

# Calculation of So-Called General Relativistic Phenomena by Advancing Newton's Theory of Gravitation, Maintaining Classical Conceptions of Space and Relativity

Reiner Georg Ziefle

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## Abstract

*With the example of the motion of Mercury around the Sun it is shown how Newton's theory of gravitation should be advanced by taking into consideration the finite velocity of gravitational expansion and the present concept of transference of forces by particles to be able to calculate so-called general relativistic phenomena such as the additional motion of Mercury's perihelion, the curvature of a light beam at the surface of the Sun, and the phenomena observed at the binary pulsar PSR 1913+16, maintaining classical conceptions of a Euclidean space and the Galilean principle of relativity.*

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**Key words:** perihelion, Mercury, relativity, GRT, pulsar, PSR 1913+16, gravitation, Paul Gerber, Newton, Einstein

## 1. INTRODUCTION

Newton's theory of gravitation has, in contrast to Einstein's theory of general relativity, the deficiency that certain phenomena cannot be predicted by it. An example is the problem of the motion of Mercury's perihelion. In the 19th century scientists searched for a further planet in our solar system in order to be able to correctly explain the motion of Mercury's perihelion on the basis of Newton's theory of gravitation. But the planet they called Volcano was never found. However, Einstein's theory of general relativity was later able to explain this phenomenon as well as others. Newton assumed that gravitational force has an instantaneous effect, that is, a gravitational expansion with infinite speed. Today we know that gravitational expansion cannot be infinitely fast. One of the first scientists who tried to develop Newton's theory of gravitation further by considering the finite velocity of gravitational transference and by assuming that the gravitational transference might probably have the value of the velocity of light was Paul Gerber, a German school teacher, whose publication in the year 1917 is discussed later.<sup>(1)</sup> But, as far as I know, there does not exist a scientific publication on the attempt to develop Newton's theory of gravitation further by considering the present concept of transference of forces by particles. In a comprehensive scientific

view, this is an incomplete and consequently unsatisfactory matter.

## 2. ADVANCING NEWTON'S THEORY OF GRAVITATION

To be able to explain the so-called general relativistic phenomena by advancing Newton's theory of gravitation we have to go back to the imagination of Newton about space and relativity, the way it used to be in the physicists' imagination until the beginning of the 20th century, before Einstein himself developed his ideas. While Newton's theory of gravitation takes place in a Euclidean space, Einstein's space is a non-Euclidean, or a so-called curved, space. While Newton believed in the Galilean principle of relativity, Einstein established a completely new kind of principle — a relativistic one. For a paradigm it is shown with the example of the motion of Mercury how Newton's theory of gravitation can be developed further if we postulate the following, of which the first and second points, to present-day physicists, sound, of course, very strange: (1) We live in an Euclidean space. (2) The Galilean principle of relativity is valid. (3) The speed of gravitational extension has the same speed as light, i.e., about 299 792.458 km/s. (4) The gravitational force is transferred by particles called gravitons. From this we get the fol-

lowing derivation: Gravitons, which are emitted by matter, respectively a mass, shall move from this matter in all directions by the speed of light in a Euclidean space. Next we want to go from the assumption that Mercury is in a resting position with respect to the Sun. In this case a certain number of gravitons emitted by the Sun will run across Mercury. The relative frequency with which the gravitons emitted by the Sun meet Mercury depends on the velocity with which the gravitons move with respect to Mercury.

If Mercury did not move, the graviton's velocity with respect to Mercury would have the speed of light ( $c$ ), whose relative value is 1. In this case the relative value of the frequency with which the gravitons emitted by the Sun meet Mercury is also 1. If Mercury moves around the Sun, which is the case in reality, with the velocity  $v$ , the velocity of the gravitons emitted by the Sun would run across Mercury with a faster velocity than before, so that the relative value of the graviton's velocity with respect to Mercury should be greater than 1, which is of course not possible in relativistic physics. But we have postulated that the Galilean principle of relativity should be valid, so that we want to assume, nevertheless, that this is possible. If the relative value of the velocity of the gravitons emitted by the Sun with respect to Mercury is greater than 1, that is to say not  $c$  but  $x$  (Fig. 1), then the relative value of the frequency with which the gravitons emitted by the Sun meet Mercury increases by the factor  $x$ . As Mercury moves around the Sun with the velocity  $v$ , however, the relative value of the velocity of the gravitons emitted by Mercury and running across the Sun should be greater than  $c$ , that is to say also  $x$ . In this case the relative value of the frequency with which the gravitons emitted by Mercury meet the Sun also increases by the factor  $x$ . The factor  $x$  we can calculate easily by the Pythagorean theorem, which is, in spite of the curved planetary orbit of Mercury, sufficiently correct if we regard very small distances. We then get the formula for  $x$ :

$$x = \sqrt{c^2 + v^2}.$$

To get the formula for relative values we have to divide the absolute values of  $c$  (velocity of the gravitons) and  $v$  (velocity of Mercury around the Sun) by the absolute value of  $c$ , so that we get

$$x = \sqrt{\left(\frac{c}{c}\right)^2 + \left(\frac{v}{c}\right)^2} = \sqrt{1 + \left(\frac{v}{c}\right)^2}.$$

