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Short Communication

GRAVITY ANTENNA

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ABSTRACT

It points to the costly experiments on the detection of gravitational radiation, which have not yet yielded an indisputable result. It is shown that the well-known theories predict the possibility of finding the gravitational Lorentz forces on the Earth. It points to known experiments in which these forces are found. On the basis of this assumption, it is made that the gravitational radiation of cosmic objects can be detected on the Earth as a manifestation of the gravitational Lorentz forces. The construction of a gravitational antenna designed to detect gravitational waves is proposed. It is shown that such a design is much simpler than known gravitational antennas and telescopes.

Keywords: Gravitational radiation; gravitational waves; gravitational Lorentz forces; gravitational antennas and telescopes.

INTRODUCTION

Immediately after the prediction of the existence of gravitational waves by Albert Einstein in 1916, the question arose about the wave detection because Albert Einstein himself doubted that they could be detected (Pais, 1982). For this detection, various designs of gravitational detectors have been developed. Recently, reports of the registration of these waves are questionable. It is important to note that existing gravitational detectors are grandiose structures (see numerous references in Wikipedia on gravitational wave observatory, https://en.wikipedia.org/wiki/Gravitational-wave_observatory) that are capable of recording signals from infinitely more grandiose sources such as black holes in exceptional periods of their existence. Any practical use of gravitational waves with such proportions of the characteristics of the measuring technique and the waves themselves is not possible. Also, it is possible to mention some recent achievements in the registration of gravitational waves. The gravitational waves predicted by Einstein (1916) were confirmed in recentexperiments by a large group consusting of more than 1,000 researchers, engineers, and space specialists in (Abbott *et al*., 2016). To confirm Einstein's prediction of the gravitational wave existence that can also propagate with the speed of light, this large group has accumulated several billions of the United States dollars during the last half-century. As a result, many other projects on gravitational phenomena were not properly supported finantially.

At the same time, the field of human activity, where the use of gravitational phenomena is needed, is recently indicated by Zakharenko (2016, 2017, 2018). It is shown that the development of space technologies is possible with the creation of an instantaneous interplanetary connection and this connection can be feasible only with some phenomena incorporating gravitation. The speed of spreading of the gravitational phenomena, according to the estimates of various authors, exceeds the speed of light (c) by a factor of 10^{13}, see, for example, in (Khmelnik, 2017; Fedulaev, 2006). Zakharenko (2016, 2017, 2018) also considers the interrelation of acoustic waves with gravitational phenomena in solids, and then shows that such interrelations can serve as the basis for the development of solid-state transducers of acoustic waves into some gravitational phenomena and backward converters. The latter, obviously, can be considered as detectors of gravitational waves. With the fast gravitational phenomena, it is also possible to constitute a fast processor because the speed of some gravitational phenomena can be thirteen orders faster that the speed of light representing the limitation for the modern processor technologies.

Consider below the construction of a gravitational antenna that is something intermediate between the grandiose existing detectors and the indicated miniature detectors of the future.

Lorentz force analogue in gravitational field

Maxwell's equations for the electromagnetic field in the form of equations (1)-(4) proposed by Heaviside are well-

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known. All the formulas are given in Appendix 1. Heaviside is also the author of the theory of gravity (Heaviside, 1893) in which the gravitational field is described by equations (6)-(9) analogous to the form of equations (1)-(4). Later it was shown (Gravitoelectromagnetism, https://en.wikipedia.org/wiki/Gravitoelectromagnetism) that in the weak gravitational field, the gravitational analogs of the equations of the electromagnetic field can be derived from the basic equations of the general relativity theory and therefore, have the same form (6)-(9).

In electrodynamics, the Lorentz force acting on electric charges moving in a magnetic field is defined by expression (5). In Heaviside's gravity theory, a force analogous to the Lorentz force, acting on the mass moving in the gravitational field, is also defined by (10). This force can be also called the gravitomagnetic Lorentz force. Heaviside set the coefficient $\varsigma = 1$. The same definition of the Lorentz force in the gravitational field is obtained from the basic equations of the general relativity theory. The only difference is that the coefficient $\varsigma = 2$.

