Relativity and View Effects

Bernard Fischli (ab.fischli@sunrise.ch)
Institution Not Indicated

Article

Keywords: Rest Frames, Ehrenfest Paradox, Lorentz Boosts, relativistic energy

Posted Date: September 16th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-76408/v17

Relativity and View Effects

Bernard A. Fischli

25 rue de Moillebeau, Geneva, Switzerland

e-mail : bernardfischli@gmail.com

Abstract

This paper describes a new interpretation of relativity.

The concept of rest frames of the observer and the object clarifies the initial assumptions used in General Relativity and underlines the necessity to review whatever impacts relativity. Relativistic view effects, calculated using reciprocal Lorentz factors and deflecting the paths of photons, are examined in addition to interactions. The Ehrenfest paradox is solved, and it is not compatible with a curved space. View effects specific to each point of view are the solution. The concept of a seen speed is introduced.

The calculation of the deflection of light by the sun explains in detail why the deflection angle must be double the value obtained with Newton's laws. This is due to gravitation as well as to relativistic view effects. As already noted by Einstein the deflection of light can only take place if the speed of light varies in vacuum. This is done by gravitation.

The compatibility of General Relativity with the new interpretation is discussed. The main argument for this compatibility is due to the use in General Relativity of a Pseudo-Riemannian geometry describing intrinsic views which introduce the rest frame concept. They are compatible with view effects. Differences subsist mainly regarding energy.

Relativistic energy is examined. The relationship of Special Relativity between speed and energy is confirmed for electromagnetism where path speeds are limited to the speed of light. Such speed limits do not apply to gravitation where total energy is composed of rest mass energy plus a kinetic energy as defined in classical mechanics.

When gravitation acts on objects that transfer their path information by light, the paths of the photons will be deflected by relativistic view effects modifying that information. View effects are optical illusions interpreted in General Relativity as interactions introducing dark energy.

1.Introduction

Galileo Galilei introduced the notion of inertial reference frames, to be called inertial frames, where the laws of motion would be valid in a Euclidian space. Newton proposed an absolute inertial frame in uniform motion relative to the stars. Einstein discarded the notion of an absolute inertial frame and developed Special Relativity that describes space transformations keeping the speed of light constant. Inertial frames, as defined in Newton's first law, are reference frames where objects either remain at rest or move at constant velocity unless acted upon by a force.

This paper is focused on relativity which can be explained by starting from the classical description of interactions and then adding the impact of relativity matching the empirical evidence. Interactions valid in a flat space such as Newton's gravitation laws, to be called Newton's laws, will be further examined with an emphasis on gravitation. Electromagnetism will be analyzed when reviewing energy.

An observer is a person or an equipment registering positions and movements in space as recorded by instruments such as an eye or a sensor of a camera or of a telescope or of whatever can record pictures of the impact of light waves or gravitational waves. An observer always observes out of his own rest reference frame, to be called a rest frame. A rest frame {ct,x,y,z} can be interpreted to be an inertial frame relative to a chosen reference, in this case the observer. Thereby, the laws of motion such as Newton's laws refer to the rest frame of the observer. What could be the use of inertial frames not matching the rest frame of the observer? They would represent inertial frames from which no observations would be made.

The observer sees an object. The words seeing and viewing are here synonymous to recording. An object is the subject of the information recorded by an observer, for instance on a photon, a black hole neighborhood, a car, an electron, a point on a wall or whatever else. An observation does not interact with an observed object, but a measure interacts with a measured object.

The observer and the object are represented by their rest frames and the laws of motion describe the relative motions and positions of these rest frames as seen by the observer. Both the observer and the object are located at the origins of their rest frames.

In Special Relativity (1) the rest frame of the observer is $(x^{\alpha}) = (ct, x, y, z)$ and the rest frame of the object is $\{X^{\alpha}\} = \{c\tau, X, Y, Z\}$

t is the time of the clock of the observer and τ is the time of the clock of the object, c is the speed of light. The index α refers to the four variables.

In its rest frame the object always has the position $\{c\tau, 0, 0, 0\}$

Then $\quad \dfrac{d^2X^{\alpha}}{dp^2} = 0 \qquad [1]$

where p is an affine parameter, for example the time τ.

Equation [1] is valid in space and time and can be rewritten as:

$$\frac{d^2X^{\alpha}}{dp^2} = \frac{d}{dp}\left(\frac{\partial X^{\alpha}}{\partial x^{\mu}}\frac{dx^{\mu}}{dp}\right) = 0$$

and results in the equation of General Relativity called the geodesic equation:

$$\frac{d^2x^{\mu}}{dp^2} + \Gamma^{\mu}_{\nu\rho}\frac{dx^{\nu}}{dp}\frac{dx^{\rho}}{dp} = 0 \qquad [2]$$

with $\quad \Gamma^{\mu}_{\nu\rho} = \dfrac{\partial x^{\mu}}{\partial X^{\alpha}}\dfrac{\partial^2 X^{\alpha}}{\partial x^{\nu}\partial x^{\rho}}$

$\Gamma^{\mu}_{\nu\rho}$ is called the Christoffel symbol.

Equation [1] is valid for all points on the path of the object and equation [2] applies to the same path. Equation [2] results from the rest frame concept and is not limited to gravitation.

General Relativity uses intrinsic views introducing the rest frame concept as well as described in the section ''8.On General Relativity''. The prevailing interpretation of relativity considers that equation [2] results from Einstein's equivalence principle and concerns only gravitation as calculated from a curved space with a local curvature described by metric tensors. But due to the rest frame concept, at this stage of the theory, there is no information on the sources impacting space and paths. The sources could be interactions and view effects. Interactions act using forces and by exchanges of energy. View effects modify the paths of photons without using additional forces and exchanges of energy. In what follows, excepted electromagnetism, the interactions shall be as described in classical mechanics including Newton's laws.

A careful choice of the observer may simplify the calculations of interactions. When considering the deflection of light by the sun it is convenient to locate a virtual observer in the center of the sun and the observations shall be transmitted to the final observer usually located on earth.

2.On the importance of the movements of the observer

The importance of the movements of the observer relative to the observed object is explained by simple examples.

Observer one and observer two are standing together. It starts raining and there is no wind. Both see the object, a raindrop, falling on a straight-line path pointing to the center of the earth due to gravitation. Observer one has an umbrella and stays in place. Observer two has no umbrella and decides to walk home at constant speed. He notices that his front side gets more wet than the back and understands that this is a consequence of his speed relative to the raindrops which now follow a straight-line path not pointing to the center of the earth. Observer one still sees the raindrops following straight-line paths pointing to the center of the earth.

Observer two gets increasingly wet. He decides to run home. During the acceleration phase his speed relative to the raindrops progressively increases and so does the slope of his seen raindrop paths. Therefore, observer two sees the raindrops following a curved path. Observer one still sees a straight-line path.

Observer three is the raindrop travelling next to the observed raindrop. They have a relative speed of zero. Observer three sees the other raindrop not moving at all.

