Photon, graviton and antigraviton

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Abstract

— Aim:

Human nature appears to urge us to drive ever further and ever faster and to ask deep questions even about the completely unknown. In this context, A photon appears to be such a mystery on its own, however even if not completely unknown.

Methods: The usual physical rules and laws were used.

Results: Newton's gravitational constant G is not a constant. An experiment is proposed to proof this issue definitely. The photon itself is determined by a graviton and an antigraviton.

Conclusion: A graviton and an antigraviton are the determining parts of a photon.

Keywords ***— Photon, Graviton, Antigraviton.***

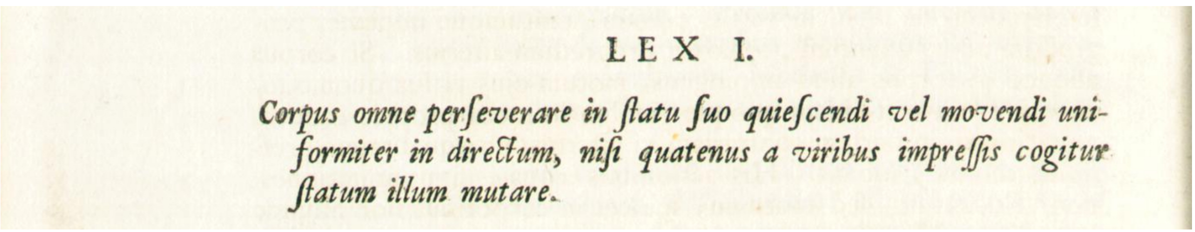
I. Introduction

Change as such is one of the crucial features of objective reality. By time, the concept of motion itself became central to any understanding of change. In other words, scientist were forced to address the question of what exactly motion is. The English mathematician *Sir Isaac Newton* (1642 – 1727) published in the year 1687 in his book *Philosophiæ Naturalis Principia Mathematica* (see Newton 1687) three basic mathematical axioms in order to describe the relationship between the motion of an object and the forces acting on the same under any circumstances. Following Newton and other, space is a real and mind-independent entity. According to Newton, space and time are absolute, "Spatium absolutum . . . "(see Newton 1687, p. 5) and "Tempus absolutum . . . "(see Newton 1687, p. 5)

It's worth pausing briefly to contrast Newton's view of space and time with those of Leibniz and of other. Leibniz's views on the metaphysics of space and time is straightforward and clear. Leibniz himself simply denies a mind-independent reality of space and time. In 1715 Leibniz(see also Leibniz et al. 1998) warned other of the dangers Newton's philosophy.

Newton's first law

Following Newton, every object remains at rest or in uniform motion in a straight line unless compelled to a change by the action of an external force.


LEX I.

Corpus omne perſeverare in ſtatu ſuo quieſcendi vel movendi uniformiter in directum, niſi quatenus a viribus impreſſis cogitur ſtatum illum mutare.

Figure 1: Definition of Newton's first law. (see Newton 1687, p. 12)

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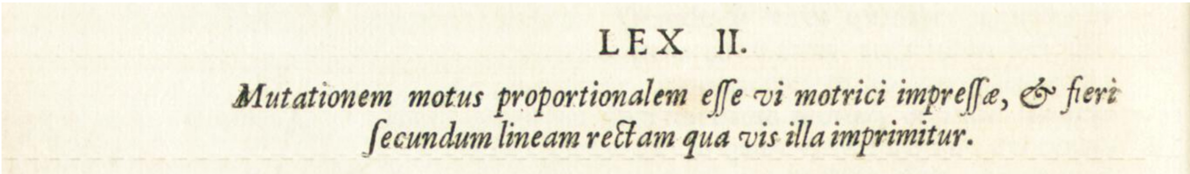
[5] https://zenodo.org/search?page=1&size=20&q=keywords:%22Baruk%C4%8Di%C4%87%22&sort=mostviewed

Usually, Newton's first law is normally taken as the definition of inertia. However, the same law has been pioneered by Galileo too.

Newton's second law

Newton's second law states that the rate of change of momentum of a body over time occurs in the same direction as the applied force and is directly proportional to the force applied.



LEX II.

Mutationem motus proportionalem esse vi motrici impressæ, & fieri secundum lineam rectam qua vis illa imprimitur.

Figure 2: Definition of Newton's second law. (see Newton 1687, p. 12)

Leonhard Euler (1707-1783), a pioneering Swiss mathematician and physicist, formulated 1752 Newton lex secunda (see also Euler 1752) in its mathematical form something like

$$ {}_{0}F_{\mathrm{t}} \equiv {}_{0}m_{\mathrm{t}} \times {}_{0}a_{\mathrm{t}} \tag{1} $$

where ${}_{0}\mathrm{F}_{\mathrm{t}}$ is the (net) force applied from the point of view of a co-moving observer O at a certain run of an experiment t, ${}_{0}\mathrm{m}_{\mathrm{t}}$ is the mass of the body from the point of view of a co-moving observer at a certain run of an experiment t, and ${}_{0}\mathrm{a}_{\mathrm{t}}$ is the body's acceleration from the point of view of a co-moving observer at a certain run of an experiment t.

Newton's first (and second) laws of motion are valid especially under conditions of inertial frames of reference. It is interesting to note in this context Einstein's position on inertial frames of reference and the whole theory of relativity.

> "The theory of relativity is a theory of principle. To understand it, the principles on which it rests must be grasped. ... The great attraction of the theory is its logical consistency. If any deduction from it should prove untenable, it must be given up. A modification of it seems impossible without destruction of the whole. "
> (see Albert Einstein 1920)

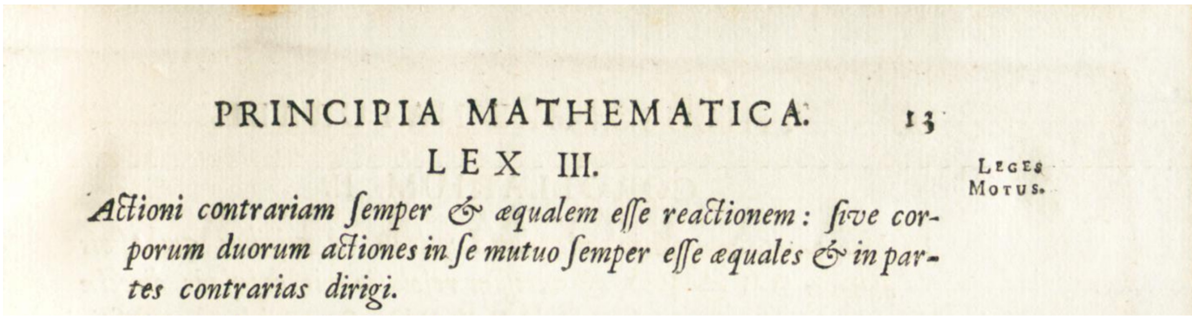
Therefore under conditions of inertial frames of reference from the point of view of a stationary observer R we obtain

$$ {}_{\mathrm{R}}F_{\mathrm{t}} \equiv {}_{\mathrm{R}}m_{\mathrm{t}} \times {}_{\mathrm{R}}a_{\mathrm{t}} \tag{2} $$

where ${}_{\mathrm{R}}\mathrm{F}_{\mathrm{t}}$ is the (net) force applied from the point of view of a stationary observer R at a certain run of an experiment t, ${}_{\mathrm{R}}\mathrm{m}_{\mathrm{t}}$ is the mass of the body from the point of view of a stationary observer at a certain run of an experiment t, and ${}_{\mathrm{R}}\mathrm{a}_{\mathrm{t}}$ is the body's acceleration from the point of view of a stationary observer at a certain run of an experiment t.

Newton's third law

Newton's third law demands that all forces between two objects exist in equal magnitude and opposite direction. In other words, for every action (force) there is an equal and opposite reaction or **actio est reactio**.



PRINCIPIA MATHEMATICA. 13

LEX III.

LEGES MOTUS.

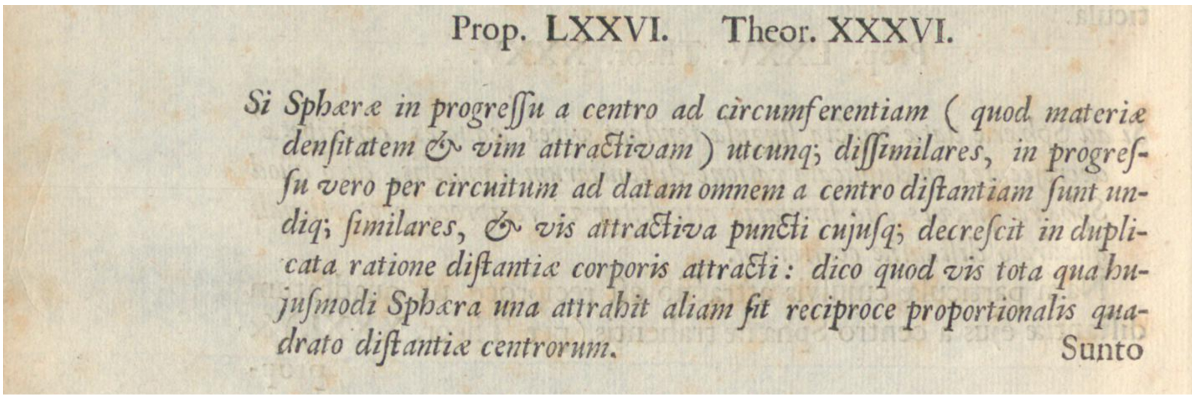
Actioni contrariam ſemper & æqualem eſſe reactionem: ſive corporum duorum actiones in ſe mutuo ſemper eſſe æquales & in partes contrarias dirigi.

Figure 3: Definition of Newton's third law. (see Newton 1687, p. 13)

From a different point of view, Newton used his third law to establish the law of conservation of momentum. However, there are conditions where Newton's third law appears to fail.

