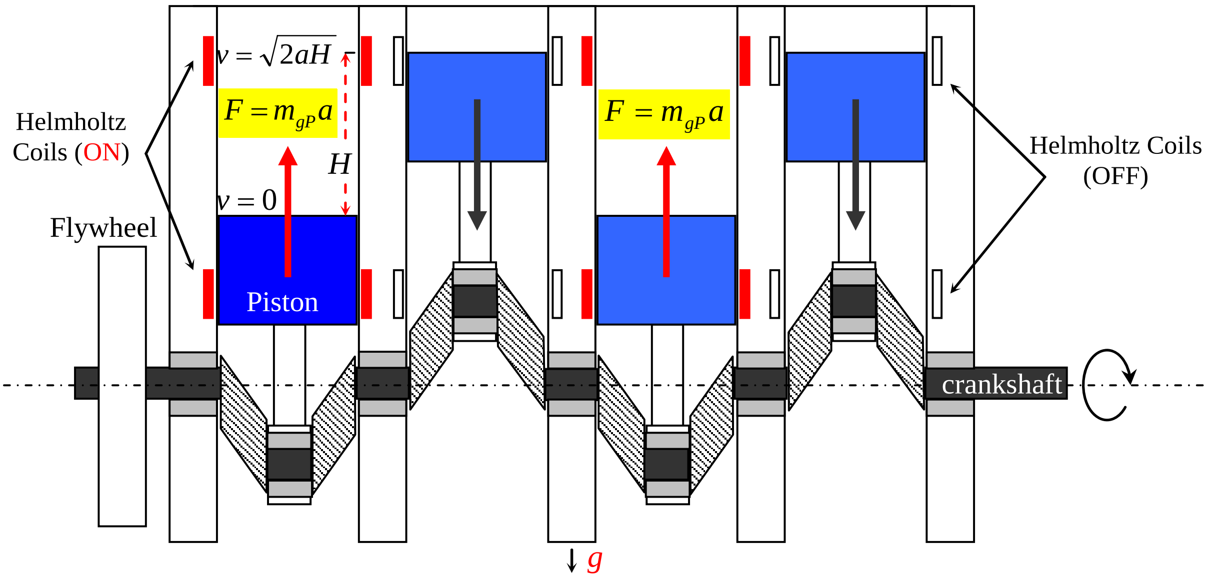

Fig. 3 – Schematic diagram of a Gravitational Motor with design similar to the Internal Combustion Engine. Here the pistons are made with materials whose *magnetic permeabilities* are *Extremely High*. The Helmholtz Coils provide the alternating magnetic field H_{rms}.

APPENDIX C: **Gravitational Thruster of Fluids**

In a previous paper [6] it was shown that, when the gravitational mass, m_{g1}, of a plate is reduced by the factor $\chi_1 = m_{g1}/m_{i01}$, then the gravity acceleration *after* the plate, g_1, is reduced at the same proportion, i.e., $g_1 = \chi_1 g$ where g is the gravity acceleration *before* the plate (See Fig. 4).

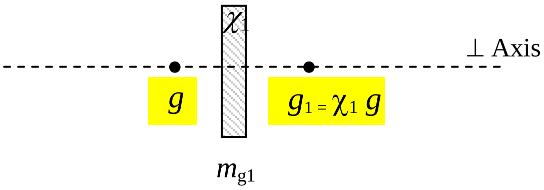

Fig. 4 - The gravity acceleration *after* the plate is $g_1 = \chi_1 g$ where g is the gravity acceleration *before* the plate. The perpendicular axis of the plate can be in any direction.

Consequently, *after* a *second* plate, with gravitational mass, m_{g2}, the gravity becomes: $g_2 = \chi_2 g_1 = \chi_1 \chi_2 g$, where $\chi_2 = m_{g2}/m_{i02}$. In a generalized way, we can write that *after* the *nth* plate the gravity, g_n, will be given by

$$g_n = \chi_1 \chi_2 \chi_3 \cdots \chi_n g \qquad (C1)$$

If $\chi_1 = \chi_2 =,...,= \chi_n = \chi < -1$, and n is *odd* then, the gravitational forces, F, between a body B *before* the *first* plate and another body A *after* the *nth* plate are *repulsive* (See Fig.5), and given by

$$F = m_{gA} g_n = m_{gA}\left(\chi^n g\right) = m_{gA}\left(-\left|\chi^n\right|\right)\left(-G\frac{M_{gB}}{r^2}\right) =$$
$$= +\left|\chi^n\right| G \frac{M_{gB} m_{gA}}{r^2} \qquad (C2)$$

