



The Origin of Gravity

The Origin of Gravitation

The acceleration of a free falling particle is caused by the refraction of its oscillating components by a cloud of exchange particles. - This also explains the weakness of gravity and the attracting-only effect

1 Abstract

It is a well proven fact that the speed of light is reduced in a gravitational field. As a consequence, a light beam which passes a big object is bent towards the object. This bending process is quantitatively explained by the refraction of light at the gravitational potential. - The same happens every light-like particle.

From the spin and from the magnetic moment of an elementary particle it can be concluded, that the constituents of such particle oscillate permanently at the speed of light c . For the electron this was determined by Paul Dirac in 1928. If the effect of refraction is applied to this oscillation within an elementary particle, it yields the correct gravitational acceleration of a free physical object in a gravitational field.

This evaluation does not only yield the gravitational behaviour of an object at rest but also explains the acceleration of fast objects in a gravitational field, which is normally explained by Einstein's general relativity ("curvature of space-time"). The refraction of light-like objects by the field is an equivalent, but easier, replacement for Einstein's model of a curved space-time.

And, very surprisingly, you will find that the mass of an object is not the cause of its gravitational field.

This consequence has the potential to eliminate the problems of Dark Matter and Dark Energy, and additionally the very grave problem of Quantum Gravity.

The structure of particles used here is called the Basic Particle Model.

2 Bending of a Light Beam Passing a Massive Object

The speed of light is not constant in the vicinity of matter but depends for e.g. the sun on the gravitational potential in the following way:

$$c_{red}(r) = c \cdot \left(1 - 2 \cdot \frac{G \cdot M}{r \cdot c^2}\right)^p \tag{2.1}$$

where c is the speed of light in the gravitation-free space, c_{red} is the reduced speed of light in the field, G is the gravitational constant; M is the mass of the source, which is traditionally said

to cause the gravitational potential; r is the distance to the centre of the gravitational source. The power p is $\frac{1}{2}$ or 1 depending on the direction of motion with respect to the centre of gravity; that means it is 1 for the radial direction and $\frac{1}{2}$ for the tangential one.

This equation was experimentally determined the first time by the Shapiro experiment in 1970 for small changes of c .

(Remark: The equation (2.1) can also be derived using Einstein's general relativity. We do not use Einstein at this place but use instead the experimental result as such. Later we will derive the equation by physical considerations in contrast to the structural ones of Einstein.)

From classical optics it follows that a light beam, which passes an area in which the speed of light depends on the position, is bent towards the area where the speed of light is lower.

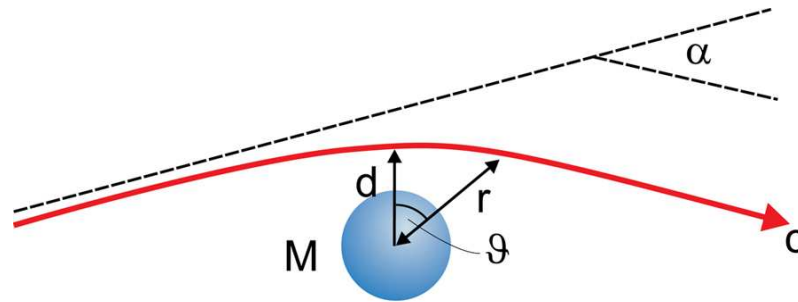


Figure 2.1: A light-like object deflected by a massive object

The deflection of a light beam passing the sun was correctly given for the first time by Albert Einstein. He predicted the gravitational acceleration of the photon to be twice the value of the Newtonian acceleration (as it was for the first time predicted by von Soldner in 1801). This was historically taken as an important proof of Einstein's concept of a 4-dimensional curved space-time. We will, however, see that Einstein's concept is not necessary to achieve this result. A calculation, which is based on the classical assumption of refraction, yields the same result.

2.1 The Amount of Deflection

Here now follows a brief collection of equations, which describe the deflection of the path. A detailed deduction of the refraction process is given in the Appendix A.

The first step necessary is a derivative of c with respect to the direction y - perpendicular to the path of the particle (y being equivalent to d at the vertex). And we define x as the distance of the point of consideration to the vertex of the path.

We can now describe r by the components x and y :

$$r^2 = x^2 + y^2. \quad (2.2)$$

Then taking into account the dependency of the reduction of c from x and y , which follows in a somewhat complex way from equations (2.1) and (2.2), we get

$$c_{red} = c \cdot \left[1 - \frac{GM}{c^2 \sqrt{x^2 + y^2}} \left(1 + \frac{x^2}{x^2 + y^2} \right) \right]. \quad (2.3)$$

This now derived with respect to y yields

$$\frac{dc}{dy} = \frac{GM \cdot y}{c} \cdot \left(\frac{1}{r^3} + \frac{3x^2}{r^5} \right). \quad (2.4)$$

Here we suppose that the deflection is small (i.e. $\alpha \ll 1$, so (x,y) describes an almost straight line).

We can then determine the differential deflection angle $d\alpha$ by applying the classical refraction mechanism:

$$d\alpha = \frac{1}{c_0} \frac{dc}{dy} dx. \quad (2.5)$$

If we now replace in eq. (2.4) r and x by ϑ , the angle between the direction of the vertex of the path (i.e. the closest position to the sun), and y by d , then we get

$$d\alpha = \frac{GM}{c^2 d} \cdot (3 \sin^2 \vartheta \cos \vartheta + \cos \vartheta) d\vartheta. \quad (2.6)$$

The equation (2.6) integrated over $d\vartheta$ from $\vartheta = -\pi/2$ to $\vartheta = \pi/2$ yields

$$\alpha = 4 \cdot \frac{GM}{c^2 d}. \quad (2.7)$$

After inserting now

- $G = 6.674 \cdot 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$
- $M = 1.989 \cdot 10^{30} \text{ kg}$
- $c = 2.998 \cdot 10^8 \text{ m s}^{-1}$
- $d = 6.95 \cdot 10^8 \text{ m}$

we get, after converting to angular units, the correct result of

1.75 arc-sec.

This corresponds to twice the normal gravitational acceleration (Newton) and conforms to the observation. This numerical result as well as the analytical result (2.7) conform also to the prediction of general relativity – however without any use of general relativity.