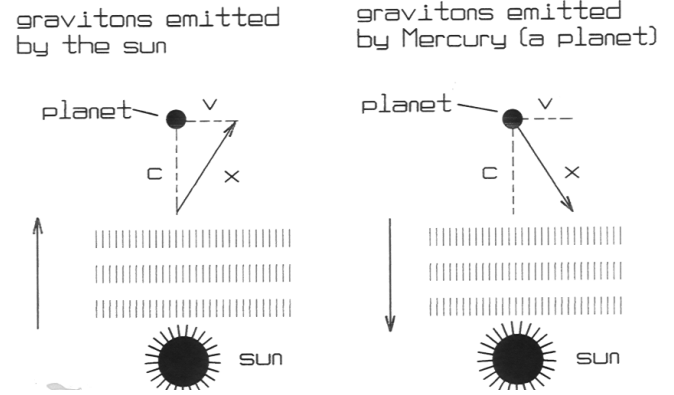


Figure 1. The relative velocity of the emitted gravitons related to the Sun and Mercury.

The factor  $x$  I am going to call the “gravitational factor of motion”  $\gamma'$  in the following:

$$\gamma' = \sqrt{1 + \left(\frac{v}{c}\right)^2}.$$

Hereby the frequency of the interaction between the gravitons emitted by the Sun and the mass  $m$  of Mercury increases by the factor  $\gamma'$ . Because the relative frequency with which the gravitons emitted by Mercury meet the Sun also increases by the factor  $\gamma'$ , the frequency of the interaction between the gravitons emitted by Mercury and the mass  $M$  of the Sun also increases by the factor  $\gamma'$ . To get the whole factor of the increasing of the gravitational interaction between the Sun and Mercury, we therefore have to square the factor  $\gamma'$ . By this knowledge, Newton should have had to multiply his formula for the force of gravitation by the factor  $(\gamma')^2$ , and the formula for the force of gravitation should have been

$$F = \frac{(\gamma')^2 GMm}{r^2},$$

where  $G$  stands for the Newtonian gravitational constant,  $M$  for the mass of the Sun, and  $m$  for the mass of a planet. This result can be interpreted to mean that  $G$  is not as constant as Newton thought. Because of the differing speed of Earth around the Sun during one year of 1 km/s,  $G$  should therefore fluctuate slightly. In the formula of Newton's kinetic equation

for planets, which is not pointed out here, the factor  $(\gamma')^2$  would be preserved in the numerator, although the mass  $m$  of a planet cancels out in the numerator and denominator because of the proportionality, respectively equivalence, of inert and heavy mass.

### 3. CALCULATION OF SO-CALLED GENERAL RELATIVISTIC PHENOMENA

But for our further considerations we don't even need the formula of Newton's kinetic equation for planets. Without this it is possible to derive the difference of the motion of Mercury's perihelion as opposed to Newton's theory of gravitation. As gravitation causes an acceleration of masses, the postulated additional gravitational effect must cause an additional gravitational acceleration of a mass such as Mercury, depending on the mass's velocity relative to the Sun. The conception of today's physicists goes from the assumption that gravitational acceleration depends on the largeness of the masses and the distance between the centers of the masses. But what happens if two masses, which are attracting each other by gravitational force, are increasing or if the distance between two masses is decreasing? If we go from imagining that gravitational force is transferred by gravitons, an increased mass will emit more gravitons by the factor the mass has increased and therefore the frequency of the interaction between these emitted gravitons and another mass increases by the same factor. If the distance between two masses decreases by a certain factor, there are arriving at each mass more gravitons in the same time by the square of this factor, so that the frequency of the gravitational interaction between the emitted gravitons and the masses is also increasing by the square of this factor. If these effects cause gravitational acceleration, the additional gravitational effect, which I derived above, must also cause gravitational acceleration if as pointed out by the movement of Mercury around the Sun the frequency of the interaction between the masses and the gravitons emitted by the Sun and the planet is increasing by the square of the factor  $\gamma'$ . If an additional acceleration of Mercury results, so that the acceleration increases by the factor  $(\gamma')^2$ , the velocity of the planet must also increase by the same factor. If the velocity is increasing by the factor  $(\gamma')^2$ , in a certain time a larger angle is also traversed by the radius of the elliptical orbit of Mercury by the factor  $(\gamma')^2$ . Each angular position  $\phi_1$  therefore changes by the factor  $(\gamma')^2$ , so that we get for the changed angular position  $\phi_2$

$$\begin{aligned}\phi_2 &= (\gamma')^2 \times \phi_1, \\ &= \left(1 + \left(\frac{v}{c}\right)^2\right) \times \phi_1.\end{aligned}$$