The movements of an observer can have a strong impact on the perceived path of the object and the laws of perceived motion of the object must incorporate that impact as done by an observer taking pictures out of his rest frame.

3.On the Ehrenfest paradox

The Ehrenfest paradox is about a disc rotating at constant angular velocity ω and whose circumference is subject to a relativistic length contraction by a reciprocal Lorentz factor $1/\gamma$

$$\frac{1}{\gamma}=\sqrt{1-\frac{(\omega r_d)^2}{c^2}} \qquad [3]$$

when observed from the center of the disc where r_d is the uncontracted radius of the disc and c is the speed of light supposed to be constant in vacuum. In what follows the paradox is a thought experiment. The disc rotates in a room in the presence of furniture to which the reciprocal Lorentz contraction applies as well.

A fixed observer does not rotate with the disc and a rotating observer rotates with the disc. Both are simultaneously located in the center of the disc. The fixed observer observes a contraction of the circumference of the disc but no contraction of the furniture whose speed relative to the fixed observer is zero. Simultaneously the rotating observer observes no contraction of the disc but a contraction of the furniture whose relative speed depends on the angular velocity of the rotating observer. No curved space can explain that. View effects can explain that.

The rotating observer sees a contracted table in the room. The fixed observer sees an uncontracted table. The rotation of an observer cannot contract a table, but view effects can contract the view of a table.

When the rotating observer sees different points on the table the local contraction specific to a point will depend on the speed of that point relative to the rotating observer and that speed depends on the relative distance to the point and on the angular velocity. Therefore, relativistic view contributions must be calculated for each point of view excepted for simple cases such as all the points on the circumference of the disc which are all subject to the same contraction.

A point on the radiusr_d of the disc is shared with the circumference of a circle with a smaller radius r_c centered on the disc. As a curved space is excluded the circumference of that circle is equal to 2π times the radius r_c as observed from the center of the circle. Owing to the circular symmetry of that case a circle remains a circle after relativistic contractions and the proportionality of 2π between the circumference and the radius remains valid.

The fixed observer sees each point on the radius r_d moving at a different speed depending on its distance from the center of the disc. Using that speed, the contraction factor applicable at a point may be as calculated with equation [3]. A point close to the center would have a low path speed and contraction. A point at a greater distance to the center would have a higher path speed and a stronger contraction. An average of the contractions applying to the various points on the radius r_d will always be smaller than the contraction applying to the circumference of the circle with radius r_d which would not respect the proportionality factor of 2π.

A possible solution consists in introducing a factor specific to each circle and representing only the local contribution valid at the point common with the radius of the disc and applicable to the calculation of the overall contraction factor of a circle with radius r_d. The local contribution factor may be called the contribution factor of the circle with radius r_c.

The solution of the Ehrenfest paradox should respect the following conditions:

a) It should be compatible with view effects.
b) The formula of the Lorentz factor introduces a relativistic contraction dependent on the speed of light. This contraction is due to a view effect tied to that factor. Therefore, the solution should use somehow the Lorentz factor.
c) The path speed of the object impacts the relativistic view effects. A higher speed results in a higher contraction.
d) The solution must respect the proportionality factor of 2π between the circumference and the radius of any circular path contracted by a relativistic view effect.

The reciprocal Lorentz factor is proposed as a contribution factor as described above. Determining the overall contraction factor by only using the contraction factor specific to the circumference of the disc would not respect condition d).

The overall contraction factor λ applicable to both the radius and the circumference of the disc, respecting thereby condition d), is obtained by integrating the contribution factors over r_d :

$$\int_0^{r_d} \sqrt{1 - \frac{(r_c \omega)^2}{c^2}}\, dr_c$$

r_d is the uncontracted radius of the disc.
r_c is the uncontracted radius of a circle centered on the disc.
ω is the constant angular velocity of the disc.
v_c is the uncontracted path speed of a point on the circle with radius r_c.
v is the uncontracted path speed of a point on the circumference of the disc.

We have: $\omega = \frac{v}{r_d}$ and $v_c = r_c \omega = v \frac{r_c}{r_d}$ and $\beta = \frac{v}{c}$

$$\int_0^{r_d} \sqrt{1 - \frac{(\beta r_c)^2}{r_d^2}}\, dr_c$$

The equation is solved by substituting r_c with $x = \frac{r_c}{r_d} \beta$

and by substituting x with u and x=sin(u)
and using Euler's formula.

The contracted value of the disc radius is:

$$\left(\frac{1}{\beta} \left(\frac{\arcsin(\beta)}{2} + \frac{\sin(2\arcsin(\beta))}{4} \right) \right) r_d = \lambda r_d \qquad [4]$$

with $0 \le \beta \le 1$ that is with a speed v of no more than the speed of light.

Path speed	*Overall contraction factor*
Speed of light C	$\frac{\pi}{4} = 0.7854$
$\frac{\pi}{12}$C=0.2618 C=78'485'665 meters per second	0.988468

The impact of the overall contraction factor λ is negligible up to speeds very close to the speed of light.

The prevailing interpretation of Special Relativity supposes no contraction of the radius of the disc. Why would the contraction be limited to the circumference of a circle? Point specific view effects solve the paradox. The disc itself never shrinks.

The straight-line going from the observer to the object shall be called a ''line of sight''. A line of sight can be impacted by various contractions as is the case for the radius of the Ehrenfest paradox.

A path subject to view effects can result from any origin such as interactions or movements of the observer. Any contracted infinitesimal path segment keeps the path orientation and direction unchanged. Both the infinitesimal uncontracted and contracted path segments are confined within the same angle of view of the uncontracted segment seen by the observer. The smaller contracted segments are parallel shifted to fit the angle as required to join the neighboring contracted infinitesimal segments. This parallel shift towards the observer keeps the angles of two triangles, each composed of the two sides of the angle of view plus of one of the path segments, unchanged. Therefore, the contraction factor of the path segment applies to the other two triangle sides. For infinitesimal path segments both such sides almost merge with the line of sight to which they apply that factor as a contribution factor specific to the contracted path segment. This is done independently of the respective side lengths and therefore of path orientation and direction.

The speed on a parallel shifted infinitesimal path segment fitting the angle of view is calculated from the uncontracted path speed v linearly reduced to match the position of the related point on the line of sight. This is possible as a speed is determined by the segment length while the same time interval value, measured by the clock of the observer, applies to any such segments fitting the angle. That speed is used to calculate the corresponding contribution factor as done for the Ehrenfest Paradox disc and the overall contraction factor λ of each line of sight can be determined with formula [4] independently of speed orientation and direction. A line of sight contracted as per formula [4] ends at the position of a contracted path point and the seen path is built by all contracted points. View effects result from contractions specific to lines of sight and do not impact angular motions seen by the observer.

Special Relativity supposes a contraction valid only in the direction of the path speed. This implies a contraction factor based on velocity instead of speed. The new interpretation calculates the contractions of lines of sight using speeds independently of their orientation and direction.

A high path speed induces a high overall contraction of the line of sight. This is how the deflection of light by the sun is impacted by relativistic view effects. We record the paths of the past including the impact of relativistic view effects.