2.2 The Acceleration

Next we will need the acceleration of the beam at the vertex of the path. The acceleration a within the beam follows from the deflection angle α in the way:

$$a = c^2 \frac{d\alpha}{dx}. \quad (2.8)$$

Inserting here (2.5):

$$d\alpha = \frac{1}{c} \frac{dc}{dy} dx$$

we get

$$a = c \frac{dc}{dy}. \quad (2.9)$$

Now using (2.4):

$$\frac{dc}{dy} = \frac{GM \cdot y}{c} \cdot \left(\frac{1}{r^3} + \frac{3x^2}{r^5} \right).$$

yields

$$a = GM \cdot y \cdot \left(\frac{1}{r^3} + \frac{3x^2}{r^5} \right). \tag{2.10}$$

At the vertex there is $x=0$ and $y = r$, and so get

$$a_{\text{vertex}} = \frac{GM}{r^2} \tag{2.11}$$

which is the Newtonian acceleration.

3 Reference of Gravity to the Basic Particle Model

3.1 The Structure of Elementary Particles

The above chapter was about gravity at fast motion. Next we have to understand the effect of gravity to an object at rest.

To understand further implications of the refraction process for the phenomenon of gravity, we have to investigate the general structure of matter, which means, the structure of elementary particles.

From the dynamic parameters of an elementary particle, its spin and its magnetic moment, and also from its relativistic behaviour it follows that a particle is built by sub-particles, called here "basic particles", which orbit each other at the speed or light c as shown in figure 3.1.

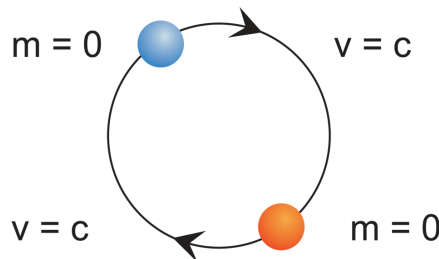


Figure 3.1: Basic Particle Model

This structure was in principle already detected in 1930 by Erwin Schrödinger, when he analysed the Dirac function of the electron and found that there must be a permanent internal oscillation at the speed of light c . He called this oscillation in German "Zitterbewegung" ("ZBW").

The Basic Particle Model (<http://www.ag-physics.org/structure>) assumes that this structure is valid for all leptons and also for all quarks.

3.2 Conditions for the Refraction of an Elementary Particle

In textbooks, which deduce gravitational lensing in a classical way, the refraction of light or light-like particles in a situation of varying speed of light is normally explained by a pair of photons or a pair of particles. We have, however, to assume that also a single object is

subject to refraction. So, also a basic particle is subject to refraction in the appropriate situation.

This is a necessary assumption at this place to make the following considerations work. It can be logically understood from the view of the particle, if we assume that even a basic particle has an expansion (kind of a charge cloud, which may be arbitrarily small) or it is in a process of permanent oscillation.

3.3 Gravity for an Object at Rest

3.3.1 Gravitational Acceleration a Special Orientation

If an elementary particle is placed in a gravitational field, its basic particles are subject to refraction as explained above. This refraction causes the basic particles to deviate from their circular path. This will in turn cause a movement of the entire elementary particle.

If we take an elementary particle oriented in such a way that its orbital axis points towards the source of gravity, then the refraction causes the basic particles to spiral towards the source of gravity. So the entire elementary particle will move into the direction of the source. Due to the refraction, the pitch angle of the basic particles, α , will steadily increase. This causes the elementary particle to perform an accelerated motion towards the gravitational source.

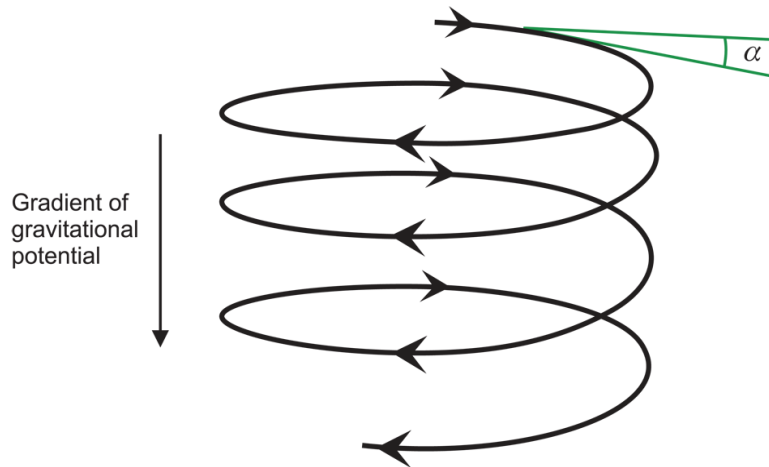


Figure 3.2: Progressive spiralling downwards

Figure 3.2 shows the accelerated motion downwards. Please note that here only the path of one of the two basic particles is shown to keep the drawing simple.

In this case the acceleration of the (composed) elementary particle is similar to the acceleration given in equation (2.11)

$$a = \frac{G \cdot M}{r^2} \tag{3.1}$$

which is again the Newtonian acceleration.

3.3.2 Gravitational Acceleration in Arbitrary Orientations

In the general case the orientation of the axis is at an arbitrary angle θ with respect to the vertical direction (see figure 3.3).

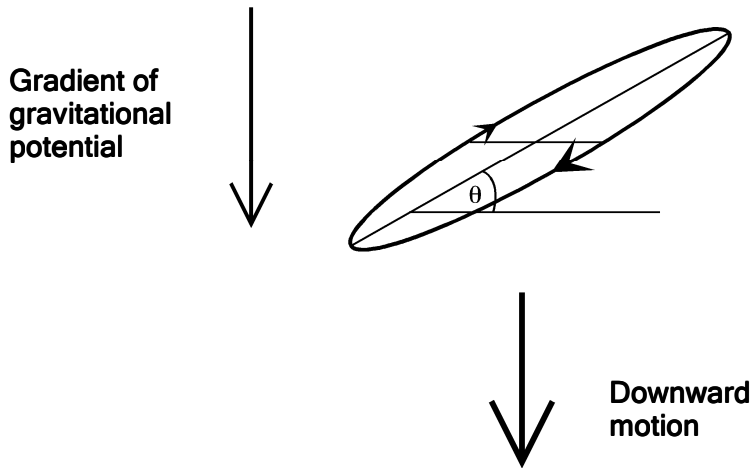


Figure 3.3: General orientation of a particle

In this case only the projection of the refraction into the vertical direction is effective for gravity. This means on the one hand, that the gravitational acceleration is reduced compared to the case above. But, on the other hand, the effect of reduction is compensated by the increase of refraction for the vertical component as it is visible in eq. (2.10), i.e. the term with a factor of 3.

