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The electromagnetic cause of gravity

Dr. Andreas Gimsa

Stirling Technologie Institut gemeinnützige GmbH, D-14478 Potsdam, Germany

Abstract

Under the condition of the expansion of the universe and all masses with their atoms and charges in it, the electromagnetic cause of the gravitational force is determined with the help of the Lorentz force. The gravitational force, which could be founded here electromagnetically, is identical with the mechanical gravitational force of Newton, which is confirmed experimentally many times and is correct, but still unfounded.

Keywords: Gravitation, Gravitational force, Lorentz force

1. Introduction

In the publication "The electromagnetic origin of gravity" [9.] the gravitational force was represented electromagnetically. At the end of the description the equation (20) given there shows a correct calculation rule for the gravitational force between two masses. It was assumed there that the described displacement currents come about by the spatial enlargement of the charges themselves, i.e. the protons and electrons. These also become larger, but the displacement currents are even easier to derive from the geometric enlargement of the atoms. The mean distances of the electrons from the protons become larger. The resulting time-forming electric displacement currents lead to gravitation. In addition, in [9.] erroneously a geometrically averaged number of charges was calculated.

In this paper, the electromagnetic origin of gravity will be reexamined and verified.

2. The displacement currents during the expansion of the universe

With the growth of the universe all masses grow spatially with their atoms. Consequently, this also concerns the orbitals of the electrons. It is assumed here that there are not only electric but also magnetic elementary charges in the atoms. The magnetic elementary charges cannot exist in space as free charges, because they presumably form time and are therefore in another dimension. They elude with it the direct spatial observation. This is also the reason why only closed magnetic field lines are perceived in space. The sources of the magnetic elementary charges are in the time. The magnetic elementary charges could be in the protons and could be responsible for the strong force.

The enlargement of all atoms at the expansion of the universe leads to displacement currents, because also the distances of the charges contained in the atoms increase. The displacement current is not a current in which a charge is transported. It corresponds to the change of an electric or a magnetic flux.

The calculations made here with their correct and observable results show that the displacement currents, which is modelled in figures 1 and 2, always have a defined spatial direction. The current is perpendicular to the axis of motion of the two masses which fall on each other from assumed rest due to the gravitational effect. This uniform direction of the displacement current is directly related to the uniform direction of time, which is perpendicular to the three spatial dimensions and runs from the past into the future. While both masses are only in their rest positions, they will move on their axis of motion and collide in the future. There is always a pair of displacement currents, one electric and one magnetic, each with a defined direction, which are perpendicular to each other. The displacement current can be understood as a quantity of charge

moved in time. During the expansion of the universe, time could emerge from the magnetic displacement current, which is perpendicular to the electric one $t = \vec{Q}_{mg}/\vec{I}_{mg}$.
It shall be proved that gravity is a consequence of the expansion of the universe. From the following explanations it can be concluded that it could not occur in a static universe.
The electric displacement current $\vec{I}_{el\,1}$ (Figure 1) is accompanied by a charge displacement of the charges. $\vec{Q}_{el\,1}$ is associated with it. The magnetic flux density $\vec{B}_1$ is a consequence of the magnetic displacement current $\vec{I}_{mg\,1}$ which is perpendicular to the electric displacement current. It does not occur in space and therefore cannot be represented in the spatial representation of figure 1. This magnetic displacement current forms time in the region of mass m_1. Up to now in physics the time is assumed as given, but it arises only according to electromagnetic rules with the expansion of the universe in the area of masses.
The electric displacement current $\vec{I}_{el\,2}$ (Figure 1) is accompanied by a charge displacement of the charges. $\vec{Q}_{el\,2}$ is associated with it. The magnetic flux density $\vec{B}_2$ is a consequence of the magnetic displacement current $\vec{I}_{mg\,2}$which is perpendicular to the electric displacement current. It does not occur in space and therefore cannot be represented in the spatial representation of figure 1. This magnetic displacement current forms time in the region of mass m_2.
The electric displacement current $\vec{I}_{el\,1}$ together with the magnetic flux density $\vec{B}_2$ which acts from the distance on the mass m_1 leads to a half of the gravitational force. This process can be described according to the "right hand rule". Here the thumb has the direction of the electric displacement current $\vec{I}_{el\,1}$ the index finger the direction of the magnetic field lines of the magnetic field with the flux density $\vec{B}_2$ and the middle finger the direction of the resulting Lorentz force.
The electric displacement current $\vec{I}_{el\,2}$ together with the magnetic flux density $\vec{B}_1$ which acts from the distance on the mass m_2 leads to the other half of the gravitational force. This process can also be described according to the "right hand rule". Here the thumb has the direction of the electric displacement current $\vec{I}_{el\,2}$ the index finger the direction of the magnetic field lines of the magnetic field with the flux density $\vec{B}_1$ and the middle finger the direction of the resulting Lorentz force.
The two Lorentz forces from the two displacement currents add up to form the gravitational force.
Figure 2 shows a symmetrical process to figure 1, where the magnetic displacement currents are not invisible in time but observable in space. $\vec{I}_{mg}$ do not occur invisibly in time but observably in space. The electric field lines of the electric fields with flux densities $\vec{D}_1$ and $\vec{D}_2$ are closed and have no sources in space. The time in this symmetrical process is formed by the electric displacement current $t = \vec{Q}_{el}/\vec{I}_{el}$. This process cannot occur during the expansion of the universe, because no magnetic elementary charges are observed. They are not present. If one assumes a pulsation of the universe instead of the endless expansion, a contraction phase is conceivable, in which the electrical and magnetic components of the matter are interchanged. The consideration of the process symmetrical to figure 1 according to figure 2 and the corresponding calculations have therefore a purely theoretical value and take place here because it could be determined that exactly the same gravitational force results.
The electric and magnetic flux densities shown in Figure 1 and Figure 2 are $\vec{D}$ and $\vec{B}$ do not result from electric or magnetic fields acting outwardly, but result from the change in electric and magnetic flux due to the spatial magnifications of the charges. The displacement current flows even in vacuum when a field changes there. It can be expressed as a change in charge with time. For the electric displacement current, the relationship known according to Maxwell is valid:

$$\vec{I}_{el} = \varepsilon \int_A \frac{\partial \vec{E}}{\partial t} d\vec{A} = \varepsilon_0 \varepsilon_r \int_A \frac{\partial \vec{E}}{\partial t} d\vec{A} = \varepsilon_r \int_A \frac{\partial \vec{D}}{\partial t} d\vec{A} = \frac{d\vec{Q}_{el}}{dt} \qquad (01)$$

