Electromagnetic Influence on Gravitational Mass – Theory, Experiments, and Mechanism of the Solar Corona Heating

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Abstract

Based on the model of Expansive Nondecelerative Universe, the aim of the present contribution is to contribute to the theoretical rationalization of some experiments, in particular of those performed by Podkletnov and de Aquino and devoted to the gravitational mass cessation, to offer a mechanistic explanation of the Solar corona heating, and to propose an experiment to verify the explanation of the heating in the Earth conditions.

Introduction

Among the problems of current physics, issues concerning gravity are still ranked in “top ten”. Theoretical approaches focused on elaboration of a theory of quantum gravitation unifying all four (or more?) fundamental forces are in progress, successful completion of the theory seems to be, however, far beyond the horizon. Simultaneously with theoretical attempts (for a general survey, see [1]), experiments aimed at influencing the gravitational mass by other forces have been developed and tentatively explained [2-8]. The gravity has penetrated also into chemistry as manifested by space-craft experiments
(preparation of compounds, alloys or mixtures that, due to the gravitational force acting at the Earth, cannot be prepared in the Earth conditions) as well as by a newly elaborated rationalization of some quantum chemical effects [9-10].

A careful inspection of the contributions devoted to experiments involving gravitational effects [2-7] may lead the reader to a conclusion on the necessity to introduce a theoretical approach different of those applied in the original papers. It concerns, namely, an approach based on the general theory of relativity and benefiting from the ability to localize and quantify the gravitational energy. The Expansive Nondecelerative Universe (ENU) model [8,11-13] satisfies the above requirements. The purpose of the present contribution is to contribute to the rationalization of some experiments, in particular of those performed by Podkletnov [2-4] and de Aquino [5-7], to offer a mechanistic explanation of the Solar corona heating, and to propose an experiment enabling to verify the explanation in the Earth conditions.

**Podkletnov’s phenomenon**

In the papers by Podkletnov [2-4] a detection of an anomalous force originating at a high-voltage discharge directed from a superconductive emitter to a target electrode is described. The effect has been attributed to forces of gravitational nature. At the Podkletnov’s experiments, the following conditions were applied: the discharge time was $10^{-5}$ to $10^{-4}$ s, the current peak value at the discharge was of the order $10^4$ A, the voltage varied from 500 kV to 2 MV, the interelectrode distance ranged from 15 cm to 2 m, the total charge of the emitter was about 0.1 C, and the discharge energy approached $10^5$ J. The formed gravitational impulse propagated as a coherent beam in the same direction as the discharge. It penetrates through different media, apparently without any energy loss and caused a deflection of a 10 - 50 g pendulum. The energy of the deflection was independent on the pendulum material and mass, and depended on the voltage only.

One of the possible explanations of the Podkletnov’s phenomenon was offered in [8]. At the Podkletnov’s experiments, a mean intensity of the electrostatic field was

$$E \cong 2.5 \times 10^6 \text{ V m}^{-1}$$  

(1)
which corresponds to a mean energy density

\[ \varepsilon_e \approx 27 \text{ J m}^{-3} \]  \hspace{1cm} (2)

As shown in [8], energy density of gravitational field at the Earth surface is

\[ |\varepsilon_g| = \frac{Rc^4}{8\pi G} = \frac{3m_{\text{Earth}}c^2}{4\pi ar_{\text{Earth}}^2} = 24.29 \text{ J m}^{-3} \]  \hspace{1cm} (3)

where \( R \) is the scalar curvature, \( a \) is the gauge factor, \( m_{\text{Earth}} \) and \( r_{\text{Earth}} \) are the Earth mass and radius, respectively. Based on (2) and (3) it follows

\[ \varepsilon_e \approx \varepsilon_g \]  \hspace{1cm} (4)

The Earth gravitational field interferes with the electrostatic field created in the Podkletnov’s equipment which leads to a local cessation of the gravitational field. The corresponding deviation from the vertical direction of the gravity causes the observed pendulum deflection. In [8] it was proved that the deflection in vertical direction, \( h_v \), is described by

\[ h_v \approx \frac{Q}{g} \]  \hspace{1cm} (5)

where \( g \) is the Earth surface gravitational acceleration (9.80665 m s\(^{-2}\)) and \( Q \) is the total charge of the emitter.