Newtonian Constant of Gravitation G

Newton himself defined his constant(see Newton 1687, p. 198) on page 198 as follows:



Prop. LXXVI. Theor. XXXVI.

Si Sphæræ in progreſſu a centro ad circumferentiam (quod materiæ denſitatem & vim attractivam) utcunq; diſſimilares, in progreſſu vero per circuitum ad datam omnem a centro diſtantiam ſunt undiq; ſimilares, & vis attractiva puncti cujuſq; decreſcit in duplicata ratione diſtantiæ corporis attracti: dico quod vis tota qua hujuſmodi Sphæra una attrahit aliam ſit reciproce proportionalis quadrato diſtantiæ centrorum. Sunto

Figure 4: Definition of Newton's gravitational constant. (see Newton 1687, p. 198)

In the past three decades numerous precision measurements with various methods of the Newtonian Constant of Gravitation G were performed. Even though it is repeated once and again that Newtonian Constant of Gravitation G is fundamental natural constant it is equally extremely difficult to measure the same very accurately. Unfortunately, G is still known only with a certain relative standard uncertainty.

II. Material and methods

Force, velocity, acceleration et cetera are usually described as vectors. As of now, in the interests of simplification, we abstain to specially mark vectors.

2.1 Definitions

2.1.1 The number +0

Definition 2.1 (The number +0). *Let c or c_R or c_O denote the speed of light in vacuum (see also Drude 1894; Tombe 2015; W. E. Weber and Kohlrausch 1856; W. Weber and Kohlrausch 1857), let ε_0 denote the electric constant and let μ_0 the magnetic constant. Let i denote the imaginary number (see also Bombelli 1579). The number +0 is defined as the expression*

$$
\begin{aligned}
+0 &\equiv +1-1 \\
&\equiv +1+i^2 \\
&\equiv +1+e^{i\pi} \\
&\equiv +\left(c^2\times\varepsilon_0\times\mu_0\right)+e^{i\pi}
\end{aligned}
\tag{3}
$$

while '= 'or $\equiv$ denotes the equals sign (see also Recorde 1557) or equality sign (see also Rolle 1690) used to indicate equality and '- '(see also Widmann 1489; Pacioli 1494) denotes minus signs used to represent the operations of subtraction and the notions of negative as well and '+ 'denotes the plus (see also Recorde 1557) signs used to represent the operations of addition and the notions of positive as well.

Remark 2.1. *Roger Cotes (1682 – 1716) (see also Cotes and Halley 1714) or Leonhard Euler's (1707 – 1783) identity (see also Euler 1748) is regarded as one of the most beautiful equations (see also Wilson 2018). In this context, it is provisionally presumed, that Euler's identity (see also Euler 1748) is logically sound and correct.*

2.1.2 The number +1

Definition 2.2 (The number +1). *Again, let c denote the speed of light in vacuum (see also Drude 1894; Tombe 2015; W. E. Weber and Kohlrausch 1856; W. Weber and Kohlrausch 1857), let ε_0 denote the electric constant and let μ_0 the magnetic constant. Let i denote the imaginary number (see also Bombelli 1579). The number +1 is defined as the expression*

$$\begin{aligned} +1 &\equiv +1+0 \\ &\equiv +1-0 \\ &\equiv +\left(c^2 \times \varepsilon_0 \times \mu_0\right) \end{aligned} \tag{4}$$

while again '= 'or $\equiv$ may denote the equals sign (see also Recorde 1557) or equality sign (see also Rolle 1690) used to indicate equality and '- '(see also Widmann 1489; Pacioli 1494) denotes minus signs used to represent the operations of subtraction and the notions of negative as well and '+ 'denotes the plus (see also Recorde 1557) signs used to represent the operations of addition and the notions of positive as well.

2.1.3 The relationship i

Definition 2.3 (The relationship i). *Let c or c_R or c_O denote the speed of light in vacuum (see also Drude 1894; Tombe 2015; W. E. Weber and Kohlrausch 1856; W. Weber and Kohlrausch 1857), let ε_0 denote the electric constant and let μ_0 the magnetic constant. It is $+\left(c^2 \times \varepsilon_0 \times \mu_0\right) = +1$ and $\frac{1}{c^2} = (\varepsilon_0 \times \mu_0)$. Let ${}_Rh_t$ denote Planck's constant (see also Planck 1901) as proposed by Max Planck in 1900. The Planck constant links the radiation frequency (${}_Rf_t$) with the energy value (${}_RE_t$) by the relationship*

$${}_RE_t \equiv {}_Rh_t \times {}_Rf_t \tag{5}$$

Let $\hbar$ denote Dirac's/Schrödinger's (see also Schrödinger 1926; Dirac and Fowler 1926) constant determined as ${}_R\hbar_t \equiv \frac{{}_Rh_t}{2 \times \pi}$. The relationship i, which is different from the imaginary number, is defined as the expression

$$\begin{aligned} +i &\equiv \frac{{}_Rh_t}{c^2} \equiv {}_Rh_t \times \frac{1}{c^2} \\ &\equiv {}_Rh_t \times \varepsilon_0 \times \mu_0 \\ &\equiv 2 \times \pi \times {}_R\hbar_t \times \varepsilon_0 \times \mu_0 \end{aligned} \tag{6}$$

while '= 'or $\equiv$ denotes the equals sign (see also Recorde 1557) or equality sign (see also Rolle 1690) used to indicate equality and '- '(see also Widmann 1489; Pacioli 1494) denotes minus signs used to represent the operations of subtraction and the notions of negative as well and '+ 'denotes the plus (see also Recorde 1557) signs used to represent the operations of addition and the notions of positive as well.

2.1.4 Time and special relativity

Definition 2.4 (Time and special relativity).

Mathematically, time (see also A. Einstein 1905) from the point of view of a co-moving observer ${}_0t_t$ and time from the point of view of a stationary ${}_Rt_t$ are related by the equation

$${}_0t_t \equiv \left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \times {}_Rt_t \tag{7}$$

where v denotes the relative velocity between the stationary and co-moving observer and c is the speed of the light in vacuum.

Mathematically, mass (see also A. Einstein 1905) from the point of view of a co-moving observer ${}_{0,1}m_t$ and mass from the point of view of a stationary ${}_{R,1}m_t$ are related by the equation

$$ {}_{0,1}m_t \equiv \left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \times {}_{R,1}m_t \tag{8} $$

where v denotes the relative velocity between the stationary and co-moving observer and c is the speed of the light in vacuum. From this follows that

$$ \frac{{}_{0,1}m_t}{{}_{R,1}m_t} \equiv \left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \tag{9} $$

At the same time t or run of an experiment, a second mass (see also A. Einstein 1905) from the point of view of a co-moving observer ${}_{0,2}m_t$ and the same second mass from the point of view of a stationary ${}_{R,2}m_t$ are related by the equation

$$ {}_{0,2}m_t \equiv \left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \times {}_{R,2}m_t \tag{10} $$

while v denotes again the relative velocity between the stationary and co-moving observer and c is the speed of the light in vacuum. From this follows that

$$ \frac{{}_{0,2}m_t}{{}_{R,2}m_t} \equiv \left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \tag{11} $$

2.1.5 Mass equivalent of an object

Definition 2.5 (Mass equivalent of an object).

Changes of objective reality can be determined by mass-less objects too while some of these mass-less objects may posses some energy but no mass, i. e. neither a rest-mass nor a 'relativistic mass'et cetera. Thus far, let ${}_{0}m^{*}{}_{t}$ denote the 'mass equivalent'of a certain object from the point of view of a co-moving observer (see also A. Einstein 1905), let ${}_{R}m^{*}{}_{t}$ denote the 'mass equivalent'of the same object from the point of view of a stationary observer (see also A. Einstein 1905). In general, it is

$$ \begin{aligned} {}_{0}m^{*}{}_{t} &\equiv \frac{{}_{0}E_t}{c^2} \\ &\equiv \frac{\left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \times {}_{R}E_t}{c^2} \\ &\equiv \left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \times {}_{R}m^{*}{}_{t} \end{aligned} \tag{12} $$

where v denotes the relative velocity between the stationary and co-moving observer and c is the speed of the light in vacuum, ${}_{0}E_t$ is the rest energy of the mass-less object and ${}_{R}E_t$ is the 'relativistic 'energy of the mass-less object.

Thus far, especially a wave with a frequency ${}_{R}f_t$ from the point of view of a stationary observer can be determined by mass-less objects but with an energy too and can convert all of its energy into mass. The mass-equivalent from the point of view of a stationary observer can be calculated as follows:

$$ \begin{aligned} {}_{R}m^{*}{}_{t} &\equiv \frac{{}_{R}E_t}{c^2} \\ &\equiv \frac{h \times {}_{R}f_t}{c^2} \\ &\equiv \left(\frac{h}{c^2}\right) \times ({}_{R}f_t) \end{aligned} \tag{13} $$

while the energy ${}_{R}E_t$ associated with a single photon is given by ${}_{R}E_t \equiv h \times {}_{R}f_t$ (see Planck–Einstein relation).

2.1.6 Velocity, acceleration and time

Definition 2.6 (**Velocity, acceleration and time**).