So also in the case of an arbitrary orientation of the elementary particle we can get the result eq. (3.1)

$$a = \frac{G \cdot M}{r^2}$$

which is the well known result for the classical case (Newton).

4 The Equivalence Principle

4.1 Equivalence Classically

The (weak) equivalence principle treats the fact that every object undergoes the same gravitational acceleration independent of its mass.

In order to explain this fact, Newton has introduced the equivalence principle, saying that there exists an inertial mass and a gravitational mass. Both types of mass are said to be equivalent to a high degree, and as a consequence the gravitational force onto an object is strictly proportional to the inertial force, and so every object undergoes strictly the same acceleration in a certain gravitational field.

Einstein had, when he developed general relativity, adopted this principle and made it to one of the pillars of his theory.

Neither Newton nor Einstein ever made the attempt to explain this phenomenon on a physical basis.

4.2 Equivalence Based on the Particle Model

If we look to the figure 3.2, it is obvious that the deflection of the path of the basic particles is independent of the radius of the particle and, because of the particle model (<http://www.ag-physics.org/structure>) used here, independent of the mass of the particle. So it has a very natural cause that the gravitational acceleration is independent of the mass. No assumptions about any equivalence are needed.

Figure 3.2 shows, why an elementary particle at rest is subject to a gravitational acceleration. It is in fact gravitational lensing on a micro-scale.

This is the *physical* cause that the gravitational acceleration is independent of the mass of an object.

5 The Schwarzschild Solution

The work with Einstein's field equations is an extremely challenging task. A short time after Einstein published general relativity, Karl Schwarzschild presented a solution for the simplified, less general situation of a spherically symmetric field, like the one of the sun, which is a very frequent case in astronomy. The experiments and observations cited in the literature as proofs for Einstein's general relativity refer usually to the results of the Schwarzschild solution.

An elementary particle is, according to the Basic Particle Model, built by two sub-particles orbiting each other. Their temporal behaviour is given by special relativity (<http://www.ag-physics.org/rtime>), from which the following equation results for the proper time of an object in motion:

$$\tau = t \cdot \left(1 - \frac{v^2}{c^2}\right)^{1/2}. \quad (5.1)$$

Here t is the time in the system at rest, and τ describes the development of temporal processes in the system at motion. This equation is now derived with respect to dt and then squared and reordered:

$$c^2 \left(\frac{d\tau}{dt}\right)^2 = c^2 - v^2. \quad (5.2)$$

In a gravitational field this time behaviour changes. The understanding of this change directly guides us to the Schwarzschild solution.

We first split the speed into a radial and a tangential component as the Schwarzschild solution is normally presented in polar coordinates:

$$c^2 \left(\frac{d\tau}{dt}\right)^2 = c^2 - v_{rad}^2 - v_{tan}^2 \quad (5.3)$$

where v_{rad} and v_{tan} denote the radial and the tangential component of the speed respectively in relation to the centre of the gravitational source.

Now we have to take into account that c changes in a gravitational field in the following way according to (2.1):

$$c_{redu}(r) = c \cdot \left(1 - 2 \cdot \frac{G \cdot M}{r \cdot c^2}\right)^p$$

where p is $\frac{1}{2}$ or 1 depending on the direction of motion in respect to the centre of gravity.

Further the size of the elementary particles changes in the gravitational field as a consequence of the change of the speed of light c in the field. By taking into account this fact when using eq.(5.3) we get – as deduced in detail in the appendix B:

$$c^2 \left(\frac{d\tau}{dt} \right)^2 = \left(1 - 2 \frac{G \cdot M}{r \cdot c^2} \right) \cdot c^2 - \left(1 - 2 \frac{G \cdot M}{r \cdot c^2} \right)^{-1} \left(\frac{dr}{dt} \right)^2 - \left(\frac{d\phi}{dt} \cdot r \right)^2 \quad (5.4)$$

It is usual to abbreviate the equations by using the common definition for the so-called Schwarzschild radius r_s

$$r_s = 2 \cdot \frac{G \cdot M}{c^2} \quad (5.5)$$

and we can denote the derivative with respect to t by a prime. So we get:

$$\boxed{c^2 \tau'^2 = \left(1 - \frac{r_s}{r} \right) \cdot c^2 - \left(1 - \frac{r_s}{r} \right)^{-1} r'^2 - \phi'^2 \cdot r^2} \quad (5.6)$$

which is a popular form of the Schwarzschild solution.

A detailed deduction is given in appendix B.

6 The Cause of Gravity

We have seen that gravity is in fact not a force but a refraction process. And the cause of the refraction is the varying speed of light c in the vicinity of matter.

6.1 Varying Speed of Light

Equation (2.1) is the basis to explain all phenomena of gravity. Now we have to understand this dependency.

The reduction of c is can be explained by the exchange particles, which build the binding field of the basic particles (<http://www.ag-physics.org/structure>).

According to the Basic Particle Model, the binding field is the field of the strong interaction, which is – also according to the model – the universal force in our world affecting all existing particles. These exchange particles, which effect an attraction or a repulsion in a random way, interact as well with every light-like particle. They cause such a particle to be deflected towards the origin of the exchange particle (which is the basic particle) or away from it. So the light-like particle performs a random walk as depicted in figure 6.1. As a result the average speed of the light-like particle is reduced, even though the microscopic speed is still the speed of light c .