What could be retained from Special Relativity? A reciprocal Lorentz factor $1/\gamma$ as equation [3] is used for the calculation of a contracted length and for the determination of contribution factors. In what follows the contribution of Special Relativity will also be based on the examination of Lorentz boosts which are coordinate transformations along the x-axis describing the impact of a constant relative speed v between two reference frames as due to the constraints of the speed of light.

4.On time

A local time difference is a measure of the size of a local change. In classical mechanics the local change is the infinitesimal segment of the path of an object corresponding to the infinitesimal time difference. The path of the object and the times seen and measured in the rest frame of the observer are described by the laws of interactions applying in inertial frames.

In Special Relativity a similar relationship applies to a Lorentz boost:

$$d\tau^2 = -\frac{1}{c^2}ds^2 = dt^2 - \frac{1}{c^2}dx^2$$

τ is the time of the clock moving with the object on the x axis
t is the time of the clock of the observer located on the x axis
x is the space coordinate of the rest frame of the observer applying to the path of the object.
ds^2 is the square of an interval between two events. An event in a four-dimensional reference frame {ct,x,y,z} determines a unique position in space and time.

A relative movement between clocks impacts the difference in clock rates:

$$d\tau^2 - dt^2 = -\frac{1}{c^2}dx^2$$

The following relationships apply to a Lorentz boost where we have $v = {dx}/{dt}$

$$d\tau^2 = dt^2 - \frac{1}{c^2}dx^2 = dt^2\left(1 - \frac{v^2}{c^2}\right) = \frac{1}{\gamma^2}dt^2 \qquad [5]$$

v is the constant relative speed between the clock of the observer and the clock of the object as calculated in the rest frame of the observer before relativistic contractions.

The Lorentz factor γ is:

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Equation [5] introduces a difference in clock rates due to a constant speed v between two clocks with times t and τ. This effect is called velocity time dilation. An observer's clock time interval will always be dilated respective to the clock time interval of the object as the constant speed v results from previous accelerations of unknown origin implicitly supposed to locally impact the clock of the object by decreasing its clock rate relative to the observer's clock.

Clock rates also depend on gravitational time dilation. A gravitational potential impacts the frequency of electromagnetic waves. Atomic clocks measure time by monitoring the frequency of radiation emitted by atoms including the shift due to the gravitational potential.

The clock with the lowest gravitational potential always has the slowest rate. This differentiation is possible as the information on the origin and the value of the local impact on a clock is available.

When measuring time differences between two clocks the clock rate differences will be due to the velocity and gravitational time dilations encountered during the respective trips of the clocks. The total clock times difference depends on the clock times spent with each value of a clock rate as done in 1971 by Haefele and Keating (2) who recorded a time difference on two flights around the world and their measures matched predictions with an accuracy of about 10%. The satellites of the Global Positioning System GPS are the continuous empirical evidence that different clock rates impact the performance of the system.

The formula $1/\gamma$ of the contribution factors applying to the calculation of lines of sight and therefore to view effects is also used for velocity time dilation. We have from [5]:

$$d\tau = \frac{1}{\gamma}dt$$

The relative lengths of the uncontracted and the contracted infinitesimal path segments dL and dL_c can be calculated by using the reciprocal Lorentz factor ${1}/{\gamma}$ as done for length contraction in the Ehrenfest paradox:

$$dL_c = \frac{1}{\gamma}dL$$

Velocity time dilations and contracted segment lengths have the same contraction factor values. This is a consequence of the fact that both concern the path of the object. Their contraction factors represent the impact of the same constraint of the speed of light at the same path location. Clock times are independent of lines of sight as a clock is both its observer and object.

A time difference between two clocks results from different local impacts of the clock paths. View effects impact time differences only if the corresponding information is delivered by light. All this supposes that Lorentz transformations apply.

5.On Lorentz transformations

Relativistic view effects impact the perception of the path of the object. The path originates from the laws of interactions combined with the contributions from the relative movements between the observer and the object and provides the initial conditions applying to the calculations of the view effects.

In a Lorentz boost the observer is located on the x axis where the object advances at constant relative speed v. When the observer is not located on that path, the relativistic view effects result in a parallel shift towards the observer. As per equation [4] the constant path speed applies the same overall contraction factor λ to all lines of sight and produces the shift. The infinitesimal segment lengths dL are all contracted by the same factor λ as well:

$$dL_c = \lambda dL$$

with dL_c and dL as previously defined.

An observer registers the movements of the object represented by a succession of path points whose lines of sight are contracted by relativistic view effects. The information received by the observer is mostly limited to the observation of the contracted path of the object. He often does not know what the object's clock indicates and must use his own clock to calculate a ''seen speed'' v_s of the object. The ''seen speed'' is the speed along the contracted path as recorded by the observer.

The seen speed v_s valid in this case is constant and independent of the frequency of the photon delivering an object path information on a line of sight. It is:

$$v_s = \frac{dL_c}{dt} = \lambda \frac{dL}{dt} = \lambda v$$

v is the constant speed of the object as described above with $v = {dL}/{dt}$. This formula is equivalent to $v = {dx}/{dt}$ as both relate to uncontracted values valid in the rest frame of an observer located on the x axis.

t is the time of the clock of the observer.

A seen speed v_s is always smaller than a positive real speed v as λ is then smaller than one.

A redshift on a line of sight is measured at the location of the observer where a local contribution factor with a value of one applies. Therefore, redshifts are not impacted by relativistic view effects. They represent the uncontracted relative speed between the observer and the object.

In Special Relativity the three space components v_f^α of the four-velocity are defined as the division of each infinitesimal not contracted segments dx^α, not seen by the observer, by the infinitesimal clock time $d\tau$, not delivered by stars. For a Lorentz boost the following formula applies to the x space coordinate:

$$v_f = \frac{dx}{d\tau} = \frac{dx}{{dt}/{\gamma}} = \frac{dx}{dt}\gamma = v\gamma$$

τ is the time of the clock of the object

What should be interpreted as the real speed is the speed v valid in the same Lorentz boost where the following relations apply to speeds v and v_s:

$$v = v_f \sqrt{1 - \frac{v^2}{c^2}} = \sqrt{\frac{1}{\frac{1}{v_f^2} + \frac{1}{c^2}}}$$

and $$v_f = \sqrt{\frac{1}{\frac{1}{v^2} - \frac{1}{c^2}}}$$

with the following values:

v	v_f
0.0995 C	0.1 C
0.4472 C	0.5 C
0.7071 C	C
0.8944 C	2 C
0.99995 C	10 C
C	∞

That the space component of the four-velocity may have an infinite value when the path speed is the speed of light requires further examination detailed in the section ''9.On energy and speed''.

Relativistic view effects are specific to observations. When swapping the roles of the observer and the object a length contraction is always seen by the one chosen as observer.

6.Examples of relativistic view effects

As calculated for the Ehrenfest paradox and due to view effects, the fixed observer located in the disc center sees a disc size smaller than the actual size.