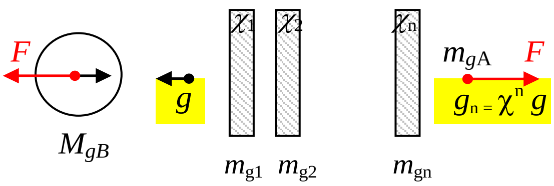

Fig. 5 – The gravity after a battery of plates

This possibility shows that, by means of a battery of similar plates, we can make particles acquire enormous accelerations. In practice, this can lead to the conception of a *Gravitational Thruster of Fluids* (See Fig.6). In this case, the plates have the same dimensions (with the same inertial mass m_{i0P}), and they are made of materials with *Extremely High Permeability*, μ, *subjected* to an alternating magnetic field, H_{rms}, of *Extra-low frequency*, f. If the gravitational masses of the plates are, m_{gP}, then, according to Eq. (9), we can write that

$$\chi = \frac{m_{gP}}{m_{i0P}} = \left\{1 - 2\left[\sqrt{1 + \left(\frac{\mu^3 \sigma}{4\pi f \rho^2 c^2}\right) H_{rms}^4} - 1\right]\right\} \qquad (C3)$$

If the plates are made of Supermalloy, we get

$$\chi = \frac{m_{gP}}{m_{i0P}} = \left\{1 - 2\left[\sqrt{1 + 3.6 \times 10^{-20}\left(\frac{H_{rms}^4}{f}\right)} - 1\right]\right\} \qquad (C4)$$

If $f = 1Hz$ and $H_{rms} = 4 \times 10^5 A/m \ (B = 0.5T)$, , then Eq. (C4) yields

$$\chi = m_{gP}/m_{i0P} \cong -57.7 \qquad (C5)$$

If g refers to the gravity produced by a sphere with inertial mass $m_{i0} = 10Kg$, and $M_g = m_{i0}$, at the distance $r = 1cm$, then $g = GM_g/r^2 = 6.6 \times 10^{-6} m.s^{-2}$. Thus, the gravity acceleration *after* the *nth* plate, g_n, for $n = 5$, will be given by

$$g_n = \chi^5 g = \left|\left(-57.7\right)^5\right| g = +4.2 \times 10^3 m.s^{-2} \qquad (C6)$$

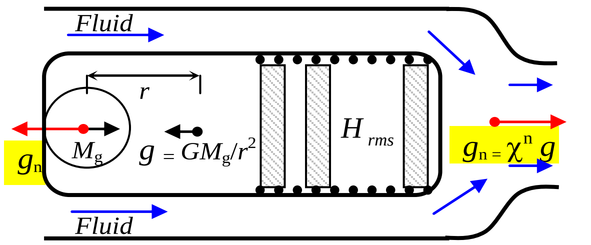

Fig. 6 - *Gravitational Thruster of Fluids*

Note that this system can be modified to produce *microgravity environments* (See Fig. 6a). In a previous paper [7] we described another way to produce microgravity environments in order to "activate" the cellular *autophagy*. After an infection, autophagy can destroy *bacteria* and *viruses*.

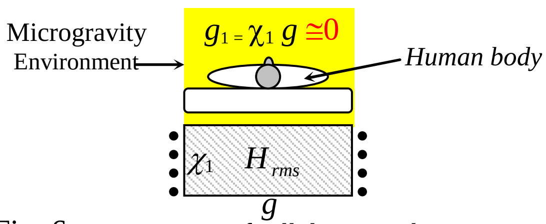

Fig. 6a – *Activation of cellular Autophagy* in Human bodies.