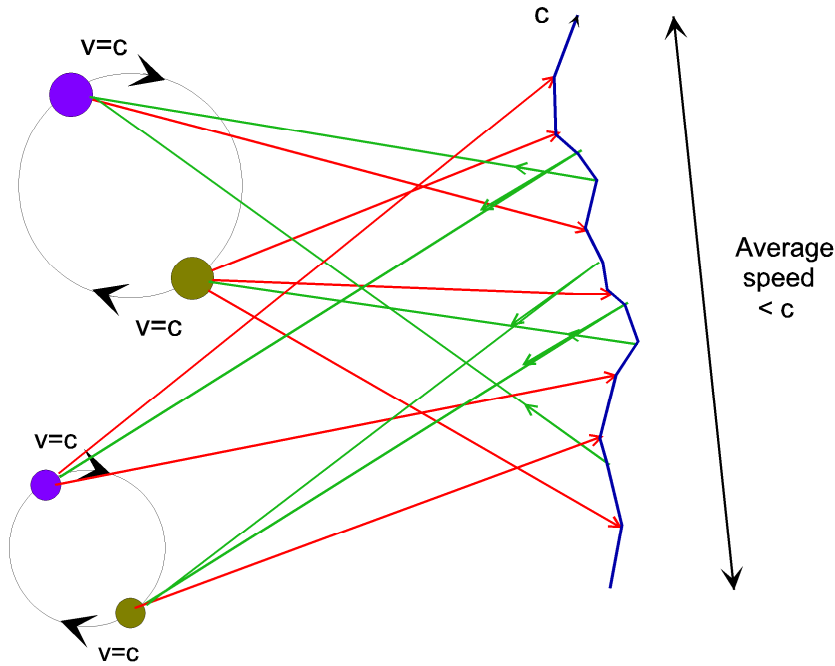


Figure 6.1: Disturbed way of a light-like particle

According to the Basic Particle Model, the field of every basic particle is built by a similar collection of elementary charges (of the strong field), and it is so independent of the type of the elementary particle, to which the basic particle belongs. And so also the flow of exchange particles is independent of the type of the particle. Consequently also the reduction of c and so the gravitational effect is independent of the particle, which means that it is independent of the size and consequently independent of the mass of the elementary particle. *Every elementary particle provides the same contribution to the gravitational field.*

This understanding is in contrast to the conventional physics, but it helps to overcome the principle problems of present gravitational physics.

Remark: There is an apparent conflict here to the fact that the forces within an elementary particle in the binding function have a limited range. This seems not to conform with the unlimited range of the effect of gravity. The solution is that the binding field is set up as a multi-pole field by a composition of monopole charges of the strong force. The exchange particles of those monopole charges, which cause the disturbance of the path of a light-like particle, have an unlimited range as we know it similarly about electric charges.

6.2 Speed Reduction in Detail

The reduction of c is, as mentioned above, caused by the continuous deflection of the light-like particle. This reduction will now be determined.

We have to consider two orthogonal cases, the motion in the tangential direction with respect to the centre of gravity, and in the radial direction. In the tangential direction the reduction is

$$c_{eff, tan} = c \sqrt{1 - \frac{v^2}{c^2}} \quad (6.1)$$

as this is a crossway disturbance of the path. In the radial direction it is

$$c_{eff,rad} = \frac{c^2 - v^2}{c} = c \cdot \left(1 - \frac{v^2}{c^2}\right) \quad (6.2)$$

which is greater than in the former case as it is a longitudinal disturbance of the path.

The effective amount of the influence onto the speed depends on two facts

1. The influence of a single exchange particle
2. The rate of exchange particles.

As the influence of the exchange particles adds on in a random way, the resulting deflection depends on the square root of the rate of particles and so on the square root of the number of particles causing the gravitational field. The rate further depends on the distance between the particles, which build the gravitational source, and the point under investigation. Combining all that, the resulting equation is

$$c_{eff} = c \cdot \left(1 - \frac{g \cdot N}{c^2 \cdot r}\right)^p \quad (6.6)$$

where again $p=1$ for radial motion and $p=1/2$ for tangential motion.

Further the binding field in an elementary particle and so the size of any objects in a gravitational field is given by the equation

$$r_{red} = r \cdot \left(1 - \frac{g \cdot N}{c^2 \cdot r}\right)^{(p-1/2)}$$

We have used here N to denote the number of elementary particles causing the gravitational field to reflect the fact that this influence is independent of the mass of a particle. And so we have to use a different gravitational constant denoted here as g .

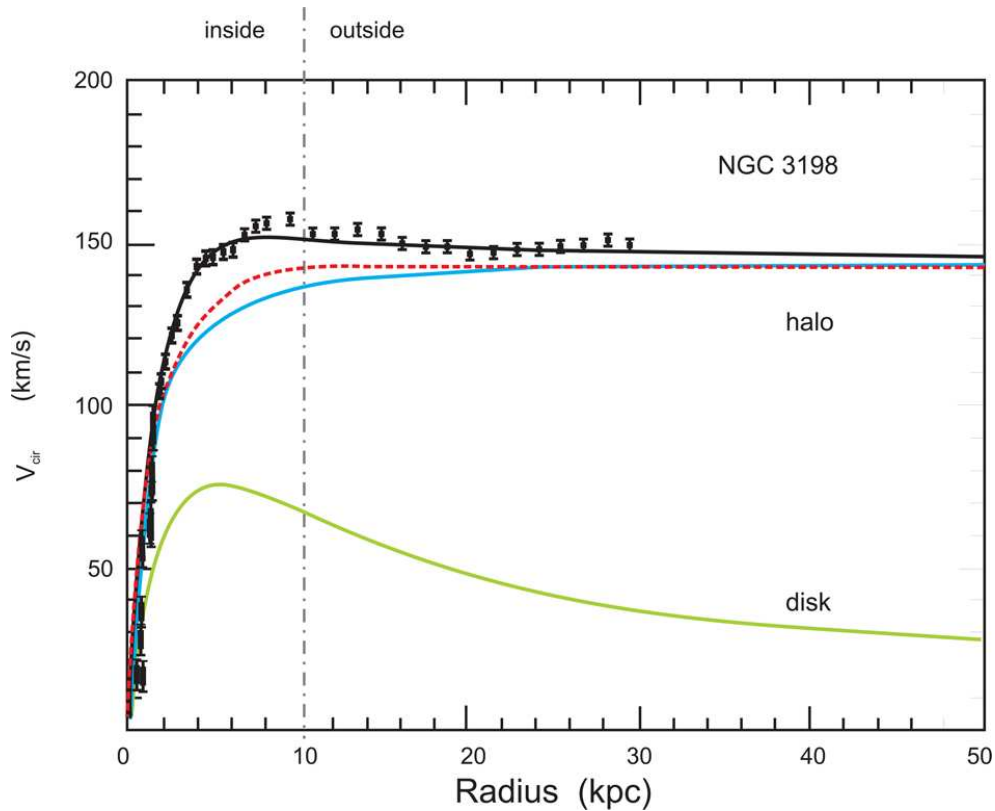
The deduction is given in detail in appendix C.