Particle accelerators such as the CERN and Fermilab subject particle paths to relativistic constraints. Particles rotating clockwise collide with particles rotating anticlockwise when the requested speed is reached. The particles are the objects. The measures are done by detectors placed where the particles collide, and no relativistic view effects apply.

Relativistic view effects depend on the speed v of an object. That speed results from interactions and from the movements of the observer relative to the object. These movements contribute to the view effects by impacting the path speed used to calculate the contribution factors. An example is the rotation of the observer or of the disc as described for the Ehrenfest paradox. Observations made on earth include view effects due to the earth's rotation. The nearest star is Proxima Centauri at 4.244 light years and the contribution of the earth's rotation to the path speed is of 9740 times the speed of light whenever the observer does not compensate that rotation.

Stars are observed on earth to move on a circular path due to the rotation. This cannot be explained by Special Relativity that assumes an object's path contracted to a point in the center of the rest frame of the observer when the path speed reaches the speed of light. But such a path is compatible with a contraction of the line of sight by a factor of $\pi/4$. Contribution factors valid at points on the line of sight with speeds above the speed of light should have a value of zero and result in a smaller overall contraction factor.

Information delivered by light will not reach the observer whenever the speed relative to the object will be higher than the speed of light as described in the section ''10. On empirical evidence''. This does not apply to the path of stars seen from earth where the path speed is perpendicular to the line of sight. Furthermore, the telescopes for professional use are mounted since decades in a configuration with computerized tracking to compensate for rotations of any origin.

7.On the deflection of light by the sun

Bending of light by the sun has been an iconic case establishing Einstein as the foremost scientist in the new relativistic world of the early 20th century. The calculations of the deflection angle by Cavendish date back to the late 18th century and Soldner published in 1804 a more detailed analysis. The resulting deflection had about half the value determined by Einstein in 1915 using General Relativity.

Travelling on a straight-line path, the light particle called photon is attracted to the sun, but its high speed provides an escape after an exceedingly small deflection. A simple calculation is detailed in mathpages (3).

Expressed in a reference frame with the sun and the virtual observer located at the origin and the photon moving on an almost straight-line parallel to the x-axis with $y = r_0$ at $x = 0$, r_0 being the radius of the sun, the path deviation of the photon is, when supposing a uniform rate of acceleration a in the direction of the y axis:

$$y(t) = y_0 + v_0 t + \frac{1}{2} a t^2$$

t is the time
y_0 is the initial position
v_0 is the initial speed in the direction of the y axis

For an almost constant speed of the photon the time can be approximated by

$$t \approx \frac{x}{c}$$

c is the speed of light in vacuum with a value of 299 792 458 meters per second

We have:

$$\frac{dy}{dx} = \frac{v_0}{c} + \frac{a}{c^2} x = \tan(\theta)$$

θ is the angular coordinate with, for very small angles: $\tan(\theta) \approx \theta$

The gravitational acceleration calculated with Newton's law is:

$$a = \frac{MG}{r^2} \frac{r_0}{r}$$

where M is the mass of the sun, r is the distance from the center of the sun to the photon and G is the gravitational constant. The term $\frac{r_0}{r}$ is added to obtain the acceleration transverse to the path.

Then:

$$\frac{d\theta}{dx}=\frac{d}{dx}\left(\frac{dy}{dx}\right)=\frac{a}{c^2}=\frac{MGr_0}{c^2r^3}$$

With $r^2=r_0^2+x^2$ the deflection angle α of the photon results:

$$\int_{-\infty}^{+\infty}\frac{MGr_0}{c^2\left(r_0^2+x^2\right)^{1.5}}dx=\frac{2MG}{c^2r_0}=0.8754 \text{ arcseconds} \approx \alpha$$

mathpages (3) goes on to a more rigorous approach based on a hyperbolic path with varying photon speeds. Compared to the previous simple calculation this adds terms of a Taylor series with corrections of about $2*10^{-6}$ arcseconds, a negligible amount.

As seen by the virtual observer located in the center of the sun, the contributions of the relativistic view effects to the deflection of light by the sun must match the non-relativistic path calculated with Newton's gravitation law. Starting from a straight-line path accelerated due to gravitation, view effects add a bending of the line respecting the initial conditions given by the speeds valid at each path point. These speeds impose strong constraints to the determination of the bending and enforce its calculation using Newton's laws.

Given its sufficient accuracy, the same straight-line approach described above can be used to determine the view effects. A straight-line with path point speeds equal to those valid for gravitation and seen by the same observer will be bent by view effects to the same deflection angle and the same acceleration required to match the same straight-line speeds as with gravitation. The total deflection angle will therefore be double the angle calculated from Newton's laws. The added deflection of the photon can be compared to the impact of a curved mirror on the transfer of information by light. About $4*10^{-6}$ arcseconds must be added to the double of the value calculated with the above approximation. This result is compatible with the empirical evidence described in (4). In this calculation a photon is simultaneously the object and the information provider.

Starting from the path due to an interaction as seen in the rest frame of the observer, the additional deflection angle originating from view effects can also be obtained by selecting enough path points, calculating the contraction factor λ of each line of sight using equation [4] with the path speed v valid at the considered point and interpolating between the contracted points. Such a matching of the speed and acceleration due to Newton's law is like the approach described above. This method applies to any path with speeds of no more than the speed of light. For path speeds higher than light, points on the lines of sight moving faster than light should have contribution factors of zero value.

The acceleration of the photon induces changes in the contribution factors. As a contraction of the length of a straight-line path cannot bend a path by itself the bending is due to the contraction of the lines of sight. As the speed of light never reaches infinity an accelerated object advancing on a straight line is observed as advancing on a bent line due to a view effect.

The deflection due to view effects is a consequence of the fact that such relativistic effects come on top of the initial conditions resulting from gravitation and that they can be calculated, up to negligible terms for this special case, as an additional bending of an accelerated straight-line path. This has the added advantage to explain the doubling of the deflection angle.

A more detailed description results from a decomposition of the hyperbolic path of the photon.

The impact parameter b determines the shortest distance from the center of the sun, where the virtual observer is located, to each of the asymptotes of the hyperbola, with:

$$b = -a\sqrt{(e^2 - 1)}$$

a is the semi-major axis that can be approximated by $a \approx -\frac{\mu}{c^2}$

where c is the speed of light and μ is the standard gravitational parameter with, for the sun:

$$\mu = 1.3271244 \cdot 10^{20} \frac{m^3}{\sec^2}$$

e is the eccentricity with, as calculated in (5):

$e \approx \frac{c^2 r_0}{GM} = 4.711 \cdot 10^5$ with c, G, M and r_0 as previously defined

The impact parameter b has a calculated value of $6.951 \cdot 10^8$meters for both asymptotes, to be compared with a sun radius of $6.957 \cdot 10^8$meters.

The distance of closest approach is the periapsis distance r_p with:

$r_p \approx a(1 - e) = 6.95638 \cdot 10^8$meters

As the radius of the sun, the impact parameter and the periapsis distance have almost the same value, the hyperbolic path of the photon can be described by the incoming asymptote up to its nearest point to the sun, to be called the impact point, then by a circular path ending at the impact point of the outgoing asymptote and finally by the outgoing asymptote. This is only possible as the hyperbolic path in an almost straight-line.