For the difference  $\Delta\phi = \phi_2 - \phi_1$  we get

$$\begin{aligned}\Delta\phi &= \phi_2 - \phi_1 \\ &= \left(1 + \left(\frac{v}{c}\right)^2\right) \times \phi_1 - \phi_1 \\ &= \left(\frac{v}{c}\right)^2 \times \phi_1 + \phi_1 - \phi_1 \\ &= \left(\frac{v}{c}\right)^2 \times \phi_1.\end{aligned}$$

The velocity dependence of each angle of an elliptical orbit is given by

$$v(\phi) = \frac{v_{\min} \times (1 + e)}{1 - e \times \cos \phi},$$

where  $e$  is the eccentricity of the elliptical orbit and  $v_{\min}$  is the velocity at the aphelion position. The eccentricity of the elliptical orbit of Mercury is 0.2056 and the velocity of Mercury at the aphelion position is 38.86 km/s. The change of angle  $\Delta\phi$  at each angular position can be calculated by

$$\Delta\phi = \frac{v_{\min} \times (1 + e)}{c \times (1 - e \times \cos \phi_1)} \times \phi_1.$$

To calculate the change in the angular position for the whole movement of the planet on its elliptical orbit we have to use the median velocity of Mercury around the Sun, which is 47.88 km/s.<sup>(4)</sup> This is related to the speed of light by a relative velocity of  $1.5971 \times 10^{-4}c$ , so that we get the square of a "gravitational factor of motion"  $\gamma'$

$$\begin{aligned}(\gamma')^2 &= \left(\sqrt{1 + \left(\frac{v}{c}\right)^2}\right)^2 = 1 + (0.00015971)^2 \\ &= 1.000000255073.\end{aligned}$$

As the median angular position of an elliptical planetary orbit is  $\pi$ , hereby results from the median angular position  $\phi_1$  an altered angular position  $\phi_2$ :

$$\begin{aligned}\phi_2 &= (\gamma')^2 \times \phi_1 \\ &= (\gamma')^2 \times \pi \\ &= \left(1 + \left(\frac{v}{c}\right)^2\right) \times \pi.\end{aligned}$$

For the median difference  $\Delta\phi = \phi_2 - \phi_1$  we get

$$\begin{aligned}\Delta\phi &= \phi_2 - \phi_1 \\ &= (\gamma')^2 \phi_1 - \phi_1 \\ &= (\gamma')^2 \pi - \pi \\ &= \left(\frac{v}{c}\right)^2 \times \pi.\end{aligned}$$

As there results an alteration for each angular position along the whole route of Mercury's path from perihelion to perihelion, that is,  $2\pi$ , we have to multiply this difference by  $2\pi$  so that we get for the alteration of the angular position per revolution around the Sun

$$\begin{aligned}\Delta\phi &= 2\pi \times \left(\frac{v}{c}\right)^2 \times \pi \\ &= 2\pi^2 \times \left(\frac{v}{c}\right)^2 \\ &= 2\pi^2 \times 0.000\,000\,025\,507\,3 \\ &= 0.000\,000\,503\,494 \text{ rad.}\end{aligned}$$

We get the same result if we partially integrate the formula for  $\Delta\phi$  and put in for  $v$  the median velocity of Mercury ( $v = 47.88 \text{ km/s}$ ):

$$\begin{aligned}\Delta\phi &= \int_0^{2\pi} \phi_1 d\phi_1 \times \left(\frac{v}{c}\right)^2 \\ &= \left[\frac{1}{2}(\phi_1)^2\right]_0^{2\pi} \times \left(\frac{v}{c}\right)^2 \\ &= \frac{1}{2}(2\pi)^2 \times \left(\frac{v}{c}\right)^2 \\ &= 2\pi^2 \times 0.000\,000\,025\,507\,3 \\ &= 0.000\,000\,503\,494 \text{ rad.}\end{aligned}$$

If we divide  $2\pi^2$  by  $2\pi$ , we get the median angular position  $\pi$  of the elliptical orbit, as mentioned above.

Contrary to Newton's theory of gravitation, we get an alteration of the angular position of Mercury's perihelion per revolution around the Sun of  $5.034\,94 \times 10^{-7} \text{ rad}$ , or  $2.884\,81 \times 10^{-5} \text{ degrees}$ . The time Mercury needs for one revolution around the Sun is 87.969 days.<sup>(4)</sup> This is 4.1521 revolutions around the Sun per year (365.256 days:87.969 days). To get the conveniently cited alteration of the angular position of Mercury's perihelion in degrees per hundred years we have to multiply the alteration of the perihelion position per year by  $4.1521 \times 10^2$ :

$$\Delta\phi = 0.000\,028\,848\,1^\circ \times 4.1521 \times 100 = 0.011\,978^\circ.$$