APPENDIX D: **Another type of Gravitational Motor**

In Fig.7, we show a schematic diagram of another type of Gravitational Motor. Now the Gravitational Motor has 4 Gravity Control Cells (GCC), which can be made with *plates* of materials with *Extremely High Permeability*, μ, *subjected* to an alternating magnetic field, H_{rms}, of *Extra-low frequency*, f. If the gravitational masses of the plates are, m_{gP}, then, according to Eq. (9), we can write that

$$\chi = \frac{m_{gP}}{m_{i0P}} = \left\{1 - 2\left[\sqrt{1 + \left(\frac{\mu^3 \sigma}{4\pi\ f\rho^2 c^2}\right) H_{rms}^4} - 1\right]\right\} \quad (D1)$$

For *Supermalloy plates*, (See Eq. (11)), we get

$$\chi = \frac{m_{gP}}{m_{i0P}} = \left\{1 - 2\left[\sqrt{1 + 3.6 \times 10^{-20}\left(\frac{H_{rms}^4}{f}\right)} - 1\right]\right\} \quad (D2)$$

If $f = 1Hz$ and $H_{rms} = 4 \times 10^5 A/m$, $(B = 0.5T)$, then Eq. (D2) yields the following value for the *correlation factor* χ:

$$\chi = m_{gP}/m_{i0P} \cong -57.7 \quad (D3)$$

The Gravity Control Cells, GCC1, GCC2 and the GCC3 are placed below the rotor (See Fig.7); GCC1 and GCC2 on the right and GCC3 on the left. Above the GCC1 the local gravity, $\vec{g}$, is intensified for $\vec{g}' = \chi_1 \chi_2 \vec{g} = +n\vec{g}$, where $\chi_1 = -n$ and $\chi_2 = -1$ are the correlation factors for GCC1 and GCC2, respectively. Above the GCC3 the local gravity becomes $\vec{g}'' = \chi_3 \vec{g} = -n\vec{g}$, where $\chi_3 = -n$. The function of GCC4 and GCC5 (See Fig.7), is only to revert the gravity down to values very close to g.

As the gravity acceleration on the left *half* of the rotor becomes $\vec{g}'' = -n\vec{g}$ while the gravity acceleration on the right *half* of the rotor becomes $\vec{g}' = +n\vec{g}$, the torque on the rotor is

$$T = \left(-\vec{F}'' + \vec{F}'\right) \times \vec{r} = = \left(-\tfrac{1}{2} m_g \vec{g}'' + \tfrac{1}{2} m_g \vec{g}'\right)\vec{r} \quad (D4)$$

($m_g \cong m_{i0}$ is the mass of the rotor), and the rotor spins with angular velocity ω.

Then, the average power, P, of the gravitational motor is given by

$$P = T\omega = nm_{i0} g\omega\, r \quad (D5)$$

On the other hand, we have that

$$g'' + g' = \omega^2 r \quad (D6)$$

Therefore the angular speed of the rotor is

$$\omega = \sqrt{2ng/r} \quad (D7)$$

By substituting (D7) into (D5) we obtain the expression of the average power of the *gravitational motor*, i.e.,

$$P = nm_{i0} gr\sqrt{\frac{2ng}{r}} = m_{i0}\sqrt{2n^3 g^3 r} \quad (D8)$$

Now consider an electric generator coupling to the gravitational motor in order to produce electric energy. Since $\omega = 2\pi f$ then for $f = 60Hz$ we have

$$\omega = 120\pi rad.s^{-1} = 3600 rpm \quad (D9)$$

. Therefore for $\omega = 120\pi rad.s^{-1}$ and $\chi_1 = \chi_3 = -n = -57.7$ (See (D3)) the Eq. (D7) tells us that we must have

$$r = 2ng/\omega^2 = 0.0786m \quad (D10)$$

Since $r = R/3$ and $m_i = \rho\pi R^2 h$ where ρ, R and h are respectively the mass density, the radius and the height of the rotor then for $h = 0.5m$ and $\rho = 7800 Kg.m^{-3}$ (iron) we obtain

$$m_i = 75.69kg \quad (D11)$$

Then Eq. (D8) gives

$$P \cong 4.04 \times 10^5 W \cong 404kW \cong 541HP$$

Thus, when coupled to a conventional generator of electrical energy, this Gravitational Motor can supply an amount of electrical energy of about[2] $0.9\left(4.04 \times 10^5 W\right)\left(3600s\right) = 1.3 \times 10^9 j = \cong 361kW$ per hour. This energy is enough to supply about 180 homes, each one with an average consumption of about 2kW per hour[3].