Just as there is an electric displacement current, according to Maxwell's complete equations, if there are elementary magnetic charges in atoms, there should be a magnetic displacement current that flows as the charge increases:

$$\vec{I}_{mg} = \mu \int_A \frac{\partial \vec{H}}{\partial t} d\vec{A} = \mu_0 \mu_r \int_A \frac{\partial \vec{H}}{\partial t} d\vec{A} = \mu_r \int_A \frac{\partial \vec{B}}{\partial t} d\vec{A} = \frac{d\vec{Q}_{mg}}{dt} \tag{02}$$

The displacement currents at the masses m_1 and m_2 according to equations (01) and (02) are shown as models in figures 1 and 2.

3. The electromagnetic cause of the gravitational force

The well-known Lorentz force, which acts on a moving electric charge $\vec{Q}_{el}$ moving with the velocity $\vec{v}$ in an electromagnetic field is calculated as follows:

$$\vec{F}_{Lorentz} = \vec{Q}_{el}\vec{E} + \vec{Q}_{el}(\vec{v} \times \vec{B}_{mg}) \tag{03}$$

If there is no external electric field for the electric charge of field strength $\vec{E}$ the equation (03) simplifies to the resulting force $\vec{F}_{res}$:

$$\vec{F}_{res} = \vec{Q}_{el} \, (\vec{v} \times \vec{B}_{mg}) \tag{04}$$

If, as shown in figure 1, the velocity of the electric charge is $\vec{Q}_{el}$ in the form of the electric displacement current $\vec{I}_{el}$ perpendicular to the field lines of the magnetic field with the flux density $\vec{B}_{mg}$ equation (04) can be further simplified by omitting the cross product:

$$\vec{F}_{res} = \vec{Q}_{el} \, \vec{v} \, \vec{B}_{mg} \tag{05}$$

On the mass m_1 in figure 1 is affected by the electric displacement current $\vec{I}_{el\,1}$ in the magnetic field with the flux density $\vec{B}_2$ which emanates from the mass m_2 the resulting force:

$$\vec{F}_{res1} = \vec{Q}_{el\,1} \, \vec{v}_1 \, \vec{B}_2 \tag{06}$$

On the mass m_2 in figure 1 is affected by the electric displacement current $\vec{I}_{el\,2}$ in the magnetic field with the flux density $\vec{B}_1$which emanates from the mass m_1 the resulting force:

$$\vec{F}_{res2} = \vec{Q}_{el\,2} \, \vec{v}_2 \, \vec{B}_1 \tag{07}$$

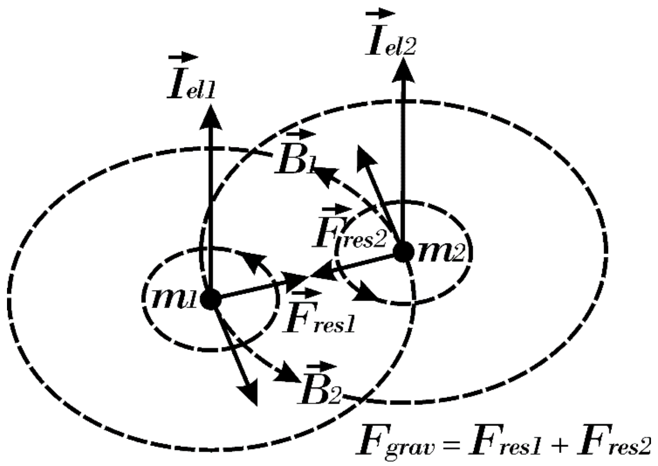

Figure 1: Electromagnetic origin of gravitational force due to electric displacement current during the expansion of the universe.

If the universe pulsates and if magnetic monopole charges exist in space during the contraction of the universe, there should be, starting from Maxwell's equations, a force comparable to the Lorentz force on a moving magnetic charge $\vec{Q}_{mg}$ which moves with the velocity $\vec{v}$ in an electromagnetic field:

$$\vec{F}_{res} = \vec{Q}_{mg}\vec{H} + \vec{Q}_{mg}(\vec{v} \times \vec{D}_{el}) \tag{08}$$

If there is no external magnetic field for the magnetic charge of the field strength $\vec{H}$ the equation (08) is simplified:

$$\vec{F}_{res} = \vec{Q}_{mg} \, (\vec{v} \times \vec{D}_{el}) \tag{09}$$

If, as shown in Figure 2, the velocity of the magnetic charge is $\vec{Q}_{mg}$ in the form of the magnetic displacement current $\vec{I}_{mg}$ is perpendicular to the field lines of the electric field with the flux density $\vec{D}_{el}$ equation (09) can be further simplified by omitting the cross product:

$$\vec{F}_{res} = \vec{Q}_{mg}\,\vec{v}\,\vec{D}_{el} \qquad (10)$$

On the mass m_1 in figure 2 is affected by the magnetic displacement current $\vec{I}_{mg\,1}$ in the electric field with flux density $\vec{D}_2$ which emanates from the mass m_2 the resulting force:

$$\vec{F}_{res1} = \vec{Q}_{mg\,1}\,\vec{v}_1\,\vec{D}_2 \qquad (11)$$

On the mass m_2 in figure 2 is affected by the magnetic displacement current $\vec{I}_{mg\,2}$ in the electric field with flux density $\vec{D}_1$ which emanates from the mass m_1 the resulting force:

$$\vec{F}_{res2} = \vec{Q}_{mg\,2}\,\vec{v}_2\,\vec{D}_1 \qquad (12)$$

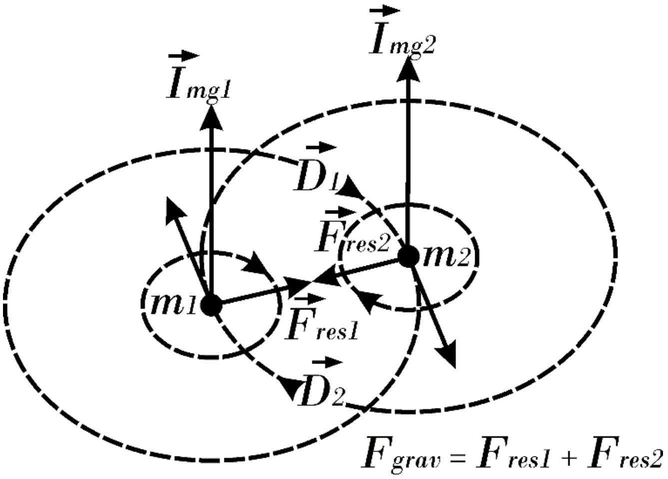

Figure 2: Electromagnetic origin of gravitational force by magnetic displacement current during theoretical contraction of the universe.