Expressed in angular seconds this is 43.12":

$$\Delta\phi = 0.011\,978^\circ \times 60 \times 60 = 43.12''.$$

According to Einstein's theory of general relativity, the additional advance of the perihelion's position per hundred years is, as opposed to Newton's theory of gravitation, 43.03" angular seconds.<sup>(3)</sup> The observation for the additional forward motion of Mercury's perihelion is about  $43.11'' \pm 0.45''$  per hundred years.<sup>(3)</sup> The same conclusions result by using Newton's formula for the whole energy of an elliptical planetary orbit.<sup>(2)</sup> According to Newton's mechanics, the whole energy of an elliptical planetary orbit is the same as that of a circular orbit with the diameter of the major axis of the ellipse or with a radius of the semimajor axis ( $a$ ) and is given by the formula

$$E = \frac{mv^2}{2} - \frac{GMm}{r} = -\frac{GMm}{2a}.$$

The term  $(mv^2/2)$  stands for the kinetic energy ( $E_k$ ) and the term  $(GMm/r)$  stands for the potential energy of gravitation ( $E_g$ ), which is defined as a negative gravitational potential. On the basis of our considerations we have to postulate that the Newtonian gravitational constant depends on the speed of a planet or of any other object with a gravitational interaction, respectively, in our case, with the speed of Mercury. If by the motion of Mercury the Newtonian gravitational constant increased by the factor  $(\gamma')^2$ , the whole energy of the elliptical planetary orbit would decrease by the factor  $(\gamma')^2$ , because of its negative algebraic sign, so that the whole energy of an elliptical planetary orbit would be smaller by the factor  $(\gamma')^2$  than Newton expected. Clas-

sical mechanics predicts that the orbiting velocity of a planet is larger if the energy  $E$  of an elliptical orbit is smaller. This means that, if the whole energy  $E$  of the elliptical planetary orbit is smaller by a certain factor, the angle traversed by the radius in a certain time must also be larger by this factor, so that the sidereal revolution of Mercury around the Sun is finished before the perihelion position is reached again, so that the perihelion position must advance by each revolution around the Sun.

If we regard the photons of a light beam as particles (as Einstein did himself) with a gravitational interaction, in the case of a light beam striking the surface of the Sun, the square of the “gravitational factor of motion”  $\gamma'$  would be

$$(\gamma')^2 = \left( \sqrt{1 + \left( \frac{v}{c} \right)^2} \right)^2 = 1 + \left( \frac{v}{c} \right)^2 = 1 + \left( \frac{c}{c} \right)^2 = 2.$$

As we postulated that the Newtonian gravitational constant depends on the speed of any object with a gravitational interaction by the motion of a light beam, respectively a photon, the Newtonian gravitational constant should also in this case increase by the factor  $(\gamma')^2$ , so that the curvature of a light beam at the surface of the Sun should have double the value as is expected by Newton’s mechanics:

$$\Delta\phi = \frac{2 \times 2GM}{c^2 r} = \frac{4GM}{c^2 r}.$$

This is the correct value, as is predicted by Einstein’s theory of general relativity.<sup>(5)</sup>

By simple considerations other so-called general relativistic phenomena can also be calculated. According to Kepler’s second law, in the same time the same area of an elliptical planetary orbit is always traversed by its radius. This means that the area ( $\Delta A$ ) traversed by the radius in a certain time and the time ( $\Delta t$ ) the radius needs to traverse this area are proportional. However, if the velocity increases by the factor  $(\gamma')^2$  in a certain time, a larger angle is traversed by the radius of the elliptical orbit of Mercury, also by the factor  $(\gamma')^2$ . And, if in a certain time a larger angle ( $\Delta\phi$ ) is traversed by the radius by a certain factor, a larger part ( $\Delta A$ ) of the planetary orbit is traversed by the square of this factor, as an area is a square measure with respect to an angle. According to this,  $\Delta A$  is proportional to  $\Delta\phi^2$ , so that we get, for the median difference  $\Delta A = \Delta A_2 - \Delta A_1$ ,

$$\begin{aligned} \Delta A &= \left( \left( \frac{v}{c} \right)^2 \times \phi_1 \right)^2 \times \Delta A_1 \\ &= \left( \left( \frac{v}{c} \right)^2 \times \pi \right)^2 \times \Delta A_1 \\ &= [0.000\,000\,025\,507\,3\pi]^2 \times \Delta A_1 \\ &= 0.000\,000\,000\,000\,006\,421\,39 \times \Delta A_1. \end{aligned}$$

According to Kepler’s second law,  $\Delta A$  and  $\Delta t$  are proportional, but if the radius traverses a larger part of the area of the planetary orbit in the same time, which is larger by  $\Delta A$ , the time the radius needs to traverse this area is shorter by  $\Delta t$ , so that  $\Delta t$  must have a negative algebraic sign. Therefore we get

$$\Delta t = -0.000\,000\,000\,000\,006\,421\,39 \times \Delta t_1.$$

According to our considerations, the time that Mercury needs for one revolution around the Sun is less than Newton expected by a factor of  $-6.421\,39 \times 10^{-15}$ . As Mercury needs 87.969 days ( $\Delta t_1 = 7\,600\,521$  s) for one revolution, Mercury needs about  $4.88 \times 10^{-8}$  s less per revolution around the Sun:

$$\begin{aligned} \Delta t &= -0.000\,000\,000\,000\,006\,421\,39 \times \Delta t_1 \\ &= -0.000\,000\,000\,000\,006\,421\,39 \times 7\,600\,521 \text{ s} \\ &= -0.000\,000\,048\,806 \text{ s}. \end{aligned}$$

According to this, the revolution of Mercury or of another planet around the Sun must be faster than Newton would have expected and must get slightly faster and faster with time, so that the orbit of a planet loses energy.

