Deceasing of Gravitational Mass of the *Magnesium* subjected to an Alternating Magnetic Field of Extremely Low Frequency.

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Here we propose an experiment in order to check the decreasing of *Gravitational Mass* of the *Magnesium* subjected to an alternating magnetic field of *Extremely Low Frequency*. In addition, we show how the *Inertial Properties*, of a Spacecraft with *Mg* core, can be strongly reduced. *Gravity Multipliers* made of *Mg* are presented, and then it is show its use in several devices.

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

INTRODUCTION

In this paper it is suggest an experiment in order to check the decreasing of *Gravitational Mass* of the light metal *Magnesium* subjected to an alternating magnetic field of Extremely Low Frequency. Also we show how the *Inertial Properties*, of a Spacecraft with *Magnesium* core, can be strongly reduced. In addition, *Gravity Multipliers* of *Mg* are presented. It is then shown its use in *Gravitational Motors*, *Gravitational Thruster of Fluids*, production of *Microgravity environments*, and a *Cooling and Heating Gravitational System*.

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

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

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

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

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

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

where k_r is the real part of the *propagation vector* $\vec{k}$ (also called *phase constant*); $k = \left|\vec{k}\right| = k_r + ik_i$; 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

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

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

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

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

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

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

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

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

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

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

SUGGESTED EXPERIMENT

Let us now consider an experiment where the light metal *Magnesium (Mg)*, whose characteristics are given by: $\sigma = 2.2\times 10^7\, S/m$; $\rho = 1738\, kg/m^3$, is subjected to an alternating magnetic field B_{rms} with *Extra-low frequency*, f . According to Eq. (9), we have that

$$\chi = \frac{m_g}{m_{i0}} = \left\{1 - 2\left[\sqrt{1 + \frac{5.1\times 10^{-12} B_{rms}^4}{f}} - 1\right]\right\} \qquad (10)$$

For $f = 0.1 Hz$ Eq. (10) gives

$$\chi = \frac{m_g}{m_{i0}} = \left\{1 - 2\left[\sqrt{1 + 5.1\times 10^{-11} B_{rms}^4} - 1\right]\right\} \qquad (11)$$

For $B_{rms} = 500T$ Eq. (11) gives

$$\chi = -1.1 \qquad (12)$$

Thus, we get

$$P_{(Mg)} = m_{g(Mg)}g = \chi\ m_{i0(Mg)}g$$

$$= -1.1 m_{i0(Mg)}g \qquad (13)$$

In 2018, physicists from the Institute for Solid State Physics at the University of Tokyo, Japan, have recorded the largest magnetic field ever generated indoors — a whopping $1{,}200T$ [3]. This means that the experiment suggested in this work will can be carried out in the very near future.

INERTIAL PROPERTIES

Now, we will show how the *Inertial Properties* of a Spacecraft can be strongly reduced.

Consider the schematic diagram of a spacecraft shown in Fig. 1. At the center of the spacecraft there is a *Magnesium Core, subjected* to an alternating magnetic field B_{rms} with *Extra-low frequency*, f *. According to Eq. (10), the *gravitational mass of the Magnesium core*, m_{gC} , is expressed by the following equation:

$$m_{gC} = \left\{1 - 2\left[\sqrt{1 + \frac{5.1\times 10^{-12} B_{rms}^4}{f}} - 1\right]\right\} m_{i0C} \qquad (14)$$

In the equation (14), m_{i0C} is the *rest* inertial mass of the Magnesium Core.

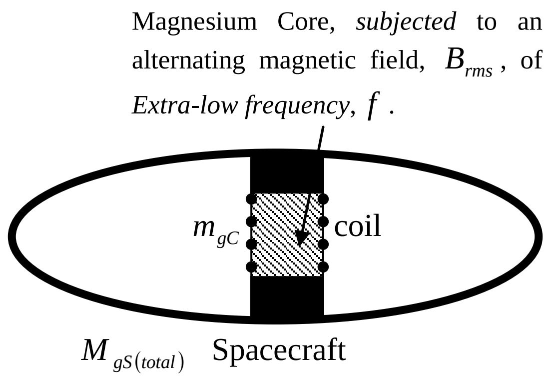

Fig.1 – Schematic diagram of an Ellipsoidal Spacecraft

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

$$M_{gS(total)} = M_{gS} + m_{gC} \qquad (15)$$

where M_{gS} is the total gravitational mass of the spacecraft *without* the gravitational mass of the Magnesium 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 Magnesium core). Thus, Eq. (15) can be rewritten as follows:

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* Note that, another possibility is to apply the magnetic field *through the entire spacecraft*. In this case the coil must be, obviously, positioned in the *edges* of the spacecraft.