First and foremost, velocity is a physical vector quantity. In other words, magnitude and direction are needed to define velocity. In order to have a constant velocity, it is necessary that an object posses a constant speed in a constant direction. Speed is the scalar absolute value (magnitude) of a velocity vector and denotes only how fast an object is moving. In general, velocity is defined as the rate of change of position with respect to time or equally as change or difference in velocity times the duration of the period. An object may posses an average acceleration $\underline{a}$ over a certain period of time. Let $\Delta\ {}_{0}t$ denote the duration of the period of time from the point of view of a co-moving observer. Let $\Delta\ {}_{0}v$ denote the change in velocity of an object. Mathematically it is,

$$\Delta_0 v_t \equiv {}_0\underline{a}_t \times \Delta_0 t_t \tag{14}$$

Mathematically, from the point of view of a co-moving observer, we define

$${}_0a_t \equiv \lim_{\Delta_0 t_t \to +1} \left(\frac{\Delta_0 v_t}{\Delta_0 t_t} \right) \tag{15}$$

or equally

$${}_0a_t \equiv \frac{{}_0v_t}{{}_0t_t} \tag{16}$$

From the point of view of a stationary observer, it is

$${}_Rv_t \equiv {}_Ra_t \times {}_Rt_t \tag{17}$$

and equally

$${}_Ra_t \equiv \frac{{}_Rv_t}{{}_Rt_t} \tag{18}$$

2.1.7 Force, mass and acceleration

Definition 2.7 (**Force, mass and acceleration**).

Einstein had a far reaching and a big impact on our current understanding of energy(see also A. Einstein 1905; Albert Einstein 1919b; A. Einstein 1948), time(see also Albert Einstein 1918b; Albert Einstein 1918a; A. Einstein and Rosen 1937) and space(see also A. Einstein 1916; Albert Einstein 1920; Weinert 2005). All of physics before Einstein was deeply rooted inside notions like absolute space and absolute time. Among others, Einstein provided evidence that these concepts are erroneous under certain circumstances. Classical physics as such and especially our understanding of mass, time, acceleration, momentum, force, and energy et cetera had to be re-examined. Mathematically, Newton's second law can be expressed as

$${}_0F_t \equiv {}_0m_t \times {}_0a_t \tag{19}$$

However, in special theory of relativity, the four-force is defined as the rate of change in the four-momentum ${}_0p$ of an entity with respect to the entity's proper time ${}_0t$. It is

$${}_0F_t \equiv \frac{\delta_0 p}{\delta_0 t} \tag{20}$$

Even though the concept of velocity has undergone a change and Euler's form of Newton's second law (see eq. 1) is not widely used in Special Relativity Theory, the old definition is not incorrect. Furthermore, we have to accept that

$$\frac{{}_0F_t}{{}_0m_t \times {}_0a_t} \equiv +1 \tag{21}$$

where ${}_0F_t$ is the (net) force acting on a body from the point of view of a co-moving observer O at a certain run of an experiment t, ${}_0m_t$ is the mass of the body from the point of view of a co-moving observer at a certain run of an experiment t, and ${}_0a_t$ is the body's acceleration from the point of view of a co-moving observer at a certain run of an experiment t.

However, under conditions of inertial frames of reference and from the point of view of a stationary observer R, the same system has to be described as

$${}_RF_t \equiv {}_Rm_t \times {}_Ra_t \tag{22}$$

and equally as

$$\frac{{}_{R}F_{t}}{{}_{R}m_{t} \times {}_{R}a_{t}} \equiv +1 \tag{23}$$

where ${}_{R}F_{t}$ is the (net) force acting on a body from the point of view of a stationary observer R at a certain run of an experiment t, ${}_{R}m_{t}$ is the mass of the body from the point of view of a stationary observer at a certain run of an experiment t, and ${}_{R}a_{t}$ is the body's acceleration from the point of view of a stationary observer at a certain run of an experiment t. The SI unit for acceleration is known to be metre per second squared.

2.2 Axioms

2.2.1 Axioms in general

Rightly or wrongly, axioms (Hilbert 1917) as introduced by Newton(see also Newton 1687) in the year 1687 can be one starting point of scientific reasoning(Easwaran 2008). In the light of the foregoing it was, therefore, only logical that Einstein himself pointed out the true meaning of axioms very precisely.

"**Grundgesetz (Axiome)**
und
Folgerungen
zusammen bilden das was man
eine 'Theorie'
nennt. "
(see also Albert Einstein 1919a, p. 17)

Albert Einstein's (1879-1955) position translated into English sounds as follows: *Basic law (axioms) and conclusions together form what is called a 'theory'* or appropriate axioms and conclusions derived from the same are a main logical foundation of any 'theory'. However, an axiom is equally a free creation of the human mind and need not to be free of errors. In light of the thousands of years of often bitter human experience, the scientific development has taught us all more or less that human knowledge is relative too. Even if axioms or experiments and other suitable proofs are of help to encourage us more and more in our belief of the correctness of a theory, it is difficult to proof the correctness of a theorem or of a theory et cetera once and for all.

**"Niemals aber kann die Wahrheit einer Theorie erwiesen werden.
Denn niemals weiß man,
daß auch in Zukunft eine Erfahrung bekannt werden wird,
die Ihren Folgerungen widerspricht..."**
(see also Albert Einstein 1919a)

Albert Einstein's position translated into English: 'But the truth of a theory can never be proven. For one never knows if future experience will contradict its conclusion; and furthermore there are always other conceptual systems imaginable which might coordinate the very same facts. '

There is, therefore, an urgent need to point out once again that one single experiment is enough to refute a theorem, a hypothesis or a theory. Einstein himself in combining new insights with ancient wisdom over years and centuries rewarded us with the following surprising conclusion.

**"No amount of experimentation
can ever prove me right;
a single experiment
can prove me wrong."**
(Albert Einstein. Cited according to: Robertson 1997, p. 143)

We do not think that any further comments on these words of wisdom are necessary.

2.2.2 Axiom I. Lex identitatis - The law of non-contradiction

In this context, we define axiom I mathematically as

$$+1 = +1 \tag{24}$$

Historically, Aristotle himself discussed already principles like **the law of excluded middle** and **the law of contradiction** as examples of axioms. In this context, **lex identitatis** is an axiom too, and do possess the potential to serve as the most basic and equally as the most simple axiom of science. In point of fact, can and how can something be **identical with itself**(Hegel 1812; Koch 1999; Förster and Melamed 2012; Newstadt 2015) and in the same respect different from itself. An increasingly popular view on identity is the one advocated by Gottfried Wilhelm Leibniz (1646-1716):

> **"Chaque chose est ce qu'elle est.**
> **Et dans autant d'exemples qu'on voudra**
> **A est A,**
> **B est B.** "
> (see Leibniz 1765, p. 327)

or **A = A**, **B = B** or **+1 = +1**. Exactly in complete compliance with Leibniz, Johann Gottlieb Fichte (1762 - 1814) elabortes on this subject as follows:

> **"Each thing is what it is ;**
> **it has those realities which are posited when it is posited,**
> **(A = A.)** "
> (see Fichte 1889, p. 141)

2.2.3 Axiom II. Lex contradictionis - The law of contradiction

In this context, axiom II or **lex contradictionis**, the negative of lex identitatis, or

$$+0 = +1 \tag{25}$$

is of no minor importance too. In philosophy, **the principle of explosion** or the principle of Pseudo-Scotus (Latin: **ex contradictione (sequitur) quodlibet**) demand us to accept that from falsehood or from a contradiction, any statement can be proven or anything may follow. However, scientist inevitably have false beliefs and make mistakes. In order to prevent us from falling into logical inconsistency or logical absurdity, it is necessary to posses the possibility to start a reasoning with a contradiction too. However and in contrast to the way of reasoning with inconsistent premises as proposed by para-consistent logic (see Newton Carneiro Alfonso da Costa 1958; Newton C. A. da Costa 1974; Quesada 1977; Priest 1998; Carnielli and Marcos 2001; Priest et al. 2018), in the absence of technical and other errors of reasoning, the contradiction itself need to be preserved. In other words, **from a contradiction does not anything follows but the contradiction itself**.

2.2.4 Axiom III. Lex negationis - The unity and the struggle between identity and contradiction

$$\neg(0) \times 0 = 1 \tag{26}$$

where $\neg$ denotes (logical (Boole 1854) or natural) negation (Royce 1917; Heinemann 1943; Ayer 1952; Hedwig 1980; Kunen 1987; Horn 1989; Wedin 1990; Koch 1999; Horn 2001; Speranza and Horn 2010; Förster and Melamed 2012; Newstadt 2015). In this context, there is some evidence that $\neg(1) \times 1 = 0$. In other words, it is $(\neg(1) \times 1) \times (\neg(0) \times 0) = 1$

III. Results

3.3 Newton's law of motion

Theorem 3.1 (Newton's law of motion)**.** *There are conditions of special theory of relativity where the equation*

$$_{0}F_{t} \equiv {}_{R}F_{t} \tag{27}$$

is valid.

Proof by modus ponens. **If** the premise

$$\underbrace{+1 = +1}_{(Premise)} \tag{28}$$

is true, **then** the conclusion

$$_{0}F_{\mathrm{t}} \equiv {}_{\mathrm{R}}F_{\mathrm{t}} \tag{29}$$

is also true, the absence of any technical errors presupposed. The premise

$$(+1) = (+1) \tag{30}$$

is true. Substituting one part of this premise by equation 21 it is

$$\frac{_{0}F_{\mathrm{t}}}{_{0}m_{\mathrm{t}} \times {}_{0}a_{\mathrm{t}}} \equiv +1 \tag{31}$$

Substituting the rest of equation 31 by equation 23 it is

$$\frac{_{0}F_{\mathrm{t}}}{_{0}m_{\mathrm{t}} \times {}_{0}a_{\mathrm{t}}} \equiv \frac{_{\mathrm{R}}F_{\mathrm{t}}}{_{\mathrm{R}}m_{\mathrm{t}} \times {}_{\mathrm{R}}a_{\mathrm{t}}} \tag{32}$$