The individual coefficients of equations (06), (07), (11) and (12) are to be determined and assigned numbers for the gravitational system **Earth-Moon.** It is calculated with the average distance r of their centers.

Equation (06) is used to calculate the resulting force $\vec{F}_{res1}$ by the electric displacement current $\vec{I}_{el\,1}$ in the magnetic field with the flux density $\vec{B}_2$ can be determined (Figure 1):

The total electric charge $\vec{Q}_{el\,1}$ on the mass m_1 results from the number of individual charges. The number of single charges in turn is multiplied by the object mass m_1 as well as the proton mass m_p and the electron mass m_e is calculated:

$$\vec{Q}_{el\,1} = N_{e1}e \qquad \text{with} \qquad N_{e1} = \frac{m_1}{m_p + m_e} \qquad (13)$$

For the earth with the mass m_1 result $N_{e1} = 3.571\;10^{51}$ electric elementary charges. The total electric charge according to (13) is accordingly $\vec{Q}_{el\,1} = 5.722\;10^{32}\;As$.

The velocity $\vec{v}_1$ of the displacement current $\vec{I}_{el1}$ from the atomic enlargement with the expansion of the universe is extremely slow and corresponds to the ratio of the Bohr radius r_{bohr} to the age of the universe t_{uni}. While the radius of the universe r_{uni} grows with the speed of light, the Bohr radius grows r_{bohr} extremely much slower.

$$\vec{v}_1 = \frac{r_{bohr}}{t_{uni}} \qquad \text{with} \qquad t_{uni} = 13.8\;10^9 a \qquad \text{and} \qquad r_{bohr} = \frac{4\pi\varepsilon_0\hbar^2}{m_e\,e^2} \qquad (14)$$

The velocity $\vec{v}_1$ of the displacement current $\vec{I}_{el1}$ is $1.216\;10^{-28}\;m/s$ and is equal on all masses. All atoms in the objects expand with the universe.

The magnetic flux density $\vec{B}_2$ in equation (06) is caused by the mass m_2 caused by the mass. It results from the magnetic field strength. For a point-like magnetic charge in space, the magnetic field strength is equivalent to the known electric field strength at a distance of r:

$$\vec{H}_2 = \frac{\vec{Q}_{mg\,2}}{4\pi\mu_0\, r^2} \tag{15}$$

In the Earth-Moon system and in many other gravitational systems, the masses can be considered as point-like with respect to their gravitational effect due to their large distance.

This results in the magnetic flux density $\vec{B}_2$ with the absolute permeability μ and the distance r between earth and moon:

$$\vec{B}_2 = \mu\vec{H}_2 = \mu_0\mu_r\vec{H}_2 = \mu_0\mu_r\frac{N_{p2}p}{4\pi\mu_0\, r^2} = \mu_r\frac{N_{p2}p}{4\pi\, r^2} \tag{16}$$

The number of magnetic charges N_{p2} is again related to the object mass m_2 as well as with the proton mass m_p and the electron mass m_e is calculated. It corresponds to the number of electric charges on this mass:

$$N_{p2} = \frac{m_2}{m_p+m_e} \tag{17}$$

This results for the mass m_2 of the moon $N_{p2} = 4.393\ 10^{49}$ magnetic elementary charges.

The substance-dependent permeability μ_r is that of vacuum and by definition has the value 1.

$$\mu_r = 1 \tag{18}$$

The magnetic flux density $\vec{B}_2$ according to equation (16) is then $\vec{B}_2 = 1.428\ 10^{15}\ Vs/m^2$.

The resulting force according to equation (06) by the electric displacement current $\vec{I}_{el\,1}$ in the magnetic field with the flux density $\vec{B}_2$ can then be written as follows:

$$\vec{F}_{res1} = \vec{Q}_{el\,1}\,\vec{v}_1\,\vec{B}_2 = N_{e1}e\frac{r_{bohr}}{t_{uni}}\frac{N_{p2}}{4\pi\, r^2}p = \frac{m_1}{m_p+m_e}e\frac{r_{bohr}}{t_{uni}}\frac{\frac{m_2}{m_p+m_e}}{4\pi\, r^2}p \tag{19}$$

$$\vec{F}_{res1} = \frac{m_1 m_2}{\left(m_p+m_e\right)^2}\frac{r_{bohr}}{t_{uni}}\frac{ep}{4\pi\, r^2} \approx \frac{m_1 m_2}{{m_p}^2}\frac{r_{bohr}}{t_{uni}}\frac{ep}{4\pi\, r^2} \tag{20}$$

$$\boldsymbol{\vec{F}_{res1}} = \vec{Q}_{el\,1}\,\vec{v}_1\,\vec{B}_2 = 5.722\ 10^{32} \times\ 1.216\ 10^{-28}\ \times 1.428\ 10^{15}\ N = \mathbf{9.936\ 10^{19}}\boldsymbol{N}$$

Equation (07) is used to calculate the resulting force $\vec{F}_{res2}$ by the electric displacement current $\vec{I}_{el\,2}$ in the magnetic field with the flux density $\vec{B}_1$ can be determined (Figure 1):

The total electric charge $\vec{Q}_{el\,2}$ on the mass m_2 results from the number of individual charges. The number of single charges is in turn multiplied by the object mass m_2 as well as with the proton mass m_p and the electron mass m_e:

$$\vec{Q}_{el\,2} = N_{e2}e \qquad \text{with} \qquad N_{e2} = \frac{m_2}{m_p+m_e} \tag{21}$$

For the moon with mass m_2 result $N_{e2} = 4.393\ 10^{49}$ electric elementary charges. The total electric charge according to (21) is accordingly $\vec{Q}_{el\,2} = 7.039\ 10^{30}\ As$.