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

$$\cong M_{i0S} + \left\{1 - 2\left[\sqrt{1 + \frac{5.1\times10^{-12} B_{rms}^4}{f}} - 1\right]\right\} m_{i0C} \quad (16)$$

Therefore, for $\left(5.1\times10^{-12} B_{rms}^4 / f\right) >> 1$, we get

$$M_{gS(total)} \cong M_{i0S} - \left[\sqrt{\frac{5.1\times10^{-12} B_{rms}^4}{f}}\right] m_{i0C} \quad (17)$$

For example, if $M_{gS} \cong M_{i0S} = 10{,}000kg$; $m_{i0C} = 5{,}000kg$; $f = 0.1Hz$ and, $B_{rms} \cong 529T$, then Eq. (17) yields

$$M_{gS(total)} < 8kg \, .$$

This means that the weight of the spacecraft becomes less than 80N.

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* [4]).

GRAVITY MULTIPLIER

In a previous paper [5] it was shown that, when the gravitational mass, m_{g1}, of a plate (*very thin 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. 2).

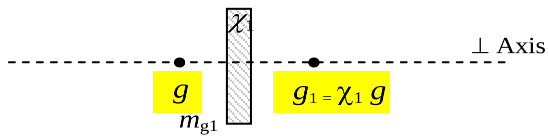

Fig. 2 - The gravity acceleration *after* the plate is $g_1 = \chi_1 g$ where g is the gravity acceleration *before* the plate. The perpendicular axis of the plate can be in any direction.

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

$$g_n = \chi_1 \chi_2 \chi_3 \cdots \chi_n g \quad (18)$$

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.3), and given by

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

$$= +\left|\chi^n\right| G \frac{M_{gB} m_{gA}}{r^2} \quad (19)$$

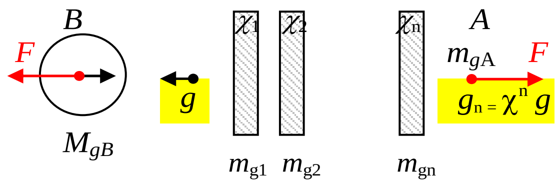

Fig. 3 – The gravity after a battery of plates

In this case, the plates have the same dimensions (with the same inertial mass m_{i0P}), and they are made of *Magnesium*, *subjected* to an alternating magnetic field, B_{rms}, with *Extra-low frequency*, f. If the gravitational masses of the plates are, m_{gP}, then, according to Eq. (10), we can write that

$$\chi = \frac{m_{gP}}{m_{i0P}} = \left\{1 - 2\left[\sqrt{1 + \frac{5.1\times10^{-12} B_{rms}^4}{f}} - 1\right]\right\} \quad (20)$$

If $f = 0.1Hz$ and $B_{rms} = 600\ T$, , Eq. (20) gives

$$\chi = m_{gP}/m_{i0P} \cong -2.5 \quad (21)$$

Then, the gravity after the $n = 5$ plate is

$$\chi^n = (-2.5)^5 = -97.6$$

Therefore, we get

$$g_n = \chi^n g = -97.6g \quad (22)$$

Thus, this system multiply the gravity, g, by $97.6\ times$.

We can use the Gravity Multipliers to convert *gravitational energy* into *rotational kinetic energy* by means of a Gravitational Motor, which design can be similar to the Internal Combustion Engine. In that Gravitational Motor, the pistons can be designed as shown in Fig. 4.