7 Present Problems of Gravity

1. **Dark Matter**: It is presently not understood, why a rotating galaxy has a stable configuration. By conventional calculations the mass within the galaxy can only explain ca. 1/6 of the necessary centripetal acceleration. - If we assume, that not the mass of the stars is the cause of the gravitational field but e.g. the number of elementary particles, which build the stars, then we are close to a solution without assuming things like "dark matter" or undetected elementary particles.
2. **Dark Energy**, which is a phantom as the acceleration of supernovae is only a seeming evaluation result. The acceleration in fact disappears if it is accepted that the speed of light was greater at former times. This latter assumption by the way solves also other open problems of the cosmology. For details look here: (<http://www.ag-physics.org/darkenergy>).
3. **Quantum Gravity**: According to chapter 6 the phenomenon of gravity is a very weak side effect of the strong interaction. As on the other hand strong interaction is fully covered by quantum mechanics, any discrepancy between QM and gravity disappears.

7.1 The "Dark Matter" Phenomenon

Some decades ago it was detected that the rotational speed within and around big galaxies is in conflict with the equilibrium speed determined on the basis of standard gravity. Figure 7.1 shows the discrepancy for the galaxy NGC 3198.



**Figure 7.1: Equilibrium conflict at the galaxy NGC 3198
(The radius of the galaxy is 10 kpc)**

The solid (green) curve labelled "disk" is the rotational speed dependent from the radius as a result of a normal gravitational calculation. The uppermost single values are measurements of the real speed; a curve (also solid, black) is fitted through these measurements. The medium solid (blue) line labelled "halo" describes the required distribution of the assumed "Dark Matter" in order to explain the measured values.

The red dotted line, which is very close to the "halo" curve, follows from the assumption described above, that every elementary particle contributes equally to the gravitational field. It is the contribution of light particles (i.e. neutrinos and photons). In the drawing the height of this line was chosen to fit into the needs of this diagram, but it fits within a tolerance of a factor 2-3 to the assumed data; its curvature, however, is given by the natural distribution of the light particles and is not parameterised.

Of the light particles mentioned, the photons are mainly generated by the hot, shining stars in the centre of the galaxy. The neutrinos are similarly generated by the nuclear processes within the stars, the sources of which are also mostly in or close to the centre of the galaxy. These particles build a continuous flow off the centre with the speed of light c (or almost this speed). This flow causes their spatial distribution to be

$$\rho \propto \frac{1}{r^2}$$

where r is the distance to the centre of the galaxy. The number of particles N within a sphere up to a radius r_0 is then

$$N = \int \rho \cdot 4\pi r^2 dr \propto \int_0^{r_0} \frac{1}{r^2} \cdot 4\pi r^2 dr \propto r_0.$$

The acceleration a in the gravitational field towards the centre is for (r_0 here renamed r)

$$a \propto \frac{1}{r^2} \cdot N \propto \frac{1}{r^2} \cdot r = \frac{1}{r}.$$

The centrifugal acceleration on the other hand is

$$a = \frac{v^2}{r}.$$

In order to keep both accelerations in a balance, it follows for the orbital speed v that

$$\frac{v^2}{r} \propto \frac{1}{r} \quad \Rightarrow v = \text{const.}$$

This is the reason for the curvature of the red dotted line in figure 7.1, and so it provides the contribution to the gravitational field, which is elsewhere assigned to the so called "Dark Matter".

8 Conclusion

We have shown that gravity is not the force # 4 but a refraction process effective on all particles. The refraction approach conforms to the results of the Einsteinian way at least up to the Schwarzschild solution, as it is demonstrated here. And it is easy enough to be taught at a college level.

This approach provides answers to several open questions about gravity:

1. The weakness of this effect (which is primarily not a force)
2. The attracting-only effect.

The investigation of the cause of the related processes explains

1. The phenomenon called Dark Matter
2. The open conflict with quantum mechanics called Quantum Gravity.

The related understanding of relativity in general solves the apparent problem of Dark Energy in a very easy - and physical - way.

Generally speaking, there is no longer a need for the assumption of a 4-dimensional curved space in order to explain the phenomena named above. In addition we have to accept that the mass of an object is not the cause of the object's gravitational field.

An explanation for the ('Origin of (inertial) Mass') <http://www.ag-physics.org/rmass> is also available.

NOTE:

The concept of the (Basic Model of Matter) <http://www.ag-physics.org/structure> was presented initially at the Spring Conference of the German Physical Society (Deutsche Physikalische Gesellschaft) on 24 March 2000 in Dresden by Albrecht Giese.

Comments are welcome to: note@ag-physics.de.

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Appendices

A1 Mathematical Deduction of the Refraction Process

In the following we will call the velocity of light in the field-free vacuum c_0 in order to distinguish it from the variable values of c in the corresponding situations. So eq. (2.1) has the following appearance:

$$c(r) = c_0 \cdot \left(1 - 2 \cdot \frac{G \cdot M}{r \cdot c_0^2}\right)^p. \quad (\text{A.1})$$

Again: The power p is $\frac{1}{2}$ or 1 depending on the direction of motion in respect to the centre of gravity; that means it is 1 for the radial direction and $\frac{1}{2}$ for the tangential one.

The effective speed of light for an arbitrary direction can be composed from its components:

$$c_{\text{eff}} = \sqrt{c_{\text{rad}}^2 + c_{\text{tan}}^2}. \quad (\text{A.2})$$

Here c_{rad} is the radial component of c , where “radial” means the direction from the photon to the centre of gravity horizontal component of c , and c_{tan} is the “tangential” direction perpendicular to it. Refer to figure A.1.