The velocity $\vec{v}_2$ of the displacement current $\vec{I}_{el2}$ from the atomic enlargement with the expansion of the universe is extremely slow and corresponds to the ratio of the Bohr radius r_{bohr} to the age of the universe t_{uni}.

$$\vec{v}_2 = \frac{r_{bohr}}{t_{uni}} \tag{22}$$

The velocity $\vec{v}_2$ of the displacement current $\vec{I}_{el2}$ is $1.216\ 10^{-28}\ m/s$ and is equal on all masses. All atoms in the objects expand with the universe.

The magnetic flux density $\vec{B}_1$ in equation (07) is caused by the mass m_1 caused by the mass. It results from the magnetic field strength. For a point-like magnetic charge in space, the magnetic field strength is equivalent to the known electric field strength at a distance of r:

$$\vec{H}_1 = \frac{\vec{Q}_{mg\,1}}{4\pi\mu_0\, r^2} \tag{23}$$

In the gravitational system Earth-Moon the masses can be considered as point-like with respect to their gravitational effect because of their large distance.

This results in the magnetic flux density $\vec{B}_1$ with the absolute permeability μ and the distance r between earth and moon:

$$\vec{B}_1 = \mu \vec{H}_1 = \mu_0 \mu_r \vec{H}_1 = \mu_0 \mu_r \frac{N_{p1}}{4\pi\mu_0\, r^2} p = \mu_r \frac{N_{p1}}{4\pi\, r^2} p \quad (24)$$

The number of magnetic charges N_{p1} is again related to the object mass m_1 as well as with the proton mass m_p and the electron mass m_e. It corresponds to the number of electric charges on this mass:

$$N_{p1} = \frac{m_1}{m_p + m_e} \quad (25)$$

The following results for the mass m_1 of the earth $N_{p1} = 3.571\ 10^{51}$ magnetic elementary charges.

The substance-dependent permeability μ_r is that of vacuum and by definition has the value 1.

$$\mu_r = 1 \quad (26)$$

The magnetic flux density $\vec{B}_1$ according to equation (24) is then $\vec{B}_1 = 1.161\ 10^{17}\ Vs/m^2$.

The resulting force according to equation (07) by the electric displacement current $\vec{I}_{el\ 2}$ in the magnetic field with the flux density $\vec{B}_1$ can then be written as follows:

$$\vec{F}_{res2} = \vec{Q}_{el\ 2}\, \vec{v}_2\, \vec{B}_1 = N_{e2} e \frac{r_{bohr}}{t_{uni}} \frac{N_{p1}}{4\pi\, r^2} p = \frac{m_2}{m_p + m_e} e \frac{r_{bohr}}{t_{uni}} \frac{\frac{m_1}{m_p + m_e}}{4\pi\, r^2} p \quad (27)$$

$$\vec{F}_{res2} = \frac{m_1 m_2}{(m_p + m_e)^2} \frac{r_{bohr}}{t_{uni}} \frac{ep}{4\pi\, r^2} \quad (28)$$

$$\boldsymbol{\vec{F}_{res2}} = \vec{Q}_{el\ 2}\, \vec{v}_2\, \vec{B}_1 = 7.039\ 10^{30} \times\ 1.216\ 10^{-28}\ \times 1.161\ 10^{17}\ N = \mathbf{9.936\ 10^{19} N}$$

The gravitational force during the expansion of the universe is simply the sum of the first resulting force $\vec{F}_{res1}$ and the second force of equal magnitude $\vec{F}_{res2}$:

$$\boldsymbol{\vec{F}_{grav}} = \vec{F}_{res1} + \vec{F}_{res2} = 9.936\ 10^{19} N + 9.936\ 10^{19} N = \mathbf{1.987\ 10^{20}\ N} \quad (28a)$$

The following calculations with equations (29) to (44) refer to the theoretical possibility that the universe pulsates and that magnetic monopole charges exist in space during the contraction of the universe (see figure 2).

Equation (11) is used to calculate the resulting force $\vec{F}_{res1}$ by the magnetic displacement current $\vec{I}_{mg\ 1}$ in the electric field with the flux density $\vec{D}_2$ can be determined (Figure 2):

The total magnetic charge $\vec{Q}_{mg\ 1}$ on the mass m_1 results from the number of individual charges. The number of single charges in turn is multiplied by the object mass m_1 as well as with the proton mass m_p and the electron mass m_e:

$$\vec{Q}_{mg\ 1} = N_{p1} p \qquad \text{with} \qquad N_{p1} = \frac{m_1}{m_p + m_e} \quad (29)$$

For the earth with the mass m_1 result $N_{p1} = 3.571\ 10^{51}$ magnetic elementary charges. The total magnetic charge according to (29) is accordingly $\vec{Q}_{mg\ 1} = 2.156\ 10^{35}\ Vs$.

The velocity $\vec{v}_1$ of the displacement current $\vec{I}_{mg1}$ at the charge reduction with the contraction of the universe is extremely slow and corresponds to the ratio of proton radius r_p (see below) to the radius of the universe r_{uni} multiplied by the speed of light c.

The velocity $\vec{v}_1$ of the displacement current $\vec{I}_{mg1}$ from the atomic reduction with the contraction of the universe is extremely slow and corresponds to the ratio of the Bohr radius r_{bohr} to the age of the universe t_{uni}.

$$\vec{v}_1 = \frac{r_{bohr}}{t_{uni}} \quad (30)$$

The velocity $\vec{v}_1$ of the displacement current $\vec{I}_{mg1}$ is $1.216\ 10^{-28}\ m/s$ and is equal on all masses. All atoms in the objects contract with the universe.

The electric flux density $\vec{D}_2$ in equation (11) is caused by the mass m_2 caused by the mass. It results from the electric field strength. For a point electric charge in space, the electric field strength at a distance is given by r:

$$\vec{E}_2 = \frac{\vec{Q}_{el\,2}}{4\pi\varepsilon_0\, r^2} \quad (31)$$

In the gravitational system Earth-Moon the masses can be considered as point-like with respect to their gravitational effect because of their large distance.