Rearranging equation 32, we obtain

$$\frac{_{0}F_{\mathrm{t}}}{_{0}m_{\mathrm{t}} \times \frac{_{0}v_{\mathrm{t}}}{_{0}t_{\mathrm{t}}}} \equiv \frac{_{\mathrm{R}}F_{\mathrm{t}}}{_{\mathrm{R}}m_{\mathrm{t}} \times \frac{_{\mathrm{R}}v_{\mathrm{t}}}{_{\mathrm{R}}t_{\mathrm{t}}}} \tag{33}$$

or

$$\frac{_{0}F_{\mathrm{t}} \times {}_{0}t_{\mathrm{t}}}{_{0}m_{\mathrm{t}} \times {}_{0}v_{\mathrm{t}}} \equiv \frac{_{\mathrm{R}}F_{\mathrm{t}} \times {}_{\mathrm{R}}t_{\mathrm{t}}}{_{\mathrm{R}}m_{\mathrm{t}} \times {}_{\mathrm{R}}v_{\mathrm{t}}} \tag{34}$$

or

$$\frac{_{0}F_{\mathrm{t}} \times \left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \times {}_{\mathrm{R}}t_{\mathrm{t}}}{_{0}m_{\mathrm{t}} \times {}_{0}v_{\mathrm{t}}} \equiv \frac{_{\mathrm{R}}F_{\mathrm{t}} \times {}_{\mathrm{R}}t_{\mathrm{t}}}{_{\mathrm{R}}m_{\mathrm{t}} \times {}_{\mathrm{R}}v_{\mathrm{t}}} \tag{35}$$

or

$$\frac{_{0}F_{\mathrm{t}} \times \left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \times {}_{\mathrm{R}}t_{\mathrm{t}}}{\left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \times {}_{\mathrm{R}}m_{\mathrm{t}} \times {}_{0}v_{\mathrm{t}}} \equiv \frac{_{\mathrm{R}}F_{\mathrm{t}} \times {}_{\mathrm{R}}t_{\mathrm{t}}}{_{\mathrm{R}}m_{\mathrm{t}} \times {}_{\mathrm{R}}v_{\mathrm{t}}} \tag{36}$$

Equation 36 simplifies as

$$\frac{_{0}F_{\mathrm{t}}}{_{0}v_{\mathrm{t}}} \equiv \frac{_{\mathrm{R}}F_{\mathrm{t}}}{_{\mathrm{R}}v_{\mathrm{t}}} \tag{37}$$

Under conditions of special theory of relativity it is $v \equiv {}_{0}v_{\mathrm{t}} \equiv {}_{\mathrm{R}}v_{\mathrm{t}}$. Equation 37 simplifies further as

$$_{0}F_{\mathrm{t}} \equiv {}_{\mathrm{R}}F_{\mathrm{t}} \tag{38}$$

In other words, our conclusion is true.

□

3.4 Mass and special relativity theory

Theorem 3.2 (Mass and special relativity theory)**.** *Under conditions of special theory of relativity where the axiom* $+1 = +1$ *is valid, we must accept equally that*

$$({}_{0,1}m_t) \times ({}_{R,2}m_t) \equiv ({}_{0,2}m_t) \times ({}_{R,1}m_t) \tag{39}$$

Proof by modus ponens. **If** the premise

$$\underbrace{+1 = +1}_{(Premise)} \tag{40}$$

is true, **then** the conclusion

$$({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}}) \equiv ({}_{0,2}m_{\mathrm{t}}) \times ({}_{\mathrm{R},1}m_{\mathrm{t}}) \tag{41}$$

is also true, the absence of any technical errors presupposed. The premise

$$(+1) = (+1) \tag{42}$$

is true. Multiplying eq. 42 by $\left(\sqrt[2]{1-\frac{v^2}{c^2}}\right)$ it is

$$\left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \equiv \left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \tag{43}$$

Substituting the result of eq. 9 into eq. 43 it is

$$\left(\frac{{}_{0,1}m_{\mathrm{t}}}{{}_{\mathrm{R},1}m_{\mathrm{t}}}\right) \equiv \left(\sqrt[2]{1-\frac{v^2}{c^2}}\right) \tag{44}$$

Substituting the result of eq. 11 into eq. 44 it is

$$\left(\frac{{}_{0,1}m_{\mathrm{t}}}{{}_{\mathrm{R},1}m_{\mathrm{t}}}\right) \equiv \left(\frac{{}_{0,2}m_{\mathrm{t}}}{{}_{\mathrm{R},2}m_{\mathrm{t}}}\right) \tag{45}$$

and equally

$$({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}}) \equiv ({}_{0,2}m_{\mathrm{t}}) \times ({}_{\mathrm{R},1}m_{\mathrm{t}}) \tag{46}$$

Multiplying by the speed of the light in vacuum c^2, it is

$$({}_{0,1}m_{\mathrm{t}}) \times c^2 \times ({}_{\mathrm{R},2}m_{\mathrm{t}}) \times c^2 \equiv ({}_{0,2}m_{\mathrm{t}}) \times c^2 \times ({}_{\mathrm{R},1}m_{\mathrm{t}}) \times c^2 \tag{47}$$

or

$$({}_{0,1}E_{\mathrm{t}}) \times ({}_{\mathrm{R},2}E_{\mathrm{t}}) \equiv ({}_{0,2}E_{\mathrm{t}}) \times ({}_{\mathrm{R},1}E_{\mathrm{t}}) \tag{48}$$

However, under conditions of special theory of relativity it is necessary to accept the relationship

$$({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}}) \equiv ({}_{0,2}m_{\mathrm{t}}) \times ({}_{\mathrm{R},1}m_{\mathrm{t}}) \tag{49}$$

In other words, our conclusion is true.

□

Remark 3.2. *However, the co-moving observer of the mass* ${}_{1}m_t$ *denoted by* ${}_{0,1}m_t$ *need not to be identical with co-moving observer of the mass* ${}_{2}m_t$ *denoted by* ${}_{0,2}m_t$ *and vice versa. This relationship may be valid for the stationary observers too.*

3.5 Newton's gravitational constant is observer dependent

Theorem 3.3 (Newton's gravitational constant is observer dependent)**.** *Paul Adrien Maurice Dirac (1902 – 1984) proposed in 1937 that physical constants like Newton's gravitational constant might be subject to change over time(see Dirac 1938) but did not provide a proof. In the following, Brans and Dicke (see Brans and Dicke 1961) developed a specific scalar-tensor theory of gravitation which predicts a variation Newton's gravitational constant with time. Today, super-string theories provide a framework for studying the time variation of fundamental constants. The value of Newton's gravitational constant is observer dependent. In general, it is*

$$ {}_{0}G_t \equiv \left(1-\frac{v^2}{c^2}\right) \times {}_{R}G_t \tag{50}$$

Proof by modus ponens. **If** the premise

$$ \underbrace{+1=+1}_{(Premise)} \tag{51}$$

is true, **then** the conclusion

$$ {}_{0}G_{\mathrm{t}} \equiv \left(1-\frac{v^2}{c^2}\right) \times {}_{\mathrm{R}}G_{\mathrm{t}} \tag{52}$$

is also true, the absence of any technical errors presupposed. The premise

$$ (+1) = (+1) \tag{53}$$

is true. Multiplying by ${}_{0}\mathrm{F}_{\mathrm{t}}$ (see theorem 3.1), it is

$$ {}_{0}F_{\mathrm{t}} \equiv {}_{0}F_{\mathrm{t}} \tag{54}$$

or

$$ {}_{0}G_{\mathrm{t}} \times \left(\frac{({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}})}{{}_{0}d_{\mathrm{t}}{}^2}\right) \equiv {}_{0}F_{\mathrm{t}} \tag{55}$$

where ${}_{0}\mathrm{F}_{\mathrm{t}}$ denotes (net) force as measured by the co-moving observer, ${}_{0}\mathrm{G}_{\mathrm{t}}$ denotes Newton's gravitational constant as measured by the co-moving observer, ${}_{0}\mathrm{d}_{\mathrm{t}}{}^2$ is the distance between the two masses (see theorem 3.2) as measured by the co-moving observer. According to theorem 3.1, eq. 55 changes too

$$ {}_{0}G_{\mathrm{t}} \times \left(\frac{({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}})}{{}_{0}d_{\mathrm{t}}{}^2}\right) \equiv {}_{\mathrm{R}}F_{\mathrm{t}} \tag{56}$$

The force measured on the same system by the stationary observer R is

$$ {}_{0}G_{\mathrm{t}} \times \left(\frac{({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}})}{{}_{0}d_{\mathrm{t}}{}^2}\right) \equiv {}_{\mathrm{R}}G_{\mathrm{t}} \times \left(\frac{({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}})}{{}_{\mathrm{R}}d_{\mathrm{t}}{}^2}\right) \tag{57}$$

where ${}_{\mathrm{R}}\mathrm{F}_{\mathrm{t}}$ denotes (net) force as measured by the stationary observer R, ${}_{\mathrm{R}}\mathrm{G}_{\mathrm{t}}$ denotes Newton's gravitational constant as measured by the stationary observer R, ${}_{\mathrm{R}}\mathrm{d}_{\mathrm{t}}{}^2$ is the distance between the two masses (see theorem 3.2) as measured by the stationary observer R. According to theorem 3.2, eq. 49 it is $({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}}) \equiv ({}_{0,2}m_{\mathrm{t}}) \times ({}_{\mathrm{R},1}m_{\mathrm{t}})$. Equation 57 can be rearranged without any changes as

$$ {}_{0}G_{\mathrm{t}} \times \left(\frac{({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}})}{{}_{0}d_{\mathrm{t}}{}^2}\right) \equiv {}_{\mathrm{R}}G_{\mathrm{t}} \times \left(\frac{({}_{\mathrm{R},1}m_{\mathrm{t}}) \times ({}_{0,2}m_{\mathrm{t}})}{{}_{\mathrm{R}}d_{\mathrm{t}}{}^2}\right) \tag{58}$$