So, on the Earth one can use equations (6)-(10) to describe gravitational interactions. Thus, in a weak gravitational field of the Earth there are gravitational waves having a gravitoelectric component with an intensity E_g and a gravitomagnetic component with the induction B_g. These waves can be formed by uneven mass currents (for example, turbulent fluid flows) and act on the moving masses by the Lorentz forces.

Known experiments with gravity

According to the General Relativity, gravitational radiation on the Earth from cosmic sources is extremely weak and its detection is a task of exceptional difficulty (Pais, 1982). However, such a view can be challenged.

Based on the analysis of Samokhvalov's experiments in Samokhvalov (2009, 2010a,b; 2011a,b), Khmelnik (2012, 2017) shows that the Maxwell-like equations of gravity must be supplemented with a certain empirical gravitational permeability coefficient ξ that is similar to the coefficient of the magnetic permeability μ of the medium in the electromagnetism, see in Appendix 1. It is further shown that with such an addition, the results of experiments are in good agreement with the equations of gravity. The value of this coefficient is determined from these experiments for a vacuum, as $\xi \sim 10^{12}$.

In Khmelnik (2017) it is shown further that the Maxwell-like equations of gravitation, supplemented with the coefficient of gravitational permeability, allow us to describe and explain a number of natural phenomena.

Known gravitational radiation detectors

The costly experiments on gravitational radiation detection are known (see numerous references in Wikipedia for the gravitational wave observatory, https://en.wikipedia.org/wiki/Gravitational-wave_observatory) and they have no effect until now. Detection is based on the fact that gravitational waves must change the body size or distance between two proofmasses.

In the first method, the *gravitational antenna* represents a metal cylinder with a weight of by about 2 tons and a length of by about 2 meters, suspended so that it can oscillate under influences of weak forces that can be produced. The cylinder length is measured by piezosensors with a sensitivity of 10^{-16} m. The cylinder length varies with any smooth change in the frequency of the gravitational wave. There is a hope to detect this wave when this frequency coincides with the fundamental frequency of gravitational antenna oscillations. The measurements are refracted by thermal noise and therefore, the gravitational antenna is installed in a vacuum chamber with cooling down to several degrees Kelvin.

In the second method, the *gravitational telescope* is a vacuum tunnel with a length of by about 2 km. Two proofmasses are placed in this tunnel and the distance between them is measured by a laser interferometer. This distance can vary with a change in the gravitational wave frequency and there is a hope to detect this wave.

As pointed out, the grandiosity and extremely low sensitivity of these designs exclude any practical use of the gravitational waves with their help. Therefore, based on the foregoing, another design of the gravitational antenna is proposed. It is expected that the development of many technological directions can support a proper detection of the gravitational waves and the other gravitational phenomena mentioned in Zakharenko (2018).

The proposed gravitational antenna

A massive body is placed in heat-insulated chamber (as in the first method described in the previous section). However, the chamber doesn't get cool. Moreover, a heater must be built in the body of gravitational antenna.

Atoms of our antenna make thermal vibrations. Below in Appendix 2 it is shown that the average velocity of atomic motion in such vibrations at the room temperature, for example, for copper has a value of $V_T \sim$ 3,000 cm/s.

Let us denote the atom velocity vector as $\overline{V_T}$ called the "thermal" velocity vector. It can also be assumed that the thermal motion takes place under the influence of the certain "thermal" force denoted by the vector $\overline{F_T}$. As shown in Appendix 2, this vector varies with the frequency of $f \sim 5\times10^{12}$ Hz and with the period of time $\tau \sim 0.2\times10^{-12}$ second to change its direction to the opposite. The antenna is in a gravitomagnetic field with the induction vector $\overline{B_g}$. Under the influence of the Lorentz gravitational force $\overline{F_g} \equiv \overline{V_T} \times \overline{B_g}$ such atoms must move on the "gravitational" velocity vector $\overline{V_g}$ directed along the vector $\overline{F_g}$. Thus, the total force acting on an atom is $\overline{F} = \overline{F_T} + \overline{F_g}$.