This results in the electric flux density $\vec{D}_2$ with the absolute permittivity ε and the distance r between earth and moon:

$$\vec{D}_2 = \varepsilon\vec{E}_2 = \varepsilon_0\varepsilon_r\vec{E}_2 = \varepsilon_0\varepsilon_r\frac{N_{e2}e}{4\pi\varepsilon_0\, r^2} = \varepsilon_r\frac{N_{e2}e}{4\pi\, r^2} \quad (32)$$

The number of electric charges N_{e2} is again related to the object mass m_2 as well as with the proton mass m_p and the electron mass m_e. It corresponds to the number of magnetic charges on this mass:

$$N_{e2} = \frac{m_2}{m_p+m_e} \quad (33)$$

This results for the mass m_2 of the moon $N_{e2} = 4.393\ 10^{49}$ electric elementary charges.

The substance-dependent permittivity ε_r corresponds exactly like the substance-dependent permeability μ_r to that of the vacuum and by definition has the value 1:

$$\varepsilon_r = 1 \quad (34)$$

The electric flux density $\vec{D}_2$ according to equation (32) is then $\vec{D}_2 = 3.791\ 10^{12}\ As/m^2$.

The resulting force according to equation (11) by the magnetic displacement current $\vec{I}_{mg\,1}$ in the electric field with the flux density $\vec{D}_2$ can then be written as follows:

$$\vec{F}_{res1} = \vec{Q}_{mg\,1}\,\vec{v}_1\,\vec{D}_2 = N_{p1}p\frac{r_{bohr}}{t_{uni}}\frac{N_{e2}}{4\pi\, r^2}e = \frac{m_1}{m_p+m_e}p\frac{r_{bohr}}{t_{uni}}\frac{\frac{m_2}{m_p+m_e}}{4\pi\, r^2}e \quad (35)$$

$$\vec{F}_{res1} = \frac{m_1 m_2}{(m_p+m_e)^2}\frac{r_{bohr}}{t_{uni}}\frac{ep}{4\pi\, r^2} \quad (36)$$

$$\boldsymbol{\vec{F}_{res1}} = \vec{Q}_{mg\,1}\,\vec{v}_1\,\vec{D}_2 = 2.156\ 10^{35} \times 1.216\ 10^{-28} \times 3.791\ 10^{12}\ N = \mathbf{9.936\ 10^{19} N}$$

Equation (12) is used to calculate the resulting force $\vec{F}_{res2}$ by the magnetic displacement current $\vec{I}_{mg\,2}$ in the electric field with the flux density $\vec{D}_1$ can be determined (Figure 2):

The total magnetic charge $\vec{Q}_{mg\,2}$ on the mass m_2 results from the number of individual charges. The number of single charges in turn is multiplied by the object mass m_2 as well as with the proton mass m_e and the electron mass m_p is calculated:

$$\vec{Q}_{mg\,2} = N_{p2}p \qquad \text{with} \qquad N_{p2} = \frac{m_2}{m_p+m_e} \quad (37)$$

For the moon with mass m_2 result $N_{p2} = 4.393\ 10^{49}$ magnetic elementary charges. The total magnetic charge according to (37) is then $\vec{Q}_{mg\,2} = 2.652\ 10^{33}\ Vs$.

The velocity $\vec{v}_2$ of the displacement current $\vec{I}_{mg2}$ from the atomic reduction with the contraction of the universe is extremely slow and corresponds to the ratio of the Bohr radius r_{bohr} to the age of the universe t_{uni}.

$$\vec{v}_2 = \frac{r_{bohr}}{t_{uni}} \quad (38)$$

The velocity $\vec{v}_2$ of the displacement current $\vec{I}_{mg2}$ is $1.216\ 10^{-28}\ m/s$ and is equal on all masses. All atoms in the objects contract with the universe.

The electric flux density $\vec{D}_1$ in equation (12) is caused by the mass m_1 caused by the mass. It results from the electric field strength. For a point electric charge in space, the electric field strength at a distance is given by r:

$$\vec{E}_1 = \frac{\vec{Q}_{el\,1}}{4\pi\varepsilon_0\, r^2} \tag{39}$$

In the gravitational system Earth-Moon the masses can be considered as point-like with respect to their gravitational effect because of their large distance.

This results in the electric flux density $\vec{D}_1$ with the absolute permittivity ε and the distance r between earth and moon:

$$\vec{D}_1 = \varepsilon\vec{E}_1 = \varepsilon_0\varepsilon_r\vec{E}_1 = \varepsilon_0\varepsilon_r \frac{N_{e1}}{4\pi\varepsilon_0\, r^2} e = \varepsilon_r \frac{N_{e1}}{4\pi\, r^2} e \tag{40}$$

The number of electric charges N_{e1} is again related to the object mass m_1 as well as with the proton mass m_p and the electron mass m_e is calculated. It corresponds to the number of magnetic charges on this mass:

$$N_{e1} = \frac{m_1}{m_p+m_e} \tag{41}$$

The following results for the mass m_1 of the earth $N_{e1} = 3.571\ 10^{51}$ magnetic elementary charges.

The substance-dependent permittivity ε_r corresponds to that of the vacuum and, by definition, has the value 1.

$$\varepsilon_r = 1 \tag{42}$$

The electric flux density $\vec{D}_1$ according to equation (40) is then $\vec{D}_1 = 3.082\ 10^{14}\ As/m^2$.

The resulting force according to equation (12) due to the electric displacement current $\vec{I}_{el\,2}$ in the magnetic field with the flux density $\vec{B}_1$ can then be written as follows:

$$\vec{F}_{res2} = \vec{Q}_{mg\,2}\,\vec{v}_2\,\vec{D}_1 = N_{e2}p\frac{r_{bohr}}{t_{uni}}\frac{N_{e1}}{4\pi\, r^2}e = \frac{m_2}{m_p+m_e}p\frac{r_{bohr}}{t_{uni}}\frac{\frac{m_1}{m_p+m_e}}{4\pi\, r^2}e \tag{43}$$

$$\vec{F}_{res2} = \frac{m_1 m_2}{\left(m_p+m_e\right)^2}\frac{r_{bohr}}{t_{uni}}\frac{ep}{4\pi\, r^2} \tag{44}$$

$$\boldsymbol{\vec{F}_{res2}} = \vec{Q}_{mg\,2}\,\vec{v}_2\,\vec{D}_1 = 2.652\ 10^{33} \times 1.216\ 10^{-28}\ x\ 3.082\ 10^{14}\ N = \mathbf{9.936\ 10^{19}}\boldsymbol{N}$$

Also during the contraction of the universe the gravitational force is simply the sum of the first resulting force $\vec{F}_{res1}$ and the second equal force $\vec{F}_{res2}$:

$$\boldsymbol{\vec{F}_{grav}} = \vec{F}_{res1} + \vec{F}_{res2} = 9.936\ 10^{19}N + 9.936\ 10^{19}N = \mathbf{1.987\ 10^{20}}\ \boldsymbol{N} \tag{44a}$$

The gravitational force during the theoretically considered contraction of the universe is exactly as large as during the expansion and it remains attractive.