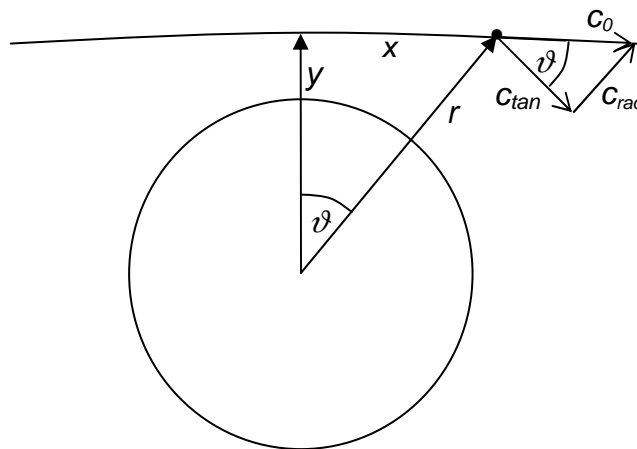


Figure A.1: Components of c at gravitational lensing

To shorten the equations, we will use the common definition for the so called Schwarzschild radius r_s as a measure for the strength of the gravitational field

$$r_s = 2 \cdot \frac{G \cdot M}{c_0^2} \quad (\text{A1.3})$$

where we follow initially the current conventions that the gravitational field is given by the mass of the gravitational source.

We can then write the components according to (A.1)

$$c_{tan} = c_0 \cdot \left(1 - \frac{r_s}{r}\right)^{1/2} \quad \text{and} \quad c_{rad} = c_0 \cdot \left(1 - \frac{r_s}{r}\right)^1. \quad (\text{A1.4})$$

For a photon, which passes the gravitational source (e.g. the sun), the split between the radial and the tangential component can be described by

$$c_{rad} = c \cdot \sin \vartheta \quad (\text{A1.6})$$

and

$$c_{tan} = c \cdot \cos \vartheta \quad (\text{A1.7})$$

where ϑ is the angle between the radius vector of the actual position of the photon to the centre of the sun on the one hand and the radius vector of its closest position to the sun (vertex) on the other hand according to figure A.1.

Combining (A1.4) thru (A1.7) we get

$$c = c_0 \cdot \left[1 - \frac{r_s}{2r} (1 + \sin^2 \vartheta)\right] \quad (\text{A1.8})$$

taking into account that $r_s \ll r$ (i.e. the gravitational source is not a Black Hole).

We will denote the distance of the photon under consideration from the vertex of the light path as x (figure A.1). Then there is

$$\sin \vartheta = \frac{x}{r}. \quad (\text{A1.9})$$

Further we define the coordinate perpendicular to x as y (see again figure A.1). At the vertex of the light path y is the distance of the light path from the centre of the gravitational source (e.g. of the sun). We can now replace r by these two parameters according to

$$r^2 = x^2 + y^2. \quad (\text{A1.10})$$

Then (A1.8) can be presented as

$$c = c_0 \cdot \left[1 - \frac{r_s}{2\sqrt{x^2 + y^2}} \left(1 + \frac{x^2}{x^2 + y^2}\right)\right]. \quad (\text{A1.11})$$

Now, as y is perpendicular to x and does so not depend on x , we can perform a straight differentiation with respect to y :

$$\begin{aligned} \frac{dc}{dy} &= c_0 \cdot \left[\frac{r_s}{4} (x^2 + y^2)^{-3/2} \cdot 2y + \frac{3}{2} \cdot \frac{1}{2} x^2 r_s (x^2 + y^2)^{-5/2} \cdot 2y \right] \\ \frac{dc}{dy} &= \frac{c_0 r_s y}{2} \cdot \left(\frac{1}{r^3} + \frac{3x^2}{r^5} \right). \end{aligned} \quad (\text{A1.12})$$

We can now determine the differential deflection angle $d\alpha$:

$$d\alpha = \frac{1}{c_0} \frac{dc}{dy} dx. \quad (\text{A1.13})$$

So we get:

$$\frac{d\alpha}{dx} = \frac{r_s y}{2} \left(\frac{1}{r^3} + \frac{3x^2}{r^5} \right). \quad (\text{A1.14})$$

Next we will integrate (A1.14) to determine the full deflection angle. To achieve this, it is more convenient to integrate over the angle ϑ rather than over x . The angle ϑ depends on x , y , and r in the following way:

$$r = \frac{y}{\cos \vartheta} \quad (\text{A1.15})$$

$$x = y \cdot \tan \vartheta. \quad (\text{A1.16})$$

And following from this:

$$\frac{dx}{d\vartheta} = y \cdot \frac{1}{\cos^2 \vartheta} \quad (\text{A1.17})$$

where we assume that the change of y along the light path is negligible (i.e. α is very small). So the derivative of α with respect to ϑ is (if continuing with (A1.14) and (A1.17):

$$\begin{aligned} \frac{d\alpha}{d\vartheta} &= \frac{d\alpha}{dx} \cdot \frac{dx}{d\vartheta} = \frac{r_s y^2}{2 \cos^2 \vartheta} \left(\frac{\cos^3 \vartheta}{y^3} + \frac{3 \cos^5 \vartheta}{y^5} \cdot y^2 \cdot \tan^2 \vartheta \right). \\ \frac{d\alpha}{d\vartheta} &= \frac{r_s}{2y} (\cos \vartheta + 3 \sin^2 \vartheta \cdot \cos \vartheta). \end{aligned} \quad (\text{A1.18})$$

Now the integral over $d\vartheta$ is

$$\alpha = \frac{r_s}{2y} \int (\cos \vartheta + 3 \sin^2 \vartheta \cdot \cos \vartheta) d\vartheta = \frac{r_s}{2y} (\sin \vartheta + \sin^3 \vartheta). \quad (\text{A1.19})$$

The integration limits for ϑ inserted as $\vartheta = -\pi/2$ to $\vartheta = \pi/2$ yields

$$\alpha = \frac{r_s}{2y} \cdot 4 = 4 \cdot \frac{GM}{c^2 y}. \quad (\text{A1.20})$$

This result is the value given in chapter 2

This result is also achieved if using Einstein's general relativity. ((It is obvious from the preceding, that the very challenging way of Einstein is not necessary.))

The numerical result is given in chapter 2 of the main part

We wish to remind that this result corresponds to twice the normal gravitational acceleration and conforms to the observation. It conforms also to the prediction of general relativity – however without any use of general relativity.

Appendix B The Schwarzschild Solution

The Schwarzschild solution is normally deduced by starting with Einstein's field equations and the use of the Riemannian geometry and herewith developing the special solution. We will present here a different deduction. We will start with the physical version of special relativity

and the Basic Particle Model and demonstrate how easily this solution can be deduced from these physical fundamentals.

An elementary particle is, according to the Basic Particle Model, built by two sub-particles orbiting each other. Their temporal behaviour is described by the following equation for the proper time τ of an object at motion eq. (5.1) / chapter 5:

$$\tau = t \cdot \left(1 - \frac{v^2}{c^2}\right)^{1/2}. \quad (\text{B.1})$$

This equation follows from the Basic Particle Model as well as from Einstein's special relativity (i.e. part of the Lorentz transformation).

