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► **To cite this version:**

Fran de Aquino. Decreasing of the Gravitational Mass in materials with Extremely High Permeability subjected to an Alternating Magnetic Field of Extremely Low Frequency. 2020. hal-02492397v4

HAL Id: hal-02492397

<https://hal.science/hal-02492397v4>

Preprint submitted on 16 Apr 2020 (v4), last revised 21 Sep 2020 (v7)

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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

$$\begin{aligned} \chi = \frac{m_g}{m_{i0}} &= \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{\Delta p}{m_{i0} c} \right)^2} - 1 \right] \right\} = \\ &= \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{U n_r}{m_{i0} c^2} \right)^2} - 1 \right] \right\} = \\ &= \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{W n_r}{\rho c^2} \right)^2} - 1 \right] \right\} \end{aligned} \quad (1)$$

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

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

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*); $k = |\vec{k}| = k_r + ik_i$; ε , μ and σ , are the electromagnetic characteristics of the medium in which the incident (or emitted) radiation is propagating ($\varepsilon = \varepsilon_r \varepsilon_0$; $\varepsilon_0 = 8.854 \times 10^{-12} F/m$; $\mu = \mu_r \mu_0$ where $\mu_0 = 4\pi \times 10^{-7} H/m$; 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

$$\begin{aligned} W &= \frac{1}{2} \varepsilon v^2 \mu^2 H^2 + \frac{1}{2} \mu H^2 = \\ &= \frac{1}{2} \mu H^2 (\varepsilon v^2 \mu) + \frac{1}{2} \mu H^2 = \mu H^2 \end{aligned} \quad (6)$$

For $\sigma \gg \omega\varepsilon$, 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

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

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 sinusoidally (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

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

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)

$$\mu_r = 1,000,000 \text{ At } 0.5 \text{ T}$$

$$\sigma = 7.04 \times 10^5 S/m$$

$$\rho = 7590 \text{ kg.m}^{-3}$$

Supermalloy (annealed in H controlled cooling)

$$\mu_r = 1,000,000 \text{ At } 0.7 \text{ T}$$

$$\sigma = 1.6 \times 10^6 S/m$$

$$\rho = 8770 \text{ kg.m}^{-3}$$

Iron (99.95% pure Fe annealed in H)