In gravitation the photon is accelerated in the straight-line path of the incoming asymptote and decelerated in the straight-line path of the outgoing asymptote. These accelerated and then decelerated straight-lines produce the contribution of the view effects to the total deflection angle as described above.

In the circular path between the two impact points the force of gravitation is perpendicular to the path of the photon, keeping thereby the path speed constant. The circular path will be impacted by a constant contraction factor keeping after contraction the angle of deflection between the impact points as calculated from gravitation. The relativistic view effect for a circular path will only confirm the deflection value due to gravitation without adding any contribution.

The speed of light in vacuum has always the same value when measured in reference frames with constant speed relative to the observer. This does not apply when a photon is accelerated due to gravitation as seen in the rest frame of the virtual observer.

Einstein wrote on page 89 of his 1920 book on relativity (6):

Quote
…according to the general theory of relativity, the law of the constancy of the velocity of light in vacuo, which constitutes one of the two fundamental assumptions in the special theory of relativity and to which we have already frequently referred, cannot claim any unlimited validity. A curvature of rays of light can only take place when the velocity of propagation of light varies with position.
Unquote

This is the case due to gravitation as well as to relativistic view effects since a non-accelerated straight-line path is parallel shifted without any bending of the path.

Variations in the speed of light are compatible with relativistic view effects but points on the lines of sight moving faster than light should have contribution factors of zero value.

The orbital speed of the earth around the sun is if of about 29'780 m/s. It is too small to impact the deflection angle of the photon seen from earth. The final observer measures the difference between the angular position of the photon received directly from the source and the one after bending by the sun and view effects. The result is independent of the rotation of the earth and the deflection angle will be as seen by the virtual observer.

A photon has no rest mass. According to Newton's second law:

$$f = ma$$

with f being the force, m the mass and a the acceleration, a photon may be accelerated to infinity at the slightest impact of a force. However, this equation can only be fully interpreted if the considered force is detailed in the equation.

The acceleration due to gravitation, calculated with Newton's laws, valid if one mass is much larger than the other and when observed from the center of the larger mass M_0 , is:

$$a = \frac{GM_0}{r^2}\vec{r}_u$$

a is the acceleration of the small mass
G is the gravitational constant
r is the distance between the centers of the two masses
$\vec{r}_u$ is the unit vector in the direction of the larger mass

This is the acceleration used at the beginning of this section. It does not depend on the mass of a photon deflected by the sun. It depends only on the mass of the sun and on the distance to the center of the sun.

A photon will never reach an infinite speed when deflected. On the path from the periapsis point to the final observer the photon is decelerated as it is attracted to the sun and will reach again the speed c valid in vacuum when the attraction to the sun becomes negligible.

8.On General Relativity

General relativity has the best matching of empirical evidence concerning gravitation and is considered as a monument in physics. The possible drawback is its opacity which blurs the interpretation of the theory behind thick mathematical smoke. The curved space that justified the theory being invalidated; the question is raised whether the new interpretation could put the theory on more solid ground.

Einstein's famous equation of General Relativity is:

$$E^{\mu\nu} = \frac{8\pi G}{c^4}T^{\mu\nu}$$

$E^{\mu\nu}$is the Einstein tensor and $T^{\mu\nu}$is the stress-energy tensor.

The Einstein tensor expresses curvatures in a pseudo-Riemannian manifold and depends on derivatives of first and second order as is in general the case for the equations used in physics (7) for flat spaces. The relativistic constraints are introduced by locally applying a Minkowski metric representing the impact of Lorentz transformations on space.

Newton's gravitation laws are valid in a flat space and use forces. A Newtonian potential is a representation of the potential impact of forces. General Relativity supposes a space curved by a Newtonian potential resulting in geodesic paths. A space curvature is another way to represent the impact of the same forces. The geodesic equation [2] originates from the rest frame concept and applies to both the flat Minkowski space of Special Relativity and the curved space of General Relativity. Therefore, it seems reasonable to assume that both approaches could be valid and that the paths calculated in General Relativity could be equivalent to those calculated in a flat space.

General Relativity uses a Newtonian gravitational potential for the approximations made in the calculations of weak and slowly variable fields (1). Why should Newton's laws curve the space? They could be considered to introduce gravitation in the flat space of the rest frame of the observer. The same comment applies to the Schwarzschild metric of objects whose mass distribution respects a spherical symmetry. The Schwarzschild metric is extensively used to describe the characteristics of black holes. Michell and Laplace had already proposed the existence of black holes in the late 18^{th} century. The description of gravitational waves also makes extensive use of Newtonian notions (1). All this is interpreted here as Einstein's choice of Newton's laws for gravitation with an added theoretical layer to include relativistic view effects.

The main argument for the equivalence of the two approaches results from the use of a pseudo-Riemannian geometry in General Relativity. That geometry is intrinsic. It describes what an observer located anywhere in the existing space will record, in contrast to an extrinsic point of view where the observer is in a space of higher dimension. In other words, a pseudo-Riemannian geometry introduces view effects of all sorts and could be compatible with relativistic view effects. The rest frame concept introduces intrinsic views as well. Moreover, the geometry applies the same gravitational potential formula independently on whether space is flat or curved.

General Relativity calculates the path of the object in the rest frame of the observer by using a Newtonian gravitational potential providing the initial conditions for the relativistic view effects. Intrinsic views of a pseudo-Riemannian geometry adapt the length and orientation of a line of sight to match a path point. The corresponding relativistic constraints result in a contraction of the line and modify the path seen by the observer.

Does General Relativity match the results of the new interpretation by locally applying a Minkowski metric, originally valid in a flat space, to metric tensors and therefore to space and to lines of sight as done by view effects using relativistic contribution factors? This would explain why both give the same value for the deflection of light. However, the impact of rotations on relativistic views may not have always been considered with General Relativity but should be examined and clarified. Calculations relating to a virtual observer must be corrected if necessary to fit the real observer and General Relativity may include curved space solutions not compatible with a flat space.

As mentioned in his 1920 book on relativity (6), Einstein found that, according to General Relativity, the law of the constancy of the speed of light in vacuum cannot claim any unlimited validity and that a curvature of rays of light can only take place when the velocity of propagation of light varies with position. This implies that the combined impacts of metric tensors and the Newtonian gravitational potential result in a violation of the constancy of the speed of light in vacuum.

The new interpretation retains that the laws of nature apply to the rest frame of the observer, but General Relativity introduces gravitation using local inertial reference frames. A closer examination is required to sort out where General Relativity and the new interpretation produce the same results and where they do not. Of concern are the impacts of view effects on energy and of contribution factors on gravitational paths.

9.On Energy

The relativistic energy-momentum equation of Special Relativity and valid for electromagnetism and gravitation is:

$$E_t^2 = m_0^2 c^4 + p^2 c^2 \qquad [6]$$

E_t is the total relativistic energy

m_0 is the rest mass of the object

c is the speed of light

p is the magnitude of the three-dimensional relativistic momentum of the object with:

$$p^i = \frac{m_0 v^i}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}} = m_0 v^i \gamma$$

v^i is the space component i of the path speed v previously defined.