This equation is now derived with respect to t and then squared and reordered:

$$c^2 \left(\frac{d\tau}{dt}\right)^2 = c^2 - v^2. \quad (\text{B.2})$$

In a gravitational field this time behaviour changes. The understanding of this change directly guides us to the Schwarzschild solution.

We first split the speed into a radial and a tangential component as the Schwarzschild solution is normally given with polar coordinates:

$$c^2 \left(\frac{d\tau}{dt}\right)^2 = c^2 - v_{rad}^2 - v_{tan}^2 \quad (\text{B.3})$$

where v_{rad} and v_{tan} denote the radial and the tangential component of the speed respectively.

Now we have to take into account that the components of c which are c_{rad} and c_{tan} change in a gravitational field according to eq. (A.1) in the following way:

$$c_{rad} \rightarrow c'_{rad} = c_{rad} \cdot \left(1 - \frac{r_s}{r}\right) \quad (\text{B.4})$$

$$c_{tan} \rightarrow c'_{tan} = c_{tan} \cdot \left(1 - \frac{r_s}{r}\right)^{1/2}. \quad (\text{B.5})$$

Here again, to abbreviate the equations, we have used the common definition for the so-called Schwarzschild radius r_s

$$r_s = 2 \cdot \frac{G \cdot M}{c^2}.$$

As a consequence of the change of c depending on the direction, the binding field within a particle contracts and so the size of particles in radial direction in relation to the centre of gravity:

$$r \rightarrow r' = r \cdot \left(1 - \frac{r_s}{r}\right)^{1/2}. \quad (\text{B.6})$$

Now, inside the gravitational field, the following occurs according to (B.4) thru (B.6):

1. The circular motion within the elementary particle changes to an ellipsoidal shape. That means, it is compressed in the radial direction of the gravitational field
2. The speed of the basic particles in the orbit changes from c to a value between c_{rad} and c_{tan} depending on the actual direction of motion.

This unfortunately complicates the calculation of the temporal development.

To solve this, we use a trick here in the way that we change to a modified coordinate system. We define a new radial coordinate \hat{r} in the following way:

$$\hat{r} = r \cdot \left(1 - \frac{r_s}{r}\right)^{-1/2}. \quad (\text{B.7})$$

That has a corresponding derivative with respect to the time

$$\hat{r}' = \hat{v}_{rad} = v_{rad} \left(1 - \frac{r_s}{r}\right)^{-1/2}. \quad (\text{B.8})$$

The coordinate in the tangential direction and so v_{tan} remains unchanged.

In the system of (v_{tan}, \hat{v}_{rad}) we now have the following situation

1. The orbit within the elementary particle is circular again
2. The speed of light is still reduced but now independent of the direction of motion and is

$$c_{grav} = c \cdot \sqrt{1 - \frac{r_s}{r}}$$

where c is here the speed of light outside a gravitational field. c_{grav} replaces c_{rad} and c_{tan} . The duration of the orbital period of the elementary particle is not changed by this coordinate transformation, so we can use it for our calculation.

We can now, in the scope of the alternate coordinate system, write the (Lorentz) equation as

$$c^2 \left(\frac{d\tau}{dt}\right)^2 = c_{grav}^2 - \hat{v}_{rad}^2 - v_{tan}^2. \quad (\text{B.9})$$

Please be aware of the physical meaning of this equation. It describes the extension of the temporal period of the orbit within an elementary particle in a gravitational field.

Now inserting

$$c_{grav} = \sqrt{1 - \frac{r_s}{r}} \cdot c,$$

$$\hat{v}_{rad} = \frac{dr}{dt} \cdot \left(1 - \frac{r_s}{r}\right)^{-1/2} = r' \left(1 - \frac{r_s}{r}\right)^{-1/2},$$

$$v_{tan} = \frac{d\varphi}{dt} \cdot r = \varphi' \cdot r$$

into (B.9) yields

$$\boxed{c^2 \left(\frac{d\tau}{dt}\right)^2 = \left(1 - \frac{r_s}{r}\right) \cdot c^2 - \left(1 - \frac{r_s}{r}\right)^{-1} r'^2 - \varphi'^2 \cdot r^2} \quad (\text{B.10})$$

which is a usual form of the Schwarzschild solution.

Note (1):

The reduction of c in the gravitational field is used here as a fact; it will be explained at another place.

Note (2):

This deduction of the Schwarzschild solution only uses basic mathematics. Neither the Riemannian geometry nor Einstein's field equations are needed.

Appendix C Varying Speed of Light

Equation (A.1):

$$c(r) = c_0 \cdot \left(1 - 2 \cdot \frac{G \cdot M}{r \cdot c_0^2}\right)^p. \quad (\text{C.1})$$

is the basis to explain all phenomena of gravity. Now we have to understand this dependency.

The reduction of c is caused by the exchange particles, which build the binding field of the basic particles (<http://www.ag-physics.org/structure>).

Equation (2.1) is the basis to explain all phenomena of gravity. Next the question has to be answered, why c is reduced in the vicinity of matter. The answer is that the reduction of c is caused by the effect of the exchange particles, which build the binding field of the basic particles.

According to the Basic Particle Model, the binding field is the field of the strong interaction, which is – also according to the model – the universal force in our world affecting all existing particles.

These exchange particles, which cause an attraction or repulsion in a random way, interact as well with every light-like particle. They cause such a particle to be deflected towards the origin of the exchange particle (which is the basic particle) or away from it. So the light-like particle performs a random walk as depicted in figure C.1. As a result the average speed of the light-like particle is reduced, even though the microscopic speed is still the speed of light c .