$$\mu_r = 200,000$$

$$\sigma = 1.05 \times 10^7 S/m$$

$$\rho = 7600 \text{ kg.m}^{-3}$$

For these materials Eq. (9), respectively, gives

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

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

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

For $f = 60Hz$, the result is

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

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

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

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

$$\chi_{Metglas} = -3.3 \Rightarrow m_{g(Metglas)} = -3.3 m_{i0(Metglas)}$$

$$(P_{Metglas}) = m_{g(Metglas)} g = -3.3 m_{i0(Metglas)} g = -3.3P$$

$$\chi_{Smalloy} = -5.1 \Rightarrow m_{g(Smalloy)} = -5.1 m_{i0(Smalloy)}$$

$$(P_{Smalloy}) = m_{g(Smalloy)} g = -5.1 m_{i0(Smalloy)} g$$

$$\chi_{Iron} = -0.13 \Rightarrow m_{g(Iron)} = -0.13 m_{i0(Iron)}$$

$$(P_{Iron}) = m_{g(Iron)} g = -0.13 m_{i0(Iron)} g$$

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

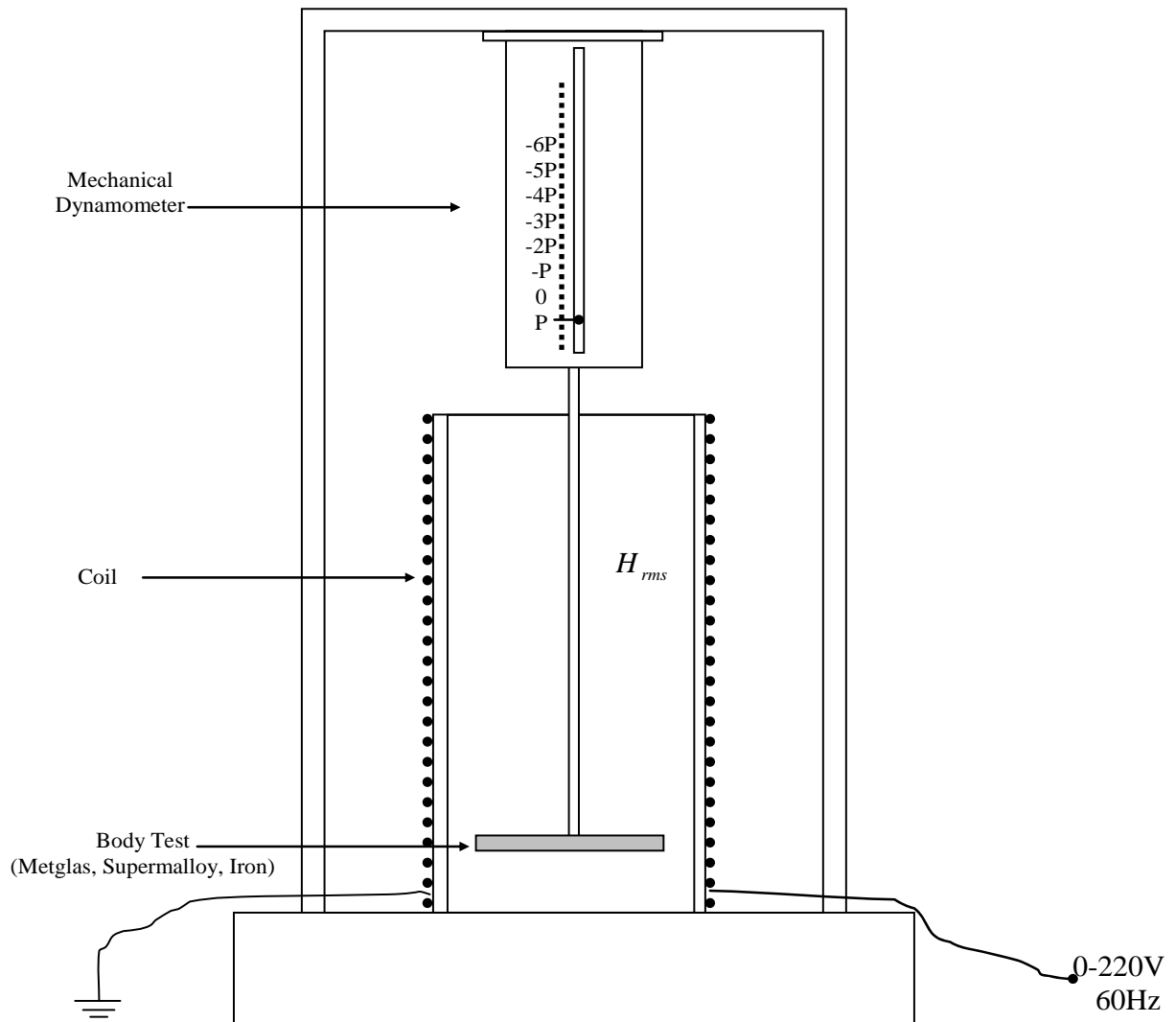


Fig. 1 – Schematic diagram of the experimental set-up to check the decreasing of the *Gravitational Mass* in materials with *Extremely High Permeability* subjected to an Alternating Magnetic Field with frequency $f = 60\text{Hz}$.

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

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

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.

Ferromagnetic core with *Extremely High Permeability*, μ , subjected to an alternating magnetic field, H_{rms} , of *Extra-low frequency*, f .

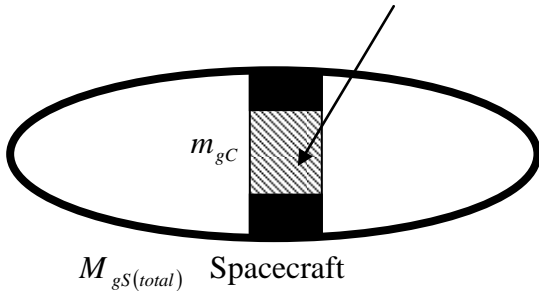


Fig.2 – Schematic diagram of an Ellipsoidal Spacecraft

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

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

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:

$$\begin{aligned} M_{gS(total)} &\cong M_{i0S} + m_{gC} = \\ &\cong M_{i0S} + \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{\mu^3 \sigma}{4\pi f \rho^2 c^2} \right) H_{rms}^4} - 1 \right] \right\} m_{i0C} \quad (A3) \end{aligned}$$

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

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

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

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

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

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

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 ($< 1 \text{ s}$), 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

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

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 Superalloy, the result is

$$\chi = \frac{m_{gP}}{m_{i0P}} = \left\{ 1 - 2 \left[\sqrt{1 + 3.6 \times 10^{-20} \left(\frac{H_{rms}^4}{f} \right) - 1} \right] \right\} \quad (B2)$$

If $f = 1Hz$ and $H_{rms} = 7.2597 \times 10^5 A/m$, ($B_{rms} \cong 0.9T$), then Eq. (B2) yields