I revised my predictions for other so-called general relativistic phenomena, for example the phenomena observed at the binary pulsar PSR 1913+16.<sup>(6,7)</sup> In this case the calculation is a little bit more difficult, as there are two stars, a pulsar and its unseen companion. The pulsar and its companion both follow eccentric elliptical orbits around their common center of mass. The eccentricity of the pulsar’s elliptical orbit is given by  $e = 0.617$ . The minimum separation is called periastron and the maximum separation is called apastron. The period of the orbital motion is 7.75 h and the stars are nearly equal in mass, about 1.4 solar masses ( $m_p = 1.42$ ,  $m_c = 1.41$ ). Therefore in the following we go from the simplifying assumption that the parameters of the elliptical orbit of the pulsar are

also valid for the orbit of the companion. During the movement on their orbits the stars move more slowly when they are at the apastron than when they are at the periastron. The velocity of the stars varies from a minimum of 75 km/s to a maximum of 300 km/s. The median velocity of the stars is 187.5 km/s. As the two elliptical orbits have an inclination ( $i$ ) toward each other of about 21 angular degrees ( $\cos i = 0.933$ ), the median velocity  $v_m$  with respect to the common center of mass is 175 km/s:

$$\begin{aligned} v_m &= 187.5 \text{ km/s} \times \cos i \\ &= 187.5 \text{ km/s} \times 0.933 \\ &= 175 \text{ km/s.} \end{aligned}$$

This is  $0.000\,584c$ . According to our considerations, in this case we expect the square of the *gravitational factor of motion*  $\gamma'$  to be

$$(\gamma')^2 = \left( \sqrt{1 + \left( \frac{v}{c} \right)^2} \right)^2 = 1.000\,000\,341.$$

The semimajor axis of the elliptical orbit of the pulsar is given by  $a_1$ . For the minimum distance of the pulsar on the major axis from its elliptical focus we get

$$q = a_1 \times (1 - e) = a_1 \times 0.383.$$

With respect to the plane through the center of mass and the two stars we get a minimum distance from the center of mass at the periastron of

$$q' = a_1 \times (1 - e) \times \cos i = a_1 \times 0.383 \times 0.933 = 0.375 \times a_1.$$

And for the maximum distance of the pulsar on the major axis from its elliptical focus we get

$$Q = a_1 \times (1 + e) = a_1 \times 1.617.$$

With respect to the plane through the center of mass and the two stars we get a maximum distance from the center of mass at the apastron of

$$Q' = a_1 \times (1 + e) \times \cos i = a_1 \times 1.617 \times 0.933 = 1.509 \times a_1.$$

As we can see, the distances are smaller with respect to the elliptical orbit, which is projected on the plane

through the center of mass and the two stars, than the analog distances on the major axis. This is the reason why we got a slower median velocity of 175 km/s instead of 187.5 km/s as the pulsar or its companion is moving around the smaller projected orbit in the same time as on the larger elliptical orbit in the plane of the major axis. There is an important difference between the orbit of Mercury — where the Sun stays at the elliptical focus, so that the gravitational effect of the Sun against Mercury is unaltered — and that of the two stars, which are moving around their common center of mass. The gravitational effect of each star with respect to the common center of mass alters with the distance of each star from the common center of mass. From the data of distances at the apastron and the periastron we can see that the relative gravitational effect, which is caused in the common center of mass by each star at the periastron, is about 18 times stronger than at the apastron, where the relative gravitational effect is 1 with respect to the gravitational effect at the periastron. As the gravitational effect is reciprocal to the square of the distance, we get for the relative gravitational effect at the periastron compared with the gravitational effect at the apastron

$$\frac{[a_1 \times (1 + e) \times \cos i]^2}{[a_1 \times (1 - e) \times \cos i]^2} = \frac{(1 + e)^2}{(1 - e)^2} = \frac{1.617^2}{0.383^2} = 17.83.$$