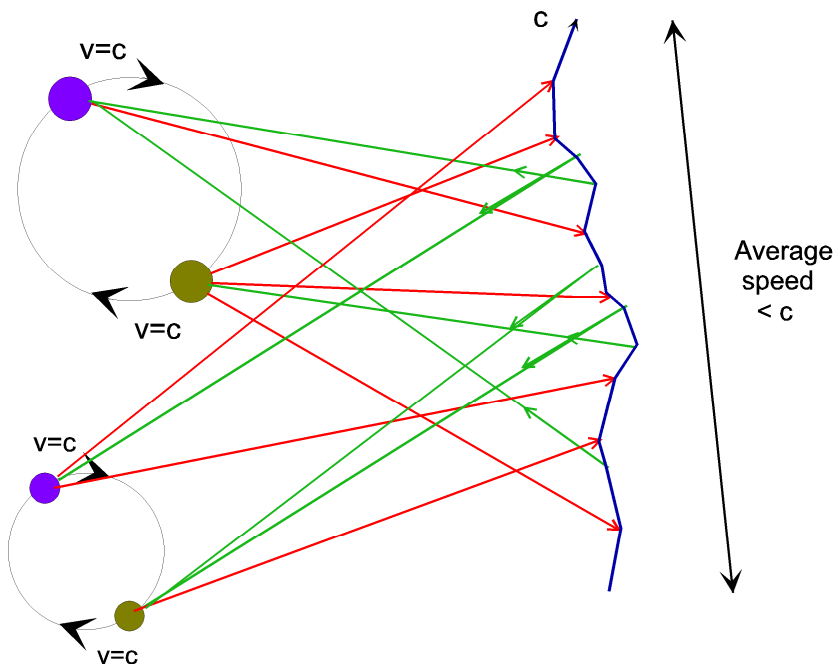


Figure C1: Disturbed way of a light-like particle

According to the Basic Particle Model, the field of every basic particle is built by a similar collection of elementary charges (of the strong field), and is so independent of the elementary particle, to which the basic particle belongs. The same is true for the flow of exchange

particles. Consequently the reduction of c and so the gravitational effect is independent of the elementary particle, which means that it is independent of the size and consequently independent of the mass of the elementary particle. Every elementary particle provides the same contribution to the gravitational field.

This understanding is in contrast to the conventional physics, but it helps to overcome the principle problems of present gravitational physics.

Speed Reduction in Detail

The reduction of c is, as mentioned above, caused by the continuous deflection of the light-like particle. This reduction will now be determined in detail. We will treat here two orthogonal cases in such a way the every arbitrary motion of such a particle is a vector combination of these two cases.

In the case of the tangential motion of a light like particle at speed c , every interaction with an exchange particle coming from the centre of the gravitational field causes a cross speed v , which can be into either side depending on the sign of the exchange particle. This reduces the effective speed of the original motion to the projected value c_{eff} . See figure C2.

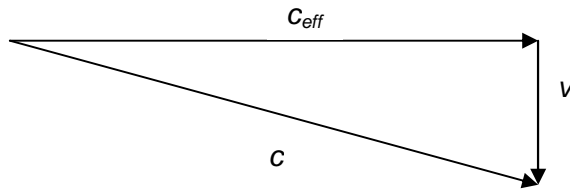


Figure C2: Transverse deflection

The projected effective speed is in this case

$$c_{eff,tan} = \sqrt{c^2 - v^2} \quad \text{or}$$

$$c_{eff,tan} = c \sqrt{1 - \frac{v^2}{c^2}} \tag{C.2}$$

The other case is a light-like particle moving into a radial direction in relation to the centre of gravity. The effective speed is in this case given as follows:

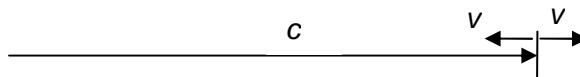


Figure C3: Longitudinal deflection

With an attracting impact of an exchange particle we get for the effective speed over an assumed distance s

$$c_{rad} = c - v$$

and for the travel time over this distance s

$$t_1 = s/(c - v);$$

and correspondingly with a repelling impact

$$t_2 = s/(c + v).$$

The time of both cases averaged:

$$t_{avg} = (t_1 + t_2)/2 = s \cdot \frac{c}{c^2 - v^2}. \quad (C.3)$$

For the effective speed:

$$c_{eff} = \frac{s}{t_{avg}} = \frac{c^2 - v^2}{c} = c \cdot \left(1 - \frac{v^2}{c^2}\right). \quad (C.4)$$

Now for the quantity of the deflection speed v we calculate the following:

The deflection speed is the sum of all single deflection steps which are caused by the exchange particles. The rate of these steps is proportional to the number of particles N in the configuration which builds the gravitational source. But as these events consisting of attracting and repelling pulses are adding up randomly, the resulting deflection is - by the rules of random statistics - the square root of the sum of impacts. So we have

$$v \propto \sqrt{\frac{N}{f(r)}}. \quad (C.5)$$

If inserting eq. (C.5) into the eq. (C.2) and (C.4) we get:

$$c_{eff} = c \cdot \left(1 - g \frac{N}{c^2 \cdot f(r)}\right)^p \quad (C.6)$$

where $p=1$ for radial motion and $p=1/2$ for tangential motion.

The function $f(r)$ comprises several aspects. A basic particle, which is deflected from its original path by the random process described above, is in the longer term guided back to its original path to keep the particle in the average on its path. Further on it is known in the case of photons that particles, which are originally not correlated to each other, get correlated if they move for some time side by side to each other. This behaviour could also be assumed for the exchange particles. This fact will influence the range dependency of the deflection process. The collection of these influences shall be covered by the function $f(r)$.

As we do not have further information or an actual model about these correlation aspects, we go here the way that we adapt the function to the experimentally known result. That means to assume

$$f(r) = r; \quad \text{and so}$$

$$c_{eff} = c \cdot \left(1 - \frac{g \cdot N}{c^2 \cdot r}\right)^p. \quad (C.7)$$

The parameter g is the proportionality factor for the influence of the flow related to N particles.

The dependency of the extension of multi-pole fields in a gravitational field works in an analogue way to the contraction of fields at motion and is not derived here. The result for the reduced distance is as referred to in section 5.2.6

The dependency of the expansion of multi-pole fields in a gravitational field follows from two facts:

1. The propagation speed of the binding field depends on the direction corresponding to (C.1).
2. The binding field is built by a multi-pole configuration of charges which has to have a specific geometrical set up. As a consequence of point 1. the field is deformed in a way that the distance to the multipole minimum of

works in an analogue way to the contraction of fields at motion and is not derived here. The result for the reduced distance is as referred to in section 5.2.6

$$r_{red} = r \cdot \left(1 - \frac{g \cdot N}{c^2 \cdot r}\right)^{(p-1/2)}$$

where again $p=1$ for radial motion and $p=1/2$ for tangential motion.