The co-moving observer 0 will measure its own gravitational constant ${}_{0}\mathrm{G}_{\mathrm{t}}$ and its own distance ${}_{0}\mathrm{d}_{\mathrm{t}}{}^2$ between the two masses. The stationary observer R will measure its own gravitational constant ${}_{\mathrm{R}}\mathrm{G}_{\mathrm{t}}$ and its own distance ${}_{\mathrm{R}}\mathrm{d}_{\mathrm{t}}{}^2$ between the same two masses. The values measured can be identical but need not. The distances can be simplified as ${}_{0}d_{\mathrm{t}}{}^2 \equiv c_{\mathrm{t}}{}^2 \times {}_{0}t_{\mathrm{t}}{}^2$ or as ${}_{\mathrm{R}}d_{\mathrm{t}}{}^2 \equiv c_{\mathrm{t}}{}^2 \times {}_{\mathrm{R}}t_{\mathrm{t}}{}^2$. Equation 58 changes to

$$ {}_{0}G_{\mathrm{t}} \times \left(\frac{({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}})}{c_{\mathrm{t}}{}^2 \times {}_{0}t_{\mathrm{t}}{}^2}\right) \equiv {}_{\mathrm{R}}G_{\mathrm{t}} \times \left(\frac{({}_{\mathrm{R},1}m_{\mathrm{t}}) \times ({}_{0,2}m_{\mathrm{t}})}{c_{\mathrm{t}}{}^2 \times {}_{\mathrm{R}}t_{\mathrm{t}}{}^2}\right) \tag{59}$$

or to

$$ {}_{0}G_{\mathrm{t}} \times \left(\frac{({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}})}{{}_{0}t_{\mathrm{t}}{}^2}\right) \equiv {}_{\mathrm{R}}G_{\mathrm{t}} \times \left(\frac{({}_{\mathrm{R},1}m_{\mathrm{t}}) \times ({}_{0,2}m_{\mathrm{t}})}{{}_{\mathrm{R}}t_{\mathrm{t}}{}^2}\right) \tag{60}$$

According to theorem 3.2, eq. 49 it is $({}_{0,1}m_{\mathrm{t}}) \times ({}_{\mathrm{R},2}m_{\mathrm{t}}) \equiv ({}_{0,2}m_{\mathrm{t}}) \times ({}_{\mathrm{R},1}m_{\mathrm{t}})$. Equation 60 simplifies further as

$$ {}_{0}G_{\mathrm{t}} \times \left(\frac{+1}{{}_{0}t_{\mathrm{t}}{}^{2}}\right) \equiv {}_{\mathrm{R}}G_{\mathrm{t}} \times \left(\frac{+1}{{}_{\mathrm{R}}t_{\mathrm{t}}{}^{2}}\right) \tag{61} $$

In general, it is ${}_{0}t_{\mathrm{t}}{}^{2} \equiv \left(1-\frac{v^{2}}{c^{2}}\right) \times {}_{\mathrm{R}}t_{\mathrm{t}}{}^{2}$ (see definition 2.4). Eq. 61 simplifies as

$$ \frac{{}_{0}G_{\mathrm{t}}}{\left(1-\frac{v^{2}}{c^{2}}\right) \times {}_{\mathrm{R}}t_{\mathrm{t}}{}^{2}} \equiv \frac{{}_{\mathrm{R}}G_{\mathrm{t}}}{{}_{\mathrm{R}}t_{\mathrm{t}}{}^{2}} \tag{62} $$

and as

$$ \frac{{}_{0}G_{\mathrm{t}}}{\left(1-\frac{v^{2}}{c^{2}}\right)} \equiv {}_{\mathrm{R}}G_{\mathrm{t}} \tag{63} $$

In general, it is

$$ {}_{0}G_{\mathrm{t}} \equiv \left(1-\frac{v^{2}}{c^{2}}\right) \times {}_{\mathrm{R}}G_{\mathrm{t}} \tag{64} $$

Finally, Newton's gravitational constant is observer dependent, varying with time (see Ritter et al. 1976; Barrow 1996) and not a constant. In other words, our conclusion is true.

□

Remark 3.3. *The correctness's of equation 64 can be proofed by a simple, highly precise earth bound measurements of Newton's gravitational constant G with the same apparatus and experimental setup at perihelion and aphelion too.*

Background.

*Our planet earth is surrounding our sun in an approximately elliptical (a kind of non-circular) orbit. The **perihelion** (p) is the point in the orbit of our earth which is nearest to the sun. Let ${}_{p}v_{t}$ denote the relative velocity between earth and sun at perihelion at a certain run of an experiment or Bernoulli trial t. In point of fact, ${}_{p}v_{t}$ is approximately equal to the orbital velocity of our earth at a certain run of an experiment or Bernoulli trial t. Earth comes closest to the sun every year around **January 3**. Earth is about **147.1 million kilometers** from the sun every year around January 3. The **aphelion** (a) is the point in the orbit of our earth which is farthest from the Sun. Let ${}_{a}v_{t+x}$ denote the relative velocity between earth and sun at aphelion at a certain run of an experiment or Bernoulli trial t+x. In point of fact, ${}_{a}v_{t+x}$ is approximately equal to the orbital velocity of our earth at a certain run of an experiment or Bernoulli trial t+x. In particular, the Earth's orbit has its aphelion around **July 5**, at which it is approximately **152.1 million kilometers** from the Sun.*

Experiment.

Today, there is no definitive relationship between Newton's gravitational constant and the other fundamental constants of nature and there is no theoretical prediction for Newton's gravitational constant value against which to test experimental results. Still, let ${}_{a}G_{t+x}$ denote the value of Newton's gravitational constant as determined at aphelion. Let ${}_{p}G_{t}$ denote the value of Newton's gravitational constant as determined at perihelion. Repeated and most possible precise measurements of Newtonian gravitational constant are performed at aphelion and at perihelion under otherwise identical conditions with the same apparatus and experimental setup. The result of these experiments will be a statistically significant and large discrepancy or difference between ${}_{a}G_{t+x}$ and ${}_{p}G_{t}$. In point of fact, every single experiment performed under these conditions will provide evidence that

$$ {}_{a}G_{t+x} \neq {}_{p}G_{t} $$

and will refute once and again the constancy of Newton's gravitational constant. Performing this or similar experiments is also important because of the key role that Newton's gravitational constant has in theories of particle physics, astrophysics, cosmology, gravitation et cetera. The researcher will find that

$$ \frac{{}_{a,\,R}G_{t+x}}{{}_{p}G_{t}} \approx \frac{\left(1-\frac{{}_{p}v^{2}}{c^{2}}\right)}{\left(1-\frac{{}_{a}v^{2}}{c^{2}}\right)} \tag{65} $$

where $_{a}v$ denotes the orbital velocity at aphelion and $_{p}v$ denotes the orbital velocity at perihelion. Figure 5 may provide an overview of the experiment proposed.

Historically, the value of the Newtonian constant of gravitation, in the following abbreviated by the capital letter G too, has been measured by many different methods including torsion balances, atom interferometer, a pair of pendula, a beam balance(see S. Schlamminger, Pixley, et al. 2014) et cetera. First measured over more than 200 years ago by Nevil Maskelyne (1732-1811) (see Maskelyne 1775) and later by Henry Cavendish(1731-1810) (see Cavendish 1798), an exact(see Quinn et al. 2013) determination of the Newtonian constant of gravitation, a fundamental constant of nature, is notoriously difficult to be established. Since the time of Maskelyne, more than 200 experiments(see George T. Gillies 1987) have been conducted to determine the exact value of G, however only with limited success. The Newtonian constant of gravitation is still known only with relatively poor accuracy(see Stephan Schlamminger 2016) with about 0.1%. To put it bluntly, a precise value of the Newtonian constant of gravitation remains an unsolved isssue for modern experimentalists. Measured values of Newton's constant of gravitation gathered by different experimentalist groups vary significantly(see Gershteyn et al. 2002) while researchers still aren't sure why. Often, unidentified experimental random and/or systematic errors, different experimental setups that have been used et cetera are held responsible for these discrepancies and the large spread between the values of G obtained by different groups while a Birge ratio(see Rothleitner and S. Schlamminger 2017) of about five has been published. However, evidence is increasing (see Barukčić 2016d; Barukčić 2015) that the Newtonian constant of gravitation is not a constant. Anderson et al. found Newtonian gravitational constant exhibit a periodic oscillation (a solid sinusoid curve) (see Anderson et al. 2015) while Schlamminger et al. disagreed (see S. Schlamminger, Gundlach, et al. 2015). Matters are further complicated because several unified field theories (see Hellings 1988) including the Brans-Dicke theory(see Brans and Dicke 1961) are predicting that Newtonian gravitational constant varies in space and time. A list of Newtonian gravitational constant experiments has been presented by (see George T. Gillies 1987; George T Gillies 1997; Rothleitner and S. Schlamminger 2017). After more than 200 experimental measurements and over 200 years of trials, the relative measurement uncertainty of G is as high as 10^{-5}. At first glance, it seems difficult accept the Newtonian constant G as being a constant.