Figure 1 shows two copper atoms A and B located in a gravitomagnetic field with the induction $\overline{B_g}$. Both atoms oscillate under the action of the force $\overline{F_T}$ along the velocity vector $\overline{V_T}$. This is shown as two pale circles around each bright atom. The velocity vector $\overline{V_T}$ of atom A is directed at an angle to the vector induction $\overline{B_g}$ and therefore, the gravitomagnetic Lorentz force $\overline{F_g} \equiv \overline{V_T} \times \overline{B_g}$ acts on atom A. Consequently, the total force $\overline{F} = \overline{F_T} + \overline{F_g}$ acts on atom A. The velocity vector of atom B is directed along the induction vector $\overline{B_g}$ and therefore, the gravitomagnetic Lorentz force does not act on atom B.

In the absence of the induction vector $\overline{B_g}$, the gravitomagnetic Lorentz force does not act on all copper atoms. It can be assumed that in this case, the velocity vectors are uniformly distributed in all directions. Consequently, in the absence of the Lorentz force, the thermal radiation of our antenna propagates uniformly in all directions: it is possible to say that in this case, the antenna pattern is a sphere. When the Lorentz force appears, the radiation of our antenna becomes asymmetric because some of the atoms are acted upon by the Loretz force $\overline{F_g}$ and the radiation pattern becomes an ellipsoid whose major axis is directed along the vector $\overline{F_g}$.

Consequently, antenna directional pattern must be deformed under the induction $\overline{B_g}$ with the frequency f_g of the gravitational wave, and deformation limit should be determined by the value of the induction B_g. This phenomenon can be detected, as at the present time very sensitive meters of terahertz radiation are available (Bratman *et al*., 2011).

So, the proposed gravitational antenna (see in Fig. 2) should be solid body 1, maybe with internal well-stabilized heater 2 placed in thermally insulated chamber 3 and surrounded by some receivers of terahertz radiation 4. Heater 2 is required in order to increase the thermal velocity and Lorentz force depending on the velocity, and eventually, the gravitational antenna sensitivity can be increased.

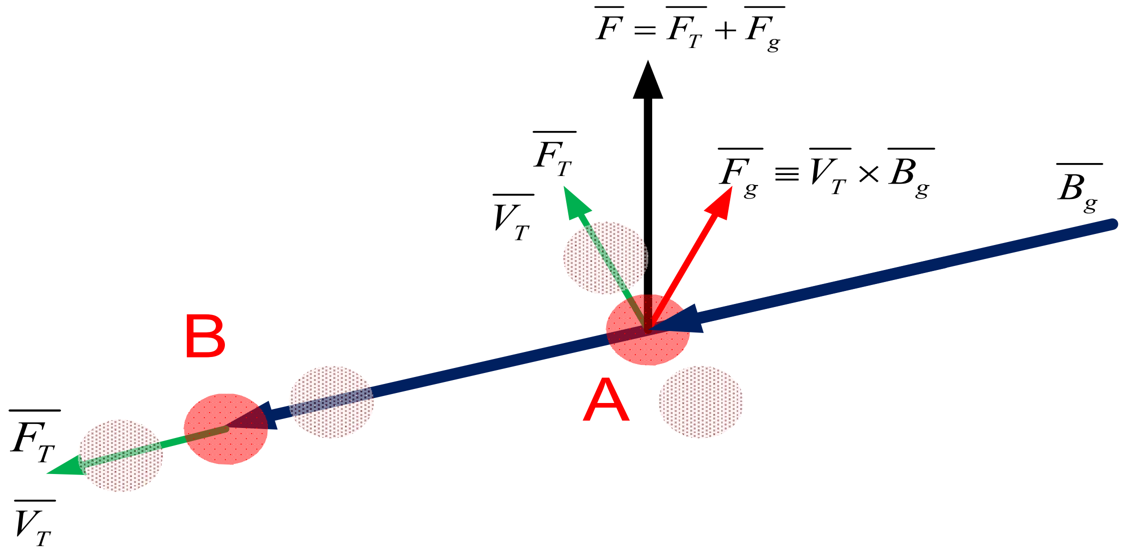

Fig. 1. The forces acting on the copper ato.