**Solar corona**

The temperature profile of the Sun and its surroundings belongs still to the enigmas of physics. At the core of the Sun, the temperature reaches about 15 million K which is understandable since energy is created in the Sun. Passing from the core to the surface the temperature decreases and at the Sun’s surface it is about 5,500 K. Next part (outside of the chromosphere) is corona. There is no source of energy, its temperature, however, is extremely high (about 1 million K [14]). The question is, what mechanism is applied at the corona heating, preserving thus its temperature? This part offers a possible explanation.

The mean magnetic field intensity at the Sun’s surface is [15]

\[ \bar{H} \approx 10^2 \text{ A m}^{-1} \]  \hspace{1cm} (6)
and during some processes the intensity may increase in sunspots up to

\[ H_{\text{max}} \simeq 10^5 \text{ A m}^{-1} \quad (7) \]

A magnetic field intensity with a density identical to the gravitational energy density on the Sun’s surface is the critical density \( H_{\text{crit}} \) reaching

\[ H_{\text{crit}} \simeq 4 \times 10^4 \text{ A m}^{-1} \quad (8) \]

which corresponds to the critical magnetic induction

\[ B_{\text{crit}} \simeq 5 \times 10^{-2} \text{ T} \quad (9) \]

Interference of the gravitational and magnetic fields can lead to origination of a gravitational impulse that can increase the kinetic energy of the particles forming the Solar corona, i.e. its temperature. The mechanism of the corona ”heating” may be, therefore, similar to that of the Podkletnov’s phenomena. The difference is that instead of pendulum and electrostatic discharge, rather plasma particles and magnetic impulses are in action, i.e.

\[ \frac{3m_{(\text{Sun})}c^2}{4\pi ar_{(\text{Sun})}^2} = \frac{B_{\text{crit}}^2}{2\mu_0} \quad (10) \]

At the Podkletnov’s experiments, along with a high voltage, also a discharge must be created. Similarly, the Sun’s magnetic field with \( B_{\text{crit}} \) must influence on the particles (electrons) and induce their precession with the frequency

\[ \omega_e = \frac{B_{\text{crit}}e}{m_e} \quad (11) \]

where \( m_e \) is the electron mass. In order no avoid damping, the mentioned precession must equal to the plasma frequency \( \omega_{pl} \) [16] in a given region

\[ \omega_e = \omega_{pl} = \left( \frac{e^2n_{e(\text{Sun})}}{\varepsilon_0m_e} \right)^{1/2} \quad (12) \]

where \( n_{e(\text{Sun})} \) denotes a concentration of the electrons with a given precession frequency in a space.

In order the Podkletnov’s phenomenon may occur, a region with the concentration of the plasma electrons of \( n_{e(\text{Sun})} \) must be just near the Sun.
surface where at $B_{\text{crit}}$ given by (1) the electrons will have identical precession and plasma frequencies. Based on (10)–(12) it follows

$$n_e(Sun) = \frac{3m_{(Sun)}}{2\pi m_e a_r^2(Sun)} \approx 10^{16} \text{ m}^{-3}$$  \hfill (13)

Experimental observation of the Sun and its environment has brought an evidence that such a region (the boundary of chromosphere and corona) really exists. Thus, just in this region, conditions for the corona heating by the Podkletnov’s phenomenon are satisfied (as a matter of fact, there is no other place where they might exist).

## A model experiment

The above conclusions on the conditions required to heat the Solar corona may be experimentally verified in a laboratory. Here, such an experiment is suggested. The gravitational energy density at the Earth surface (24.29 J m$^{-3}$ [8]) equals to magnetic field density when

$$H_{\text{crit(Earth)}} = 7.000 \times 10^3 \text{ A m}^{-1}$$  \hfill (14)

or

$$B_{\text{crit(Earth)}} = 8.796 \times 10^{-3} \text{ T}$$  \hfill (15)

Applying (13) to the conditions at the Earth surface leads to the value of concentration of electrons in the plasma with identical the plasma and electron precession frequencies

$$n_e(Earth) \approx 5.5 \times 10^{14} \text{ m}^{-3}$$  \hfill (16)