Equations (20), (28), (36) and (44) contain magnetic elementary charges, which are indispensable for the electromagnetic description of gravity. The obvious conclusion is: They exist in the atoms. For the gravitational system earth-moon with the center distance r between both objects the determined gravitational force amounts to $1.987\ 10^{20}N$. It is left here to the reader to determine this gravitational force according to Newton. The usual negative sign of the gravitational force results from the definition that repulsive forces are positive and is not considered here.

The slowed down time flow in the gravitational field is an indication that the caused force inhibits its cause, namely time as a displacement current.

4. Basic physical equations in connection with gravitation

The gravitational force between two masses has already been described as a force with electromagnetic charges and the quotient of the coupling constants $\alpha_{grav}/\alpha_{em}$ [1.]. For the magnetic elementary charge thereby applies: $p^2 = 4\pi\alpha_{em}c\mu_0\hbar$ with $p = 6.036\ 10^{-17}\ Vs$ [3.].

$$F_{grav} = \gamma\frac{m_1\, m_2}{r^2} = \frac{m_1\, m_2}{m_p\, m_e}\frac{e^2}{4\pi\varepsilon_0 r^2}\frac{\alpha_{grav}}{\alpha_{em}} = \frac{m_1\, m_2}{m_p\, m_e}\frac{p^2}{4\pi\mu_0 r^2}\frac{\alpha_{grav}}{\alpha_{em}} \tag{45}$$

Another calculation rule for the gravitational force involves the proton radius r_p and the radius of the universe r_{uni} with:

$$F_{grav} = \frac{m_1\, m_2}{m_p\, m_e} \frac{p^2}{4\pi\mu_0 r^2} \frac{r_p}{2\alpha_{em}\, r_{uni}} \tag{46}$$

The following simple form of gravity as a magnetic force which would assume the existence of monopoles in space is not applicable as equation (03) shows:

$$|F_{grav}| \neq F_{mg} = \frac{m_1\, m_2}{m_p\, m_e} \frac{p^2}{4\pi\mu_0 r^2} \tag{47}$$

The magnitude of the gravitational force F_{grav} is just not equal to that of the magnetic force F_{mg}. The gravitational force occurs in space, as equation (45) shows, weakened by the factor $\alpha_{grav}/\alpha_{em}$.

The coupling constant of the gravitational interaction α_{grav} has a value of $3.2\; 10^{-42}$ and the coupling constant of the electromagnetic interaction α_{em} has a value of $7.3\; 10^{-3}$. Thus the attenuation factor $\alpha_{grav}/\alpha_{em}$ has the extremely small value of $4.4\; 10^{-40}$. The following relationship was established between the characteristic impedance of the vacuum and the Klitzing resistance [3.]:

$$2\alpha_{em} = \frac{Z_0}{R_{Kl}} \tag{48}$$

This relationship is introduced in equation (45) and shows the gravitational force in another concise notation:

$$F_{grav} = \frac{m_1\, m_2}{m_p\, m_e} \frac{p^2}{4\pi\mu_0 r^2} \frac{R_{Kl}}{Z_0} \frac{r_p}{r_{uni}} = \frac{m_1\, m_2}{m_p\, m_e} \frac{e^2}{4\pi\varepsilon_0 r^2} \frac{R_{Kl}}{Z_0} \frac{r_p}{r_{uni}} = F_{mg} \frac{R_{Kl}}{Z_0} \frac{r_p}{r_{uni}} = \frac{m_1\, m_2}{m_p\, m_e} \frac{c\hbar\alpha_{grav}}{r^2} \tag{49}$$

Equation (49) now shows a simple relation between the gravitational force F_{grav} and the magnetic force F_{mg}which contains two dimensionless coefficients: 1. the ratio of the Klitzing resistance to the characteristic impedance of the vacuum $R_{Kl}/Z_0 = 68.5$ and 2. the ratio of the proton radius to the radius of the universe $r_p/r_{uni} = 6.4\; 10^{-42}$. The characteristic impedance of the vacuum Z_0 is approx. $377\; \Omega$. The radius of the universe can be easily calculated using the age of the universe: $r_{uni} = c\; t_{uni}$ [4.]. The gravitational force is slightly larger than according to (47) because the Klitzing resistance is larger than the wave resistance of the vacuum and it is therefore extremely much smaller than according to (47) because the proton radius is much smaller than the radius of the universe. The well-known Klitzing resistance shows up in the quantum Hall effect: If a current flows at low temperatures and perpendicular to a strong magnetic field through a thin metal film as a 2-dimensional electron system, the Hall voltage is formed. It does not grow linearly with the magnetic field, but in steps. The Hall resistance is the quotient between the Hall voltage and the current. The Klitzing resistance $R_{Kl} = U_H/I = h/e^2 = 25{,}813\; \Omega$ is the largest Hall resistance. The electrons in the metal film are deflected by the Lorentz force. They always move with the same energy on a discrete circular path, which corresponds to a certain energy level. The vacuum characteristic impedance Z_0 opposes the propagation of electromagnetic waves in vacuum. As an impedance of space, it causes electromagnetic waves to propagate in vacuum only at the speed of light. The coupling constant of the strong interaction is $\alpha_{st} = 0.5$. In quantum physics, this value represents a maximum value, which can be reached at about 0.5 femtometers quark distance. The coupling constant stops growing at larger distances. This leads at atomic distances to the cohesion of quarks and also of protons. At higher energies and smaller distances, the quarks behave like free particles. So they are, so to speak, confined in a space region.

