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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.

Fran De Aquino

Professor Emeritus of Physics, Maranhao State University, UEMA.
 Titular Researcher (R) of National Institute for Space Research, INPE
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 www.professorfrandaquino.org
 deaquino@elointernet.com.br

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 $H = H_m \sin \omega t$ 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* ($f < 100\text{Hz}$) 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)

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

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

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

Supermalloy (annealed in H controlled cooling)

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

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

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

Iron (99.95% pure Fe annealed in H)

$$\mu_r = 200,000$$

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

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

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 $f = 60\text{Hz}$, 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 $H_{rms} = 4 \times 10^5 \text{ A/m}$ ($B = 0.5\text{T}$), we get

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

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

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

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

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

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

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

References

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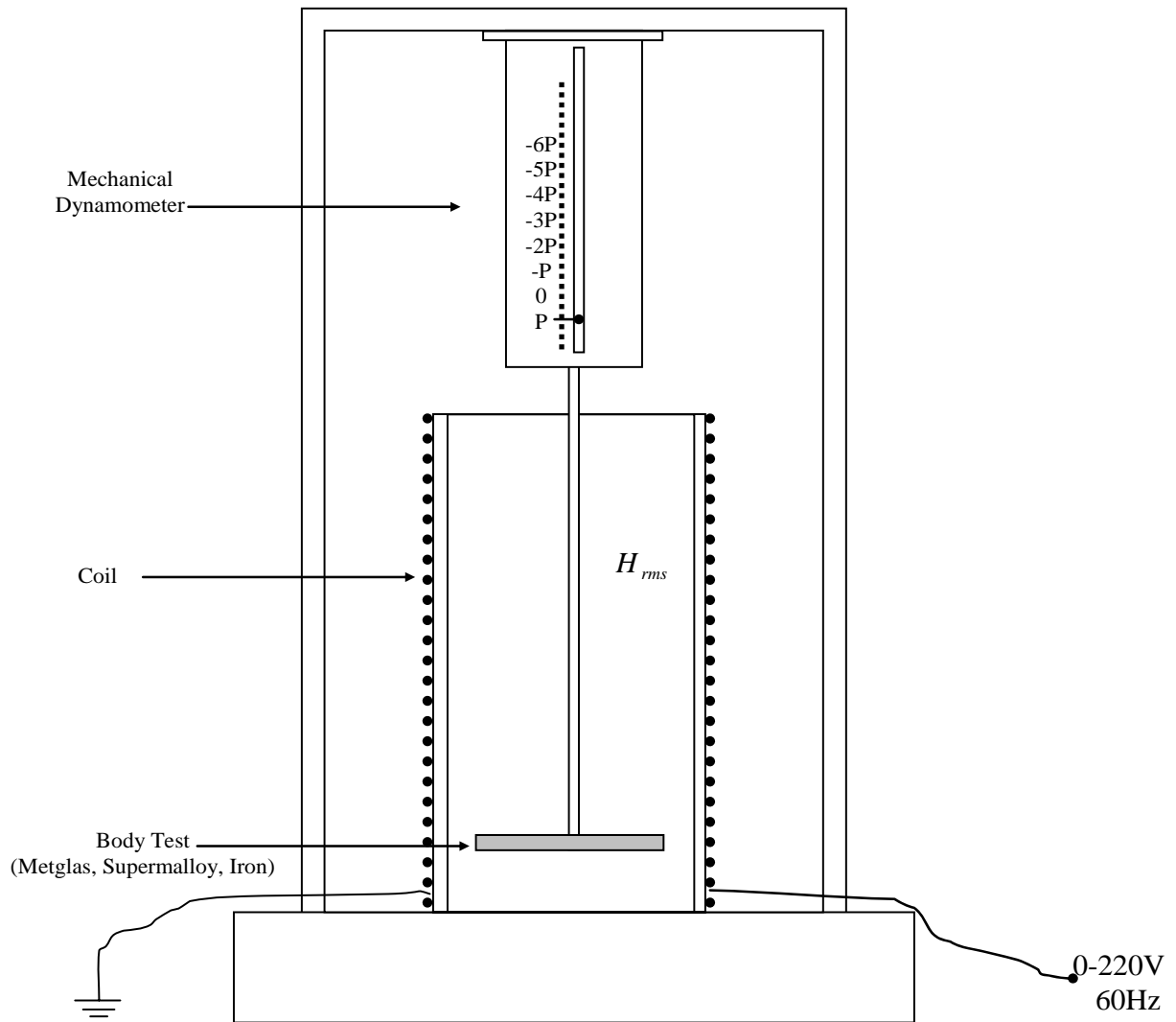


Fig. 1 – Schematic diagram of the experimental set-up to check the decreasing of the *Gravitational Mass* in materials with *Extremely High Permeability* subjected to an Alternating Magnetic Field with frequency $f = 60\text{Hz}$.