The term $m_0 c^2$ represents the energy content of the mass of the object at rest. The term $p^2 c^2$ represents the contribution of relativistic kinetic energy. The relativistic kinetic energy is defined relative to an observer. The rest mass energy does not depend on a path speed and is not impacted by relativistic view effects.

Transformation rules were introduced to account for the empirical evidence on the speed of light which remains unchanged when measured in reference frames with a constant speed relative to the observer. These rules were applied to space, forces and energy using a Lorentz factor γ.

Many experiments were conducted to confirm the relativistic relations using electromagnetic forces and measuring in particular the Lorentz factor γ

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

which also applies to the calculation of relativistic contractions.

One of the most accurate measurements was conducted by Meyer et al (8). The expression

$$Y = \frac{m/m_0}{\sqrt{\left(1 - \frac{p^2}{m_0^2 c^2}\right)}}$$

originates from the Lorentz factor γ and has a calculated value of 1.

The relativistic mass m is defined by: $m = \gamma m_0$ and p by: $p = m_0 v \gamma$

The experimental set-up consisted in deflecting relativistic electrons on a path where the electrons were first deflected by magnetic forces and then by electrostatic forces. The electrostatic forces were adjusted until the electrons could be detected by the sensor and the electrostatic deflector was then calibrated using protons.

The measured mean value was: $Y = 1.00037 \pm 0.00036$

Many other experimental approaches have been conducted. They include relativistic measures related to electromagnetism whenever the corresponding forces have been used in the set-up. The important result is that the empirical evidence confirms the Lorentz factor. This has a consequence. The reciprocal Lorentz factors used in the section ''3.On the Ehrenfest paradox'' are related to electromagnetism.

Special Relativity defines energy using the following formula:

$$E_t = \frac{m_0 c^2}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}} = \gamma m_0 c^2 \qquad [7]$$

Equations [6] and [7] are equivalent and each can be calculated from the other equation.

Equation [7] is more compact and therefore more difficult to understand. It is usually interpreted as meaning that the speed of an object is limited to the speed of light except for trivial cases where no energy is transferred and that the total energy increases towards infinity the closer the path speed gets to the speed of light. This traditional interpretation must be closely examined given the arguments detailed in this paper.

Photons travel at the speed of light. As confirmed by experiments (9), electrons have an upper speed limit which is the speed of light. Given the evidence gathered in accelerators, this particularity can be extended to all particles impacted by electromagnetism, and these cannot exceed the prevailing speed limit whatever the energy input may be. Moreover, the relationship of Special Relativity between speed and kinetic energy was measured and confirmed (10) as well. These results were obtained using electromagnetic forces. Therefore, the energy equations [6] and [7], which depend on the Lorentz factor, apply to electromagnetic interactions.

No laboratory measures confirm the validity of Lorentz factors with gravitation, and this casts doubt on the pertaining energy formula.

As described for the Ehrenfest paradox, a rotation of the disc produces relativistic view effects with contraction values depending on the path speed v. The same view effects can be obtained with a fixed disc and a rotating observer. A rotating observer will observe stars moving with a path speed of many times the speed of light. How could the rotation of an observer be the source of an infinite amount of energy when the path speed reaches the speed of light? A rotation of an observer cannot be that. View effects due to the rotation of an observer cannot provide any energy modifying the path of an object but they impact the view of a path.

The supposition that a path speed v originating from whatever source should always respect the law of the constancy of the speed of light in vacuum is due to an interpretation of equation [7] which must be subjected to a more detailed analysis.

The total relativistic energy E_t can be expanded in a Maclaurin series:

$$E_t = m_0 c^2 + \frac{1}{2} m_0 v^2 + m_0 c^2 \left\{ \frac{3}{8}\left(\frac{v}{c}\right)^4 + \frac{5}{16}\left(\frac{v}{c}\right)^6 + \cdots \right\}$$

The term $m_0 c^2$ is the rest mass energy and $\frac{1}{2} m_0 v^2$ is energy as generally used in classical mechanics. The other terms in powers of $\frac{v}{c}$ starting from $\left(\frac{v}{c}\right)^4$ depend on the ratio of the path speed to the speed of light and must be examined.

Let us examine equation [7]. That equation:

$$E_t = \frac{m_0 c^2}{\sqrt{1-\frac{v^2}{c^2}}} = \gamma m_0 c^2$$

gives a complex number with an imaginary part if the fraction v/c is greater than one, thereby limiting the speed v to no more than the speed of light. However, the terms of the Maclaurin series including the fraction v/c originate from the use of a Lorentz factor γ valid for the energy of electromagnetism where it represents the impact of the limitations in the speed of light. The first two terms of the Maclaurin series are:

$$m_0 c^2 + \frac{1}{2} m_0 v^2$$

$m_0 c^2$ is the rest mass energy and $\frac{1}{2} m_0 v^2$ is the kinetic energy specific to the observer and they should remain valid in gravitation. Do terms in v/c apply to gravitation?

In his 1905 paper (11) introducing Special Relativity, Einstein calculated the energy formula valid for electromagnetism starting from Maxwell's equations and then applying a Lorentz boost to the forces. Regarding his calculation of the relativistic mass, the English translation mentions on page 22:

Quote
We remark that these results as to the mass are also valid for ponderable material points, because a ponderable material point can be made into an electron (in our sense of the word) by the addition of an electric charge, no matter how small.
Unquote

He then applied the same argument to ''kinetic energy'' being the work calculated with such a modified electrostatic force accelerating an electron. That energy corresponds to the total energy E_t of equation [6] less the rest mass energy.

Einstein's argument is not a proof. Furthermore, how could an energy calculated starting from Maxwell's equations apply to gravitation knowing that the electrostatic forces used for the determination of energy can be up to $4 \cdot 10^{40}$ times stronger than gravitational forces? General Relativity calculates the supposed curved space starting from a Newtonian gravitational potential which is not compatible with Maxwell's equations. Therefore, the energy formula of electromagnetism should not apply to gravitation. The empirical evidence must be further examined to solve this case.

As detailed in section ''3.On the Ehrenfest paradox'', relativistic view effects deflect photons without using forces and exchanges of energy and are not compatible with a curved space.

The relativistic energy-momentum equation [6] is calculated using the path speed v with no need to introduce additional variables such as the three space components of the four velocity v_f which describe a velocity with no meaning in physics. They do not represent a seen speed v_s either which is computed as described in section ''5.On Lorentz boosts''.

Calculations are always done in the rest frame of the observer and an energy impacting the observer will be assigned to an impact on an object if that impact is equivalent to a difference in potential energy between the observer and the object. A rotation of an observer has no impact on energy, but it induces view effects specific to the observer.

10.On dark energy and the speed of light

Empirical evidence has traditionally been considered as the supreme test of any theory in physics but will not represent the fundamental laws of nature whenever view effects result in a deformation of reality. Relativistic view effects are new to physics and their impact must be analyzed.