Note that this electrical energy is produced *without the use of any type of fuel*,

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[2] Assuming an efficiency of 90%.

[3] In the US *typical household* power *consumption* is about 1.3 kW per hour. http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3.

because the energy, which moves the Gravitational Motor comes from Earth's gravitational field, i.e., the Gravitational Motor converts directly energy from the Earth's gravitational field into rotational mechanical energy.

Thus, the Gravitational Motors are similar to the turbines of the hydroelectric plants. While the turbines convert energy from the Earth's gravitational field into rotational mechanical energy, by means of water of the rivers, this type of Gravitational Motors convert energy from the Earth's gravitational field *directly* into rotational mechanical energy, by using the GCCs.

Finally, note the *small volume* of the rotor of this type Gravitational Motor, it shows that the total volume of the motor can be smaller than 1m3.

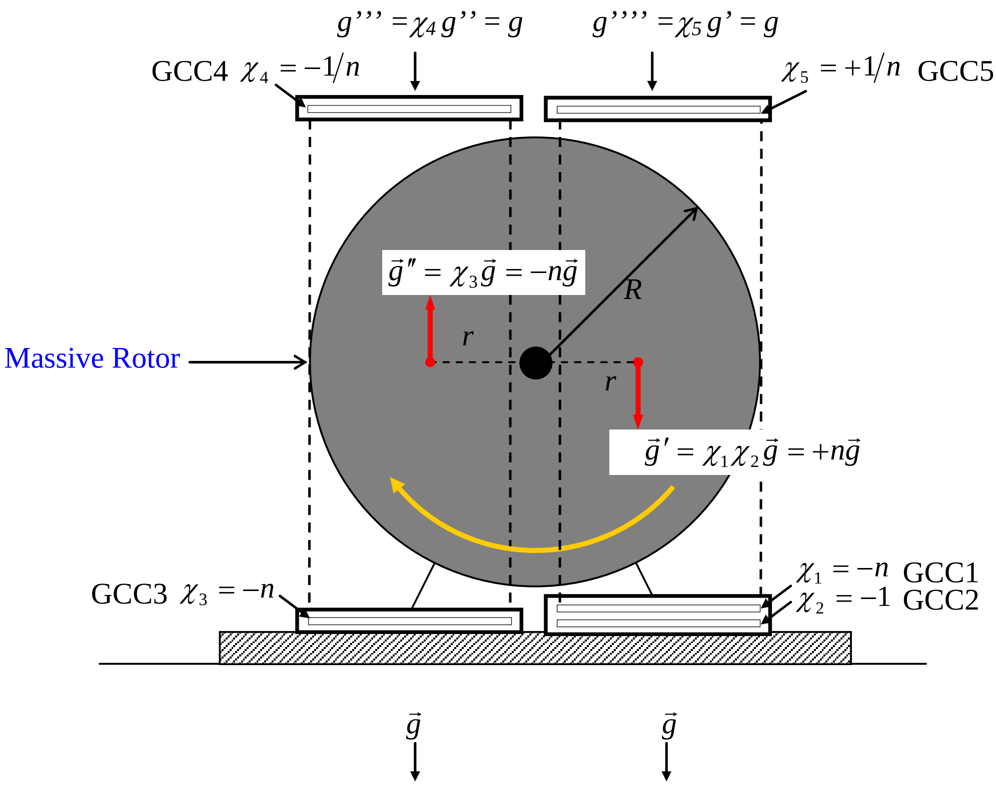

Fig. 7 – Schematic diagram (cross-section) of another type of Gravitational Motor.

APPENDIX E: **Cooling and Heating Gravitational System**

Consider the system shown in Fig. 8. It shows two spherical shells A and B connected by a tube; inside this system there is a liquid with density ρ. Bellow spherical shell A there is a plate (in red Fig.8) made of ferromagnetic material with *Extremely High Permeability,* μ, *subjected* to an alternating magnetic field H_{rms} of *Extra-low frequency,* f. According to Eq. (9), the *gravitational mass,* m_{gC}, of the ferromagnetic plate, is then given by

$$m_{gC} = \left\{1-2\left[\sqrt{1+\left(\frac{\mu^3\sigma}{4\pi\ f\rho_p^2c^2}\right)H_{rms}^4}-1\right]\right\}m_{i0C} \qquad (E1)$$

In equation (E1), σ is the electrical conductivity of the ferromagnetic material; ρ_p is its mass density and m_{i0C} is the *rest* inertial mass of the mentioned ferromagnetic plate.