For the median relative gravitational effect caused in the center of mass by each star we get

$$\frac{17.83 + 1}{2} = 9.415.$$

This means that the median gravitational effect, which is caused by each star in the common center of mass, is about 9.415 times stronger than in the case of an elliptical orbit, so that the relative gravitational effect in the center of mass is unaltered. If the median gravitational effect caused by the companion in the common center of mass is about 9.415 times stronger than in the case of an elliptical orbit, the gravitational effect is unaltered in the center of mass, respectively 1. According to our considerations above, the angle traversed by the radius of the elliptical orbit of the pulsar in a certain time must be on average 9.415 times larger, so that the effect we derived above must be on average 9.415 times greater. To get the alteration of the angular position of the periastron, we therefore have to multiply the effect we derived above for the alteration of Mercury's perihelion position by 9.415, so that we expect

$$\begin{aligned}
\Delta\phi &= 2\pi \times [(\gamma')^2 \pi - \pi] \times 9.415 \\
&= 2\pi^2 \times \left(\frac{v}{c}\right)^2 \times 9.415 \\
&= 2\pi^2 \times 0.000\,000\,341 \times 9.415 \\
&= 0.000\,006\,73 \text{ rad} \times 9.415 \\
&= 0.000\,063\,4 \text{ rad.}
\end{aligned}$$

Accordingly, the alteration of the angular position of the pulsar (and its companion) at the periastron per revolution around the common center of mass is about  $6.34 \times 10^{-5}$  rad, which is about 0.003 63 angular degrees. The time the pulsar needs for one revolution around the common center of mass is 7.75 h. This gives 1131 revolutions per year, so that we get an alteration of the pulsar's position at the periastron per year of about  $4.1^\circ$ :

$$\Delta\phi = 0.003\,63^\circ \times 1131 = 4.1^\circ.$$

This means that the periastron is advancing about 4 angular degrees per year, as is also predicted by Einstein's theory of general relativity. Depending on the method, the observed alteration of the periastron's angular position is  $4.0^\circ$ , respectively  $4.22^\circ$ , per year.<sup>(6,7)</sup> According to our considerations above, this also means that the area ( $\Delta A_1$ ) of the elliptical orbit of the pulsar and of its companion, which is traversed by the radius in a certain time, is on average larger by the square of the factor 9.415 than the complying part of an elliptical orbit, where the gravitational effect in the center of mass would be unaltered, respectively 1, so that we get

$$\Delta A'_1 = (9.415)^2 \times \Delta A_1.$$

And, as  $\Delta A$  and  $\Delta t$  are proportional,

$$\Delta t'_1 = (9.415)^2 \times \Delta t_1.$$

For the relative alteration of the time that the pulsar needs for one revolution we get

$$\begin{aligned}
\Delta t &= -[(\gamma')^2 \pi - \pi]^2 \times \Delta t'_1 \\
&= -\left[\left(\frac{v}{c}\right)^2 \pi\right]^2 \times \Delta t'_1 \\
&= -[0.000\,000\,341\pi]^2 \times \Delta t'_1 \\
&= -0.000\,000\,000\,001\,148 \times \Delta t'_1.
\end{aligned}$$

When the position of the periastron is reached depends on the arrival of both stars at their minimum separation, so that we have to regard the elliptical orbit of the pulsar and its companion, and therefore have to double this result, if we want to calculate the relative alteration of the arrival of the pulsar and its companion at the periastron:

$$\begin{aligned}
\Delta t &= -2 \times 0.000\,000\,000\,001\,148 \times \Delta t'_1 \\
&= -0.000\,000\,000\,002\,296 \times \Delta t'_1.
\end{aligned}$$

Thus we get a relative alteration of about  $-2.3 \times 10^{-12}$ . Einstein's theory of general relativity predicts an alteration of  $-2.4 \times 10^{-12}$ , while the observed relative alteration of time with respect to the arrival at the periastron is  $(-2.30 \pm 0.22) \times 10^{-12}$  per revolution.<sup>(7)</sup> As the pulsar and its companion need about 7.75 h ( $\Delta t'_1 = 27907$  s) per revolution around the common center of mass, they therefore need  $6.4 \times 10^{-8}$  s less per revolution to reach the position of the periastron:

$$\begin{aligned}
\Delta t &= -0.000\,000\,000\,002\,296 \times \Delta t'_1 \\
&= -0.000\,000\,000\,002\,296 \times 27\,907 \text{ s} \\
&= -0.000\,000\,064\,07 \text{ s.}
\end{aligned}$$

This is about  $73 \times 10^{-6}$  s per year (1131 revolutions). According to this, the revolution of the pulsar and its companion around the common center of mass is faster than Newton would have expected and must get faster and faster with time, so that the system is losing energy, which is explained by present-day physicists by gravitational radiation.<sup>(6-8)</sup>

#### 4. DISCUSSION

According to my considerations, the postulated additional gravitational effect must cause an additional gravitational acceleration on a mass such as Mercury, depending on the mass's velocity relative to the Sun. The conception of today's physicists starts from the assumption that gravitational acceleration depends on the size of the masses and the distance between the centers of the masses. If we go from the imagination, that gravitational force is transferred by gravitons, an increased mass will emit more gravitons by the factor the mass has increased and therefore the frequency of the interaction between these emitted gravitons and another mass increases by the same factor. If the distance between two masses decreases by a certain factor, more gravitons are arriving at each mass in the

same time by the square of this factor, so that the frequency of the gravitational interaction between these emitted gravitons and the masses is also increasing by the square of this factor. If these effects cause an acceleration, the additional gravitational effect, which I derived above, must also cause an acceleration, if as pointed out by the motion of Mercury or another planet around the Sun the frequency of the interaction between the gravitons emitted by the Sun and the planet and their masses increases by the square of the factor  $\gamma$ .