Such a concentration of free electrons is present in a sample of hydrogen containing $3.9 \times 10^{21}$ hydrogen atoms in a cubic meter when being at the temperature of 3000 K. This sample is exposed to a pulsing magnetic field with $B_{\text{crit}}$ given by (15). In the direction of the magnetic poles, a second sample of hydrogen (room temperature, concentration about $10^{20}$ in a cubic meter) will be placed next to the first sample. After some time of magnetic field pulsing, the temperature of the second sample should increase. The temperature of the control samples placed in other directions should be preserved.
Rationalization of experiments performed by de Aquino

Stemming from the special relativity theory and classical physics, de Aquino [17] discussed relations between the inertial and gravitational masses. Using a very detailed and precise mathematical treatment he manifested that in the absence of electromagnetic field, the masses are identical. In the presence of such a field, the gravitational mass may be reduced or even nullified.

In his experiment [5], de Aquino worked with discs-shaped organic luminescent material. According to quantum statistical mechanics, an average number of photons forming the photon gas inside a luminescent material is given as

\[
\bar{N}_{(h\nu)} = \left( \exp\left(\frac{\lambda_e}{\lambda_{(h\nu)}}\right) - 1 \right)^{-1}
\]

where \( \lambda_e \) and \( \lambda_{(h\nu)} \) are the Compton wavelength of the electron, 

\[
\lambda_e = 2.42 \times 10^{-12} \text{ m}
\]

and a mean wavelength of a photon emitted or absorbed by a luminescent material, respectively.

In the experiment, a material emitting blue light with 

\[
\lambda_{(h\nu)} = 461 \text{ nm}
\]

was used. The radiation output of the material is expressed as

\[
P_{(h\nu)} = \bar{N}_{(h\nu)} h\nu^2 = \frac{hc^2}{\lambda_{(h\nu)}^2 \left( \exp\left(\frac{\lambda_e}{\lambda_{(h\nu)}}\right) - 1 \right)}
\]

Based on (18)–(20) it can be calculated that for the radiation of 461 nm wavelength

\[
P_{(h\nu)} \approx 56 \text{ W}
\]

The ENU model provides a general relation [18] for the gravitational output of a body with the mass \( m \)

\[
|P_g| = \frac{d}{dt} \int \frac{Rc^4}{8\pi G} dV = \frac{mc^2}{t_c}
\]

where the present cosmological time calculated by the ENU model is [12]

\[
t_c = 4.296 \times 10^{17} \text{ s}
\]
A general condition for the interference of the electromagnetic and gravitational fields may be expressed as

\[ P_{(h\nu)} = |P_g| \]  

(24)

Stemming from (20)-(24), the ENU provides a total mass of the electroluminescent disc

\[ m_{(disc,calc)} \cong 267 \text{ kg} \]  

(25)

In the de Aquino’s experiment [5] the discs of a mass

\[ m_{(disc,exp)} \cong 264 \text{ kg} \]  

(26)

were used. Thus, the ENU based calculated and experimental masses coincide.

If both approaches are consistent, equation (22) can be exploited to calculate a more precise value of the cosmological time and such a calculation leads to

\[ t_c = 4.169 \times 10^{17} \text{ s} = 1.32 \times 10^{10} \text{ years} \]  

(27)

At the same time, the above rationalization leads to a conclusion on a time dependence of the vacuum permittivity \( \varepsilon_0 \) and permeability \( \mu_0 \).

In the Podkletnov’s experiments, the electromagnetic field interferes with the Earth gravitational field. In case of the experiments carried out by de Aquino, the electromagnetic field interferes with the gravitational field of a body.

Relation (24) is applicable also for the experiment [5] with radiation of extra-low frequency (ELF) acting on a ferromagnetic material. It this case it must hold

\[ \eta R_a I^2 = \frac{m_{Fe} c^2}{t_c} \]  

(28)

where \( R_a \) is the antenna impedance (116 m\( \Omega \)), \( I \) is the current (130 A), \( m_{Fe} \) is the mass of iron powder (29 kg). In such a case the absorption coefficient is

\[ \eta = 3.17 \times 10^{-3} \]  

(29)

For the iron powder used at the experiment, conductivity gradient \( \sigma = 10 \text{ S m}^{-1} \), \( \mu = 75 \mu_0 \) and for the frequency 60 Hz, the skin layer thickness is

\[ \delta = \left( \frac{2}{\omega \sigma \mu} \right)^{0.5} \cong 2.43 \text{ m} \]  

(30)
The thickness of the iron powder then must be

\[ d = \eta \delta \approx 8 \text{ mm} \]  

which is in an excellent agreement with the experimental value.