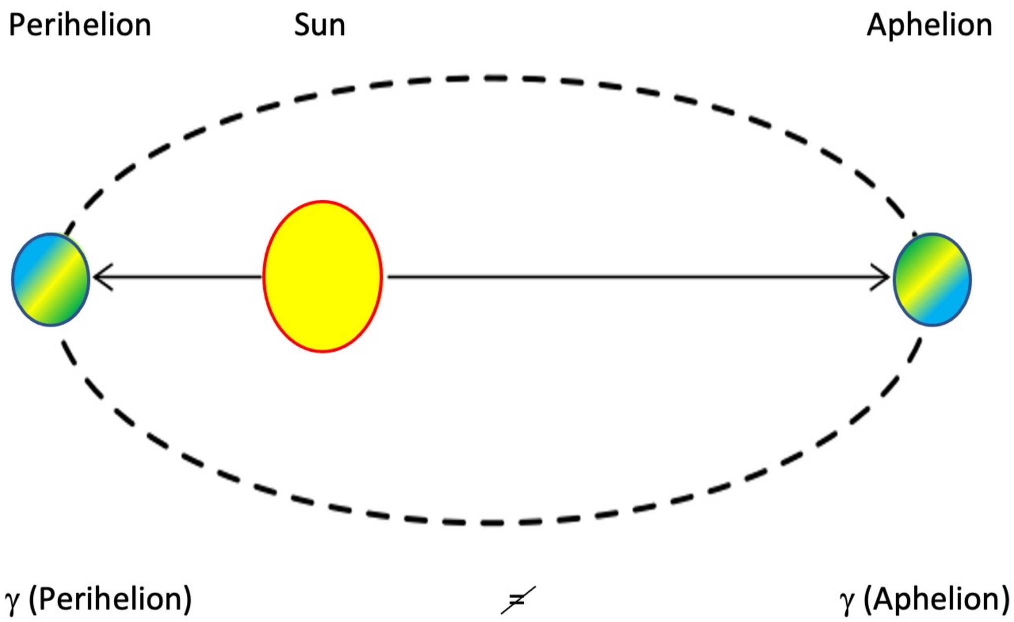


Figure 5: Contrary to expectation, Newton's constant γ (see Newton 1687, p. 198) measured with the same apparatus and under identical conditions on our earth at aphelion will differ statistically significantly from Newton's constant γ measured on our earth at perihelion. Cause: among other, relative velocity between sun and earth. But truth is also that a significant statistical difference is not allowed, if Newton's constant γ is really a constant.

In last consequence, we expect something like the following result of the variation of the Newtonian constant G as illustrated by figure 6.

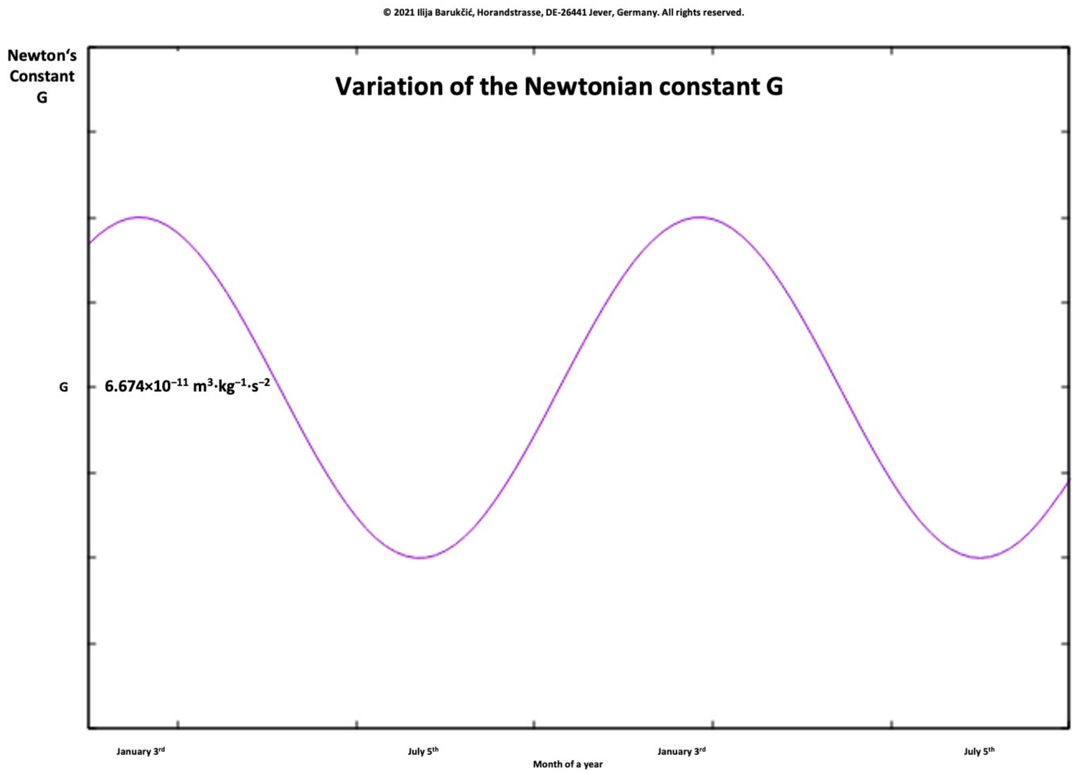


Figure 6: Newtonian constant of gravitation γ (see Newton 1687, p. 198) is the fundamental constant which is the most difficult to be measured accurately. Today, γ is known with a relative standard uncertainty which is several orders of magnitudes greater than the relative uncertainties of other fundamental constants of nature. It might be reasonably assumed that Newtonian constant of gravitation γ is not a constant.

3.6 Mass equivalent of a photon

Theorem 3.4 (Mass equivalent of a photon). ***Photons****, a term coined in 1926 by Gilbert Newton Lewis (see Lewis 1926) (1875 – 1946), are the quantum of the electromagnetic field and move at the speed of light in vacuum, c_R = 299792458 (m/s). In general, material particles shows wave-particle duality theoretically(see Broglie 1925; Barukčić 2013; Barukčić 2016b) as well as experimentally and vice versa. Like other elementary particles photons themselves exhibit properties of both(see Young 1804; Barukčić 2011; Barukčić 2013; Barukčić 2016b) waves(see Huygens 1690) and particles (see Newton 1704). However, photons as electromagnetic waves carry energy(see also Khrapko 2015) and therefore may cause gravity but are affected by space-time curvature too. Meanwhile, Luo et al. (see also Luo et al. 2003) published an experimental upper limit on photon mass. Under conditions of special theory of relativity where the axiom $+1 = +1$ is valid, we must accept the mass equivalent of a photon as*

$$ {}_{R}m^{*}{}_{t} \equiv \left(\frac{h}{c^2}\right) \times ({}_{R}f_{t}) \tag{66} $$

Proof by modus ponens. **If** the premise

$$ \underbrace{+1 = +1}_{(Premise)} \tag{67} $$

is true, **then** the conclusion

$$ {}_{\mathrm{R}}m^{*}{}_{\mathrm{t}} \equiv \left(\frac{h}{c^2}\right) \times ({}_{\mathrm{R}}f_{\mathrm{t}}) \tag{68} $$

is also true, the absence of any technical errors presupposed. The premise

$$ (+1) = (+1) \tag{69} $$

is true. Substituting one part of this premise by equation 13 it is

$$ {}_{\mathrm{R}}m^{*}{}_{\mathrm{t}} \equiv {}_{\mathrm{R}}m^{*}{}_{\mathrm{t}} \tag{70} $$

or

$$ {}_{\mathrm{R}}m^{*}{}_{\mathrm{t}} \equiv \frac{{}_{\mathrm{R}}E_{\mathrm{t}}}{c^2} \tag{71} $$

or

$$ {}_{\mathrm{R}}m^{*}{}_{\mathrm{t}} \equiv \frac{h \times {}_{\mathrm{R}}f_{\mathrm{t}}}{c^2} \tag{72} $$

or

$$ {}_{\mathrm{R}}m^{*}{}_{\mathrm{t}} \equiv \left(\frac{h}{c^2}\right) \times ({}_{\mathrm{R}}f_{\mathrm{t}}) \tag{73} $$

In other words, our conclusion is true.

□

Remark 3.4. *Under conditions, where ${}_{R}f_{t} = +1$ it is*

$$ \begin{aligned} {}_{R}m^{*}{}_{t} &\equiv \left(\frac{h}{c^2}\right) \times ({}_{R}f_{t}) \\ &\equiv \left(\frac{h}{c^2}\right) \times (+1) \\ &\equiv \left(\frac{h}{c^2}\right) \\ &\equiv \left(\frac{6.6260755 \times 10^{-34}}{299792458^2}\right) \\ &\equiv 7.3725032764905e-51 \end{aligned} \tag{74} $$

The mass-equivalent of a photon follows as ${}_{R}m^{*}{}_{t} \equiv 7.3725032764905 \times 10^{-51}$. The Supernovae Cosmology Project(see Perlmutter et al. 1999) study group and the High-Z Supernova Team(see Riess et al. 1998) provided evidence that the expansion of the universe is accelerating while the value of the cosmological constant appears to be approximately 10^{-52} (m^{-2}) which is numerically not far away from the value of the mass-equivalent of a photon calculated before. The question which must therefore be asked is: does there exist any relationship between these two entities?

3.7 Mass equivalent of a graviton

Theorem 3.5 (Mass equivalent of a graviton)**.** *The **graviton** itself, originally coined by the russian physicists Dmitrii Blokhintsev and F. M. Galperin (see Blokhintsev and Gal'perin 1934) is a hypothetical elementary particle presumed to be mass-less. Gravitons are thought to carry the force(see Newton 1687) of gravity in a way similar to photons importance for the electromagnetic force and are a cornerstone of theories of quantum gravity and the various(see Goenner 2004) proposals for a unified(see Barukčić 2016c; Barukčić 2016a; Barukčić 2020c; Barukčić 2020a; Barukčić 2020b) field theory (see Weyl 1918; A. Einstein 1925), "**a generalization of the theory of the gravitational field**"(see Albert Einstein 1950). Even though notoriously hard to be observed in nature, gravitons are increasingly important for general relativity and for quantum theory too especially since the discovery of general(see Albert Einstein 1915; A. Einstein 1916; Albert Einstein 1917; A. Einstein and Sitter 1932) theory of relativity predicted gravitational waves (see Castelvecchi and Witze 2020; Abbott et al. 2016).*

Thought experiment.

The whole and empty universe is determined only by two photons(see also M. A. Grado-Caffaro and M. Grado-Caffaro 2013) with the mass equivalent ${}_{p,1}m^{*}{}_{t}$ and ${}_{p,2}m^{*}{}_{t}$ which are travelling with constant velocity with respect to each other. Fig. 7 may illustrate this experimental setup in more detail.