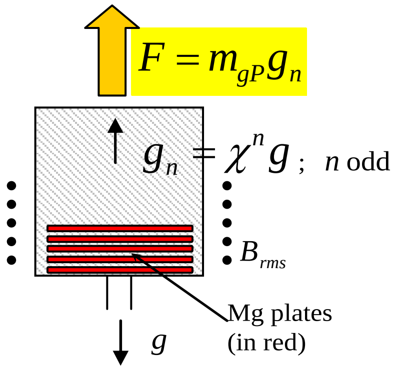

Fig. 4 – Gravitational Piston.
(m_{gP} is the mass of the piston.)

Then, the gravitational force, $\vec{F}$, acting on *one* piston (See Fig.4) is

$$\vec{F} = m_{gP}\vec{g}_n \cong m_{i0P}\chi^n\vec{g}; n \quad odd \qquad (23)$$

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

$$\overline{v} = \tfrac{1}{2}\sqrt{2aH} = \sqrt{|\chi^n g|H/2} \qquad (24)$$

where H is the *stroke length* of the piston. Thus, we can write that

$$\overline{P} = F\overline{v} = m_{i0P}\sqrt{|\chi^n|^3 g^3 H/2} = m_{i0P}\sqrt{g_n^3 H/2} \qquad (25)$$

For $\chi = -2.5$; $n = 5$; $g = 9.81 m.s^{-2}$; $g_n = -97.6g = -956.4$ (See Eq. (22)); $m_{i0P} = 5kg$ and $H = 0.15m$, then Eq.(25) gives

$$\overline{P} = 4\times10^4 W = 40kW \cong 53HP \qquad (26)$$

For 4 *pistons* the total power is

$$\overline{P} \cong 212\ HP$$

ANOTHER GRAVITATIONAL MOTOR

In Fig.5, we show a schematic diagram of another type of Gravitational Motor, with different characteristics to the type previously proposed. Now the Gravitational Motor has 4 *Gravity Multipliers* (GM), which can be made with *plates* of *Magnesium*, *subjected* to an alternating magnetic field, B_{rms}, with *Extra-low frequency*, f.

The Gravity Multipliers, GM1, GM2 and the GM3 are placed below the rotor (See Fig.5); GM1 and GM2 on the right and GM3 on the left. Above the GM1 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 GM1 and GM2, respectively. Above the GM3 the local gravity becomes $\vec{g}'' = \chi_3\vec{g} = -N\vec{g}$, where $\chi_3 = -N$. The function of GM4 and GM5 (See Fig.5), 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

$$\begin{aligned} T &= \left(-\vec{F}'' + \vec{F}'\right)\times\vec{r} = \\ &= \left(-\tfrac{1}{2}m_g\vec{g}'' + \tfrac{1}{2}m_g\vec{g}'\right)\vec{r} \end{aligned} \qquad (27)$$

($m_g \cong m_{i0}$ 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

$$P = T\omega = Nm_{i0}g\omega\, r \qquad (28)$$

On the other hand, we have that

$$-g'' + g' = \omega^2 r \qquad (29)$$

Therefore the angular speed of the rotor is

$$\omega = \sqrt{2Ng/r} \qquad (30)$$

By substituting (30) into (28) we obtain the expression of the average power of the *gravitational motor*, i.e.,

$$P = Nm_{i0}gr\sqrt{\frac{2Ng}{r}} = m_{i0}\sqrt{2N^3g^3r} \qquad (31)$$

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

$$\omega = 120\pi rad.s^{-1} = 3600rpm \qquad (32)$$

Therefore for $\omega = 120\pi rad.s^{-1}$ and $\chi_1 = \chi_3 = -N = \chi^n = (-2)^7 = -128$, the Eq. (30) tells us that we must have

$$r = 2Ng/\omega^2 = 0.0176\ m \qquad (33)$$

Since $r = R/3$ and $m_{i0} = \rho\pi R^2 h$ where ρ, R and h are respectively the mass density, the *radius* and the height of the rotor then for $h = 0.25m$ and $\rho = 7800Kg.m^{-3}$ (*Iron*), we get

$$m_{i0} = 17.1kg \qquad (34)$$

Thus, Eq. (31) gives

$$P \cong 1.4 \times 10^5 W \cong 140\ kW \cong 187\ HP$$

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

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.