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

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

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

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

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

Thus, we can write that

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

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

$$\bar{P} = 1.1 \times 10^5 W \cong 147HP \quad (B6)$$

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

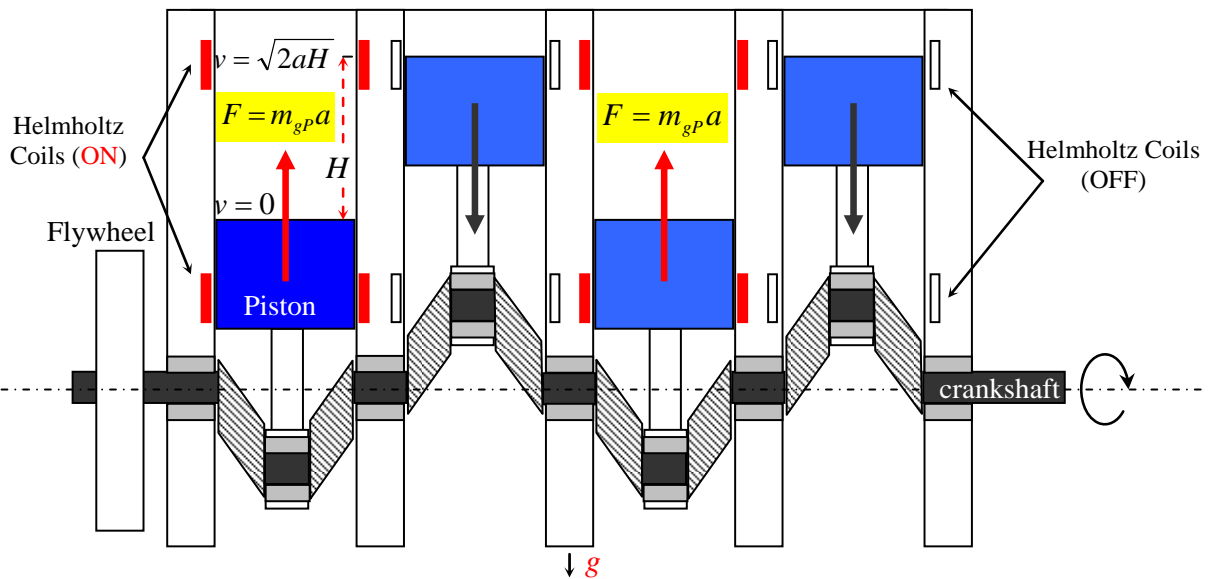


Fig. 3 – Schematic diagram of a Gravitational Motor with design similar to the Internal Combustion Engine. Here the pistons are made with materials whose *magnetic permeabilities* are *Extremely High*. The Helmholtz Coils provide the alternating magnetic field H_{rms} .

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).

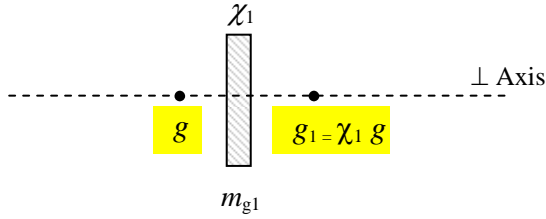


Fig. 4 - The gravity acceleration *after* the plate is $g_1 = \chi_1 g$ where g is the gravity acceleration *before* the plate. The perpendicular axis of the plate can be in any direction.

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 n th plate the gravity, g_n , will be given by

$$g_n = \chi_1 \chi_2 \chi_3 \dots \chi_n g \quad (C1)$$

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

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

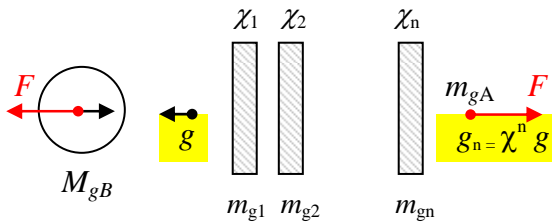


Fig. 5 – The gravity after a battery of plates

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

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

If the plates are made of Supermalloy, we get

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

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

$$\chi = \frac{m_{gP}}{m_{i0P}} \cong -57.7 \quad (C5)$$

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

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

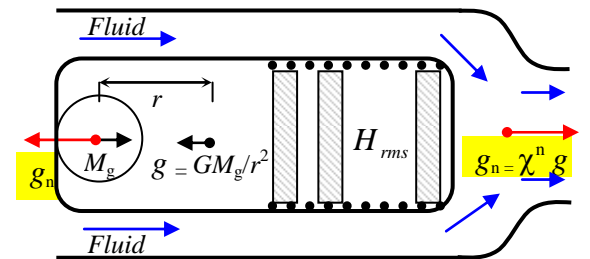


Fig. 6 - Gravitational Thruster of Fluids

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