Electromagnetic forces are negligeable in the universe scale as positive and negative charges cancel out over large distances where gravitation rules. The Planck Collaboration (12) found results that suggest our universe is spatially flat to a one σ accuracy of 0.2%.

An upper speed limit remaining unchanged in vacuum when calculated in any reference frame with a constant speed relative to the observer and valid for electromagnetism implies that a photon cannot be accelerated above the speed of light c when subjected to electromagnetic forces as otherwise no upper speed limit would be valid. These constraints are incorporated in the related energy formula [7] by applying a Lorentz factor γ to the formula.

Einstein wrote (6) that the law of the constancy of the velocity of light cannot claim any unlimited validity and that a curvature of light can only take place if the speed of light varies with position, in other words if a photon is accelerated or decelerated. This is done by Newton's gravitation laws which calculate the deflection of light by the sun matching the empirical evidence (4) and signifies that these laws are not concerned by the speed limit applicable to electromagnetism. Therefore, the terms including the fraction v/c in the Maclaurin series of the relativistic energy E_t do not apply to gravitation. The total energy E_g valid for gravitation is then given by:

$$E_g = m_0 c^2 + \frac{1}{2} m_0 v^2 \qquad [8]$$

This means that the calculation of dark energy shall be reviewed by applying the correct energy formula for gravitation and by discarding view effects as they do not contribute to energy.

General Relativity implies that relativistic contribution factors apply to each location in space. In that space a Newtonian gravitational potential is introduced. Both the resulting paths of the objects and the paths of the photons delivering the path information to the observer are modified by the local contribution factors. The impact on information delivery results in view effects which are optical illusions. The view effects are then interpreted by General Relativity as originating from some sort of interaction with a corresponding energy called dark energy.

The gravitational binding energy U of a mass M is the minimum energy calculated with Newton's laws as required to gradually extract its components from the remaining gravitational field until no such field subsists. Such an energy, with and without dark energy, can be determined starting from the deflection of light by the sun using the deflection angle α:

$$\alpha \approx \frac{2MG}{c^2 r_0} = 0.8754 \text{ arcsecond}$$

M, G, c and r_0 are as defined in the section ''7.On the deflection of light by the sun''.

Relativistic view effects double the angle α. When supposing that this increase of the angle originates from Newton's laws instead of view effects we have:

$$2\alpha \approx \frac{2(2M)G}{c^2 r_0}$$

The same total deflection angle of 2α is obtained from Newton's laws by supposing a solar mass twice as important and this is valid for a symmetric spherical body as the sun for which the forces act as if the mass was concentrated in the center of the sphere.

When assuming a constant density of the mass M of a sphere with radius R, the gravitational binding energy U_M of the sphere is:

$$U_M = -\frac{3GM^2}{5R}$$

With a mass of $2M$ we have:

$$U_{2M} = -\frac{12GM^2}{5R} = 4U_M$$

The gravitational binding energy U_M calculated with Newton's laws for a mass of one M represents 25% of the total gravitational binding energy U_{2M} which adds the supposed impact of view effects as calculated with Newton's laws for a mass of two M, introducing dark energy. Optical illusions as view effects cannot be the origin of additional energy and dark energy does not exist.

The Supernova Cosmology Project (CSP) led by Saul Perlmutter (13) determined a share of 30% for mass energy and of 70% for vacuum energy. Vacuum energy can be interpreted as originating from view effects and mass energy as originating from Newton's gravitation laws. That the CSP found a percentage of 30% instead of 25% for the new interpretation was to be expected as General Relativity implies that contribution factors apply to space and therefore also to gravitational paths, increasing thereby the energy share of 25% attributed to Newton's laws.

The Lorentz transformations used by contribution factors do not impact gravitational paths as they do not concern gravitation. Otherwise, gravitation could not accelerate photons. However, when gravitation acts on objects that transfer their path information by photons, the paths of these photons will be deflected as described by view effects, modifying thereby the information.

A photon is limited to the speed of light c except when accelerated by gravitation. However, on very short distances, electrostatic forces are about $4 \cdot 10^{40}$ times stronger than gravitational forces whose impact on the photon speed is usually very limited unless acted upon by major objects of the universe and a photon will be decelerated back to speed c when leaving the gravitational potential of the object. Consequently, calculations of relativistic view effects should remain valid in most cases for observations of planets and stars excluding both black holes and the big bang which have strong impacts on photon speeds. Whenever light significantly exceeds the speed c, the calculation of the view effects may still be done with formula [4] using the light speed valid at the considered location and contribution factors of zero value at points on the line of sight with speeds faster than light.

Lorentz factors do not relate to gravitation where Galilean transformations apply. Electromagnetism relates to Lorentz factors and Lorentz transformations apply. Both types of transformations are valid in the flat rest frame of the observer. In that frame a photon travels in vacuum at the speed of light c corrected due to the impact of gravitation which uses Galilean transformations. Relativistic view effects result from photon paths modified by overall contractions of lines of sight. These rules have been employed to calculate the deflection of light by the sun. Furthermore, gravitational time dilation is empirical evidence of the effects of gravitation on electromagnetic waves.

When calculated in the rest frame of observer one emitting light signals, such signals will be limited to the prevailing speed of light and never reach observer two located on an object impacted by gravitation and resulting in a speed higher than light relative to observer one. Consequently, observer one and observer two will be mutually invisible. When information on the positions is limited to a transmission by light neither of these observers can record relative speeds higher than the prevailing speed of light. Object with speeds higher than light remain visible when their speed relative to an observer is smaller than the prevailing speed of light.

The rotation of the earth and movements of the observer impact the speed of objects relative to the observer. Such contributions to the speed do not represent real movements of an object and they must be sorted out from the speed v to get meaningful data on paths and energy.

Curved space solutions not compatible with a flat space should be excluded.

The cosmic distance ladder must account for relativistic view effects.

The sun produces only a limited acceleration on a nearby object. A black hole has a stronger impact. The strongest impact results close to the big bang as soon as Newtonian gravitation applies and results in extremely high relative speeds. Newtonian gravitation laws are valid on the photon scale and may help validate the inflation period. Invisible objects described above contribute to the dark matter content. Some invisible matter could have been absorbed by black holes. The impact on cosmology of speeds higher than the speed of light of objects subject to extreme forces and amounts of energy, such as due to black holes and to the big bang, remains to be determined.

11.On Relativity and Quantum effects

Particle accelerators use electromagnetic forces. Accelerations to speeds close to the speed of light produce high energy collisions resulting in decays of highly energetic particles as described by the Standard Model. An ever more important share of the energy provided by the accelerators is absorbed by the particles the closer they get to the speed of light. The remaining energy is transformed in kinetic energy of the particles until, at the speed of light, the energy would be completely absorbed by the particles themselves. Particles absorb kinetic energy as well during collisions. No particle may travel faster than at the speed of light under these conditions as per equation [7] an infinite supply of total energy to the particle is required to reach that speed. The energy for the collisions is delivered by electromagnetic forces and quantum electrodynamics is the link to the Standard Model.