Within this range they can move freely. For the coupling constant α_{st} the following relationship was given for the first time [2.]:

$$\alpha_{st} = \sqrt{\frac{\hbar}{m_p\, r_p\, c}} = 0.5 \tag{50}$$

Equation (50) can be introduced into (45) for a different notation of the gravitational force:

$$F_{grav} = \gamma \frac{m_1 m_2}{r^2} = \frac{m_1\, m_2}{m_p\, m_e} \frac{p^2}{4\pi\mu_0 r^2} \frac{r_p}{2\alpha_{em} r_{uni}} = F_{mg} \frac{r_p}{2\alpha_{em} r_{uni}} = F_{mg} \frac{\alpha_{st}}{\alpha_{em}} \frac{r_p}{r_{uni}} \tag{51}$$

The equality of the ratios of fundamental forces and their coupling constants [2.] is valid:

$$\frac{\alpha_{st}}{\alpha_{em}} = \frac{F_{st}}{F_{mg}} \tag{52}$$

Therefore, equations (51) and (52) can be used to write for the gravitational force:

$$\boxed{F_{grav} = F_{st}\frac{r_p}{r_{uni}}} \tag{53}$$

If now the ratio r_p/r_{uni} from equation (51) is introduced into (53), the result is:

$$F_{grav} = \gamma\frac{m_1 m_2}{r^2} = F_{st}\frac{r_p}{r_{uni}} = F_{st}\frac{F_{grav}}{F_{mg}}\frac{Z_0}{R_{Kl}} \tag{54}$$

From this follows for the strong force F_{st}:

$$\boxed{F_{st} = F_m\,\frac{R_{Kl}}{Z_0}} \tag{55}$$

Equation (55) shows that the strong force follows from the magnetic force and equation (53) shows that the gravitational force follows from the strong force. This is another indication that there are not only electric but also magnetic charges in the elementary particles.

The strong force could originate from the magnetic field of magnetic monopoles.

The simplification of equation (49) leads to novel calculation rules for the Newtonian gravitational value γ:

$$\gamma = \frac{1}{m_e m_p}\frac{r_p}{r_{uni}}\frac{R_{Kl}}{Z_0}\frac{e^2}{4\pi\varepsilon_0} = \frac{1}{m_e m_p}\frac{r_p}{r_{uni}}\frac{R_{Kl}}{Z_0}\frac{p^2}{4\pi\mu_0} \tag{56}$$

$$\gamma = \frac{1}{m_e m_p}\frac{r_p}{r_{uni}}\frac{R_{Kl}}{Z_0}\frac{epc}{4\pi} \tag{57}$$

The correctness of equations (56) and (57) can be easily checked. The gravitational value γ is $6.7\,10^{-11}\,m^3/(kg\,s^2)$. With this concatenation of numerous elementary quantities with the necessity that the correct unit for γ must come out, it is extremely improbable that the equation (57) is not correct.

In the publication [1.] another formula for the gravitational value was found:

$$\gamma = \frac{2\hbar^2}{c\,t_{uni}\,m_e {m_p}^2} \tag{58}$$

Hereby it becomes quite clear that the gravity value must change with the age of the universe. However, one must also consider the mass reductions of electron and proton with the time.

With the equations (57), (58) and (48) and the known connection $e^2 = 4\pi\alpha_{em}c\varepsilon_0\hbar$ the following calculation rule follows for the proton radius:

$$r_p = \frac{\hbar}{{\alpha_{em}}^2 c\;m_p}\frac{{Z_0}^2}{{R_{Kl}}^2} \tag{59}$$

Only the time-variable proton mass m_p determines the time-variable proton radius. All other quantities in equation (59) are real invariant natural constants. The calculated proton radius is 0.84 femtometers and agrees exactly with the actual measured radius [5.].

It is very advantageous that such essential quantities as the gravitational value and the proton radius can be described physically and calculated mathematically exactly.

Alan Guth describes in [6.], that a massed, compressible spherical shell, which contracts under its own gravity, produces an external gravitational field, which was not present before in the same space area within the spherical shell. He deduced from it that thereby energy is released and the gravitational energy must be negative accordingly.

With the expansion of the universe an opposite process could take place in principle. The outer gravitational field of the universe is erased and for this energy is needed. The energy could come from the masses. These would have to become smaller with the age of the universe. With it would be also explicable that for the universe the amount of the mass energy corresponds exactly to the gravitational energy [7.]:

$$-\gamma\frac{{m_{uni}}^2}{r_{uni}} + m_{uni}\,c^2 = 0 \qquad \text{with} \qquad r_{uni} = c\,t_{uni} \tag{60}$$

While the mass m_{uni} falls during the expansion of the universe, the amount of gravitational energy also falls to the same extent, because r_{uni} increases and γ rises even quadratically.

Equation (60) is formally correct, but does not establish the existence of everything from nothing. The explanation of the gravitational force as Lorentz force with electromagnetic origin has far-reaching consequences. Many attempts of explanation of gravitation also one of my own, are hereby falsified. It is no longer surprising that masses with so-called positive gravitational charge attract each other, although otherwise charges of the same polarity repel each other. The masses themselves have a neutral electric charge towards the outside and they move towards each other only due to the effect of the Lorentz force. Thus, gravity does not need any interacting particles, because the Lorentz force is caused by the electric and magnetic displacement current and the change of the magnetic and electric flux during the expansion of the universe. This also means that there can be no gravitational waves. The negative sign of the gravitational energy does not surprise any more and also not the fact that in the universe the amount of the sum of all mass energies corresponds to that of the gravitational energy. Because it does not exist as independent energy actually at all, it is an energy which exists in the charges and in the form of electromagnetic field energy. This energy becomes free in consequence of the effect of the Lorentz force with the distance reduction between objects. The mass energy can also be understood as energy of charges and atomic fields. Charge displacement can lead either to energy release, as in free fall, or to energy absorption, as in the separation of masses. Because this process of mass separation requires energy, the masses must become smaller as the universe expands. It is believed by some scientists that the universe pulsates and contracts after an expansion phase. With the explanation of the gravitational force as Lorentz force this is obvious: The gravitation would remain attractive also with continued time direction from the past into the future with matter. The time during the contraction of the universe could then arise from the electric displacement current.