The above mentioned ideas may be applied also in the field of thermodynamics. In the centre of stars (e.g. the Sun) the gravitational and radiation energies must be balanced, i.e.

\[ \left| \frac{3m_{(\text{Sun})}c^2}{4\pi a r_g^2_{(\text{Sun})}} \right| = \frac{4\sigma_{SB}T_{(\text{Sun})}^4}{c} \]  

where \( r_g(\text{Sun}) \) is the gravitational radius of the Sun (\( \approx 3 \times 10^3 \) m), \( \sigma_{SB} \) is the Stefan-Boltzmann constant (\( 5.67 \times 10^{-8} \) kg s\(^{-3}\) K\(^{-4}\)), \( T_{(\text{Sun})} \) is the temperature in the centre of the Sun. Relation (32) leads to

\[ T_{(\text{Sun})} \approx 1.5 \times 10^7 \text{ K} \]  

which is identical (within the degree of accuracy of its estimation) to that published in various literature sources [e.g. 19].

In one of the latest de Aquino’s contributions [20], changes in the gravitational mass of a body due to its interaction with electromagnetic radiation of very low frequency are described and measured. The used antenna was a half-wave dipole encapsulated in an iron sphere (made from 99.95% iron, \( \mu = 5000\mu_o, \sigma = 1.03 \times 10^7 \text{ S m}^{-1} \)). The antenna impedance was \( 8.29 \times 10^{-6} \Omega \) and the 9.9 mHz radiation emitted by the antenna was completely absorbed by the iron along a critical thickness 0.110 m.

De Aquino mathematically predicted a dependence of the iron sphere gravitational mass on current, and experimentally proved that the total mass of the iron sphere (inertial mass of 60.5 kg) is nullified just at the current of 8.51 A.

To rationalize this experiment case, instead of comparison of the outputs expressed by equation (24) rather energies are to be related. The reason is a relatively long time of radiation passage (about 16 s) through the iron layer.

The gravitational energy density associated with a 60.5 kg iron sphere with a 0.110 m radius is

\[ |\varepsilon_g| = \frac{3m_{Fe}c^2}{4\pi a\delta^2} \]  

\[ 8 \]
An amount of the gravitational energy in the sphere is

$$|E_g| = \frac{m_{Fe}c^2\delta}{a} \quad (35)$$

At interference of the gravitational and electromagnetic fields of iron sphere, each iron atom absorbs the energy $h\nu$ and thus the total electromagnetic energy in the iron sphere will be

$$E_{(h\nu)} = \frac{m_{Fe}}{m_{(atom)}}h\nu \quad (36)$$

where $m_{(atom)}$ is the mass of an iron atom. Identity of (35) and (36) leads to

$$h\nu = \frac{m_{(atom)}c^2\delta}{a} \quad (37)$$

Relation (37) is valid when the gauge factor

$$a = 1.399 \times 10^{26} \text{ m} \quad (38)$$

which is in excellent agreement with its value calculated using the ENU model [12]. This value corresponds to the cosmological time

$$t_c = 1.48 \times 10^{10} \text{ years} \quad (39)$$

In this way, the de Aquino experiments and the ENU model provide an interval of the cosmological time

$$t_c = (1.32 - 1.48) \times 10^{10} \text{ years} \quad (40)$$

In case of more experimental data available, the cosmological time can be calculated more precisely.

The above conclusions can be taken as a challenge both for those planning and performing experiments and those elaborating theoretical approaches. The given data manifest a mutual coherence of the Podkletnov’s, de Aquino’s and ours approaches. In addition, they bring a clear evidence of the necessity to exploit the general theory of relativity so as to understand and rationalize experiments devoted to gravitational mass changes.
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