As mentioned in the introduction, one of the first scientists who tried to develop Newton's theory of gravitation further by considering the finite velocity of gravitational transference and by assuming that the velocity of the gravitational transference might probably have the value of the velocity of light was Paul Gerber, a German school teacher.<sup>(1)</sup> Gerber imagined that a mass causes a status of enforcement in its surrounding space, which spreads by the velocity of light. He apprehended that by assuming a finite velocity for the gravitational transference the movement of masses should affect the gravitational interaction between masses. He went from the assumption that gravitation is the result of a gravitational potential, which is caused in an attracted mass by the status of enforcement spreading from an attracting mass. The gravitational potential he defined as the positive work that has to be achieved to move an attracted mass, which is at a certain distance from an attracting mass, in an indefinitely far position from the attracting mass. If the velocity by which this has to be achieved is of no relevance, it means that the velocity is approximately zero. If an attracting mass, for example Mercury, has a certain velocity with respect to the attracted mass, for example the Sun, the status of enforcement would spread faster from Mercury toward the Sun. However, if Mercury is moving with respect to the status of enforcement spreading from the Sun in the direction of Mercury by a certain velocity, the status of enforcement and the velocity of the mass would pass each other by the sum of their velocities. As Mercury moves around the Sun, the potential that would be able to be developed in the mass of the Sun and the mass of Mercury in the case Mercury is in a resting position with respect to the Sun therefore would not have the time any more that the potential would need to develop a certain value, so that the positive gravitational potential should be lower than before. This means that by the motion of a mass against another mass the gravitational interaction between the masses would decrease. Hereby, according to Gerber, the kinetic energy would rela-

tively increase with respect to the decreasing positive gravitational potential. Therefore the time Mercury needs for one sidereal rotation around the Sun would decrease, while the rotation of the radius with a certain length of Mercury's elliptical orbit would slow down, so that the perihelion would be reached later than with respect to the sidereal period of revolution. After these considerations, Gerber applied Newton's kinetic equations for planets to this derivation of an acceleration of the period of Mercury's revolution. By this he could also calculate the difference of the perihelion position of 43 angular seconds per hundred years against Newton's theory of gravitation.

Gerber starts from the assumption that gravitation is the result of a gravitational potential, which is caused in an attracted mass by the status of enforcement spreading from an attracting mass. This means that gravitational energy is spreading from the attracting mass out to outer space. If we regard the principle of mass-energy conservation, in this case the attracting mass should lose energy and therefore mass, so that we should be able to observe a decrease of masses gradually due to that loss. But as yet no observation reports such a decrease of masses. By the movement of Mercury around the Sun, according to Gerber, the gravitational interaction is decreasing, while, according to my conclusions, the gravitational interaction is increasing. It's true that, according to Gerber's conclusions, the kinetic energy is relatively increasing with respect to the decreasing positive gravitational potential. But let's again have a look at Newton's formula for the whole energy of a planetary orbit:

$$E = \frac{mv^2}{2} - \frac{GMm}{r} = -\frac{GMm}{2a}.$$

As mentioned above, the term  $(mv^2/2)$  stands for the kinetic energy ( $E_k$ ) and the term  $(GMm/r)$  stands for the potential energy of gravitation ( $E_g$ ), which is here defined as a negative gravitational potential. If the gravitational interaction, respectively the positive gravitational potential, is decreasing, as Gerber postulated, the negative gravitational potential in the formula above is less negative and therefore increasing, so that there would result a higher energy of the elliptical orbit of Mercury. According to classical mechanics, a higher energy of an elliptical orbit results in a slower revolution around the Sun. This means that in this case we have to postulate a deceleration of the period of Mercury's revolution around the Sun and not an acceleration as Gerber thought.