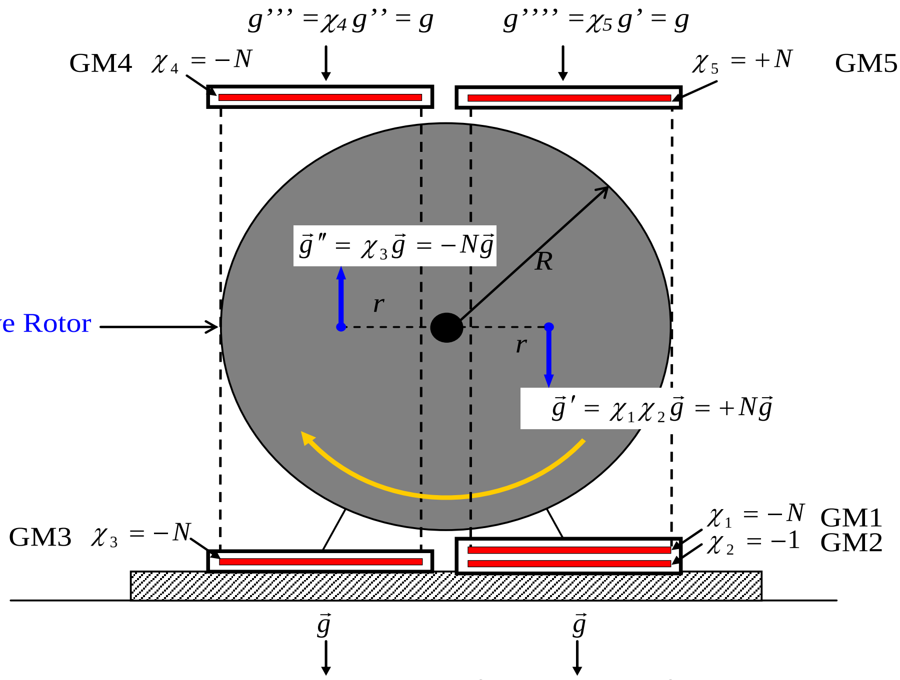

Fig. 5 – Schematic diagram (cross-section) of another type of Gravitational Motor.

GRAVITATIONAL THRUSTER OF FLUIDS

The *Gravity Multipliers* can be used to 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 gravity acceleration *after* the *nth* plate, g_n, for $\chi = -2.5$ (See Eq. (21)), $n = 7$ and $g = 9.8m.s^{-2}$, is given by

$$g_n = \chi^n g = (-2.5)^7 g \cong -5{,}981 m.s^{-2} \qquad (35)$$

In Fig.7 it is shown a schematic diagram of a *thruster system* - using a *Gravitational Thruster of Fluids*, for spacecrafts in the Earth's atmosphere. This system can be used to propeller the spacecraft in any direction.

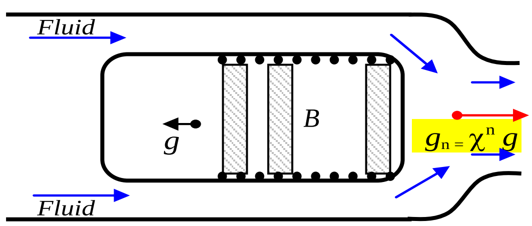

Fig. 6- *Gravitational Thruster of Fluids*

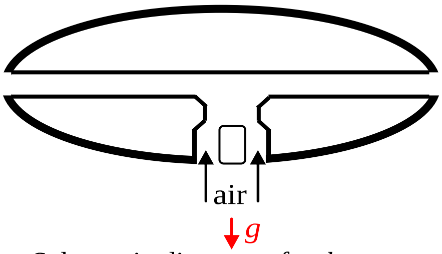

Fig.7 – Schematic diagram of a *thruster system* - using a *Gravitational Thruster of Fluids*, for spacecraft in the Earth's atmosphere.

MICROGRAVITY ENVIROMENTS

In a previous paper [6] we described a way to produce *microgravity environments* at level of the Earth's surface, in order to "activate" the cellular *autophagy process*. After an infection, autophagy can destroy *bacteria* and *viruses*. Based on the theory here explained, it easy to see that, microgravity environments can be also produced using an *Mg* plate, subjected to an alternating magnetic field B_{rms} with *Extra-low frequency*, f (See Fig.8).