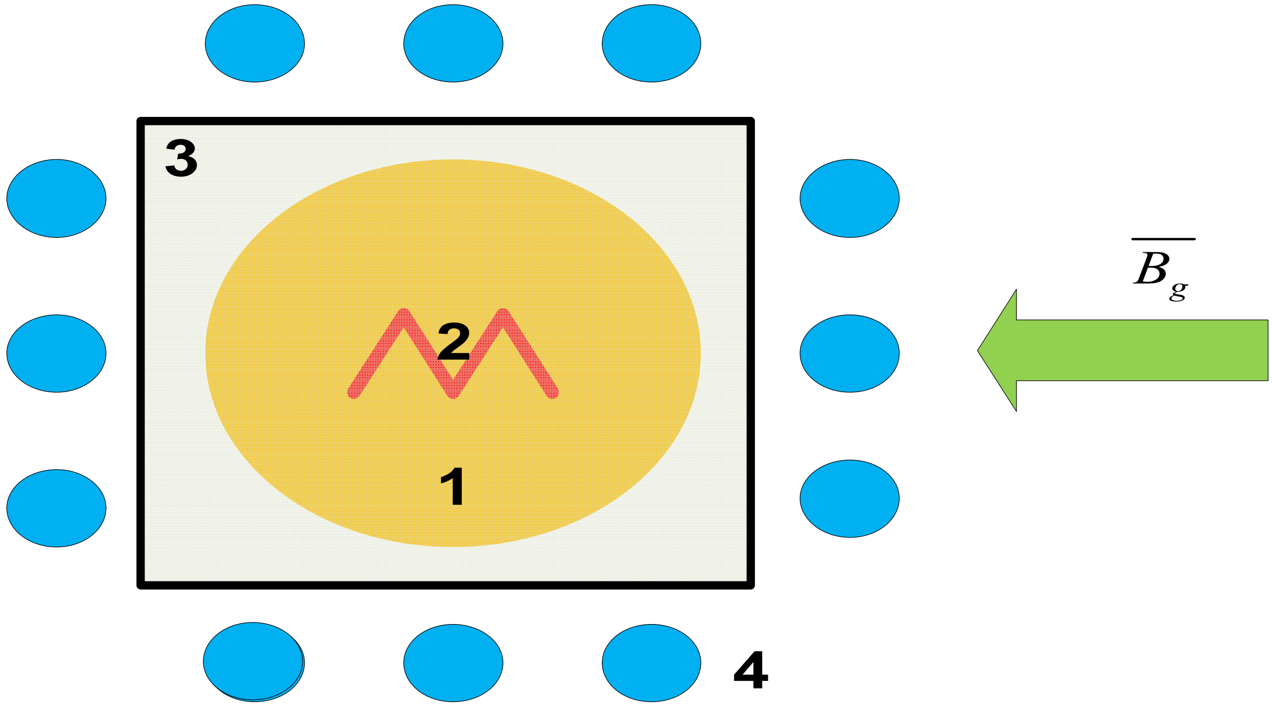

Fig. 2. The gravity Antenna.

CONCLUSION

Detecting gravitational waves is a task that is very important for building a physical picture of the World, and, in the future, for the use of gravitational waves in space technologies. At the same time, such detection is a task that requires very significant funding. Therefore, the search for new methods of this detection is an actual problem.

The article shows that a gravitational antenna can be implemented much simpler than existing ones. The antenna design is based on the fact that the equations of gravitation are modified on the basis of experiments. These experiments show the existence of significant gravitomagnetic forces of Lorentz. The modification is that these equations are supplemented with a coefficient of gravitational permeability that is similar to the coefficient of magnetic permeability and can be found from the same experiments. From the modified equations it follows that a solid body can be a source of terahertz radiation modulated by gravitational radiation from an external source.