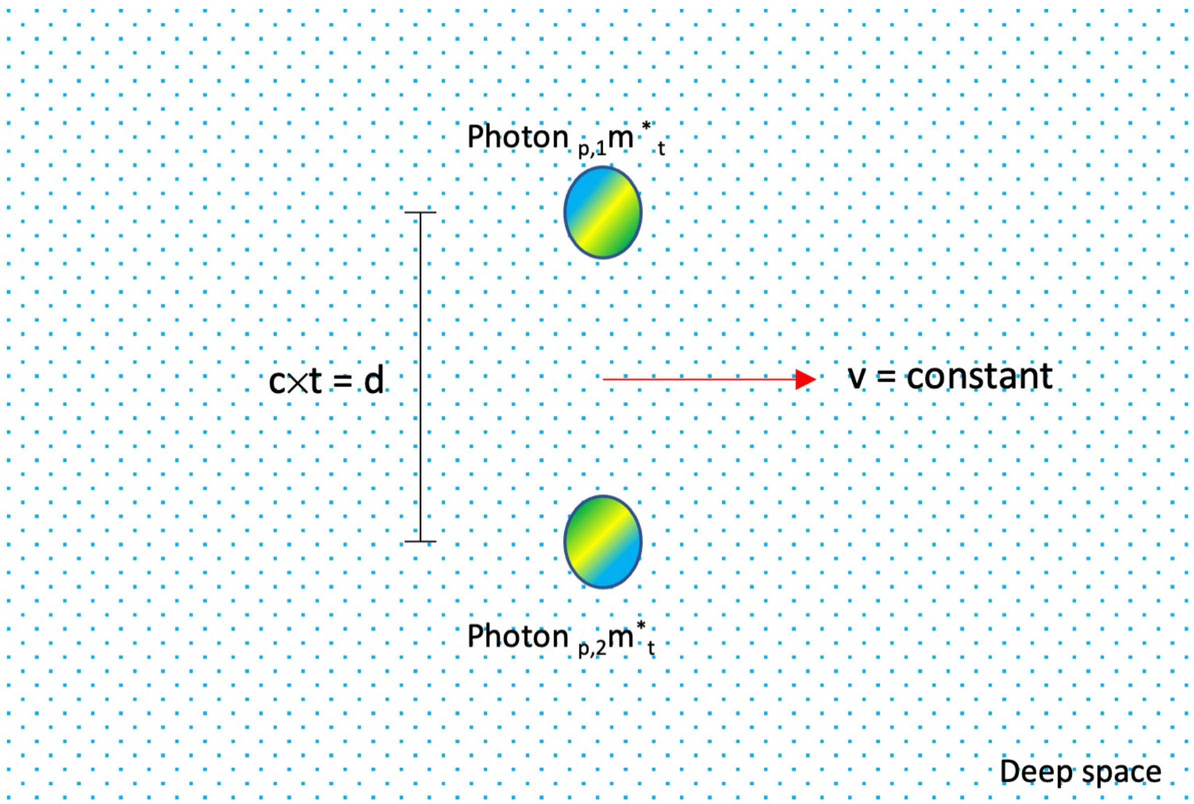


Figure 7: Two photons in deep space (c is speed of the light in vaccum, t is the time, d is the distance between both, m^* is mass equivalent).

How does the one photon knows how far away the same may be from the second photon? Is there any gravitational force or interaction between these two photons? It is necessary to consider that photons as electromagnetic waves carry energy(see also Khrapko 2015) and therefore may cause gravity. Energy as such is the source of gravitation and creates gravity even under conditions of two dimensions. Therefore, even these two photons should add to the stress-energy tensor and should exert some gravitational pull. Under some certain conditions of the special theory of relativity where the axiom $+1 = +1$ is valid, the mass-equivalent of a graviton, denoted as ${}_{\gamma}m^*{}_t$, follows approximately as

$$ {}_{\gamma}m^*{}_t \equiv 3.62680652781443e-111 \tag{75}$$

Proof by modus ponens. **If** the premise

$$\underbrace{+1 = +1}_{(Premise)} \tag{76}$$

is true, **then** the conclusion

$$ {}_{\gamma}m^*{}_{\mathrm{t}} \equiv 3.62680652781443e-111 \tag{77}$$

is also true, the absence of any technical errors presupposed. The premise

$$(+1) = (+1) \tag{78}$$

is true. Multiplying by ${}_0\mathrm{F}_\mathrm{t}$ (see theorem 3.1), it is

$$ {}_0F_\mathrm{t} \equiv {}_0F_\mathrm{t} \tag{79}$$

or

$$ {}_0F_\mathrm{t} \equiv {}_0G_\mathrm{t} \times \left(\frac{\left({}_{\mathrm{p},1}m^*{}_\mathrm{t}\right) \times \left({}_{\mathrm{p},2}m^*{}_\mathrm{t}\right)}{{}_0d_\mathrm{t}{}^2} \right) \tag{80}$$

where ${}_0\mathrm{F}_\mathrm{t}$ denotes (net) force as measured by the co-moving observer, ${}_0\mathrm{G}_\mathrm{t}$ denotes Newton's gravitational constant as measured by the co-moving observer, ${}_0\mathrm{d}_\mathrm{t}{}^2$ is the distance between the two masses (see theorem 3.2) as measured by the co-moving observer. According to Einstein, it is

$$ {}_{\mathrm{p},1}m^*{}_\mathrm{t} \equiv \frac{{}_{\mathrm{p},1}E_\mathrm{t}}{c^2} \tag{81}$$

and equation 80 changes slightly as

$$ {}_{0}F_{\mathrm{t}} \equiv {}_{0}G_{\mathrm{t}} \times \left(\frac{\left(\frac{{}_{\mathrm{p},1}E_{\mathrm{t}}}{c^2} \right) \times \left(\frac{{}_{\mathrm{p},2}E_{\mathrm{t}}}{c^2} \right)}{c^2 \times {}_{0}t_{\mathrm{t}}{}^2} \right) \tag{82} $$

or as

$$ {}_{0}F_{\mathrm{t}} \equiv {}_{0}G_{\mathrm{t}} \times \left(\frac{\left({}_{\mathrm{p},1}E_{\mathrm{t}} \right) \times \left({}_{\mathrm{p},2}E_{\mathrm{t}} \right)}{c^2 \times c^2 \times c^2 \times {}_{0}t_{\mathrm{t}}{}^2} \right) \tag{83} $$

or as

$$ {}_{0}F_{\mathrm{t}} \equiv \left(\frac{{}_{0}G_{\mathrm{t}}}{c^2 \times c^2 \times c^2} \right) \times \left(\frac{\left({}_{\mathrm{p},1}E_{\mathrm{t}} \right) \times \left({}_{\mathrm{p},2}E_{\mathrm{t}} \right)}{{}_{0}t_{\mathrm{t}}{}^2} \right) \tag{84} $$

According to Planck (see eq. 5) and Einstein (see eq. 81), it is

$$ {}_{\mathrm{p},1}m^{*}{}_{\mathrm{t}} \equiv \frac{{}_{\mathrm{p},1}E_{\mathrm{t}}}{c^2} \equiv \frac{{}_{\mathrm{R}}h_{\mathrm{t}} \times {}_{\mathrm{p},1}f_{\mathrm{t}}}{c^2} \tag{85} $$

and equation 84 changes to

$$ {}_{0}F_{\mathrm{t}} \equiv \left(\frac{{}_{0}G_{\mathrm{t}}}{c^2 \times c^2 \times c^2} \right) \times \left(\frac{\left({}_{\mathrm{R}}h_{\mathrm{t}} \times {}_{\mathrm{p},1}f_{\mathrm{t}} \right) \times \left({}_{\mathrm{R}}h_{\mathrm{t}} \times {}_{\mathrm{p},2}f_{\mathrm{t}} \right)}{{}_{0}t_{\mathrm{t}}{}^2} \right) \tag{86} $$

or to

$$ {}_{0}F_{\mathrm{t}} \equiv \left(\frac{{}_{0}G_{\mathrm{t}} \times {}_{\mathrm{R}}h_{\mathrm{t}} \times {}_{\mathrm{R}}h_{\mathrm{t}}}{c^2 \times c^2 \times c^2} \right) \times \left(\frac{\left({}_{\mathrm{p},1}f_{\mathrm{t}} \right) \times \left({}_{\mathrm{p},2}f_{\mathrm{t}} \right)}{{}_{0}t_{\mathrm{t}}{}^2} \right) \tag{87} $$

It is ${}_{\gamma}F_{\mathrm{t}} \equiv {}_{\gamma}m_{\mathrm{t}} \times {}_{\gamma}a_{\mathrm{t}}$ (see eq. 1). Eq. 87 changes to

$$ {}_{\gamma}m^{*}{}_{\mathrm{t}} \times {}_{\gamma}a_{\mathrm{t}} \equiv \left(\frac{{}_{0}G_{\mathrm{t}} \times {}_{\mathrm{R}}h_{\mathrm{t}} \times {}_{\mathrm{R}}h_{\mathrm{t}}}{c^2 \times c^2 \times c^2} \right) \times \left(\frac{\left({}_{\mathrm{p},1}f_{\mathrm{t}} \right) \times \left({}_{\mathrm{p},2}f_{\mathrm{t}} \right)}{{}_{0}t_{\mathrm{t}}{}^2} \right) \tag{88} $$