For the constant number of effects of the universe the following formula was given in [1.]:

$$N_{uni} = \sqrt{\frac{2\, m_{uni}{}^3}{m_e m_p{}^2}} = \frac{m_{uni}\, t_{uni}\, c^2}{\hbar} \qquad (61)$$

From this, a new formula for the age of the universe can be derived:

$$t_{uni} = \sqrt{\frac{2\, m_{uni}}{m_e}}\, \frac{\hbar}{m_p c^2} \qquad (62)$$

The constant number of effects $N_{uni}\hbar = m_{uni}\, t_{uni}\, c^2$ of the universe is a measure for its entropy. For the age of the universe can also be written:

$$t_{uni} = \frac{m_{uni}}{m_p\, m_e} \frac{e\, p}{4\pi\, c^2} \frac{r_p}{r_{uni}} \frac{R_{Kl}}{Z_0} \qquad (63)$$

In equation (63) the gravitational value γ can be introduced and it can be brought into another form by subsequent elimination of γ with (57) into another form:

$$t_{uni} = \sqrt{\frac{m_{uni}}{4\pi} \frac{R_{Kl}}{Z_0} \frac{r_p}{c^3} \frac{ep}{m_e m_p}} \qquad (64)$$

The equations (62) and (64) can be equated. From this follows the relation for the proton already published in [8.]:

$$\frac{r_p m_p c}{\hbar} = 4 \qquad (65)$$

By equating the gravitational force according to equation (20) from [9.] with the gravitational force determined here according to equations (28), (28a) and the simplification $m_p \approx m_p + m_e$ two interesting formulas for the Newtonian gravitational value γ and the Bohr radius r_{bohr} can be derived. With equation (57) it follows for the gravitational value γ:

$$\boxed{\gamma = \frac{r_{bohr}\, ep}{2\pi\, m_p{}^2\, t_{uni}}} \qquad (66)$$

The proton radius with equation (20) from [9.] and equations (28) and (28a) given above can be written even more simply than with (59):

$$\boxed{r_p = \frac{2\, r_{bohr}\, m_e}{m_p} \frac{Z_0}{R_{Kl}}} \qquad (67)$$

5. The gravitational force, determined from the enlargement of the protons

In the source [9.] the gravitational force was described in a comparable form with the Lorentz force at the enlargement of the protons with the expansion of the universe. Thereby was calculated erroneously with a geometrically averaged number of charges. This shall be corrected here. Since the mechanism of action is in principle the same as with the enlargement of the atoms, here only briefly the electromagnetic components, as they appear in the equations (06) and (07), are determined.

$$\vec{Q}_{el\,1} = \frac{m_1}{m_p+m_e} e \tag{68}$$

$$\vec{v}_1 = \frac{r_p}{t_{uni}} \quad \text{with } r_p \text{ as the proton radius} \tag{69}$$

$$\vec{B}_2 = \mu_r \frac{N_{p2} p}{4\pi\, r^2} \quad \text{with } \mu_r = \alpha_{st} \frac{R_{Kl}}{Z_0} \frac{m_p}{m_e} \text{ and } \quad N_{p2} = \frac{m_2}{m_p+m_e} \tag{70}$$

The substance-dependent permittivity μ_r of the proton includes the coupling constant of the strong force α_{st} according to equation (50), the ratio of the Klitzing resistance R_{Kl} to the wave resistance of the vacuum Z_0 and the ratio of the mass of the proton to the mass of the electron.

It follows for the resulting force F_{res1}:

$$F_{res1} = \vec{Q}_{el\,1} \vec{v}_1 \vec{B}_2 = \frac{m_1}{m_p+m_e} e \frac{r_p}{t_{uni}} \alpha_{st} \frac{R_{Kl}}{Z_0} \frac{m_p}{m_e} \frac{\frac{m_2}{m_p+m_e} p}{4\pi\, r^2} = \frac{m_1 m_2}{(m_p+m_e)^2} \frac{r_p}{t_{uni}} \alpha_{st} \frac{R_{Kl}}{Z_0} \frac{m_p}{m_e} \frac{ep}{4\pi\, r^2} \tag{71}$$

$$\vec{Q}_{el\,2} = \frac{m_2}{m_p+m_e} e \tag{72}$$

$$\vec{v}_2 = \frac{r_p}{t_{uni}} \quad \text{with } r_p \text{ as the proton radius} \tag{73}$$

$$\vec{B}_1 = \mu_r \frac{N_{p1} p}{4\pi\, r^2} \quad \text{with } \mu_r = \alpha_{st} \frac{R_{Kl}}{Z_0} \frac{m_p}{m_e} \text{ and } \quad N_{p1} = \frac{m_1}{m_p+m_e} \tag{74}$$

$$F_{res2} = \vec{Q}_{el\,2} \vec{v}_2 \vec{B}_1 = \frac{m_2}{m_p+m_e} e \frac{r_p}{t_{uni}} \alpha_{st} \frac{R_{Kl}}{Z_0} \frac{m_p}{m_e} \frac{\frac{m_1}{m_p+m_e} p}{4\pi\, r^2} = \frac{m_1 m_2}{(m_p+m_e)^2} \frac{r_p}{t_{uni}} \alpha_{st} \frac{R_{Kl}}{Z_0} \frac{m_p}{m_e} \frac{ep}{4\pi\, r^2} \tag{75}$$

$$F_{grav} = F_{res1} + F_{res2} \tag{76}$$

Of course, the force components F_{res1} and F_{res2} of equations (71) and (75) are not additional force components of gravity. The description with the magnification of the protons represents an alternative to the description with the magnification of the atoms.

6. Summary

Starting from Maxwell's equations, the electromagnetic origin of gravity could be derived. Gravitation follows from the displacement currents and the flux changes which occur with the enlargement of the atoms due to the expansion of the universe. To describe gravity with general relativity as a curvature of space-time must be rejected. The present publication justifies why the earth and the moon remain on their orbits and in the end the universe maintains cohesion during its expansion. It could be confirmed here that with the expansion of the universe all objects must grow along. New formulas for the gravitational constant, the proton radius and the age of the universe were given.

It is interesting that the formulas (01) to (12) keep their validity also with antimatter.

The finding that all masses become smaller as the universe expands, and that all massed objects expand with the universe, which is now 10 years old and has been published several times, has been verified [10.].

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