Equation(E1) can between rewritten as follows:

$$\chi = \frac{m_{gC}}{m_{i0C}} = \left\{1-2\left[\sqrt{1+\left(\frac{\mu^3\sigma}{4\pi\ f\rho_p^2c^2}\right)H_{rms}^4}-1\right]\right\} \qquad (E2)$$

In a previous paper [6] it was shown that, when the gravitational mass, m_g, of a plate is reduced by the factor $\chi = m_g/m_{i0}$, then the gravity acceleration *above* the plate, g', is reduced at the same proportion, i.e., $g' = \chi g$ where g is the gravity acceleration *below* the plate. Here, the gravity above the ferromagnetic plate becomes then $g' = \chi g$, where g is the gravity below the system. Therefore, the pressure p_a at point *a* (See Fig.8)is given by

$$\vec{p}_a = \rho h \vec{g}' = \rho h \chi \vec{g} \qquad (E3)$$

Equation above shows that the pressure inside the spherical shell A can be reduced by reducing χ (See Eq. (E2)). The decreasing of the pressure causes the *decreasing of the temperature,* T_A, in spherical shell A, $(P'/T' = P/T)$. In this case the system shown in Fig 8 can works like a *Cooling Gravitational System.*

By increasing the magnitude of the magnetic field H_{rms}, it is possible to make χ *negative* (See Eq. (E2)), and also to increase its magnitude $|\chi|$. In this case, g' will be expressed by $g' = -|\chi|g$, and the pressure p_b at point *b* becomes

$$\vec{p}_b = \rho h \vec{g}' = -\rho h|\chi|\vec{g} \qquad (E4)$$

Note that, the pressure $\vec{p}_b$ is in opposite direction to $\vec{g}$. The increase of $\vec{p}_b$ causes a *increasing of the pressure inside the spherical shell* B, producing consequently, an *increasing of the temperature,* T_B, in the spherical shell B. In this case, the system shown in Fig 8 can works like a *Heating Gravitational System.*

Note that in all the red hatched area, gravity is g'.

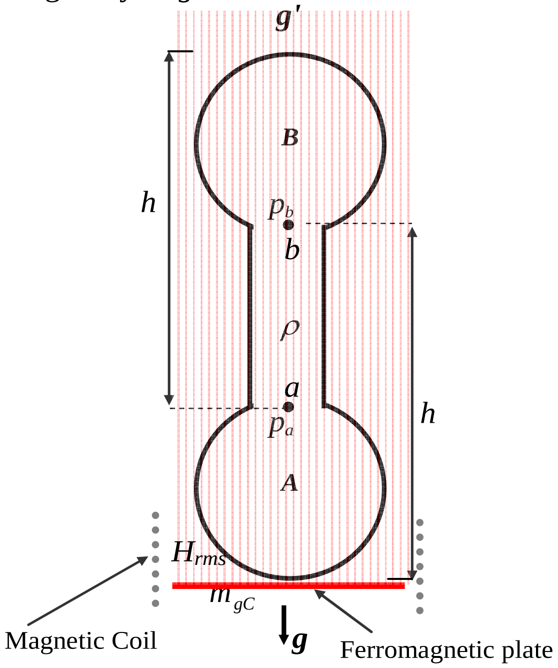

Fig.8 – Schematic Diagram of an element of Gravitational System for Cooling and Heating.

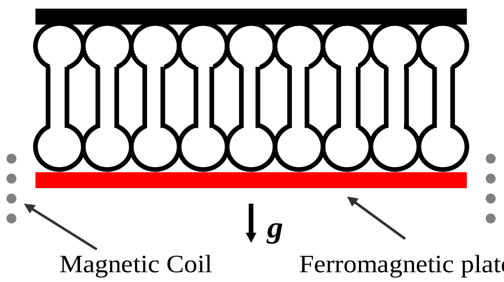

Fig.9 – Schematic Diagram of a Gravitational System for Cooling and Heating.

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