The mass-equivalent of a graviton under conditions where

$$ {}_{\gamma}a_{\mathbf{t}} \equiv {}_{\mathbf{p},\mathbf{1}}f_{\mathbf{t}} \equiv {}_{\mathbf{p},\mathbf{2}}f_{\mathbf{t}} \equiv {}_{\mathbf{0}}t_{\mathbf{t}}{}^{\mathbf{2}} \equiv +1 $$

follows as

$$ {}_{\gamma}m^{*}{}_{\mathrm{t}} \equiv \left(\frac{{}_{0}G_{\mathrm{t}} \times {}_{\mathrm{R}}h_{\mathrm{t}} \times {}_{\mathrm{R}}h_{\mathrm{t}}}{c^2 \times c^2 \times c^2} \right) \tag{89} $$

and equally as

$$ {}_{\gamma}m^{*}{}_{\mathrm{t}} \equiv \left(\frac{(6.67259e-11) \times (6.6260755e-34) \times (6.6260755e-34)}{(299792458)^2 \times (299792458)^2 \times (299792458)^2} \right) \tag{90} $$

and at the end as

$$ {}_{\gamma}m^{*}{}_{\mathrm{t}} \equiv 3.62680652781443e-111 \tag{91} $$

In other words, under the conditions assumed, our conclusion is true. □

3.8 Photon, graviton, and antigraviton

Theorem 3.6 (Photon, graviton, and antigraviton)**.** *In the following let ${}_{p}m^{*}{}_{t}$ denote the mass equivalent of a photon,let ${}_{\gamma}m^{*}{}_{t}$ denote the mass equivalent of a graviton, let ${}_{\Lambda}m^{*}{}_{t}$ denote the mass equivalent of anti-graviton, the particle of the field $\Lambda \times g_{\mu\nu}$. In this publication, this particle is called lambdon. In general, it is*

$$ \left({}_{p}m^{*}{}_{t} \right) \equiv \left({}_{\Lambda}m^{*}{}_{t} \right) + \left({}_{\gamma}m^{*}{}_{t} \right) \tag{92} $$

Proof by modus ponens. **If** the premise

$$\underbrace{+1 = +1}_{(Premise)} \tag{93}$$

is true, **then** the conclusion

$$({}_{\mathrm{p}}m^{*}{}_{\mathrm{t}}) \equiv ({}_{\Lambda}m^{*}{}_{\mathrm{t}}) + ({}_{\gamma}m^{*}{}_{\mathrm{t}}) \tag{94}$$

is also true, the absence of any technical errors presupposed. The premise

$$(+1) = (+1) \tag{95}$$

is true. Multiplying eq. 95 by the mass-equivalent of the photon, it is

$$({}_{\mathrm{p}}m^{*}{}_{\mathrm{t}}) \equiv ({}_{\mathrm{p}}m^{*}{}_{\mathrm{t}}) \tag{96}$$

Adding +0 to eq. 96, it is

$$({}_{\mathrm{p}}m^{*}{}_{\mathrm{t}}) + 0 \equiv ({}_{\mathrm{p}}m^{*}{}_{\mathrm{t}}) + ({}_{\gamma}m^{*}{}_{\mathrm{t}}) - ({}_{\gamma}m^{*}{}_{\mathrm{t}}) \tag{97}$$

where ${}_{\gamma}\mathrm{m}^{*}{}_{\mathrm{t}}$ is the mass-equivalent of the graviton. Eq. 97 can be rearranged as

$$({}_{\mathrm{p}}m^{*}{}_{\mathrm{t}}) + 0 \equiv ({}_{\mathrm{p}}m^{*}{}_{\mathrm{t}}) - ({}_{\gamma}m^{*}{}_{\mathrm{t}}) + ({}_{\gamma}m^{*}{}_{\mathrm{t}}) \tag{98}$$

We define the mass-equivalent of the particle anti-graviton, denoted as ${}_{\Lambda}\mathrm{m}^{*}{}_{\mathrm{t}}$ (i. e. lambdon which is the particle of the field $\Lambda \times g_{\mu\nu}$) as

$$({}_{\Lambda}m^{*}{}_{\mathrm{t}}) \equiv ({}_{\mathrm{p}}m^{*}{}_{\mathrm{t}}) - ({}_{\gamma}m^{*}{}_{\mathrm{t}}) \tag{99}$$

Finally, equation 98 changes to

$$({}_{\mathrm{p}}m^{*}{}_{\mathrm{t}}) + 0 \equiv ({}_{\Lambda}m^{*}{}_{\mathrm{t}}) + ({}_{\gamma}m^{*}{}_{\mathrm{t}}) \tag{100}$$

and our conclusion is true. □

Remark 3.5. *The detection of individual gravitons, though not prohibited by any fundamental law, may be impossible today with any physically reasonable detector. However, the equation 100 derived as*

$$({}_{p}m^{*}{}_{t}) \equiv ({}_{\Lambda}m^{*}{}_{t}) + ({}_{\gamma}m^{*}{}_{t}) \tag{101}$$

is valid. Therefore, under conditions where

$$({}_{\Lambda}m^{*}{}_{t}) \equiv +0 \tag{102}$$

it should be possible to measure the graviton directly or ex negativo. The justified question is, under which conditions is eq. 102 given? It is reasonable to assume that this is probably the case where

$$(Electricfield(E)) \equiv (Magneticfield(B)) \equiv +0 \tag{103}$$

Fig. 8 may illustrate these experimental conditions in more detail.

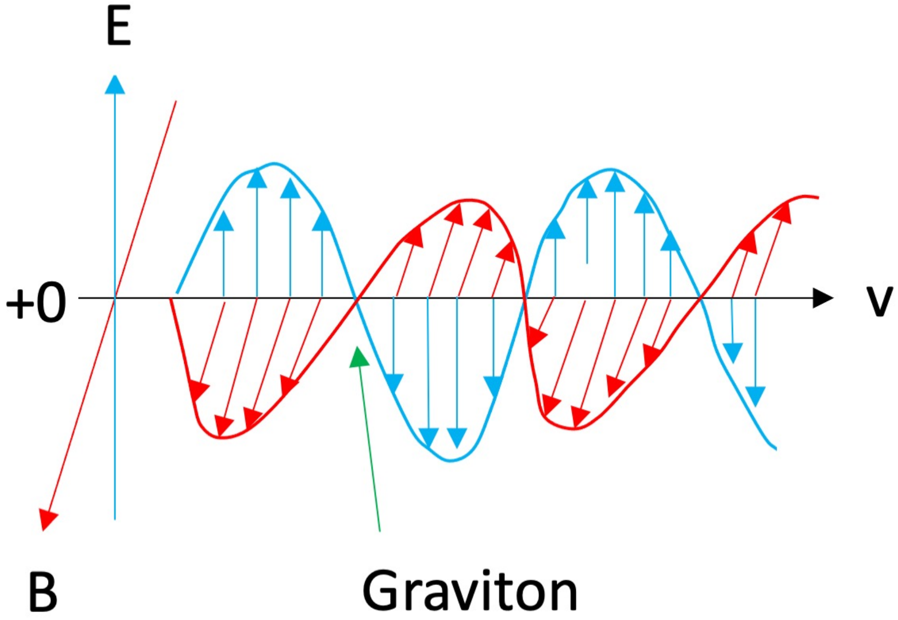


Figure 8: An electromagnetic wave as the unity and the struggle between antigraviton (i. e. lambdon) and graviton. Theoretically, measurements of gravitons should be possible especially inside an electromagnetic wave where an electric field (E) = magnetic field (B) = 0.

Electromagnetic waves can serve as a basis for solving the issue of a quantum computer with a central process unit (CPU) working at more than 1 Peta-Herz.

IV. Discussion

In particular, inappropriate generalisations and the risk over-simplifying complex issues include the threat of losses of logical clearness arising from a questionable starting point. However, even if Newtonian gravitational constant G has been the first physical constant to be introduced into the physical sciences the same is still one of the most difficult constants to be measured accurately so far. As provided by this publications, this is hardly surprising and no reason for concern. The Newtonian gravitational constant G, one of the most important fundamental physical constants in nature, is not a constant. One could therefore almost state that conversely Newtonian gravitational constant G does show us how important it is to be extremely precise when performing measurements and analysis of objective reality.

Another problem at which a closer look should be taken is the particle wave duality of a photon itself. In general, particles may show wave-particle duality(see Barukčić 2021) theoretically(see Broglie 1925; Barukčić 2013; Barukčić 2016b) as well as experimentally. Like other elementary particles photons themselves, a term coined in 1926 by Gilbert Newton Lewis (see Lewis 1926) (1875 – 1946), exhibit properties of both(see Young 1804; Barukčić 2011; Barukčić 2013; Barukčić 2016b) waves(see Huygens 1690) and particles (see Newton 1704). Taking a more closer look on the photon, the same appears to be a contradictory quantum mechanical entity. To bring it to the point. One result (see law of nature 3.6) of this publication justifies the assumption that the **photon** is determined by a **graviton**, the hypothetical and elementary particle which mediates the force of gravity (attraction) and equally by an **antigraviton**, the elementary but still hypothetical particle of the field $\Lambda \times g_{\mu\nu}$ which mediates the counter-force of gravity or anti-gravity.

Scientist have yet to discover the quantum nature of antigravitons. However, in some theories, a graviphoton or gravivector(see Zachos 1978; Scherk 1979; Pollard 1983; Maartens 2004) which emerges as a kind of an excitation of the metric tensor in space-time dimensions higher than four is understood more or less as a kind of a partner of a graviton and is linked to a type of anti-gravity. Nonetheless, an antigraviton should not be confused with a graviphoton or gravivector.

V. Conclusion

In consideration of all pertinent circumstances, it is not necessary to present the fundamental importance of Newton's gravitational constant G once again. However, it could not be denied that there are still doubts and uncertainties about the constancy of Newton's gravitational constant G. Thus far, the time has come for high accuracy experiments (see figure 5) which should be able to set the final seal on this issue.

VI. Important note

The reader who is reading this article is invited to be aware that in our times it was not possible to publish the content of this article by a Web of Science, EBSCO, Scopus, PubMed/Medline et cetera indexed journal. So one should be extremely cautious and very careful before taking the theorems derived in this publication formally as new or established scientifically validated knowledge.

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VIII. Patient consent for publication

Not required.

IX. Conflict of interest statement

No conflict of interest.

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