According Eq. (20), we get

$$\chi_1 = m_{gP}/m_{i0P} = \left\{1 - 2\left[\sqrt{1 + 5.1\times10^{-12} B_{rms}^4/f} - 1\right]\right\}$$

For $B = 395.6715\ T$,and $f = 0.1Hz$ equation above gives $\chi_1 \cong 1.3\times10^{-6}$. Thus, we get $g_1 = \chi_1 g = 1.2\times10^{-5} m.s^{-2}$. The acceleration experienced by a body in a *microgravity* environment, by definition, is one-millionth (10^{-6}) of that experienced at Earth's surface (1g). Consequently, a *microgravity* environment is one where the acceleration induced by gravity has little or no measurable effect.

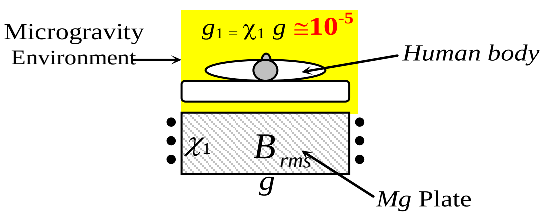

Fig. 8 – *Activation of cellular Autophagy process* in Human bodies.

COOLING AND HEATING GRAVITATIONAL SYSTEM

Consider the system shown in Fig. 9. It has two hollow spheres A and B connected by a tube; inside this system there is a liquid with density ρ. Bellow sphere A there is an *Mg* plate (in red Fig.9), subjected to an alternating magnetic field B_{rms} with *Extra-low frequency*, f .

The pressure p_a at point *a* (See Fig.9) is

$$\vec{p}_a = \rho h \vec{g}' = \rho h(\chi \vec{g}) \qquad (36)$$

Equation above shows that the pressure inside the sphere A can be *reduced* by *reducing* χ. The decreasing of the pressure causes the *decreasing of the temperature*, T_A, in sphere A, $(P'/T' = P/T)$. In this case, the system shown in Fig 9, it can works like a *Cooling Gravitational System*.

By increasing the magnitude of the magnetic field B_{rms} , it is possible to make χ *negative* (See Eq. (20)), 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

$$\vec{p}_b = \rho h \vec{g}' = -\rho h |\chi| \vec{g} \qquad (37)$$

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 9 can works like a *Heating Gravitational System*.

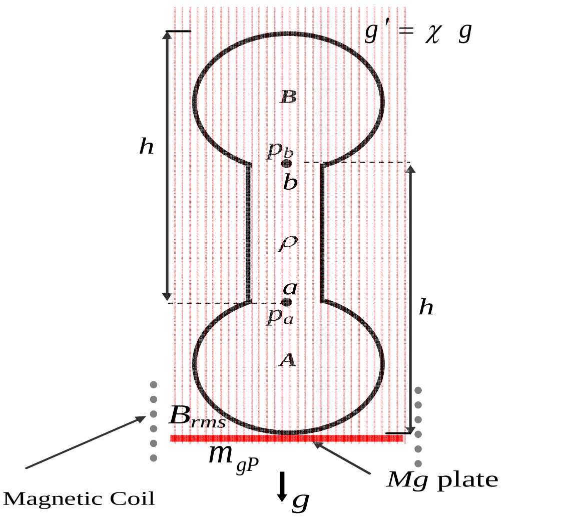

Fig.9 – Schematic Diagram of *one element* of Gravitational System for Cooling and Heating.

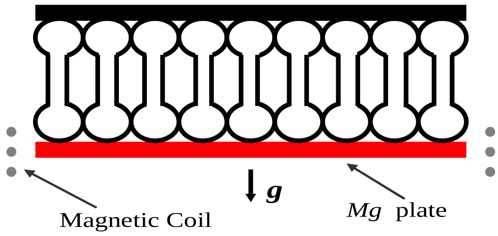

Fig.10 – Schematic Diagram of a Gravitational System for Cooling and Heating.

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