In 1999 Paul Marmet<sup>(9)</sup> published another derivation of the additional advance of Mercury's perihelion position, based on the assumption of the principle of mass-energy conservation: "Classical Description of the Advance of the Perihelion of Mercury." It is useful to cite parts of his publication: "Let us mention first that we believe that the principle of mass-energy conservation is one of the most important fundamental principles in physics. ... Energy always possesses mass and mass always possesses energy. ... The logical explanation implies that the atoms having extra gravitational energy on Earth ... have a slightly larger mass than the atoms at a lower potential energy on Mercury. ... The principle of mass-energy conservation requires that one Mercury-kilogram (at Mercury-distance from the Sun) contain slightly less mass than the Earth-kilogram (at Earth-distance from the Sun), even if the number of atoms is exactly the same (by definition)." In the following Marmet points out that, using quantum mechanics, clocks on Mercury should function at a different rate and that lengths on Mercury and Earth should also be different. "Physical lengths can be expressed either in Earth-meters or in Mercury-meters. ... The same orbit of Mercury can also be measured using the shorter standard Earth-meter. Then, the *number* of Earth-meters to measure the same physical orbit of Mercury is larger when it is measured using the shorter Earth-meter. We must notice that Newton's laws of physics deal with the *numbers* that are fed into the equations. Since the *number* of meters to measure the same physical length (using the longer Mercury-meters) is smaller than the *number* of Earth meters, we must not be surprised to find different physical results when Newton's laws use the correct local (proper) number. ... [T]he Mercury observer, measuring a smaller number of local meters to the Sun (with the longer local meter), will calculate that the velocity of Mercury *must* be larger (than the Earth observer using the Earth-meter). ... [T]he absolute mass of the Sun does not change because it is measured with respect to the moving Mercury-kilogram. However, the *number* of Mercury-kilograms that represents the Sun will be different. ... the *number* of Mercury-kilograms in the Sun is larger than the *number* using Earth-kilograms. ... We know that  $G$  is an absolute physical constant. However, since the standard units existing on Mercury are different from the standard units on Earth, different numbers will then express the same physical gravitational constant  $G$ ."

By using different numbers for the changed Mercury-units for  $G$ , for the mass of the Sun, and for the Mercury-meters for the length of the radius of Mercury's orbit (while the mass of Mercury expressed in Mercury-kilograms cancels out in the numerator and denominator), Marmet is also able to calculate the correct value of the advance of the perihelion of Mercury. Because of the local smaller mass-unit of Mercury, Marmet uses a larger numerical mass, and, because of the larger Mercury-meters of Mercury, he uses a smaller numerical length in the formulas for Mercury, so that there is a change of Mercury's orbit and also a stronger gravitational attraction between Mercury and the Sun. Although Marmet's model suits classical mechanics "locally," that is to say, by his model it is possible to calculate the so-called relativistic phenomenon of the additional advancing of Mercury's perihelion by using local values, his model doesn't represent a pure classical physical theory, as it uses quantum mechanics to derive local values, respectively units. Using values in the classical equations, which are with respect to the locality of Mercury remote values, for example the values used on Earth, by Marmet's model it is not possible to calculate the additional advance of Mercury's perihelion.

## 5. CONCLUSIONS

There exist at least four possible derivations by which so-called general relativistic phenomena can be calculated, such as the advance of Mercury's perihelion. As pointed out above, Paul Gerber's derivation contradicts the principle of energy-mass conservation and also classical mechanics, while Paul Marmet's model doesn't represent a pure classical physical theory, as his model uses quantum mechanics to derive local values. By Marmet's model it is only possible to calculate the additional advance of Mercury's perihelion if we use local values in the classical equations. However, Einstein's theory of general relativity needs a lot of additional assumptions, which result in a completely new physical insight. As shown above, it is possible to advance Newton's theory of gravitation only by taking into consideration the finite velocity of gravitational expansion and the present concept of transference of forces by particles to be able to calculate so-called general relativistic phenomena maintaining classical conceptions of a Euclidean space and the Galilean principle of relativity. By the theory introduced in this article it is possible to predict so-called general relativistic phenomena without using local values or relativistic physics. By our postulation that motion causes an additional gravitational effect,

we touch on Einstein's theory of general relativity, as Einstein postulated an equivalent effect of mass caused by motion. But our conclusions also mean that the velocity of gravitational expansion is, with respect to different observers, noninvariant or nonconstant. This is an antithesis to relativistic physics, but no contradiction to the fact that we on Earth measure a (relatively) constant velocity of light. As there obviously exist more than one consistent theory to explain and calculate so-called general relativistic phenomena, it is to be decided which one complies with reality. For this we should consider Ockham's razor. With respect to Ockham's razor we have to ascertain that there cannot be fewer additional assumptions in Newton's

theory of gravitation than in our derivation, that is to say, gravitational interaction is caused by something, as for example gravitons, and the gravitational interaction is transferred by a certain finite velocity, as for example the velocity of light. Without these two assumptions, Newton's theory of gravitation is incomplete. Another question that arises is this: Is it also possible to explain and calculate so-called special relativistic phenomena by advancing Newton's mechanics by alternative conceptions about the traveling of light? In fact this is also possible! But this is to be discussed in another article.

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### Résumé

*En utilisant l'exemple du mouvement de Mercure autour du soleil, la nécessité de développer la théorie de la gravitation de Newton est démontrée en prenant en considération la vitesse finie de l'expansion gravitationnelle ainsi que le concept actuel de transfert des forces par les particules de manière à permettre le calcul des phénomènes dits « de relativité générale », tels que le mouvement supplémentaire du périhélie de Mercure, la courbure des rayons lumineux à la surface du soleil et les phénomènes observés sur le pulsar binaire PSR 1913+16 en conservant les concepts classiques de l'espace euclidien et le principe galiléen de la relativité.*

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### Reiner Georg Ziefle

Philosophische Fakultät der FernUniversität Hagen  
Holzmühlstrasse 31  
91578 Leutershausen, Federal Republic of Germany