The total relativistic energy E_t of electromagnetism is empirical evidence (10) and its Maclaurin series:

$$E_t = \gamma m_0 c^2 = m_0 c^2 + \frac{1}{2} m_0 v^2 + m_0 c^2 \left\{ \frac{3}{8}\left(\frac{v}{c}\right)^4 + \frac{5}{16}\left(\frac{v}{c}\right)^6 + \cdots \right\} \quad [9]$$

describes the respective roles of rest mass energy, kinetic energy and energy absorbed by particles due to quantum effects. The energy supplied by the accelerators is transformed into other representations of energy each impacting the particle as recorded by the observer. Terms in v/c of the Maclaurin series represent neither a speed nor a velocity of the object. They determine the share of supplied energy transformed in absorption energy.

Particles with a rest mass and a charge such as electrons are subjected to both kinetic and absorption energy when being impacted by electromagnetic forces. Their relativistic mass should be calculated using only absorption energy.

The constraints of the speed of light do not relate to gravitation which acts on kinetic energy but excludes absorption energy.

Gravitation accelerates photons to speeds higher than the speed of light c in vacuum, resulting in kinetic energy relative to an observer located for example in the center of a mass as described for the deflection of light by the sun. This changes the relative speed and thereby the frequency of photons measured by the observer as due to Doppler effects. The kinetic energy specific to that gravitational acceleration is calculated from the resulting frequency shift of the photon.

The total gravitational energy E_g for objects with a mass is given by:

$$E_g = m_0 c^2 + \frac{1}{2} m_0 v^2$$

The calculation of the deflection of light by the sun uses only Newtonian gravitation as electromagnetic forces cannot accelerate a photon above the speed of light. Newtonian gravitation laws are independent of photon frequency. The frequencies of electromagnetic waves range from 10^4 to 10^{24} hertz and photon energy is linearly dependent on frequency. In General Relativity energy is supposed to curve the space and thereby impact the deflection of light. The empirical evidence (4) of the deflection of light by the sun, which is accurate up to about 10^{-5} arcseconds, detects no dependency on frequency but the impact may be too small to be detected. The new interpretation uses Newton's laws and considers that no such dependency applies.

12.On inertial mass

Interactions of any kind use exchanges of energy including kinetic energy which is tied to a speed relative to an observer. Exchanges of kinetic energy explain inertial behavior. An object can be accelerated when absorbing kinetic energy from whatever source and can be decelerated when transferring kinetic energy to other objects. An inertial reaction is proportional to the exchanged kinetic energy excluding energy absorption. Relativistic view effects introduce a distortion of reality and do not contribute to inertial behavior.

The work w is the energy transferred to or from an object using a force f along a path C and according to the work-energy principle it is equal to the change in the kinetic energy E_k with:

$$w = \int_C f \cdot ds = \Delta E_k$$

Then, using Newton's second law, we have:

$$w = \int_C m_i a \cdot ds = \Delta E_k \qquad [10]$$

a is the acceleration and m_i is the inertial mass from Newton's second law. An acceleration impacts a speed relative to an observer and concerns kinetic energy. In gravitation and electromagnetism, kinetic energy depends on the rest mass m_0. The integration of the acceleration a solves equation [10]:

$$m_i \frac{1}{2}\left(v_2^2 - v_1^2\right) = m_0 \frac{1}{2}\left(v_2^2 - v_1^2\right)$$

v_1 is the speed at the beginning of the path and v_2 is the speed at the end of the path.

Thereby, the inertial mass m_i results equal to the rest mass m_0 valid for both gravitation and electromagnetism.

However, to obtain these results with electromagnetism it is necessary to use only kinetic energy and to discard absorption energy described by equation [9]. Absorption energy does not concern gravitation and its kinetic energy remains as described by equation [8].

The rest frame of the object makes certain that it is always possible to cancel the impact of relative speeds at any location on the path of the object independently on whether inertial masses exist or not.

13.On the respective impacts of relativity

In electromagnetism the speed limit of objects remains unchanged in any reference frame with a constant speed relative to the observer. Particles with an electric charge and photons cannot be accelerated by electromagnetism beyond that limit. These constraints apply to the related energy formula. They also result in a deflection of the path of photons.

Gravitation remains as described by Newton with a rest mass energy added to the energy formula. It is valid in a flat space with no speed limit and even accelerates photons. When gravitation acts on objects that transfer their path information by light, the deflected paths of the photons introduce view effects modifying the information. Such optical illusions are interpreted by General Relativity as being due to dark energy delivered by some sort of interaction.

The impact of gravitational forces on the speed of objects with a mass usually results in speeds smaller than the speed of light unless they are acted upon by major bodies of the universe which can generate speeds higher than light.

References

1) Blanchet Luc, Introduction à la Relativité Générale, Institut d'Astrophysique de Paris, UMR 7095 du CNRS, Université Pierre et Marie Curie, 75014 Paris, France
2) Hafele J. C., Keating Richard E., Around-the-World Atomic Clocks, Predicted Relativistic Time Gains and Observed Relativistic Time Gains, Science, New Series, Vol. 177, No. 4044 (Jul. 14, 1972), pp. 166-170
3) mathpages, 6.3 Bending Light, pp. 1-5, https://www.mathpages.com/rr/s6-03/6-03.htm
4) Will Clifford M., The 1919 measurement of the deflection of light, Department of Physics, University of Florida, Gainsville FL 32611, USA
5) Soares Domingos S.L., Newtonian gravitational deflection of light revised, Physics Department, ICEX, UFMG, C.P. 702, 30.123-970, Belo Horizonte, Brazil.
6) Einstein Albert, Relativity, The Special and General Theory, published 1920, Digital Reprint, Elegant Books, p. 89
7) Reference (1), p.50
8) Meyer V., Reichart W., Staub H.H., Experimentelle Untersuchung der Massen-Impulsrelation des Elektrons, Helvetia Physica Acta, Band 36 (1963), Heft VII, Persistenter Link: http://doi.org/10.5169/seals-113412
9) Guiragossián Z.G.T. et all, Relative Velocity Measurements of Electrons and Gamma Rays at 15 GeV, Physical Review Letters, 34, 335, Published 10 February 1975, DOI: https://doi.org/10.1103/PhysRevLett.34.335
10) Bertozzi William, Speed and Kinetic Energy of Relativistic Electrons, American Journal of Physics 32, 551 (1964), https://doi.org/10.1119/1.1970770
11) Einstein Albert, Zur Elektrodynamik bewegter Körper, Annalen der Physik, Volume 322, Issue 10 / p. 891-921, first published: June 30,1905, https://doi.org/10.1002/andp.19053221004, English translation: On the electrodynamics of moving bodies, p. 22
12) Planck Collaboration, Planck 2018 results. VI. Cosmological parameters, September 14, 2020, arXiv: 1807.06209v3, p. 42
13) Perlmutter Saul, Supernovae, Dark Energy, and the Accelerating Universe, Physics Today, April 2003, p.57