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Appendix 1. The Equations of Electro-magnetism and Gravito-magnetism

Further we shall use the following notations:

q stands for the electric charge $[(\text{g}\times\text{cm})^{1/2}]$;
ρ the electric charge density $[(\text{g}\times\text{cm})^{1/2}/\text{cm}^{3}]$;
J the electric current density $[(\text{cm}\times\text{s})^{-1}\,(\text{g}/\text{cm})^{1/2}]$;
c the speed of light in a vacuum, $c \sim 3\times10^{10}$ [cm/s];
E the electric field intensity $[(\text{g}\times\text{cm})^{1/2}/\text{s}^{2} = 3\times10^{4}\ \text{V/m}]$;
B the magnetic induction $[(\text{g}/\text{cm})^{1/2}/\text{s} = \text{Gs}]$;
ε the permittivity of the medium;
μ the permeability of the medium;
v the speed [cm/s];
F the force $[\text{g}\times\text{cm}/\text{s}^{2}]$;
m the mass [g];
ρ_g the mass density $[\text{g}/\text{cm}^{3}]$;
J_g the mass current density $[\text{g}/(\text{s}\times\text{cm}^{2})]$;
G the gravitational constant, $G \sim 7\times10^{-8}$ $[\text{cm}^{3}/(\text{g}\times \text{s}^{2})]$;
E_g the gravito-electric field intensity $[\text{cm}/\text{s}^{2}]$;
B_g the gravito-magnetic induction $[\text{cm}/\text{s}^{2}]$.

The Maxwell equations for electromagnetism in CGS system are as follows:

$$\mathrm{div}E = 4\pi\rho \tag{1}$$

$$\mathrm{div}B = 0 \tag{2}$$

$$\mathrm{rot}E = -\frac{1}{c}\frac{\partial B}{\partial t} \tag{3}$$

$$\mathrm{rot}B = \frac{4\pi \cdot \mu}{c} J + \frac{\varepsilon}{c}\frac{\partial E}{\partial t} \quad (4)$$

The Lorentz force for the electric charge is

$$F = qE + \frac{q}{c}\left[v \times B\right] \quad (5)$$

The Maxwell equations for gravito-electromagnetism in the CGS system (supplemented by the analogy with equations (1)-(4) and the yse of the permeability ξ) are written as follows:

$$\mathrm{div}E_g = 4\pi G\rho_g \quad (6)$$

$$\mathrm{div}B_g = 0 \quad (7)$$

$$\mathrm{rot}E_g = -\frac{1}{c}\frac{\partial B_g}{\partial t} \quad (8)$$

$$\mathrm{rot}B_g = \frac{4\pi G\xi}{c} J_g + \frac{1}{c}\frac{\partial E_g}{\partial t} \quad (9)$$

The Lorentz force for the mass is

$$F = mE_g + \varsigma\frac{m}{c}\left[v \times B_g\right] \quad (10)$$

where ς is the coefficient equal to 1 by Heaviside and equal to 2 in the general relativity theory.

Appendix 2. The rate of copper atoms thermal motion

At first, let us consider some constants for copper (Reif, 1967):

C_V = 0.385 kJ/(kg×K) is the heat capacity,
η = 16.7 K^{-1} is the coefficient of linear thermal expansion,
ρ = 9 $\mathrm{g/cm^3}$ is the mass density,
$m = 10^{-22}$ g is the atom mass,
$\alpha = 2.3\times10^{-8}$ cm is the interatomic distance,
$\chi = 7.3\times10^{-13}$ is the compressibility,
$\alpha = 3a/\chi = 10^5$ is the elasticity coefficient,
$s_0 \sim (kT/\alpha)^{1/2} = 0.4\times10^{-10}\ (T)^{1/2} = 6\times10^{-10}$ cm is the average value of the amplitude of the oscillations of the atom,
$\omega \sim (\alpha/m)^{1/2} = (3a/\chi m)^{1/2} = 3\times10^{13}$ rad/second is the frequency of the vibrations of the atoms,
$f = \omega/2\pi \sim 4.8\times10^{12}\ \mathrm{s}^{-1}$ is the frequency of atoms' vibrations,
$\lambda = c/f \sim 0.06$ mm is the wavelength of the thermal terahertz radiation,
$\tau = 1/f \sim 0.2\times10^{-12}$ second is the period of the atoms' oscillations.

Depending on temperature, the average rate of copper atom thermal motions is determined by formula of the following type $V_T = s_0/\tau \sim 200T^{1/2}$ cm/s. In particular, when temperature T = 230 K we obtain V_T = 3,000 cm/s.

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